Hong Kong Buildings’ Carbon Footprint and DSM

WWF-Hong Kong

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Solutions for a living planet

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Worst Ever Carbon Emissions

- 2010: Greenhouse gas emissions – Historical high carbon output.
- 2011: If emitted the same amount (32 Gt) – Exceeded 9 years ahead of schedule; impossible to prevent the temperature rise beyond 2°C.
- BAU: IPCC's projections – Around a 50% chance of a rise in global average temperature of more than 4°C by 2100.
- 2010: The wettest year on record and third warmest for sea surface temperatures.
- 2040: Toxic algae threaten economy & human health
- Changing climate: Overgrowth of algae and toxic bacteria and viruses in the water (US) according to the National Oceanic and Atmospheric Administration (NOAA).
- Blooms of *Alexandrium catenella* ("red tide"), which produces saxitoxin, a poison that can accumulate in shellfish. (Shrimp, Mussels...)

If everyone in the world lives a similar lifestyle like Hong Kong, we need **2.2 planets** to sustain our living.

Hong Kong people have an average Ecological Footprint of 4.0 global hectares (gha) per person.

A nation’s ecological footprint is the sum of land and sea area used to provide the food, fibre and timber resources it consumes, to absorb the waste it emits, and to locate its infrastructure.

Source: *Hong Kong Ecological Footprint Report 2010*
• The ecological footprint is a widely used measure of humanity’s demand on nature.

• Hong Kong’s Ecological Footprint per person is higher than that of Beijing and Shanghai, but 26% lower than Singapore.

• Hong Kong’s carbon footprint makes up 60% of total ecological footprint in 2007, out of which 74% is embodied in imports.

Source: Hong Kong Ecological Footprint Report 2010
Total Carbon Footprints by Industrial Sector

Direct emissions from the construction sector and emissions from all upstream material inputs.

74% of carbon footprint is embodied in import goods

Source: Hong Kong Ecological Footprint Report 2010
Total Carbon Footprints by Household Consumption Category

Housing is the only consumption category for which more than half of the carbon Footprint comes from internal emissions.

This portion of the carbon Footprint is primarily attributable to household electricity use, heating and air conditioning.

Source: Hong Kong Ecological Footprint Report 2010 (draft version)
Building Energy Efficiency – Wedge to Climate Change

• Buildings consume 32% of the world’s resources, including 12% of its water, and up to 40% of the energy consumption. Buildings produce 40% of waste going to landfill and generate 40% of greenhouse gas emissions.

• In Hong Kong, buildings account for 56% of Hong Kong's total energy consumption and 89% of Hong Kong's total electricity use. It also accounts for 65% of the Hong Kong’s carbon footprint.

• Life Safety Code & Inspection Mechanism for Building (U.S.) - adding 5% to building costs (Building Energy Code…?)

• Achieving the International Energy Agency’s (IEA) target of a 77% reduction in the worldwide carbon footprint against the 2050 baseline by IPCC.

• The WBCSD’s Energy Efficiency in Building study - net cost additions to achieve the IEA target is 7% of total building costs worldwide.

Energy Consumption of All Commercial Segments 2006 (TJ)

Total Power Consumption = 110,088 TJ

Restaurant 21% 22,937
Retail 16% 17,159
Office 14% 15,085
Other Commercial 50% 54,907

Source: EMSD End-user Data Report, 2008
# Energy Use and Floor Areas of Offices

- Energy Intensity of Office has surged 26% since 1991

<table>
<thead>
<tr>
<th>Year</th>
<th>Energy Use ('000,000kWh)</th>
<th>Floor Area ('000 m²)</th>
<th>Energy Intensity (kWh/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991</td>
<td>1,854</td>
<td>5,034</td>
<td>368</td>
</tr>
<tr>
<td>1996</td>
<td>3,041</td>
<td>6,586</td>
<td>462</td>
</tr>
<tr>
<td>2001</td>
<td>3,869</td>
<td>8,119</td>
<td>476</td>
</tr>
<tr>
<td>2006</td>
<td>4,190</td>
<td>9,062</td>
<td>462</td>
</tr>
<tr>
<td>2007</td>
<td>4,254</td>
<td>9,206</td>
<td>462</td>
</tr>
</tbody>
</table>

