- Teacher guidelines for case study -
How much energy do date centers use?

Generic green skills

Cognitive competencies:

- Environmental awareness and a willingness to learn about sustainable development
- Ability to make judgments based on both evidence and sustainability values
- Innovation skills to identify opportunities and create new strategies to respond to green challenges

Interpersonal competencies:

- Communication and negotiation skills to discuss conflicting interests in complex contexts
- Strategic and leadership skills to enable policymakers and business executives to create conditions conducive to cleaner production

Technological competencies:

- Quantification and monitoring (energy)

Learning objective

Students are expected to:

1. Recognize how much energy data centers use and what solutions there are for this issue.
2. Find out how Hong Kong responds to data center energy consumption issues and how it can be further improved.

Format

Individual learning and small group work

Role of teacher

Facilitator

Resources needed

A3 paper, student worksheet, case study

Time required

1 hour

Assessment

The assessment will be based on:

Students' presentation, according to the clarity and accuracy of their arguments.

Suggested teaching and learning sequences

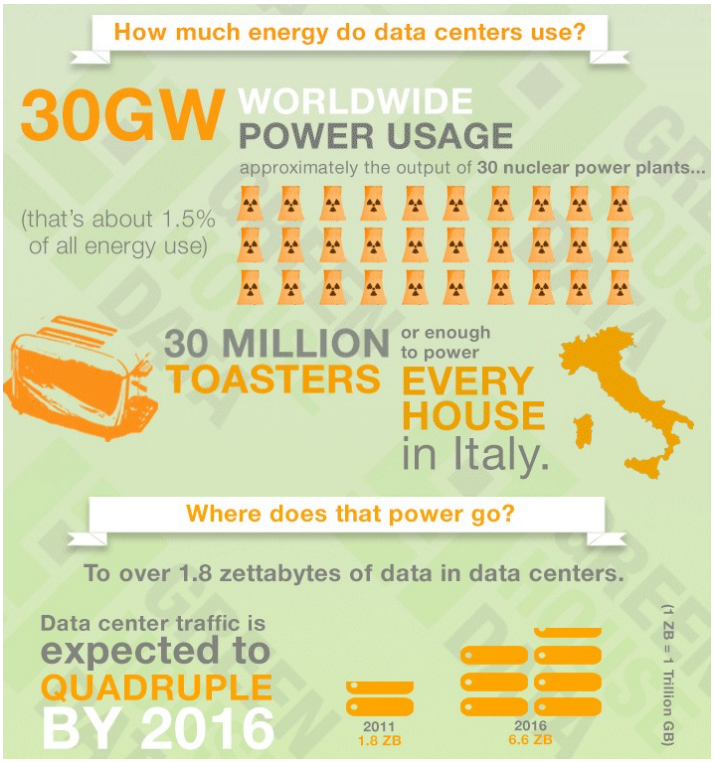
Before the class:

1. Assign case studies regarding different data centers (Apple, Microsoft or Google) to students. Ask everybody to read about Hong Kong.
2. Remind students to read and summarize solutions used by the companies for the assigned cases studies.

During the class:

Part 1: Warm-up activity

1. Describe the issue using the picture: how much energy do data centers worldwide use to enable web users to perform online activities?
2. Ask students individually to calculate the bill for running a data center in Hong Kong for one whole year to understand how much energy is consumed.



Part 2: Small group discussion and presentation

1. Divide students into groups of 6 and facilitate the group discussion focused on:
   - What are the currently used or proposed solutions for addressing the energy consumption issue by different data centers in the case study? It will be better if each group has students examine different data centers for their pre-class reading.
   - What solutions have been implemented in Hong Kong? How do they work?
2. Guide students' engagement into a simulative activity. Ask them to make decisions – if they were the owner of Hong Kong Broadband Network (HKBN) band and they want to further improve the energy consumption by this data center, what solutions could be applied based on the experience from other data centers introduced in this case study and why?
3. Ask students to write down their findings on an A3 poster and share their ideas with the class.

Part 1: Warm-up activity

Calculating the energy bill for running a data center in Hong Kong
Assuming you are a data center operator in Hong Kong, running 2,000 racks of servers round the clock, how much is your energy bill likely to be each year?

1. Taking into account the cooling and redundant power usage, each server rack consumes about 3kVA (three units of power) per hour. Given each rack consumes 3 power units per hour**, how many power units does one server rack consume in a year?**
   - 3 power units x 24 hours x 365 days=26,280 units of power

2. Assuming each data center houses 2,000 racks, **how many power units will the entire data center consume?**
   - 2,000 racks x 26,280 power units = 52,560,000 power units/year

3. Assuming your power company, CLP, charges HK$1.5 per power unit, **how much will your total energy bill be for running a data center in Hong Kong for one year?**
   - HK$1.5 x 52,560,000 power units= HK$78,840,000

Part 2: Group discussion

1. **Please specify how these solutions help save energy or which green technologies have been used to address the energy consumption issue.**

2. **What green technologies have been used in the Microsoft, Apple and Google data centers?**
   - **Microsoft:**
     Wind, solar and hydro-electric sources
     Custom Azure Cloud hardware
     Operational efficiency
     The efficiency of the data center infrastructure
   - **Apple:**
     Solar arrays, biogas fuel cells
     Uses outside air cooling, especially during the winter
     Wind power
     Micro-hydro projects
   - **Google:**
     Using artificial intelligence to manage energy efficiency

3. **What solutions have been implemented in Hong Kong? How do they work?**
   - **Quick Wins**
     Energy audit **monitors the performance of server equipment** such as: replacing fluorescent lighting and zoning air-conditioning and lighting to reduce overall energy consumption.
   - **Long-term Investment**
     A detailed energy audit across all HKBN operations identified opportunities to save a further HK$3.5 million over five years through benchmarking and setting new temperature standards in other data

centers, replacing belt-driven air-conditioning fans with **high-efficiency chillers**, and continuing to update lighting and install infrared motion sensors.

- **Dialogue for success**
  Preceding the initial phase of the program, HKBN defined four clear sustainability priorities with senior management support – talent, environment, community and social enterprise. In working to become a green office, colleagues or 'talents' were guided by the **'4 Cs': commit, calculate, cut, communicate**.

4. **If Hong Kong Broadband Network (HKBN) wants to further improve the energy issue of its data center, what solutions do you think it could borrow from Microsoft, Apple and Google and why?**
   Open to all the possible answers. Teachers need to guide students to consider the local context and resources when adapting green technologies from the successful cases of Microsoft Azure, Apple and Google.

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