Liberal Studies Curriculum Resources Booklet Series

Energy Technology and the Environment

Liberal Studies Section
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Contents

*** Special thanks to the following academics for reviewing this booklet and giving valuable advice:**

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Preamble

Liberal Studies is an inter-disciplinary core subject of the senior secondary curriculum. It looks at significant contemporary issues ensuring that senior secondary students experience a broad and holistic education, developing their knowledge and broadening their horizons. With the learning experience gained in this subject, students can enhance their social awareness, develop thinking skills and foster positive values and attitudes.

The *Liberal Studies Curriculum and Assessment Guide (Secondary 4 - 6)* ("*Curriculum and Assessment Guide*") clearly states that the design of this curriculum is based on the necessary knowledge and capacity for students' learning in primary and junior secondary education. It aims to "consolidate and broaden the foundational knowledge of every student through studying a range of contemporary issues in different contexts". This curriculum comprises three interconnected Areas of Study, which in a balanced manner, "represent broad areas of concern about the human condition and the contemporary world. They serve as platforms for the exploration of related issues, so that students can develop a more coherent understanding of the world and come to appreciate the connections among concepts."

As "platforms for the exploration of related issues", the three Areas of Study provide a solid foundation for students in their enquiry learning process. The six modules, various themes and key enquiry questions further indicate the focuses and pathways for enquiry, and help students apply the knowledge, concepts and perspectives of different subjects (such as science, economics, history and culture) in specific contexts in order to extend the breadth and depth of these Areas of Study. In this regard, in addition to focusing on the development of students' enquiry skills, teachers should consider if the selected issues can as a whole cover each Area of Study, module and theme in a balanced way when planning the teaching progress and internal assessment for this subject. This will help students fully understand relevant knowledge and broaden their horizons.

The Education Bureau and the Hong Kong Examinations and Assessment Authority jointly prepared the *Liberal Studies Curriculum and Assessment Resource Package - Interpreting the Curriculum and Understanding the Assessment* ("*Resource Package*") in June 2013 to help teachers better understand the breadth and depth of the curriculum and the requirements of the public assessment. Teachers generally believe that the *Resource Package* is conducive to the planning of the curriculum and teaching progress. In order to

further illustrate the highlights of the curriculum, the Education Bureau published the *Liberal Studies Curriculum Resources Booklet Series* based on the interpretation of the curriculum made in the *Resource Package* published in 2013 and the Medium-term Curriculum Review recommendations released in 2015. This booklet series provides teachers and students with more appropriate learning and teaching resources according to the six modules of the curriculum to reduce teachers' workload. Each booklet has a similar structure, comprising four parts as follows:

- **Learning and teaching focuses:** This is mainly excerpted from relevant parts of the *Resource Package* of 2013, listing out the learning and teaching focuses of this module and suggesting relevant examples of enquiry for teachers' reference. Relevant contents will be revised in accordance with the results of the Medium-term Curriculum Review.

- **Basic concepts and relevant information:** This part provides students with the basic knowledge for learning this module, including basic concepts students should master and some useful relevant information. It also includes diversified and balanced views for reference in the issue-enquiry process. Teachers may distribute relevant information to students if deemed necessary.

- **Learning and teaching exemplars:** This part selects specific issues for enquiry in respect of the learning and teaching focuses of this module, and designs the learning and teaching flow and class activities. The leading modules and related modules are presented in some exemplars, showing the focus of the enquiry and the connection with other modules respectively. These exemplars show that the enquiry process requires attention to the development of both knowledge and skills. Students are expected to adopt multiple perspectives in thinking and foster positive values and attitudes. Each exemplar not only corresponds to the learning and teaching focuses of the module, but also suggests different learning and teaching strategies required in light of teaching and learning contexts, so as to develop students' critical thinking and modest learning attitude which refrains from making any rash criticism. Teachers may also adjust the learning contents and learning and teaching strategies with reference to the suggestions on learning and teaching in this booklet in order to cater for student diversity.

- **Further reading and references:** This part provides teachers with references for lesson preparation in order to complement the teaching contents. Teachers are advised to pay attention to the publications listed in Part A and encourage students to

select some of them for extracurricular reading depending on their interests and abilities, with a view to improving their understanding of the module and developing their independent learning capabilities.

We hope that this booklet series is helpful for teachers in refining their teaching of Liberal Studies. A series of support measures will be introduced in the future, such as conducting seminars and workshops, sharing of frontline teaching experience and updating the learning and teaching exemplars and relevant learning and teaching resources on the Web-based Resource Platform for Liberal Studies (http://ls.edb.hkedcity.net). When using the booklet series and other references, teachers may refer to the latest version of the *Curriculum and Assessment Guide* and make school-based adaptations. In addition, in order to keep abreast of the development of teaching issues, with reference to the sources indicated, teachers may update the relevant information and statistical data as appropriate.

During the course of the preparation for the booklet series, we have consulted with the Curriculum Development Council Committee on Liberal Studies and frontline teachers and invited a number of experts and scholars to review the contents. We hereby express our gratitude to them.

 Comments and enquiries on the booklet series may be sent to:

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Part I : Learning and Teaching Focuses

"Energy Technology and the Environment" mainly explores the impacts of the development of energy technology in our daily lives, the relationship between energy use and economic development, the environmental problems arising from the use of energy, the relationship between energy policy and the quality of life, and the influence of the distribution of renewable energy on international relations. In addition, this module also elaborates on the concept of sustainable development, its promotion and the responsibilities that various stakeholders should bear for the future of sustainable development. To sum up, teachers are advised to summarise the learning and teaching focuses in this module into the following four aspects:

1. **Development and Application of Energy Technology**
2. **Relationship between Energy Policy and the Environment**
3. **Concept and Practice of Sustainable Development**
4. **International Collaboration and Conflicts Concerning Energy and Environmental Problems**

When enquiring into the issues in this module, **students must possess the relevant basic knowledge on energy**. For example, students should gain a basic understanding of the forms of energy, energy conversion and energy efficiency, which may help them explore the issues relating to energy technology. Students also need to understand climate change, basic environmental protection, as well as the interdependence of living things and their environment. However, **students need not investigate too deeply into the underlying scientific theories**. They should have acquired a basic understanding of the abovementioned knowledge in basic education.

This module **does not require students to acquire an in-depth understanding or any kind of expertise in various energy technologies; nor is it necessary to understand the operational details of these various energy technologies**. Teachers are advised to focus on the **controversies arising from the positive and negative impacts of such energy technologies on society, particularly the different views of the various stakeholders on these issues**. In this way, teachers can guide students to conduct their analysis and make judgments based on concrete evidence, such as statistical graphs, run charts and energy consumption.

1. Development and Application of Energy Technology

When carrying out curriculum planning for this part, teachers may make use of one or two cases to help students understand **the role of energy use in improving human life and promoting economic development, and the potential environmental costs**. Then, teachers may **conduct in-depth discussions with students about such issues as the development and use of renewable and non-renewable energy sources and the latest developments of energy technologies**.

- **Examples of energy use in human history**: Teachers may consider selecting several examples of energy use in human history for student discussion. These discussions should **serve as an introduction**, and students need not acquire an in-depth understanding of the cases. Teachers may guide students to study the details of these cases in the future when dealing with the key points of learning and teaching. The following is a suggested example for discussion and teachers should focus on **acquainting students with the pros and cons of energy use**:

  - Reform and opening-up of China: Teachers do not need to go into the details of the reform and opening-up process at this stage; nor is it necessary to elaborate too much on issues beyond the scope of energy use. Teachers are advised to place their focus of enquiry on the **relationship between energy use and economic development,** and guide students to consider **how to deal with the conflicts between economic growth and environmental protection**.

- **Development and use of non-renewable energy**: Teachers are advised to **introduce various types of energy,** and then guide students with specific cases to **explore the use of non-renewable energy and the environmental problems that may arise**.

  - Use of **fossil energy** and ensuing environmental problems: Teachers are advised to firstly introduce to students various types of fossil energy and their exploration. Teachers may then focus on several specific cases (such as China-related examples in relation to the curriculum contents in Module 3) to help students understand that many countries are trying to reduce their dependence on fossil energy because **the use of fossil energy has caused environmental pollution, which affects human health and impairs the quality of life**.

- Use of **nuclear energy** and the controversies produced: Teachers are advised to use Japan's Fukushima Daiichi nuclear accident, which took place in March 2011, as an example to **acquaint students with the pros and cons of nuclear power generation. It is not necessary, however, for students to investigate too deeply into the underlying scientific theories**. The recommended enquiry focuses are as follows:

  - Teachers may require students to discuss **whether or not the development of nuclear power should continue**. The controversies may focus on issues such as **the requirements for its development, the safety of its operation and its impacts on the environment**.

  - If teachers judge that one more case is needed to enhance students' understanding of nuclear power, they may consider taking France as another example. As the most nuclear power-reliant country in the world, France is one of the few European nations which continues to support the use of nuclear power after the Fukushima Daiichi nuclear accident. Teachers should guide students to study and comment on the reasons for France's continual use of nuclear power, and to compare it with the case of Germany (which has decided to shut down its nuclear power plants in the future) and China (which will continue with its nuclear power development). In this way, students may **make more informed analysis and judgment on whether or not nuclear power should be further developed**.

- **Development and use of renewable energy**: Teachers are advised to provide students with cases relating to renewable energy development in some countries or regions. Students should be encouraged to study these cases, and then **summarise the most common controversies over the use of renewable energy**. For example, the funding, technologies and other prerequisites needed to develop renewable energy, and the impacts of the use of renewable energy on the environment, economy, and society.

  - Development of **renewable energy originating from natural resources**: Teachers may select **cases where some countries have developed renewable energy according to their natural environment,** and encourage students to study these cases. For example, teachers may take Denmark and Iceland as

examples. Denmark lacks such resources as coal and petroleum, so it has hastened the development of wind energy by taking advantage of its geographic location. Iceland accelerated the development of geothermal power by using its rich geothermal resources, and all electricity consumed in the country is generated from hydropower and geothermal power. China set up a hydroelectric power plant by making use of the geographical features of the Three Gorges located in China's southwestern region. Teachers may also encourage students to discuss whether or not Hong Kong or the Mainland should draw on the experiences of these countries and regions in developing renewable energy.

- Controversies over **biofuel** development: Soaring global oil prices over the past few years have driven many countries to develop energy sources apart from fossil fuels or seek out alternative energy sources. Biofuel is a very popular option (it can be produced from biomass materials such as corn, sugar cane, weeds, and food waste). Teachers are advised to choose countries that actively develop biofuels (such as the US and Brazil) as examples for enquiry. The enquiry should emphasise the **controversies over biofuel development**. For example, the impact on the global food supply, whether the production of biofuel has pushed up food prices, whether biofuels are environmentally-friendly, and whether biofuel development will be sustainable. In addition, teachers may further encourage students to discuss whether Hong Kong or the Mainland has the conditions to develop biofuels.

- Brief summary: Teachers should emphasise that even though renewable energy development is undoubtedly the general trend, **all countries and regions should, according to their natural environment and the available technologies and funds, develop the kind of renewable energy most suitable to their situation**. Teachers should also remind students that the development, production and transportation of renewable energy may cause damage to the environment. Therefore, **full consideration should be given to the development costs, the cost- effectiveness and the interests of different stakeholders before deciding whether to develop or continue to develop any renewable energy**.

2. Relationship Between Energy Policy and the Environment

Energy is important in our daily lives, and the uses of various types of fossil energy impact the environment to various degrees. All governments formulate energy policies that suit their national resources on the basis of using energy in an efficient way while endeavouring to protect the environment. Teachers are advised to **encourage students to discuss the impacts of energy use on the environment. Then students may explore what factors should be taken into consideration when formulating energy policies in the light of specific cases in Hong Kong and the Mainland**.

- **Impact of energy use on the environment**: There are many examples to illustrate how energy use affects the environment directly or indirectly. Teachers are advised to take acid rain and light pollution as examples for enquiry. Other issues in relation to air pollution and global warming may be used in other learning and teaching focuses.

  - Acid rain: Teachers may help students understand how acid rain is formed. It should be highlighted that acid rain is directly **related to human's use of energy and industrial development**. As for its impact, not only does acid rain pollute the environment, it also damages cultural relics. Teachers may encourage students to further enquire **from the perspective of heritage conservation**.

  - Use of air-conditioning: The power consumption of air-conditioning accounts for a very large proportion of the electricity consumption in Hong Kong. Excessive use of air conditioning has been found by environmental groups in many commercial buildings, shopping centres and on transportation, which leads to the depletion of energy. In the context of Hong Kong, teachers may encourage students to study the impact of the excessive use of air-conditioning and the roles played by various stakeholders in reducing the excessive use of air-conditioning.

  - Light pollution: Hong Kong is commonly known as the "Pearl of the Orient"; its brilliant night scene formed by lights attracts many visitors. However, not only does excessive illumination consume significant amounts of energy, it also causes light pollution. Teachers may encourage students to explore **the impact of light pollution and the roles of various stakeholders in reducing the impact of light pollution**.

- **Discussions on energy policies**: Teachers may introduce the following three factors that respective governments usually consider when formulating energy policies: **"energy safety, energy price and supply stability, and impact on the environment"**[1]. Teachers may use specific examples to help students **understand how governments consider these factors when formulating energy policies** (an example from Hong Kong is advised), and **how the energy policies match the overall development of a country** (an example from China is advised). In addition, if teachers take Hong Kong's energy policy as an example for enquiry, students should be encouraged to analyse these factors **in combination with the concept of quality of life in Module 2, especially from the perspective of the environment**.

  - Hong Kong's energy policies: When exploring the energy policies in Hong Kong, teachers may apply specific examples to illustrate the three considerations above when the government formulates energy policies:
    - Safety: Teachers could take the contingency plans of the Daya Bay Nuclear Power Plant as an example to discuss **to what extent these contingency plans can ensure public safety**.
    - Energy price and supply stability: In 2008, the Hong Kong SAR Government signed the new S*cheme of Control Agreement* with two power companies. Teachers could use this case as an example to **discuss** with students **whether the energy policies of the Hong Kong Government could balance the demands of respective stakeholders, and what improvements should be made**.
    - Environmental quality: Teachers may make use of Hong Kong's air quality data on the website of the Environmental Protection Department and the measures (e.g. Switching Off Idling Engines, Action Blue Sky and encouraging citizens to use energy-saving light bulbs or LED lights instead of tungsten light bulbs) proposed by the Hong Kong SAR Government to **analyse the air quality in Hong Kong and evaluate the effects of these measures**.

  - China's energy policies: Teachers are advised to analyse the issues **in terms of optimisation of the current energy structure, development of alternative energy (in particular the development of renewable energy and nuclear power), stabilisation of energy prices, energy saving and emission reduction**. Teachers may also consider encouraging students to read the sections on energy production and policies in **national development planning** (they may refer to the *13th Five-Year Plan* to be published in 2016) for **further**

[1] Refer to *Issues of Science, Technology and the Environment in Perspective* (Chapter IV), p.70.

discussion of the considerations of the Chinese Government when developing energy policies and how to respond to the demands of respective stakeholders.

- Brief summary: With regard to the issue of energy policy, apart from taking Hong Kong and the Mainland as examples for discussion, teachers may also discuss the energy policies of the United States and Japan, depending on students' abilities and time available so as to broaden their horizons. However, no matter which country or region teachers take as an example when discussing energy policy, teachers should **encourage students to use the three abovementioned considerations** (energy safety, energy price and supply stability, and environmental impact) **as the basis for analysis**, and in combination with economic efficiency, social stability and environmental protection, so as to explore whether these energy policies can improve the quality of life.

3. Concept and Practice of Sustainable Development

Students need to learn the definition, limitation and contradiction of sustainable development and should understand that it is an evolving concept. After students have mastered the concept, teachers may select examples from individuals, Hong Kong, the Mainland and other countries and encourage students to **analyse the feasibility and effect of these examples including individual behaviours and governments' sustainable development plans or projects**.

- **The concept of sustainable development**: Teachers may use specific examples to point out that **the Earth is facing serious challenges**. Then, teachers should raise the concept of sustainable development and its importance. The following is a suggested example for enquiry:

> ➢ The United Nations (UN) Population Fund stated that the world population exceeded 7 billion at the end of 2011. This means that humans will face greater pressures on land, energy, food and infrastructure. Therefore, there is a need to carefully consider the direction of future development. Teachers need not explain the population increase in detail, but they should use this example to prove that when it comes to the issue of development, **humans should not only focus on economic growth and immediate interests. Instead, we should also consider future generations while trying to improve the life of mankind. By doing so, our future generations may be spared from even more serious challenges**.

➢ The concept of sustainability has undergone a process of evolution. To consolidate students' knowledge, teachers are advised to introduce some important documents and the key messages to students, such as:

> - In 1987, the UN World Commission on Environment and Development published a report titled ***Our Common Future***. It proposed the application of the concept of sustainable development to address environmental problems. In brief, sustainable development refers to "**development that meets the needs of the present without compromising the ability of future generations to meet their own needs**"[2].
> - In June 1992, the UN World Summit convened in Rio de Janeiro,

[2] The World Commission on Environment and Development (1987), *Our Common Future：The World Commission on Environment and Development.* Oxford: Oxford University Press.

Brazil. ***Agenda 21*** was released at the summit. It put forward an action plan [3] for projects of the international community aimed at **strengthening international aid efforts, eliminating poverty, and improving the environment and human health**.

- **Countries may have diverse interpretations of and allocate different priorities to sustainable development** as they are at varying stages of development. For example, with regard to economic development and environmental protection, more developed countries may attach greater importance to environmental protection, while less developed countries may prioritise economic development. This is why the international community **has failed to reach a consensus** on issues regarding sustainable development, such as climate change and the protection of the natural ecology. For details and examples for enquiry, teachers may refer to Point 4 of the Learning and Teaching Focuses.

- **Implementation and limitation of sustainable development**: Teachers are advised to use specific examples including daily behaviours of individuals and practical experiences in the local and national contexts as well as the contexts of other countries for student enquiry (enquiries may also be initiated from the global level and gradually scale down to the personal level). When exploring these examples, teachers should instruct students to pay attention to the practical experiences and **learn from these examples how science and technology promote or limit sustainable development, and how factors such as the needs of economic development, personal lifestyle and cultural customs affect the environment and energy use**. In addition, teachers are advised to encourage students to discuss these examples (especially the examples of other countries), and sum up experiences that Hong Kong or the Mainland can learn from.
  - Personal life: Teachers may select examples from daily life (such as shortening the length of a shower to save water, avoiding buying clothes only to follow fashion trends, and reusing red packets, *lai see*, from previous years) to show that **a minor change in daily life may contribute to sustainable development**. Moreover, teachers should **explain the concept of consumerism, and then encourage students to explore whether the consumption behaviours and financial management concepts of the younger generation are inconsistent with the principles of sustainable development**. The relevant issues in Module 1 should also be discussed. No

[3] The full version of Agenda 21 may be downloaded from the website of the Division for Sustainable Development of UNDESA (http://www.un.org/chinese/events/wssd/agenda21.htm).

matter what examples are used for enquiry, teachers should ask students to point out **the relationship between these examples and sustainable development**, and should conclude that **people's personal lifestyle and mindset comprise two factors that may have an impact on the environment and sustainable development**.

- Hong Kong: Teachers are advised to consider **to what extent Hong Kong people's behaviours are conducive to sustainable development** from a macro perspective. Teachers may use specific cases to help students gain an understanding of the **actions promoting sustainable development and their limitations**. The following are suggested examples for enquiry:

  - Hong Kong's ecological and carbon footprints: Teachers may guide students by taking advantage of the report on Hong Kong's ecological and carbon footprints to **discuss to what extent the behaviours of Hong Kong people are in line with the requirements of environmental protection and sustainable development**.

  - Promotion of the use of electric vehicles: Teachers may use this case to **discuss how science and technology help promote sustainable development**. Teachers may also emphasise that even though environmentally friendly products are scientifically and technologically feasible, **they cannot be effectively promoted without joint efforts from all sectors of society**.

  - Public Consultation on Municipal Solid Waste Charging: The Government published a consultation document in early 2012 suggesting the introduction of "Municipal Solid Waste Charging" as an economic means to reduce the generation of solid waste. Teachers may consider encouraging students to study **to what extent the policy would be effective in reducing solid waste, and its impact on citizens if it were to be implemented**.

- China: Teachers are advised to **choose issues in other modules** in order to strengthen students' capacity to handle cross-modular issues. The following are suggested examples for enquiry:

- Teachers may discuss with students recent cases which show that the Mainland has developed its economy at the cost of the environment so as to **study how the economy can be developed without causing too much damage to environmental ecology or sacrificing people's health**. Teachers may associate the discussion with relevant curriculum content in Module 5 at the same time.
- Teachers are advised to cite the following case for enquiry. In recent years, it has been extensively debated among the public of the Mainland whether firecrackers should be banned during the Spring Festival so as to avoid air and noise pollution. Traditional ancestral worship activities during the Qing Ming Festival have also been criticised. Teachers should then encourage students to **analyse the relationship between traditional activities and the environment as well as sustainable development, and then further discuss what is indispensable if we want to achieve desirable results in the promotion of sustainable development without radically altering traditional customs**.

➢ Other countries or regions: Teachers may cite other countries' experience in sustainable development for student enquiry. The following are suggested examples for enquiry:

- Development of mass transit systems: To improve the air quality and alleviate traffic congestion in city centres, travel by bicycle is promoted in European and Chinese cities (e.g. Holland, Denmark, Hangzhou). Teachers are advised to take one or two cities as examples and encourage students to **discuss the relationship between the promotion of bicycle commuting and sustainable development** (with emphasis on energy conservation, pollution reduction and improvement of the quality of life), **and whether Hong Kong may follow these practices**. Students may analyse these issues **in combination with issues related to the Module of Globalization.**

- Urban Greening：Hong Kong lacks land for development. In order to promote greening and improve the quality of our living environment, the Civil and Engineering Development Department formulated the Greening Master Plan (GMP) in 2004 and have been implementing the plan since that time Teachers may encourage students to **observe and reflect upon the greening opportunities and measures in their community**. In combination with the Modules of Public Health and

Hong Kong Today, students may **think about how they can lead a green and low carbon life on a personal and group level in order to achieve sustainable development**.

4. International Collaboration and Conflicts Concerning Energy and Environmental Problems

The learning and teaching focuses of this part can be considered as **the conclusion of this module**. This part aims to view the issues of energy and environment from a global perspective and explore **why these issues spark conflicts in the international community, and how such conflicts can be resolved through international cooperation**. Furthermore, these issues are closely related to the contents in the other modules, especially Module 4. Therefore, teachers may consider linking all the interrelated issues in curriculum planning.

- **Cooperation and conflicts concerning energy problems in the international community**: Teachers are advised to proceed with the conservation and distribution of non-renewable energy, and then discuss the issue with students from the perspectives of cooperation and conflicts.

  - Distribution of reserves of non-renewable energy: Teachers may start by introducing the world's non-renewable energy sources, especially the **distribution of oil reserves**, and then ask students to analyse the characteristics of these reserves and distribution of resources to **understand why energy conflicts may pose a major threat to world peace** in the future.

  - International energy organisations: Teachers are advised to consider taking the Organisation of the Petroleum Exporting Countries (OPEC) as an example to elaborate on the **objectives, functions and influences** of international organisations. Teachers may also link these organisations to the section of political globalization in the Module of Globalization. This may help students review previous lessons. **Students need not have a comprehensive understanding of these organisations, but they must have a basic knowledge of the impacts of these organizations' activities on the international community regarding the production and output of energy on the international situation**.

  - Conflicts over energy in the international community: Teachers may take the dispute between China and neighbouring countries over oil and gas in the East China Sea or the South China Sea as examples and link them to the issue of China's participation in international affairs in Module 3. Teachers are advised not to focus too much on the historical disputes between China and neighbouring countries (e.g. Japan). Instead, they may **focus on China's**

energy development and that of neighbouring countries and the relevant territorial disputes between them. Teachers may, as appropriate, select another case of international energy conflicts for students' study (for example, the scramble for resources in the Arctic region). No matter which case is chosen, teachers should **focus on exploring why all parties are scrambling for energy. They should deduce from these examples the principles and ways for resolving these disputes** so that students are able to analyse other similar cases.

- Energy diplomacy and transnational cooperation in energy development: Teachers should, by using China's reserves and use of energy as an example, help students understand China's promotion of energy diplomacy, and **investigate to what extent energy diplomacy may help ease China's energy shortage**. As for the exploration of international cooperation in energy development, **the focus should be placed on why development of such energy is worthwhile, and why transnational cooperation is needed for such development**. Teachers may consider taking the development of shale gas that has been popular in many countries in recent years as an example, and discuss the prospect of China's development of shale gas and China's cooperation with other countries in such development.

- **Collaboration and conflicts concerning environmental problems in the international community**:

  - Teachers may first introduce international concerns about climate change before elaborating on international collaboration and conflicts concerning environmental and climate problems. The following examples may be used for enquiry:

    - Teachers may analyse relevant international climate agreements (such as the *Kyoto Protocol*) and **evaluate whether they can be implemented**. In particular, students should be able to understand the stances of the countries that have signed or refused to sign the agreements and their reasons for it. **It is unnecessary for students to have an in-depth discussion about the scientific theories of climate change**. They just need to know why many scholars believe that carbon dioxide emissions give rise to greenhouse warming. On the other hand, teachers are advised to remind students that although the majority of academics tend to believe in the trend of global warming, there is also an objection to this

orientation, especially over the controversy regarding **the pace of global warming**.

- Teachers may cite one to two international conferences on climate change held in recent years for discussion. Teachers are advised to **focus on how climate change has prompted governments to convene meetings for dialogue**. The stances of some major carbon dioxide emitters (such as the US, EU member countries, Australia, China and India) at the conference may also be discussed. In this way, students can **understand the reasons why countries hold different stances when negotiating the resolution of climate change, and understand that the positions of these countries are closely related to their respective national circumstances and economic development**. Teachers may also, by **introducing the concept of global governance**, remind students that the success of global governance lies in whether different countries can resolve their disputes by seeking common ground while reserving differences.

➢ Solution to environmental disasters and ecological imbalance: Teachers are advised to choose examples of environmental disasters that have occurred in recent years and examples of any ecological imbalance caused by human behaviours for student enquiry. The following examples are suggested for enquiry:

- The enquiry of the following examples focuses on the ways the international community can **work together to solve environmental disasters**:
  - The oil leakage caused by the explosion of the British Petroleum drilling platform in the Gulf of Mexico in 2010.
  - The debris left by the tsunami triggered by a magnitude 9 earthquake in Japan in 2011 that drifted to the coast of the United States and Canada.

- The whaling issue has aroused international controversies. Many international environmental organisations have condemned Japan as hypocritical and selfish for claiming that it engages in whaling for scientific research purposes. Teachers may focus on **the reasons giving rise to the controversies and comment on the stakeholders' points of view**. Teachers may also consider using the activity to appeal for a

boycott on eating shark fin soup as a way to reduce the killing of sharks as an example. The focus of enquiry should be placed on **how the ecology can be protected by changing human behaviours and values**.

Part II: Basic Concepts and Relevant Information

Liberal Studies covers a large number of concepts. While helping students in issue-enquiry, teachers may elaborate on examples or events with relevant concepts. In this way, the nature of the issue, the phenomenon reflected and the points of conflict can be analysed so that students can gain more in-depth understanding of the curriculum. Furthermore, if students are able to master the meanings of concepts, they may apply these concepts in the discussion of other similar issues in order to construct knowledge. The process of issue-enquiry also involves the understanding of information for analysis, and providing personal views, judgments and comments that show critical thinking.

In order to assist teachers in the lesson preparation and students in their learning, this part sets out the basic concepts (Section A below) and relevant information (Section B below) that can be adopted in this module.

The basic concepts set out in Section A may be applied in understanding and dealing with the learning and teaching focuses of this module. Teachers are advised to adopt different learning and teaching strategies in class and explain to students the meanings of the concepts in conjunction with the issues, or to analyse and explain them through conceptualisation. Teachers may distribute the explanation of these concepts to students before or after class, and provide appropriate guidance to help them understand how to apply these concepts as well as understand their meanings, so that students would not regard these as materials for memorisation.

The relevant information in Section B is designed to provide students with the basic knowledge to understand this module. These include, for example, the historical background, the different opinions of stakeholders, a brief introduction of governmental and non-governmental organisations, and data showing the development trends or recent developments. The purpose is to supplement students' basic knowledge for issue-enquiry. Teachers may distribute such information to students as references if deemed necessary.

Teachers should be reminded that all the concepts and information provided in this part are for reference only. When preparing the learning and teaching materials and designing the learning activities, teachers should make adaptations based on the school context and the issue to be dealt with in class.

A. Basic Concepts

Energy Technology

Since ancient times, people have learnt how to use different energy sources such as coal and firewood. As people can easily convert these energy sources into other forms, such as burning coal to produce heat and light, these energy sources have become widely used.

Energy cannot be created or destroyed, but different forms of energy can be interconverted. For instance, dams can turn potential energy stored in river water at heights into kinetic energy that can drive a generator to produce electricity. Another example is the chemical energy in batteries, which can be converted into electrical energy. With the development of energy technology, electricity can be transmitted swiftly from power plants to users through power line network systems. A large amount of electrical energy is generated and is widely used in the world.

Through technological innovation, energy technology is designed to utilise, transmit, store and convert energy more efficiently, and ease environmental problems arising from energy use. The development of many traditional energy technologies (e.g. coal-fired power plants) has emphasised only their cost-effectiveness without considering the environmental cost. Nowadays, some countries are actively developing renewable energies, including solar, wind and tidal energies, with the aim of reducing environmental damage while maintaining modern standards of living.

Developing new energy sources or alternative energy sources may reduce our reliance on fossil fuels. For example:

- Nuclear energy is the energy released when the structure of the nucleus changes. At present, nuclear power plants all over the world generate power through nuclear fission. Low-enriched uranium is the basic ingredient to fabricate nuclear fuel. It is made by enriching naturally occurring uranium to improve its ability to produce energy. During their operations, nuclear power plants emit only a small amount of carbon dioxide. Since 1994, imported nuclear power has contributed to about one-fourth of Hong Kong's energy consumption, which is equivalent to a reduction of over 100 million tons of carbon dioxide. However, the use of nuclear power raises concerns about radiation safety and the handling of radioactive waste.

- Shale gas is a natural gas buried in shale rock formations. In the United States, shale gas production surged from comprising 1% to 40% of the nation's natural gas output between 2001 and 2013. The exploitation and utilisation of shale gas has significantly increased the global energy supply, but there are concerns that shale gas production may lead to water pollution, which poses a threat to the environment and human health.
- Developing hydrogen fuel cell vehicles can reduce carbon emissions and fossil fuel consumption. The energy efficiency of this type of vehicle is several times higher than that of ordinary cars, with much lower carbon dioxide emissions. Hydrogen fuel cells provide power to the vehicles. However, this technology is expensive, and existing gas stations cannot be easily transformed into hydrogen fuel stations. New facilities must be built for such vehicles to be widely used.

In addition, renewable energies are also environmentally friendly energy technologies (refer to the concept "renewable energy" for more details). One of the methods to achieve zero carbon emission is the use of fuel cells in which hydrogen and oxygen are split by electricity generated by wind, solar power etc. However, due to the high cost of this technology, at present it is not practical to do so.

Non-renewable Energy

Non-renewable energy resources refer to those energy sources that cannot be replenished in a short time by natural processes. These include fossil fuels such as coal, petroleum and natural gas. As these fuels are the products of natural processes over millions of years, and their reserves are limited, they are described as “non-renewables”. Nuclear power is also generally regarded as non-renewable because the element (mostly uranium) used in nuclear reactions is in limited supply and cannot be replenished. In 2012, fossil fuels accounted for more than 87% of the total global energy supply, reflecting the world’s heavy reliance on these fuels.

Fossil fuels originate from the remains of ancient animals and plants that have been buried deep underground and transformed into organic materials by underground heat and pressure over a long period of time. Some examples of fossil fuels are listed below:

Coal is mainly from ancient plant remains, which were composed of carbon, hydrogen, sulphur, nitrogen and other elements. At present, most of the world's power plants and steel mills rely on coal for fuel.

Petroleum (or crude oil) is a complex mixture of organic liquids, containing many different ingredients. Oil is a cleaner fuel than coal. Through fractional distillation, crude oil is separated into different components that can be turned into a variety of petroleum products for industrial and domestic use. Petroleum products have a wide variety of applications, ranging from power plants and motor vehicle fuels to cosmetics and medicinal products. Vehicles, such as cars, ships and jets, are propelled by internal combustion engines, which utilise petroleum fuels.

Natural gas is a colourless and odourless mixed gaseous mixture, which is mainly composed of methane. Natural gas is cleaner and relatively cheaper than some other fossil fuels. Burning natural gas produces almost no sulphur dioxide or solid particles, and emits 45% less carbon dioxide than some other fossil fuels. Natural gas is increasingly popular for power generation and is being developed as a transportation fuel.

Fossil fuels are relatively cheap, and convenient for storage and transport, but many problems remain: serious accidents have occurred in coal mines; open pit coal mining and offshore oil drilling may destroy natural habitats and landscape; oil drilling and transportation may cause oil spill accidents; burning fossil fuels leads to air pollution, acid rain and climate change.

Renewable Energy

Renewable energy refers to energy sources that are produced from everlasting natural processes (such as from sunlight and wind), and therefore can be replenished continuously. Throughout history, mankind has used renewable energies, for example burning logs and using windmills to replace manpower. Today, people are using more renewable energies instead of high-polluting fossil fuels (a non-renewable energy source) to generate electricity or propel vehicles. In 2013, renewable energy accounted for approximately 22% of the world's total electricity generation.

The sun is a direct and indirect source for most renewable energies. Due to the uneven distribution of solar radiation on the earth's surface, where the south and north poles receive less energy than the equator, a complex system of global air convection operates across the earth. Wind power generated by the resulting flow of air is an example of using solar energy indirectly. Some renewable energy sources are not from the sun, for example, tidal energy is generated by the moon's gravitational pull.

The characteristics and working principles of some renewable energy sources are summarised as follows:

- Solar power: using photovoltaic cells to generate electricity or collecting solar heat energy from the sun and converting it into electricity.
- Wind energy: using wind turbines to convert kinetic energy into electricity.
- Biofuels: using fuels derived from living things, such as ethanol (alcohol) produced from sugar cane.
- Hydroelectric power: using water falling from height to drive generators in a dam, and converting potential energy into electricity.
- Sea wave and tidal energy: using sea waves or tides to drive generators to produce electricity.
- Geothermal energy: using thermal energy inside the earth's crust to produce electricity or heat.

Renewable energy is used because of the following reasons:

- Fossil fuel depletion: Modern society relies heavily on fossil fuels. However, running out of fossil fuels may cause a global energy crisis. Renewable energy can be replenished by nature and is therefore inexhaustible. Human demand for renewable energies will catalyse the innovation and development of renewable energy technologies.

- Reducing dependence on fossil fuels: Currently, many countries rely on fossil fuels, especially on petroleum, which are in limited reserves and only available in certain locations. In addition, many countries are dependent on imported fuels, with supplies and prices affected by social and political factors. Renewable energies help eliminate dependence on fossil fuels and create a stable energy supply, which in turn facilitates a country's development.
- Environmental protection: At present, fossil fuels are still widely used, although they are generally believed to be the culprit of global warming and air pollution. However, their prices fail to reflect their environmental cost. Since most renewable energy sources produce little or almost no pollutants or greenhouse gas emissions, promoting their use is currently regarded as a way to alleviate climate change.

Resource Depletion

The consumption of natural resources and human life

Human civilisation needs to be sustained by natural resources, including energy, wildlife, forests, arable land, soil, minerals and water. The use of natural resources (including fossil fuels) helps improve mankind's quality of life through providing clean fresh water, electric power, convenient transport, leisure and sports activities.

The quality and quantity of some renewable natural resources (e.g. oxygen, fossil fuel, water, wood, cotton, meat and seafood) is deteriorating with consumption faster than natural recovery. For example, currently only 4% of the ocean remains untouched by human activities. According to the data from the Food and Agriculture Organization of the United Nations, currently 85% of the world's seafood has been overfished or is at risk of overfishing. Also, many countries are seriously wasting water resources. By 2025, it is estimated that two-thirds of the world's population and 400 Chinese cities will face water shortage problems.

Since the early 1980s, as a result of excessive resource consumption, overdevelopment, and an imbalance between population and productivity, different countries have become increasingly dependent on each other for their food supply and agricultural produce. Overconsumption by mankind not only poses a threat to the supply of natural resources, but is also the cause of global environmental issues, such as climate change. For example, an increasing demand for wood has led to excessive deforestation, adversely affecting terrain and ecosystems, and causing soil erosion and species extinction. This is one of the culprits of climate change.

Social, economic and environmental perspectives

Fast-growing populations and resource consumption have created a wide variety of global social, economic, environmental and political issues. Less developed countries, especially those poorer communities, are most vulnerable to the issues caused by the unsustainable consumption of water, fossil fuels and other natural resources.

Social perspective: The unequal distribution of resources is a reality today. In 2010, the richest 20% of the world's population possessed 80% of global resources. In many industrialised countries, poverty is still a problem receiving much attention. In 2010, approximately 1.2 billion people lived where water was in short supply, and 2.6 billion people lacked basic sanitation facilities.

Economic perspective: The global economy is growing rapidly. In 2000, the global per capita GDP was 2.6 times that of 1950. However, approximately a quarter of the world's population was still in extreme poverty. Poverty and rapid population growth have led to the deterioration of the quality of natural resources, such as soil and water (especially in less developed countries), lowering the quality of life of the rural populations and hindering their economic development.

Environmental perspective: The depletion of natural resources is closely related to environmental pollution. Rising consumption has created significant environmental pressures over the past 60 years. This is summarised below:

- The use of fossil fuels has increased nearly fivefold;
- Freshwater consumption has nearly doubled, and the global freshwater reserve has shrunk;
- Overgrazing and inappropriate agricultural practices have degraded the quality of soil;
- The rate of wildlife extinction cannot be accounted for by natural selection process.

To alleviate natural resource depletion, we can increase the efficiency of production, develop new technologies, improve energy efficiency, utilise renewable energies, reuse and recycle resources, improve the present mode of development and adapt a different lifestyle.

Climate Change

Climate change, as stated in the *United Nations Framework Convention on Climate Change*, refers to the changes in climate directly or indirectly caused by human activities. Human activities discharge greenhouse gases, which accumulate in the atmosphere and causes climate change. Greenhouse gases trap heat on the earth's surface. Greenhouse gases mainly include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), chlorofluorocarbons (CFCs), and ozone (O_3). Actually, greenhouse gases that are naturally present in the atmosphere can help maintain the temperature of the earth, but the accumulation of greenhouse gases may lead to global warming, causing climate change.

Over the last century, the global temperature has continued to rise. Some scientists estimate that the global temperature will increase between 3.7°C and 4.8°C by 2100. Global warming may melt glaciers and ice blocks, elevate global sea level, bleach coral reefs, and increase the frequency and intensity of typhoons. As mankind has produced increasing amounts of carbon dioxide and other greenhouse gases that may remain in the atmosphere for decades or even hundreds of years, we can expect to face a warmer climate. Research shows that, in Hong Kong, the recurring cycle of extreme weather events has changed significantly over the past century. Extremely high temperatures and heavy rains are increasingly frequent while extremely low temperatures are becoming increasingly rare.

Natural factors can account for changes in climate before the Industrial Revolution, which began in the 18th century. These factors include solar radiation fluctuations and volcanic eruptions that affect greenhouse gas concentrations. Since the mid-20th century, most scientists have come to the consensus that global warming is mainly caused by greenhouse gases produced by human activities. Human activities (particularly the burning of fossil fuels and lumbering) have created the highest ever level of greenhouse gas concentrations in the atmosphere.

Climate change could bring about the following adverse effects:

- Climate change lowers agricultural production in some areas, especially in seasonally dry and tropical regions.
- Rising temperatures cause sea levels to rise and glaciers to melt. By the end of the 21st century, the sea level is expected to rise between 28 and 58 cm (compared with the sea levels between 1989 and 1999). Coastal areas would be more prone to flooding.
- Climate change may increase the degree of damage caused by natural disasters, such as more severe droughts and heat waves. Tropical cyclones will become more frequent, with stronger winds and heavier rainfall.
- Climate change could further threaten biodiversity. Some species cannot survive high

temperatures and an estimated 20% to 30% of all species could become extinct.

- Climate change would alter the distribution of mosquitoes and other carriers of infectious diseases, thus increasing public health risks.
- Regarding energy use, rising temperature may increase domestic, commercial and industrial power consumption.
- Although climate change affects everyone, those countries that bear the largest responsibility for global warming (particularly rich countries) are not liable to serious loss in the short term. Conversely, those poorest countries that have produced the least amount of greenhouse gases will be affected most. This disparity has raised concerns about environmental justice.

Air Pollution

Air pollution means the presence of one or more pollutants in the air. If the concentration of pollutant(s) exceeds the stated safety level(s), this may harm human health or the environment in which plants and animals live.

Since the 19th century, industries and transportation have emitted large amounts of air pollutants that cause air pollution, especially in densely populated cities. In Hong Kong, air pollution is mainly caused by emissions from vehicles, ships and power plants, while industrial activities in the Pearl River Delta give rise to issues caused by regional smog.

