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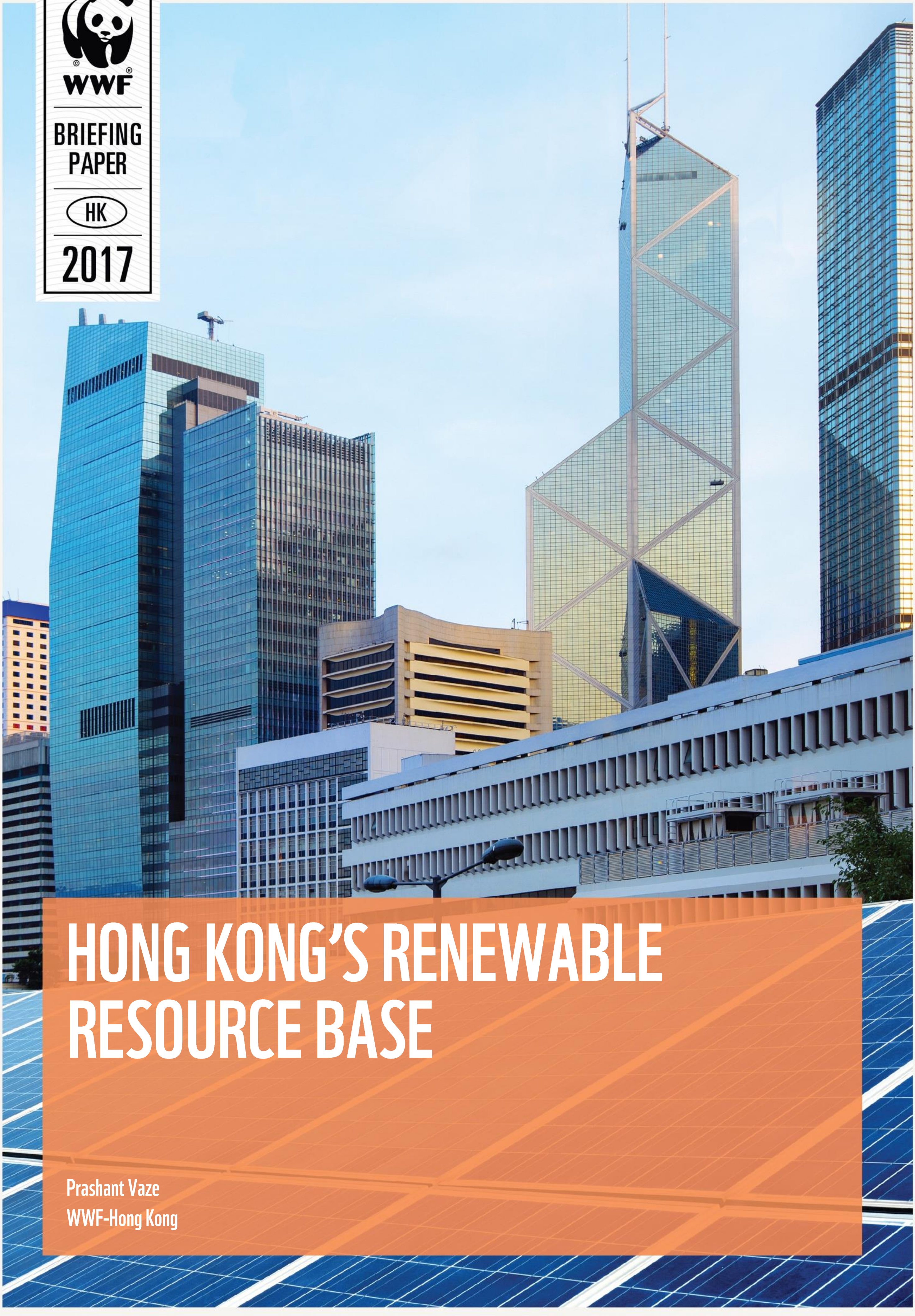

HONG KONG'S RENEWABLE RESOURCE BASE

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SUMMARY

This study examines the potential resource base for renewable electricity (RE) in Hong Kong and provides background for WWF-Hong Kong's call for the government to establish a minimum 10 per cent RE target for 2030. In addition to solar PV, WWF has also been evaluating the potential for electricity generation from wind and waste to energy. The development of RE requires financial incentives (such as a Feed-in Tariff), and more importantly, for the government to identify suitable locations for deployment (wind), and developing systems to collect and transport suitable substrate (waste).

Below is an assessment of each of the major RE technologies' resource base, these are then expressed as a share of current (44 TWh) and projected (38 TWh) 2030 electricity demand. The "per centage share 2030" figure assumes that Hong Kong, through its energy efficiency policy, succeeds in reducing electricity demand by over 1 per cent a year. The final column is an indicative breakdown of a 10% target between the RE resource classes.

	Resource base (TWh)	% share of 2014 demand	% share of 2030 demand	Indicative Target (TWh)
Solar PV	9.5	22%	25%	1.6
Off shore Wind	11.3	26%	30%	1.7
Waste	1.2	3.0%	3.0%	0.9
TOTAL	22.0	50%	57%	4.1

These results imply a theoretical potential for Hong Kong to produce over half of its projected 2030 electricity demand from renewables. There might be nature conservation, technical, cost-efficiency and aesthetic reasons why many of these sites would not be exploited so we do not suggest so ambitious a target. Our results do, however, underline that Hong is not short of renewable resources.

