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## **Hong Kong: An Urban City Fighting Air Pollution**

From a small fishing village to a global financial center, Hong Kong has transformed into a bustling, urban city that has become one of the biggest trading hubs in the world.

Hong Kong is located in Eastern Asia and borders China and the South China Sea. It is relatively small with a total area of 1108 square kilometers. It has a hilly to mountainous terrain with a subtropical monsoon climate, indicating humid, hot summers and mild winters (The World Factbook). The government system is a limited presidential democracy; being a major financial center, the economy of Hong Kong is characterized by free trade and low tax rates. Hong Kong is a highly dense city with an overall population of over 7.2 million people and a population density of 6,753.77 people per square kilometer. The average family size is 2.7 people with a monthly income of 27,500 HKD, roughly equivalent to 3,516 USD (Censtatd). With the land constraints of Hong Kong, most families live in high-rise buildings with apartments being around 484 sq ft. For comparison, this is about 4.5 times smaller than the typical house size in the United States (ShrinkThatFootprint).

With a completely urban population, Hong Kong faces growing environmental concerns regarding air pollution and over-urbanization. Over 50% of its air pollution comes from local sources, with emissions from marine vessels, power plants, and landfills being the largest contributors. The marine emissions are mainly due to the constant imports and exports Hong Kong relies on. With the limited land area of Hong Kong, there is minimal land area left for agriculture; therefore, 90% of food is imported, and 92% of Hong Kong's fresh fruits and vegetables come from China. Additionally, importing food drives up the cost of produce and doesn't always provide wide accessibility to food. Only 2% of people in Hong Kong consume an adequate amount of fruits and vegetables per day. The amount of locally grown produce has also dropped to 1.7%. In 2019, marine vessels accounted for 28% of SO<sub>2</sub>, 35% of NO<sub>2</sub>, and 20% of PM<sub>10</sub> of the total local emissions. Other major contributors to air pollution are HK Electric Holdings and China Light and Power which emit more than 75,000 tonnes of Carbon Dioxide (CO<sub>2</sub>) into the atmosphere. In the past 3 months, 1,800 deaths have been caused by air pollution in Hong Kong, costing \$860,000,000 USD (IQAir). Hong Kong has been ranked one of the most polluted major cities and the visibility is less than 8 km for more than 30% of the year. Waste is the third largest contributor to carbon emissions in Hong Kong. In 2021, the city produced 4.15 million tons of municipal solid waste, food waste accounting for 30% of that waste. Hong Kong has 3 landfills predicted to become filled in the next few years. Before China's ban on importing recyclable materials, Hong Kong imported 95% of recyclable waste to China. Now, only 1% is recycled and the rest is discarded to landfills. From 2010-2019, the municipal solid waste disposed of at landfills increased from 3.33 million tonnes to 4.04 million tonnes and the per capita disposal rate also increased to 1.47 kg per day. (EEB).

One solution to combat the air pollution caused by marine emissions is to increase vertical farming and hydroponics. Growing locally can significantly reduce carbon emissions from marine vessels by decreasing the reliance on imported food. Controlled environment agriculture (CEA), otherwise commonly known as vertical indoor farming, only utilizes the essential components to make plants grow such as energy, water, nutrients, and CO<sub>2</sub> while eliminating unnecessary inputs of traditional farming like soil and pesticides. Instead of using energy from the sun, CEA uses LED lights made specifically for the plants. This allows crops to be grown indoors. Sensors and advanced climate control technology can measure the optimal amount of energy and nutrients the plants need to reduce unused resources, like energy and water, and maximize yields. The seeds are placed in soil-free growth mediums and put in trays