Air pollutants, such as respirable suspended particulates (RSP), sulphur dioxide (SO_2), nitrogen oxides (NO_x), volatile organic compounds (VOC) and ozone (O_3), affect respiratory health. RSP can penetrate the lung, causing various health problems, particularly diseases of the respiratory and cardiovascular systems. Patients with heart or lung diseases, children and the elderly are most vulnerable to the harm caused by RSP. According to a report of the World Health Organization (WHO) in 2012, air pollution caused 7 million deaths globally.

Sulphur dioxide and nitrogen oxides dissolve in rainwater, which becomes acid rain, damaging trees and crops, and eroding external walls of buildings and artefacts with historical value.

In 2013, the Environment Bureau of Hong Kong issued the *Clean Air Plan for Hong Kong* to deal with air pollution caused by power plants, and land and sea transportation. A new air quality health index came into effect from 1 January 2014. This new index is benchmarked against the interim and ultimate targets under the WHO's Air Quality Guidelines. In addition to improving regional air quality, in 2012, the Hong Kong Special Administrative Region Government and the Guangdong Provincial Government jointly set new emission reduction targets for 2015 and 2020.

Sustainable Development

The definition of sustainable development has evolved over time. This concept emerged in the 1970s when environmental issues were beginning to become a common concern among the international community. At that time, industrialisation, rapid population growth, widespread malnutrition, the shortage of non-renewable energy sources and environmental degradation became international concerns. Since then, the global community has proposed and discussed different definitions of sustainability and sustainable development. The most widely accepted definition is from the United Nations World Commission on Environment and Development report - *Our Common Future* (also known as the "Brundtland Report"), issued in 1987. It defines sustainable development as "Development that meets the needs of the present without compromising the ability of our future generations to meet their own needs".

The Brundtland Report listed out four major challenges to the environment: poverty, development, survival and economic crisis. The report proposed that, to effectively address environmental issues and achieve sustainable development, fundamental changes must be made to social systems, such as political, economic and technological systems. This is because economic development and environmental protection are interdependent. Sustainable development is to integrate environmental, social and economic aspects to ensure that the present and future generations can enjoy a quality life.

Sustainable development is a "change process" that improves people's quality of life while at the same time conserving natural and human resources for future generations. Communities are interconnected in social, economic, political and environmental aspects, while all human activities and changes due to developments may also influence the existing socioeconomic and ecological environment. Mother nature is unable to indefinitely meet the increasing needs of humankind, and there is an uneven distribution of wealth and resources on the earth. Therefore, there is a need to explore how to develop and manage resources and technologies, and make institutional changes, to meet present and future needs and provide choices and flexibility for future generations.

The following table summarises some important events regarding sustainable development:

Year	Events
1970s	➢ The international community began to raise concerns about environmental issues. ➢ The world was facing three far-reaching crises: poverty, environmental issues and global order.
1983	➢ Brundtland Commission was formally established.
1987	➢ Brundtland Commission released a report entitled *Our Common Future*, which proposed addressing environmental issues by applying the concept of sustainable development.
1992	➢ The United Nations' World Summit was held in Rio de Janeiro, Brazil. The *United Nations Framework Convention on Climate Change* was adopted. ➢ *Agenda 21* provided an action plan for projects, which aimed at strengthening international assistance, addressing poverty and improving environmental health. ➢ The *Rio de Janeiro Declaration* set out 27 principles aimed at realising the concept of sustainable development through international collaborations.
1997	➢ A further World Summit was held in New York. This was to follow up on the goals set in 1992 and develop a comprehensive plan for the implementation of *Agenda 21*. ➢ Different countries signed the *Kyoto Protocol* in Kyoto, Japan.
2002	➢ The World Summit on Sustainable Development was held in Johannesburg, South Africa. It adopted an important document - *Plan of Implementation of the World Summit on Sustainable Development*.
2009	➢ Various countries signed the *Copenhagen Accord*.
2012	➢ The United Nations Conference on Sustainable Development (Rio+20) was held in Brazil, aimed at identifying new political commitments to sustainable development, evaluating the latest progress, implementing the outcomes of major World Summits on Sustainable Development, and responding to new challenges.
2014	➢ The United Nations Climate Summit was held in New York.
2015	➢ The United Nations Climate Summit was held in Paris.

In the 1999 Policy Address, the Chief Executive announced plans to develop Hong Kong as a world-class metropolis and, for the first time, included sustainable development in the Government's work plans. This announcement attracted some public attention.

To make Hong Kong a clean and comfortable place, people's attitudes must fundamentally change. Sustainable development needs the participation and collaboration of every citizen, business, government bureau and department.

Biodiversity

Biodiversity was initially understood as the number of species in a certain area. Biologists later extended the definition of biodiversity to include three levels: genetic diversity, species diversity and ecosystem diversity. All living things on the earth interact with one another, with a balance among natural resources where everything coexists. Biodiversity is vital to human beings, providing food, medicine, building materials and other key elements of life. Therefore, maintaining biodiversity is the responsibility and obligation of humankind.

An estimated 5-30 million animal and plant species are thought to be living on the earth and biologists have categorised around 1.9 million species. According to *Living Planet Report 2014* by the WWF, biodiversity is currently declining. The global wildlife population, including fish, birds, mammals, amphibians and reptiles, has reduced by half since 1970. The number of freshwater species has shrunk by 76%. On the "red list" of the International Union for the Conservation of Nature, it is estimated that 12-52% of species are at risk of extinction. The main threats to global biodiversity are loss and degradation of habitat, overexploitation of resources and climate change.

Although Hong Kong is a small city, it has a rich biodiversity with more than 3,000 species of flowering plants, including 120 species of orchids and over 300 species of indigenous trees, 50 species of mammals, 100 species of reptiles and amphibians, as well as numerous species of insects. Hong Kong is home to about 530 species of birds. This is one-third of all bird species found in China, and new species are continuously being discovered. Notably, Romer's tree frogs and Hong Kong bipedal lizards are unique species to Hong Kong. Some endangered species, such as the black-faced spoonbill and green feet snipe, are also found in Hong Kong. Hong Kong is located in the subtropical region, which has different kinds of habitats. Also, as Hong Kong has a lot of steep terrain, land with urban development covers less than 20% of the total area, with 40% designated as country parks. All these factors together contribute to the existence of a large number of species.

In 1992, the United Nations World Summit adopted the *Convention on Biological Diversity* ("the Convention"), which became effective in 1993 and is currently supported by 194 countries. This is an important international treaty for the protection of biological diversity. The Convention emphasises the importance of biodiversity for human well-being. In 1993, China signed the Convention, with coverage extended to Hong Kong on 9 May 2011. In addition, signatories to the Convention also adopted the *Strategic Plan for Biodiversity 2011-2020* ("the Plan") in Nagoya, Japan in 2010, with the aim of

encouraging stakeholders to take comprehensive actions to protect biodiversity. The Environment Bureau and the Agriculture, Fisheries and Conservation Department of Hong Kong formulated *Hong Kong's Biodiversity Strategy and Action Plan* to systematically scrutinise the biodiversity status and conservation measures in Hong Kong, and recommend further actions towards compliance with the Convention and the Plan.

Ecological Footprint

The ecological footprint is a set of measuring tools using the Global Hectare (gha) as a measuring unit. It is used to measure the productive area of land required to supply natural resources for human use. The productive area, also known as "biological carrying capacity", includes land used for construction as well as the forest area for absorbing carbon dioxide, in addition to those for supplying products for human use (e.g. crops, livestock, seafood, wood and paper).

Two Canadian scholars, Mathis Wackernagel and William Rees, proposed the concept of the ecological footprint in 1996. In the same year, they published the book *Our Ecological Footprint*, which formulated a set of indicators to quantify how much burden human activities can exert on the natural environment. It is assumed that ecologically productive land is needed to supply resources and absorb waste. From this, we can calculate the amount of natural resources consumed by humans in producing food and energy, and the area of land for absorbing the waste produced.

Nowadays, the consumption of industrialised countries demands raw materials and energy that far exceeds what the earth can provide. For example, carbon dioxide released by burning fossil fuels alone, needs a forest area used to absorb excess carbon dioxide that is much larger than the current forest area for absorption. In addition to the over-consumption of natural resources, an equally important global issue is the unequal allocation of and access to resources.

In the *Living Planet Report* issued by the WWF in 2014, it was pointed out that human development is overburdening the earth's carrying capacity. With consumption exceeding natural regeneration, sustainable development cannot be achieved. Currently, the human consumption of natural resources exceeds what the earth can produce by nearly 20%. This phenomenon of living beyond means (or ecological debt) has emerged since the 1980s and is reflected by the fact that terrestrial, freshwater and marine biodiversity has dramatically fallen by 40% over the past 20 years.

The carbon footprint accounts for a major portion of Hong Kong's ecological footprint. The carbon footprint is a measure of the amount of greenhouse gases produced directly or indirectly by our daily activities. Hong Kong people are currently overusing natural resources. If all the people in the world lived this way, we would need 2.6 earths to provide such an amount of resources. At present, Hong Kong's per capita ecological footprint is 4.7 global hectares, which is around 150 times its maximum biological carrying

capacity of 0.03 earth hectares. This is an ecological deficit that ranks ninth in the world and second in Asia only after Singapore. It is estimated that, by 2050, we need the resources from three earths to meet global needs, if the present situation remains unchanged.

Waste Management

Waste management refers to the strategies and systems necessary for managing waste. With a prosperous economy, Hong Kong produces a variety of waste every day. These include municipal solid waste from household, commercial and industrial sectors, construction waste and special waste (e.g. dewatered sludge from sewage treatment plants, livestock waste and animal carcasses). The World Bank estimated that, by 2025, the world's urban population will reach 4.3 billion and each person will produce 1.42 Kg of municipal solid waste per day. Improper waste management may lead to the spread of diseases, threaten human health and cause environmental problems. The goals of waste management include reducing the impact on human health and local communities, as well as the impact on the environment, such as water, air, soil and the ecosystem. It also aims at protecting precious natural resources and raw materials, as well as reducing the use of landfills.

The "4Rs" concept (i.e. reduce, reuse, recycle and replace) is the most common strategy for waste management. Of the 4Rs, the reduction of waste is the best choice in terms of saving costs and creating long-term benefits for the entire society. If waste reduction is unfeasible, reusing, recycling or recovering items are the alternative actions (in order of priority) for waste management. The practice of "recycling" and "replacing" waste may be restricted to certain types of waste and constrained by difficulties in the operation of collection, as well as the recycling or recovering processes for new use. In addition, the "recycling" process often involves tedious waste separation procedures, which requires cooperation from the public. , while "replacing" requires people to change their lifestyle.

In 2013, solid waste in Hong Kong had a recycling rate of about 37%, with 63% dumped into landfills. The Environment Bureau of Hong Kong published the *Blueprint for Sustainable Use of Resources 2013-2022*, which aims at reducing per capita municipal solid waste by approximately 40% (from the 2011 level) by 2022 and change the current proportions to 55% recycling, 23% modern incineration and 22% landfill) to ease the burden on landfills.

There are generally two methods of waste disposal:

- Incineration is the burning of solid waste under controlled conditions to break it down into materials that cause minimum harm to the environment. In the early 1980s, the amount of solid waste rose dramatically in Hong Kong. In order to relieve the pressure on landfills, the government built three incinerators in Lai Chi Kok, Kennedy Town and Kwai Chung. However, the costs of construction, maintenance and repair were significant. Also, the burning of solid waste produces a carcinogen called "dioxin".

The Government stopped using the incinerators in Lai Chi Kok and Kennedy Town in 1990 and 1993 respectively and shut down the incinerator in Kwai Chung in 1997. However, new-generation incinerators emit a significantly lower level of air pollutants.

- Landfill is currently the only waste disposal method in Hong Kong, which covers and compresses solid waste with soil. The covering process must be repeated every day to prevent the release of unwanted smells from the landfill and to prevent insects and animals from proliferating. A comprehensive monitoring system is necessary to prevent groundwater pollution caused by sewage leaks. Landfill was originally an economic method of waste disposal, but due to rising land prices and maintenance costs, landfill has become increasingly costly. Hong Kong previously had 13 landfill sites in operation, but all of these sites have now been closed, and some have been restored for community landscaping and recreational use. At present, Hong Kong has three large, modern strategic landfill sites in the northeast, southeast and west New Territories, equipped with cutting-edge technologies. These sites started operating in the 1990s, but as solid waste continues to rise, these landfill sites are expected to reach their full capacity by 2019-2020.

Polluter Pays Principle

The polluter pays principle, or cost internalisation, requires polluters and related parties to pay for decontamination costs, compensate for the environmental and social impacts they cause, and include these costs in the prices of the products they produce.

The polluter pays principle was first proposed at the United Nations Conference on Environment and Development in 1992. This principle aims at reducing pollution with the belief that the free market economy is the most effective way to address the problem of pollution. For example, factories pollute the environment during the manufacturing process, but the cost of handling this pollution is usually paid by governments or taxpayers. This means factories do not include the cost of handling pollution in production costs, so that this cost is indirectly borne by others. The polluter pays principle is to put the pollution cost back into the production cost, so that polluters cannot transfer the pollution cost to others.

In 1995, Hong Kong implemented the Sewage Services Charging Scheme, which, in accordance with the requirements of relevant legislation, includes two categories of charges: a sewage charge and a trade effluent surcharge. With the exemption of toilet flushing water, all residential and non-residential buildings with water supplied by the Water Supplies Department must pay a sewage charge. Wastewater discharged from industrial and commercial activities has a higher concentration of waste than residential wastewater, so industrial and commercial sectors are required to pay a surcharge in addition to the sewage charge. Sewage charges are calculated according to the amount of water consumed.

Before the introduction of this charging scheme, wastewater collection and treatment costs were fully reimbursed by the government. The public did not know the cost of sewage services and thus lacked the motivation to reduce water pollution. Since the introduction of the charging scheme, wastewater polluters have been required to pay the costs of sewage services based on the quality and quantity of wastewater they discharge. Although the polluter pays principle takes the pollution costs into account, the principle does not necessarily reduce the production and emission of pollutants, because some cash-rich or highly profitable companies may continue to discharge pollutants.

“Extended Producer Responsibility” (EPR) has also gained wider attention in recent years. Serving as an environmental policy tool, EPR requires producers to take up the responsibility of handling their products after they have been used (i.e. recycle, reuse or

dispose of the products). In making decisions regarding the manufacturing process, manufacturers need to consider the environmental impact of the entire life cycle of their products. In addition, EPR is a policy tool that provides incentives for producers to put more environmental considerations into their product design, packaging and material selection processes. This policy tool encourages producers to minimize the waste of resources throughout all stages in the life cycle of their products and the product's packaging.

Green Lifestyle

The notion of "Green" represents life, health, nature and the harmony between man and nature. Green living means living a green lifestyle, incorporating the concept of sustainability into everyday life, and caring for the environment and human well-being. Green living aims to reduce a reliance on natural resources and to live in accordance with the "4Rs" concept. "Reducing" means reducing the use or purchase of unnecessary things; "Reusing" means fully utilising materials and discarding them only when they cannot be re-used; "Recycling" means giving things to other people in need, that we no longer need for ourselves, but are still intact, and useful to others. "Recycling" also means turning waste into reusable materials; "Replacing" means using environmentally friendly materials instead of those which cause pollution. We can live a greener life in our choice of clothing, food, housing and transport. This type of lifestyle is healthier for the environment.

Looking at clothing the process of making clothes pollutes the environment, and therefore buying fewer clothes is a greener way of living. If we need to buy clothes, we should consider buying those made of environmentally friendly materials. We should consider donating old clothes, buying second-hand clothes as well as minimising the amount of water and energy used in the washing of clothes.

We should reduce food waste. In 2012, government statistics indicated that Hong Kong people produced approximately 3,300 tonnes of food waste daily, which accounted for 36% of the solid waste dumped in landfills. Therefore, it is particularly important to reduce food waste. In addition, we can choose local produce and organic food to reduce pollution due to the transportation of food, as well as avoid eating endangered species such as blue-fin tuna. We should also reduce the use of disposable tableware.

In the home, we can change our interior design and living habits in order to live a greener life. We may consider using environmentally friendly utilities such as electrical appliances with energy-saving labels and LED light bulbs, which increase the energy efficiency of our homes. We should turn off electric appliances when not in use. When it is hot, we should open windows and turn on a fan for better air circulation so as to reduce the use of air conditioning. When necessary, we should set the air conditioner to an optimal temperature (preferably 25.5^{o}C).

Regarding transportation, all engine-driven vehicles, including public transportation vehicles and private cars, emit large amounts of carbon dioxide. However, as public transportation carries more passengers than private cars, public transport should be the preferred choice. In order to reduce Hong Kong's carbon footprint, we should cycle and walk instead of using vehicles.

Urban Planning

Urban planning means designing and monitoring the use of land and space by considering the patterns and economic functions of the urban environment, and the impact on society, and people's activities. Urban planning often involves engineering, architectural, social and political considerations, and engagement with the public and people's opinions. As a planning and implementation process, urban planning aims at increasing the cost-effectiveness and stability of urban development, by taking into account public demands and future trends, such as sustainable development.

In Hong Kong, the aim of urban planning is to direct and monitor the use of land and development, in order to build a quality living and working environment, to boost economic development and to promote the health, safety, convenience and general welfare of the community.

Some Factors to be Considered in Urban Planning

- The density of development: Density is a measure of the total human activities in an area, including population, employment and the area of development.
- Mixed land use: Mixed land use refers to using adjacent land zones for different purposes. In these areas, there are not only residential buildings, but also a variety of facilities, such as shops, offices and parks.
- Road network connectivity: Road network connectivity usually means the accessibility and reachability of different routes from one place (Point A) to another place (Point B) within the same road network.
- Regional aesthetics: Regional aesthetics refers to whether a place has attractive features. However, these features are often intangible and difficult to quantify. There are many factors that may affect regional aesthetics, including building design, layout, decoration, landscape (particularly the number of trees and the presence of shade), and public recreational facilities.

Two Different Approaches in Urban Planning

Since the emergence of modern cities, there have been two concepts or thoughts in relation to urban space planning. One is the pursuit of rationality, development and industrial civilisation. This approach is characterised by dividing an area into different functional zones, such as those for work, recreation and housing. Its architectural style is characterised by cement, steel and glass buildings. Different functional zones are connected by vehicle transportation or large scale public transport infrastructures. The other approach advocates the concept of "organic" urban planning, which builds on existing social and

personal relationships, preserves historical buildings, and encourages walking or cycling as the predominant means of transportation.

B. Relevant Information

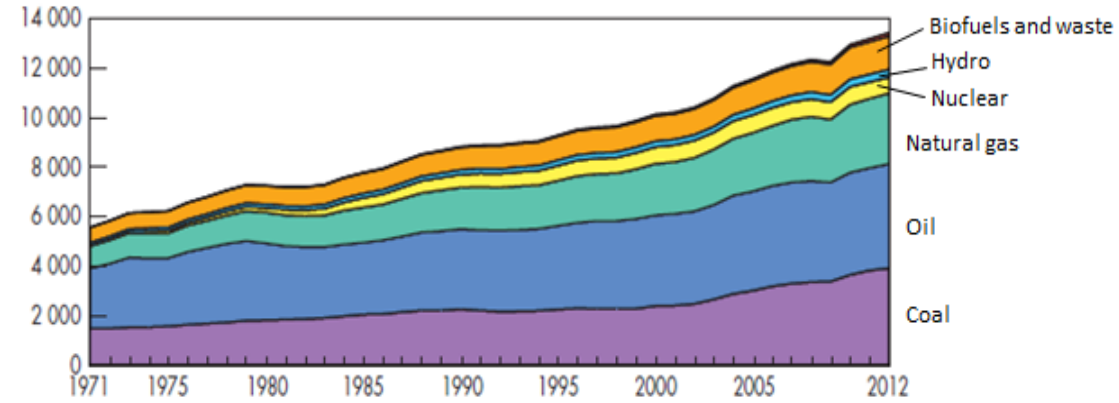
International Energy Development

While world energy consumption has risen in recent years (especially in emerging economies, such as countries with large amounts of energy produced or consumed e.g. in Russia, Brazil and India), growth is slowing down. On the other hand, the types of energy sources are becoming increasingly diverse.

Currently, crude oil (i.e. unprocessed oil) and coal are the world's main primary energy sources. Primary energy refers to energy sourced directly from natural resources. Among the different fossil fuels, the supply of natural gas has experienced the fastest growth. Non-fossil energy sources, such as nuclear and hydroelectric power, account for approximately 6 to 7% of the global electricity supply. According to *World Energy Outlook 2014*, there are four major types of energy sources in the world energy supply: oil, natural gas, coal and low-carbon energy sources.

Total world supply of different types of primary energy (1971-2012)

(Million tons)

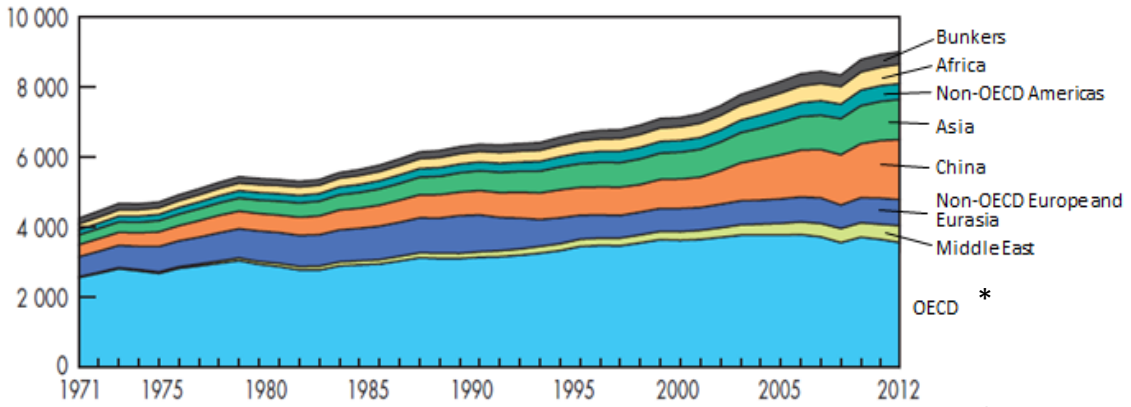


*Primary energy: an energy form that can be used directly and has not undergone any conversion or transformation process, e.g. coal, oil, hydropower and solar energy.

Developing regions, such as China, the Asia-Pacific region and the Middle East, have been reporting increasing growth of energy consumption. It is anticipated that the global consumption of primary energy will increase 41% from 2012 to 2035 even though the growth rate continues to slow down.

(Million ton)

Total world energy consumption in different regions (1971-2012)



* Organisation for Economic Co-operation and Development (OECD)：OECD consists of 34 members with a market economy, the OECD is an intergovernmental organisation set up to allow its members to jointly respond to a globalised economy as well as deal with the challenges and opportunities faced by society and various governments.

The development of various energy sources is summarised below:

1. Oil

Currently, oil is still one of the most commonly used fuels in the world. In 2013, oil accounted for the largest proportion of primary energy supply, followed by coal and natural gas. In recent years, while natural gas and nuclear power are gradually replacing oil as the fuel for electricity generation, oil still accounts for 90% of the fuel used for transportation purposes. Major suppliers of crude oil include Saudi Arabia, Russia, Kuwait. China reported the world's largest growth (5%) in oil consumption in 2013. However, this growth rate is lower than the previous ten years' average rate.

2. Coal

In 2013, the global coal production was approximately 78,650,000 tonnes. Worldwide coal consumption increased from 47,620,000 tonnes in 2000 to 76,970,000 tonnes in 2012, representing a 60% growth. However, there are signs of a slow down in growth in recent years. Asia, in particular China, has contributed mostly to the growth in coal consumption. Currently, coal is still cheap for electricity generation, accounting for more than 40% of the global electricity supply.

3. Natural Gas

There has been a rapid growth in the proportion of natural gas in electricity generation. With the exception of Europe, the production and consumption of natural gas in the world has been rising. Natural gas is expected to grow 2.4% annually until 2018. The U.S. and Russia are the two largest producers of natural gas, together accounting for nearly 40% of the global supply.

4. Nuclear Energy

According to the World Nuclear Association, in 2015, more than 435 nuclear reactors located in 31 countries are currently in operation worldwide. Nuclear power constitutes approximately 11% of the global electricity supply. Sixteen countries have adopted nuclear power as their primary electricity supply. For example, three quarters of the electricity in France is generated by nuclear power; nuclear-generated electricity also contributes more than one-third of the electricity supply in countries like Belgium, Finland and Korea.

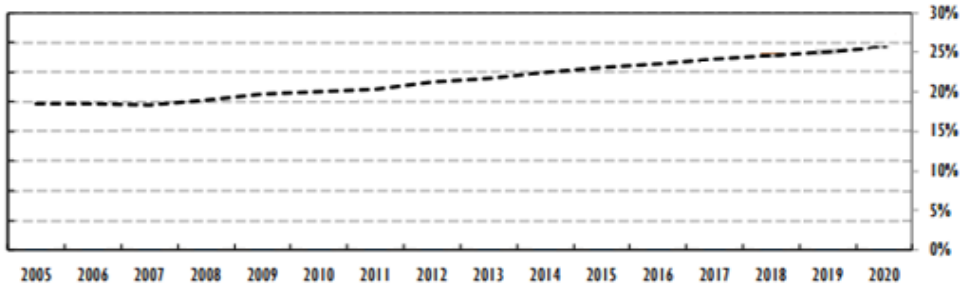
In the aftermath of the 2011 nuclear accident in Fukushima, Japan, globally the development of nuclear power has remained at a stand-still. A number of developed countries are currently planning to phase out all nuclear power plants; Germany, for example, plans to accomplish this by 2022. However, the international community is still divided about the development of nuclear power. China has re-launched its nuclear development plan, planning to double its nuclear capacity by 2020.

5. Renewable Energy

According to estimates of the United States Department of Energy, renewable energy currently constitutes approximately 11% of global energy production; this figure is expected to increase to approximately 15% by 2040. As predicted by the International Energy Agency, the proportion of renewable energy in global electricity generation will increase from 18% in 2005 to approximately 27% in 2020 (refer to the figure below).

Worldwide electricity generation by renewable energy
(historical data and projection)

(Percentage of World Total)



In addition, according to the *Renewable Energy Policy Network for the 21st Century*, the largest growth of global investment in renewable energy was seen in 2014. The value reached USD270.2 billion between 2011 and 2013 (excluding large-scale hydropower projects). The growth of investment in the less developed countries was particularly prominent, reaching USD131.3 billion and contributing 48.6% of the total global investment in renewable energy.

Sources:

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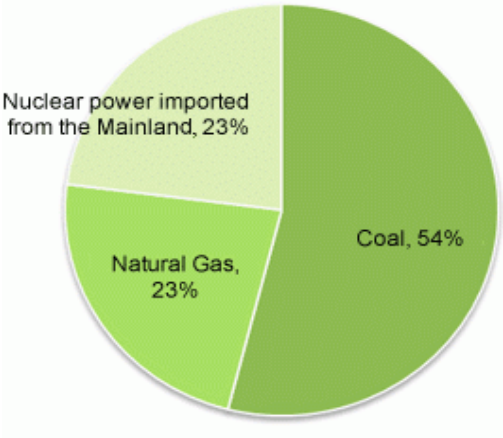
Energy Supply and Energy Policy in Hong Kong

As a highly developed city, Hong Kong is experiencing a greater demand for energy which has been intensifying since 2000. However, traditional electricity generation using coal and oil is facing many challenges. For example, there are concerns about air pollution and a shortage of fuel supplies. There are no indigenous energy resources in Hong Kong, so we have to source energy supplies almost entirely from outside. The following chart illustrates Hong Kong's fuel mix for electricity generation in 2009.



(Source: Electrical and Mechanical Services Department (2011):The Energy Scene of Hong Kong.
http://www.energyland.emsd.gov.hk/tc/energy/energy_use/energy_scene.html)

Electricity is supplied by China Light and Power Hong Kong Limited (CLP) and the Hongkong Electric Company Limited (HEC). The following table shows the trend of electricity consumption in Hong Kong (2000-2010):

Unit: Terajoule

Year	Domestic	Commercial	Industrial	Transport	Total
2000	32 234	76 689	17 769	3 983	130 675
2001	32 799	80 589	16 759	3 991	134 138
2002	33 394	83 549	16 112	4 057	137 112
2003	34 365	84 921	14 851	4 297	138 434
2004	34 134	86 671	15 430	4 967	141 202
2005	35 811	88 561	14 636	5 163	144 171
2006	35 428	93 317	14 015	2 444	145 204
2007	36 422	95 051	13 104	2 495	147 072
2008	37 100	95 543	12 182	2 520	147 345
2009	38 972	96 728	11 143	2 523	149 366
2010	39 344	97 894	11 082	2 540	150 859

The objectives of the government's energy policy are:

- to ensure that the energy needs of the community are met safely, reliably, efficiently and at reasonable prices; and
- to minimise the environmental impact of energy production and promote efficient use and energy conservation.

What measures have been implemented to address energy issues in Hong Kong?

- Revamping the fuel mix for local electricity generation: The greatest contributor of greenhouse gases in Hong Kong is power generation. Electricity generation mainly relies on fossil fuels as energy sources, with coal and natural gas accounting for 53% and 22% respectively. After a public consultation on Hong Kong's future fuel mix for electricity generation in 2014, the Hong Kong Government formulated policies to improve local air quality and tackle challenges posed by climate change, including using more natural gas for electricity generation.
- Adopting renewable energy technologies: Since 2005, in addition to considering the use of renewable energy technologies for new buildings or existing buildings with major renovations, the Government also encourages schools and other institutions to use renewable energies so as to reduce the demand for electricity in buildings.
- To address the issue of fuel mix for electricity generation and to ensure a stable supply of electricity, the Hong Kong Government maintains a long-term collaborative relationship with the Mainland to secure a supply of nuclear energy and natural gas.

Sources:

1. Environmental Campaign Committee. "Teaching Kit for Liberal Studies " . Retrieved from http://www.eccteachingkit.org.hk/upload/download/energy3.pdf
2. Electrical and Mechanical Services Department. (2012). *香港能源最終用途數據 2012*. Retrieved from http://www.emsd.gov.hk/tc/energy_efficiency/energy_end_use_data_and_consumption_indicators/hong_kong_energy_end_use_data/data/index.html
3. "Consultation on Future Fuel Mix for Electricity Generation". Retrieved from http://www.enb.gov.hk/en/resources_publications/policy_consultation/electricity_generation.html

International Energy Agency

International Energy Agency (IEA) is an intergovernmental organisation formed by countries with high oil consumption with the aim of enhancing economic cooperation. Established during the 1973-74 oil crisis, the IEA initially served to coordinate measures adopted by different countries, under a limited oil supply. Its headquarters are located in Paris, France. The IEA is made up of 29 member countries: Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, South Korea, Luxembourg, the Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom and the United States.

As an adviser on energy policies, the IEA works closely with its member countries to provide citizens with reliable and clean energy at affordable prices. The IEA has updated and extended its missions in accordance with the changing energy market. The IEA adopt a decision-making process that aims at enhancing energy safety, economic development and environmental protection, as well as balancing these three dimensions. The IEA is currently focused on formulating policies to deal with climate change, reforms in the energy market, and collaborations in energy technology development. It also works on collaboration relationships with other countries, in particular, major energy consumers and producers, such as China, India, Russia and the Organization of the Petroleum Exporting Countries (OPEC). The IEA also carries out energy-related research studies in a wide range of fields, collects and compiles information from different sources, publishes reports (such as the *Oil Market Report* and the *World Energy Outlook*) and provides the public with analysis on the latest energy policies with practical recommendations.

Source: The web page of International Energy Agency (IEA) http://www.iea.org/

Kyoto Protocol

The *Kyoto Protocol* is a multilateral agreement. To reduce global warming, a total of 84 countries signed the *Kyoto Protocol* at the third session of the conference to the United Nations Framework Convention on Climate Change in 1997. Delegates from 149 countries and regions attended the conference in Kyoto, Japan. The *Kyoto Protocol* took effect on 16 February 2005, after the signing of Russia in 2004. The countries of the European Union and 191 other countries signed the agreement.

The *Kyoto Protocol* is a legally binding agreement to limit greenhouse gas emissions of the more developed countries. It was an agreement of international importance to reduce greenhouse gas emissions. The *Kyoto Protocol* established a commitment period between 2008 and 2012 when the greenhouse gas emissions of more developed countries had to be reduced to 94.8% of their 1990 levels. For example, the reduction targets for the European Union (EU), the United States (U.S.) and Japan were 8%, 7% and 6% respectively. On the other hand, emissions of certain countries, such as Ireland, Australia and Norway, were allowed to exceed levels recorded in 1990. To promote sustainable development, on the top of emission-reduction commitments, countries had to implement or develop relevant policies and measures depending on their circumstances. For example, they could enhance energy efficiency in relevant sectors of the national economy; explore, promote, develop and increase the uses of new energy sources and renewable energies.

To encourage signing countries to achieve their reduction targets, the protocol allowed four methods to reduce emissions:

- Allowing “emissions trading” between any two of the more developed countries. This meant any country exceeding its emissions target could purchase emission units from another country with an excess of quotas.
- Using “net emission” to measure greenhouse gas emissions, which meant that the amount of carbon dioxide taken up by forests could be deducted from the actual emission levels.
- Adopting a “clean development mechanism”, encouraging more developed countries to help less developed countries reduce greenhouse gas emissions. The amount of emissions reduced by such efforts could be counted as a reduction in the amount of emissions for the more developed countries.

- Allowing the adoption of "joint implementation", which meant EU member states were treated as a single unit, whereby the overall reduction targets could be met as certain countries reduced their emissions to compensate for over emissions by others.

In 2012, the delegates from almost 200 countries that attended the United Nations Climate Change Conference agreed to extend the *Kyoto Protocol* until 2020. However, for a few countries it is not legally binding; these countries have heavy greenhouse gas emissions, such as the United States, China and India. While the parties to the second commitment period are committed to reducing their greenhouse gas emissions by at least 18% below the levels in 1990 in the period 2013 to 2020, the parties to the second commitment period are not the same as the first period.

Sources:

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2. "聯合國氣候大會延長《京都議定書》至 2020", 8 December 2012, BBC 中文網.

Government Organisations in Hong Kong Related to Sustainable Development

In Hong Kong, it was clearly stated in the 1999 Policy Address that, to build a world-class city and a clean, comfortable and pleasant home, Hong Kong would require a fundamental change of people's mindset. In simple terms, sustainable development for Hong Kong means:

- finding ways to increase prosperity and improve the quality of life while reducing pollution and wastage;
- meeting our own needs and aspirations without damaging the well-being of future generations; and
- reducing the environmental burden we put on neighbouring regions outside Hong Kong, and helping to preserve our common natural resources.

In 1997, the Hong Kong Government initiated the *Study on Sustainable Development for the 21st Centur*y in Hong Kong (SUSDEV 21), to introduce the elements of sustainable development into government policies and promote the ideas of sustainable development to the public: Sustainable Development in Hong Kong is to balance social, economic, environmental and resource needs, for the needs of both present and future generations. At the same time, through the efforts of the public and the government, it aims to achieve a vibrant economy, social progress and a high quality environment in the local, national and international level.

Council for Sustainable Development

The Council for Sustainable Development was established in March 2003, and comprises members with a range of expertise and experience. Establishment of the council is conducive to public discussions on the promotion of sustainable development in Hong Kong. Its roles are:

- advising the Government on what should be the priorities when promoting sustainable development;
- advising on the sustainable development strategy for Hong Kong that will integrate economic, social and environmental considerations;
- facilitating community participation in the promotion of sustainable development in Hong Kong through various means, including the award of grants from the Sustainable Development Fund; and
- promoting public awareness and understanding of the principle of sustainable development.

The Council for Sustainable Development proposes and studies important topics related to sustainable development, such as municipal solid waste, renewable energy, living space, population policy, air quality, sustainable built environment and climate change. Listed below are some council-led issues with public consultation.

- "Making Choices for Our Future" (2004)
- "Enhancing Population Potential for a Sustainable Future" (2005)
- "Clean Air – Clear Choices" (2007)
- "Building Design to Foster a Quality and Sustainable Built Environment" (2009)
- "Municipal Solid Waste Charging" (2013)

Sustainable Development Division

The Sustainable Development Division of the Environment Bureau was set up in 2001. Its main tasks are to facilitate the integration of sustainable development into the Government's new initiatives and provide support to the Council for Sustainable Development. It also introduced a new sustainability assessment system within the Government. Under the system, all bureaux and departments are required to carry out sustainability assessments of new strategic initiatives or major programmes that may bring about noticeable or persistent implications on the economy, environment and society of Hong Kong. For details refer to http://www.enb.gov.hk/tc/susdev/su/sus.htm.

Sources:

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Emissions Trading

As stipulated in Article 17 of the *Kyoto Protocol*, countries that signed the protocol are allowed to sell emission units of greenhouse gases (including carbon dioxide and methane,) to other countries with over-target emissions through "emissions trading" on the market. The aim is to encourage countries to meet emission reduction targets. Since carbon dioxide is the principal greenhouse gas, emissions trading is often referred to as "carbon trading". To avoid "overselling" and subsequently missing emissions targets, all parties are required to maintain a record of transactions and unit reserves in their national registries.

The European Union Emissions Trading Scheme (EU ETS), whose establishment was based on the *Kyoto Protocol*, is the largest multi-national trading scheme in the world for greenhouse gas emissions, and the only one with a mandatory feature. The scheme sets limits on carbon dioxide emissions from large enterprises (e.g. power stations and factories) in EU member states. Through its cap-and-trade rules, EU member states should abide by the caps on the total emissions amounts agreed under the scheme, whereby emission allowances are assigned to all factories, power stations and other facilities. The total amount of greenhouse gas emissions is limited within the "caps", under which member states are allowed to sell or purchase additional allowances, thereby ensuring that the overall emissions are within the set limits. At the end of each year, all enterprises and factories are required to report differences between their emissions and allowances; enterprises and factories with emissions exceeding their allowances will be fined. In the event that a company's emissions are lower than its allowances, the company may choose to retain the difference to be used in the future, or otherwise sell it to other companies. One allowance unit is equivalent to one tonne of carbon dioxide. The price for the allowances is subject to change in accordance with supply and demand. In 2012, the total trading volume for emissions allowances was EUR5.6 billion, involving 790 million EU allowances.

Sources:

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Mass Transit Systems

Mass transport systems generally refer to modes of transportation that provide services to the general public. Comprised of roads, vehicles and station facilities, mass transport systems include airways, railways, roads and public cycling trail systems.

Air transportation means transporting people, cargo or mail using planes and helicopters. Air transportation is fast. It is used for international trading where the transportation of valuables, live cargo, fresh produce and fragile items are involved. It is also the primary transportation means for long-distance tourism.

Railway transport is a reliable form of land transportation. It generally refers to transportation systems that operate on specified tracks, including metro systems, light rail systems, single-track systems and maglev train systems. Railway transport is suitable for both long and short distance transportation (including international and local transport), which is safe and has high capacity capabilities. Currently, among the 236 countries and regions in the world, 144 of them have built their own railway transport systems, with approximately 90 providing passenger services. Railway transport systems are still the transportation means that carries the largest number of passengers.

Road transport is a fast and convenient form of land transportation that is also “point to point”. It is convenient and versatile. People living in cities travel frequently on buses. In Hong Kong, there were approximately 325 licensed vehicles for every kilometre of road in 2009.

Traditional transportation means remain popular alongside the gradual progress in the development of new transport technologies (e.g. electric vehicles, fuel cell vehicles, biodiesel to power vehicles). The heavy dependence of traditional transportation on fossil fuels (e.g. petrol) leads to air pollution. A reduction of air pollution can be achieved by the development of a low-carbon public transport system, which includes promoting the use of bicycles.

Hangzhou in China has developed a large-scale public bicycle system. The system features free rental of bikes for 60 minutes, with rental and return services being offered at all service points located all around the city. The system has approximately 3,000 service points with an inventory of more than 67,000 bicycles, serving approximately 230,000 rentals on a daily basis. The local government plans on increasing the number of bicycles to 175,000 by 2020.

Sources:

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Plastic Shopping Bag Levy

According to the *Hong Kong Blueprint for Sustainable Use of Resources 2013-2022* published by the Environment Bureau, Hong Kong aims to reduce the municipal solid waste disposal rate by 40% on a per capita basis by 2022. A concerted effort from all Hong Kong citizens in their daily lives is required to practice the new, environmentally-friendly "Use Less, Waste Less" culture. The first stage of the Environmental Levy Scheme on Plastic Shopping Bags was implemented in Hong Kong in July 2009. The results of a subsequent telephone survey indicated that more than 75% of the interviewees said they did not ask for plastic shopping bags when shopping at registered retail outlets, while nearly 80% agreed that the levy scheme would help them develop the habit of bringing their own shopping bags. To reduce the use of plastic shopping bags, a growing number of overseas cities (including several international cities) have introduced or are considering introducing similar measures suitable for their specific situations. Sharing many similarities with Hong Kong, the Mainland and Taiwan have already implemented their own levy schemes on plastic bags. The Legislative Council of Hong Kong passed legislation in March 2014 and officially started the full implementation of the Environmental Levy Scheme on Plastic Shopping Bags on 1 April 2015. In accordance with the new legislation, if there is a sale of retail goods, the seller must charge the customer not less than 50 cents for each plastic shopping bag provided. After full implementation, the levy scheme will be extended significantly from some 3,500 retail outlets to 60,000 or more. Those service businesses that sell goods will be regulated too.