Source: Energy & Environmental Policy Research Unit, Department of Management Sciences, City University and WWF Joint Research
Decoupling of Energy Use and Floor Area of Office Building

Source: Energy & Environmental Policy Research Unit, Department of Management Sciences, City University and WWF Joint Research
Occupied Floor Area by Building Grade

Occupied floor area at year end

Year
--- | --- | --- | --- | ---
Grade A 2770 | 3908 | 4702 | 5358 | 5476
Grade B 1217 | 1556 | 2072 | 2266 | 2249
Grade C 1047 | 1122 | 1345 | 1437 | 1481

Source: Energy & Environmental Policy Research Unit, Department of Management Sciences, City University and WWF Joint Research
Initial Observation & Follow Up Questions

- Energy Intensity increases over the years – more energy usage per m²
- High Correlation between Energy Usage and Floor Area
- Increases in the amount of Grade A buildings
- Factors affecting Offices’ Energy Consumption
- Which grade of Office Building is more energy efficient?

Source: Energy & Environmental Policy Research Unit, Department of Management Sciences, City University and WWF Joint Research
Normalization of Different Factors

• Age factor: Building Age

• Occupancy factors: Floor Area; Operation Schedule; Number of Employees

• Climate factor: Degree-day Temperature

• People factors: Occupants’ Behavior and Maintenance factor; Indoor Temperature set point

• Energy end-use factors: Chiller equipment type; Air side distribution type; Air side control; Water side distribution control; Lighting equipment; Lighting control; Office equipment.

Source: Energy & Environmental Policy Research Unit, Department of Management Sciences, City University and WWF Joint Research
**Significant Factors Affecting Energy Use of Offices**

<table>
<thead>
<tr>
<th>Grade A</th>
<th>Grade A/B (with Central A/C)</th>
<th>Grade A/B (with Central A/C)</th>
<th>Grade C (No Central A/C)</th>
<th>Grade C (No Central A/C)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Whole Building</strong></td>
<td>Common Area</td>
<td>Tenant Area</td>
<td>Common Area</td>
<td>Tenant Area</td>
</tr>
<tr>
<td>Air side control</td>
<td>Chiller equip. type</td>
<td>Tenant behavior</td>
<td>Chiller equip. type</td>
<td>Tenant behavior</td>
</tr>
<tr>
<td>Lighting control</td>
<td>Water side distribution control</td>
<td>Office equip. (no.)</td>
<td>Indoor temp set point</td>
<td>Office equip. (no.)</td>
</tr>
</tbody>
</table>

Source: Energy & Environmental Policy Research Unit, Department of Management Sciences, City University and WWF Joint Research
## Energy Use Intensity for Grade A/B/C Offices

**Normalized EUI* (Kwh/m²)**

<table>
<thead>
<tr>
<th>Grade A Whole Building</th>
<th>Grade A/B with Tenant</th>
<th>Grade C with Tenant</th>
</tr>
</thead>
<tbody>
<tr>
<td>582</td>
<td>316</td>
<td>243</td>
</tr>
</tbody>
</table>

* Energy Use Intensity

**Moreover, per m², per year:**

- Common Area of Grade A office occupies about 35% of Floor Area
- Grade A (whole building) uses more (almost double) energy than office buildings with tenants.
- For office buildings with tenants in Grade A/B, their common area uses more energy (almost double) than their tenants.
- For office buildings with tenants in Grade C, their common area uses much less energy (around 25% or less) than their tenants.