We recommend that the government set a 10 per cent domestically sourced renewable electricity target for 2030.

Thank you for comments and feedback received from Gavin Edwards, Olivia To, Cathryn Chu, Douglas Anderson and other experts that wished to remain anonymous. Editorial support was provided by Saul Symonds and Rainy Siu. Any errors or omissions are the responsibility of the author.

TOTAL ELECTRICITY DEMAND

Hong Kong's total electricity consumption in 2014 was **43.9 TWh** (Electrical and Mechanical Services Department (EMSD) data: HKEEUD 2016, Table 3 – 158147 TJ electricity consumption by all sectors). In order to meet its climate goals, WWF-Hong Kong has advocated[1] energy efficiency should be heavily deployed to reverse upward trends for electricity demand growth fuelled by population and economic growth. In the above-referenced paper it was assumed, in the absence of energy efficiency measures, that demand would grow to 54.6 TWh/yr in 2030. But if energy efficiency is appropriately incentivised, demand could fall by over 1 per cent per annum, meaning that demand in 2030 would be **38.3 TWh,** around 13 per cent less than 2014**.**

SUPPLY OF ELECTRICITY IN HONG KONG FROM SOLAR

A number of studies have estimated the potential for renewables in Hong Kong. An early analysis on behalf of EMSD in 2002 based largely on desk studies[2] calculated substantial potential: solar 17 per cent of annual power demand, wind 24 per cent, energy from waste 3 per cent. Later work by EMSD staff[3] calculated lower but still substantial potential: solar 5.9 TWh/yr (around 13 per cent), onshore wind 2.6 TWh/yr (around 5 per cent). Neither of these studies properly took into account the suitability of buildings to accommodate solar PV and have been superseded by more rigorous analysis. This WWF briefing paper is based on the more rigorous analysis.

The calculation in this paper looks at three sorts of space that can be used to site solar panels:

- roofs of existing buildings
- open space
- reservoirs

Annual electricity yield per square meter in Hong Kong

This study estimates the solar potential of reservoirs for the first time. The yield of a solar panel depends on the amount of sunlight that reaches it. The Hong Kong Observatory has published a mean monthly figure for measured sunlight over the last 20 years at it King's Park weather station. The figures are below

HONG KONG SUNLIGHT INTENSITY		
Month	$kWh/m^2/d$	Days/month
January	2.82	31
February	2.75	28
March	2.82	31
April	3.29	30
May	3.91	31
June	3.97	30
July	4.6	31
August	4.23	31
September	4.01	30
October	3.95	31
November	3.44	30
December	2.98	31
TOTAL	3.57	

The above table suggests that one square meter in Hong Kong receives 1303 kWh of insolation per year (3.57kWh/d). This figure is significantly higher than locations in Europe where solar PV is already well established. European insolation levels range between 900 and 1200 kWh/yr. The SunPower panels installed by WWF at the Tai O village homes have an efficiency of 20 per cent. Their newer models are more efficient still and we expect efficiency gains in future as the industry innovates further[4]. In our calculation of the potential for reservoirs we assume that PV cells have an efficiency of 20 per cent at converting sunlight into electricity and the system has an efficiency of 15 per cent (loss due to some of the system area being used for edges, cabling etc) thereby yielding 195kWh/m²/yr.

Roof space

The WWF assessment of available roof space is based on work undertaken by Professor MS Wong's work for Hong Kong's Central Policy Unit[5]. This assessment made an aerial assessment of suitable roof space using LiDAR imaging to develop a three-dimensional perspective of the rooftops of Hong Kong buildings. Decision rules were used by the GIS software to create a 1m buffer around the panel, and remove areas smaller than $3m^2$. The study also used a year's satellite data to assess the amount of cloud cover at different months of the year to further adjust the potential solar resource.

The results of this work suggested there were 233,152 suitable buildings (out of 309,000 buildings) with a total rooftop area of 28,643,335 m^2. In the paper Professor Wong assumes that this space will yield 2.66 TWh of electricity a year. This is based on the solar PV panels having an efficiency of conversion of just 7.8 per cent which is lower than is expected from modern PV modules.