From 1 April 2015, all merchants in Hong Kong (regardless of their scale and nature) are required to charge customers not less than 50 cents, for plastic shopping bags when selling goods by retail, the income of which shall be retained by merchants themselves. Under the *Product Eco-responsibility (Amendment) Ordinance 2014* (amending Ordinance), plastic bags used for hygiene reasons, such as for holding food item not packaged or in a non-airtight package or in a frozen/chilled state, are exempted from the charge. Plastic bags for pre-packaging of goods are also exempt, while bags provided with services also fall outside the scope of this regulation.

Sources:

1. "Full Implementation of the Plastic Shopping Bag Charging". Retrieved from http://www.epd.gov.hk/epd/psb_charging_mobile/files/pdf/EPD_Practical_Guideline.pdf
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Air Quality Health Index

To provide more timely and useful air pollution information to the public, the Environmental Protection Department of Hong Kong (EPD) launched the Air Quality Health Index (AQHI) to replace the Air Pollution Index on 30 December 2013.The AQHI informs the public of the short-term health risks resulting from air pollution, so that people can take precautionary measures to safeguard their health. The AQHI is reported on a scale of 1 to 10 and 10+, and are grouped into five health risk categories as shown below:

The AQHI is reported hourly at ambient and roadside stations. The EPD also provides AQHI forecasts that serve to alert the public before the onset of serious air pollution. In addition, the EPD also provides susceptible groups, such as children, the elderly and those with heart or respiratory illnesses with relevant health advice. The AQHI is calculated based on the cumulative health risk attributable to four air pollutants: ozone, nitrogen dioxide, sulphur dioxide, and particulate matter (including PM10 and PM2.5). The health risks associated with each pollutant are obtained from medical research studies in Hong Kong.

How to interpret AQHI data?

The health effects of air pollution depend on the concentrations of the air pollutants and the duration of exposure. Exposure to moderately high pollution levels for a short period of time normally will not lead to significant health problems.

The general AQHI is more relevant to most of us, as it represents the air pollution that we are exposed to for most of the time. The roadside AQHI is relevant to those who spend several hours continuously a day on busy streets. At present, the EPD operates 12 general air quality monitoring stations and 3 roadside air quality monitoring stations. Data from these stations is used for reporting general AQHI and roadside AQHI respectively.

The effects of air pollution on different groups of people vary. The AQHI system provides different health advice for people with varying degrees of susceptibility to air pollution, including people with heart or respiratory diseases, children and the elderly, outdoor workers, and the general public.

Sources:

1. “About AQHI”. Retrieved from http://www.aqhi.gov.hk/en/what-is-aqhi/about-aqhi.html
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Environmental Impact Assessment

Environmental impact assessment (EIA) is an assessment system that stipulates the requirements of giving a detailed description of the potential environmental impact and effective mitigation measures of major engineering projects. With legislation, this system allows the impacts of these engineering projects on cultural heritage and natural environment to be taken into the decision-making process. In Hong Kong, the *Environmental Impact Assessment Ordinance* became effective on 1 April 1998. The Ordinance requires engineering projects related to the construction or renovation of roads, railways and depots, airports and port facilities, reclamation, hydraulic and marine facilities, as well as dredging and dumping, to submit EIA reports, and obtain environmental permits before commencing construction. The EIA report must contain a description of the environment around the project site, including information about natural resources, ecological systems and human population density. In addition, the report should also list out different construction plans, together with the potential impacts they may bring.

While the assessment mainly focuses on whether the project would negatively affect the air quality and nearby sites of cultural heritage, it also evaluates whether excessive noise or land pollution would be made. In addition to listing specific and feasible mitigation measures to reduce the environmental impacts of their projects, relevant parties are also required to explain why the proposed construction plans were selected. Under the current system, the general public and members of the Advisory Council on the Environment (ACE) are allowed to comment on the project profiles and reports submitted by organisations.

While the EIA requires the provision of possible alternative plans and their environmental impacts, sufficient evidence to justify the necessity of projects is not needed. However, the Ordinance ensures the implementation of mitigation measures, which are agreed upon while carrying out the assessment. As these mitigation measures are conditions for obtaining an environmental permit, implementation of such measures are legally binding. The public is allowed to comment on the EIA report before the environmental permit is issued. Under the current EIA Ordinance, project profiles and EIA reports are required to be open for public viewing and comments for 14 days and 30 days respectively. These documents are required to be put on the website of the EIA Ordinance Register Office for public viewing.

The Ordinance also requires the ACE to be consulted. Established in 1994, the council is the primary organisation that advises the government on issues related to environmental protection and conservation. Under the EIA Ordinance, the Director of the Environmental Protection Department is required to consider the advice of the council on an EIA report. The council is not comprised of government officials. On the contrary, its members include scholars, environmental concern groups, professionals, businessmen and district organisations.

Sources:

1. "Cyber Help Bench for Environmental Impact Assessment (English version only)". The web page of Environmental Protection Department. Retrieved from http://www.epd.gov.hk/eia/hb/content/index.htm
2. "Environmental Impact Assessment Ordinance". The web page of Environmental Protection Department. Retrieved from http://www.epd.gov.hk/eia/cindex.html
3. Batterman Stuart. (2003). "Environmental Impact Assessment". In *Environmental Encyclopedia* 3rd Ed, ed. by Marci Bortman *et al***.** Detroit : Gale, pp.495-496.

Urban Greening

Greening is an important means to improve the urban environment. There are a number of benefits of planting trees and growing greenery, such as creating fresh air, preventing pollution, lowering the temperature, improving soil quality, conserving the ecological system, as well as beautifying the environment. Plants can not only lower the soil temperature by blocking sunlight and adsorbing heat, but they can also increase humidity and improve the microclimate, thereby reducing the "heat island effect". However, it is not easy to plant greenery in highly populated urban areas. Therefore, it is necessary to develop new greening methods, such as rooftop greening and vertical greening. Through photosynthesis, plants absorb carbon dioxide and release oxygen, and also absorb certain pollutants (e.g. sulphur dioxide and nitrogen dioxide) in the air, and therefore can help purify the air. Greening can also beautify the environment, especially in a highly populated city like Hong Kong. Trees and shrubs can make our environment look fresh and comforting. Greening can improve the living environment and quality of life in cities.

Some forms and examples of urban greening:

1. Urban greening allows free access to public open spaces and parks, and provides local residents with venues where they can exercise, have fun and relax. The Sun Yat Sen Memorial Park in Sheung Wan is one of the many green open spaces in Hong Kong:

(Source of the photo: Panoramio.com)

2. Rooftop greening is the planning of large quantities of plants on a rooftop. Through rooftop greening, buildings become more energy-efficient and some carbon dioxide is absorbed. Also, rooftop greening can reduce the heat island effect, improving air quality, draining rain water and increasing biodiversity.

(Source of the photo: The University of Hong Kong)

3. Vertical greening refers to vegetation that grows directly on a building's external walls, or on a green-wall structural system. The benefits of vertical greening include reducing energy consumption, lowering carbon dioxide emissions, reducing air pollution, mitigating the urban heat island effect and reducing noise.

Since 2004, the Hong Kong Government has started to formulate Greening Master Plans for different districts, in order to better coordinate the planning, designing and implementation of greening measures. The aim of the Greening Master Plan is to set up a holistic greening plan for different regions, identifying appropriate locations to grow plants, as well as identifying appropriate planting themes and species. This helps achieve sustainable and consistent outcomes to improve greening conditions in different regions. In March 2010, the Government established the Greenery, Landscape and Tree Management (GLTM) Section in accordance with the recommendations of the *Report of the Task Force on Tree Management*. The GLTM Section aims to initiate a new strategic policy on greening, landscaping and tree management, in order to continue the development of the green environment in Hong Kong.

Sources:

1. "The Greening Policy". The web page of Development Bureau. Retrieved from https://www.greening.gov.hk/en/home/index.html
2. "Greening Hong Kong". The web page of GovHK. Retrieved from http://www.gov.hk/en/residents/environment/sustainable/greening.htm

Agriculture and Organic Farming in Hong Kong

Hong Kong's local agriculture has a long history of supplying quality fresh agricultural produce for local consumption. However, the agricultural sector has been diminishing over time as Hong Kong evolves towards a predominantly urbanised and service-oriented economy and becomes more reliant on imports for its food supply. Despite its relatively small size, Hong Kong's local farming industry still produces a sizeable amount of vegetables, poultry and pigs for local consumption. The value of local agricultural output in 2014 was HK$830 million, including HK$279 million from agricultural produce, HK$248 million from livestock produce and HK$303 million from poultry produce.

Agricultural activities in Hong Kong are primarily carried out in the New Territories and suburban areas. According to statistics published by the Agriculture, Fisheries and Conservation Department, of the approximately 4,523 hectares of agricultural land in Hong Kong (excluding fish ponds), about 729 hectares are active agricultural land. The government has always been supportive of agricultural development, with dedicated efforts focused on encouraging and supporting local farmers to develop organic farming.

In addition to serving as the source of primary products, the continuous development of Hong Kong's local agriculture can also bring a variety of benefits, including the diversification of the local food supply, the provision of job opportunities, the facilitation of sustainable development, as well as enabling the public to better understand the mutual influences between nature and human activities.

Organic Farming

The development of organic farming in Hong Kong has only a very short history. During the 90's, the local agricultural sector declined due to rapid urbanisation and the profound shift in the economic structure of Hong Kong. The Government began to promote organic farming in 2000. Organic farming can produce food in an environmentally friendly and sustainable manner and better protect our farmlands and countryside. It can also open up a niche market that can bring potentially high profits for local farmers. It can also offer a wider and better choice of fresh vegetables to local residents. In order to further develop the local organic farming industry and bring confidence to consumers, it is necessary to have an organic certification service provided by an independent third party. With a grant from the Agricultural Development Fund of the Vegetable Marketing Organization (VMO), the Hong Kong Organic Resource Centre (HKORC) was established in December 2002. The

HKORC worked on a set of organic production and processing certification standards applicable to Hong Kong. After comprehensive consultations with the industry and interested parties, the standards were established in 2004. In December 2004, the HKORC launched an independent organic certification service for organic farmers and organic food processors. As of June 2015, there were 540 organic farms in Hong Kong. These organic farms include traditional family-operated farms, enterprise-operated farms, educational/leisure farms and self-claimed organic farms.

Sources:

1. "Agriculture in HK". The web page of Agriculture, Fisheries and Conservation Department. Retrieved from http://www.afcd.gov.hk/english/agriculture/agr_hk/agr_hk.html
2. "Public Consultation on the New Agricultural Policy: Sustainable Agricultural Development in Hong Kong". Retrieved from http://www.fhb.gov.hk/download/press_and_publications/consultation/141229_f_agricultural/e_consultation_document.pdf
3. "Organic Farming in Hong Kong". The web page of Agriculture, Fisheries and Conservation Department. Retrieved from http://www.afcd.gov.hk/english/agriculture/agr_orgfarm/agr_orgfarm.htm

Part III: Learning and Teaching Exemplars

Liberal Studies adopts an issue-enquiry approach in selecting curriculum content and teaching strategies. Teachers have to consider the learning and teaching focuses involved in the "questions for enquiry" in the Curriculum and Assessment Guide when choosing appropriate issues, as well as designing and arranging classroom activities for students to explore the issues.

This part provides four exemplars for teachers' use. All these exemplars are related to the learning and teaching focuses of this module, and some may also touch on other modules. Teachers are advised to read Part A of each exemplar to understand its overall design rationale, the suggested lesson time and the learning objectives. Teachers are also advised to note the basic concepts these exemplars involve and the learning experiences and knowledge students have acquired in the junior secondary curriculum. The above information may help teachers estimate the lesson time required and adjust the breadth and depth of contents based on the students' progress.

Part B of each exemplar introduces the flow of learning and teaching, and suggests different learning and teaching strategies for teachers to adopt. These include reading before or after class, data analysis (including texts, cartoons and figures), group discussions, mock forums, role plays, debates, direct teaching and summarising by teachers. In order to save teachers' time in the preparation of teaching materials, most classroom activities are accompanied by relevant worksheets or reading materials. As to homework, the main ideas for designing questions are also provided for reference by teachers when reviewing students' work. Each of the above sets of materials is included in the last part of each exemplar as an appendix. Teachers may consider distributing copies of these appendices to students.

These four exemplars are only for reference in the design of teaching issues and activities, and are not supposed to be used without any adaptations in the classroom. When using these exemplars, teachers are advised to incorporate them into the carefully planned school-based teaching progress, so as to use lesson time effectively for various learning and teaching activities such as dealing with learner diversity, explaining students' work performance and arranging internal assessment.

Senior Secondary Liberal Studies
"Energy Technology and the Environment" Module
Learning and Teaching Exemplar (1)

Development of Electricity-generating Sources in Recent Years and the Feasibility of Developing Renewable Energy

A. Basic information of the exemplar

Topic	Development of electricity-generating sources in recent years and the feasibility of developing renewable energy
Relevant modules, themes and issues for enquiry	**Leading** Module 6 : Energy Technology and the Environment Theme 1: The influences of energy technology ● To what extent does the development of energy technology create or solve environmental problems? ● What are the implications of environmental change on the development of energy technology? ● How do energy problems affect international relationship, and the development of countries and societies? Theme 2: The environment and sustainable development ● How do science and technology match with sustainable development? What are the constraints? ● How do the living styles of people and social development affect the environment and the use of energy?
	Related Module 2: Hong Kong Today; Theme 1: Quality of Life ● Which aspects of the quality of life are seen to be more important? Which are seen to be immediate needs? Who might make the decisions? Why?
Overall design rationale	This exemplar starts with the use of electricity in students' daily lives to encourage their motivation in learning about energy-related issues. In the exemplar, students are able to understand the features of different energy sources through categorisation and analysis. In addition, students are guided to develop an in-depth understanding of the pros and cons associated with different sources of commonly used energy by studying their respective costs for electricity generation, and data on life-cycle of greenhouse gas emissions. Subsequently, students will learn about energy usage and supply in Hong Kong. Through role plays, students are also guided to reflect on how different stakeholders in our society can do their part to "save energy and reduce carbon dioxide emissions" in order to achieve sustainable development for the entire society. This exemplar also leads students to adopt a global perspective in analysing energy usage. By participating in a simulated energy conference of the United Nations, students are guided to reflect on policies relating to energy development adopted by different countries (including more developed countries and less developed countries), thereby gaining an understanding of

	their respective points of interest in energy-related issues and their attitudes towards the development of renewable energy. In conclusion, the aim of this exemplar is to provide students with a better understanding of the major types of energy and reflect on their pros and cons. It also enables students to gain an understanding of new trends in energy development and energy consumption by examining international energy policies from recent years. Then, students may review their personal habits in using energy and think about feasible ways to save energy.
Time required	5 lessons (40 minutes per lesson), approximately 200 minutes in total
Learning objectives	Knowledge: ● To enhance the understanding of the pros and cons associated with different energy sources. ● To discuss energy usage in different parts of the world by learning about the current energy requirements of society. ● To examine energy policies implemented in different parts of the world and their influential factors.
	Skills: ● To collect and summarise information from different sources. ● To make conceptualised observations using data obtained through issue-enquiry. ● To apply relevant knowledge and concepts when discussing contemporary issues. ● To interpret data from different perspectives. ● To express ideas in speaking and writing. ● To develop interpretation and data processing skills. ● To develop problem-solving skills and critical thinking.
	Values and Attitudes: ● To adopt an open and tolerant attitude towards other people's views and values. ● To appreciate and respect diversity in cultures and views in a pluralistic society. ● To reflect on the significance and value of technology in people's lives.
Basic concepts for application	Energy technology, renewable energy, non-renewable energy, green lifestyle, resource depletion, quality of life, sustainable development.
Relevant learning experiences at	Having studied various subjects in a range of learning areas such as Personal, Social and Humanities Education, students at junior secondary level are expected to have a general idea about energy types and energy use. Students

junior secondary levels	should have also studied some principles of power generation from subjects related to science education. If teachers think that students lack basic knowledge, it is recommended that a brief introduction should be made before using this exemplar.

B. Design of classroom learning and teaching

Lesson	Learning and teaching strategies and flow
Before class	**Lesson Preparation** Ask students to examine their household utility bills and answer the questions in Appendix 1. Bring them to the next class for discussion. Ask students to draw or write energy sources other than coal and natural gas (Question 6 in Appendix 1). Remind students that electricity is just one form of energy, and is therefore not an energy source.
1	**Lead-in (around 20 minutes)** ● Show a household utility bill (Appendix 1) to students and ask the following questions: ➢ Have you ever checked the utility bill of your household? How much do you pay for electricity every month/two months? ➢ What does your family use the electricity for? Which appliances consume more electricity? ➢ Which months show the highest consumption of electricity? Why? ➢ Where does Hong Kong secure its electricity supply from? How can electricity be generated? ● Explain the importance of electricity in people's lives (e.g. lighting, cooking, air-conditioning, entertainment and communication) by going through the household utility bill, and then tell students that while the majority of electricity consumed in Hong Kong is generated by power stations (i.e. coal or natural gas), some electricity is supplied by nuclear power plants located in Guangdong Province. Teachers may mention that power stations emit large amounts of carbon dioxide and **air pollutants** during electricity generation, contributing to the greenhouse effect and environmental pollution. Power stations are a major source of **air pollutants** in Hong Kong, additional sources include road transport, such as the exhaust from motor vehicles[1]. **Group Discussion (around 20 minutes)** ● First, ask students to discuss ways to categorise energy with their group members or neighbours, then write down their categorisation criteria or names of different categories on the worksheet of Appendix 1 (Question 6), and explain the reasons. Each group appoints a representative to write the answers on the

[1] Refer to *2013 Hong Kong Emission Inventory Report* (P.2) for 2013 emission of pollutants in Hong Kong, published by Air Science Group, Environmental Protection Department in June 2015. http://www.epd.gov.hk/epd/sites/default/files/epd/2013EIReport_eng_1b.pdf

Lesson	Learning and teaching strategies and flow
	blackboard or whiteboard. ● Make suggestions or correct the answers given by students, and then divide their answers into crude categories. Possible categories include **renewable energy/non-renewable energy**, clean/polluting energy sources. Then tell students that different energy sources have their strengths and weaknesses, and different countries or regions determine their fuel mix based on their unique conditions. Such conditions include the economic development of the region, the natural resources available, its scientific development, living standards and the needs of its people, as well as the importance attached to environmental protection.
2	**Reading data sources (around 15 minutes), group discussion (around 25 minutes)** ● Divide students into groups and distribute the role cards from Appendix 2 (drawing lots is a possible option). The objective of distributing the role cards is to encourage students to actively participate in activities, and enhance a sense of involvement during the discussion. Ask students to play different roles based on their grouping arrangement. ● Distribute Appendix 3. Students are given 15 minutes to read relevant information and complete worksheet 1 of Appendix 4. They should analyse the features of the energy commonly used in electricity generation such as cost, safety and impact on the environment. Before or during students' reading, explain: ➢ The entire life cycle of an electricity-generating mode should be considered when measuring the pollution level of the technology used, namely from the stage where energy is extracted, to the construction, maintenance, operation, retirement and disposal of power stations (Source D). ➢ Pay attention to the approach used when calculating the amount of greenhouse gas emissions for any type of energy technology. Take solar energy for example, while the technology releases no greenhouse gases upon generating electricity, the raw materials used to manufacture solar cells or panels still produce pollutants; as a result, the amount of greenhouse gas emissions throughout its life cycle is approximate to that of nuclear power (Source E). ● Invite students to write their answers on the blackboard after completing worksheet 1 (or ask them to draw concept maps and mark the pros and cons with different colours), and debrief after the activity. For example: ➢ Hydro energy: The cost of electricity generation is lower because it

Lesson	Learning and teaching strategies and flow
	provides an unlimited supply of energy as long as there is a sufficient reserve of water, and it is thought to pose fewer threats to mankind. However, hydroelectric power is limited by geographical conditions, and the construction of hydroelectric power facilities and dams can disrupt rivers and land, at times even affecting the movement of geologic features and the surrounding ecological environment. ➢ Wind power: The cost of electricity generation is relatively higher, especially for offshore wind farms. While it is regarded as a highly safe technology with less environmental impact (e.g. lower greenhouse gas emissions), it is still limited by geographical conditions. ➢ Natural gas: The cost of electricity generation is lower and it also emits less greenhouse gases and fewer pollutants. However, there is a risk of leakage during transportation and therefore environmental damage. ➢ Nuclear power: While the cost of electricity generation is not the highest, and it emits smaller amounts of greenhouse gases, there is doubt about the safety of nuclear power as well as concerns about the treatment of nuclear waste. ➢ Solar power: This technology is generally associated with a higher cost of electricity generation, but it emits smaller amounts of greenhouse gases and pollutants. However, it is limited by climatic or geographic conditions, including the length of sun exposure, and the availability of land where solar power plants can be built. ➢ Coal: The cost of electricity generation is not high and the public considers it to be safe. However, it emits large amounts of pollutants and greenhouse gases, causing air pollution as well as exacerbating global warming and climate change.
3	**Reading data sources (around 10 minutes), group discussion (around 15 minutes), presentation of discussion results (10 minutes)** ● Divide students into groups. Distribute the reading materials in Appendix 5 and lead the student discussion. Taking Hong Kong's profile into account, ask students to group the above features (such as cost, safety and environmental impact) into three categories based on their respective importance (high, medium or low), and discuss their reasons and rationale. For weaker students, illustrate with 1 to 2 examples. For example: ➢ Some think that environmental impact is of greater importance for Hong Kong because pollution in Hong Kong has been under increasingly intense public scrutiny in recent years. Therefore, the ability of any source of

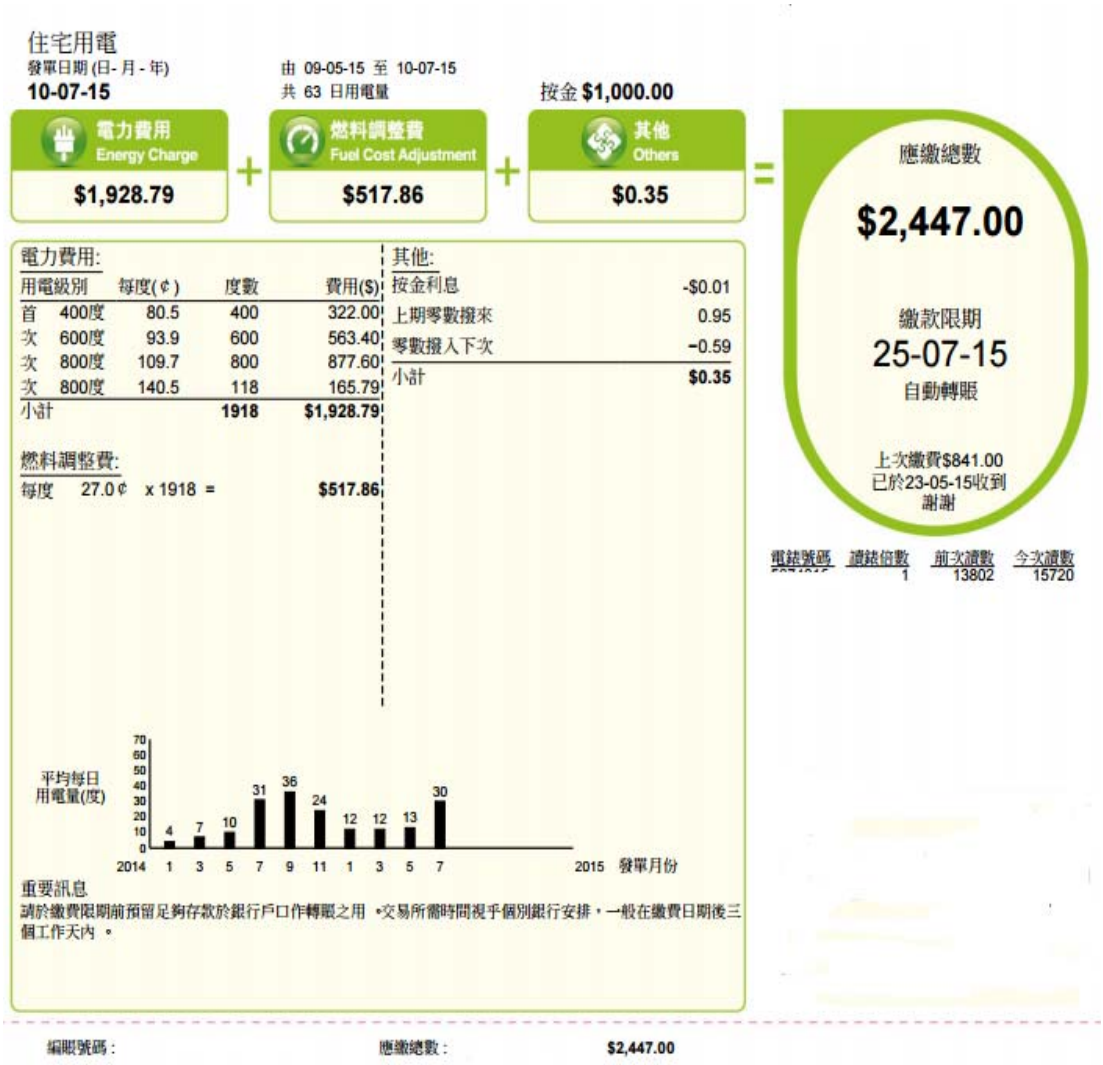
Lesson	Learning and teaching strategies and flow
	energy to reduce the emission of pollutants has become an important factor to be considered. ➢ Some think that "the cost of electricity generation" is less important for Hong Kong residents because Hong Kong is a wealthy society with a large population, so even if there was an increase in the cost of electricity generation, the shared cost that each household would bear would remain low. ➢ Safety should be considered of greater importance because Hong Kong is densely populated, so any accident involving electricity generation is likely to cause a large number of casualties. If time allows, consider inviting each group to share their discussion results. Explain that there are no right or wrong answers, what is important is that they have sound evidence to back-up their views.
	Arranging after-class reading and activities in the next lesson (around 5 minutes) ● Ask students to read the basic concepts ("**energy technology**", "**non-renewable energy**", "**renewable energy**", "**resource depletion**") and the relevant information ("International energy development") to consolidate learning and prepare for the next class activity. ● Inform students that the next class activity will focus on the energy development of four countries (China, Japan, the United States and Germany). A simulated world summit will be held during class, to seek international collaborative opportunities and facilitate the development of renewable energy, thereby achieving the goal of reducing emissions.
4-5	**Understand the current development of renewable energy in different countries (around 30 minutes)** ● Give a brief introduction to the theme of the simulated meeting: "How to promote the development of renewable energy". ● Remind students that those playing delegates of these countries should not make up stances and arguments. They should be based on actual facts. For example, students may support their stances with reading materials provided by the teacher, media reports that they have collected on their own, as well as other reliable information. ● Distribute Appendix 6. Ask students to read the materials to understand the renewable energy developments of China, the United States, Japan and Germany and highlight key points. Guide students to help them understand the unique conditions of these countries, such as economic development, natural resources,

Lesson	Learning and teaching strategies and flow
	scientific development and pollution. These factors may affect how resources are allocated to the development of renewable energy. For example: ➢ China has focused on promoting the development of renewable energy in recent years in order to reduce air pollution; ➢ Following the Fukushima Daiichi nuclear accident on 11 March, 2011 Japan has been attempting to become less dependent on nuclear energy; ➢ Thanks to improved extraction technologies for shale gas in recent years, the U.S. has obtained greater supplies of natural gas (shale gas is a form of natural gas) and reduced its emissions and pollution. As a result, the U.S. no longer needs to direct as much resources to develop renewable energy. ● Distribute Appendix 7. Each group should write down the states of national affairs and issues faced by their respective countries, and briefly explain how such issues/states may affect the development of renewable energy in these countries.
	Simulated Energy Summit of 4 Countries: Seeking collaborative opportunities among different nations (around 30 minutes) ● When students gain an understanding of the four countries, encourage them to discuss how these countries may collaborate with one another in the field of renewable energy to put their respective strengths to use and form relationships of mutual benefit, with a view to promoting the use of renewable energy. For example: ➢ Experts from China and the the United States could carry out research studies on the technology of wind power, discussing how to make wind power more efficient or otherwise lower its cost of electricity generation. ➢ Since China's economy has developed rapidly in recent years, many Chinese investors are eager to find investment opportunities. They could invest in renewable energy projects in the United States, Japan and Germany, which could also create more jobs for those countries. ➢ The United States can draw lessons from the examples set by Germany or Japan in the promotion of renewable energy, and find a way to encourage its own people to use renewable energy more. ● Ask students to hold discussions within their groups and decide which country they want to form a partnership with; then ask group leaders/representatives to approach other groups with a view to persuading them and discussing details about the partnership. Prepare cue cards or tips for different countries, and then distribute new arguments to students when appropriate. ● Distribute Appendix 8. Students may wear name badges for the four-nation energy summit. Encourage students to interact with other groups and discuss

Lesson	Learning and teaching strategies and flow
	collaborative opportunities among different countries. After the representative of a country successfully teams up with that of another, complete Appendix 8. In addition to elaborating on the needs or strengths of the country represented and the benefits for the other country, the representative should also evaluate the difficulties that may be encountered. ● To facilitate the development of renewable energy in 2 countries or a multiple of countries, students should refer to information collected to persuade others to form a partnership of mutual collaboration and development to achieve a win-win situation.
	Teacher summary and debriefing (around 10 minutes) ● In addition to inviting students that have procured partnerships with other countries to share the information they used, also invite students who did not share their information in order to analyse the difficulties they faced. Through the sharing session, evaluate whether students' speeches and analyses are appropriate. ● For more capable students, encourage them to think further on why certain countries can direct resources to develop renewable energy, while others continue to use fossil fuels to generate electricity. This may relate to a country's unique geographical conditions, economic development, fossil fuel reserves and the size and distribution of its population. ● Ask students to consolidate their answers on Appendix 8 after class and submit the assignment in the next class.
	Instruction and arranging after-class assignment (around 10 minutes) ● Distribute after-class assignment (Appendix 9). Ask students to reflect on the strengths and weaknesses of renewable energy, and ask them to discuss effective methods to reduce greenhouse gas emissions within the context of Hong Kong. In order to help students gain a preliminary understanding of greenhouse gas emissions in Hong Kong, read part of the information with students and encourage them to finish their homework by applying the knowledge they have acquired in the past few lessons, while focusing on the following: ➢ Strengths and weaknesses of different renewable energy sources, such as wind power, hydro energy and solar power. ➢ Effective solutions to reduce local greenhouse gas emissions.

-- End of learning and teaching exemplar --

Appendix 1：Examining the Household Utility Bill



Source: provided by the resource developer

1. Have you ever checked the utility bill of your household? How much do you pay for electricity every month/two months?

   _____

2. What does your family use the electricity for? Which appliances consume more electricity? Which appliances can reduce energy consumption? Can you estimate the maximum percentage to be reduced?

Appliances	Use of time	Can the energy consumption be reduced?	How can energy consumption be reduced?

3. Which months show the highest consumption of electricity? Why?

_____

_____

_____

4. Where does Hong Kong secure its electricity supply from? How else can electricity be generated?

_____

_____

_____

5. Which energy sources have you learnt about or heard of?

6. Discuss with group members and then group the above energy types into two categories:

Energy types	Examples

Appendix 2

Role cards

Chairperson

Responsibility：Lead group members to hold discussion while managing the time for the discussion.

Time-keeper

Responsibility：Assist the chairperson with timing. Remind the 2 presenters to finish their presentations within the time limit.

Presenter（1）

Responsibility：Report key points from the discussion.

Recorder（1）

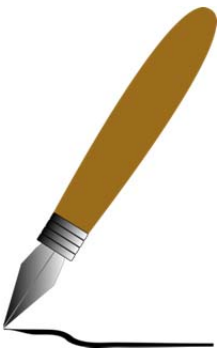
Responsibility：Record key points from the discussion.

Presenter（2）

Responsibility：Assist Presenter (1), give supplementary information and provide examples for explanation.

Recorder（2）

Responsibility：Assist Recorder (1), record key points from the discussion.



Appendix 3: Reading Materials (Comparison of major energy sources)

Read the following sources and complete the table in Appendix 4：

Source A: Development of nuclear energy

Currently, all types of reactors commonly used in nuclear power stations are based on the same principle: generating heat through chain reaction in nuclear fission. The heat then drives turbines to generate electricity. The public is divided over their views on nuclear power. For example, as nuclear reactors emit no carbon dioxide during operation, some people favour nuclear power to reduce greenhouse gas emissions. In addition, as each kilogram of uranium can produce energy equivalent to 2.5 million kilograms of coal, nuclear power is regarded as having a low production cost, which makes it highly cost-effective.

However, many anti-nuclear groups argue that while nuclear power stations do not directly emit greenhouse gases during operation, large amounts of fossil fuel are still consumed when mining uranium and building the nuclear plants, thereby generating greenhouse gases. In addition, only approximately 30% of energy consumed is used for electricity generation; the remaining 70% or so is wasted as heat, causing temperatures in the air, rivers and oceans to rise. In the aftermath of the Fukushima Daiichi nuclear accident, the public has realised that even the slightest oversight in the management of nuclear power stations can lead to catastrophic consequences (e.g. radiation leaks), causing severe and vast regional damage.

Daya Bay Nuclear Power Plant

Source of the photo: http://www.dbcp.gov.hk/chi/safety/plants.htm

Sources: Extracted and adapted from the following articles

1. Nuclear Energy Agency. (2012). “The Role of Nuclear Energy in a Low-carbon Energy Future”. Organisation for Economic Co-operation and development. Retrieved from https://www.oecd-nea.org/nsd/reports/2012/nea6887-role-nuclear-low-carbon.pdf
2. Shanghai Translation Publishing House. (2014). *十萬個為甚麼 新視野版 能源與環境 1*. Hong Kong: Hong Kong Educational Publishing.

Source B: Use of fossil fuel and natural gas

Fossil fuel, including coal, oil and natural gas, is a dominant source of the global energy mix. Regarding environmental impacts, the amount of greenhouse gases emitted by burning natural gas is less than that by fossil fuel, such as oil and coal. According to the Intergovernmental Panel on Climate Change (IPCC), in order to generate the same amount of heat, the amount of carbon dioxide generated by burning natural gas is 14% less than oil and 36% less than coal. Coal, oil and natural gas are usually measured in metric ton, barrel and m^3 respectively. Energy consumption is expanding with social development. As a result, reserves for various forms of natural energy resources, which take millions of years to form, are depleting. An energy shortage crisis is emerging as the rate of energy consumption far exceeds that of energy resource formation.

Natural gas is considered a relatively clean fossil fuel because it emits neither sulfur dioxide nor suspended particulates when burned, and it does not produce solid waste. However, burning natural gas still emits carbon dioxide and nitrogen dioxide. In addition, there is a risk of methane leakage during transportation. According to some research, methane can cause even greater greenhouse effects than carbon dioxide, and therefore it is considered one of the main causes of global warming. As an inflammable substance, natural gas is likely to explode if a container is struck or damaged by an outside force, and therefore requires larger storage space. Damage to the ecological system and land erosion may also occur during the construction of related power stations and transportation facilities, which may lead to landslides and the degrading of soil quality.

HEC Submarine Gas Pipeline

Source of the photo: http://www.hkie.org.hk/ea/chi/details.asp?id=75

Sources: Extracted and adapted from the following articles

1. “Glossary of Energy-related terms”. Office of Energy Efficiency and Renewable Energy. United States Department of Energy. Retrieved from http://energy.gov/eere/energybasics/articles/glossary-energy-related-terms#N
2. Environmental Protection Agency. (2013). “Natural Gas”. United States Environmental Protection Agency. Retrieved from http://www.epa.gov/cleanenergy/energy-and-you/affect/natural-gas.html
3. Environmental Campaign Committee. “香港：可持續未來通識教材”. Retrieved from http://www.eccteachingkit.org.hk/web/energy_prod.html
4. Intergovernmental Panel on Climate Change (2014). *Assessment for Climate Change.* United Nations Environment Programme (UNEP) and the World Meteorological Organisation (WMO). Retrieved from http://ipcc.ch/

Source C: Use of Coal

Coal is a commonly used fossil fuel. For example, in Hong Kong, coal is the major source of energy for electricity generation, comprising approximately 53% of its current fuel mix. Coal takes millions of years to form underground under intense pressure and heat. Like natural gas, coal is a non-renewable energy form because it cannot be produced within a short period of time.

While burning coal emits a number of pollutants such as sulphur dioxide, nitrogen oxides and suspended particulates, methane is emitted from coal mines, accelerating global warming. Coal mining can also result in large-scale land damage, and coal reserves are often evacuated when coal dust and other forms of mining waste are produced during the process. Therefore, many people believe that electricity generation by coal causes more pollution than other energy sources.

However, its rich reserves and ease of storage makes coal less costly in construction and mining.

HK Electric Lamma Power Station
Coal yard

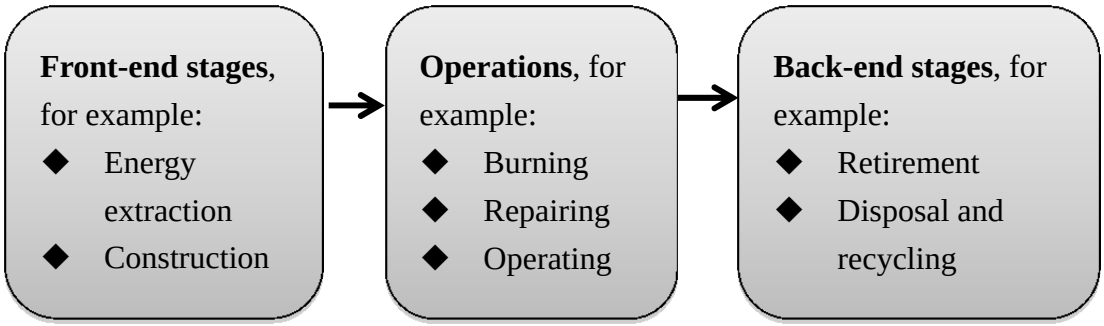
Source of the photo:
https://www.hkelectric.com/zh/our-operations/electricity-generation?textonly=0

Sources: Adapted from the following articles

1. Environmental Protection Agency. (2013). “Coal”. United States Environmental Protection Agency. Retrieved from http://www.epa.gov/cleanenergy/energy-and-you/affect/coal.html
2. Electrical and Mechanical Services Department. (2015) “Energy”. http://www.energyland.emsd.gov.hk/en/energy/environment/pollutants.html
3. Environmental campaign committee.“香港：可持續未來通識教材”. Retrieved from http://www.eccteachingkit.org.hk/web/energy_prod.html

Source D: Life cycle of energy production

Life cycle of energy production



When calculating the amount of greenhouse gas emissions for power generation technology, the whole life cycle should be considered. This includes fuel extraction, refinery, transportation, construction of power stations, back-end handling and retirement.

If the whole life cycle is considered, electricity generation using renewable energy generally leads to less greenhouse gas emissions than fossil fuel:

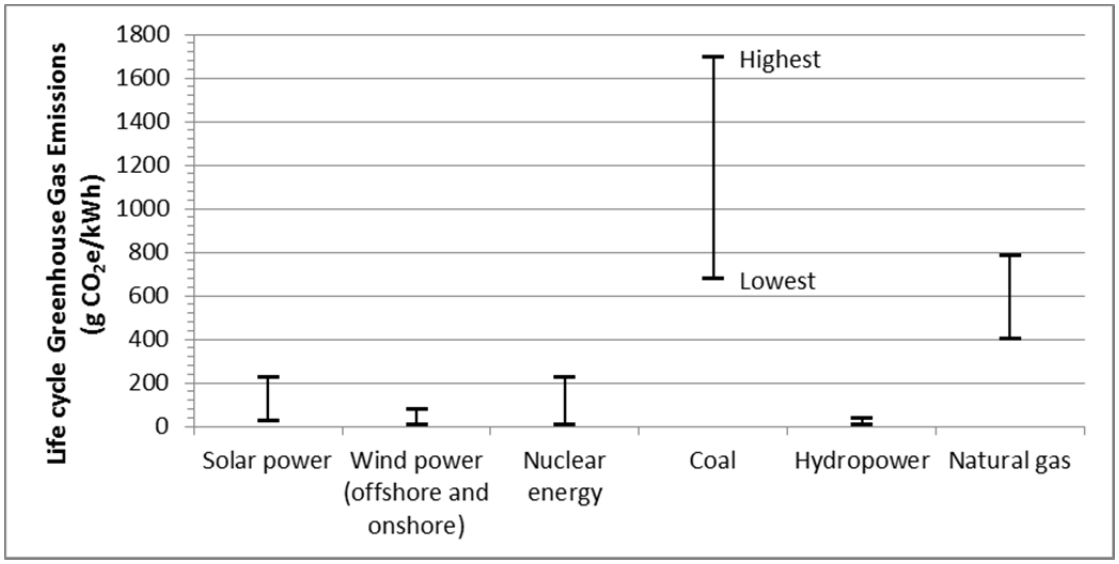
- For electricity generation by fossil fuel, the majority of greenhouse gases are emitted in the operation stage when fossil fuel is burned.
- For electricity generation by renewable energy (e.g. solar energy, wind energy, hydroelectric energy), the majority of greenhouse gases are emitted in the front-end stage, such as the construction of hydroelectric power facilities.
- Nuclear power plants have a limited lifespan. A power plant has to be shut down and demolished at the end of its lifespan. In addition, all facilities must be cleaned before transforming them into general usage, and the process emits large amounts of greenhouse gases.

