Hong Kong's Solar PV Future: Stakeholder Perspectives

A Study Report

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Executive Summary

The urgency to reduce rising greenhouse gas emissions, address global climate impacts, and transition to a low-carbon energy system has never been greater. Once an expensive technology, solar photovoltaic (PV) has experienced rapid cost reductions in recent years. Such rapid changes have led to an upsurge of policy interest and deployment in major global cities such as New York City, London, Seoul, Tokyo, and Singapore, where major solar initiatives have been launched and plans and targets have been put in place.

Hong Kong has however lagged behind. As of early 2017, there are about 4 MW in total of solar PV installations, with many of them being demonstration projects. One of the latest government installations is the Drainage Service Department's solar installation at Siu Ho Wan Sewage Treatment Works (1.1 MW). To date, Hong Kong has yet to set a solar or renewable energy (RE) target. According to the Hong Kong Climate Action Plan 2030+ published in early 2017, the government has stated that the city has a realizable RE potential of 3-4% to the city's total electricity consumption by 2030 (Environment Bureau, 2017). It is an opportune time for Hong Kong to revisit solar PV as a meaningful energy option for our city.

This is a report on a study undertaken jointly by Hong Kong Baptist University, City University of Hong Kong, The University of Hong Kong, and Stanford University in 2016 and 2017. We aim to:

- To provide an **international review of urban solar policy developments** and good practice in New York City, London, Seoul, Tokyo, and Singapore, and a review of solar developments in Hong Kong;
- To identify and examine Hong Kong stakeholders' perceptions of **five major possible solar policies for Hong Kong**. These include Feed-in Tariffs (REFIT), Net Metering, Solar Leasing, Renewable Energy Certificates (RECs), and Renewable Energy Bonds (RE Bonds). We examine their understanding, attitudes, perceived drivers and barriers as they relate to these policies, as well as their willingness-to-pay;
- To develop **a scenario-based solar policy roadmap** for Hong Kong, and to **engage stakeholders in dialogue** and debate in a deliberative workshop;
- To develop **policy recommendations** for facilitating the development of solar policies in Hong Kong; and
- To develop an **online solar map** for Hong Kong – the first of its kind on the Greater China region – as an innovative way to educate and engage the public in solar policy development.

Based on approximately 100 face-to-face interviews, and two deliberative workshops which engaged approximately 60 participants, our project presents several key findings:

- Project participants generally supported Hong Kong to introduce solar policies, particularly the Renewable Energy Feed-in-tariff (REFIT), Net Metering, and Solar Leasing
- Around 55% of workshop participants supported the implementation of REFIT, Net Metering and Solar Leasing in the next 1 to 2 years
- Workshop participants' support for the implementation of REFIT, Net Metering and Solar Leasing increased after deliberation: Prior to deliberation, only about half of workshop participants supported the implementation of REFIT (n = 20), Net Metering (n = 21), and Solar Leasing (n = 25) in the next 1 to 2 years; and after deliberation, there was a modest increase in support for REFIT (n = 34), Net Metering (n = 29), and Solar Leasing (n = 33). People may become more supportive of controversial policies after intensive learning and deliberative processes, and when they are more informed and equipped to make thoughtful energy decisions
- Major barriers identified include the cost of long payback on solar PV, building-related technical and institutional barriers and potential "*solar controversies"*: one example is cross-subsidization
- About 80% of our project participants (n = 67) who were asked about their willingness-to-pay indicated that they were willing to pay about at least an extra 5% (i.e. $20, $50, $100, or expressed in terms of 5-20% more) of their monthly electricity bills to support solar power development in Hong Kong

Our findings have policy implications:

- There is public support and policy legitimacy for the government to take action and introduce solar policies (in particular REFIT, Net Metering and Solar Leasing) immediately to enhance solar PV uptake. This finding has policy implications particularly in the context of the Hong Kong Government's current exploration of introducing REFIT and RECs in the next Scheme of Control period with the utility companies
- Sufficient attention is required to engage the public about possible "solar controversies" and other equity issues
- Building-related regulations need to be reviewed so that they can be responsive enough to capture the potential benefits that solar PV can bring to Hong Kong
- Government, utility, business, and community-led actions altogether could capture the potential benefits that solar PV can bring to Hong Kong

This report is structured into four sections: project overview, methodology, key findings, and policy recommendations. We include supplementary information in the appendices.

1. Project Overview: Significance and Our Research Consortium

This project is significant in the following ways:

1. **Credibility and combined expertise**

   This project is a collaboration between three universities in Hong Kong (Baptist University, City University and The University of Hong Kong) and Stanford University in the US. The project team is interdisciplinary with expertise in energy policy, energy engineering, environmental economics, public engagement, and geographical information systems (GIS).

2. **Robustness in analysis**

   This project adopts a multi-method approach. Data were collected through desk-top study, face-to-face interviews, deliberative workshops, and pre-and post-workshop questionnaires. We utilize the multiple datasets to derive *combined insights* into the observed phenomena. The combined effect of these complementary dataset has enhanced the robustness of our analysis.

3. **Hear what the often "invisible" stakeholders say**

   This project involved 99 participants: 50 potential solar PV adopters who are house-owners; 19 sampled citizens from the general population, and 30 representatives from the commercial and institutional sectors. The views of solar PV adopters and the general public are generally given less attention in solar energy discussions in Hong Kong.

Figure 1. The research consortium in this project.

2. Methodology: A Multidisciplinary and Multi-method Research Project

This is an innovative project that adopts an interdisciplinary, multi-method research approach. We link qualitative analysis (desk-top research and in-depth, face-to-face interviews) with a quantitative methodology (a pilot deliberative polling (DP)) to collect participants' considered views on solar policies.

Our qualitative study investigated the deliberative interactions among three main stakeholder groups: Group A - prospective solar PV adopters (who are house-owners and own rooftops), Group B - Hong Kong citizens, and Group C - stakeholders from business and institutional sectors (who come from two local power companies, the aviation sector, property developers, etc). Quantitative data derived from our pilot DP provide insights regarding changes in, for example, people's support to different solar PV policies.

This project was conducted between January 2016 and March 2017, comprising two main phases – face-to face interviews, and the deliberative workshop.

In Phase 1 (June 2016-March 2017), following a desk-top study and an international review of urban solar developments, we conducted 99 semi-structured face-to-face interviews with stakeholders in Hong Kong. Our interviewees came from three different stakeholder groups, prospective solar adopters, ordinary citizens, and representatives from commercial and institutional sectors. Out of our 99 interviewees, 50 of them are "prospective solar PV adopters". This first group of interviewees are people who own a house and therefore have a rooftop. The second group of interviewees are 19 ordinary Hong Kong citizens. They were sampled from the general population in Hong Kong by a professional polling institution (The Public Opinion Programme) at The University of Hong Kong. The third group of interviewees came from the commercial and institutional sectors. These 30 interviewees came from power companies[1], the aviation sector, property developers, hotel sector, and schools. Each of these interviews was conducted by a trained interviewer, and took between 30 minutes to 2 hours. All interviews were conducted in face-to-face format, except for 8 interviewees, where interviews were conducted over the telephone upon request. All interviews were audio-recorded and transcribed, with the exception of 2 interviewees who declined to be recorded. Interview notes were taken instead.

In Phase 2 (November 2016), we invited all 99 interviewees to join the deliberative workshop titled "Deliberative Workshop on Solar PV Development in Hong Kong: Prospects and Policy Challenges" in November 2016. 57 of them accepted the invitation and attended our workshop.