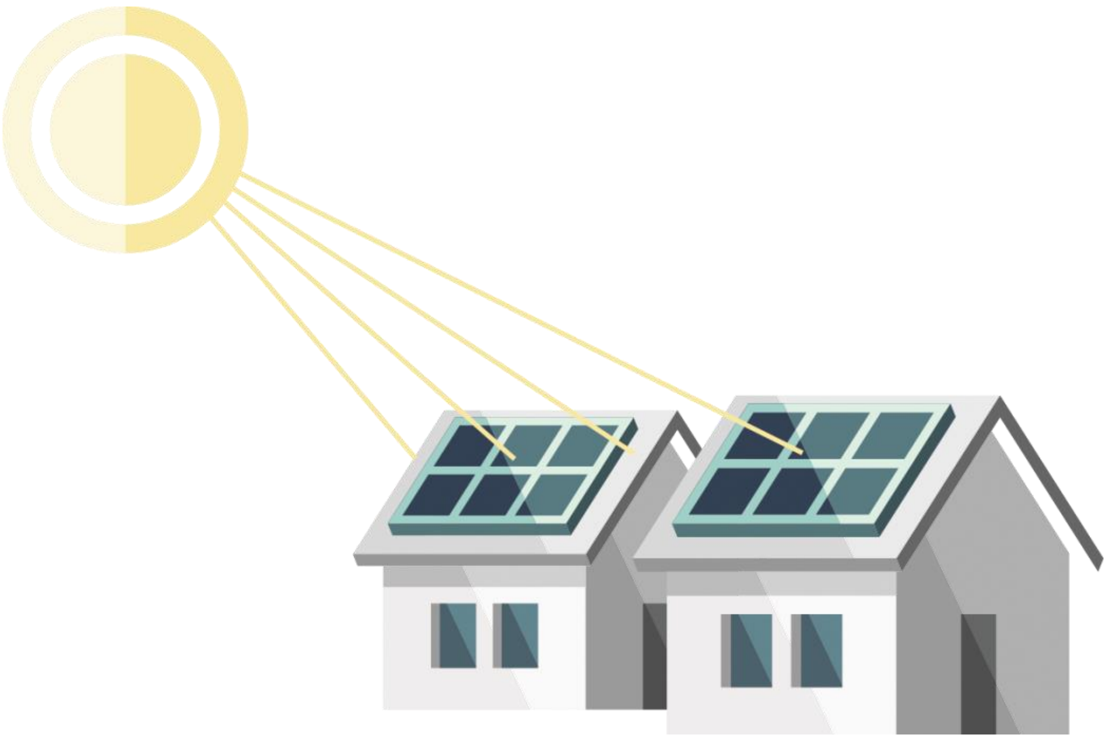
The Central Policy Unit funded a second study, also conducted by Hong Kong Polytechnic University, which came up with an estimate of 4.67 TWh from the rooftops[6] *alone*. This study ignored the contribution that might be made from open space. This second study also used LiDAR to remotely sense the area and topography of roof-space in Hong Kong, but a different model to assess the impact of shading from obstructions. It took no account of cloud cover. The second study is not used in this paper.

Building Integrated Photovoltaics (BIPV)

As well as roof tops, the south-facing walls and windows of buildings can be utilised with solar panels integrated into the walls, or with semi-transparent panels used over the windows. The latter also block light and heat entering into the building. Several buildings in Hong Kong have trialled these technologies such as the Wanchai Tower and buildings in Hong Kong Science Park[7]. Side elevations of buildings receive far less direct sunlight than rooftops and so a greater area of solar panels is needed to produce the same amount of energy over a year. This means they are less commercially attractive than roof top solar. No estimate has been made of Hong Kong's BIPV resource. But as the prices of panels fall, the technology will become more viable especially in new buildings where it can be introduced into the original design.

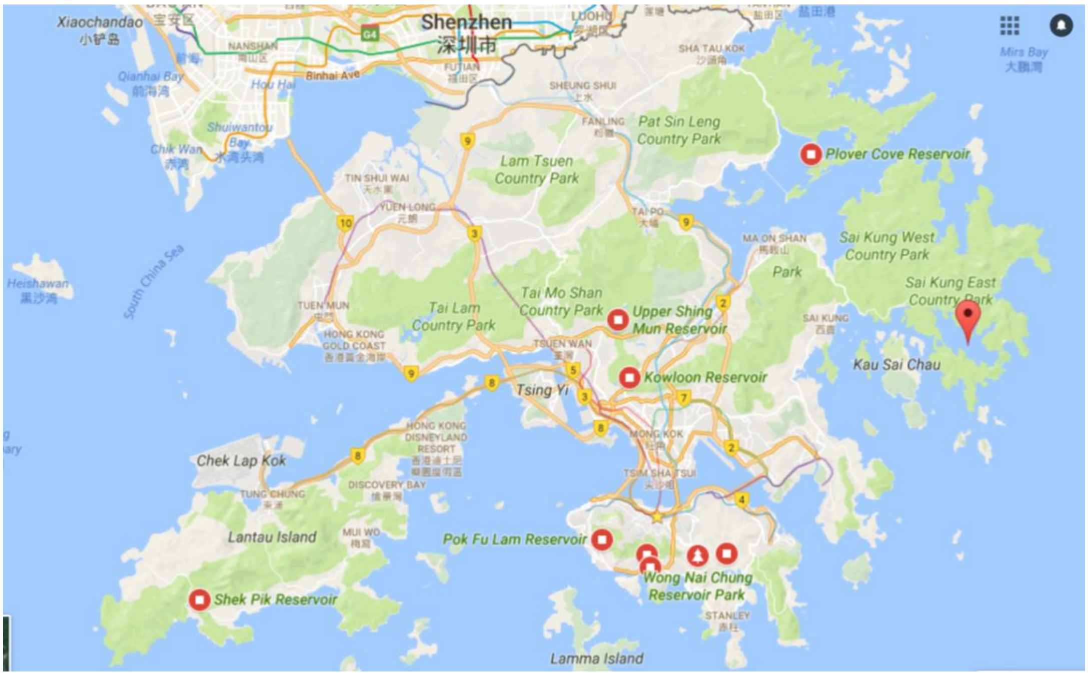
Open space

The Wong paper makes an assessment of the open space available for installing solar PV. It says: "Considering the open spaces, there are about 24,217,705m^2 of open spaces in Hong Kong, and some are suitable for installing PV modules. The total estimated energy in these 2,475 open space areas is about 38 TWh." The paper calculates the resource in *suitable* open space is 2.88 TWh, again assuming that the solar panels convert sunlight to electricity with an efficiency of 7.5 per cent, far lower than is observed with modern panels.