Sources: Extracted and adapted from the following articles

1. Intergovernmental Panel on Climate Change. (2011). "Renewable Energy Sources and Climate Change Migration". Retrieved from http://srren.ipcc-wg3.de/report
2. United Nations Environment Programme. (2011). "Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication". Retrieved from http://www.unep.org/greeneconomy/Portals/88/documents/ger/ger_final_dec_2011/Green%20EconomyReport_Final_Dec2011.pdf
3. Intergovernmental Panel on Climate Change. (2014). *Climate Change 2014 Mitigation of Climate Change*. New York: Cambridge University Press. Retrieved from http://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_full.pdf
4. Hong Kong Nuclear Investment Co. Ltd. "Nuclear power – Station decommissioning". Retrieved from https://www.hknuclear.com/nuclear/power/decommission/pages/stationdecommissioning.aspx?lang=en

Source E

Life-cycle greenhouse gas emissions for various types of power generation technologies



Note:

- The above chart shows the maximum and minimum amount of emissions as estimated by different research studies, the range of the figures is shown with bars like the letter "I".
- gCO2e is a unit of the amount of greenhouse gases emitted.
- The kilowatt hour (kWh) is a metric unit of energy used to indicate the amount of energy consumed by a 1-kilowatt appliance in an hour.

Source: National Renewable Energy Laboratory of the U.S. Department of Energy. "Life Cycle Greenhouse Gas Emissions from Electricity Generation". Retrieved from http://www.nrel.gov/docs/fy13osti/57187.pdf

Source F

The expected levelised cost of electricity (LCOE) for major power generation technologies used in the U.S. in 2020*

Power generation technologies	Expected levelised cost of electricity (US dollars / Megawatt-hour **)
Coal	60.4
Natural gas	14.4
Nuclear power	70.1
Wind power	57.7
Offshore wind power	168.6
Hydroelectric power	70.7
Solar power	109.8

* Levelised cost of electricity (LCOE) is used to compare the life-cycle costs of electricity generation of different power generation technologies, taking into account the costs of the stages of power station construction, transportation, fuel and retirement.

** Megawatt-hour refers to 1 million watt hours and is a unit of power.

Source: U.S. Energy Information Administration. (June 2015). “Levelized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook 2015”.

Source G: Hydroelectric power

Hydroelectric power is a form of renewable energy that is widely used in the world. It is common for countries rich in water resources, such as China, Canada, Brazil, the U.S. and Russia, to build large hydroelectric power plants to generate electricity. For a few countries, such as Norway, Iceland and Canada, hydroelectric power constitutes more than half of their national electricity supplies. There are no rivers in Hong Kong with sufficient water flow to allow the construction of large hydroelectric power plants, it is, however, still feasible to install small hydroelectric power plants in certain areas.

Hydroelectric power makes use of falling water to rotate turbines and drive electricity generators to generate electricity. It is considered the most developed renewable energy technology. It can also be used for agricultural irrigation and flood control. However, the use of hydroelectric power is constrained by geographic environment, and the construction of power plants may also cause geological disturbances. In addition, because of insufficient oxygen the anaerobic respiration of organisms living at the bottom of dams increase the amount of carbon dioxide contained in the water.

Three Gorges Project

Source of the photo:
http://www.bbc.com/zhongwen/trad/focus_on_china/2011/05/110523_cr_china_3gereges.shtml

Sources: Extracted and adapted from the following articles

1. “再生能源救到香港？”, 22 March 2015, *Ming Pao.*
2. Electrical and Mechanical Services Department. “Hydroelectric”. Retrieved from http://re.emsd.gov.hk/english/other/hydroelectric/hyd_tech.html
3. Electrical and Mechanical Services Department. “Hydroelectric”. Retrieved from http://re.emsd.gov.hk/english/other/hydroelectric/hyd_tech.html
4. Environmental campaign committee. “香港：可持續未來通識教材”. Retrieved from http://www.eccteachingkit.org.hk/web/energy_prod.html

Source H: Wind power generation

Wind power makes use of wind to drive wind turbines, which in turn drive generators to generate electricity. However, in order to produce electricity in a cost-effective manner, large areas of land with strong wind are necessary. Some European countries have built wind farms at sea. The construction costs at sea, even in shallow locations, are three to four times of that on land, resulting in higher electricity costs. The costs are even higher in deeper locations, as the technology needed for this is still relatively new. Denmark has the most advanced technology in wind power generation.

Wind power generators are key for wind power generation. Wind power generators are comprised of several parts including, among others, blades, a turbine gearbox, an electric generator, a control system and a tower. The blades are used to capture and transform wind into mechanical energy. As the power of wind varies and its direction is always changing, energy has to be stored. Energy is stored when there is sufficient wind, and used when there is insufficient wind. Wind power is a green energy, as it generates electricity by a natural process, without producing pollutants. However, large wind power systems produce noise, and giant towers can also interfere with TV signals. Therefore, wind power systems must be constructed in places with strong and consistent wind, and far from urban areas.

Source of the photo: This photo was taken by the resource developer

Sources: Extracted and adapted from the following articles

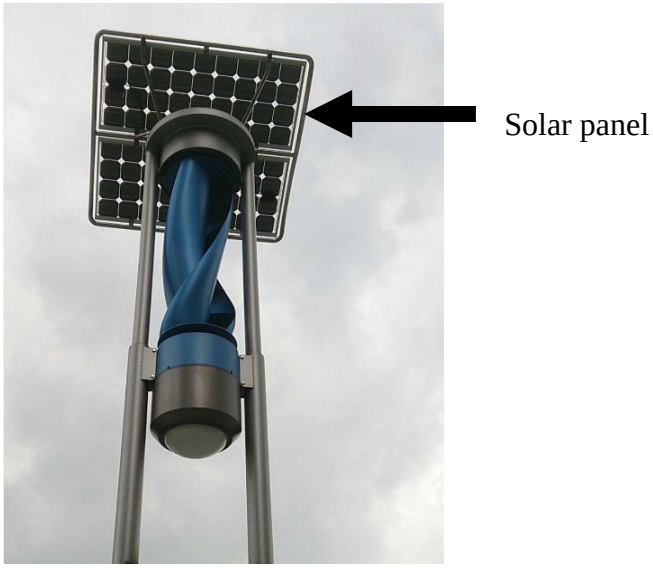
1. “再生能源救到香港？”, 22 March 2015, *Ming Pao*.
2. Shanghai Translation Publishing House. (2014). *十萬個為甚麼 新視野版 能源與環境 1*. Hong Kong: Hong Kong Educational Publishing

Source I: Solar power

As the use of solar power does not emit air pollutants, it is therefore a clean energy. In addition, there will always be a supply of solar energy as long as the sun exists. By using different technologies, solar energy can be converted into thermal or electrical energy. Currently, two technologies are used:

Solar photovoltaic technology is made up of solar cells that convert light energy into electrical energy. In addition to powering watches and calculators, solar cells can provide light. The second technology is solar water heating. Solar water heaters are installed on rooftops to absorb as much sunlight as possible; sunlight heats water in the tank, which can then be transported for indoor use.

For places with sufficient sunlight, there is an unlimited supply of solar energy, and the process of electricity generation will neither produce pollutants nor cause greenhouse gas emissions. However, the cost of solar power is high, and the production of raw materials for solar panels can cause pollution. Some wealthy countries outsource the production of solar cells to other countries, which means exporting pollution to those countries. Solar power depends on the weather, and is inappropriate in areas without sufficient sunlight.



Source of the photo: This photo was taken by the resource developer

Sources: Extracted and adapted from the following articles

1. “太陽能發電利弊” , 13 October 2011, *Wenweipo*.
2. “太陽能真的夠「綠」嗎？還是包裹著糖衣的毒藥”, 1 September 2014, *天下雜誌*.
3. Electrical and Mechanical Services Department. “Solar Photovoltaic”. Retrieved from http://re.emsd.gov.hk/tc_chi/solar/solar_ph/solar_ph_to.html
4. Environmental campaign committee. “香港：可持續未來通識教材” . Retrieved from http://www.eccteachingkit.org.hk/web/energy_prod.html

Appendix 4：Questions for Discussion

Worksheet 1：Comparison of common power generation technologies

	Cost	Environmental Impact	Safety	Possible limitations
Nuclear power				
Coal				
Natural gas				
Wind power				
Hydroelectric power				
Solar power				

Appendix 5：Discussion on the importance of different criteria in Hong Kong

Refer to the following sources and complete the worksheet:

Source A

A survey by Global Finance Magazine found that Hong Kong is the 6th wealthiest place in the world, outperforming its neighbours, such as Japan, Taiwan and Korea. Hong Kong also enjoys a higher wealth index than the U.S., which ranks 7th on the list. In addition to GDP, the research also takes other factors into account including the quality of life of citizens, their income distribution, as well as life expectancy and educational attainment.

According to the Human Development Report 2013 published by the United Nations, Hong Kong ranked 13th in the world in the human development index, sharing with Japan the number one position in Asia. The human development index takes into consideration a variety of aspects in a country's economic and social conditions, and is therefore considered an index that can reflect the living and economic conditions of people living in different regions.

Based on statistics of the Hong Kong Trade Development Council in 2014, the economic and trade conditions of Hong Kong are summarised as follows:

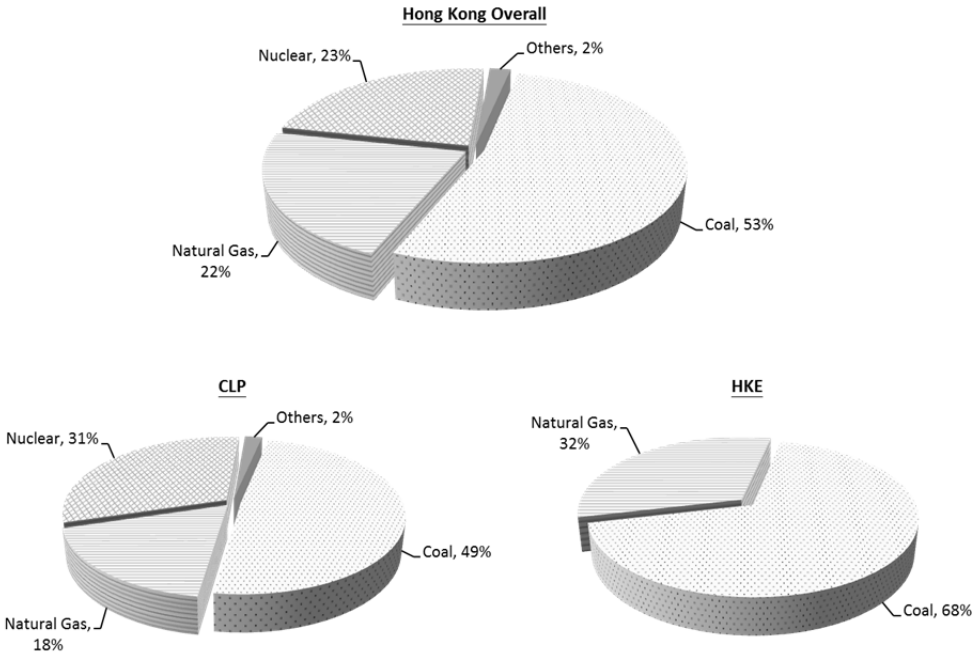
Major Economic Indicators	
Population	7,240,000
Gross Domestic Product (GDP)	US$289.2 billion*
GDP per capita	US$39,900
Unemployment Rate	3.2%

* Note: Hong Kong is the world's most service-oriented economy, with service sectors accounting for more than 90% of its GDP.

Sources:

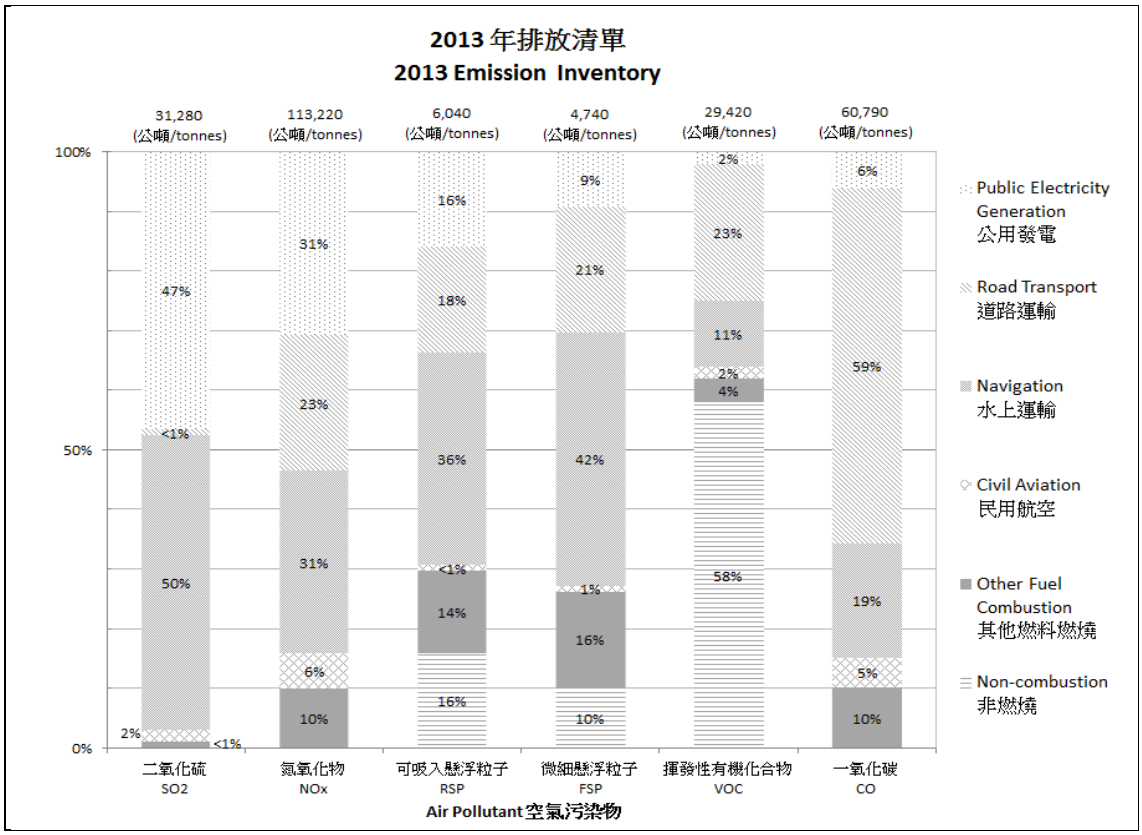
1. "Economic and Trade Information in Hong Kong". The web page of HKTDC Research. Retrieved from http://hong-kong-economy-research.hktdc.com/business-news/article/%E5%B8%82%E5%A0%B4%E7%92%B0%E5%A2%83/%E9%A6%99%E6%B8%AF%E7%B6%93%E8%B2%BF%E6%A6%82%E6%B3%81/etihk/tc/1/1X000000/1X09OVUL.htm.
2. United Nations Development Programme. (2013). Human Development Report 2013:The Rise of the South: Human Progress in a Diverse World. Retrieved from http://hdr.undp.org/sites/default/files/hdr2013_en_summary.pdf

Source B: Fuel Mix for Electricity Generation in Hong Kong in 2012



Source: HKSAR Environmental Bureau. (2014). "Public Consultation on Future Fuel Mix for Electricity Generation". Retrieved from http://www.enb.gov.hk/sites/default/files/en/node2605/Consultation%20Document.pdf

Source C: Hong Kong Emission Inventory in 2013



Note: Other fuel combustion sources include non-road mobile machines operating on construction sites and at container terminals. Non-combustion sources include paints and associated solvents, consumer products and printing, whereas those for RSP and FSP include paved road dust, construction dust, quarry production and cooking fumes.

Source: Environmental Protection Department. (June 2015). "Hong Kong Air Pollutant Emission Inventory". Retrieved from http://www.epd.gov.hk/epd/english/environmentinhk/air/data/emission_inve.html

Source D

Like every other place in the world, Hong Kong is facing high levels of carbon dioxide emissions, which cause climate change. In Hong Kong, electricity generation is one of the main sources of greenhouse gas emissions. A number of factors, including geographical restrictions and cost, make it impractical for Hong Kong to adopt the practices of some foreign countries, which is to replace fossil fuel by generating renewable energy effective on a large scale.

Hong Kong's geographical location is the most important factor. Taking solar power as an example, large areas of land can be found in many foreign countries for the installation of solar panels. While solar panels can be installed on the roofs of buildings,and Hong Kong is densely packed with buildings of varying heights, solar panels may be blocked by other buildings, resulting in a significant reduction in their performance. In addition, the rooftops of many buildings are owned by owners' corporations, which makes it difficult to gain access to roof space for the installation of solar panels. Wind power generation requires sizeable wind fields, and oceans with strong winds are ideal locations to generate wind power. However, with its geographical limitations, their implementation in Hong Kong face many difficulties.

Energy generation from waste is a more feasible approach for Hong Kong. For example, the methane gas produced in landfills can be used to generate electricity. However, there is a major problem with this approach: it is difficult for the public to gain access to the energy produced because these energy-from-waste facilities are all located far away from residential areas.

Sources: Extracted and adapted from the two articles below

1. 蘇偉文 "可再生能源與電力政策" , 19 May 2015, *Oriented Daily*.
2. "再生能源救到香港？", 22 March 2015, *Ming Pao*.

With reference to the above sources, when the Hong Kong Government chooses to generate electricity, what is the relative importance of the three factors? Why? (Rank the relative importance by writing 1, 2 or 3 (1 is the most important))

	Relative Importance	**Reasons**
Cost		
Environmental Impacts		
Safety		

Appendix 6：Simulated Summit of Leaders from Four Countries
(Reading materials)

Discussion topic：How to promote the development of renewable energy?

Background information

As the “greenhouse effect”, “climate change” and “global warming” have become environmental topics of global importance, members of the international community are seizing opportunities offered by international platforms to discuss feasible methods to reduce greenhouse gas emissions. However, global carbon dioxide emissions continued to increase in 2014, reaching a new record high (refer to figure 2). The chart below shows the amount of energy consumed and greenhouse gas emitted in the world.

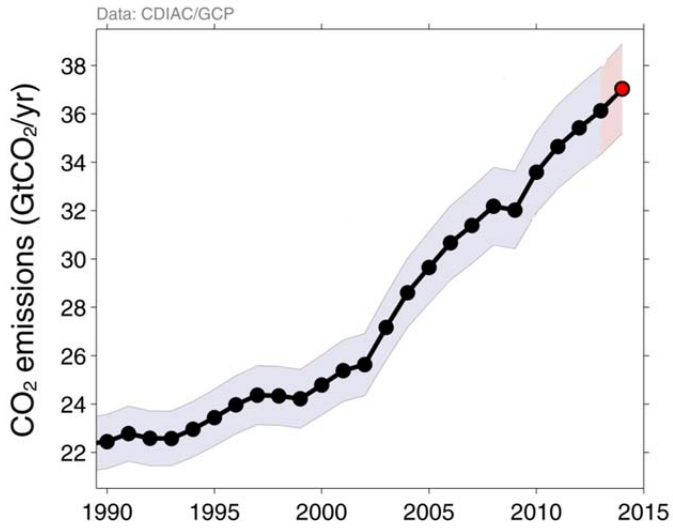
Figure 1：World Energy Consumption by Region (2014)

World Energy Consumption by Region (2014)					
Regions	**Oil / Million tons**	**Natural Gas / Mtoe***	**Coal / Mtoe***	**Nuclear Energy / Mtoe***	**Hydroelectricity/ Mtoe***
North America	1024.4	866.3	488.9	216.1	153.5
South & Central America	326.5	153.1	31.6	4.7	155.4
Europe and Eurasia	858.9	908.7	476.5	266.1	195.7
Middle East	393.0	418.6	9.7	1.0	5.2
Africa	179.4	108.1	98.6	3.6	27.5
Asia Pacific	1428.9	610.7	2776.6	82.5	341.4
World Total	4221.1	3065.5	3881.8	574.0	879.0

* Mtoe (Million tons of oil equivalent) is a unit of energy defined as the amount of energy released by burning one million tons of crude oil.

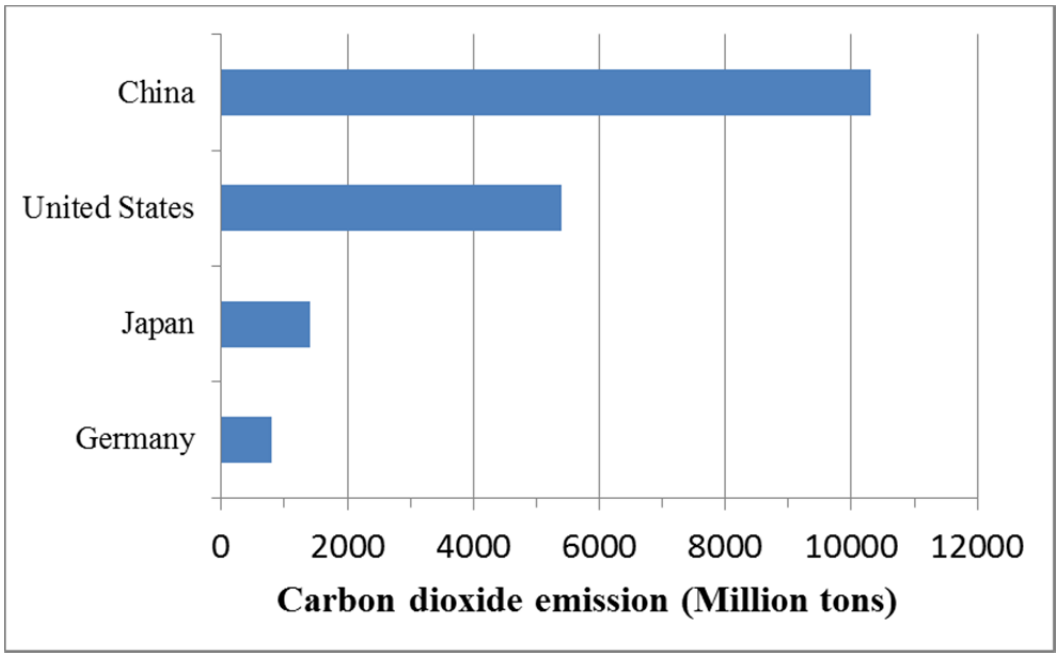
Source: “BP Statistical Review of World Energy 2015”, P.41. Retrieved from https://www.bp.com/content/dam/bp/pdf/energy-economics/statistical-review-2015/bp-statistical-review-of-world-energy-2015-full-report.pdf

Figure 2：World CO_2 Emission (1990-2014)



Source: Global Carbon Project. “Figures from the Global Carbon Budget 2014”. Retrieved from http://folk.uio.no/roberan/learnmore/more_GCP2014_figures.shtml

Figure 3：CO_2 emissions of 4 countries in 2013



Source: PBL Netherlands Environmental Assessment Agency and the Institute for Environment and Sustainability (IES) of the European Commission’s Joint Research Centre (JRC). (2014). “Trends in Global CO_2 Emissions:2014 Report”. Retrieved from http://edgar.jrc.ec.europa.eu/news_docs/jrc-2014-trends-in-global-co2-emissions-2014-report-93171.pdf

You will be playing experts in the field of energy from China, the U.S., Japan and Germany attending this conference. Your mission is to seek opportunities to establish international collaborations to facilitate the development of renewable energy. National delegates should discuss relevant issues from a multiple of perspectives, including the distribution of natural resources, environmental and geographical factors and the status of economic development. Students may refer to the materials provided below to gain an understanding about the development of renewable energy in different countries.

Source A: Representative from the U.S.

In addition to ranking second and fourth in the world in coal and hydroelectric power usage respectively, the U.S. is the world's largest consumer of all other energy sources, such as oil, natural gas, nuclear power (nuclear power currently accounts for approximately 19% of the national electricity supply in the U.S.), renewable energy and biomass energy. With a net import ratio of 52%, oil supply is still the biggest energy gap faced by the U.S. However, its supply of natural gas is promising. Thanks to nation-wide development of shale gas, not only is the U.S. able to meet its own need for natural gas, it also has surplus for export. With the advances in extraction and exploration technologies, the U.S. has successfully extracted large amounts of shale gas in recent years[1]. Gradually, coal-fired power plants are being replaced by cheaper gas-fired power plants. The U.S. is now the world's largest producer of natural gas.

"The current generation is the last generation that can solve the nation's problems, the U.S. must take action", U.S. President Barack Obama said. The objective of his *Clean Power Plan* is to replace coal burning with zero-emission renewable energy to generate electricity in the next 15 years. It is intended to replace coal-fired power plants with high levels of emissions with natural gas-fired power plants of lower carbon emissions. The ultimate goal is to reduce greenhouse gas emissions by electricity companies in the U.S to 1/3 of their current levels. The U.S. is also actively expanding its use of renewable energy. For example, while increasing the supply of electricity generated by solar and wind power, the U.S. also provides financial aid to households for the installation of renewable energy facilities.

[1] Shale gas was first discovered in New York State, U.S. in 1821. Shales are fine-grained sedimentary rocks originating from sea basins millions of years ago. These shales were gradually covered by a layer of organic matter brought by rivers; this layer of rocks and organic matter were then covered by layers of rocks through various movements of the earth (e.g. tectonic plate collisions). The fine-grained sedimentary rocks were then broken into many thin layers, which were soft, fragile and likely to crack. Under the combined effect of pressure and heat, the organic matter buried within these thin layers of shale was converted into hydrocarbons such as natural gas. Unlike conventional fossil fuels that are trapped in shallower oil (gas) fields, shale gas is stored in the tight pores and gaps of shale. The shale has to be broken for the trapped gas to be released.

As the world's two largest automobile markets and the biggest oil consumers, the U.S. and China are committed to forming collaborative relations with the aim to ensure energy safety and reduce pollution, by accelerating the development of electric vehicles and advancing research studies on energy-saving technologies. In order to invent electrical appliances of greater energy efficiency, the Lawrence Berkeley National Laboratory (LBNL), a U.S.-based institute, has carried out joint-research projects on the use of magnetic materials with a number of Chinese universities, including the University of Science and Technology Beijing, Tsinghua University and Shanghai University. In addition, the Brookhaven National Laboratory under the U.S. Department of Energy has sponsored 20 Chinese officials to participate in training sessions organised in three cities in the west coast of the U.S., with a view to enhancing their understanding of the management of the urban environment, green building awareness and the development of clean power.

Sources: Extracted and adapted from the articles below

1. "美國能源政策三大要素：安全、效率、低碳", 31 July 2014, *Chinatimes*.
2. "奧巴馬出台清潔能源計劃", 3 August 2015, BBC 中文網.
3. "Advancing American Energy", the Official Website of the White House, USA. Retrieved from https://www.whitehouse.gov/energy/securing-american-energy#energy-menu

Source B: Representative from China

Finding a solution for the issue of air pollution in the Mainland is a pressing task for the Government. China has initiated many research studies on reducing carbon dioxide emissions through the use of cleaner energy such as wind power, solar power, hydroelectric power and natural gas. The potential re-launch of China's nuclear power projects has become the focus of discussions in recent years as air pollution from smog escalates.

The collaboration between the U.S. and China on renewable energy began in 2000 and was extended in 2014. The collaboration covers governmental, business and academic sectors. In order to reduce greenhouse gas emissions, both countries are focusing on finding solutions in energy production, transportation, manufacturing and construction. For example, results obtained from scientific research in the U.S. will be used in developing China's infrastructure. In 2010, China also proactively assisted Chinese investors to invest in wind-power businesses in the U.S., creating jobs for Americans.

Sources: Extracted from the articles below

1. "內陸核電站「十三五」啟建", 18 October 2014, *Takungpao*.
2. "中國核電發展步伐繼續", 9 December 2014, *Wenweipo*.
3. U.S. Department of Energy. (January, 2011). "U.S. – China Clean Energy Cooperation: A Progress Report by The U.S. Department of Energy".
4. Zhang, W., Yang, J., Sheng, P., Li, X., and Wang, X. (December, 2014). "Potential Cooperation in Renewable Energy between China and the United States of America". In Energy Policy, vol 75, pp 403-409.

Source C: Representative from Japan

The Fukushima Daiichi nuclear accident in Japan traumatised local residents and significantly damaged the ecological system. It also prompted relevant authorities to re-evaluate Japan's energy policies. The accident caused a shortage in power supply, pushing the Japanese Government to examine energy consumption in the country and seek ways to replace nuclear power.

According to the International Energy Agency (IEA), energy efficiency (i.e. methods to reduce energy wastage) is the most important "hidden fuel", and it has contributed significantly to the history of energy development. The IEA measured the performance of energy efficiency measures adopted by its eleven member states between 2005 and 2010. It found that the amount of energy saved was equivalent to US$420 billion of petroleum. As a member of the international community, Japan is a world leader in developing technologies to enhance energy efficiency.

Japan has had energy efficiency plans in place for years and the majority of these are related to residential, business and transportation services. Japan is committed to constantly improving energy conversion and performance standards for its products. The Japanese Government discloses those companies that fail to comply with its policy, in order to encourage producers and importers to actively explore ways to enhance the energy efficiency of high-energy consuming equipment. Organisations from the U.S. and Japan also host roundtable conferences from time to time, to discuss how the two countries can collaborate in the development of renewable energy and energy efficiency, in both the private and public sectors.

Sources: Extracted from the following articles

1. "紓緩氣候變化：從樓宇節能減排開始", 30 November 2011, *Greenpeace*.
2. Editorial. (May 13, 2013). "Renewable Energy Policy". *The Japan Times*.
3. Ministry of Economy, Trade and Industry. (11 March, 2015). "The Third Japan-US Renewable Energy Policy Business Roundtable was Held".

Source D: Representative from Germany

Following the Fukushima Daiichi nuclear accident in Japan, Germany resolved to use nuclear power as a transitional fuel. This allows more time for the government and domestic energy companies to research and develop renewable energy technologies, with a view to gradually replacing fossil fuel with clean energy for electricity generation. Under pressure from the anti-nuclear movement in Germany, the German chancellor Angela Merkel formulated a national policy to achieve the sustainable development of energy. She announced that the 6 oldest nuclear power plants will be shut down by 2021, while the deadline for closing the remaining 3, newly built nuclear power plants is set at 2022. As nuclear power accounts for nearly 30% of the power supply in Germany, there is a pressing need for the German government to find alternative fuels. As a result, in addition to financing approximately EUR20 billion every year to support the development and operation of renewable energy technologies, the German government also compensates the nation's industrial and commercial sectors to encourage power companies and enterprises to increase their use of renewable energy.

In Germany, not only do enterprises use renewable energy for electricity generation. Each household has its own underground cables, so that any family that generates electricity by renewable energy is allowed to feed any surplus power to the national power network, and earn money from this. In order to even out the fluctuations in wind and solar power production, Germany has been working to upgrade its smart power network, with a view to effectively make use of the hundreds of thousands of household solar power facilities and small gas-fired generators located all over the country.

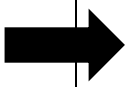
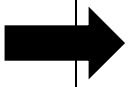
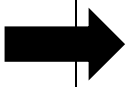
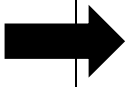
In the first quarter of 2014, renewable energy constituted 27% of the German fuel mix. This far exceeded the power supply by renewable energy of 12%, which was agreed among EU members in 1997. Germany has also been collaborating with other countries in many energy-related matters. For example, a leading solar energy company in China has agreed to share its solar energy technologies with its German partners and sell its solar panels to Germany. The Chinese National Energy Conservation Centre has also signed an agreement with the German Energy Agency, agreeing to exchange ideas and share resources in relation to energy-saving plans and energy efficiency issues.

Sources: Extracted and adapted from the following articles

1. "從德國的能源政策出發", 15 October 2014, *Hong Kong Economic Journal.*
2. "德國率先退核發展綠色能源 電動汽車闖出環保路", 9 October 2014, *Hong Kong Daily News.*
3. Du Juan. (30 March, 2014). "Chinese-German cooperation on new energy runs deep.", Chinadaily.com.cn.

Appendix 7：Worksheet for the Simulated Meeting

Development of renewable energy in different countries

Country	Problem(s) encountered / Situations faced by the country (Quote directly from the sources)	Possible impacts on the development of renewable energy (Students may infer from the sources)
China		
The United States		
Japan		
Germany		

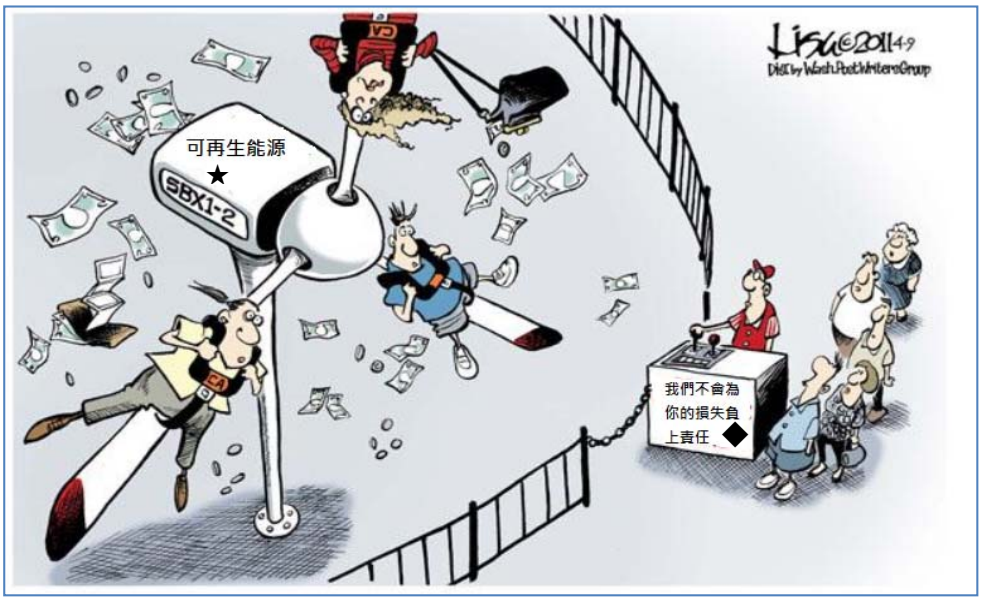
Appendix 8：Worksheet on International Collaboration

Your country: _____

1. Country you want to seek collaboration with	_____
2. Potential collaboration opportunities in renewable energy	
3. Needs or strengths of your country	
4. Potential benefits for the working partner	
5. Possible difficulties	

Appendix 9：After-class Assignment

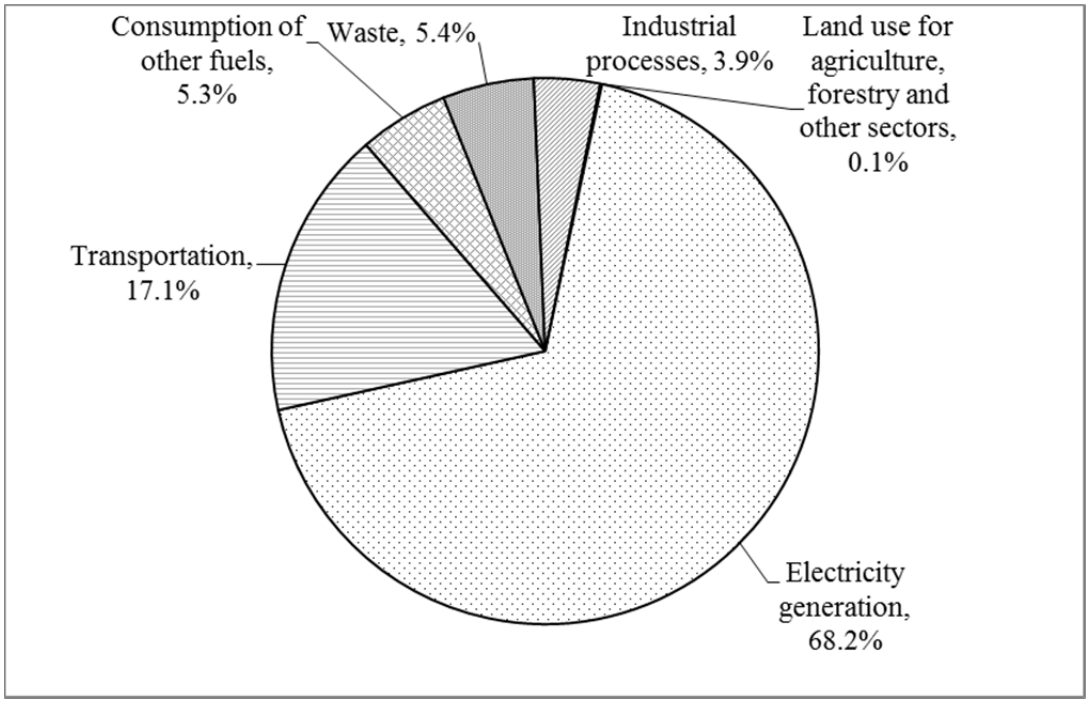
Source A



★ renewable energy
◆ "We will not be responsible for your loss."

Source: Lisa Benson (2011). Retrieved from
http://www.cartoonistgroup.com/subject/The-Renewable+Energy-Comics-and-Cartoons.php/1

Source B：2012 Greenhouse gas emissions in Hong Kong by source



Note:
1. Electricity Generation includes towngas production, which accounts for only about 1% of greenhouse gas emissions caused by energy production
2. Consumption of other fuels include use of fuel for combustion in commercial, industrial and domestic premises

Source: Environmental Protection Department. "Greenhouse Gas Emissions in Hong Kong by Sector", Retrieved from
http://www.epd.gov.hk/epd/sites/default/files/epd/english/climate_change/files/HKGHG_Sectors_201506.pdf

Source C

Studies[1] show that two renewable energy technologies, namely solar power and energy from waste, are suitable for development in Hong Kong. Hong Kong has been utilising solar power for more than two decades, primarily to heat water. Solar water heaters are installed in low-density buildings and swimming pools located in the suburbs. Energy from waste is mainly used to provide fuel for electric generators at landfills.

However, the development of renewable energy in Hong Kong has always been limited by two factors: the high costs, and Hong Kong's geographical limitations. According to the China Light and Power Company (CPL), its wind farms only account for 1.4% of the company's total electricity supply, but the overall tariff increased by 2%. That means the cost for wind power remains high.

Many consider Germany to be a paragon in the development of renewable energy. However, while having one of the fastest growths in the use of renewable energy over the last decade, its utility rates have also risen. This is because of the increasing use of renewable energy in electricity generation. As a result, more than 100,000 households cannot afford renewable energy, and some have had their power supply cut.

Sources: Extracted and adapted from the following articles
1. "周全治：可再生能源額外成本誰負擔？", 29 May 2015, Sing Tao Daily.
2. Electrical and Mechanical Services Department. "齊來認識可再生能源". Retrieved from http://www.emsd.gov.hk/filemanager/tc/content_299/re_leaflet_chi.pdf

Questions

(a) Identify the views of the cartoon author towards renewable energy. What evidence in Source C can be used to support the author's viewpoints? Explain.

(b) "In Hong Kong, the development of renewable energy can improve people's quality of life." To what extent do you agree with this viewpoint?

[1] The Electrical and Mechanical Services Department appointed an advisory firm at the end of 2000 to carry out a two-phased research project, studying the feasibility of broadly applying renewable energy technologies in Hong Kong.http://www.emsd.gov.hk/emsd/c_download/sgi/re_leaflet_chi.pdf

Intention of Assessment

Assessment Focus

The source of the assessment item includes a text relating to renewable energy, a chart on the 2013 air pollutant emissions in Hong Kong, and a cartoon. The cartoon reflects the high cost of renewable energy (e.g. wind power), which may lead to an increase in electricity prices. The text describes the development of renewable energy in Hong Kong and the possible restraints, to encourage students to reflect on the strengths and weaknesses of renewable energy and its impact on the quality of life.

Expected student performance

- Knowledge
  - For question (a), students should point out the concerns related to costs in developing renewable energy, including all costs to be occurred throughout the lifespan of any given technology (e.g. purchasing turbines, or building power stations), and explain how these costs may be borne by taxpayers and the public.
  - For question (b), students should first present their own stances and comment on the likelihood of developments in renewable energy technologies enhancing the quality of life for people. They should quote from the chart of greenhouse gas emissions in Hong Kong from Source B and the textual information from Source C, following which, they should analyse the costs and benefits of developing renewable energy. This question requires students to have a concrete understanding of all common renewable energy technologies and their strengths and weaknesses, space requirements and geographical limitations (such as the development of wind power, which requires areas with strong wind). Students with strong learning skills should perform the analysis from multiple perspectives, taking into account geographical, social and economic factors. For example, due to restrictions posed by geographical conditions, there is a very limited reserve of land for development in Hong Kong, so any large renewable energy system may limit local land development in the future; in addition, some of the renewable energy systems may have an impact on Hong Kong's landscape, as well as noise pollution. Students should explain their views by using appropriate data. For example, since it is shown in Source B that "electricity generation" is the biggest source of greenhouse gas emissions in Hong Kong, developing renewable energy technologies to generate electricity could therefore be an effective method to reduce carbon dioxide emissions. However, this approach may lead to increased costs in electricity generation.

- Skills
  - Giving appropriate response with a clear personal stance.
  - Extracting and interpreting the core messages of charts and written texts, and transforming them into advanced knowledge and concepts.
  - Describing statistical data, identifying the features of the cartoon, explaining the causes leading to the trends.
  - Using relevant concepts as supporting evidence.