This workshop was conducted using an innovative deliberative participation method called Deliberative polling (DP) trademarked by our collaborator institution, the Center of Deliberative Democracy (CDD) at Stanford University, which modifies conventional polling by integrating deliberative practices into traditional polling methods. Traditional polling methods have the limitation of being static, revealing only snapshots of public opinion while respondents are generally ill-informed. In contrast, quantitative analysis of

[1] Two interviewees represented local utility company A. They attended the workshop but did not take part in an interview. The team attempted to request for follow-up interviews, and local utility company A referred the team to the company's position for interview data.

the pre- and post-deliberation questionnaires of DPs can provide public opinion that is not only representative, but can also more accurately reflect the considered and informed opinion of the public process.

Our deliberative workshop is a pilot DP – while a full-scale DP usually requires at least 250 participants, our workshop had 57 participants. Two replicated half-day workshops were held on 4th (Friday) and 5th (Saturday) November 2016 to allow participants to choose to attend the one that best accommodated their schedules.

Our workshop was designed to incorporate several essential elements of DP. The project team sent a briefing document to all workshop participants several days before the event. The briefing document contains balanced information regarding urban solar developments in Hong Kong and other global cities, five possible solar policies for Hong Kong, and the Hong Kong Solar PV Roadmap. At the workshop, participants shared their views, debated, and clarified issues upon key themes critical to solar PV deployment in small groups and expert Q&A sessions. Participants also completed pre- and post-workshop questionnaires.

Please refer to Appendix 1 for supplementary information on the methodology; Appendix 2 for the face-to-face interview and workshop questionnaires (in Chinese); Appendix 3 for case studies of major global cities; Appendix 4 for the complete list of selected quotations that can be found throughout the report and their respective English translations[2]; Appendix 5 for workshop participants' evaluations of the workshop; and Appendix 6 for the briefing document (in Chinese) that was provided to all workshop participants several days prior to the workshop.

[2] Project participants are identified via a coding system. In group conversations, some codes are used more than once but do not necessarily indicate the same person across conversations.

3. Findings and Discussion

3.1. Key Finding 1: Our research challenges the general assumptions relating to solar power in Hong Kong

Like any developed city, Hong Kong faces numerous constraints in developing solar PV. Given the city's highly urbanized setting and low deployment of solar PV, it may be convenient to make certain assumptions about solar PV's prospects in Hong Kong. However, our project findings provide evidence that challenges these assumptions. Table 1 summarizes these findings, followed by elaborations.

Table 1. Summary of findings challenging general assumptions relating to solar PV in Hong Kong.

General Assumptions	This project found that…
It is okay not to consider solar in Hong Kong	• Global cities (e.g. New York City, London, Seoul, Tokyo and Singapore) have been proactively developing urban solar • Hong Kong is a laggard but it can also seriously consider solar as a meaningful energy option
Hong Kong people are not interested in solar power	• Solar can deliver economic and environmental benefits • Prospective solar adopters (e.g. residential or C&I) are motivated to install or planning to install solar; becoming prosumers
Solar is an expensive energy option	• Costs have significantly decreased and are forecasted to further decrease in the near future • Emerging business models may drive solar PV prices down
Hong Kong does possess the technical capabilities for solar	• Hong Kong does possess a number of technical capability and strengths in terms of pilot project knowledge and management, technical expertise, and standardisation
Hong Kong people do not want to pay for RE, including solar	• Around 80% of project participants (n = 67) who were asked about their willingness-to-pay indicated that they were willing to pay at least 5% (i.e. $20, $50, $100 or expressed in terms of 5-20% of their electricity bill) monthly to support solar power development in Hong Kong)
Utilities are reluctant to adopt RE, including solar	• Utilities generally welcome RE and do not perceive solar as posing a major threat to grid reliability nor profitability at its current development trajectory • Solar may have to overcome some challenges in Hong Kong's electricity market, such as its monopolized energy market, reliability as number one priority etc.

3.1.1. Assumption 1: It is okay not to consider solar as an energy option in Hong Kong.

What we found: There is an emerging global trend of rapid solar deployment in urban settings; Hong Kong needs to seriously consider solar as a meaningful energy option.

Many cities elsewhere have been active in developing solar PV. These include major global cities such as New York City, London, Seoul, Tokyo, and Singapore **(Figure 3; see case studies of each city in Appendix 3).** Singapore, a city often compared with Hong Kong in terms of global rankings, far exceeds Hong Kong in solar PV installed capacity. These trends also point to active political leadership, such as in opening up the domestic market and promoting new business models, so as to prioritise distributed RE such as urban solar. The data from our interviews also suggest that Hong Kong has to play its part as a globalised and developed city in combating climate impacts and should not be a laggard in urban energy policy.

RE is an option worthy of meaningful and serious consideration for Hong Kong. Locally, Hong Kong has an inherent need to integrate more RE into the fuel mix. For one, Hong Kong has to meet its own energy and carbon targets. Hong Kong has committed to realise 65-70% carbon intensity reduction targets (or 26-36% in absolute terms) by 2030 using 2005 as a baseline (Environment Bureau, 2017). And second, other available energy options, namely nuclear, natural gas, and hydro, face numerous limitations. While solar may have its own sets of limitations and constraints in Hong Kong's unique context, it may be one of the more advantageous energy sources. Solar power can also be an instrument for engaging citizens in RE development through prosumption and community solar projects.

3.1.2. Assumption 2: Hong Kong people are not interested in solar power.

What we found: Hong Kong people are quite interested in and do care about solar power.

Quote 1

我住在錦繡花園的，我不想付款支持綠色能源，但我想在綠色能源裏拿一些着數，我提出的方案是，我把我的屋頂租給一些投資者，我只收租，其他問題你幫我解決，包括地契公契，或者技術和後面一連串保養等，我只是收租。

R40 // 4 Nov Expert Q&A

All three stakeholder groups expressed interest in different approaches to installing and generating solar energy. These range from utility-scale deployment from both utilities to institutional actors such as the Airport Authority, all the way to the household scale from the environmentally-concerned village house owner. Their interest stems from mainly economic and environmental benefits (**Quote 1)**. Despite their interest however, the various limitations they encountered made it difficult to proceed further in installing solar PV systems. Some interests and concerns are sector-specific. Comparisons of these interests and concerns across the three groups can be found in 3.2 (Table 2).