that are stacked vertically to reduce land use. Through CEA, farmers can reduce their land use from 90-99% (ZipGrow). Additionally, they can grow 3 to 10 times more crops in the same amount of space compared to traditional farms and vertical farms can result in 7 to 14 times more growth cycles than conventional practices. The plants grown in CEA environments are fed nutrients hydroponically, where nutrient-infused water feeds the plant sitting in the growth medium, or aeroponically, where plant roots dangle freely and are misted with nutrient-infused water. Even though water is used in hydroponics, compared to traditional farming, hydroponics uses 90% less water and reduces the risk of pests through its elimination of soil, isolating diseased crops, and eliminating the need for pesticides (PSCI). Leafy vegetables are most suited to be grown through aeroponics as they have a fast growth rate and are the most profitable. Leafy vegetables, such as bok choy and Chinese broccoli, are the second most consumed produce in Hong Kong which allows aeroponic farms to be an appropriate solution for reducing emissions related to imported food (AirGarden). The largest consumed product in Hong Kong is rice which costs \$240 million dollars in imports per year (The Observatory of Economic Complexity). Traditionally, rice is grown on large plots of land with a humid and hot climate. This method is very specific and uses large amounts of water as rice is one of the most water-intensive crops. Studies have shown that growing rice through hydroponics is possible. In fact, India has adopted a method of growing rice in hydroponic rice nurseries in response to harsh weather and limited land and water. This has proved to be successful and has decreased water use by 85% while growing rice and reduced water-borne diseases from transmitting to farmers (Debangshi). However, this process does come with costs. According to ZipGrow, the initial startup cost for a 500 sq ft hydroponic farm would be \$50,000. It would take 172.8 kWh per day to power the LED lighting which would cost about \$22.46 per day depending on the electricity provider. For a 3.6-week growing cycle, the farm would produce about 537.6 pounds each of lettuce and basil allowing for a revenue of around \$10,482 (ZipGrow). Although these farms have high start-up costs that pose a large challenge to integrate, these farms are highly profitable. With government subsidies, the urban farming industry can begin to develop in Hong Kong and individuals who are interested in starting these vertical farms can have the means to do so. The population of farmers in Hong Kong has decreased from 15,200 in 1991 to 4,300 in 2015. Investing in vertical farms and hydroponics will benefit Hong Kong's agriculture industry and economy. The government of Hong Kong encourages residents to live a more environmentally sustainable lifestyle and has allocated funds to solutions to reduce carbon emissions. CEA is a solution the government could begin to invest in as it is profitable while reducing climate volatility in the country. This solution also does not need to be implemented on such a large scale at once. Residents can purchase their own hydroponic growing kits and practice agriculture in their apartments, enabling them to have access to fresh produce even with space limitations and at a low cost. Vertical farming has already proven to be successful in other neighboring countries with high urban populations such as Japan and Singapore as farms there can produce 30,000 heads of lettuce a day (Piechowiak). In addition to this method of agriculture, Hong Kong can focus its attention on transforming available rooftop space to grow more local produce. Hong Kong has the greatest number of skyscrapers in the world and has 6 million square meters of rooftop space which could be used for agriculture; however, only 1% is used. Organizations such as Rooftop Republic are working to increase locally grown produce through integrating innovative, urban agriculture practices. They have built 80 urban farms and have installed 88,000 sq ft of green space so far. Root vegetables, such as potatoes, radishes, and carrots, are types of vegetables that are popularly consumed in Hong Kong and can be effectively grown on rooftops but struggle in aeroponic or hydroponic environments (University of Washington). Investing in rooftop gardens will provide access to more agricultural possibilities and enable more opportunities for residents to engage with agriculture. Not only do rooftop gardens reduce pollution from marine vessels importing food, but they also counteract the heat island effect and remove pollutants such as ground-level ozone, carbon monoxide, sulfur dioxides, and nitrogen oxides. This will greatly improve the air quality in Hong Kong and provide a better environment for more plants to thrive.