--- End of Appendix --

Senior Secondary Liberal Studies
"Energy Technology and the Environment"
Module
Learning and Teaching Exemplar (2)

Public Policies Promoting the Development of Electric Vehicles

A. Basic information of the exemplar

Topic	Public policies promoting the development of electric vehicles
Relevant modules, themes and issues for enquiry	**Leading** Module 6：Energy Technology and the Environment Theme 1: The Influence of Energy Technology ● To what extent does the development of energy technology create or solve environmental problems? Theme 2: The Environment and Sustainable Development ● How do the living styles of people and social development affect the environment and the use of energy? ● What responses could be made by different sectors of society, governments and international organisations regarding the future of sustainable development?
	Related Module 2: Hong Kong Today；Module 1:Quality of Life ● Which aspects of the quality of life are seen to be more important? Which are seen to be immediate needs? Who might make the decisions? Why?
Overall design rationale	In addition to using electric vehicles as an example to help students explore and discuss the ways in which technologies can facilitate the implementation of sustainable development, this exemplar also focuses on the importance of policies in the promotion of sustainable development. To encourage students' interest, teachers can start with students' personal experiences, and then guide them in developing an understanding of how the Government promotes the use of electric vehicles as a measure to address the issue of air pollution in Hong Kong. This exemplar enables students to understand the factors considered by the Government when formulating policies and the difficulties that they may encounter. In addition, even if an environmentally friendly technology is feasible, its effective promotion would still require the cooperation of various stakeholders in society.
Time required	4 lessons (40 minutes per lesson), approximately 160 minutes in total
Learning objectives	Knowledge: ● To understand the situation regarding air pollution in Hong Kong and the Government's measures to promote the use of electric vehicles. ● To understand the measures or policies adopted by different countries to promote the use of electric vehicles. ● To understand the factors to be considered by the Government in developing and implementing any environmental or energy policy.

	Skills: ● To collect and summarise information from different sources. ● To make conceptualised observations using data obtained through issue-enquiry. ● To apply relevant knowledge and concepts when discussing contemporary issues. ● To interpret data from different perspectives.
	Values and attitudes: ● To adopt an open and tolerant attitude towards other people's views and values. ● To consider personal and social topics and issues from multiple perspectives and make sound judgments with reasoning and creativity. ● To understand the importance of environmental protection and sustainable development, to respect natural resources, and to practise a green lifestyle.
Basic concepts for application	Air pollution, energy technology, renewable energy, non-renewable energy, resource depletion, quality of life, sustainable development, green lifestyle, climate change.
Relevant learning experience at junior secondary levels	Having studied various subjects of Personal, Social and Humanities Education, as well as Science Education Key Learning Areas in the junior levels, students should have acquired a basic understanding of the composition of air, the balance of carbon dioxide and oxygen in nature; air pollution, acid rain, global warming, the greenhouse effect; the role of individuals in environmental protection; concepts of planning and managing resources; and choice and costs in the use of scarce resources. If teachers find that students do not have a sufficient understanding of this knowledge, teachers may briefly introduce them before using this exemplar.

B. Design of classroom learning and teaching

Lesson	Learning and teaching strategies and flow
1-2	**Lead-in (around 10 minutes)** ● Show a picture of an electric taxi (Appendix 1) to students and ask whether they have seen or ridden similar taxis on the road, and what the differences are between electric and conventional taxis (e.g. an electric taxi has no exhaust pipe and delivers a quieter drive). Teachers may mention that electric vehicles (such as electric taxis, buses, minibuses and private cars) are already used in Hong Kong (refer to the diagram of Appendix 1). ● Explain that electric vehicles are vehicles solely powered by electricity. Gasoline is not needed for this type of vehicle, but their batteries need to be charged. Electric vehicles do not have exhaust pipes and generate no exhaust fumes on the road. Electric vehicles are generally more energy efficient than their counterparts that use gasoline, i.e. they consume less energy with the same output. Drivers of electric cars only pay for electricity, which costs less than gasoline in Hong Kong. Teachers may take this opportunity to introduce concepts such as **energy technology**, roadside **air pollution** and cost-effectiveness.
	Reading data sources and teacher debriefing (around 20 minutes) ● Distribute Sources E-H (Appendix 1). Briefly explain to students that the sources are about air pollution in Hong Kong and the Government's measures to promote the use of electric vehicles. Allow students to divide the reading tasks among group members, and ask them to highlight or write down the key information or relevant basic concepts before sharing such information within their respective groups. Teachers may invite each group to present the key points discussed. For example, one source shows that there are signs of worsening roadside air pollution in Hong Kong. Although slightly lower roadside pollution levels have been recorded in recent years, the problem is still serious. Promoting electric vehicles is one of the government's measures to mitigate the problem. The government provides economic incentives and charging facilities to promote its use. Introduce concepts such as **air pollution**, **non-renewable energy** and **energy technology**.
	Reading data sources and group activity (around 20 minutes) ● Distribute short articles about measures or policies implemented by different countries in promoting electric vehicles (Appendix 2), including the Mainland, the United States, the United Kingdom, Japan and India. After reading the data sources, ask students to put policies in to different categories, such as providing economic incentives, strengthening support

Lesson	Learning and teaching strategies and flow
	facilities, and research and development. Students need to complete the worksheet of Appendix 2 (students within each group work together to fill in one worksheet, so that they can cooperate and exchange ideas). Teachers may also guide each group to complete the measures or policies of a region, and compare the differences among different regions.
	Students' presentation (around 15 minutes) ● Ask 2-3 groups to present the results of their categorization, and point out that the government can promote environmental protection through different measures or policies, such as providing economic incentives, offering convenient support facilities, conducting research and development into energy technologies, education or promoting a **green lifestyle** to change people's choices, habits or attitudes.
	Instruction about after-class activity (around 15 minutes) ● Encourage students to interview other teachers who have driving licenses (each group interviews one teacher). Students may conduct interviews using the worksheet in Appendix 3. Students may first introduce to teachers the electric car and their approximate price. Then they may explain why the Hong Kong Government is promoting the use of electric vehicles, and introduce existing government measures. Then, students may ask the teachers whether they would buy an electric vehicle and the factors they would need to consider. Students should record the interview process and teachers' responses, and then report their findings in the next lesson. ● If students are of high abilities, they may set the interview questions themselves. The teacher may invite one of the groups to organise the data collected from the different groups, and then report the findings in the next lesson.
3-4	**Students' presentation (around 20 minutes)** ● Each group of students report the findings obtained from interviewing teachers. ● Use the blackboard to summarise the findings by students. For example, other teachers may take the following into consideration when deciding whether to buy an electric car: economic considerations (e.g. the price, taxes, utility rates/oil prices), environmental protection (e.g. air quality), supporting facilities (e.g. whether there is an adequate number of charging stations at convenient locations). ● Ask students to copy information from the blackboard and categorise on their own, and come up with a name for each category. ● Further explain that all the above factors should be considered when

Lesson	Learning and teaching strategies and flow
	developing and implementing any environmental or energy policies. These are also the three dimensions involved in **sustainable development** (economy, society and environment). The government also needs to take into account and balance the different interests or points of view of various stakeholders. Bring in relevant concepts, such as **sustainable development**, a **green lifestyle**, **resource depletion**, **air pollution** and **climate change**.
	Group activity (around 40 minutes) ● Ask students to play the role of the Secretary for the Environment, who wants to promote the development of electric vehicles in Hong Kong. However, an editorial in a local newspaper has commented on the policy, questioning the adequacy of government support measures. Ask students to draft a written reply to this media comment. ● Distribute an editorial regarding electric vehicles (Appendix 4). In groups, students should analyse the arguments of the editorial (Appendix 5) and complete the worksheet. ● Instruct students to form groups and discuss how to write the reply. Teachers may demonstrate how to write a reply and how to organise the contents. Students should complete the worksheet (Appendix 6). In accordance with students' learning needs, encourage them to use Template 1 (focus on setting the writing framework) or Template 2 (focus on training students to write arguments and supporting evidence). Students may apply information about electric vehicles learned in the last lesson (e.g. government stances and supporting measures, the promotion of electric vehicles in other regions) to respond to arguments in the editorial. Students may clarify misunderstandings of the public about the policy, explain the stance of the government and elaborate on existing government measures or measures to be implemented. The objective of the written reply is to enhance the communication between the government and the public or relevant stakeholders, clarify understandings, reiterate government stances and respond to different views with an impartial attitude. Students may respond by applying relevant concepts such as **air pollution**, **climate change**, **sustainable development**, **green lifestyle** and energy efficiency. ● If Template 2 is used, list all arguments given by the students, then discuss and select those arguments that are strong and with multiple perspectives before holding discussions. Students may find examples to support their arguments after class. ● Ask 2-3 groups of students to report their discussion results and summarise students' presentations on the board.

Lesson	Learning and teaching strategies and flow
	<u>Teacher summary and arranging after-class assignment</u> (around 10 minutes) ● Summarise students' presentations and point out that the government needs to consider the opinions and interests of different members of society when developing or promoting environmental or energy policies, so as to address their needs. In the area of environmental or energy issues, policy inclinations are often necessary to change the existing situations of society (e.g. to improve roadside air quality). These include economic incentives (e.g. lower tax rates), legislation (e.g. regulating the emission of pollutants) and public education. ● Distribute after-class assignment (Appendix 7) and ask students to complete after the lesson. Students can answer in the form of a concept map, but they should answer the questions by applying the concepts and knowledge they learnt in the lessons, together with their own knowledge about the issue. ● Instruct students to divide the question into a few parts and then understand the requirement of each part. For example, when analysing the difficulties related to the promotion of electric vehicles in Question (a), even the drivers, being one of the many stakeholders to be considered, can be further categorised into sub-categories (e.g. drivers of private cars, drivers of public transport vehicles, drivers of commercial vehicles, drivers who have only just passed their driving test or drivers with years of driving experience), who may not necessarily share the same viewpoint. In addition, the difficulties they are likely to face can also be analysed from multiple perspectives, including on a short-term, mid-term or long-term basis. When comparing "developing electric vehicles" and "implementing the idling engine ban" in Question (b), students should determine whether the focus of discussion will be "general air pollution" or "roadside air pollution".

--- End of learning and teaching exemplar --

Appendix 1：Photo of electric vehicles and reading sources

Source A

Source of the photo: This photo was taken by the resource developer.

Source B: Electric Bus

Source of the photo: The website of the Environmental Protection Department. Retrieved from http://www.epd.gov.hk/epd/misc/ehk12/tc/ch1a.html

Source C: Electric Minibus

Source of the photo: The website of Sina Hong Kong. Retrieved from http://news.sina.com.hk/news/20131001/-2-3079666/1.html

Source D: Electric Private Car

Source of the photo: This photo was taken by the resource developer.

Source E

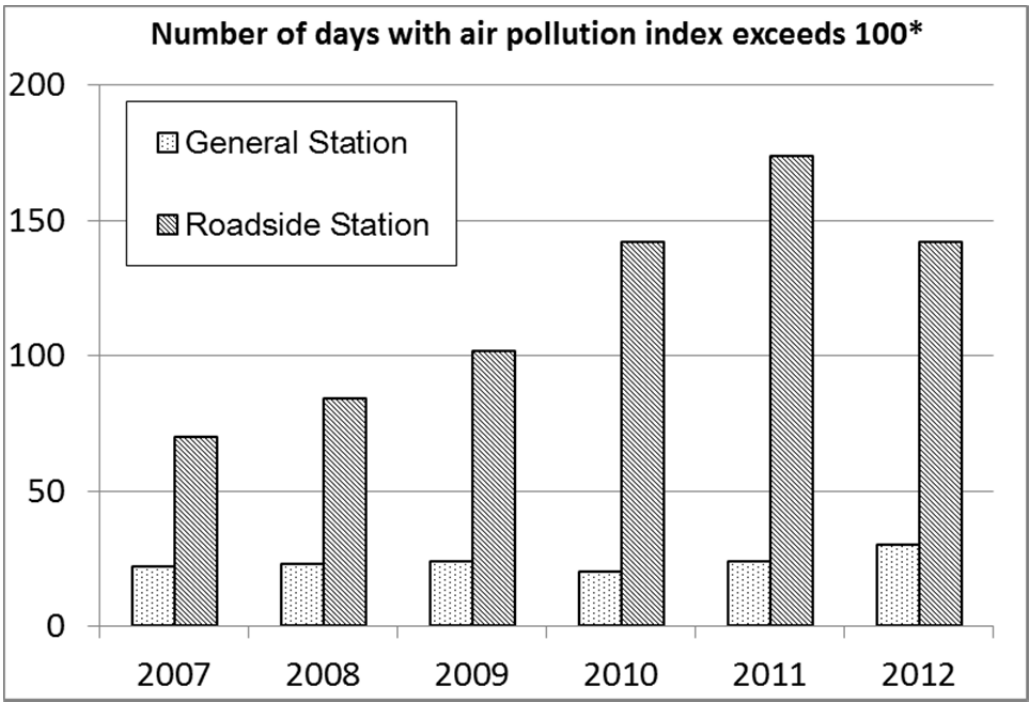
Roadside Air Pollution

On our busy streets, air pollution is mainly caused by motor vehicles, particularly diesel vehicles such as trucks, buses and minibuses, which emit large amounts of particulates and nitrogen oxides (NOx). The pollutants are often trapped at the roadside when flanked by tall buildings, thereby causing roadside levels of respirable suspended particulates and nitrogen dioxide (NO_2) to exceed the Air Quality Objectives.

Compared with 1999, roadside concentrations of some of the major air pollutants dropped in 2013: respirable suspended particulates, sulphur dioxide (SO_2) and NOx dropped by 37%, 59% and 29% respectively, and the number of vehicles prosecuted fell by nearly 90%.

Source: "Cleaning the air at Street Level". (27 Nov 2015). The web page of the Environmental Protection Department. Retrieved from http://www.epd.gov.hk/epd/tc_chi/environmentinhk/air/prob_solutions/cleaning_air_atroad.html

Source F



* This is the previous Air Pollution Index (API) data. If the API exceeds 100, the air pollution level is very high. The Environmental Protection Department (EPD) launched the Air Quality Health Index (AQHI) to replace the API effective from 30 December 2013 (refer to the relevant information "Air quality health index").

Source: "Air Pollution Index (1995 – 2013)". The website of the Environmental Protection Department Air Quality Health Index. Retrieved from http://www.aqhi.gov.hk/gt/related-websites/air-pollution-index.html

Source G

How the Government Promotes the use of electric vehicles (EVs)

Electric vehicles emit no exhaust fumes. Replacing conventional vehicles with those powered by electricity can help improve roadside air quality and reduce greenhouse gas emissions. In addition, the wider use of electric vehicles promotes the development of eco-friendly industries.

In order to achieve this goal, the Hong Kong Government established the Steering Committee on the Promotion of Electric Vehicles. Chaired by the Financial Secretary and comprised of members from different sectors of society, the committee is responsible for recommending a strategy complementary with specific measures to promote the use of electric vehicles in Hong Kong. It also considers the energy efficiency, environmental benefits and the creation of business opportunities with the use of EVs.

Government's measures to promote the use of electric vehicles

The Hong Kong Government promotes the use of electric vehicles through the following measures:

1. First Registration Tax for EVs is waived till the end of March 2017. Furthermore, enterprises that procure EVs receive 100% profits tax deduction for the capital expenditure on EVs in the first year of procurement.
2. A HK$300 million Pilot Green Transport Fund was established in March 2011. Transport operators and non-profit-making organizations providing transport services, and goods vehicle owners may apply for funding to trial green and low carbon transport technologies (including EVs).
3. The ultimate objective of the Government's relevant policy is to have zero emission buses operating across the territory. To this end, the Government has allocated HK$180 million for franchised bus companies to purchase 36 single-deck electric buses for trial, to assess their operational efficiency and performance under local conditions. The trial

began at the end of 2015. In addition, the Hong Kong Productivity Council has developed the first "Hong Kong-branded" electric bus.

4. There are now more than 1,200 EV chargers available for public use in Hong Kong.

EV models in Hong Kong

As at the end of December 2015, there were 4,198 EVs in use on the roads, compared to less than 100 at the end of 2010. At present, 52 EV models from seven countries are type-approved by the Transport Department. These include 36 models of private cars and motorcycles, and 16 models for public transport and commercial vehicles.

Charging facilities

Staff from the Electrical and Mechanical Services Department explain how to operate EV medium chargers

The availability of charging facilities is critical in the adoption of EVs. The Government is working with the private sector in expanding the EV charging infrastructure in Hong Kong. There are now more than 1,200 EV chargers for public use including about 200 medium chargers in Hong Kong, covering all 18 districts. In addition, there are now 11 quick chargers set up in various districts, so that there is always one within a distance of 20 km. There are also 142 other quick chargers using other charging specifications. The Government will also launch a pilot scheme that enables suppliers of electric taxis to install quick chargers at car parks administered by the Transport Department. The Government will monitor the growth in the number of EVs and consider the need to expand the charging network.

* Based on charging times, chargers for electric vehicles can be categorised into three: standard speed chargers, medium speed chargers and quick chargers. A full charge takes 8 to 10 hours on a standard speed charger, 4 to 5 hours on a medium speed charger, while a quick charger can perform an 80% charge in 30 minutes.

Sources:
1. “在香港推廣使用電動車輛”, 7 Feb 2016., The website of Environmental Protection Department. Retrieved from http://www.epd.gov.hk/epd/tc_chi/environmentinhk/air/prob_solutions/promotion_ev.html
2. Press Releases,. “100 public EV medium chargers available for use in August”. Retrieved from http://www.info.gov.hk/gia/general/201407/29/P201407290408.htm

Source H

While electric vehicles can be used to achieve “zero-emissions” on roads, their high price is still unacceptable for many people. Compared to an average vehicle powered by an internal combustion engine, the price of an electric vehicle with a similar performance is two to three times higher. In addition, the batteries of electric vehicles have to be replaced every 3 or 4 years, which is usually one-third of the vehicle price. Therefore, the accumulated cost for an electric vehicle is significant and impedes its popularity. In March 2011, the Hong Kong Government announced plans to expand the charging network for electric vehicles to facilitate its future development, and transform Hong Kong into a city that is convenient for the use of electric vehicles. However, time and capital are needed to achieve a territory-wide penetration of charging stations. In addition, it should be noted that while it takes 1 or 2 minutes to fill up a conventional gasoline tank, charging electric vehicles is quite different. Even with the most advanced quick-charging system available today, an 80% charge still takes 15 minutes, with an electric current of 100 to 400 amperes. This makes it difficult for current charging stations and power facilities to meet such intense and concentrated demands for quick charging.

Source: “電動車 路遙遙”, 14 April 2011, Metro Daily. Retrieved from http://www.metrohk.com.hk/?cmd=detail&id=159294

Appendix 2：Measures or policies implemented by different countries in promoting electric vehicles

Country/ Region	Measures implemented by the Government
China	 In 2009, the Chinese Government implemented policies promoting electric vehicles (e.g. the Automobile Industry Adjustment and Revitalization Plan《汽車振興規劃》) and was piloted in 13 cities. In the coming 4 years, the government would provide an electric vehicle subsidy of 1.37 billion yuan. The subsidy per electric vehicle and motorbike is 8,000 and 11,000 yuan respectively. The State Environmental Protection Administration of China also provides a subsidy of 3,000 yuan. The policy is to be extended to year 2015. Besides, all public buses in Shenzhen would be replaced by electric ones in 3 years so as to reduce carbon emission.
The United States	 President Barack Obama announced the plan of electric vehicle development in March 2009, with an aim to create 100,000 jobs, reduce the reliance on crude oil imports and promote sustainable development. Under the plan, there is a tax credit of USD$7500 for each plug-in hybrid vehicle (i.e. vehicles which are powered by both gasoline and electricity) was included. On top of that, a 2.4-billion subsidy was given to battery manufacturers. By 2025, electric vehicles have to achieve a mpg (miles per gallon) of 39, restricted by the government.
The United Kingdom	 In April 2009, the UK government launched its green car strategy along with an order to allow the mass production of electric and hybrid vehicles. The £250 million measures included plans to subsidise residents up to £5,000 to purchase electric vehicles, and invest £20 million in building necessary charging stations and other related infrastructures for electric vehicles. In addition, not only were electric vehicles exempt from the £8 “London Congestion Charge”, they were even provided with free parking by the Greater London Authority. Furthermore, the UK government also funded research projects related to low emission automobile, as well as subsidised collaboration programmes between the public and business sectors, so as to build more charging facilities. By March 2013, the government has already installed over 4000 charging stations through this partnership programme.

Japan	 Japan announced year 2009 as "the Year of Electric Cars". In addition to subsidising the central and local governments to purchase electric vehicles for official uses, the Ministry of the Environment also decided to standardise the charging devices for electric and hybrid vehicles to meet international specifications. Effective from April 2009, the Japanese government also allowed passenger transport services to use electric vehicles. Besides, the Japanese government has been actively supporting the research and development of "Next Generation Vehicles" including electric cars and hybrid cars. The "Next Generation Vehicle Promotion" programme is implemented to boost the use of eco-friendly cars. The government provides subsidies to all eligible "Next Generation Vehicle" models (including electric vehicles and hybrid vehicles). Each purchase is eligible for a subsidy of up to ¥1,380,000, and is waived from the car weight tax (¥13,200) and the car acquisition tax (¥121,500). The Japanese Ministry of Economy, Trade and Industry have been discussing with EU officials about the collaborative development of rechargeable batteries and solar batteries for "Next Generation vehicles".
India	 India is the second most populous country in the world. Bicycles and motorbikes are the major transportation vehicles in India. With rapid economic development, together with worsening air quality, the government is more concerned about environmental protection. In 2010, the government announced the "NEMMP 2020 Plan", aiming at assisting the electric vehicle manufacturers in the country. For every 2-wheel and 4-wheel electric vehicles purchased, there would be a 20% subsidy. However, since the scheme was called off in March 2012, due to decelerated growth in India's macro economy, the sales of electric vehicles also started to decline. The Indian government re-launched the scheme later in April 2014, this time subsidising up to 29,000 rupees (US$ 457) for every new electric motorcycle sold. On the other hand, car manufacturers would also be allowed to apply for government subsidies at the end of each month. Also, a part of the funding (a total of 7.95 billion rupees) is used for a number of research and development projects, such as building technology platforms (including infrastructure for testing purposes), promoting and increasing market needs, building charging infrastructure and testing electric vehicles.

Source: Extracted and adapted from Education Bureau (2011),. *Issues of Science, Technology and the Environment in Perspective*, Chapter 5, P.89.

Worksheet for Group Discussion

Type of measure	**Details of the measure**	**Country／Region**
Economic Incentive		
Research and development		
Support facilities		
Others (e.g. Legislation)		

Appendix 3：Interviewing other teachers about their decisions on purchasing electric vehicles

Before the interviews, students should prepare relevant information about electric vehicles (using the knowledge learnt in class) to introduce electric vehicles to teachers.

Name of the teacher interviewed：_____

Subject：_____

Question	Teacher's response
How many years have you been driving?	
Do you drive/own a private car?	
How many times do you drive every week?	
Would you consider buying an electric vehicle?	
Why would you consider buying/not consider buying?	
Do you think the government's promotion of electric vehicles could persuade you to buy one? Why?	
(This question is for teachers who will not consider purchasing electric vehicles) What do you think the government can do to persuade people to buy electric vehicles?	
(Set one more meaningful question that you would like to ask the interviewee)	

Appendix 4：An editorial about electric vehicles (Extracted)

Empty promises about charging facilities are not the way to promote electric vehicles

Investors are optimistic about the future of electric vehicles. In fact, promoting "zero-emission" electric vehicles is a way to tackle the problem of air pollution. The government established the "Steering Committee on the Promotion of Electric Vehicles" in 2009, chaired by the Financial Secretary. The committee suggests strategies and concrete measures on the development of electric vehicles. To lure car buyers to choose electric vehicles, the government has extended the exemption of the first registration tax of electric vehicles to March 2017. In addition, enterprises will receive a 100% profit tax deduction for expenses to buy electric vehicles in the year the enterprise purchases the electric vehicles. According to the Environmental Protection Department, the government aims to replace all diesel buses with zero-emission buses in Hong Kong. To achieve this, funding of HK$180 million was approved to subsidise a pilot programme by three franchised bus companies using 36 electric buses, in the first quarter of 2015.

While the exemption of the first registration tax of electric vehicles is attractive, car owners are concerned about the price of electric vehicles and the potential issues of an all-electric range* of vehicles, for example, the implications for a user if a vehicle runs out of battery in the middle of a journey. Despite the government's active promotion and development of electric vehicles, car buyers are still skeptical.

The Environmental Protection Department installed around 100 medium speed chargers in August 2014, which save at least 60% charging time over standard speed chargers. Apart from these medium speed chargers, there are currently about 1,000 standard speed chargers and 10 quick chargers in different districts in Hong Kong.

According to figures from the Transport Department, the current number of licensed motorized vehicles exceeds 0.69 million. While there are 611 private cars per 1,000 residents in Hong Kong, there are only about 1,000 standard speed charging stations and 100 medium speed chargers for electric vehicles. This fails to meet the needs of tens of thousands of car owners and drivers. This inconvenience also reduces people's confidence in switching to electric vehicles, and thus affects their decision to switch to electric vehicles.

In 2013, BYD** electric taxis were introduced to Hong Kong. In addition to environmental protection, fuel costs can also be saved. Nonetheless, the taxi sector says that support facilities are insufficient. BYD electric taxis can only be charged with a specific type of charging socket. However, these facilities can only be found in Tuen Mun, Tai Po and Ma On Shan.

If the government is serious about promoting electric vehicles, then charging facilities should not be allowed to maintain their current half-available status.

*All-electric range is the driving range of an electric vehicle after a full charge. The higher the all-electric range, the longer an electric vehicle can be driven without being re-charged, after a full charge.

** BYD is an electric vehicle manufacturer in the Mainland.

Source: "推廣電動車不能口惠而電不至", 26 August 2014, *Hong Kong Economic Journal*.

Appendix 5：Analysis of the arguments of an editorial

Students should read the editorial and complete the following worksheet in groups (one worksheet for each group).

Which policy area is mentioned in the article? (To be summarised with no more than 4 words)	<table><tr><td></td><td></td><td></td><td></td></tr></table>
What background information is mentioned in the article (including data)?	
Which stakeholders are involved? What are their concerns?	
What is the author's argument/opinion? What evidence is there to support his/her argument?	
What suggestions did the writer give?	

Appendix 6：Draft a reply for the Government

Template 1

Dear Editors of XX (name of the newspaper)

We appreciate the opinions expressed in your editorial titled "Empty promises about charging facilities are not the way to promote electric vehicles" dated __ (day) __ (month) 2014, and hereby reply as follows:

Stance of the Government	
Supplemental information or clarification to be made regarding background information contained in the editorial	
Difficulties/ restrictions faced by the government (e.g. the feasibility of collaborating with the industrial and commercial sectors to set up more charging stations)	

Response(s) to the opinion(s) expressed in the editorial (e.g. pointing out whether government measures currently in force are adequate)	
Response(s) to suggestion(s) made in the editorial (it is advisable to add information including positions and difficulties of the government, as well as measures to be implemented)	

Template 2

Dear Editor,

Having read your editorial titled “Empty promises about charging facilities are not the way to promote electric vehicles”, we appreciate your support to the development of electric vehicles. However, further discussions are needed with regard to your comments on charging facilities.

(argument) In comparison to conventional vehicles, electric cars have zero roadside emissions and achieve greater energy-efficiency. Since the technologies of electric vehicles have been advancing noticeably in recent years, car manufacturers are increasingly more motivated to develop and produce electric vehicles.

(example) For example, thanks to advancement in battery technology, electric vehicles can now deliver cheaper long-distance trips than using gasoline. Furthermore, many sports car manufacturers, including Porsche, are also planning on introducing their own electric car models.

(argument) _____

_____

(examples) (may search the information at home)

(argument)

_____

_____

(examples)(may search the information at home)

_____

With an aim to promote the use of electric vehicles and help improve roadside air quality, we will continue to pay close attention to advancement made in charging technologies and the popularity of using electric vehicles, while expanding the charging network in due course.

Secretary for the Environment

Appendix 7：Conclusion and Assignment

Read the following sources:

Source A

> Hong Kong promotes electric vehicles to improve air quality and raise people's awareness of protecting the environment. However, electricity consumption will increase as a result of more electric vehicles. If the source of electricity generation is not clean, it only means a change in the form of pollution. The China Light and Power Company initiated a campaign aimed at changing people's misconceptions that electric vehicles have weak air-conditioning and are underpowered. While more advanced fast chargers are being introduced, Hong Kong lacks experts to maintain and design electric vehicles; nevertheless, one such model developed in Hong Kong has been approved by the European Union.

Source: Extracted and adapted from various articles.

Source B

> The idling engine ban annoys drivers and passengers when the weather is hot and humid; however, exhaust fumes emitted by vehicles worsen the city's air quality and harm the health of its citizens; it also contributes to the "heat island effect". Therefore, the idling engine ban needs to strike a balance between the needs of society. The Government passed the ban with exemptions granted in different areas, The ban was postponed for 3 months in September 2011; leading many people to believe the Government leaned towards the transportation sector, and that the ban had become a "toothless tiger".

Adapted from:
1. "停車熄匙增一月寬限期", 21 July 2011, *Ming Pao*.
2. "停車熄匙條例三讀通過", 6 March 2011, *Ming Pao*.

Questions

(a) With reference to Source A, analyse the difficulties in promoting electric vehicles in Hong Kong.

(b) Is developing electric vehicles or is implementing the idling engine ban more effective in alleviating the air pollution problem in Hong Kong? Explain with reference to the above sources.

Students may answer the above questions in the form of a **concept map**.

Intention of Assessment

Assessment Focus

Students' grasp and application of concepts, such as "development of energy technology", "air pollution", "global warming", "regulation", "governance", "quality of life", "environmental protection", and "sustainable development", should be assessed through the analysis of anti-idling legislation and electric vehicle development. For the assessment focus of students' enquiry skills, students should be able to demonstrate skills like extracting and interpreting textual data as well as more advanced analytical skills, such as comparing the effectiveness of developing electric vehicles and banning idling vehicles with running engines.

Expected student performance

Knowledge

- Elaborate on the difficulties encountered in promoting electric vehicles in Hong Kong, such as the negative impression among the public about electric vehicles, the disposal of waste batteries, phasing out the use of conventional vehicles, a shortage in professional technical support and the design of electric vehicles.
- Compare the effectiveness of "developing electric vehicles" and "implementing the idling engine ban", such as their long-term principles and short-term measures, for example, too many exemptions may create a weaker deterrent effect for the ordinance. Analyse which of the above schemes would be more effective in helping Hong Kong solve its air pollution problem.

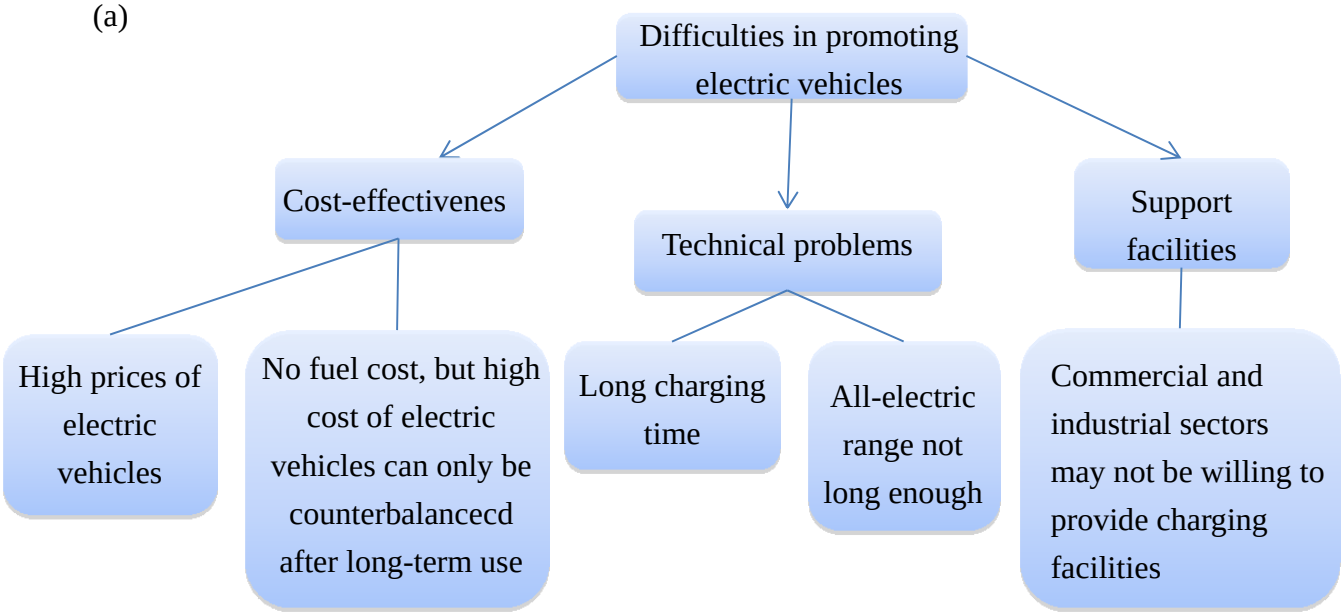
Skills

- Giving an appropriate response to demonstrate a comprehensive understanding of the question..
- Transforming data into advanced knowledge and concepts.
- Identifying the stance of stakeholders with the support of sound evidence.
- Analysing the difficulties in promoting electric vehicles in Hong Kong.
- Comparing the effectiveness of developing electric vehicles and implementing the idling engine ban.

-- End of Appendix --

Reference answers:

(a)



(b)

Developing Electric Vehicles		Implementing the Idling Engine Ban
Lower, due to inadequate number of charging stations, high prices of electric vehicles	Willingness of drivers	Low, as drivers may not follow (particularly in summer)
Bigger, able to improve roadside pollution	Area affected	Smaller, since it is only effective in streets with more parked cars
High prices of electric vehicles and need to dispose of old batteries	Cost	Drivers pay less and save fuel

Senior Secondary Liberal Studies

“Energy Technology and the Environment” Module

Learning and Teaching Exemplar (3)

Sustainable Development and Municipal Waste Management

A. Basic information of the exemplar

Topic	Sustainable development and municipal waste management
Relevant modules, themes and issues for enquiry	**Leading** Module 6: Energy Technology and the Environment; Theme 2: Environment and Sustainable Development ● How do science and technology match with sustainable development? What are the constraints? ● How do the living styles of people and social development affect the environment and the use of energy? ● What responses could be made by different sectors of society, governments and international organisations regarding the future of sustainable development?
	Related Module 2: Hong Kong Today; Theme 1: Quality of Life ● What are the different opinions of Hong Kong residents on the priorities which constitute the quality of life? ● Which aspects of the quality of life are seen to be more important? Which are seen to be immediate needs? Who might make the decisions? Why?
Overall design rationale	Hong Kong is facing serious problems with solid waste. Compared to neighbouring cities at similar levels of development, Hong Kong's solid waste is noticeably higher[1] and there is an urgent need to manage solid waste properly. Domestic waste from over-consumption goes against the principles of sustainable development, and is a major cause of Hong Kong's solid waste. Hong Kong should tackle the issue at source: to raise public awareness and reduce solid waste by reducing excessive use or wastage of resources. Based on Theme 2, "Environment and Sustainable Development" of Module 6, "Energy Technology and the Environment", this exemplar aims to explore and study sustainable development in Hong Kong by focusing on its solid waste problem and discussing the management of solid waste in other countries. Teachers may use this exemplar to help students learn about the seriousness of the solid waste problem in Hong Kong and understand the existing methods of solid waste management. Students will also understand the controversies and explore ways to alleviate the problems. Students will also learn about the multi-tiered waste management hierarchy. At the end of the lesson,

[1] "HONG KONG BLUEPRINT FOR SUSTAINABLE USE OF RESOURCES 2013 – 2022". The web page of Environment Bureau (May 2013).

	students may advise their own schools on the management of solid waste and prepare guidelines for classmates to reduce and dispose of solid waste, after looking at the issue from multiple perspectives.
Time required	5 lessons (40 minutes per lesson), approximately 200 minutes in total
Learning objectives	Knowledge: ● To understand the concepts related to sustainable development and a green lifestyle, and understand the interrelationship between human activities and the natural environment. ● To understand the current situation of municipal solid waste in Hong Kong. ● To understand how the Hong Kong Government responds to the issue of municipal solid waste and the policies and measures it uses to promote sustainable development. ● To understand and explore feasible ways to reduce solid waste effectively at source. ● To understand how other countries manage solid waste and propose how different sectors in Hong Kong can promote and put sustainable development into practice.
	Skills: ● To collect and summarise information from different sources. ● To express ideas in speaking and writing. ● To interpret data from different perspectives. ● To respond immediately to queries.
	Values and attitudes: ● To increase awareness of sustainable development. To care for and protect the natural environment, and to make insightful, reasonable and practical decisions about environmental protection. ● To be committed to creating an environment that is sustainable, where people can live in peace and work in contentment. ● To be aware of civil rights and obligations, and to participate and collaborate in community affairs. ● To respect cultural, social, economic and biological diversity. ● To care about living things and the wellbeing of humankind.
Basic concepts for application	Resource depletion, sustainable development, waste management, polluter pays principle, green lifestyle, quality of life, urban planning
Relevant learning experience at	Having studied various subjects of Personal, Social and Humanities Education, as well as Science and Technology Education Key Learning Areas in the junior levels, students should have acquired a basic

junior secondary levels	understanding of the role of individuals in environmental protection; the interdependence of living things and their environment; concepts of planning and managing resources; choice and cost in the use of scarce resources; and development in and interdependence between less developed and more developed countries. If teachers find that the students do not have sufficient understanding of this knowledge, teachers may briefly introduce them before using this exemplar.

B. Design of classroom learning and teaching

Lesson	Learning and teaching strategies and flow
Before Class	Ask students to organise and summarise information by themselves in order to propose one or more meaningful questions about "solid waste".
1	**Lead-in (around 20 minutes)** ● Play a microfilm about appreciating food to introduce the issue of solid waste management (around 1 minute) (Appendix 1). Ask the following questions to guide students: 1. Have you ever wasted food like the main character in the video? Based on your own experience, is wasting food common among classmates? 2. What environmental issue(s) in the film has/have caught your attention? 3. What social factors may lead to the above environmental issue(s)? Use the above video to introduce the issues about food waste and solid waste management in Hong Kong. Use data and graphs to demonstrate the amount of solid waste disposed of in landfills and the proportion of various types of solid waste. Food waste is one of the many types of municipal solid waste and accounts for more than 40% of the total amount of municipal solid waste disposed of in landfills (Appendix 3). Therefore, the management of food waste plays a vital part in municipal solid waste management.
	Analysis of the causes leading to an increase in the volume of municipal waste (around 20 minutes) ● Instruct students to recall and record the waste that they disposed of yesterday. Ask them to reflect whether it was necessary to dispose of it, or whether it was possible to avoid using it in the first place (Appendix 2). ● The amount of solid waste disposed of by Hong Kong people is on the rise: The total volume of Hong Kong's municipal waste has increased by almost 80% over the last 30 years. The amount of waste disposed of on a per capita basis increased by more than 30%, which is also higher than that of some Asian cities (Appendix 3). ● Through questioning, encourage students to think about the reasons why such large amounts of solid waste are produced in Hong Kong (not necessarily in the same order as below): 1. How do we define solid waste? 2. Is it possible to produce absolutely no solid waste in our lives? 3. Are wealthier people inclined to produce more solid waste?

	4. Do wealthier areas produce more solid waste? Why? 5. What kind of lifestyle is likely to produce more solid waste? 6. In Hong Kong, what factors might have caused the increase in the amount of solid waste over the last 30 years? (If students are more capable, ask them to set some meaningful questions on "municipal solid waste" and find out the answers by themselves. Students may organize and generalize the causes of "excessive municipal solid waste" on their own.) ● Conclude that it is inevitable for people to consume some resources and produce some waste. However, a wasteful lifestyle is a major cause of solid waste in modern cities. In general, more economically advanced areas or cities are likely to produce more solid waste, because wealthier people can afford to buy or consume greater amounts of resources (e.g. energy, food or other daily items), and therefore are likely to produce more pollutants or waste. Urbanisation is another factor behind excessive amounts of pollutants or waste because it is easier for people to gain access to the resources they need. Greater wealth can also easily lead to excessive use or waste of resources. Introduce concepts such as **green lifestyle**, **waste management** and **urban planning**. ● According to the multi-tiered waste management hierarchy in Source A of Appendix 6, students can evaluate whether their habits of handling solid waste fulfill the principles of sustainable development (Appendix 2). Supplement that a modern lifestyle is susceptible to losing the balance between economic, social and environmental factors, resulting in unsustainability. ● For example, from an economic perspective, while increasing consumption can enhance economic growth, it can also lead to excessive waste generation that cannot be properly managed. From a social perspective, social conflict or inequality often arise when deciding how solid waste should be disposed of.
2-3	**Lead-in by questioning (around 10 minutes)** ● Ask students if they know where their domestic food waste is transported to after being dumped into rubbish bins. Give a brief introduction to the processes of solid waste disposal in Hong Kong. For example, refuse collection vehicles collect solid waste, but some take the refuse directly to landfills, while others take the waste to refuse transfer stations before going to the landfills. In Hong Kong, solid waste not recovered or recycled will end up in landfills.