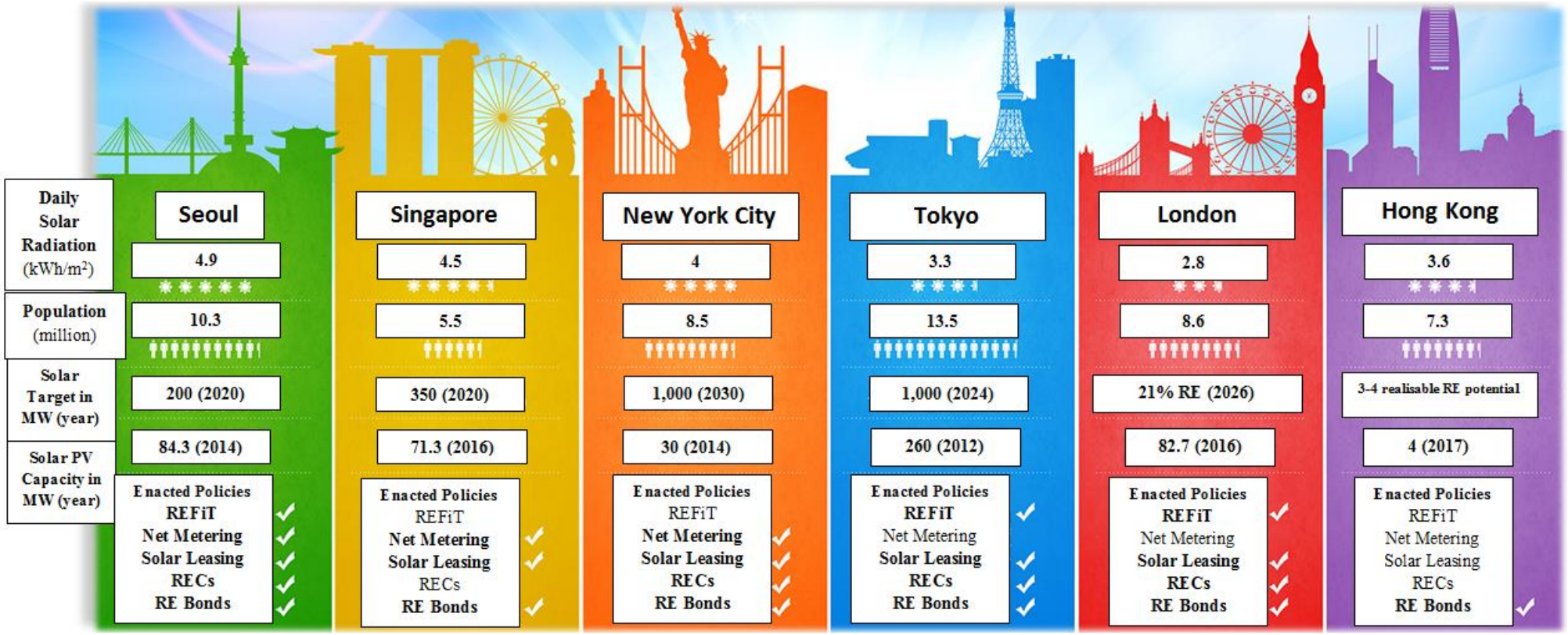

Figure 3. Overview of global cities and Hong Kong and their solar developments and policies (see details in Appendix 3).

3.1.3. Assumption 3: Solar is an expensive energy option for Hong Kong; Solar is not a cost-effective energy option for Hong Kong.

What we found: Globally, Solar PV has experienced rapid cost reductions in recent years.

Solar PV costs have gone down in recent years and could be further reduced as business models continue to evolve (see details in p. 4-6 in Appendix 6). Regionally, we border Guangdong province, and could potentially benefit from interconnected grids and price reductions in Mainland China.

3.1.4. Assumption 4: Hong Kong does not possess the technical capabilities for solar.

What we found: **Hong Kong does in fact possess solar resources, capabilities, expertise, and experience in cultivating a solar industry**.

Hong Kong receives sufficient insolation throughout the year (HKO, 2014) to support a more ambitious solar target. Some cities such as London, which receives less insolation than Hong Kong (Met Office, 2016), has been proactively developing solar PV. London has set a RE target of approximately 21% by 2026 (DECC, 2015; Mayor of London, 2015). Hong Kong currently has about 300 solar PV projects at various scales, ranging from street lamps, small village houses, to commercial buildings and government and institutional facilities (Environment Bureau, 2017). The government has also led on a number of notable projects, including the recent 1.1 MW solar farm at Siu Ho Wan Treatment Works which opened at end-2016. Since 2007, the Electrical and Mechanical Services Department has been publishing a comprehensive set of technical standardization guidelines on grid connection for RE systems (EMSD, 2016). Moreover, the Hong Kong Institute of Engineers has an "energy engineering" discipline that accredits engineers working in the field of energy.

3.1.5. Assumption 5: Hong Kong people do not want to pay for RE, including solar.

What we found: Hong Kong people may be willing to pay a higher tariff for RE, including solar.

In this study, about 80% of our project participants (n = 67) who were asked about their willingness-to-pay (n = 84) indicated that they were willing to pay about at least an extra 5% (i.e. $20, $50, $100, or expressed in terms of 5-20% more on their bill) of their electricity bills to support solar PV development in Hong Kong (See details in Key Finding 5). This finding falls in line with a previous local study conducted by Mah *et al.* (2012) on consumer perceptions on smart grid development, where over 80% of a representative sample of Hong Kong citizens (n = 505) indicated that they agree that they would like to purchase "green" electricity (e.g. electricity generated from RE) (Mah *et al.*, 2012). In terms of the tariff impact from generating electricity from RE, the Consumer Council conducted some preliminary modelling and suggested with 5% of local renewable electricity generation, tariffs would increase no more than 3% based on calculations using the European REFIT levy (Consumer Council, 2015). Details on Hong Kong people's willingness-to-pay can be found in Key Finding 5.

These results suggest that our participants from these groups were modestly willing to accept an additional charge on their monthly electricity bill for solar-generated electricity. However, interviewees and

participants also raised major concerns over issues of cross-subsidization, rate-setting, solar PV maintenance, and legality of these rooftop structures.

3.1.6. Assumption 6: Utilities are reluctant to adopt RE, including solar.

What we found: Utilities generally welcome RE such as solar PV. Solar may pose a lesser threat to utilities than initially thought.

Under a monopolised energy market and a priority of reliability of supply in Hong Kong, solar PV-generated electricity may not make a strong business case from a reliability perspective. Nonetheless, utilities may be interested in adopting RE such as solar PV for the following reasons: first, solar PV could be a potential energy technology in peak shaving of electricity load, especially during the summertime. Second, solar PV's impact on grid reliability is also relatively minor given Hong Kong's stable, reliable electricity supply, nor will its introduction pose a major threat to the profitability of utilities as the absorption of this amount is small relative to Hong Kong's overall electricity generation **(Quote 2)**. And third, utilities could introduce a more diverse range of electricity plans to end-users who prefer sourcing their electricity from RE **(Quote 3)**, particularly solar and to alleviate possible fossil fuel price spikes in the future for example, in natural gas that might otherwise risk pressure on tariff increases.

Quote 2

我想回應返，就算你們不斷裝，不斷裝，會超出我們的發電量的 1%的機會率很低，所以我們不會擔心你安裝得多，會影響我們的生意或令我們不能裝發電機，我想現時看不到這個趨勢。

EP 5 // 4 Nov Expert Q&A

Quote 3

其實係大戶嚟嘅，我一年用幾千萬度電咁，其實當我係一個大戶嘅時候我每年嘅電費都比緊兩三千萬咁，其實而家好多企業 Apple 咁樣啊，佢講到自己好 carbon neutral。可能企業佢有空間去製造一個 demand，我講到明我係用太陽能發電或者可再生能源，我願意每度電付出多一蚊。 咁我就製造咗一啲 demand 出嚟。咁個 demand 又真係好有 demand，好有需求，我要去購入既電力係黎自一個清潔能源嘅時候，咁咪製造左一個龐大市場囉。因為真係大戶先有能力做到個 demand 出嚟既時候，咁但係依家個市場上就唔存在我哋有得揀去選擇用咩能源。咁變相靠呢啲，慢慢靠啲村屋一塊一塊咁樣裝裝到下世都未有一個好大嘅 impact 去 drive 到一個 change。

CI 16 // 5 Nov Group C

3.2. Key Finding 2: There are diverse views within and across sectors on Solar PV options for Hong Kong

Interviewees revealed diverse views within and across sectors on solar PV options in Hong Kong. We highlight the spectrum of these views to provide some insights into some of these key issues, especially the more sensitive or controversial issues among different stakeholders. Taking these views into consideration may better help to engage the public and these stakeholder groups in the future.