Reservoirs

Hong Kong's Water Services Department maintains and operates 17 reservoirs with a total area of 23.8 km^2 [8].



Note: Google Maps. (2017). Retrieved from
https://www.google.com.hk/maps/search/reservoirs/@22.3632433,113.9924207,11z/data=!3m1!4b1?hl=en

Considering the extent to which solar PV could be deployed on reservoirs, a proportion of the reservoir would need to be left uncovered to allow for drift during the windy season, water quality maintenance or for habitat. The maximum amount of electricity that could be obtained from the reservoirs is calculated at 3.95 TWh assuming that 85 per cent of the reservoir area is used and the efficiency of the solar system is 15 per cent. This is based on a review of reservoir PV projects by WWF which suggest that 85 per cent cover is the maximum observed, 30 per cent the average.

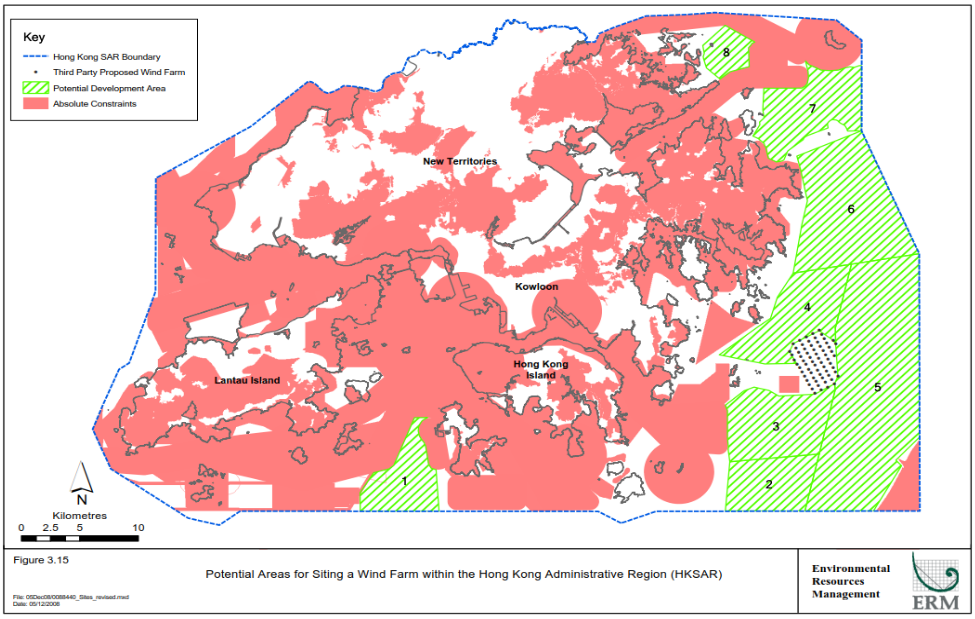
Floating Solar Power System at Shek Pik Reservoir

Total solar

The total amount of solar resource that can be deployed from these three sources is therefore 9.5 TWh/yr (Rooftop + Open area + Reservoir; 2.66+2.88+3.95). This represents 22 per cent of electricity demand in 2014.

Off-shore wind

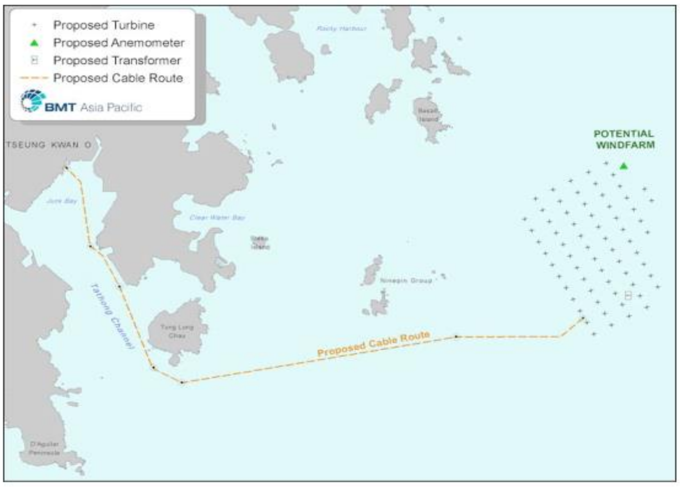
A characterisation of Hong Kong's off-shore wind resources was undertaken by consultants ERM[9] for HK Electric. The characterisation of the SAR's territory looked at the "absolute constraints" and the areas with other "potential obstacles". The absolute constraints excluded areas of water on the grounds of Wild Animals Protection Ordinance, country parks or designated marine parks, fish culture zones, gazetted artificial reefs, typhoon shelters and areas with height restrictions (because of the proximity of the airport), marine vessel fairways, etc. They also excluded sites unsuitable for wind farms because they were too deep (> 40m depth) or had insufficient resource. Some areas were defined as potential obstacles, but the consultants thought by tweaking the precise placement of each turbine the issue could be avoided. This included submarine cables, helicopter flight paths, and areas close to but outside the Geopark near Sai Kung. The diagram from the report is reproduced below. The consultants split the space into eight zones, with a combined area of 485 km². These potential obstacles lie inside zones 5 and 6. In the ERM report Figure 3.14 suggests that around 30 per cent of zones 5 and 6 could be impacted by potential obstacles. This reduces the usable area to **408 km²**.