	Reading data sources (around 10 minutes), first group discussion (around 15 minutes) ● Divide students into four groups (in the case of a large number of students, make arrangements based on actual circumstances) with each group responsible for reading about one measure to manage solid waste (Appendix 4). ● Distribute the discussion worksheets (Appendix 5) to students in each group. Ask students to fill in relevant spaces on the worksheets using the information that they have read, together with their own knowledge.
	Second round of discussion after re-grouping (around 25 minutes) ● After the first round of discussion, re-group the students. Each newly formed group (hybrid group) should be comprised of students responsible for reading each of the four different sets of information. In order to complete the worksheets, students from different groups should report the discussion results of their original groups (expert group) to their new group members, and then summarise their discussions. Since every student has an opportunity to present their findings, student engagement and involvement will be enhanced. This approach of group activity also enables students to understand the four major methods of solid waste management through peer interaction. Students will make use of and understand concepts such as economic incentives, "**waste management**", "**air pollution**" and "**resource depletion**". ● During the two rounds of group discussion, provide explanations and assistance to each group of students, and manage time.
	Feedback on the discussion results (around 20 minutes) ● Distribute Appendix 6. Show a diagram of the multi-tiered waste management hierarchy. This management structure is similar to an upturned triangle (where the top is wider than the bottom), which means that the best strategy is to reduce waste at source to prevent its generation. As waste generation cannot be avoided, the preferred option is for waste to be reused, recovered or recycled; waste disposal should always be the last resort. The ideal situation is for disposed waste to account for the smallest proportion, to avoid the generation of waste wherever possible, and improve solid waste management approaches to better fulfill the principles of sustainable development. ● Ask students if the current approach adopted in Hong Kong is in line with this structure. Point out that as Hong Kong fails to reduce waste at source, we are producing large amounts of solid waste. Although the recycling rate

	is not low (48%), currently Hong Kong solely relies on landfills to dispose of its increasing amounts of waste, and thus there is room for improvement. For example, Hong Kong still needs to determine how to reduce waste at source, increase the recycling of food waste, or to investigate the use of incineration. ● Show the chart (Appendix 3) and compare the solid waste management strategies adopted in different Asian cities. Hong Kong's recycling rate is not low in comparison with other cities, but the proportion of landfill disposal is relatively high. In addition, incineration is currently not used in Hong Kong for the disposal of solid waste.
4-5	**Lead-in, making suggestions on how to manage solid waste (around 30 minutes)** ● Instruct students to form groups and make suggestions on how to manage solid waste at their own school, to better match the principles of sustainable development. ● Ask each group to demonstrate their proposed methods with a simple drawing (Appendix 7) with appropriate tag(s), and explain in written form the implementation details. ● Distribute Appendix 7 (including the picture of the school campus, floor plan, location selection principles, guidelines on reducing solid waste). Students can present their proposed methods of reducing or managing solid waste with drawings. They can be based on the "location selection principles" together with their own personal experiences. These measures should be in line with the 4R principles and the principles of sustainable development. For example, students may draw recycle bins and explain the choice of specified locations and suggest ways to encourage students to put recyclables in the bins. Students may also draw signs representing environmental protection inspectors, and explain how they may effectively monitor students' behaviour, such as assigning inspectors to observe, during lunch, whether students have leftover food or bring their own water bottles. In addition, students may draw food waste recycle bins on the playground to promote food waste separation at source and recycling. Students may suggest one method each, or otherwise work together to come up with different methods or comment and improve others' suggestions. After students complete their drawings, invite them to share their suggestions, give them feedback and encourage them to reflect whether their proposed methods can be implemented on a community scale. They must analyse the benefits of these measures, with consideration given to the difficulties of

	implementation and their respective solutions. Introduce relevant concepts such as waste reduction at source, "**green lifestyle**", "**ecological footprint**", "**waste management**", "**polluter pays principle**".
	Producing environmentally friendly guidelines for students **(around 30 minutes)** ● Allow each group approximately 15 minutes to reflect on how the habits of their classmates lead to the generation of solid waste, and then prepare environmentally friendly guidelines. The guidelines should include at least 10 methods proposed by group members, the aim of which is to help or encourage students to reduce solid waste generation at source. Students may conclude from their daily observations that students should bring their own water bottles, as they often buy various beverages leaving behind a large volume of solid waste, such as plastic bottles and other packaging materials. Lastly, invite other groups to comment or analyse the feasibility of different guidelines and evaluate whether such guidelines would have any deterrent effect without imposing any penalty.
	Debriefing (around 10 minutes), instructing after-class assignment (around 10 minutes) ● Comment on students' suggestions and their explanations. Explain to students that this activity is set in a school context, to help them learn in a familiar environment. Students will gain a preliminary understanding of the factors to be considered when making decisions about solid waste management measures, and then reflect on what future measures should be adopted in Hong Kong to appropriately manage solid waste. ● Distribute after-class assignment (Appendix 8). The sources of the assessment item include a cartoon that conveys the role of different stakeholders in the resolution of environmental issues, and the results of a survey on the amount of waste and opinions towards the waste charging scheme. Students' ability to apply concepts/knowledge such as, "**waste management**", "**sustainable development**", "**polluter pays principle**", and "**quality of life**", will be assessed. Students should be able to demonstrate skills such as interpreting the cartoon, analysing the sources, evaluating different viewpoints and formulating arguments.

-- End of learning and teaching exemplar --

Appendix 1：Watching the video clip

Video: “Save Food, Reduce Waste” (珍惜食物 減少浪費) Duration: around 1 minute Website: https://www.youtube.com/watch?v=kFZgs3x0fu4

Answer the following questions after watching the video:

1. Have you wasted food like the main character in the film? Based on your own experience, is wasting food common among your classmates?

_____

_____

_____

2. What environmental issue(s) has the film brought to your attention?

_____

_____

_____

3. What are the social factors that caused the above environmental issue(s)?

Social Factors (summarise in not more than 6 words)	Examples or Explanation
(e.g.)	

<u>Appendix 2</u>: What kind of municipal waste did I throw away yesterday?

- I threw away_____yesterday.
- Number of item(s) I threw away: _____
- Can I choose not to throw away/ produce the "waste"?
  Why? _____
  _____
- Which type of solid waste does my "waste" belong to?
  Food waste ☐ Paper ☐ Plastic ☐ Aluminium☐
  Cloth ☐ Others ☐ (Explain: _____)

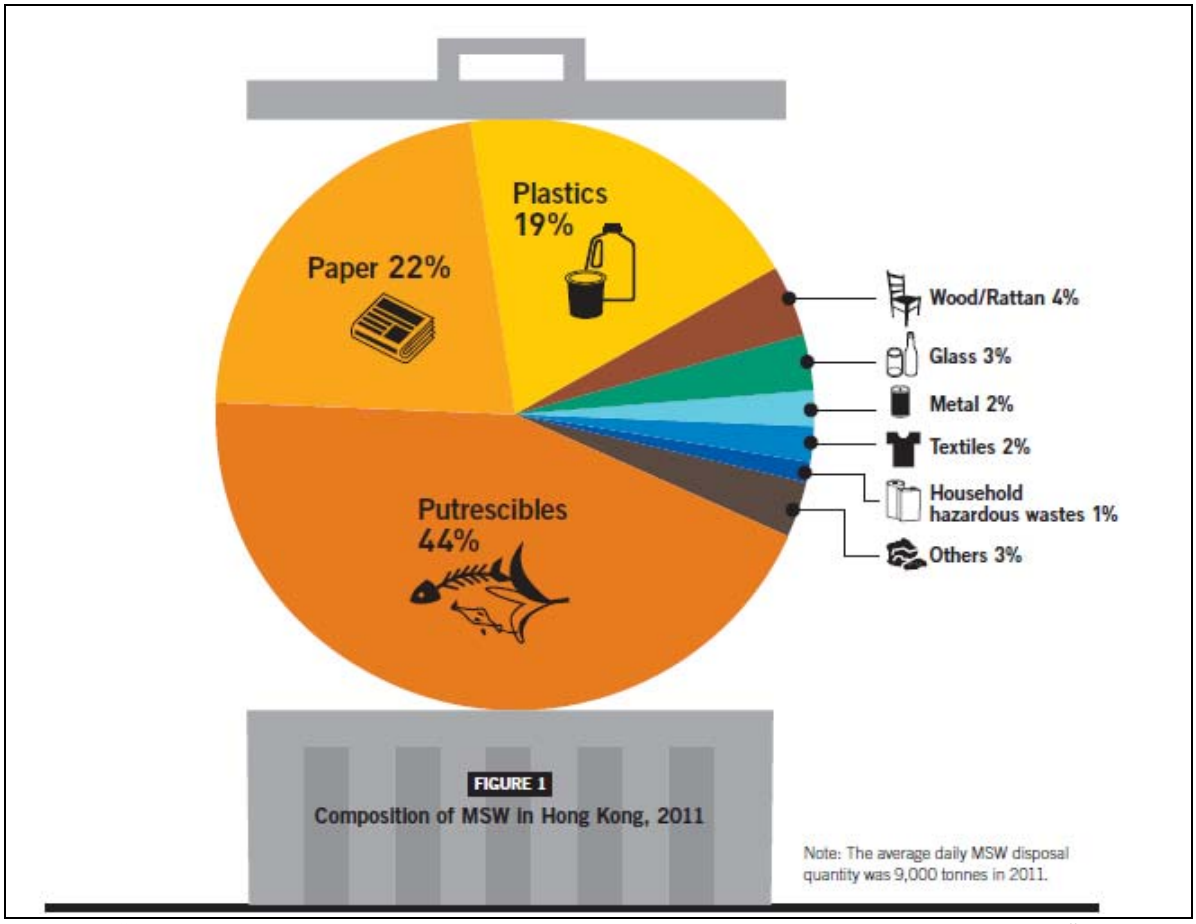
- I threw away_____yesterday.
- Number of item(s) I threw away: _____
- Can I choose not to throw away/ produce the "waste"?
  Why? _____
  _____
- Which type of solid waste does my "waste" belong to?
  Food waste ☐ Paper ☐ Plastic ☐ Aluminium☐
  Cloth ☐ Others ☐ (Explain: _____)

- I threw away_____yesterday.
- Number of item(s) I threw away: _____
- Can I choose not to throw away/ produce the "waste"?
  Why? _____
  _____
- Which type of solid waste does my "waste" belong to?
  Food waste ☐ Paper ☐ Plastic ☐ Aluminium☐
  Cloth ☐ Others ☐ (Explain: _____)

- I threw away_____yesterday.
- Number of item(s) I threw away: _____
- Can I choose not to throw away/ produce the "waste"?
  Why? _____
  _____
- Which type of solid waste does my "waste" belong to?
  Food waste ☐ Paper ☐ Plastic ☐ Aluminium☐
  Cloth ☐ Others ☐ (Explain: _____)

Appendix 3:

Source A: Composition of Municipal Solid Waste (MSW) in Hong Kong, 2011



Source: "HONG KONG BLUEPRINT FOR SUSTAINABLE USE OF RESOURCES 2013-2022". The web page of Environment Bureau (May 2013).

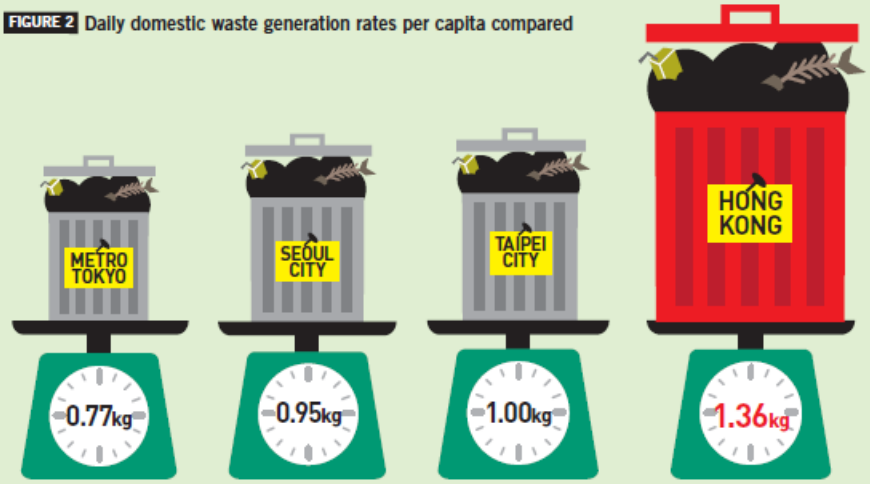
Source B: Comparison of Hong Kong's waste load with other Asian cities

Hong Kong's Waste Load Compared

Despite difficulties in making direct comparisons in the MSW disposal rates between cities because of different methods of calculation in waste quantities, the many differences in culture and habits, and different stages of industrial and commercial development, useful insights can still be gleamed from looking at cities' domestic waste generation rates.

Hong Kong has a comparatively large waste load compared to neighbouring cities at a similar level of development. Figure 2 compares Hong Kong's daily domestic waste generation rate with Seoul, Taipei City and Tokyo.

FIGURE 2 Daily domestic waste generation rates per capita compared

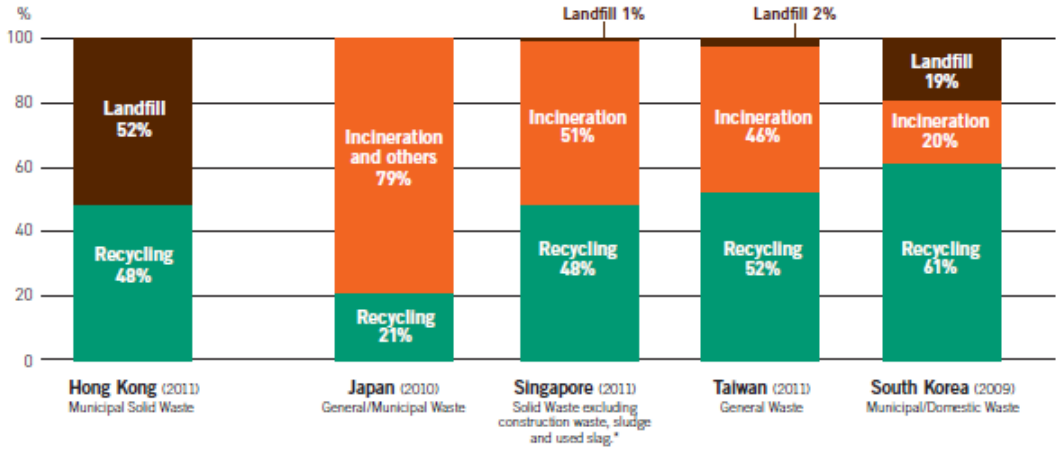


Sources: Hong Kong Environmental Protection Department; Ministry of the Environment of Japan; Taiwan environmental authority and Seoul Metropolitan Government

Note: Different places have different definitions of waste and different methods of compiling waste statistics. Hence apparently similar parameters may not be directly comparable. For example, Seoul reports its per capita municipal waste generation as 0.95 kg/day, but this only covers waste from households and small businesses, which is more similar to the domestic waste as defined in Hong Kong.

Source: "HONG KONG BLUEPRINT FOR SUSTAINABLE USE OF RESOURCES 2013-2022". The web page of Environment Bureau (May 2013).

Source C: Comparison of waste management structure with other Asian regions



* Note: The published Total Solid Waste Recycling rate is 59%. After excluding construction waste, sludge and used slag, the solid waste recycling rate is 48%.

Source: "HONG KONG BLUEPRINT FOR SUSTAINABLE USE OF RESOURCES 2013-2022". The web page of Environment Bureau (May 2013).

Source D: Types of waste

Hong Kong generates several different types of solid waste, and each has its own requirements for handling. Municipal Solid Waste (MSW) comprises solid waste from households, commercial and industrial sources. This excludes construction and demolition waste, chemical waste and other special waste. Food waste is the major constituent of municipal solid waste in Hong Kong. It comprises waste produced during food production, processing, wholesale, retail and preparation, as well as food leftovers and expired foods. It is highly degradable, which can cause odour and hygiene problems. Construction waste includes waste arising from such activities as construction, renovation, demolition, land excavation and road works. Chemical waste comprises substances specified under the Waste Disposal (Chemical Waste) (General) Regulation as posing a possible risk to health and/or the environment. Clinical waste consists of waste generated from various healthcare, laboratory and research practices as defined in Section 2 and Schedule 8 of the Waste Disposal Ordinance. It should be managed properly so as to minimize danger to public health or risk of pollution to the environment. Special waste includes animal carcasses, livestock waste, radioactive waste, grease trap waste and waterworks/sewage sludge. This waste needs to be treated separately. Arrangements are being developed for the proper treatment and disposal of this waste, but more time is needed to address community concerns about such facilities.

Source: "HONG KONG BLUEPRINT FOR SUSTAINABLE USE OF RESOURCES 2013-2022". The web page of Environment Bureau (May 2013).

Appendix 4: Comparison of Different Methods of Waste Management

Group 1: Disposal at Landfills

Source A: Hong Kong landfill sites

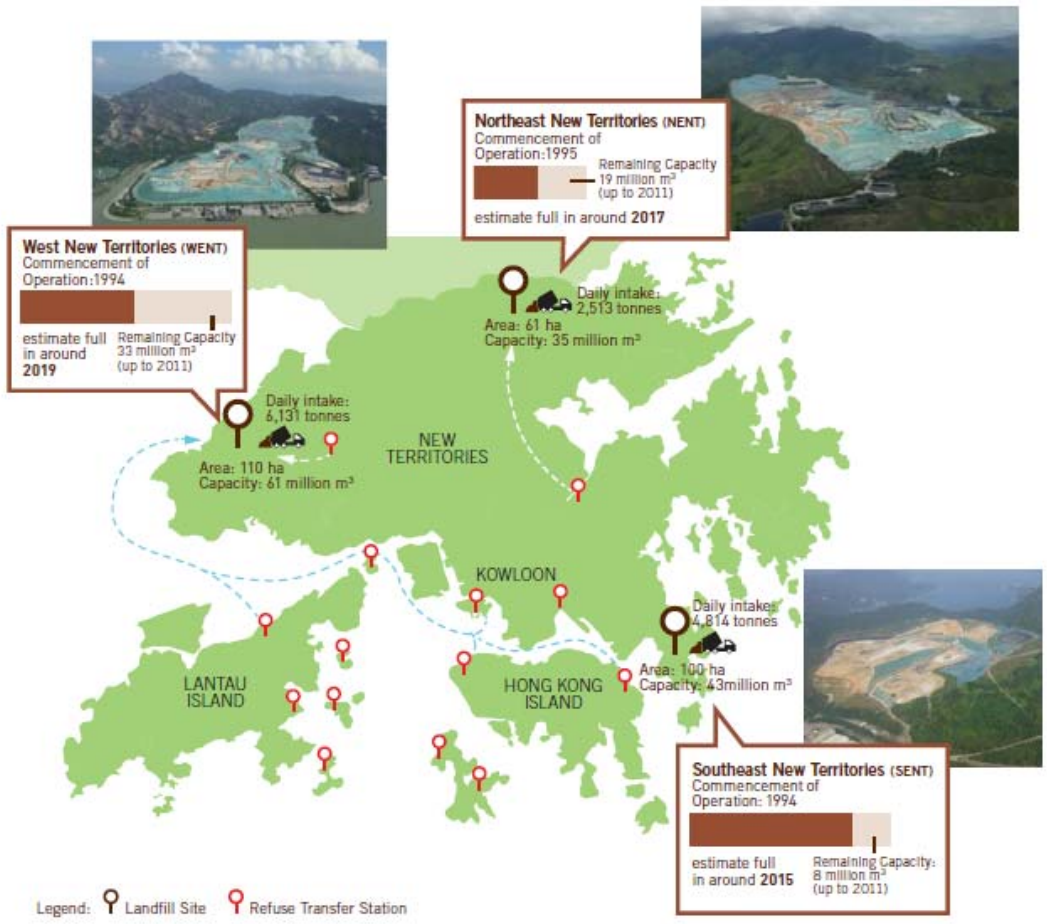
In Hong Kong, landfills have been designed and constructed as a secure containment facility incorporating multilayer composite liner systems covering the entire surface area of the site. As the sites are lined, landfill gas and contaminated liquid within the landfill (known as leachate) can be collected and treated to ensure that there will be no untreated discharges from the landfill to the environment.

Source of the photo: Environmetal Protection Department. Retrieved from http://www.epd.gov.hk/epd/tc_chi/environmentinhk/waste/waste_maincontent.html

Source: Environmetal Protection Department. Retrieved from http://www.epd.gov.hk/epd/tc_chi/environmentinhk/waste/prob_solutions/msw_linesystem.html

Source B: Distribution and use of landfill sites in Hong Kong

Previously, Hong Kong used to operate 13 landfill sites that have all been shut down, and some have been renovated to be used for community greening and recreational purposes. Currently, there are three more recent large modern landfill sites equipped with the the most advanced technologies in Hong Kong, which are strategically located in the north-eastern, south-eastern and western parts of the New Territories. Their locations took a wide spectrum of factors into consideration, including local development needs, the costs for transporting waste to different areas and the volume of exhaust emissions.



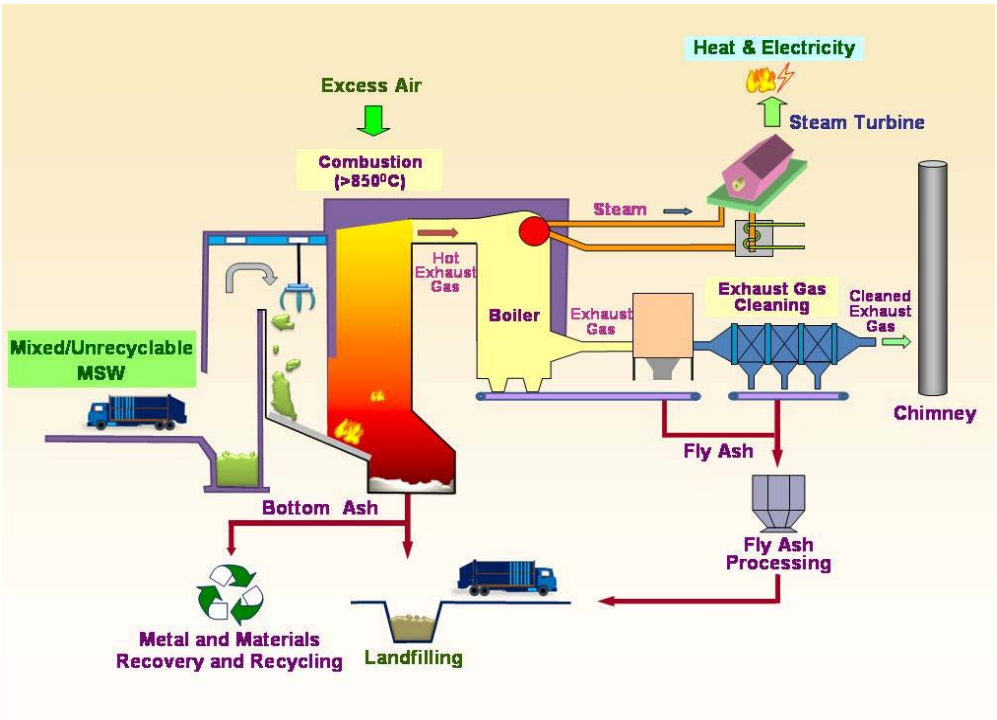
Source: "HONG KONG BLUEPRINT FOR SUSTAINABLE USE OF RESOURCES 2013-2022". The web page of Environment Bureau (May 2013).

Group 2: Incineration

Source C: Incineration

Hong Kong is currently not using incineration to treat solid waste. Incineration is a thermal treatment technology used to reduce the volume of waste requiring final disposal. Incineration can typically reduce waste volume by over 90%, and it is one of the widely used technologies for treating municipal solid waste prior to disposal at landfills. Most modern incineration plants incorporate heat recovery as well as power generation facilities to recover heat energy from the waste.

To ensure that gas emissions meet the stringent standards imposed by regulatory bodies (e.g. the European Union Waste Incineration Directive) for public health and environmental protection, modern incineration plants adopt a number of advanced design and process controls, as well as exhaust gas cleaning measures as illustrated by the flow chart below:



- Combustion – Solid waste is continuously fed into the furnace by an overhead crane. The waste is combusted in the specially designed furnace at a high temperature of over 850℃ for more than 2 seconds with sufficient supply of air, to ensure complete burning and to prevent the formation of dioxins and carbon monoxide.
- Boiler/steam turbine – The heat from the combustion is used to generate steam in the boiler. The steam then drives the turbine which is coupled to the electricity generator. The excess heat generated can also be used for other purposes, e.g. heat for swimming pool.

- Exhaust gas cleaning – The exhaust gas from the boiler is typically cleaned by the advanced pollution control systems to ensure compliance with the stringent environmental standards.
- Ash residues handling – The ash residues from incineration generally include bottom ash from the furnace and fly ash from the exhaust gas cleaning units. The bottom ash is either reused as construction material or disposed of at landfills. Fly ash is typically stabilized and solidified by reagents (e.g. cement) and disposed of at dedicated landfill with continuous environmental monitoring. Ash melting that uses the heat energy in the incinerator to melt the ash residues at a high temperature is a technology used in some place. The melted products are inert and contain no hazardous materials, so that they may be re-used (e.g. as construction material). Comparatively, ash melting is more expensive, but it has the advantages of further volume reduction and fixation of any hazardous materials in the fly ash.

Source: Problems and Solutions. The web page of Environmental Protection Department. Retrieved from http://www.epd.gov.hk/epd/tc_chi/environmentinhk/waste/prob_solutions/WFdev_IWMFtech.html

Source D: Opinions of different parties on building an incinerator

In January 2015, the Finance Committee of the Legislative Council approved funding for the construction of an incinerator on Shek Kwu Chau. The Government published an EIA report on Integrated Waste Management Facilities, which recommended the construction of an artificial island near Shek Kwu Chau to build an incinerator for waste disposal. This recommendation was supported by the shorter distance of transporting waste to Shek Kwu Chau than to Tsang Tsui, as well as the benefit of facilitating economic activities on the outlying islands. However, construction of the incinerator was strongly opposed by Cheung Chau residents, who feared that the toxic gas emitted by the incinerator when burning waste would have a negative impact on their health, given the close proximity between Shek Kwu Chau and Cheung Chau.

Various stakeholders, including environmentalists and residents of neighbouring areas, have their own opinions on the construction of the incinerator. Some think that the capability of the incinerator to process approximately 3,000 tonnes of waste on a daily basis can largely lower the pressure on local landfills and solid waste management. High temperature incineration can be used for electricity generation, supplying power to approximately 100,000 citizens living in nearby areas, and the environmental impact of the construction of the incinerator can be kept to an acceptable level. The Government will implement relevant mitigation measures. For example, corals of high ecological value can be moved to other locations, and construction can be suspended for a few months when finless porpoises inhabitat the area in winter and spring. This will also reduce the impact of noise on the dolphins and other wildlife such as white-bellied sea eagles.

Those with opposing views think that the cost for constructing the incinerator is too high. The estimated construction cost for the Shek Kwu Chau incinerator is at least HK$15 billion. In addition, the operation fees are estimated to be HK$500 per tonne of waste. Opponents are concerned about the gases and ashes containing toxic heavy metals produced by high temperature incineration, and the subsequent chemical procedures to solidify toxic ashes, and the disposal methods. Currently, Hong Kong does not have comprehensive measures of waste separation at source. Solid waste may be mixed and burned with poisonous chemicals, such as circuit boards or medical waste and the toxic gas produced will harm human health and pollute the environment. In addition, residents are concerned that the incinerator will have a negative impact on nearby water quality and the local fishing industry, harming the habitats of dolphins and birds, and damaging the ecological balance in the outlying islands.

Source: "通識把脈：建焚化爐有得有失 宜求共識", 2 March 2015, *Wenweipo*.

Group 3: Waste Recycling

Source E: The Programme on Source Separation of Domestic Waste

The Programme on Source Separation of Domestic Waste was launched territory-wide in 2005 to encourage more people to separate their waste for recycling. It began on a trial basis in 13 housing estates in the Eastern District in 2004, and proved to be successful. Some of the participating housing estates more than doubled the quantity of recyclables they recovered. They also earned additional income from selling recyclable materials, which they can use to subsidise management expenses.

The 3 existing landfills in Hong Kong are running out of space so we need to reduce our waste. By getting people to separate their waste for recycling, we can minimise the amount of waste requiring disposal. Together with other measures in the *Hong Kong Blueprint For Sustainable Use Of Resources 2013-2022* published in May 2013, the EPD is seeking to increase the recycling rate in Hong Kong to 55% by 2022. Waste separation in housing estates will be essential to ensuring the success of this goal. In recent years, the Government has tried out various forms of domestic waste separation and recovery, to find out what systems are convenient to residents, cost-effective and best suit local needs. A flexible approach is necessary because different systems may be required for different types of buildings.

Source: Environmental Protection Department. "Source Separation of Domestic Waste". Retrieved from https://www.wastereduction.gov.hk/en/household/source_intro.htm

Source F: Programme on Source Separation of Waste

Source: Environmental Protection Department. “Hong Kong Waste Reduction Website”. Retrieved from http://www.wastereduction.gov.hk/en/household/source_detail.htm

Group 4: Waste Charging

Source 7: Waste Charging Scheme

With the exception of charging for plastic shopping bags, Hong Kong has not implemented any levy scheme on solid waste. According to research studies on overseas experience and the experiences of Hong Kong's previous efforts and actions, the necessary behavioural change and reduction in waste cannot be achieved without economic incentives. Overseas experience indicates that in addition to effectively reducing the waste disposed and increasing the recycling rate, charging for municipal solid waste can reduce the generation of waste at source to a certain extent.

Currently, waste separation is a task primarily performed by waste collection workers. Municipal solid waste charging will help citizens develop the habit of thinking twice before dumping waste. If every citizen could separate their waste at source, the effectiveness of waste recovery and recycling would be largely increased.

Municipal solid waste charging is a policy that covers Hong Kong citizens of different social status, and a policy that will affect current waste collection methods. Since charges are proposed, there are concerns about economic burdens on households and the industrial and commercial sectors, especially the impact on low-income families. The experiences of other cities in implementing waste charging schemes suggest a society must reach a general consensus about a charging scheme. In addition, a series of practical issues will arise during the implementation of a charging scheme. Therefore, it is necessary for the Government to discuss the scheme with citizens and relevant stakeholders to find corresponding solutions.

Having reviewed the experiences of selected international cities, the types of charging methods can be classified broadly as follows:

Quantity-based System	The waste charge is assessed on the basis of waste quantity. Citizens purchase designated garbage bags that establish a direct link between the charge and the quantity of waste requiring treatment or disposal. This is regarded as the most effective means for waste reduction.
Proxy System	A proxy system links the waste charge to an indirect indicator of waste generation. Water consumption can reflect the level of human activity in a household, which in turn is associated with waste generation to some extent. Charges are then levied regardless of the quantity of waste actually generated.

Fixed Charge	A fixed charge system is not linked to the quantity of waste generated. Each waste producer within the same category (e.g. residents of the same district) pays an identical rate regardless of how much waste they produce.
Partial Charging	Charging, for example, can be applicable to the commercial and industrial sectors only. A charge at the gate (or "gate fee"), calculated by weight, is usually applied when waste is delivered to disposal sites or refuse transfer stations. Internationally, it is common that waste producers in the commercial and industrial sectors are responsible for handling their own waste through employing private waste collectors. The key advantage of a partial charging system is its flexibility: we might first put in place municipal solid waste (MSW) charging in those sectors where the implementation of such charging is more feasible. Accordingly, we might realise the benefits before a full charging scheme is developed.

Source: Consultation Document: Strengthening Waste Reduction: Is Waste Charging an Option?. Environment Bureau. (January 2012).

Appendix 5: Group Discussion Worksheet

Group Discussion Worksheet (1):
Comparison of various solid waste management measures

Our group's analysis on solid waste management: **Disposal at Landfills/ Incineration/Waste Recycling/Waste Charging*** is as follows:
(*Delete if inappropriate)

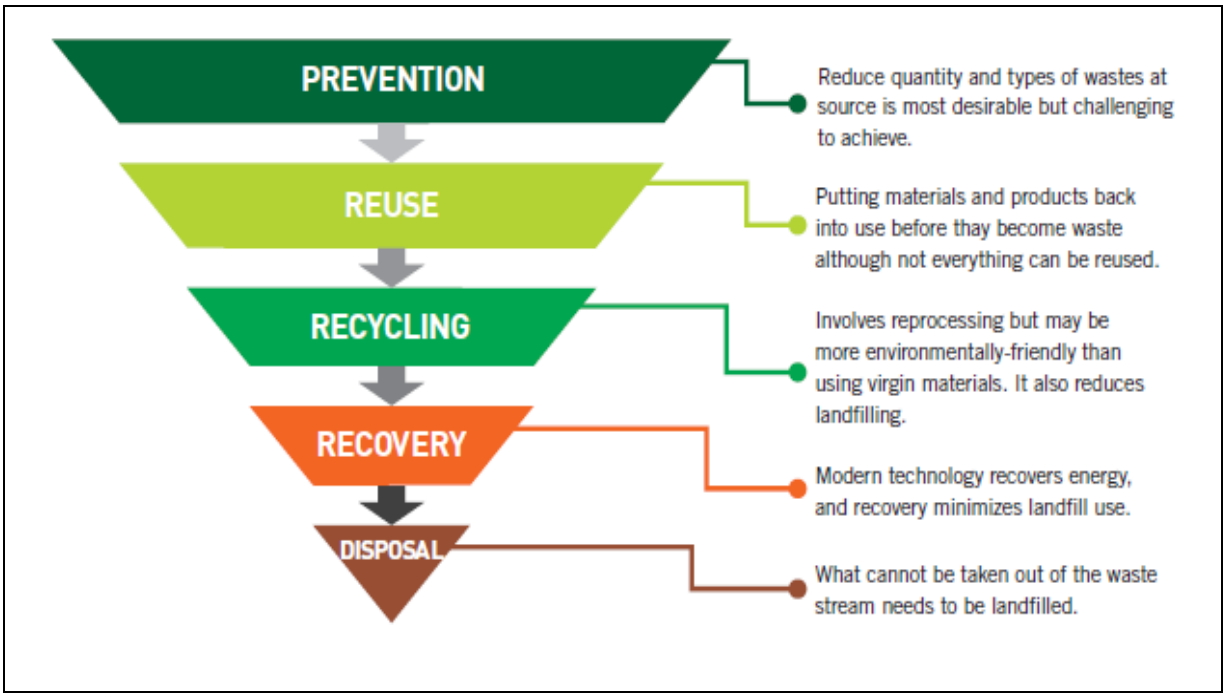
	Disposal at Landfills/ Incineration/ Waste Recycling/ Waste Charging*
1. The current situation of the measures implemented in Hong Kong	
2. Advantages of the measures	
3. Possible difficulties encountered/ existing difficulties	

Group Discussion Worksheet (2):
Worksheet for the group discussion of "hybrid" group

	Disposal at Landfills	**Incineration**	**Waste Recycling**	**Waste Charging**
1. The current situation of the measures implemented in Hong Kong				
2. Advantages of the measures				
3. Possible difficulties encountered/ existing difficulties				

<u>Appendix 6</u>: Multi-tiered waste management hierarchy and experiences in other Asian cities

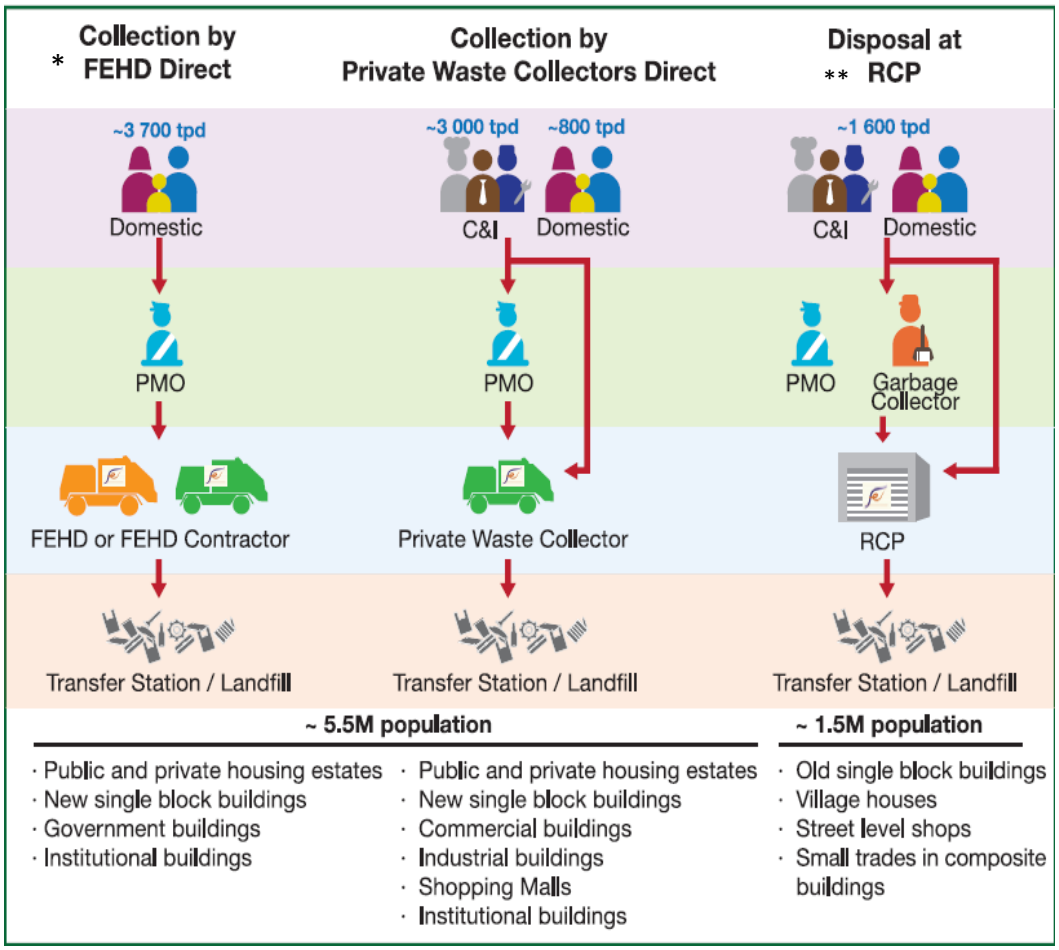
Source A：Multi-tiered waste management hierarchy



Source: "HONG KONG BLUEPRINT FOR SUSTAINABLE USE OF RESOURCES 2013-2022". The web page of Environment Bureau (May 2013).

Source B

Existing Municipal Solid Waste Collection System in Hong Kong



* Food and Environmental Hygiene Department **Refuse Collection Points

Source: "Chapter 5 Existing Waste Collection Services in Hong Kong" . *Consultation Document: Strengthening Waste Reduction: Is Waste Charging an Option?* Environment Bureau. (January 2012). Retrieved from http://www.epd.gov.hk/epd/msw_consult/file/MSW_ENG_ch5.pdf

Source C:

Per capita disposal rates and production rates of municipal solid waste of some cities

Cities	Daily Production Rate (kg/person/day)	Daily Disposal Rate
Taipei	0.88	0.35
Tokyo	1.03	0.41
Seoul	1.08	0.79
Hong Kong	1.45	0.87
London	1.45	1.04

Source: *Consultation Document: Strengthening Waste Reduction: Is Waste Charging an Option?* Environment Bureau. (January 2012).

Source D: Waste management strategies adopted by different cities in Asia

Taipei is a city with a high population density. Residents of multi-storey buildings use colour-coded garbage bags to carry waste, while large, licensed waste bags are used to collect waste of entire buildings. Hong Kong can learn certain lessons from this practice. Another unique feature of the charging scheme in Taipei is that those who generate waste are required to deliver waste to staff from the municipal waste collection fleet "at the designated location(s) and time(s)". In addition to being authorised to perform inspections, relevant staff also has the right to reject waste not carried in licensed bags.

In Seoul, residents of multi-storey apartment buildings are required to put waste in licensed waste bags and dispose of waste in public collection bins located in open spaces underground. As a result, any violation is easily detectable. Encouraging its citizens to check on one another is an important practice for Seoul to successfully implement its municipal solid waste charging scheme (the same applies to Taipei).

In the Greater Tokyo Area, certain areas are allowed to decide, on their own, whether and how to implement a charging scheme. Some suburbs and cities have implemented a charging scheme based on waste volume through the use of licensed waste bags. The waste charging scheme in Singapore aims to recover waste management costs through employing private waste collection services. The city-state government also executes other measures to promote waste reduction and recovery, for example, it provides recycling services for recyclables. However, relevant services are not treated as a supporting measure within the charging scheme, but a stand-alone measure.

Source: *Consultation Document: Strengthening Waste Reduction: Is Waste Charging an Option?* Environment Bureau. (January 2012).

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Questions for Discussion:

1. What is the multi-tiered waste management hierarchy?

   _____

   _____

   _____

2. Is the current situation in Hong Kong in line with the hierarchy?

   _____

   _____

   _____

3. Are waste management strategies in other Asian countries applicable in Hong Kong? If so, how can they be implemented? If not, why?