3.2.1. Similarities across and within groups

Table 2 highlights the key motivations and concerns across the three stakeholder groups. All three groups shared common financial, technical and administrative, and social issues. These include long payback periods, high upfront costs due to labour costs which may cost up to half of total installation costs, building related matters that included lack of or competing use of rooftop spaces as well as technical and administrative hurdles (**Quote 4**), and equity issues concerning who will end up paying for solar-generated electricity.

Quote 4

其實我會認為我們之間討論了很久，討論了一些我自己來看，是關於錢和安裝的問題，其實共通的都是這些問題，其實會不會反而有一些政策，例如樓宇維修或樓宇安裝的一些政策上面去放寬，或在一些價格方面的政策，其實如果你解決了這些，便已經可以實行得到。

Group A Participant // Nov 4 Expert Q&A

All three groups agreed that the government must take the first step in solar PV development. This may take the form of taking leadership in installing solar PV panels on existing public buildings, or by implementing policies that can facilitate deployment (**Quotes 5 and 6**).

Quote 5

A1: 是不是應該由政府去補貼或由政府先行推行在某些公眾的地方，看台也好，行人路也好，休憩地方也好，在那些地方先行去實行一個…

A2：我同意 A1 的說法，除了政府應該首先推行外，它還應該有一個政策在多少年後…

Group A // 4 Nov

Quote 6

B1：…其實睇返全世界咁多個地方點解會成功呢？第一有政府帶頭…

B2：其實我好同意頭先一位小姐所講嘅嘢。首先由政府帶頭，我喺政府嘅建築物、學校、醫院、機場、政府大廈所有地方，你問屋宇署、消防處邊啲地方係可以裝到太陽能板嘅。行咗第一步先。

Group B // 4 Nov

Quote 7

C1: I think policy must be established and developed to facilitate the individuals to get into the market. I think I agree with the roadmap. Here we describe [the] feed-in tariff subsidy and the net production calculation, whatever, and the leasing market for the solar panel is encouraging to individuals. They don't need to invest upfront a lot of money. I think this is the basic thing we could start with.

C2: Yes, exactly, especially in Hong Kong….

C3:…If the government hope[s] for RE [to become a] certain percentage of overall electricity generation, let's say, not aggressive, say 1%, then they can have different sources of input, one is from utility-scale RE system, just like our solar power system. The second may be [from the] individual customer.

Group C // 4 Nov

On the solar policy roadmap, some participants from Group C on 4 Nov found agreement with other participants within the group, and elaborated on the possible scenarios (**Quote 7**). On the other hand, Group C on 5 Nov generally concluded that this roadmap may not work in the context of Hong Kong mainly due to its geographical constraints.

Table 2. Hong Kong stakeholders and their motivations, underlying reasons, and concerns on solar PV development in Hong Kong.

	Group A	Group B	Group C
Motivations/ underlying reasons	• Environmental benefits • Social benefits • Financial incentives • Green technology	• Environmental benefits • Even I don't have a rooftop, perhaps there are ways that I can contribute • Solar is a global trend • Global citizenship • Tech innovation may go beyond our imagination • Green industry	• Corporate impacts • Have a choice of electricity supply • Beliefs that the commercial sector (especially those large electricity consumers) can take the lead and created a sizeable domestic mkt demand • Green industries: HK as a solar innovator; Innovation & Technology Bureau • Social values: "knock-on effect" (on energy practices)– from solar to energy efficiency
Concerns	• High costs and long pay-back • Lack of/ competing uses of rooftops • Technical & administrative barriers (e.g. maintenance, hurdles imposed by management companies) • Social equity (cross-subsidization) • Negative environmental impacts of PV panels	• High costs and long pay-back • Lack of/ competing uses of rooftops • Technical & administrative barriers (e.g. maintenance) • REFIT - Tariff impacts & inequity (cross-subsidization) • Grid connection (technical and administrative feasibility)	• High costs and long pay-back (including battery back-up systems) • Competing uses of rooftops • Technical & administrative barriers (e.g. shading problem; high costs for applying structural changes – HK$20,000-30,000) • Low electricity tariff, limited motivation for solar • REFIT - Tariff impacts & cross-subsidization • Owners' Corporation (OC) of buildings, Management companies of multi-owned properties are a major hurdle

3.2.2. Diverse views within and among groups

Some notable themes emerged between groups. Group A particularly highlighted that even though they are quite motivated to get on board with the solar PV development phenomenon found across the world, they remain challenged by specific building-related institutional barriers such as the building regulations and strata management problems. Group B discussions surrounded the feasibility and potential generation of solar PV in Hong Kong. Group C discussed the potential of each policy in regards to the size of the domestic market demand, and Hong Kong's need to become a solar innovator.

In Group C, some participants disagreed about the approaches on how to initiate solar PV uptake: one participant thought utilities could play a larger role in leading the deployment whereas another participant thought private ownership and deployment should lead the way **(Quote 8)**.

Quote 8
C1:…我想你已經看畢這份文件，它是建議由電燈公司開始做起，完全是錯誤的。 其實應該由自己自發, 私人去做。 因為如果由電燈公司去做的話，成本一定高 。
C2: 這我有保留。
C1: 無錯，你電燈公司地方係多，因為所需要的人力，物力，一定比普通 commercial 為多 一定…
C2: 點會呢? 唔會囉。
C1: 所以，我覺得這點可有討論空間。

Group C // 5 Nov

(i) *Different opinions between Group A and Group B*

Group A participants were generally concerned about solar PV installation costs and technical issues, and building-related concerns **(Quote 9)**.

Group B participants were generally concerned about geographical potential and constraints of solar in contributing to Hong Kong's overall energy consumption **(Quote 10)** and who might be to be the first mover in solar PV development**.**

Quote 9
除了政策外，技術支援也是一個難題，剛才跟 EP 5 討論過，太陽能板需有一定的斜度，如一間 700 呎的房子，未必有空間放置太陽能板以及其安裝架，還有維修方面。其實當中涉及很多技術上的問題，一般市民是很難掌握到。如只有政策單方面推行以作方便安裝，但安裝時出現的技術問題需要有技術人員支援才可行。

R32 // 4 Nov Group A

Quote 10
就即係推動呢個太陽能呢佢自己嘅資料根本係睇到做唔到…最後去到 2012 年呢，大致上都係估計只有五點幾個百分比。開始就估計有三十幾個百分比，實際上仲有呢個 2012-2016 再會減會 downgrade 喎，咁實際上就冇乜用。

R57 // 4 Nov Group B

(ii) *Early adopters' Experiences*

Early residential and commercial adopters **(Quotes 11-14)** pointed out that aside from building related-technical and institutional barriers (see details in 3.6.), the lengthy payback period makes it challenging to achieve significant savings. These experiences demonstrate that addressing building related barriers or financial concerns are vital to solar policy development in Hong Kong.