Source: ERM Limited (2010) "Development of an Offshore Wind Farm in Hong Kong EIA Study Volume 1 -7" undertaken under contract to HK Electric.

Substantial further work was done to characterise off-shore wind resources in 2009, with the details published within EIAs by CLP and HK Electric. The figure below shows the configuration of a possible wind farm undertaken on behalf of the wind developer Hong Kong Offshore Wind Ltd by consultants BMT[10]. It shows an array of 67 3MW turbines with a capacity of 200 MW in the southeast waters not far from Sai Kung. Its output was estimated as 1 per cent of Hong Kong's electricity demand – which was around 410GWh. From the size of the wind farm and the projected electricity yield the implied loading factor was around 24 per cent. Such a figure is satisfactory and similar to other wind sites in Asia. Wind speeds in Asian waters suitable for off-shore wind average 7-8 meters per second. Wind speeds in Hong Kong are around this mark. A wind farm half this size of the Southeast/Nine-pins scheme was proposed near HK Electric's service area south east of Lamma Island. The documentation says its output would be 175GWh.

Figure 1.1 Project Location and Configuration



Source: Reprinted from "Hong Kong Offshore Wind Farm in Southeastern Waters -Executive Summary: Reference: ESB-146/2006 Issue 3. Copyright 2009 by BMT.

Together these two schemes would generate around 1.5 per cent of Hong Kong's demand. The combined area of the two locations, around 20km², represents only 5 per cent of Hong Kong's waters that are suited to off-shore wind resource. If the 388km² of remaining sites had similar wind characteristics off-shore wind could provide 30 per cent of the city's electricity needs. Interestingly an article by academics from Hong Kong Polytechnic University **calculate 25.06 per cent of 2011 demand, 11.3 TWh could be met by offshore wind[11] with an optimised configuration of turbines in the 358km² of permitted waters**. This article is based on a careful analysis of ten years of actual wind data. Unfortunately data restrictions meant that the measurement locations tended to be land based (Waglan Island, Lantau) rather than being measured at the candidate sites themselves. We use this figure in the recommendations section at the end of this report, which is broadly consistent with the work undertaken by EMR.

There is scope to substantially increase the use of off-shore wind in Hong Kong. In the previous EIAs, WWF noted that more work needed to be undertaken to monitor nighttime bird migration in the vicinity of the sites. Hong Kong will need to address some engineering challenges related to offshore wind. Firstly, wind turbines are susceptible to damage from typhoons, and as we know climate change will increase the frequency of such extreme weather events. Turbine design is becoming more resilient, and as off-shore wind is deployed in Guangdong and Taiwan the costs of repairing blades and shafts will be better understood. Extreme weather has not stopped offshore wind farms being deployed in other countries. During the recent T10 storm, Hato offshore wind speed reached 193 km/hr. It should be noted that Hurricane Ophelia that struck the west coast of Ireland a few weeks after Hato had gusts of 190 km/hr. In USA several Category 5 hurricanes (Hurricane Allen 1980, Andrew 1992, Irma 2017) have been recorded with gusts of more than 280 km/hr!

Another challenge is that, according to the Polytechnic University study, peak generation from wind is not as well synchronised with Hong Kong's seasonal electricity demand as solar PV. Their analysis of monthly wind generation suggests wind output could potentially supply 46 per cent of October demand, but only 8 per cent of August demand. August is the month of highest demand in Hong Kong. The engineering solution to this is to ensure better interconnection with the Mainland grid to better match supply and demand across a larger geography.

A third argument against off-shore wind that the costs are prohibitive is becoming less and less true over time. In a recent auction of off-shore wind contracts in the UK the lowest price bid was $600/MW – 23 per cent lower than last year, and 62 per cent less than the overall off-shore wind farm in the UK since the first plants were constructed in the early 2000s[12]. This incredible reduction chiefly in the last ten years was due to continuing policy support for the technology by the UK Government which gave the electricity sector the confidence to invest in a skilled workforce and supply chains to succeed, which also drives installation costs down substantially.

The installation of off-shore wind turbine foundations makes extensive use of pile drivers generating high levels of underwater noise. This can impact on species with conservation interest like the finless porpoise and the green turtle. It is important contractors schedule their activities to mitigate the noise impacts, and avoid activity during the peak porpoise season. Contractors should also use less disturbing piling techniques.