Source: Energy & Environmental Policy Research Unit, Department of Management Sciences, City University and WWF Joint Research
Follow-up Questions

- Energy Consumption in Communal Area
- Energy Consumption in Tenant Area
- Infrastructure: Air-Conditioning and Lighting to pursue Energy Efficiency
- Building Energy Code (BEC)? Tighten every 2 – 3 years (WWF & PGBA)
- Tenant Operation: Behavioral Change to pursue Energy Saving & Energy Conservation
- Office Equipments? Low Carbon Office Best Practices? DSM?
- Property Management Vs Users (Tenants) Grade A: Rental Vs Electricity Bill

Source: Energy & Environmental Policy Research Unit, Department of Management Sciences, City University and WWF Joint Research
Estimated Total Power Consumption of Office Equipments 2007 (GWh)

Total Power Consumption = 479.2 GWh

- Computer: 179.2 GWh (37%)
- Printer: 66.5 GWh (14%)
- Monitor: 47.6 GWh (10%)
- Photocopier: 17.2 GWh (4%)
- Multi-Functional Device: 11.0 GWh (2%)
- Water Boiler/Dispenser: 41.4 GWh (14%)
- Others: 116.2 GWh (24%)

Source: EMSD 2008
Total and Standby Power Consumption of Office Equipments 2007 (GWh)

- Computer: 153.72 GWh, 25.66 GWh in operation, 14.3% standby
- Monitor: 45.47 GWh, 2.12 GWh in operation, 4.5% standby
- Printer: 62.04 GWh, 4.46 GWh in operation, 6.7% standby
- Photocopier: 38.36 GWh, 2.99 GWh in operation, 7.2% standby
- Fax Machine: 1.29 GWh, 0.29 GWh in operation, 14% standby
- Multi Functional Device: 13.06 GWh, 4.1 GWh in operation, 23.9% standby
- Water Boiler/Dispenser: 97.49 GWh, 18.72 GWh in operation, 16.1% standby

Total Standby = 60 GWh

Source: EMSD 2008
Observations for Electricity Use of Office Equipments

• Total electricity consumption of office equipments in HK is 479.2 GWh

• Stand-by Mode accounts for 12.44% (60 GWh) of electricity consumed by office equipments in private offices in Hong Kong

• To reduce carbon emissions - Cut standby power. (Say No to Standby)

• Office equipments under Recognition Labelling Scheme (without grading)

• Infrastructure – Legislation to make changes (it takes time)

• Operation – Policy, Low-Carbon Office Program, Incentive, Tariff Structure, Education to facilitate users’ behavioral change (it takes time)

• Carrot and Stick
• In the case of the U.S., according to Mckinsey’s report, the energy and operational savings from energy efficiency could total some US$ 1.2 trillion and require only an initial upfront investment of approximately US$ 520 billion.

• Such a program has the potential to reduce end-use energy consumption in 2020 by roughly 9.1 quadrillion BTUs, roughly 23 percent of projected demand, potentially abating up to 1.1 gigatons of greenhouse gases annually.

• This reflects a lower unit cost that can be acquired by energy efficiency measures compared to increasing power supply (changing fuel mix).
**Global GHG abatement cost curve beyond business-as-usual – 2030**

**Abatement cost**

€ per tCO₂e

- Residential electronics
- Residential appliances
- Retrofit residential HVAC
- Tillage and residue mgmt
- Insulation retrofit (residential)
- Cars full hybrid
- Waste recycling
- Low penetration wind
- Cars plug-in hybrid
- Degraded forest reforestation
- Nuclear
- Pastureland afforestation
- Degraded land restoration
- 2nd generation biofuels
- Building efficiency new build
- Organic soil restoration
- Grassland management
- Reduced pastureland conversion
- Reduced slash and burn agriculture conversion
- Small hydro
- 1st generation biofuels
- Rice management
- Efficiency improvements other industry
- Electricity from landfill gas
- Clinker substitution by fly ash
- Cropland nutrient management
- Motor systems efficiency
- Insulation retrofit (commercial)
- Lighting – switch incandescent to LED (residential)
- Gas plant CCS retrofit
- Coal CCS retrofit
- Iron and steel CCS new build
- Coal CCS new build
- Power plant biomass co-firing
- Reduced intensive agriculture conversion
- High penetration wind
- Solar PV
- Solar CSP