Quote 11
我只是曾經在家自行安裝太陽能板，但是被管理處拒絕。因為我們那裏的樓有的是預建式，有的是自行建造。管理處應該是想減低風險，其實我自己也有研究過太陽能板，我知道不只是簡單地安裝幾塊板在天台就能發電，而是可能要把水、電、喉重新安裝。

R49 // 5 Nov Group A

Quote 12
其實如果單從利益方面來說， 無論怎樣補貼，也不能做到收支平衡。因為我已經在家中自行安裝了太陽能板，也曾把輸出的電輸送上電網。所以很多人問我，你回本了嗎？還是這個月的電費節省了多少？我可以告訴你，這是不可能的。 即使你指出在村屋的空間比較多，但是我們能把整個天台也變成太陽能板，還是把整個花園也變成太陽能板，你也不可能做到收支平衡。
所以如果從個人方面去看，我們的目標並不是要賺錢，所以政府提供的補貼並不是讓我們賺錢，而是鼓勵更多的人去進行太陽能發電。

R47 // 5 Nov Group A

Quote 13
… 其實我自己公司 office 的天台擺放了十個 kilowatts 的太陽能板，其實在個過程裏面，是一個很艱苦的過程，我是要找 structural engineer 去計數入則，我要同保險公司 傾，我特地找一個有天台的 office，好老實講我當一個 showcase，但我的保險費增加了很多…我是 encounter 了很多很多問題。

CI19 // 4 Nov Plenary 1

Quote 14
We have explored the potential of having solar panels installed at the airport…financially, they are concerned about the payback…without any financial subsidy, measures here, it is talking about over 40 years than their threshold. So relatively, they would rather invest in other energy saving measures that is more financially feasible… We are also looking forward to see if the government can offer some kind of incentives to make it feasible.

CI15 // 4 Nov Group C

3.3. Key Finding 3: There is wide support for REFIT, Net Metering, and Solar Leasing

3.3.1. Overview into Project Participants' Perception of and Support for Solar Policies

We tracked and compared the data of participants from interviews, and pre- and post-workshop questionnaires. We present the following key observations and summary findings:

(i) Support for five policies: Questionnaire data from pre- and post-workshop questionnaires suggest that participants were generally supportive of three solar policies: REFIT, Net Metering, and Solar Leasing;

(ii) More preferred policy options: Participant showed more support for REFIT, Net Metering, and Solar Leasing, and showed less support for RECs and RE Bonds;

(iii) After deliberation, participants' support for policies slightly changed:

- Support for REFIT and Solar Leasing increased after the workshop;
- An increase in public support for near-term/immediate policy action, as more participants supported that REFIT, Net Metering and Solar Leasing should be <u>implemented in the next one to two years</u>; and

(iv) The above findings highlight the importance of public engagement. People may become more supportive of controversial policies after intensive learning and deliberative processes, and when they are more informed and equipped to make <u>thoughtful</u> energy decisions. Support for Solar Leasing increased after deliberation. A plausible reason for such an attitudinal change may be because Group C participants perceived this as a less controversial option than REFIT.

Details for these key observations and summarised findings can be found below in 3.3.2., 3.3.3. and 3.3.4.

3.3.2. Awareness of the five policies

Interviewees' awareness of the five solar PV policies differed greatly between Groups A and B, and Group C **(Figure 4)**. 22% of Group A interviewees (n = 11) and 37% of Group B interviewees (n = 7) have heard of REFIT, but more than 80% of Group A and B interviewees have never heard of Net Metering, Solar Leasing, RECs and RE Bonds. All Group A interviewees (n = 50) have never heard of Net Metering, whereas 11% of Group B interviewees have heard of Net Metering (n = 2). Almost half of Group C interviewees (n = 13) have heard of all five policies. Most Group C interviews have heard of REFIT (85%), followed by Solar Leasing (77%) and Net Metering (64%).

3.3.3. Ranking based on priority - Face-to-Face Interviews

In our face-to-face interviews, our team explained each solar policy by showing a set of display cards to interviewees. We used overseas case examples to illustrate how they work and asked them to rank the priority of adopting them in Hong Kong **(Figure 5)**. This was followed by their justifications for the ranking.

In terms of high priority (4 and 5 combined), REFIT (n = 57) was ranked high priority, followed by Solar Leasing (n = 45) and Net Metering (n = 39). Whereas, for low priority (1 and 2 combined), RE Bonds (n = 50) followed by RECs (n = 72) ranked the lowest.

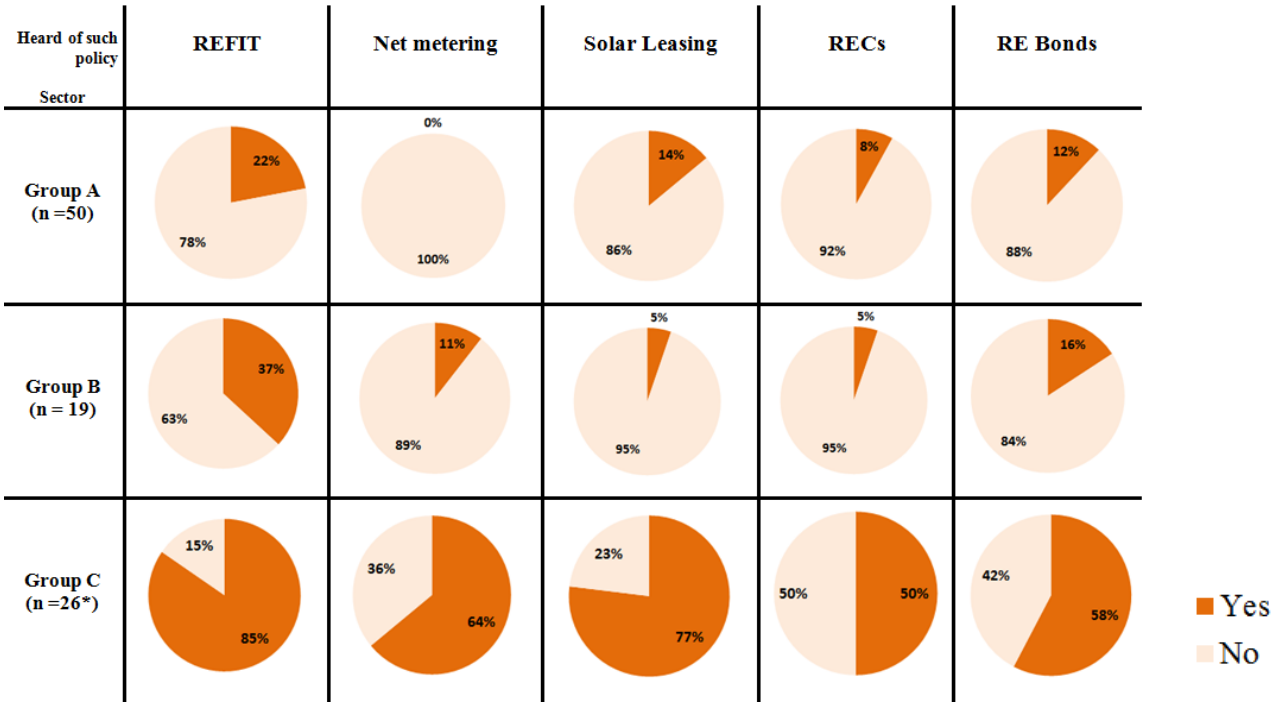

Figure 4. Interviewees and their awareness of the five solar policies.
*n = 25 for Group C's Net Metering.