On-shore wind

Hong Kong is a densely populated city with 25 per cent of land utilized for urban development and 40 per cent allocated as country parks. Little work has been done to characterise the on-shore resource base. The 2002 EMSD report notes that many of Hong Kong's hilltops have high and reliable wind with power densities of greater than 400W/m² making them suited to wind. The report says a linear arrangement along the ridges of suitable mountains would yield 2630 GWh or 7.5 per cent of Hong Kong's demand. This assessment included ridges within country parks. The author of this study is not aware of any further work to take forward this assessment.

Energy from waste

Hong Kong's seven million people produce substantial quantities of waste. From a life-cycle perspective generating energy from waste is a non-optimal way of handling material resources. WWF agrees with the government's "Use Less, Waste Less" strategy and the ambition should be a hierarchy of waste goals: firstly promoting waste minimisation by consuming less, secondly increasing the reuse of goods, thirdly recycling materials, and only when these opportunities are exhausted should energy recovery and disposal be considered. In practice this means people should avoid over-ordering food, pack uneaten food, extend the useful lives of their goods and clothes, use refillable packaging and avoid single-use packaging and cutlery, etc.

That said the residual waste has the potential to be a valuable energy source. Municipal solid waste (MSW) contains combustible wood, plastic and paper – though only the plastic component should not be viewed as renewable since it is produced from fossil fuels. If organic waste is separately collected from homes, food preparation businesses and restaurants, then it can be used to create valuable biogas. The production of biogas through a separate waste collection produces more usable energy, and gives rise to less fugitive emissions of methane than landfilling the food waste and capturing the landfill gas.

Municipal solid waste (MSW): Burning residual waste, after source separation or mechanical separation of recyclables, generates heat which can be converted to electricity (around 15 per cent efficiency), exported as heat, or exported as cooling to district cooling networks (as much as 80-90 per cent efficiency). Any incinerator must comply with stringent international regulations for air emissions. The use of electricity generated from waste may offset the use of coal, while the use of district cooling systems could potentially reduce the consumption of electricity associated with air conditioning.

The Government proposes to build the first of its integrated waste management facilities (IWMF) on a new artificial island off Shek Kwu Chau near southern Lantau[13]. Phase 1 of this facility will handle around 3000 tonnes of waste a day. In 2008, the government undertook Engineering Investigations and EIA studies. These estimated that the IWMF could export about **480GWh of electricity** (amounts to about 1 per cent of the total electricity consumption in Hong Kong). The study proposed "export of the surplus electricity to the existing power grid in Hong Kong so as to fully utilize this energy for the benefits of the community and the environment".

Organic waste: Waste is currently sent to three strategic landfill sites around the city (WENT, SENT and NENT) in the west, south and north of the New Territories. The landfill gas collected from the landfill site, arising from the decomposition of organic waste, is collected and either burnt for energy, or flared to prevent its emission into the atmosphere. Methane is twenty times more potent a greenhouse gas than carbon dioxide, as well as being explosive – flaring is a better option than fugitive emissions. There is a number of smaller closed landfill sites that are presently still producing utilisable gas which is largely being used for heat rather than electricity production. The closed site at Tseung Kwan O produces some power. The table below gives the amount of gas being produced, and the electricity that could be potentially generated. The total potential of 591 GWh/yr amounts to over 1 per cent of Hong Kong's energy demand.

Landfill site	Quantity of Gas Utilised (m^3/hr)	Annual electricity output (GWh/yr)
WENT	2917	128
SENT	3249	142
NENT	6415	281
Tseung Kwan O	903	40
TOTAL	13484	591

It is environmentally better to convert putrescent waste into biogas in purpose built bioreactors than in landfill sites. It is not possible to capture all the methane off a landfill site, especially true in landfill sites that have been retrofitted to capture methane. Bioreactors undertake the anaerobic digestion of food in a controlled environment allowing gas to be recovered, requiring less space, avoiding the production of toxic landfill leachate and avoiding blight in land values near the landfill site. They do however require the separate collection of food waste to ensure it is not contaminated with other forms of waste and their construction incurs higher capital costs. Bioreactors also face challenges in obtaining planning permission and the support of nearby residents.

The government has almost completed the construction of an organic resources recovery centre (ORRC)[14] and is in the process of building an additional 3-5. These are envisaged to handle around half of Hong Kong's food waste and the generated biogas will be used to produce electricity. In its report, the government estimates that the first of the facilities, which will handle 200 tonnes/day, will produce 14 GWh/yr of electricity for export after the plant's own power needs are met. If five facilities are built by 2022 as envisaged by the government treating 1800 tonnes/day they will generate around 126 GWh/yr, and treat around a half of the city's organic waste. This target reflects the government's perception that Hong Kong faces unique challenges in collecting separate organic waste from households. Hong Kong's high-density residential flats and excellent road system make it *well* suited to cost-effective domestic waste collection.

HK Productivity Council[15] together with the City University of Hong Kong has been researching smaller bioreactors that can be installed close to where the food waste arises. The technology produces three valuable products (biodiesel, biogas and a protein rich fishmeal). They differ from the ORRC in using two separate reaction chambers with selected microbes to ensure highly effective decomposition of the waste. The early trials suggest around 130-160m^3 of biogas per tonne of organic waste can be produced[16] with a 70 per cent methane content.