   _____

   _____

   _____

   _____

   _____

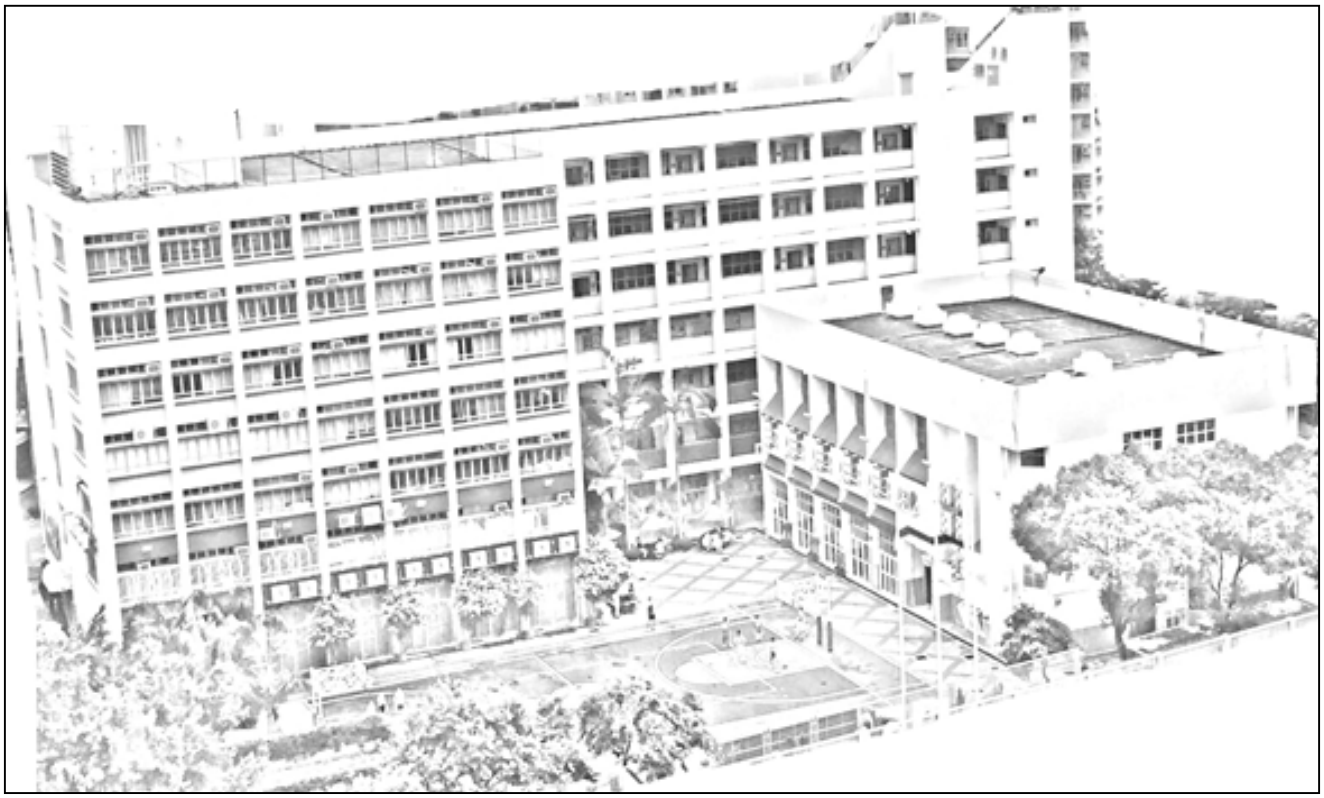
   _____

   _____

<u>Appendix 7</u>: How to implement additional waste management measures for your school

Task 1: Draw your proposed collection facilities for recycling items and other waste management measures on the elevation and floor plan below (Note: teachers are welcome to use their own school plans to encourage greater interest and a higher sense of involvement among students)

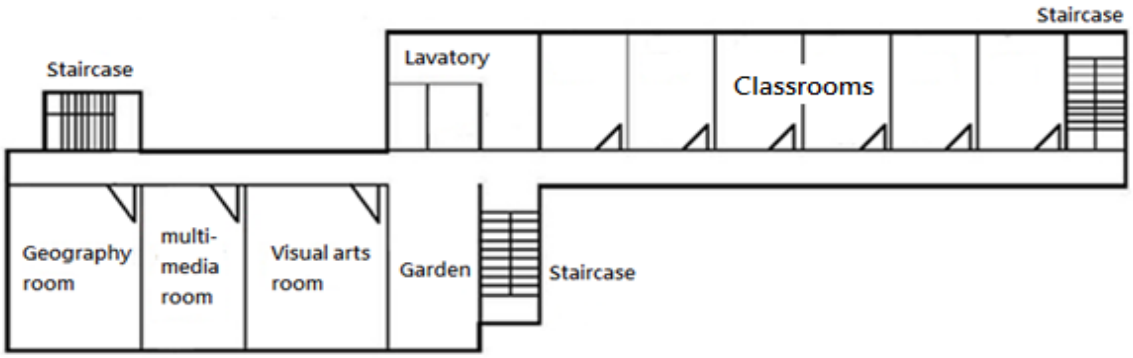
1. Picture of the school campus



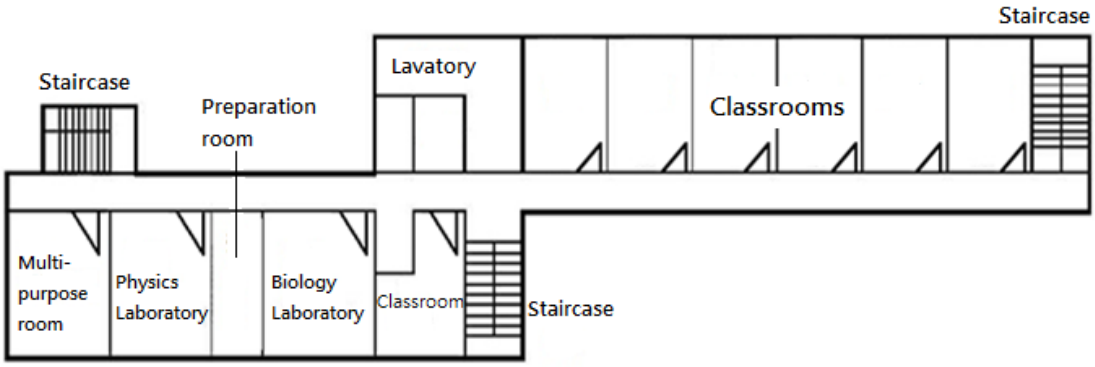
Source of the picture:
Special thanks to HKTA Yuen Yuen No.3 Secondary School for providing the picture of the school campus.

2. Floor plan (Only 4/F and 5/F are displayed. Teachers may add the floor plan of other storeys)

4/F



5/F



Refer to the following principles when drawing collection facilities for recycling items on the drawing of the school premises:

Location selection principles：

Locations of collection facilities for recycling items and collection methods should take into account the design of the school premises, but their location should also comply with the following requirements：

☐ Whether there is sufficient space on the school premises to place the collection facilities (e.g. width of the corridors, size of classrooms)?

☐ Would they block the access of teachers, students and janitors?

☐ Are they placed so that they are easily seen?

☐ Do they comply with fire safety ordinances and other relevant laws? (e.g. not blocking escape routes)

☐ Others：_____

Source: Adapted from "第三章：*為您的物業選擇廢物分類回收位置及系統*". *住宅樓宇廢物源頭分類指引手冊*. Environmental Protection Department. Retrieved from http://www.epd.gov.hk/epd/english/environmentinhk/waste/prob_solutions/guidebook2006/pdf/CHI03.pdf

Task 2: Prepare a guide that contains at least <u>ten methods</u> to encourage your classmates to reduce solid waste (refer to Source A in Appendix 6):

Let's practise a lifestyle of sustainable development together –
the reduction of solid waste starts with you!

<u>Guidelines on reducing solid waste</u>

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

Appendix 8: After-class Assignment

Consider the following sources:

Source A

Adapted from:

Global Wire Associates. (8 October 2012). Retrieved from http://globalwireonline.org/page/2/?s=waste

Source B

A survey conducted by a conservation group found that families bought, on average, just over 3 boxes of mooncakes for the Mid-Autumn Festival. According to statistics, on average each household threw 1.06 mooncakes away. In addition, fancier packaging produced more waste. The survey prompted calls for the Government to launch a waste charging scheme to ease the burden on landfill sites.

Source: Integrated from newspaper articles and websites from 17 September 2012.

Source C

A public consultation showed that over 60% of respondents would support the Government to implement a waste charging scheme based on waste volume. Such a scheme would involve a great deal of logistics and compliance issues. For example, citizens would need to buy specially printed biodegradable bags to dispose of their household waste. There are also concerns that the charging scheme might impose a heavy burden on low-income families. In Taipei, up to 27 tonnes of waste was being illegally dumped each day. The problem was addressed by withdrawing all public litter bins.

Source: Integrated from newspaper articles from 5 April to 17 December 2012.

Questions

(a) Interpret the message conveyed by Source A.

(b) According to the above sources and your own knowledge, evaluate the feasibility of the waste charging scheme in Hong Kong as suggested in Source C. Explain your answer.

Intention of Assessment

Assessment Focus

The sources of the assessment include a cartoon that conveys the role of different stakeholders in the resolution of environmental issues, a survey on the amount of waste and opinions towards a waste charging scheme. Students' application of concepts and knowledge such as, "environmental protection", "sustainable development", "quality of life", "polluter pays principle", and "economic incentive", will be assessed. Students should be able to demonstrate skills such as interpreting the cartoon, analysing the sources, evaluating different viewpoints and constructing arguments.

Expected student performance

Knowledge

- For question (a), students should explain in detail how each stakeholder in Source A can help alleviate the problem, (e.g. the Government should set up policies to reduce waste production; the business sector should reduce packaging; and citizens should adopt environmentally friendly consumption habits). Students should be able to apply relevant concepts such as "municipal waste management", "waste charging scheme", "environmental protection", "sustainable development", "quality of life", and "green lifestyle".
- For question (b), students should demonstrate a clear understanding of 'waste charging scheme' suggested in Source C, and justify to what extent they think the scheme is feasible with reference to the sources. Students are also expected to formulate their arguments on the basis of a detailed and critical evaluation regarding perspectives for and against the statement in the context of Hong Kong. They may construct their stances and arguments by considering factors such as public support, cost-effectiveness and feasibility.

Skills

- Giving appropriate response with clear personal stance.
- Extracting and interpreting the core messages in the cartoon and textual data, as well as transforming them into advanced knowledge and concepts.
- Interpreting different roles of stakeholders in the issue of municipal solid waste.
- Evaluating the feasibility of a waste charging scheme, using valid examples and relevant concepts in constructing arguments.

--- End of Appendix --

Senior Secondary Liberal Studies
"Energy Technology and the Environment" Module
Learning and Teaching Exemplar (4)

How the International Community Cope with Climate Change: Using the World Climate Summit as an Example

A. Basic information of the exemplar

Topic	How the International Community Cope with Climate Change: Using the World Climate Summit as an example
Relevant modules, themes and issues for enquiry	Leading Module 6: Energy Technology and the Environment; Theme 2: Environment and sustainable development ● How do the living styles of people and social development affect the environment and the use of energy? ● What responses could be made by different sectors of the society, governments and international organisations regarding the future of sustainable development?
	Related Module 4: Globalization ● How do people from different parts of the world react to globalization? Why?
	Related Module 3: Modern China; Theme 1: China's reform and opening-up ● In what ways has China's participation in international affairs affected the overall development of the country?
Overall design rationale	Focusing on the international community's response to climate change, this exemplar aims to help students understand that issues arising from climate change can no longer be solved by any single nation alone. It is necessary for the international community to hold a dialogue and establish collaborations in respect of environmental issues. Taking the World Climate Summit as an example, this exemplar aims to guide students to learn about agreements and any common understanding in respect of climate issues. By analysing the interests and emission-reduction obligations of different nations, students will understand the functions and limitations of the World Climate Summit. They will also learn to apply the concept of global governance to explain the importance of collaboration among different countries and their citizens to seek consensus and reserve differences in finding a solution to climate issues.
Time required	4 lessons (40 minutes per lesson), approximately 160 minutes in total
Learning objectives	Knowledge: ● To understand the causes and effects of climate change. ● To understand the relationship between the World Climate Summit and global governance. ● To think about the effectiveness of international collaboration, as

	well as the difficulties encountered and any such limitations.
	Skills: ● To make conceptual observations based on the available data in exploring the issues. ● To apply relevant knowledge and concepts in discussing contemporary issues. ● To interpret data from different perspectives. ● To express ideas effectively in speaking and writing. ● To put forward specific, concrete and feasible solutions.
	Values and attitudes: ● To adopt an open and tolerant attitude towards other people's views and values. ● To appreciate and respect diversity in cultures and views in a pluralistic society. ● To care about the global issues and changes, and act in a positive manner.
Basic concepts for application	Climate change, air pollution, resource depletion, energy technology, global governance
Relevant learning experience at junior secondary levels	Having studied various subjects in a range of key learning areas such as Personal, Social and Humanities Education, students at junior secondary levels are expected to have a general idea about the operation mode of international collaboration and the development in and interdependence between less developed and more developed countries. If teachers think that students lack relevant knowledge, it is recommended that a brief introduction should be made before using this exemplar.

B. Design of classroom learning and teaching

Lesson	Learning and teaching strategies and flow
Before class	Distribute pre-class worksheet (Appendix 1). Ask students to follow instructions on the worksheet and collect two sets of information from the Internet or other channels that offer proof of the existence of climate change (e.g. photos). Ask them to attach the information in relevant spaces on the worksheets. Remind students that they can collect local or international information on aspects such as climate, ecological environment and health risks.
1	**Lead-in (around 15 minutes)** **What is climate change?** ● Invite some students to share their pre-class preparation work. Students' answers can be related to higher temperatures, typhoons, rising sea levels, extreme rainfall, droughts, blizzards, melting icebergs, decrease in food production, reduction of species and spread of diseases. ● Show the photo of Source A (Appendix 2). Ask students if they have seen this particular condition (i.e. severe flooding) on television, and what factors might have caused it. ● While there are signs of more extreme weather in Hong Kong (e.g. heavy rain, very hot weather), many other places in the world face the same situation, which may be related to greenhouse gas emissions (e.g. carbon dioxide) and the greenhouse effect. ● Show the photo of Source B (Appendix 2). Ask students to guess in which month this photo was taken and show them a chart that sets out the average monthly temperatures in Hong Kong, as recorded by the Hong Kong Observatory (Source C in Appendix 2). Students may guess the photo was taken in July or August since the people in the photo are wearing summer clothes. Point out that this photo was actually taken on 8 November 2015, to show that the temperature in Hong Kong has been rising in recent years: while 30°C in November is becoming common in Hong Kong, the average temperature in Beijing may now drop to below -5°C in the same month. Climate change happens around us. ● Use the picture in Source D (Appendix 2) to explain the greenhouse effect and global warming, and the basic scientific knowledge behind them. ● Ask students to read *The Year's Weather - 2014* from the website of the Hong Kong Observatory (Source E, Appendix 2). Ask students about the major characteristics of the weather in 2014 and highlight or underline keywords about the characteristics of climate change (e.g. the hottest year

Lesson	Learning and teaching strategies and flow
	ever, many extreme weather events). They may also circle 3 to 4 examples of extreme weather elsewhere, e.g. snow storms in New York or a ferocious storm in the Philippines. ● To enhance students' understanding of concepts about **climate change** and extreme weather, it is also advisable to ask students about their own experience with extreme weather events in Hong Kong (e.g. very hot weather, heavy rain, hailstorms). Show the photo of hail from the website of the Hong Kong Observatory "2014年3月30日下午8時40分左右在荃灣拾獲的冰雹", which can be retrieved from http://www.weather.gov.hk/wxinfo/pastwx/2014fig7.png. ● Ask students about the causes of climate change. During the discussion with students, emphasise "human" factors (e.g. humans use fossil fuel for electricity generation, transport and industrial development, emitting large volumes of carbon dioxide; humans also cut down forests, which results in fewer trees and plants that can absorb carbon dioxide) while mentioning a few "natural" causes of **climate change**, such as volcanic activity, or changes in the energy produced by the sun. However, the Intergovernmental Panel on Climate Change (IPCC) pointed out that climate change is primarily caused by human activities. The concentration of greenhouse gases (such as carbon dioxide, methane and nitrous oxide) in the atmosphere has been rapidly increasing since 1750 and is now at an unprecedented level. The increase in the concentration of carbon dioxide is primarily due to the combustion of fossil fuels and deforestation, while the increase in the concentration of methane and nitrous oxide is related to agricultural development. **Group activity – Feasibility study (around 25 minutes)** ● Encourage students to come up with a few methods to reduce carbon dioxide emissions at school (or design a low-carbon school). Ask them to carry out a simple feasibility study (Appendix 3). ● Students may learn about electricity consumption at their school first. For example, they may ask teachers from the general office or general affairs section/resources section about the annual (e.g. last year's) electricity consumption at school (e.g. measured in kWh) and roughly estimate the share of consumption (e.g. air conditioners will account for a higher share) as well as the carbon dioxide emissions (every kWh of electricity produces 0.8 kg of carbon dioxide) for each type of facility that consumes electricity

Lesson	Learning and teaching strategies and flow
	(e.g. air conditioners, fans and lighting). Students may also study the current energy-saving measures implemented in school and their effectiveness. ● Students may demonstrate how their proposed methods can reduce the annual total emissions of carbon dioxide (e.g. reduce by 10% or 20%) by drawing on the picture of the school campus in Appendix 3 (or work together to build models with cardboard, paper or clay). Students are required to calculate the reduction of carbon dioxide emissions using their proposed facilities or methods. ➢ If students propose to install additional wind generators on the roof, they should specify in detail the size of fan blades for the wind generators, the number of generators to be installed and the installation locations. They also need to calculate relevant costs, learn about wind directions at the school, and estimate the volume of electricity to be generated and the reduction in emissions. Students are required to collect relevant information to estimate the costs for their chosen type of wind generators. To calculate the amount of electricity that can be produced, students may also use an anemometer to measure wind speed on the roof of the school building. To help understand the average wind speed and wind direction of the school area, they may refer to the web page of the Hong Kong Observatory. Wind calculators on the website below may be used to calculate the amount of electricity generated by wind energy: http://www.engineeringtoolbox.com/wind-power-d_1214.html. ➢ Students may also propose some emission-reduction strategies for individuals. For example, everyone could reduce their weekly soda count by two 330ml-cans, which would reduce the annual carbon dioxide emissions by 20kg, and their weekly paper count by 20 pages of A4 size paper, which would reduce the annual carbon dioxide emissions by 20kg.[1] ➢ Students may also suggest planting trees at school, but are required to specify the quantity and size of trees to be planted, the land area needed (on the roof, the wall or the ground), and calculate the volume of carbon dioxide that can be absorbed (each tree can absorb approximately 22 kg of carbon dioxide every year). They may refer to the website: www.arborenvironmentalalliance.com/carbon-tree-facts.asp). If students are interested, they may refer to Taiwan's EEWH (Ecology,

[1] "減碳約章", The website of Green Living Place, http://green.yot.org.hk/?page_id=361

Lesson	Learning and teaching strategies and flow
	Energy Saving, Waste Reduction and Health) green building certification system, for information about green buildings[2]. ● After discussing in groups their proposed methods and drawing these methods on the elevation plan of the school building, students are required to collect relevant information and perform relevant calculations at home, so as to present their findings to the whole class in the next lesson. In addition to making relevant suggestions, students may also share the difficulties and limitations they encountered during the process, as well as the issues that may need to be solved in order to reduce carbon emissions.
2	**<u>Group presentation – Feasibility Study</u> (around 20 minutes)** ● Students should form groups and report on methods to reduce carbon emissions at school. They are also required to share the difficulties and limitations they encountered during the process. Summarise the methods suggested by students and point out that their methods' feasibility and performance should be evaluated using actual data in order to be more persuasive in terms of the effectiveness in reducing carbon emission. In terms of limitations, multiple perspectives including the school administration, effectiveness in reducing carbon emission and the impacts on students should be considered. For example, although both wind power generation and the planting of trees require large areas of land, wind power generation is subject to weather features such as wind speed and direction, while trees need continous care with only a relatively small amount of carbon dioxide absorbed. Matters related to weight and structure should receive additional attention when planting trees on any roof.
	<u>Group Discussion and Presentation</u> (around 15 minutes) **Negative impacts of climate change on the world** ● Distribute Appendix 4 and ask students to read the information about extreme climate events in different countries or the impacts of climate change. Lead students to discuss how climate change affects people's lives in different countries. Students are divided into 5 groups, representing: 1) Farmers in Yunnan and Guizhou provinces in China: A drought leads to a shortage of drinking water and water for agricultural irrigation, negatively affecting people's health and income. 2) Residents in the Midwestern United States: Freezing weather affects people's health and work.

[2] 智慧綠建築資訊網
http://green.abri.gov.tw/art.php?no=38&SubJt=%E6%A8%99%E7%AB%A0%E4%BB%8B%E7%B4%B9

Lesson	Learning and teaching strategies and flow
	3) Residents in Southeastern France: Flooding disrupts traffic and economic activities. 4) Residents in South India: High temperatures result in heat stroke and deaths. 5) Residents in the Maldives: Rising sea levels submerge human habitats. ● Guide students to discuss which type of countries suffers the greatest impact of **climate change** and introduce the issue of inequality caused by **climate change**. For example, some are of the view that less developed countries are likely to bear the greatest impact of **climate change**, citing its direct impact on the livelihood of local residents, even living conditions; while more developed countries, with a comprehensive system of facilities and infrastructure are less vulnerable to extreme weather events. It is also advisable to mention that climate change also impacts **biodiversity** in the world.
	Arrangement of after-class reading (around 5 minutes) ● Ask students to read the data sources (Appendix 5), revise the relationship between **air pollution** problems and **resource depletion**.
3-4	**Lead-in (around 10 minutes)** ● Ask students about the after-class reading sources, such as: ➢ What energy sources are mentioned in the source? Are they renewable energies or non-renewable energies? ➢ Which countries are their biggest consumers? Why have they been consuming such large volumes of energy in recent years? ➢ What is the relationship among energy consumption, carbon dioxide emissions and economic development? ➢ What are the controversies between less developed countries and more developed countries over energy consumption? ● The aim of asking these questions is to introduce the importance of international collaboration in tackling environmental issues, thereby helping students gain a preliminary understanding of the conflict between less developed countries and more developed countries over their respective obligations to reduce carbon emissions. While less developed countries have been actively developing their economies in recent years to improve the lives of their people, the heavy use of non-renewable energy (chosen for greater availability and cheaper prices) has resulted in increased carbon dioxide emissions.

Lesson	Learning and teaching strategies and flow
	<u>Simulated class activity</u> (around 15 minutes) **Discussion on emission-reduction targets (to be introduced with students' paper consumption, simulating different calculations for carbon emissions)** ● Distribute the discussion worksheets and reference materials (Appendix 6), introduce the issue of excessive lined paper consumption at school. Ask students to think about those that are more responsible for this issue based on different case studies (namely the 5 students who perform better at mathematics or the 20 students with average performance). ● Ask students to discuss in groups and check their answers together. If necessary, remind students to approach the question from the following direction: Current total consumption, the number of students, personal capabilities, and previous consumption. ● Ask some students for their answers (number of students may vary depending on time available). For example, students may adopt the view that the 5 students who **worked hard from the beginning** should bear the greater responsibility. The arguments are a higher cumulative per capita and total paper consumption, higher per capita paper consumption for the current period, better academic performance, and using paper for personal purposes. Students may also say that the 20 students who **started working hard later** should bear the greater responsibility, citing higher total paper consumption in the current period, and higher demand for future consumption (because they need to practice more in order to perform better). ● Guide students to transform their reasons into general principles and demonstrate with a triangular diagram (which can be used to remind students that generalising principles is a practice of higher thinking, which usually requires fewer words). To guide student discussion and assist the students with weaker writing skills to answer questions, teachers may discuss the first reason and generalise the principle with students, or directly give an example for demonstration. Relevant principles may include the total consumption for the current period, the cumulative consumption (1960-2010), the current per-capita consumption, students' capabilities and future needs. Students may come up with different conclusions using different calculation methods in summarising and evaluating responsibilities. ● Show the trend in the carbon dioxide emissions of different countries from 2001 to 2011 (Appendix 7), including their total emissions, per capita

Lesson	Learning and teaching strategies and flow
	emissions and cumulative emissions (1960-2010). Ask students to describe these trends verbally and compare the emissions of different countries. For example, there is a rapid growth in the per-capita and total carbon dioxide emissions for China due to its rapid economic development in recent years. While its total emissions have overtaken those of the U.S., its per-capita and aggregated emissions are still well below U.S. levels. ● Teacher's summary: Encourage students to shift the activity scenario to one where various countries collaborate to tackle the issue of climate change, with more developed countries discussing topics related to emission reduction obligations with less developed countries. With regard to carbon dioxide emissions and global warming, the discussion may focus on countries that should take on greater responsibility, considering various factors, including total carbon-emission calculations, aggregated carbon dioxide emissions, per-capita carbon dioxide emissions, as well as a country's economic development, its resources available and technological advancement. Aiming to protect their own national interests, less developed countries and more developed countries are likely to emphasise different statistics. Therefore, the meeting and any form of collaboration will still have to conquer many challenges to reach a consensus.
	Watching video and giving a brief introduction (around 15 minutes) **Learning about the Climate Summit** ● Distribute reading materials (Appendix 8). Introduce the background of the United Nations Climate Change Conference and the development of the *Kyoto Protocol*. Give a brief introduction to the dialogue among different countries in respect of the issues of **climate change** with reference to relevant information about the *Kyoto Protocol* in this Resources Booklet. ● Play the video "宣示大於實質　氣候峰會未提具體減碳" (28 September 2014, https://youtu.be/qqJtFo91gvo, 11min 33s) to allow students to experience what is like to attend the meeting. ● The dialogue in the clip is mainly in Mandarin and English, with traditional Chinese subtitles. The first 4 minutes are comments by the host on the differences between this summit and the one held in Copenhagen in 2009; the 4th to the 7th minutes are speeches delivered by U.S. President Barack Obama and Zhang Gaoli, the vice premier of China's State Council; and the last 4 minutes are speeches delivered by UN Messenger of Peace, Leonardo DiCaprio and Secretary-General of the United Nations, Ban Ki-moon, respectively. Skip the last 4 minutes as appropriate (based on the time

Lesson	Learning and teaching strategies and flow
	available). ● Ask students to make notes about the video clip (Appendix 9). ● Summarise information from the clip. For example, the 2014 Climate Summit was held in New York, five years after the Copenhagen Climate Summit in 2009. The timing of this summit coincided with the recovery of the U.S. economy, and China having to deal with the threat of smog. This made it easier for attending countries to reach an agreement; and the attending countries also realised that the fight against **climate change** would facilitate instead of impede economic growth. The 21st United Nations Framework Convention on Climate Change (UNFCCC) Conference of the Parties (COP21) was held in Paris from November to December 2015. COP21 aims to achieve a new climate agreement that will apply to all countries, such as specifying binding emission reduction targets and providing financial support for less developed countries[3]. Ask students to highlight important issues regarding the conference and the stances of different countries.
	Group discussion, cross-group discussion and presentation **(around 30 minutes)** **Discussion on carbon emission reduction targets** ● Distribute the discussion worksheet and reference materials (Appendix 10), arrange each group to discuss the carbon emission reduction targets of a specific country, its rationale and proposed measures, and then complete relevant lists in Tables 1 and 2. Encourage students to play the roles of different leaders (China, the United States, the European Union (EU), and India) and consider the reduction targets based on the context of their countries. For example, as a developing country, China's economic development plays a vital part in improving the quality of life of its people; therefore, while it is unfeasible for China to significantly reduce its emissions, it is however, possible for the country to reduce its per-capita emissions. On the other hand, with advanced energy technologies, the United States can increase its energy efficiency and reduce total emissions through the use of technologies. For example, since the majority of American's drive cars, the government may encourage the use of transportation modes with higher energy efficiency to reduce energy

[3] Teacher may show the video about the historial background background and outcome of the 21st UNFCCC Conference of Parties (COP 21) in Paris. https://www.youtube.com/watch?v=-kuiK9BA6TE

Lesson	Learning and teaching strategies and flow
	consumption (e.g. electric vehicles). For the EU, in light of the attention directed by EU residents towards environmental protection and their willingness to make changes in their lives to reduce energy consumption, local governments may encourage more people to use eco-friendly transportation modes (e.g. using bicycles more often). As the Indian Government is committed to eliminating poverty and developing the economy, the country also faces huge challenges in reducing its total carbon dioxide emissions; however, it is feasible for India to set up long-term goals on lowering the growth in its carbon dioxide emissions. Students discuss for around 15 minutes and each group presents the key points. ● Teachers may add the following measures. For example, the countries may: ➢ increase the use of **renewable energy**, such as wind power and solar energy; ➢ plant trees to increase forest areas and absorb carbon dioxide; ➢ encourage people to practice a **green lifestyle**, with a view to reducing energy consumption. ● During group presentations, students should record the reduction targets of other groups (other countries), their rationale and proposed measures in Tables 1 and 2 of Appendix 10. **Seminar on carbon emissions reduction agreement** ● Ask students to host a cross-group seminar on methods proposed by different countries to reduce emissions. Encourage students to compare the plans of different countries, then ask students to adjust or amend the plans of other countries and explain their rationale. For example, students may attempt to persuade those countries whose targets are too low to set higher targets by providing reasons and recommending measures. For countries with targets that are too high, consider asking about the feasibility and performance of their measures. ● Regardless of whether amendments are necessary, students from different groups may take turns expressing their views and reasons. ● After listening to the suggestions of other groups, ask students to reflect on whether their proposed reduction plans need to be amended and complete Table 3. Then, ask students to verbally explain their last amendments, as well as the potential difficulties.

Lesson	Learning and teaching strategies and flow
	Teacher summary and instructing after-class assignment **(around 10 minutes)** ● Use examples from student activities to help students understand that similar discussions and disagreements may occur at an authentic summit: ➢ More developed countries and less developed countries still hold vastly different views on their respective obligations to reduce emissions. While more developed countries (e.g. the U.S.) stress that emerging economies such as China and India should take on greater responsibilities to reduce emissions, less developed countries stay firm on the principle of seeking common ground while reserving differences. China has committed to reducing carbon emissions. For example, China has announced that the country's carbon dioxide emissions will peak by around 2030 and then energy efficiency will increase. However, it should be noted that as a developing country with a population of 1.3 billion, China has to address its economic and social needs at the same time. ➢ This example reflects some of the difficulties in the implementation of **global governance.** The major participants of **global governance** are various national governments, intergovernmental organisations, non-governmental organisations and multinational corporations. The World Climate Summit is an effort of the international community to deal with climate change through international collaboration. While some scholars have pointed out that different countries can reach a common understanding to solve issues of international concerns by participating in **global governance**, World Climate Summits have made it clear that limitations faced by the international community in solving issues through **global governance** stem from different values, interests and domestic issues of the various countries (refer to the Module of "Globalization" in the *Liberal Studies Curriculum Resource Booklet Series* for concepts about **global governance**). ● Distribute and encourage students to complete assignment (Appendix 11).

-- End of learning and teaching exemplar --

<u>Appendix 1</u>: Worksheet for Pre-class Assignment

1. Collect pictures, statistical or textual data from newspapers, magazines or the Internet, and paste them onto the 2 blank spaces below:

The following 2 data sources indicate that climate change is a <u>serious/not a serious</u> problem (delete where applicable)

Source A：

Source：_____

Source B：

Source：_____

Appendix 2: Climate Change

Source A

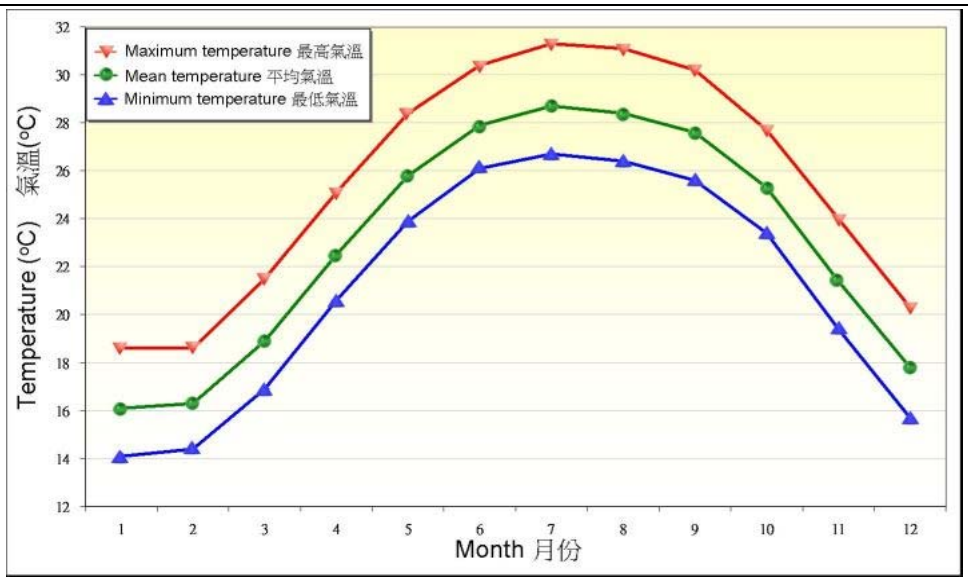
Severe flooding in Tai O when Typhoon Hagupit swamped Hong Kong in 2008

Source: “全球變暖下的香港”. Hong Kong Observatory. Retrieved from http://www.hko.gov.hk/climate_change/climate_change_c.pdf

Source B

Source of the photo: This photo was taken by the resource developer.

Source C



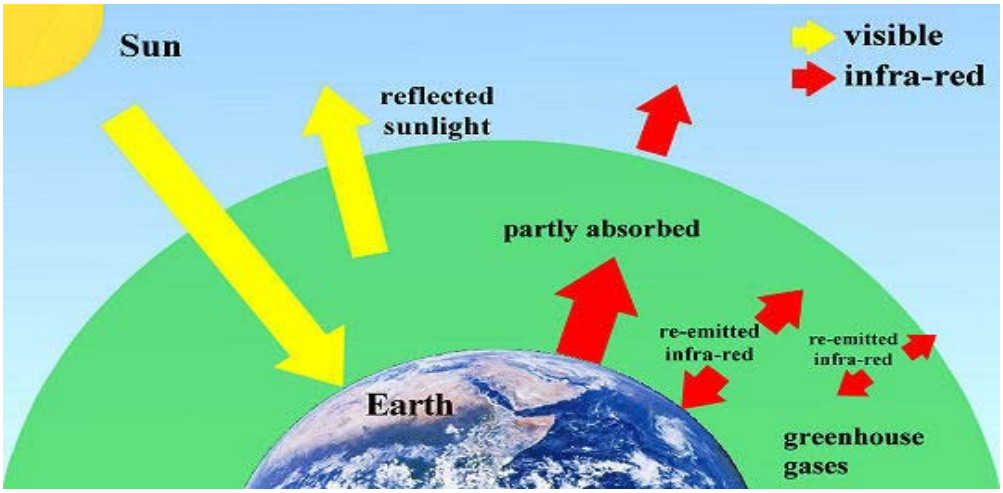
Monthly averages of the maximum, mean and minimum temperatures recorded by the Hong Kong Observatory from 1971 to 2000

Source: "香港氣象要素之月平均值 (1971-2000)" . Hong Kong Observatory. Retrieved from http://www.hko.gov.hk/cis/normal/1971_2000/normals_c.htm

Source D

The heat at the surface of the earth is mainly derived from the sun. When solar radiation reaches the earth, part of it is reflected back to space, from bright surfaces (e.g. sea, ice and clouds), and part of it heats up the earth.

The earth has an atmosphere and gases in the atmosphere (e.g. carbon dioxide) hinder the escape of heat out into space. The gases absorb part of the infra-red radiation from the surface of the earth, and then re-emit in all directions. Part of the infra-red radiation will escape to space, but part of it will bounce back to the earth, heating up the surface. This is known as the greenhouse effect (see the picture) Such gases are known as greenhouse gases. Currently, the average surface temperature of the earth is around 15°C.



As greenhouse gases increase in the atmosphere, they increase the temperatures at the surface of the earth. This is known as the greenhouse effect This warming of the climate changes climate patterns and natural systems, but will also have implications on human activities and societies.

Source: "Schematic diagram illustrating the greenhouse effect". Hong Kong Observatory. http://www.hko.gov.hk/climate_change/human_activities_uc.htm

Source E

The Year's Weather - 2014

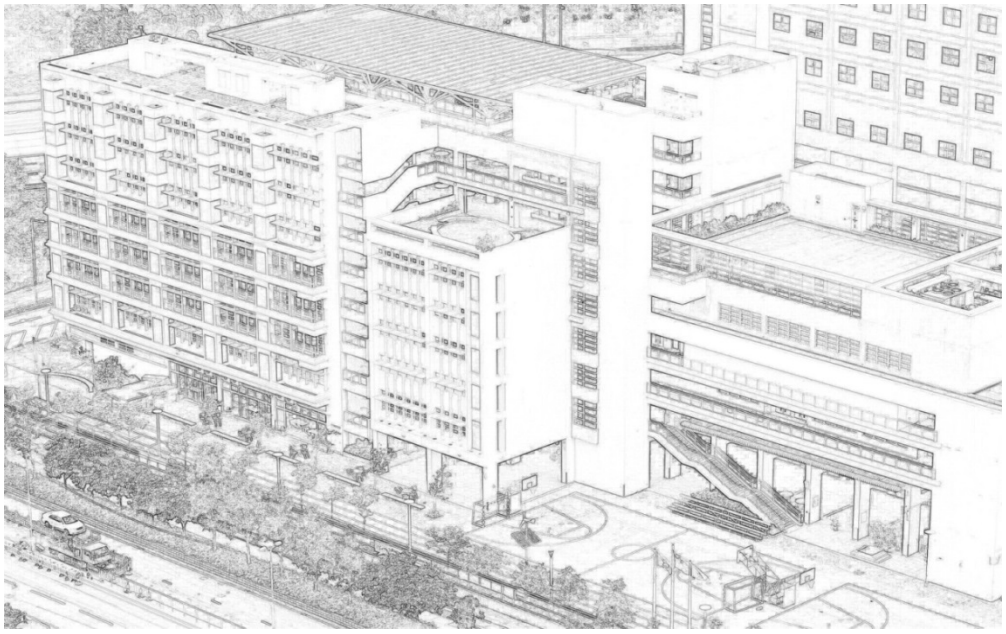
According to the World Meteorological Organization's preliminary assessment on the global average temperature from January to October 2014 is likely to be one of the hottest since 1850, when records began. Notably, extreme weather events badly hit many parts of the world in 2014, including heat waves in South Africa, Australia and Argentina; exceptional cold weather in the Midwest and along the Mississippi River in the United States; heavy snow in northern and eastern Japan, Buffalo and New York in the United States; severe droughts in northern China, parts of eastern and central Brazil, western United States, New South Wales and Queensland in Australia, and the North West province of South Africa; extreme rainfall and flooding in the United Kingdom, France and Japan; and super typhoons in the Philippines and Hainan province of China.

In Hong Kong, the overall weather in 2014 was warmer than usual. Although it was cooler in February, March and December, the weather was unusually hot from June to September and very warm in October and November. As for the whole year, the annual average temperature of 23.5 degrees was 0.2 degrees above the 1981-2010 normal (or 0.5 degrees above the 1961-1990 normal of 23.0 degrees), ranking the ninth highest on record.

Source: "The Year's Weather – 2014". Hong Kong Observatory. Retrieved from http://www.weather.gov.hk/wxinfo/pastwx/ywx2014.htm

<u>Appendix 3</u>: Feasibility study on lowering carbon dioxide emissions at school/ Establishing a low-carbon campus

Students have to show how to reduce the annual total emissions of carbon dioxide (e.g. a reduction by 10% or 20%) by drawing on the aerial picture of the school campus below, or by working together to build a model with cardboard, paper or clay. In addition, students are required to show their calculation of the reduction of carbon dioxide emissions reduction by providing relevant details in the space below.



Source of the picture: Special thanks to Hong Kong Baptist University Affiliated School Wong Kam Fai Secondary and Primary School for providing the picture of the school campus.

School's utility bill for previous year:

Electricity consumed by the school last year: kWh

CO_2 produced (each kWh of electricity produces approximately 0.8kg of CO_2):

CO_2 emitted by each type of electricity-powered facilities (rough approximation):

Air conditioners:

Electric fans:

Lighting:

Reduction of carbon dioxide emissions by the proposed facilities or methods (students may refer to different websites to calculate the amount of carbon dioxide reduction, e.g. calculating the amount of electricity that a wind generator produces http://www.engineeringtoolbox.com/wind-power-d_1214.html)

Facilities or methods proposed:

Installation locations:

Details (e.g. number, size, people involved, etc):

Amount of carbon dioxide emission reduced (kg/year):

Facilities or methods proposed:

Installation locations:

Details (e.g. number, size, people involved, etc):

Amount of carbon dioxide emission reduced (kg/year):

Facilities or methods proposed:

Installation locations:

Details (e.g. number, size, people involved, etc):

Amount of carbon dioxide emission reduced (kg/year):

Total amount of carbon dioxide emission reduced: _____kg/year

Percentage of emission reduction: _____%

Difficulties in reducing carbon dioxide emissions:

1. _____
2. _____
3. _____

Appendix 4: Worksheet on the discussion of the impacts of climate change

Source A: China

According to Chinese media reports, certain parts in China's Yunnan and Guizhou provinces suffered severe drought in 2010. There was insufficient local supply of drinking water for residents and livestock, resulting in significant economic losses. According to officials of Yunnan province, many of the local pillar industries, such as food crops, sugarcane, coffee and tea, were damaged by the drought, and the province reported an average economic loss of RMB2 billion each week.