Another solution to combat Hong Kong's air pollution is through harnessing wave energy to reduce the emissions associated with power plants. Most of Hong Kong's electricity is mainly powered by natural

gas and coal which generate large amounts of air pollutants. Hong Kong is surrounded by water which plays an important role in Hong Kong culture. In fact, it is Asia's second-highest per-capita seafood consumer (WWF). Because of its location on the western side of the Pacific Ocean, the trade winds push warm air toward Hong Kong causing it to be prone to typhoons. CorPower is a company that has developed technology to harness the energy from waves using mechanics similar to that of a human heart. This technology has been tested in Sweden and Portugal, aiming to provide 100% renewable, carbon-free electricity. Wave farms are created by a grid of CorPack Energy convertors which is like a buoy with generators in it. The buoy is anchored to the ocean floor and it moves up and down when hit by waves. The generators inside the buoy use rotational motion to create electricity. This form of electricity generation can deliver 3 to 5 times more power from the same ocean space compared to wind farms and it is storm resistant making it suitable for Hong Kong's typhoon season (CorPower Ocean). One wave farm could have up to a 30 MW capacity; to put that in perspective, that is enough electricity to power 6,000 homes a day. Additionally, this method of generating electricity can be used to power the LED lighting for hydroponics as described previously, enabling further elimination of environmental damage caused by agriculture. The biggest challenge with integrating wave energy systems is how new this technology is. Because of its relatively new technology, there is still speculation about the costs and environmental effects of integrating wave energy technology. Wave energy has the potential to be built as cheaply as \$07.5 kWh, but since there are no companies developing wave energy at scale yet, the costs are still generally high (SolarReviews). However, Hong Kong has already injected 200 million HKD into the Green Tech Fund in its 2022-2023 budget, giving it a total of \$400 million HKD to fund research and development projects to help Hong Kong decarbonize (GTF). Hong Kong can invest in this new technology to harness this renewable, sustainable energy source to support its population and environment. Due to the large amount of competence and professional skill cross-over from the oil & gas industry, it allows for a shift towards more sustainable jobs for its residents as well.

Lastly, to combat the landfill emissions from food waste, Hong Kong can implement enhanced composting programs. The Hong Kong Government has already taken initiatives to combat this issue as they have allocated \$670 million USD for waste programs and \$130 million USD for recycling funds in their 2022-2023 budget. The Hong Kong government's community recycling network has already achieved 9 recycling stations, 22 recycling stores, over 100 recycling spots, and a community smart recycling vehicle. A solution to supplement these initiatives is to invest in composting facilities and machines. Although Hong Kong has focused on recycling programs, these programs are mainly meant for plastics. For a city that generates over 1.2 million tonnes of food waste a year, developing solutions to prevent that waste from ending up in landfills is important as well. Since Hong Kong is typhoon-prone, its landfills can form leachate which occurs when landfill waste interacts with water. Leachate can leak into the surrounding environment and deposit harmful chemicals such as methane and carbon dioxide. Setting up community composting bins and an organized composting system can turn food waste into helpful nutrients to supplement local agriculture and keep food waste out of landfills. If rooftop agriculture can become more popular, effective composting sites can also provide adequate nutrients for those crops and reduce the need for chemical fertilizers. Additionally, composting can reduce methane emissions that are generated when food waste decomposes in landfills. Many countries have already passed legislation to make food waste illegal which encourages firms to donate extra food to organizations that help make food accessible to lower-income communities. For example, Taiwan, another administrative region of China, was formerly known as "Garbage Island," but now has a recycling rate of 55%. To achieve this, citizens of Taiwan collaborated to create programs to reduce waste, launching Pay As You Throw and Extended Producer Responsibility programs. Taiwan now has a very organized recycling system, using mobile apps to notify residents of garbage/recycling trucks and using government-certified bags to throw away food waste. Residents of Taiwan are required to dispose of food waste in government-certified bags which cost up to 43 cents depending on size, disincentivizing residents from generating food waste. Requiring residents to separate their food waste from other trash will prevent it from filling up landfills. Hong Kong must also shift its efforts from recycling initiatives to more composting initiatives as composting can be

more effective in the long run. There are many misconceptions surrounding the recycling process and only specific types of plastic can be processed. Additionally, China used to be the main importer of Hong Kong's recycled items but they banned imports of recycled plastics in 2018 due to too much plastic being imported without enough facilities to process it; therefore, China was experiencing increased pollution and contamination through the import of plastics which were deemed recyclable (Smith). Hong Kong does not have any Material Recovery Facilities that handle plastic recycling so encouraging the public to recycle more would not be an appropriate solution to help reduce carbon emissions in Hong Kong. On the other hand, Hong Kong has sufficient composting facilities which can be supported by increased composting initiatives. Composting can also be carried out by citizens in small apartments by using small bins and using worms to compost material. Otherwise, companies have manufactured bins, specifically made for composting food waste which citizens can purchase for a more simplistic method (PlasticFreeSeas). Composting food can reduce contamination in landfills and recycling materials, decreasing methane emissions and greenhouse gases that stem from improperly disposed food waste.