If all of Hong Kong's 3600 tonnes/day of current level of food waste were treated with such a technology, and the resulting biogas combusted in a simple gas turbine between **530 GWh/yr and 750 GWh/yr** of power could be generated from food waste. This would meet between 1.25 per cent and 2 per cent of the city's electricity need. The other valuable by-products from the process, biodiesel and fishmeal, are of significant commercial value defraying the costs of establishing a dedicated organic waste collection system. They also generate "carbon credits" by retaining carbon within the economy rather than releasing it into the environment. So far this technology has been trialled on a demonstration scale, but the proponents envisage facilities capable of handling 10 tonnes per day (about one twentieth the size of each ORRC). They estimate that the capital costs of the ten tonne scale facility are a tenth of the ORRC *per tonne capacity*, and the space requirements a third.

An interesting option might be for the small locally sited bioreactors using the HKPC approach supplemented the government's planned ORCC. An ambitious solution would be increase the share of food waste by actively collecting organic waste from homes and businesses as is common for governments in other countries. Government would also organise the establishment of small anaerobic digestion facilities close to communities to minimise extra vehicular movements. These smaller bio-generators would be well suited to small communities far from the large ORRC locations and might enable a high proportion of food waste to be collected and treated.

At the moment the ORRC Government arranges locations where they can be sited while small bioreactors do have to negotiate access and compete with other land uses. This means there is likely to be a sub-optimal use of smaller, local AD facilities,

Waste water: Hong Kong has 68 sewage treatment works situated in different watersheds downriver of population centres. Of these four have combined heat and power (CHP) installed to capture and combust sewage gas produced from secondary (biological) treatment of the waste water[17]. Together these plants treat 162 million m^3 of waste water which is 16% of Hong Kong's daily 1007 million m^3. The CHP units have a generation capacity of 3.6MW and produced 14 GWh of power in 2015-16. Treating sewage is an energy intensive process and Drainage Services Department currently consumer around 250GWh of electricity. The RE generated from sewage treatment will be used on site and reduce the need to import power.

The bulk of Hong Kong's sewage is treated at the facility at Stonecutter's Island. This has enhanced primary treatment rather than secondary (biological) treatment, so generates no sewage gas. Instead the solids are precipitated into semi-solid sewage sludge. Since no biological reaction takes place in enhanced primary treatment easily recovered energy remains locked in the sewage sludge. The sludge from Stonecutter's Island is conveyed by barge and road to the T-Park facility at Tuen Mun where a small amount of energy is extracted. The considerable heat is used to dry the sludge so it can be burnt, and the power is used to desalinate sea water to supply the steam turbine. The facility is equipped with a 2 MW generator and has the capacity to handle 2000 tonnes of sludge a day but is currently underutilised. No power is exported, but the facility is able to supply its own energy (and water) needs.

Other countries[18] also burn smaller amounts of residual sewage sludge but only after useful energy is first extracted from secondary treatment. Sewage sludge can also be burnt by co-firing in power stations, waste incinerators or cement kilns. The relatively homogenous sewage sludge produced after secondary treatment has little organic matter left and is rich in plant nutrients as well as being a good soil conditioner making it useful natural fertiliser. However, tighter concerns about heavy metals and other trace pollutants in sewage sludge mean that strict restrictions now apply on how the sludge can be applied to soil in many European countries. As a result regulations oblige water companies to burn some post-secondary treatment sludge once other options have been exhausted. Sewage sludge is a poor fuel because of its high water content and low calorific value.

If Hong Kong started to utilise its sewage more intelligently then we estimate that **100GWh** of electricity could be generated from sewage meeting 0.23% of the city's needs. By way of comparison the UK water company Severn Trent[19], which serves 8 million people, in 2014-15 produced 208 GWh of power from its sewage gas (much of it used on site). All of its sewage sludge is clean enough to be applied to soil and none is burnt.

CONCLUSIONS

The previous sections have developed estimates of the total potential RE that may be generated from Hong Kong based on bottom-up estimates of all the available resources. The figures use the most up-to-date research available externally. No external research was available on the potential for using reservoirs so WWF has calculated these itself. The figures for onshore wind have been excluded as the example in the literature was fairly provisional.

The table below shows the absolute total from each of different technologies described in the main report and expresses them as a ratio of current electricity demand and of the 2030 demand, by which time we hope electricity demand will have fallen. To avoid double counting we have assumed that food waste is diverted from landfill sites and instead provides the feedstock for small-scale anaerobic generators. Small scale AD is advocated because it provides similar amounts of electricity as gas burnt at landfill site, but avoids emissions of methane and also provides valuable biodiesel and fishmeal, so represents a better use of the waste food resource. We believe food waste could also be received by the ORRC network proposed by the government. There is scope for both technologies to complement each other – for instance the large centralised ORRC servicing districts where space cannot be secured for the smaller plants. The smaller plants can be used where it is uneconomic to arrange long distance food collection. Landfill will continue to receive some combustible renewables like plastic, which is not a renewable resource, and wood. This is excluded from the estimate.