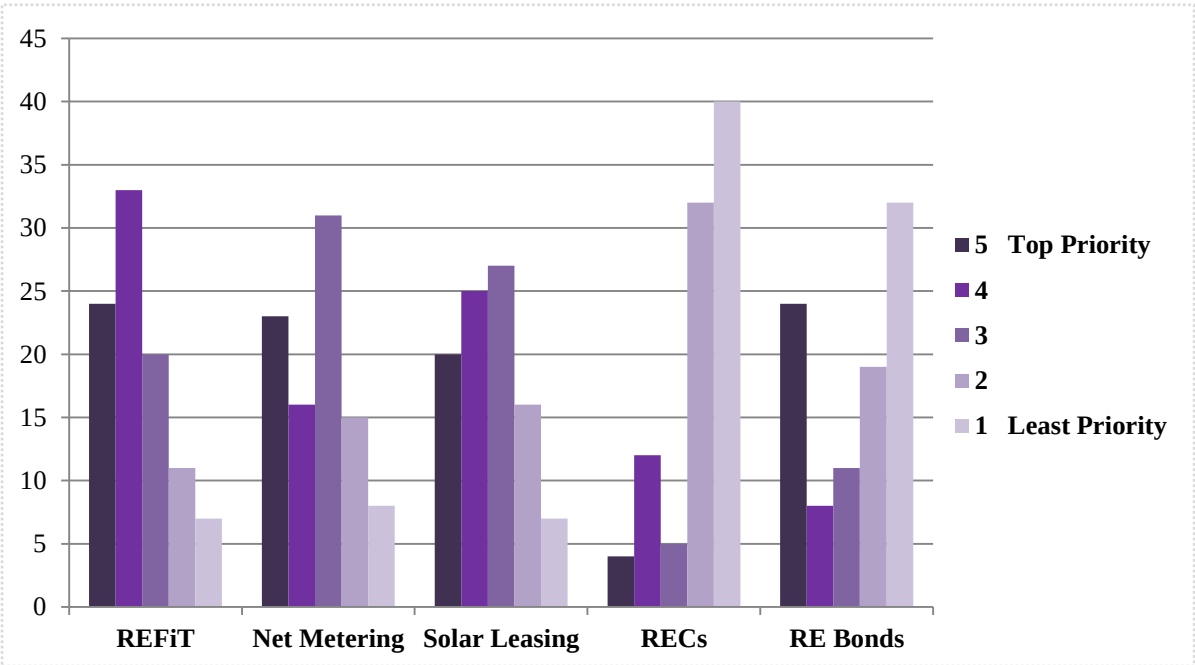

Figure 5. Interviewees and their ranking of priority for adopting solar policies in Hong Kong (n = 93-95).

Interviewees ranked REFIT as high priority because it can ensure policy impacts, lead to a substantial increase in solar PV installations, and due to its success in other countries, but it may also be controversial due to cross-subsidization. Interviewees ranked Solar Leasing as high priority because users can generate electricity from solar PV panels without owning the equipment or dealing with maintenance (**Quote 15**), and can ease the entry for solar PV adopters by lowering initial costs and making it more accessible to try out this technology. Interviewees ranked Net Metering as high priority and indicated that net metering is simple to carry out in terms of policy implementation, installation, and calculation.

While a majority of interviewees ranked RE Bonds as low priority, some that ranked RE Bonds as high priority stated that Hong Kong people's experiences with iBonds (**Quote 16**) and Hong Kong has a reputation in regulating financial transactions makes it easier for the general public to understand and accept RE bonds.

Many interviewees ranked REC as low priority, citing the policy's complication, difficulty for people to understand, Hong Kong's limited market, and its lengthy implementation period.

Quote 15
因為有個設施，方便喲，唔使自己處理，我只需要搵返相關公司佢就比到 services 我地，搞掂晒所有野。又唔使承擔風險，唔使擔心。
R09 // Interview

Quote 16
因為自從有 iBonds 之後，大家對債券認識多左，咁我諗都係錢問題。可能就算係唔話係為左可再生能源，只要有債券個名，都有人去買。買買下認識多左都會了解原來個債券係對可再生能源有用，咁 D 人先從中認識多 D 認同多左。然後先做到下一步嘅野。
R33 // Interview

3.3.4. Support for 5 possible solar policies – Deliberative Workshop

Workshop participants answered the questionnaire question, *"Do you support the introduction of the following solar policies in Hong Kong?"* before and after the workshop **(Figure 6)**.

Generally, workshop participants supported REFIT (*n* = 35-39), Net Metering (*n* = 42), and Solar Leasing (*n* = 38-40), while there was less support for RECs (*n* = 25-26) and RE bonds (*n* = 28-29).

Workshop participants' preferences slightly changed after deliberation. Support for REFIT (*n* = 35 to 39) and Solar Leasing (*n* = 38 to 40) increased.

Support for REFIT and Solar Leasing <u>across groups</u> changed after deliberation. Support for REFIT slightly increased for Groups B (n = 11 to 12) and C (n = 9 to 10), and slightly decreased for Group A (n = 16 to 15) **(Figure 7a)**. Strong support for Solar Leasing modestly increased in Group A (n = 5 to 11; **Figure 7b**).

These findings for support on solar policies are consistent with findings with the interviewees' priority of solar policies (see details in 3.3.3.).

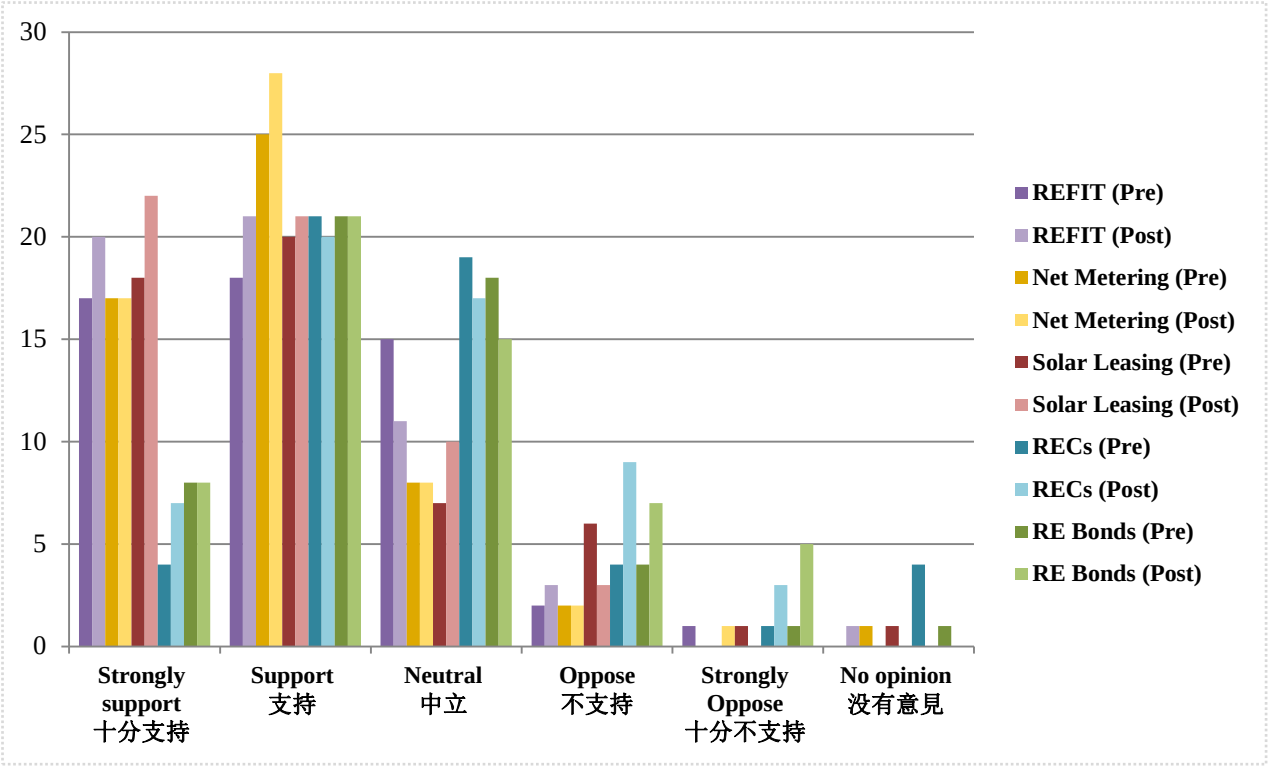

Figure 6. Workshop participants and their support for the five policies before and after the workshop (*n* = 53).