In conclusion, with a population that is 100% urban, Hong Kong must invest resources in developing technologies that are suitable for its urban environment. Hong Kong's air pollution has significantly worsened in recent years which has been contributed by the increasing amount of imported food, electricity usage, and food waste. The government of Hong Kong has shown that they are willing to acknowledge the issue of climate change and work to improve the environmental quality in Hong Kong. To combat this problem, investing in urban farming techniques, renewable energy sources, and composting initiatives are solutions that can enable the people of Hong Kong to live more sustainable and healthier lives.

## Works Cited

- Airgarden. "Aeroponics Plants List | Airgarden." Airgarden, 2024, [airgarden.com.au/pages/aeroponic-plants-list?srsId=AfmBOoq4u7hWPJJEaI8IuUTzMxFHEHC25bjpXivlMxa7Zl3OxqImQS0i](https://airgarden.com.au/pages/aeroponic-plants-list?srsId=AfmBOoq4u7hWPJJEaI8IuUTzMxFHEHC25bjpXivlMxa7Zl3OxqImQS0i). Accessed 15 Aug. 2024.
- Almerini, Ana. "Wave Energy Pros and Cons." *Solar Reviews*, 6 Dec. 2020, [www.solarreviews.com/blog/wave-energy-pros-and-cons](https://www.solarreviews.com/blog/wave-energy-pros-and-cons).
- Bai, Fangdong, et al. "Back on the Farm: The Future of Agriculture in Hong Kong." *Hong Kong Free Press HKFP*, 1 Apr. 2018, [hongkongfp.com/2018/04/01/back-farm-future-agriculture-hong-kong/#:~:text=Over%20the%20past%20few%20decades](https://hongkongfp.com/2018/04/01/back-farm-future-agriculture-hong-kong/#:~:text=Over%20the%20past%20few%20decades). Accessed 17 Mar. 2024.
- Boylan, Camille. "The Future of Farming: Hydroponics." *PSCI*, Princeton University, 9 Nov. 2020, [psi.princeton.edu/tips/2020/11/9/the-future-of-farming-hydroponics](https://psi.princeton.edu/tips/2020/11/9/the-future-of-farming-hydroponics).
- Census and Statistics Department Hong Kong Special Administrative Region. 綜合住戶統計調查 按季統計報告 *Census and Statistics Department Hong Kong Special Administrative Region*. Aug. 2022.
- Centre for Food Safety. Population-Based Food Consumption Survey. June 2021.
- Chatteris. "Urban Farming in Hong Kong." *Chatteris*, 18 Nov. 2022, [chatteris.org.hk/urban-farming-in-hong-kong/#:~:text=Urban%20farming%20is%20defined%20as](https://chatteris.org.hk/urban-farming-in-hong-kong/#:~:text=Urban%20farming%20is%20defined%20as). Accessed 17 Mar. 2024.
- CorPower Ocean. "Wave Energy - CorPower Ocean." <https://Corpowerocean.com/>, 10 June 2022, [Corpowerocean.com/wave-energy/](https://Corpowerocean.com/wave-energy/).
- Debangshi, Udit. "RICE WHEAT CROPPING SYSTEMS-CONSTRAINTS and STRATEGIES : A REVIEW." *Quest Journal*, vol. 9, no. 4, 1 Apr. 2022, pp. 63–66, <https://doi.org/10.51470/plantarchives.2022.v22.no1.004>.