Hydropower is the primary source of energy for Yunnan. In order to reduce "the conflict over water between residential needs and electricity generation", local governments have either suspended or restricted the power supply in the province. In 2010, hydroelectric power in Yunnan province operated at "less than 20% of its regular capacity". Some enterprises stopped or reduced production. According to the local government of Nanhua in Yunnan province, if the drought were to persist, more than 5,000 residents would have to be relocated.

Agricultural and industrial sectors are not the only ones severely hit by the drought. Guangxi, Yunnan and Guizhou provinces have all recently issued warnings for forest fires caused by the drought.

Source: "綜述：中國西南罕見旱災影響嚴重", 26 March 2010, BBC 中文網.

Source B: The United States

In 2015, an arctic chill arrived in the U.S. Midwest, with temperatures in Chicago hitting record lows that caused many local schools to suspend classes. The cold spell moved eastwards towards Boston and New York, where the weather was already freezing.

The cold arctic air prevailed in the Midwest, with temperatures in Chicago dropping to -22°C and breaking the record for one of the lowest temperatures since 1936. The temperature in Washington dropped to -19°C at night, with the local government offices and schools closed or suspended.

Source: "美國中西部低溫創紀錄 寒流東移再逼近波士頓", 20 February 2015, www.chinanews.com.

Source C: France

In 2014, several provinces in Southeastern France were hit by excessive, heavy rainfall, leading to rising water levels in a number of rivers and canals and causing floods that killed 6 residents. The torrential rain also damaged a section of the regional railway system. At one point, hundreds of tourists were stuck at a railway station due to suspended railway travel and had to spend the night in the waiting hall or on trains. The floods also blocked about 30 freeways. The continuous heavy rainfall also caused mudslides in other provinces.

In 2015, several European countries were hit by a heat wave, with temperatures in many French cities reaching new record highs; at one point, the temperature in Paris reached 39°C. To avoid a repetition of the tragic heat wave of 2003 that killed between 15,000 and 19,000 people, the government raised the severe weather warning level to orange for 47 regions, urging the public to pay attention to health. The heat wave led to a sharp rise in electricity consumption, with at least 3 power stations reporting mechanical failure. As these power stations had to stop operations, approximately 1 million residents had to live in blackouts at night. The government also set up a hotline to provide the public with key information about the heat wave, and urged schools to temporarily stop outdoor activities or trips. Local governments also contacted the elderly regularly to verify their health conditions. The Ministry of Labour required employers to take necessary measures to ensure the health of outdoor workers, including rearranging their working days.

Sources:
1. "法國南部暴雨成災", 3 November 2014, *Sing Tao Daily*.
2. "【歐洲熱浪】2003 年熱死近兩萬人 法推酷熱指引", 2 July 2015, *Apple Daily*.

Source D: India

In May 2015, the death toll from a heat wave in southern India reached 551, while in the state of Telangana it reached 199. In addition, 36 people died from heat stroke as a result of the heat wave in another 2 states.

While hot weather always prevails in India, in May every year before the monsoon, the temperatures in 2015 were generally higher than the average temperature of the same period in previous years. Temperatures in several areas of India reached record high levels. Maximum temperatures during the day for some parts of northern and mid-southern India stayed at about 43°C, while certain regions reached as high as 48°C.

Source: "印度高温天氣致近 800 人死亡 新德里一條道路融化", 27 May 2015, Sina news.

Source E: Maldives

Scientists predict that the Maldives and its coral islands in the Indian Ocean will be completely submerged in water within 30 years. Of its 280 islands, three have been fully evacuated. A new capital is being built on coral reefs solidified with sand and rocks, and is expected to be completed in 2020. The new capital is expected to accommodate half of the 340,000 citizens of the Maldives.

Source: *Climate Change Fact Sheet.* Climate Change Teacher Professional Development Programme. Retrieved from http://school.ecc.org.hk/eccschool/uploadfiles/english/en/Climate_change_fact_sheet.pdf

Worksheet for Group Discussion

Social Group	Potential weather conditions/ natural disasters	Possible impacts on daily life/quality of life
Farmers in Yunnan / Guizhou province, China		
Residents in the Midwestern United States		
Residents in Southeastern France and other cities		
Residents in South India		
Residents in the Maldives		

Which type of country is likely to suffer more from climate change? Why?

Appendix 5: After-class Reading Sources

Information on carbon dioxide emissions and energy consumption in the United States, China and India.

Source A

China is undergoing rapid growth in its energy consumption with an annual average growth rate of 8%. This accounts for more than half of the global growth in energy consumption. However, rapid growth in energy consumption has also brought severe environmental pollution, making China the world's biggest contributor of greenhouse gas emissions. China has been the world's largest energy consumer since 2010. China's energy consumption increased from 1.5 billion tonnes of standard coal in 2001 to 3.76 billion tons in 2013, with an annual average growth of 190 million tons and an annual growth rate of 8%. The proportion of China's energy consumption in the world increased from less than 11% at the beginning of this century to 22% in 2014. From 2002 to 2012, China's increase in energy consumption accounted for 58% of the global growth. China's energy consumption increased by 150% during the last decade. It is expected that in 2035, China will constitute more than 25% of the global energy use.

Source: "中國能源消耗增長 環境污染嚴重", October 2014. Retrieved from http://www.newsancai.com/big5/science/234-environment/61421-2014-10-09-15-19-57.html

Source B

According to a BBC report in September 2014, China's per-capita carbon dioxide emissions had overtaken those of the EU for the first time in history. While China has never denied that its economic development requires increasing use of energy resources, such as coal and oil, it points out that its per-capita emissions are not as high as many contributors of carbon emissions.

According to data from the Global Carbon Project, this is no longer the case: China's per-capita carbon dioxide emissions are now higher than that of the EU. Nevertheless, they are still lower than those of the U.S. and Australia. This published data implies that China should take even greater responsibility for global warming. Being the country with the highest total carbon dioxide emissions, China's emissions are not only twice those of the U.S., they are higher than the total emissions of the U.S. and the EU combined.

Source: "中國人均二氧化碳排放量首次超過歐盟", 21 September 2014, BBC 中文網.

Source C

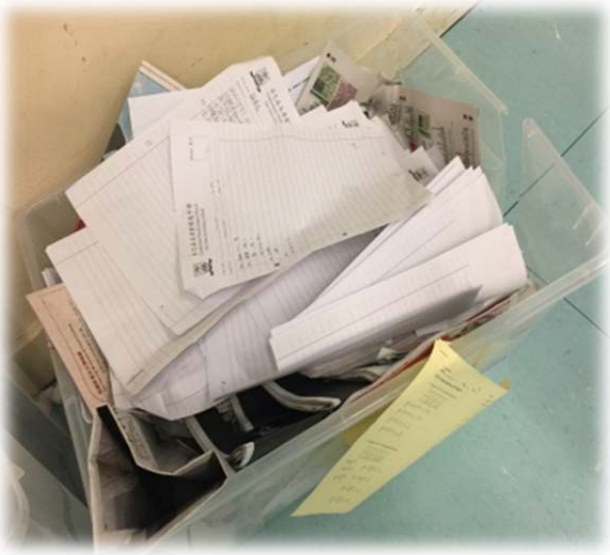
According to an analysis report published by the U.S. Energy Information Administration in 2013, India had become the world's fourth largest consumer of oil and oil products, ranking only after the U.S., China and Russia. As mentioned in the report, India's consumption of primary energy more than doubled between 1990 and 2011. However, India's per-capita average energy consumption was still lower than that of more developed countries. While having 5.5 billion barrels of proven oil reserves, mostly in the western part of the country, India still relies heavily on imported crude oil. Due to differing views held by the Ministry of Defence and oil companies, only 39 domestic oil and gas fields in India are currently used to produce oil and natural gas.

Source: www.sinopecnews.com. (25 March 2013). Retrieved from http://www.sinopecnews.com.cn/info/content/2013-03/25/content_1279445.shtml

Appendix 6: Case analysis worksheet

Complete the worksheet with reference to the following sources:

Source A: Waste paper in a class in a secondary school

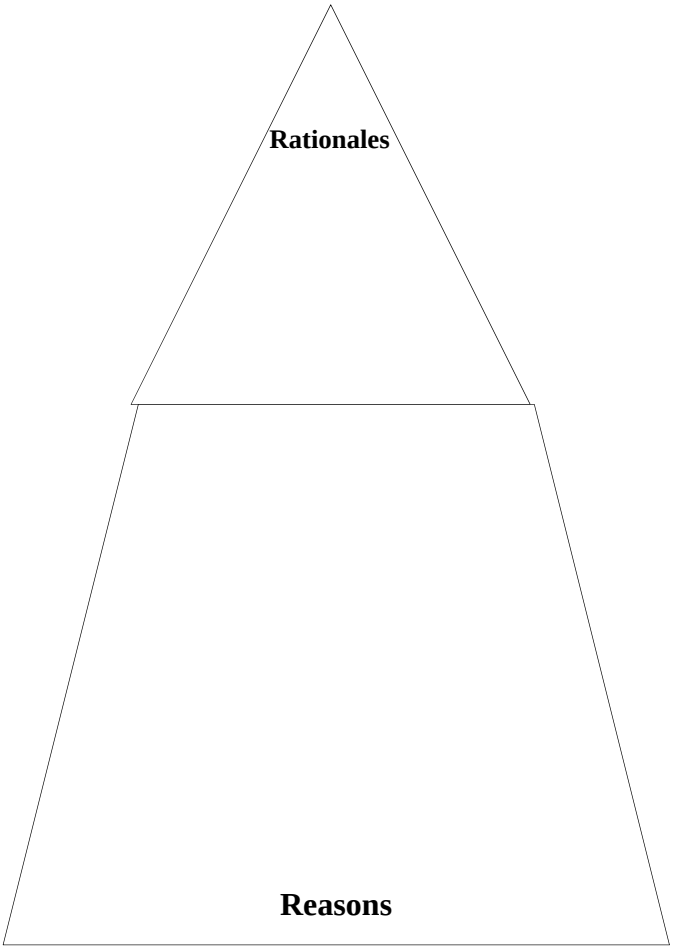


Source: Special thanks to Cumberland Presbyterian Church Yao Dao Secondary School for providing the photo.

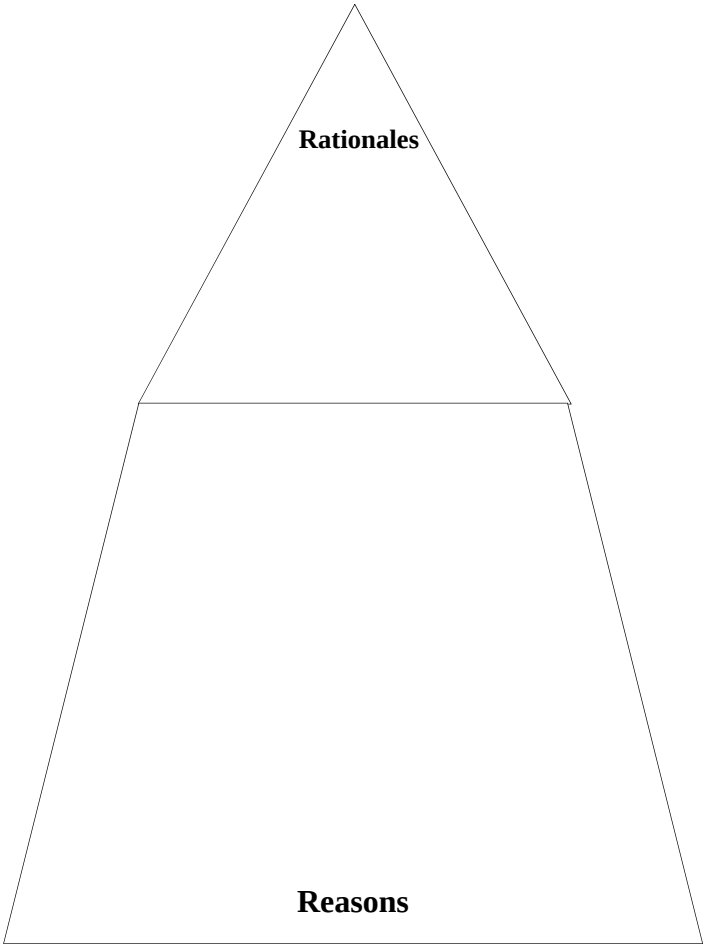
Source B

1. Try to figure out who (which group) is more responsible for the excessive consumption of lined paper based on the following case study

Issue: high classroom consumption of lined paper	
Suspect Group A (Worked hard from the beginning)	Suspect Group B (Started working hard recently)
Used to consume large volumes of paper to practice mathematical skills, therefore performed very well at Mathematics tests; having mastered the mental abacus (珠心算) recently, these 5 students managed to reduce their consumption of lined paper from a total of 80 pages to 50 pages per day. In addition to calculations, these students also use lined paper for entertainment and gaming purposes.	Used to take Mathematics lightly, therefore struggled with the subject, they seldom used lined paper to do exercises and performed unsatisfactorily at tests. However, they have been working very hard recently. They follow the example of those 5 students with a better performance and use lined paper for practice. While their academic improvement is quite noticeable, they now consume a total of 100 pages on a daily basis.



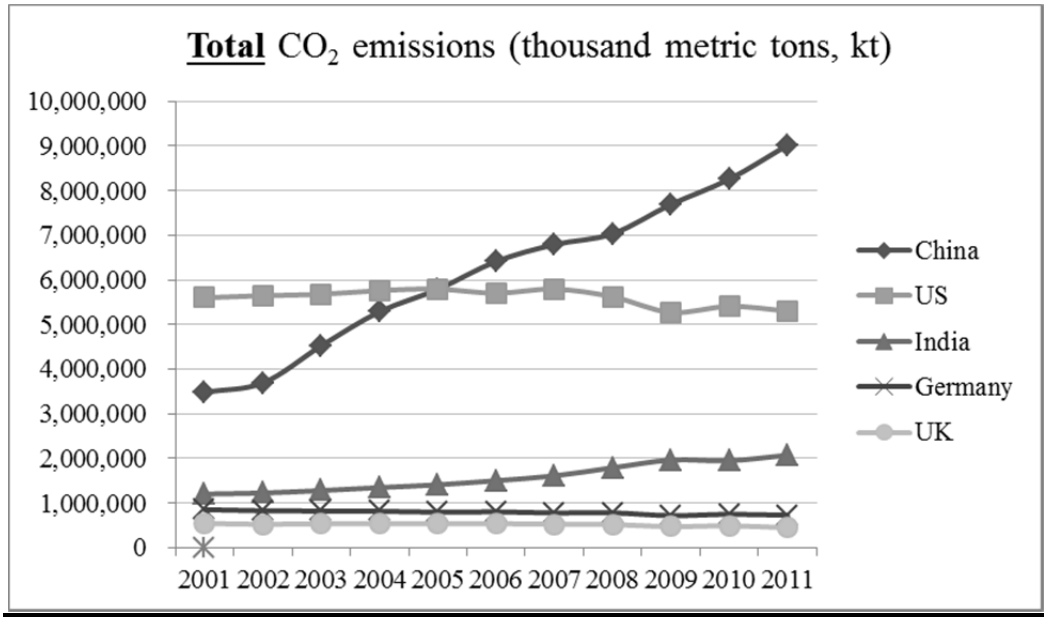
Group A (5 students) should bear greater responsibility



Group B (5 students) should bear greater responsibility

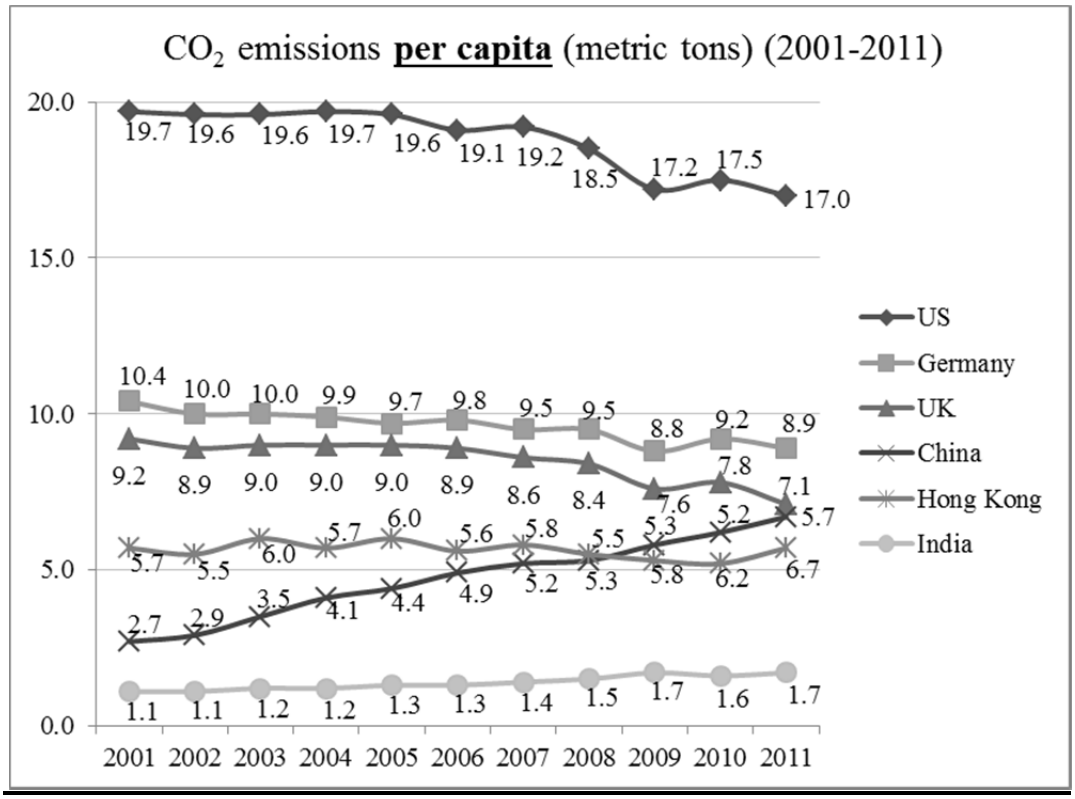
Appendix 7: Carbon Dioxide Emissions

Source A



Source: The web page of the World Bank. Retrieved from http://data.worldbank.org/indicator/EN.ATM.CO2E.KT/countries/1W?display=map

Source B



Source: The web page of the World Bank. Retrieved from http://data.worldbank.org/indicator/EN.ATM.CO2E.PC

Source C

Cumulative carbon dioxide emissions of major countries (1960-2011)

Country	Cumulative carbon emissions (Million tons)	Cumulative carbon emissions per capita (Tons)
The United States	245858.18	1008.98
China	136489.07	116.47
India	48888.32	335.51
Germany	32922.70	618.64
The United Kingdom	29442.12	516.56

Source: CAIT Climate Data Explorer. 2015. Washington, DC: World Resources Institute. Retrieved from http://cait.wri.org.

Appendix 8: Reading materials

Some academics point out that the effort of the international community to deal with climate change can be divided into 2 stages: (1) the "Convention to Kyoto" period; (2) the "Post-Kyoto to Copenhagen" period. During these two stages, different countries committed to dealing with climate change through international organisations, conventions and international meetings. However, the effectiveness of global responsive strategies has been largely reduced as more developed countries and less developed countries hold vastly different views regarding their respective emission-reduction obligations and targets based on their own interests and development needs.

Period	Description
The "Convention to Kyoto" period	**Intergovernmental Panel on Climate Change** Set up by the United Nations in 1988, the Intergovernmental Panel on Climate Change (IPCC) is responsible for studying human-induced climate change. ***The United Nations Framework Convention on Climate Change (UNFCCC)*** The convention was passed in 1992 and became effective from March 1994, setting out an overall framework and common ground for tackling challenges posed by climate change through international collaboration. UNFCCC parties host a climate conference every year, discussing emission-reduction targets and arrangements, as well as pointing out the principle that all countries should comply with the principle of "**common but differentiated responsibilities**". According to UNFCCC, in addition to taking the lead to reduce emissions, more developed countries should also provide less developed countries with capital and technical support, because of their historical responsibilities; however, the convention did not set specific emission reduction targets for each country. ***The Kyoto Protocol*** Signed in 1997, the protocol defined the main forms of greenhouse gases, whose emissions should be reduced by more developed countries by 2012, as well as related timelines and targets. The majority of more developed countries agreed to reduce their carbon dioxide emissions by at least 5% from 1990 levels by 2012. However, the U.S. withdrew from the protocol, claiming negative impacts on its economy. This is the only binding international convention on dealing with climate change.

The "Post-Kyoto to Copenhagen" period	**Difference of opinion among different countries becomes increasingly obvious** Since the U.S. withdrawal from the Kyoto Protocol, differences of opinion regarding emission-reduction obligations among concerned countries are becoming increasingly obvious. While less developed countries, such as China and India, call for compliance with the principle of "**common but differentiated responsibilities**", more developed countries, such as the U.S. and Japan, are of the view that developing countries should also accept mandatory emission-reduction targets. **"Bali Road Map" and *the Copenhagen Accord*** Adopted in 2007, the "Bali Road Map" required emission-reduction targets for the first commitment period (2008-2012) under the *Kyoto Protocol* to be completed by the end of 2009. However, as participating countries couldn't solve their differences, they ended up passing the non-binding *Copenhagen Accord*. The Accord called for quantified emission reduction commitments and targets for 2020, and suggested the establishment of a Copenhagen Green Climate Fund to help less developed countries reduce emissions, and urged more developed countries to provide clean energy and technical support for emissions reduction. **The conferences in Doha and Warsaw** Unable to address previously unresolved issues, the 2012 Doha Climate Conference only managed to convince more developed countries to agree to review their emissions reduction commitments for a second commitment period by 2014. However, countries like the U.S., Japan, Russia, New Zealand and Canada refused to join a second commitment period under the *Kyoto Protocol* as they were discontented over a lack of settings of mandatory emissions targets for less developed countries. At the 2013 Warsaw Climate Change Conference, attending countries again failed to reach an agreement on reduction obligations. They only agreed to prepare a new agreement on emissions reduction during the 2015 Paris Climate Change Conference. **Paris Agreement** At the United Nations Climate Change Conference in December 2015 held in Paris, participating countries signed the Paris Agreement and set a goal of limiting global warming to less than 2°C compared to pre-industrial levels. The parties will also try to limit the temperature increase to 1.5°C or below.

	 Source: http://www.gettyimages.com/detail/news-photo/executive-secretary-of-the-united-nations-framework-news-photo/501114176

Sources:

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Appendix 9: Video Note: Extract key information from the video clip

UN Climate Summit 2009 in Copenhagen	UN Climate Summit 2014 in New York

Key points in President Obama's speech (The United States)	Key points in Zhang Gaoli's speech (China)

Appendix 10:

Discussion worksheet for negotiating the emission reduction targets of each country

Table 1

	2012 Total greenhouse gas emissions (million metric tonnes of carbon dioxide equivalents)	**Targets for 2030 or any subsequent period** Total greenhouse gas emissions (million metric tonnes of carbon dioxide equivalents)	**Increase/ decrease %**
World	44815.54		
China	10975.50		
The United States	6235.10		
The EU	3519.99		
India	3013.77		

Table 2

	Rationale for setting emissions targets (possible perspectives include: national economy, development of energy technologies, public awareness on environmental protection)	**Suggested measures** (possible perspectives include: national economy, development of energy technologies, public awareness on environmental protection)
China		
The United States		

EU		
India		

Table 3: Reflection after the conference

Countries	**Before the conference** Emissions reduction targets Increase / decrease %	**After the conference** Emissions reduction targets Increase / decrease %	The reason why emissions targets change / does not change

Sources A: The United States

In 2014, U.S. President Barack Obama said, in addition to a commitment to reduce its greenhouse gas emissions to 17% below 2005 levels by 2020, the U.S. would set up new reduction targets that are more ambitious, expecting to deliver a greater reduction by 2050.

On top of being two of the largest economies, the U.S. and China are also the world's two main polluters. They should therefore take on the responsibility of taking the lead, so as to do "what is expected of any great nation".

In June 2014, the Obama administration took a significant political risk announcing a series of environmental protection ordinances with a long lasting impact, in order to push domestic power plants to cut their carbon dioxide emissions. President Obama expects China to do the same. With its growing its coal consumption, China has overtaken the U.S. in emissions, becoming the world's biggest greenhouse gas producer. However, China's vice premier Zhang Gaoli is firm, stating that less developed countries, including China, should be treated differently from more developed countries when it comes to emissions reduction and that they should be allowed to emit more. However, Mr. Zhang stresses the determination of the Chinese Government to halt the growth in its emissions as soon as practicable.

The latest commitment made by the Obama administration was widely criticised by republicans. According to Mitch McConnell, the senate majority leader, President Obama would dump this unrealistic plan on his successor, causing higher utility rates and fewer jobs.

Source: "奧巴馬促北京減排", 25 Sept 2014, *Sing Tao Daily*.

Source B: China

Speech of the Chinese Vice-Premier Zhang Gaoli at the 2014 UN Climate Summit (Excerpted)

China was the first among less developed countries to formulate and implement a national climate change program, and recently has launched the "National Plan for Coping with Climate Change" to guarantee the realization of the target of cutting the carbon intensity* by 40 to 45 percent by 2020 from the 2005 level. China is committed to actively promoting energy conservation and emission reduction, low-carbon development and ecological construction. In 2013, carbon intensity in China dropped by 28.5 percent from the 2005 level. That was equivalent to a reduction of 2.5 billion tons of CO_2. Between 2006 and 2013, we made obsolete a huge amount of 94.82 million kW of coal-fired power, 117 million tons of steel, 165 million tons of iron and 857 million tons of cement, produced in old ways.

China, a developing country with 1.3 billion people, faces a daunting task of growing the economy, improving people's lives and protecting the environment. As a responsible major country, China will make greater effort to effectively address climate change and take on international responsibilities that are commensurate with its national conditions, stage of development and actual capabilities. We will announce post-2020 actions on climate change as soon as we can, which will bring about marked progress in reducing carbon intensity, increasing the share of non-fossil fuels and raising forestation, as well as the peaking of total CO_2 emissions as early as possible. In addition, China will provide six million US dollars to support the UN Secretary-General in advancing cooperation on climate change.

China firmly supports the 2015 Paris Conference in reaching an agreement as scheduled. We need to stick to the UNFCCC framework and follow its principles. The principles of common but differentiated responsibilities, equity and respective capabilities must be upheld in the negotiations and final outcome of the 2015 agreement, and provisions and commitments in the UNFCCC must be fully, effectively and continuously implemented. Besides, we need to meet our respective commitments and cement the basis of mutual trust. In particular, more developed countries need to intensify emission reductions and fulfill their commitment of annual financial support of 100 billion US dollars and technology transfer to less developed countries by 2020. Lastly, both more developed and less developed countries need to follow the path of green, low-carbon development that suits their national conditions.

* Carbon intensity is measured in terms of GHG emissions per unit of GDP. Low carbon intensity means that when developing the economy, less carbon dioxide is emitted.

Source: "張高麗出席聯合國氣候峰會併發表講話", 24 September 2014, *China Radio International*.

Source C: European Union (EU)

The 2014 European Council Meeting was held on 23 October in Brussels, the EU's capital. Leaders of EU member states focused on finding ways to tackle the challenges posed by climate change. National leaders or governmental heads of the 28 EU member states attended the summit, including Herman Van Rompuy, President of the European Council, José Manuel Barroso, President of the European Commission, and New Commission president, Jean-Claude Juncker.

The President of the European Council hoped to encourage member states to reach an agreement on the *2030 Framework for Climate and Energy* at the summit. According to a draft plan published in January 2014 by the European Commission, the EU plans to reduce its greenhouse gas emissions by 40% from 1990 levels and increase its green energy utilisation to 27% of the total energy consumption by 2030. The plan became the focus of heated debate among EU member states upon its announcement. Some of the Central and Eastern European countries considered requirements under the plan too demanding. As most of these countries relied on conventional energy (e.g. coal) to generate electricity, there were concerns that the plan would result in higher domestic utility rates, negatively affecting their economic development, and ultimately damaging their national competitiveness.

After prolonged discussions, EU leaders were finally able to reach an agreement on climate change and energy issues at the EU Summit held on the 23rd October 2014. The new agreement was largely in line with the previously proposed plan.

Source: "歐盟秋季峰會關注氣候變化問題和歐洲經濟形勢", 24 October 2014, *China Radio International*.

Source D: India

According to Prakash Javadekar in September 2014, India's Minister of State, Environment, Forest and Climate Change, the most pressing task for the government of India is to eliminate poverty and drive the country's economic development. This task, which inevitably involves building additional coal-fired power plants and increased road transport, will lead to increasing emissions in India. Twenty percent of India's population are still living without electricity and it is therefore a primary task for the government of India to drive the country's economic development. India will undergo faster development, which means that their emissions will keep rising. In the foreseeable future, more than half of India's power will come from coal. Not only does the minister blame the climate crisis on the U.S., citing the fact that the U.S. has always been the world's biggest emitter of greenhouse gases, Javadekar also thinks that the very idea of India reducing carbon emissions is not worth commenting on.

Javadekar thinks that the more developed countries (e.g. the U.S.) should take on the greatest obligations to reduce emissions. Not only did more developed countries spend the last century building their economies, they also emitted large volumes of greenhouse gases into the atmosphere. He says that the Indian government is preparing a domestic action plan to tackle challenges posed by climate change. However, the plan can only serve to slow down the rise in carbon dioxide emissions. It would take at least 30 years before India could see any sign of a decrease in its emissions. Twenty percent of India's population are still living without electricity and it is therefore a primary task for the government of India to drive the country's economic development. India will undergo faster development, which means that their emissions will keep rising. In the foreseeable future, more than half of India's power will come from coal.

According to Narendra Modi, the Prime Minister of India, in light of the expanding domestic demand for electricity, India would consider tackling challenges of climate change through increased use of renewable energies (such as wind power and solar energy). This effort has been praised by international environmental organisations. Javadekar also points out that the government of India has been increasingly investing in railways and public transportation, aiming to slow down the increasing demand for private vehicles. The government is planting trees to make forests, and setting up new wildlife reserves in the country for the conservation of tigers.

Source: "印度拒絕減少溫室氣體排放：首要任務是消除貧困", 26 September 2014, *China News*.

<u>Appendix 11</u>: After-class Assignment

Read the following sources and answer the questions:

Source A: Global total CO_2 emissions in 2013 (Top 5)

Ranking	**Countries / Regions**	**Total CO_2 Emission (Million tons)**
1	China	9,977
2	The United States	5,233
3	EU (28 member states)	3,483
4	India	2,407
5	Russia	1,812

Note: Total global CO_2 emissions in 2013: 36 billion tons (2.3% above the 2012 level)

Source: The website of Global Carbon Project.

Source B

Below are 3 comments on the emissions reduction obligations of more developed and less developed countries:

- More developed countries should bear unshirkable historical responsibilities for today's global climate change. Climate change is the result of cumulative greenhouse gas (primarily carbon dioxide) emissions into the atmosphere caused by human activities since the Industrial Revolution. The accumulated emissions were mainly caused by more developed countries during their industrialisation processes.

- Although the EU stresses its consent on the principle of "common but differentiated responsibilities", the actual situation has changed quite significantly since 1990. Emission reduction targets for emerging economies should be set. While less developed countries have been talking about "historical responsibilities", the signing of the *Kyoto protocol* by the EU and their commitment to mandatory emission reduction targets showed that the EU admitted their "historical responsibilities". While the EU has managed to substantially reduce its carbon dioxide emissions in comparison to 1990, it is obvious that the EU is not able to tackle climate change alone.

- Less developed countries should promote climate change mitigation by taking more concrete actions, such as changing their concepts about development, improving energy structures and driving technological advancements. The world has not slowed down the rise in carbon dioxide emissions. The reduction of carbon dioxide

emissions should be shared by both the more developed and less developed countries: while more developed countries need to reduce total carbon dioxide emissions, less developed countries should slow down their increasing carbon dioxide emissions.

Sources: Extracted and adapted from the following 2 articles
1. "中國在應對全球氣候變化挑戰中發揮積極作用", 24 September 2014, International Daily News.
2. "歐盟美國罔顧"歷史責任" 欲強制中國印度減排", 3 December 2011, www.china.com.cn/.

Questions

(a) With regard to emissions reduction, do you think that more developed countries or less developed countries should bear greater responsibility? With reference to the above sources and your own knowledge, explain your answer.

(b) "Holding International Climate Summits to handle climate change might create more disputes rather than solve the problems". Do you agree? With reference to the above sources and your own knowledge, explain your answer.

Intention of Assessment

Assessment Focus

Using the Climate Summit as an example, students' mastery and application of "international collaboration", and effectiveness and limitations of "global governance" will be assessed. Integrating classroom teaching and personal knowledge, students should be able to give an appropriate response to the question, and present analytical and evaluative skills.

Expected student performance

Knowledge

- For question (a), students can discuss responsibilities of less developed and more developed countries from the following aspects: data on carbon dioxide emissions, economic development, and technological advancement. Regarding carbon dioxide emissions, while more developed countries report higher overall emissions, some less developed countries (e.g. China), have reported total emissions exceeding average levels of that of more developed countries. In relation to economic development, the rapid economic growth in less developed countries has intensified the issue of high carbon dioxide emissions. Less developed countries accuse more developed countries of depriving them of the right to their own economic development and of causing today's global climate problem. Less developed countries believe today's problems are a result of the activities more developed countries engaged in during the early stages of industrialisation. From a technological perspective, in light of the need for environmental technology to support and promote the reduction of emissions, less developed countries accuse more developed countries of lacking a sense of responsibility in this area.
- For question (b), students can discuss the potentially heated arguments during the conference based on the contradicting interests of different countries and the impacts of emissions reduction on their economic development. The above notwithstanding, the conference was not utterly futile. For example, as a sign of a joint effort, both China and the U.S. made the commitment to reduce emissions at the World Climate Summit 2014; in addition, all attending countries agreed on treating the *United Nations Framework Convention on Climate Change* as the common ground for the international community to reduce emissions. Students can also answer the question by proposing their own views and evidence after discussing the evidence given by both sides.

Skills

- Giving appropriate response with clear personal stance.
- Extracting and interpreting the core messages in the textual and statistical data to analyse the responsibility of countries at different levels of development towards carbon emissions and the effectiveness of global governance.
- Evaluating others' viewpoints by using what they have learnt.

--- End of Appendix –

Part IV: Extended Reading and Reference Materials

This part provides teachers with extended reading and reference materials relating to the curriculum in this module, which are divided into Categories A and B for teachers' choice.

Part A is a reference list of publications and websites which consists of the learning and teaching focuses in this module for teachers' reference in lesson preparation, and for teachers to gain a more in-depth understanding of the theoretical basis and trends associated with the issues for enquiry. Specific examples are also provided to enrich classroom learning and teaching. Publications for student reading are underlined. Teachers may encourage students to read these publications in accordance with their levels. Publications available from public libraries are also accompanied by call numbers to assist teachers and students.

Part B consists of learning and teaching resources available on the “Web-based Resource Platform for Liberal Studies” (http://ls.edb.hkedcity.net/) and are relevant to this module. These resources can be used for teachers' reference in lesson preparation, and some of them can be adapted for use in worksheets, after-class assignments or internal assessment. Teachers who have registered as members of the Hong Kong Education City are entitled to view and download resources after logging in the section for teachers and using personal passwords.

Teachers should note that all materials recommended in this part are for reference only and they are not designated readings. Please choose any and use them according to your school context.

A. **Publications and Websites** (Publications for student reading are underlined, the public library information are updated as at September 2015)

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上海世紀出版股份有限公司少年兒童出版社（2014、2015）《十萬個為甚麼新視野版--能源與環境 1》、《十萬個為甚麼新視野版--能源與環境 2》，香港：香港教育圖書公司。（香港公共圖書館索書號：302.2 4423）

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http://www.generationgreen.co.uk/	British Gas Trading Limited—Generation Green
http://www.susdev.org.hk/	Council for Sustainable Development 可持續發展委員會
http://www.earthday.net/default.aspx	Earth Day Network
http://www.ecc.org.hk/	Environmental Campaign Committee 環境保護運動委員會
http://www.foe.org.hk/	Friends of the Earth (HK)　香港地球之友
http://www.green-energy-news.com/	Green Energy News
http://www.greenpeace.org/eastasia http://www.greenpeace.org.cn/	Greenpeace East Asia 綠色和平（中國）
http://www.greenpeace.org/international/en	Greenpeace International
http://www.greenpower.org.hk/	Green Power　綠色力量
http://www.afcd.gov.hk/	HKSAR Government—Agriculture, Fisheries and Conservation Department 香港特別行政區政府——漁農自然護理署
http://www.energyland.emsd.gov.hk/	HKSAR Government—Electrical and Mechanical Services Department—Energyland 香港特別行政區政府——機電工程署——能源資訊園地
http://www.epd.gov.hk/epd/	HKSAR Government—Environmental Protection Department 香港特別行政區政府——環境保護署
http://www.en.gov.hk/	HKSAR Government—Hong Kong Environment, Transport and Works Bureau 香港特別行政區政府——環境運輸及工務局
http://www.hongkongwma.org.hk/	Hong Kong Waste Management Association 香港廢物管理學會
http://www.oxfam.org.uk/education/coolplanet/	Oxfam—Cool Planet for teachers
http://www.producegreen.org.hk/	Produce Green Foundation　綠田園基金
http://www.pepa.com.hk/	Promotion of Environmental Protection Awareness (PEPA) 綠色教育先鋒
http://www.zhb.gov.cn/	State Environmental Protection Administration of China　國家環境保護總局
http://www.conservancy.org.hk/	The Conservancy Association　長春社
https://sustainabledevelopment.un.org/	The United Nations—UN Department of Economic and Social Affairs—Division for Sustainable Development Knowledge Platform

http://www.worldbank.org/	World Bank
http://www.panda.org/	WWF
http://www.wwf.org.hk/	WWF Hong Kong　世界自然（香港）基金會
http://www.wwfchina.org/	WWF China　世界自然基金會中國網站

B. Relevant Resources on the Web-based Resource Platform for Liberal Studies

1. Teaching Packages

- 從中國城市霧霾問題看改革開放的挑戰與中國可持續發展
- 透過電動車計劃來分析香港空氣污染與能源科技的關係
- 從福島核爆事件看全球能源發展趨勢
- 「防洪淨流」通識教學材料套
- 風力發電的利弊
- 屋頂綠化與紓緩全球暖化
- 環境與可持續發展：以中國太湖藍藻事件為例

2. Publicised Resources

- 教育局通識教育組（2011）《透視科學、科技與環境議題》

3. Resource Sheets

- 國際社會就環境問題的協作：聯合國氣候變化高峰會（2014 年 9 月）
- 能源的開發及使用：頁岩氣在中國發展
- 可持續發展的實踐：荷蘭與丹麥推廣使用單車
- 經濟發展與環境破壞：內地的耕地污染情況
- 使用能源對環境的影響：香港「空氣質素健康指數」（AQHI）
- 可持續發展的實踐：香港生態足印
- 能源外交：中國取得巴基斯坦瓜達爾港（Gwadar Port）的營運權
- 能源科技與可持續發展的關係：香港發展環保電動車

4. Exemplars of Internal Assessment

Data-response Questions	Extended-response Questions
● Plans for Adjusting Fuel Mix	● Three Landfills and One Incinerator
● Municipal Solid Waste Charging Scheme	● Developing Country Parks
● Electric Vehicles	● Wasteful Chinese Banquets
● Wedding Banquet without Shark Fin Soup	● Building of the Third Runway
● Food Waste Recycling	● Air Quality Health Index
	● Low-carbon Energy in China
	● Light Pollution
	● Lung Mei Man-made Bathing Beach

5. **Learning Objects**

- 徵收「交通擁堵費」以減低空氣污染及交通擠塞
- 馬爾代夫旅遊業
- 保護藍鰭吞拿魚
- 香港光污染
- 風力發電
- 港人生態赤字
- 石油與國際政治
- 日本核洩漏事故引發對核能使用的反思
- 環境教育之生態旅遊
- 香港停車熄匙計劃
- 熱島效應
- 建設核電站的利弊
- 空氣污染與可持續發展
- 水質污染與防治
- 國際企業與污染物信息

6. **Professional Development Programmes：Knowledge Enrichment Series**

- 2014/15 學年
  - 羅惠儀博士：「中國的能源與可持續發展--中國城市的經驗」
  - 羅惠儀博士：「達致可持續發展社會：香港與外地經驗」

- 2013/14 學年
  - 羅惠儀博士：「中國的能源結構與可持續發展」
  - 張曦文女士：「氣候變化與糧食危機」

- 2012/13 學年
  - 羅惠儀博士：「可持續發展--從公眾參與出發定義、爭論和矛盾」

- 2009/10 學年
  - 袁彌昌博士：「新『大博弈』：中亞的油氣管戰爭」
  - 鍾倩玲小姐：「電動車：從研發到市場」

- 2008/09 學年
  - 井文涌教授：「中國近年在環境保護方面的工作、困難及成就」
  - 李焯芬教授：「從三門峽到三峽：中國水利事業的回顧與前瞻」
  - 倪廣恒教授：「從『南水北調』工程看中國水資源的分佈、利用及展望」

- 2007/08 學年
  - 許大偉先生：「香港的氣候與空氣污染」
  - 趙紹惠教授：「在經濟發展的壓力下維持生物多樣性--香港在追求持續性所面對的挑戰」

- 2006/07 學年
  - 張希良教授：「從經濟、環境與可持續發展、外交等角度看國家的能源開發及能源貿易」

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