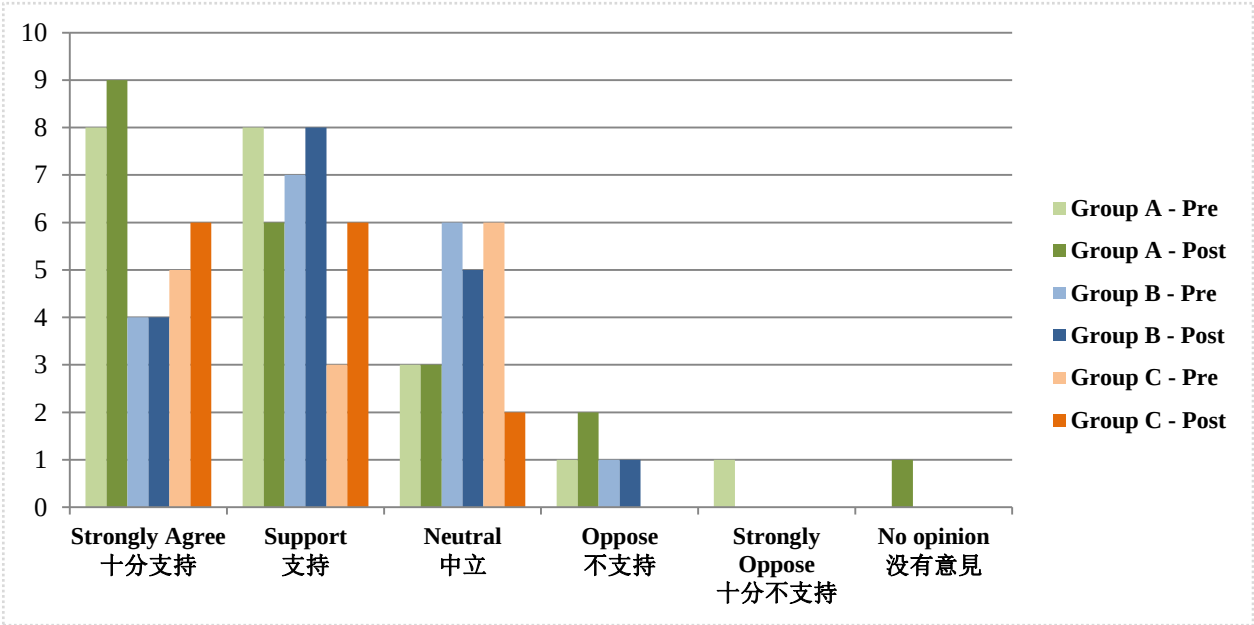

Figure 7a. Workshop participants by group and their support for REFIT (*n* = 53).

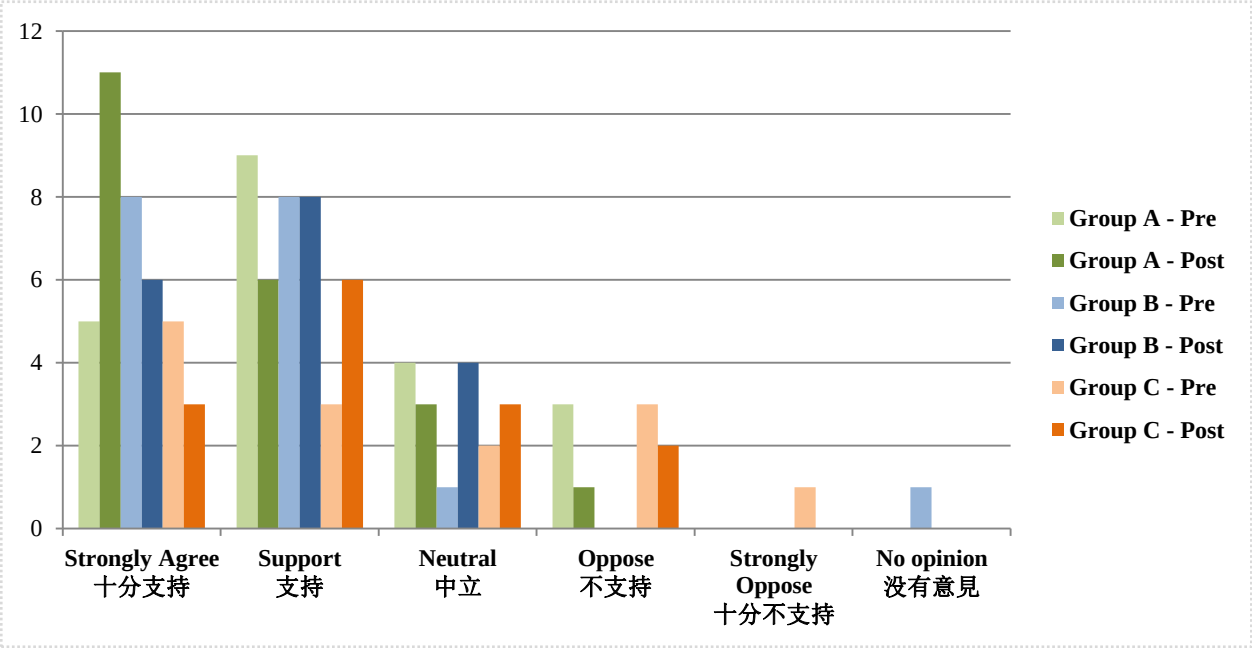

Figure 7b. Workshop participants by group and their support for Solar Leasing (*n* = 53).

3.3.5. Participants' support for variations of REFIT

We asked interviewees for their views regarding the variations on REFIT, Net Metering and Solar Leasing. We asked Group A and B interviewees only on variations of REFIT and Solar Leasing, while we asked Group C interviewees on variations of REFIT, Net Metering and Solar Leasing.

A majority of interviewees (*n* = 57) preferred variation 2 of the REFIT where not all electricity users are required to be surcharged for RE generation, and that the government would subsidise RE generation **(Figure 8)**. Some interviewees stated that compared with variation 1 of REFIT, where all electricity users would be surcharged for RE generation, variation 2 may be less controversial and have less tariff impact on vulnerable, low-income households.