- Environment and Ecology Bureau. *Waste Blueprint*. Feb. 2021, [www.eeb.gov.hk/sites/default/files/pdf/waste\\_blueprint\\_2035\\_eng.pdf](https://www.eeb.gov.hk/sites/default/files/pdf/waste_blueprint_2035_eng.pdf).
- Environment and Ecology Bureau, et al. *Clean Air Plan*. June 2021.
- Figueiras, Sonalie. "Five Hong Kong Recycling Myths That Will Shock You." *Green Queen*, 27 Sept. 2018, [www.greenqueen.com.hk/recycling-myths-hong-kong/](http://www.greenqueen.com.hk/recycling-myths-hong-kong/).
- Green Tech Fund (GTF). "Green Tech Fund." *Www.gtf.gov.hk*, [www.gtf.gov.hk/en/index.html](http://www.gtf.gov.hk/en/index.html).
- HK Electric. "Our Operations." *Www.hkelectric.com*, [www.hkelectric.com/en/our-operations#:~:text=Electricity%20is%20generated%20at%20the](http://www.hkelectric.com/en/our-operations#:~:text=Electricity%20is%20generated%20at%20the). Accessed 17 Mar. 2024.
- HKFastFacts. "Hong Kong Typhoon Season." *HKFastFacts*, [www.hkfastfacts.com/weather/hong-kong-typhoon-season.html](http://www.hkfastfacts.com/weather/hong-kong-typhoon-season.html).
- "Hong Kong (HKG) Exports, Imports, and Trade Partners." The Observatory of Economic Complexity, [oec.world/en/profile/country/hkg?yearlyTradeFlowSelector=flow1](https://oec.world/en/profile/country/hkg?yearlyTradeFlowSelector=flow1).
- Inc, ZipGrow. "Indoor Hydroponic Farming: Costs and Profits [without the Fluff]." *ZipGrow Inc.*, 14 July 2017, [zipgrow.com/indoor-hydroponic-farming-costs-profits/](https://zipgrow.com/indoor-hydroponic-farming-costs-profits/).
- International Trade Administration (ITA). "Hong Kong - Environmental Technologies." *Www.trade.gov*, 16 Feb. 2024, [www.trade.gov/country-commercial-guides/hong-kong-environmental-technologies](https://www.trade.gov/country-commercial-guides/hong-kong-environmental-technologies).
- IQAir, and Environmental Protection Department - The Government of the Hong Kong SAR. "Hong Kong SAR Air Quality Index (AQI) and Hong Kong SAR Air Pollution | AirVisual." *Www.iqair.com*, [www.iqair.com/us/hong-kong](http://www.iqair.com/us/hong-kong).
- Piechowiak, Mateusz. "Countries Using Vertical Farming." *Vertical Farming Planet*, 2019, [verticalfarmingplanet.com/countries-using-vertical-farming/](https://verticalfarmingplanet.com/countries-using-vertical-farming/).
- Plastic Free Seas. "Recycling in Hong Kong | Plastic Free Seas." *Plasticfreeseas.org*, [www.plasticfreeseas.org/recycling-in-hong-kong/#:~:text=The%20Plastic%20Recycling%20Industry%20in](https://www.plasticfreeseas.org/recycling-in-hong-kong/#:~:text=The%20Plastic%20Recycling%20Industry%20in).