**Abatement potential**

GtCO₂e per year
# Overseas Examples of Energy Efficiency Measures (Carrot - Incentive Scheme)

<table>
<thead>
<tr>
<th>Country</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taiwan</td>
<td>Residential users may enjoy an additional 5%-20% discount in the electricity tariff if they consume less electricity.</td>
</tr>
<tr>
<td>UK</td>
<td>All power companies with a customer base more than 50,000 to set carbon reduction targets. The companies have to assist their consumers to reduce energy consumption.</td>
</tr>
<tr>
<td>Singapore</td>
<td>Singapore launched the “10% Energy Challenge” in 2008. Residents who were proven to be successful in reducing their electricity consumption by 10% within a specific period of time were eligible to enter into a lucky draw.</td>
</tr>
</tbody>
</table>
| **Overseas Examples of Energy Efficiency Measures**  
| (Stick – Policy, Regulations & Legislation) |
| --- | --- |
| **The UK government** | Energy meters have been installed in 18 department headquarters in London. Public can start to monitor the reading online with an aim to increase accountability of the Administration in a bid to cut emissions by 10% over the next 12 months. |
| **The UK family** | Retrofit Homes. E.g. All cavity walls and lofts insulated where practical by 2015. E.g. Smart meter installed in 1.2 million households in London to increase the awareness of energy consumption and facilitate behavioral change. Saving in electricity bill will be used to cover capital costs of meters. 7 years pay-back period. New tenants are obliged to continue to pay for that even the old tenants have moved out. |
| **Singapore** | This new Energy Act makes companies (large industrial energy users), which consume 15 GWh or above annually to appoint an energy manager. An energy efficiency improvement plans must be submitted to the National Environment Agency (NEA) with an aim to reduce energy consumption. |
London: Breakdown of the 60% reduction
Energy efficiency vs energy supply

With courtesy of Mayor of London
London: Breakdown of the 60% reduction By sector

With courtesy of Mayor of London
London’s homes: driving our energy future: \( \text{CO}_2 \) emissions reductions

With courtesy of Mayor of London
Conclusions

• UK Case: By govt & mayor action; By Sector; By Supply / Demand;

• Carbon emissions of Buildings is High or Low? (I don’t know)

• No reliable baseline data for Building Energy available

• Lack of data; Lack of research; Lack of holistic sustainable policy research

• Energy Benchmark Survey ; Energy Index for Hong Kong

• Define contributions from the building energy efficiency towards GHG reduction target of Hong Kong

• Demand Side Management (DSM) Vs Supply Side Management (SSM) – Hong Kong needs both (U.K. 50% - 50%; EU Target: 20/20/20)

• Many DSM measures are proven effective but for Hong Kong - lack of priority and quantifiable impact

• Who pay the costs / incentives ? Who benefits? Pay-back Period?
Thank you

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+100

WWF is in over
100 countries, on
5 continents

1961

WWF was founded
In 1961

1981

WWF-Hong Kong was
established in 1981, to
deliver solutions for a
living planet

+35,000

WWF-Hong Kong has
over 35,000 individual
financial supporters

Photo: © Michel Roggo / WWF-Canon
Energy Consumption of Residential Segments
2006 (TJ)

- Private Housing: 47%, 24,315 TJ
- Public Housing: 31%, 16,206 TJ
- HASS: 15%, 8,078 TJ
- Other Housing: 7%, 3,581 TJ

Source: EMSD 2008
Total Energy Consumption of Household Appliances 2005 (GWh)

- A/C 34% (2154 GWh)
- Others 11% (1125 GWh)
- Washing Machines 6% (569 GWh)
- Electric Water Heaters 6% (572 GWh)
- TVs 7% (731 GWh)
- Fringes 14% (1425 GWh)
- Lighting 22% (2154 GWh)

Total Residential Consumption = 9,948 GWh

Source: EMSD