We have also assumed, more controversially, that sewage treatment plants undertake secondary treatment of sewage to maximise the useful energy recovery. This would allow the sewage treatment works to greatly reduce their need to import power from the grid. The best use of the sewage sludge is then to apply it to land, in so far as food safety and hygiene rules permit. We advocate clean sludge being transported to agricultural land in Guangdong as a good *circular-economy* use of the valuable organic resource. T-Park should only be used for the disposal of post-secondary treatment sludge if no better use can be found.

The table below summarises our results in terms of the available resources, an indicative split of a 10 per cent target which is explained below, resource as share of 2014 demand and as a share of 2030 demand.

The resource column below provides an indicative breakdown of how a 10 per cent RE target for Hong Kong may be made up. It assumes that the cheapest and most "shovel-ready" resources are exploited first. This would include the planned incinerator (100 per cent of resource), food waste (50% of resource), remaining sewage treatment works (50% of resource), reservoirs (30% of resource), already characterised off-shore wind sites and 10% of other offshore wind sites with good potential and 10% of solar rooftops.

Our results imply Hong Kong has a substantial RE resource base. Large swathes of sea could be utilised for off-shore wind, and the land and reservoirs are lit by abundant sunlight. The renewable resources within Hong Kong's territory could, according to our assessment, meet half Hong Kong's current electricity demand and an even higher share of future demand if energy efficiency reduces usage. We do not believe it to be feasible, desirable or economically cost-effective to set such a high target. But we do wish to stress we do not have a shortage of resource; our shortage is of ambition.

About 6.9% of the resource is from exploiting rooftop solar. Including this resource means thousands of small scale producers each making small individual contributions. It means opening up access to the grid to small scale producers to accept decentralised energy. Important issues are raised about how these will be incorporated into the existing grid. Also investment planning by the two utilities need to reflect investment in distribution grids to allow two way flows of power, and decreased investment in new fossil fuel generation.

Energy from waste only makes a modest contribution of around 3%. But it is a relatively cheap source of RE and contributes to waste management goals too. A more joined up and entrepreneurial approach is needed to handling waste. This requires a mind-set change so Government sees organic waste and sewage as a valuable resource. The present focus has been to compartmentalise waste handling as an environmental treatment issue resulting in the building of huge and far-away infrastructure which are costly to build and costly to access and likely to be underutilised. More effort needs to be spent on Government arranging a financially viable collection system.

More detailed site level analysis will no doubt reveal there are practical difficulties in exploiting energy from all of these resources but they do suggest that the Government's estimate of 3%-4% availability as being highly conservative. We believe the 10% target to tough, but achievable. Many other countries have found that RE with the right policy framework grows faster than anticipated.

As well as these local resources Hong Kong, like all other major urban areas in the world, needs to increase the sourcing of renewables from its non-urban hinterlands in Guangdong and other parts of Mainland China as improvements in transmission are rolled out. Outside Hong Kong land is less scarce and there is scope for such imported renewables to greatly assist Hong Kong to further reduce its reliance on fossil fuels and make use of on-shore wind and hydro.

WWF advocates Government should adopt a 10% RE target for locally sourced renewables and ensures policies are in place to reward RE investors be they off-shore wind developers, Government departments with access to open land or waters, or waste handling companies.

Total resource base	Resource (TWh)	Indicative WWF target (TWh)	Resource as % 2014 demand	Resource as % 2030 demand
Solar				
Solar rooftops	2.66	0.27	6.1%	6.9%
Solar on suitable open land	2.88		6.6%	7.5%
Solar on reservoirs	3.95	1.3	9.0%	10.3%
Solar sub-total	9.5	1.6	22%	25%
Offshore wind				
Ninepin	0.5	0.5	1.1%	1.2%
Lamma	0.2	0.2	0.4%	0.5%
Other off shore wind sites in HK waters	10.7	1.1	24.3%	27.8%
Wind sub-total	11.3	1.7	26%	30%
Energy from waste				
Incinerator at Shek Kwu Chau*	0.5	0.5	1.1%	1.3%
Existing landfill sites		0.0	1.3%	0.0%
STWs with secondary treatment	0.0	0.0	0.03%	0.04%
Existing T-Park sewage sludge		0.0		
Extending secondary to other STWs	0.09	0.04	0.2%	0.2%
Anaerobic digestors for food waste**	0.64	0.32	1.5%	1.7%
Waste sub-total	1.2	0.9	3%	3%
TOTAL REE OR DEMAND (TWh)	22.0	4.1	43.9	38.3
TOTAL as % total demand		11%	50% ***	57%

* includes energy from burning plastic which is not truly renewable energy

** assumes using the small bioreactors developed by Productivity Council rather than the Government's planned large-scale organic waste anaerobic digestors. The two have similar electricity generating potentials. We recommend a mixture of the two technologies should be deployed

*** as proportion of 2014 demand

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HONG KONG'S RENEWABLE RESOURCE BASE

57%

The percentage of Hong Kong's projected 2030 electricity demand that could potentially be met by RE resources

6.9%

of the potential resource is from exploiting rooftop solar

10.3%

of the potential resource is from exploiting all available reservoirs

10%

The minimum domestically sourced RE target the government should establish for 2030

together possible.
攜手為人類及自然建立可持續的未來。
Together, we can create a sustainable future for humans and nature.

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(Incorporated in Hong Kong with limited liability by guarantee 於香港註冊成立的擔保有限公司)