- Rapid Transition Alliance. "Taiwan's Transition – from Garbage Island to Recycling Leader." *Rapidtransition.org*, 19 June 2019, [rapidtransition.org/stories/taiwans-transition-from-garbage-island-to-recycling-leader/](https://rapidtransition.org/stories/taiwans-transition-from-garbage-island-to-recycling-leader/).
- Rooftop Republic Co. "How Urban Farming Can Change the World | Rooftop Republic." *Rooftop Republic Urban Farming*, [rooftoprepublic.com/pages/why-urban-farming](https://rooftoprepublic.com/pages/why-urban-farming).
- Smith, Carl. "After China's Recyclable Ban, Municipalities Shift Gears." *Governing*, *Governing*, 26 Aug. 2021, [www.governing.com/nw/after-chinas-recyclable-ban-municipalities-shift-gears#:~:text=China](https://www.governing.com/nw/after-chinas-recyclable-ban-municipalities-shift-gears#:~:text=China, Accessed 29 Aug. 2024). Accessed 29 Aug. 2024.
- Sunrun. "Megawatt - Definition | Solar Terms." *Sunrun*, 16 Aug. 2018, [www.sunrun.com/go-solar-center/solar-terms/definition/megawatt#:~:text=Breaking%20Down%20a%20Megawatt%3A](https://www.sunrun.com/go-solar-center/solar-terms/definition/megawatt#:~:text=Breaking%20Down%20a%20Megawatt%3A, Accessed 17 Mar. 2024). Accessed 17 Mar. 2024.
- Tam, Daisy. "Food Supply in Hong Kong." *HKFoodWorks*, 19 Dec. 2018, [hkfoodworks.com/research/food-supply/#:~:text=The%20lack%20of%20public%20investment%20in%20agriculture%20and](https://hkfoodworks.com/research/food-supply/#:~:text=The%20lack%20of%20public%20investment%20in%20agriculture%20and, Accessed 17 Mar. 2024). Accessed 17 Mar. 2024.
- Teng Hoi Conservation Organization. "Composting – Teng Hoi Conservation Organization." *Tenghoiconservation.org*, [tenghoiconservation.org/composting/](https://tenghoiconservation.org/composting/).
- The Centre for Health Protection (CHP). "Pattern of Fruit and Vegetables Consumption." *Www.chp.gov.hk*, 18 Mar. 2023, [www.chp.gov.hk/en/static/90021.html](https://www.chp.gov.hk/en/static/90021.html).
- The World Bank. "Agricultural Land (% of Land Area) - Hong Kong SAR, China | Data." *Data.worldbank.org*, [data.worldbank.org/indicator/AG.LND.AGRI.ZS?locations=HK](https://data.worldbank.org/indicator/AG.LND.AGRI.ZS?locations=HK).
- The World Factbook. "Hong Kong." *CIA.gov*, Central Intelligence Agency, 9 June 2022, [www.cia.gov/the-world-factbook/countries/hong-kong/#geography](https://www.cia.gov/the-world-factbook/countries/hong-kong/#geography).
- UNECE. "Air Pollution and Food Production | UNECE." *Unece.org*, [unece.org/air-pollution-and-food-production](https://unece.org/air-pollution-and-food-production).
- University of Washington. "Vegetables to Grow on Roof Gardens." Elisabeth C. Miller Library, 2024, [depts.washington.edu/hortlib/pal/vegetables-to-grow-on-roof-gardens/#:~:text=According%20to%20the%20book%2C%20the](https://depts.washington.edu/hortlib/pal/vegetables-to-grow-on-roof-gardens/#:~:text=According%20to%20the%20book%2C%20the, Accessed 15 Aug. 2024). Accessed 15 Aug. 2024.
- US EPA. "Composting Food Waste: Keeping a Good Thing Going." *Www.epa.gov*, Aug. 2020, [www.epa.gov/snep/composting-food-waste-keeping-good-thing-going#:~:text=In%20addition%2C%20composting%20lowers%20greenhouse](https://www.epa.gov/snep/composting-food-waste-keeping-good-thing-going#:~:text=In%20addition%2C%20composting%20lowers%20greenhouse).
- Wilson, Audrey. "8 Hong Kong Nicknames and the History behind Them." *Destguides*, 23 Aug. 2023, [www.destguides.com/hong-kong/hong-kong-nicknames](https://www.destguides.com/hong-kong/hong-kong-nicknames). Accessed 17 Mar. 2024.
- Wilson, Lindsay. "How Big Is a House? Average House Size by Country." *Shrinkthatfootprint.com*, 30 Apr. 2013, [shrinkthatfootprint.com/how-big-is-a-house](https://shrinkthatfootprint.com/how-big-is-a-house).
- WWF. "Oceans." *Www.wwf.org.hk*, [www.wwf.org.hk/en/oceans/#:~:text=Our%20oceans%20are%20our%20planet](https://www.wwf.org.hk/en/oceans/#:~:text=Our%20oceans%20are%20our%20planet, Accessed 17 Mar. 2024). Accessed 17 Mar. 2024.