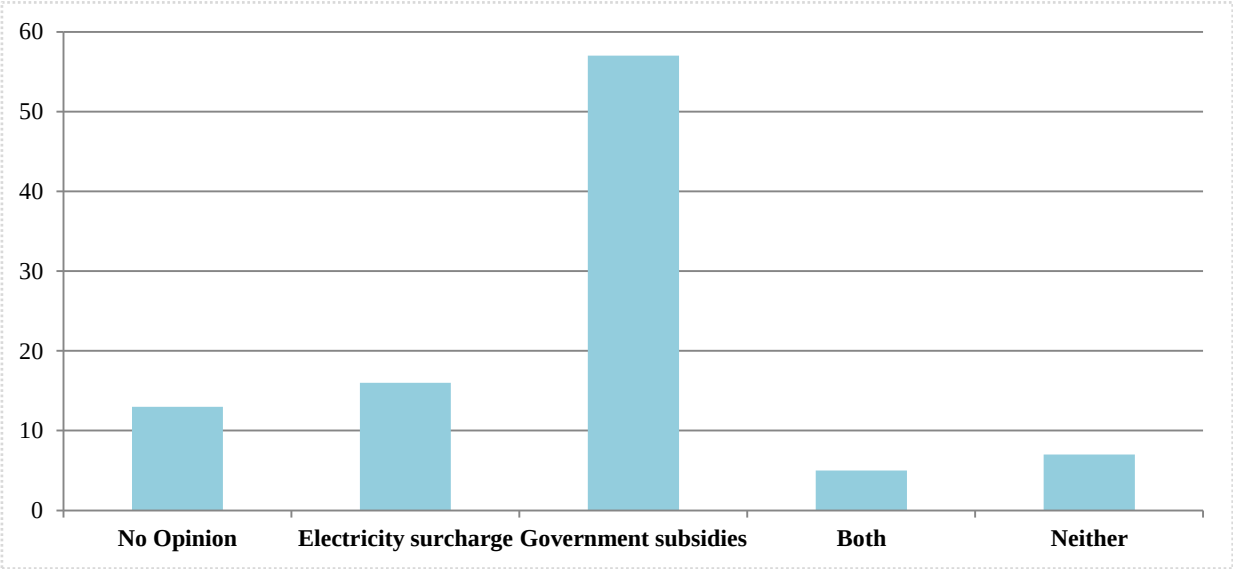

Figure 8. Interviewees and their responses to the policy variation to REFIT (*n* = 98).

3.4. Key Finding 4: Views on the Hong Kong Solar PV Roadmap: Preference for Immediate Action on REFiT and Solar Leasing

On the pre- and post-workshop questionnaires, workshop participants were asked, *"Do you think the Hong Kong government should introduce the following solar policies in the near future?"* by implementation period **(Figure 9)** based on their assessment and discussion of the Hong Kong Solar PV Roadmap (Please refer to page 22 of Appendix 6).

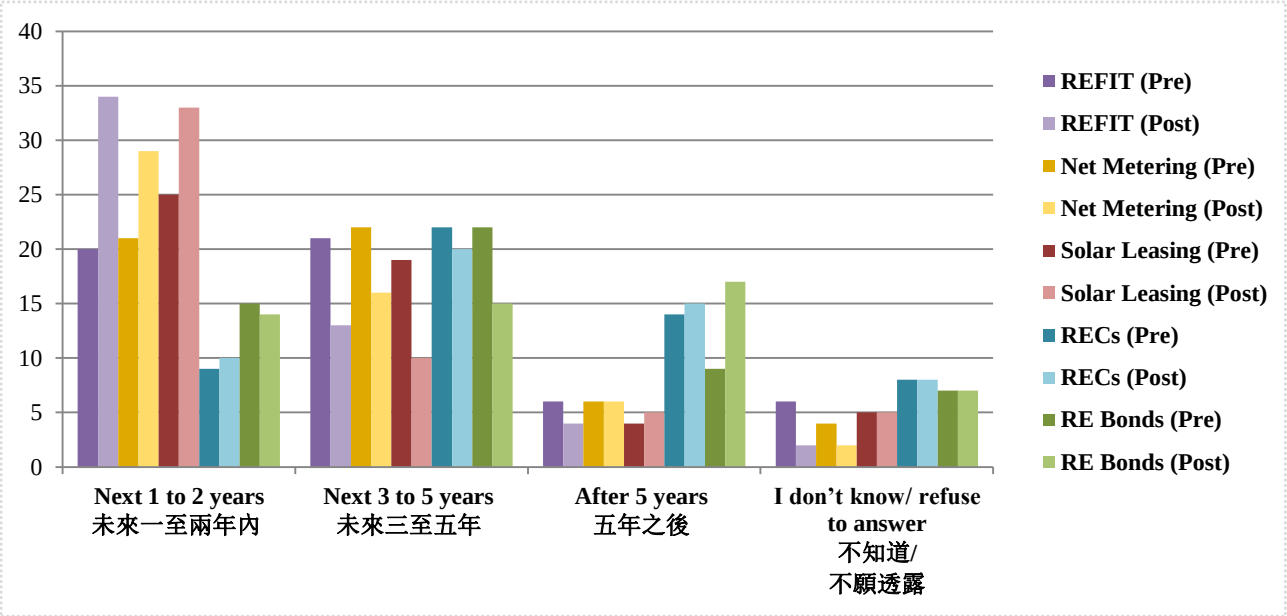

Figure 9. Workshop participants and their support of solar policies by implementation period (n = 53).

Workshop participants' support for the implementation of REFIT, Net Metering and Solar Leasing within the next 1 to 2 years increased after deliberation: prior to deliberation, only about half of workshop participants supported the implementation of REFIT (n = 20), Net Metering (n = 21), and Solar Leasing (n = 25) in the next 1 to 2 years. After deliberation, there was a modest increase in participants who supported the implementation of REFIT (n = 34), Net Metering (n = 29), and Solar Leasing (n = 33) in the next 1 to 2 years. This is found to be consistent across all stakeholder groups (with the exception of Group A on net metering).

These findings have policy implications. Our findings suggest that there is public support and policy legitimacy for the government to take action and introduce solar policies (in particular REFIT, Net Metering, and Solar Leasing) immediately to increase up solar PV uptake. This is very relevant in the context of the Hong Kong Government's current exploration of introducing REFIT and RECs in the next Scheme of Control period with the utility companies (Environment Bureau, 2017).

Participants who discussed RECs seemed to have mixed views on its implementation in the short and medium term, and also its usefulness in promoting solar development unless it is linked to the Chinese market. Although RE bonds are used elsewhere in the world, some participants seemed sceptical about the returns of such investments and would need to see evidence that satisfactory returns can be generated.

3.5 Key Finding 5: Hong Kong people are generally willing to pay to support development of solar power in Hong Kong

Generally, project participants are willing to pay for solar-generated electricity.

Around 80% of project participants (*n* = 67[3]) indicated that they were willing to pay at least 5%[4] (i.e. $20, $50, $100 or expressed in terms of 5-20% of their electricity bill) more each month to support solar power development in Hong Kong. This finding falls in line with a previous local study conducted by Mah *et al.* (2012) on consumer perceptions on smart grid development, where over 80% of a representative sample of Hong Kong citizens (*n* = 505) indicated that they agree that they would like to purchase "green" electricity (e.g. electricity generated from RE) (Mah *et al.*, 2012). This may also be a good reference point to determine the rate of the REFIT, as previous preliminary modelling work conducted by the Consumer Council suggested that at 5% of local renewable electricity generation, tariffs would increase by no more than 3% based on calculations using the European REFIT levy (Consumer Council, 2015). However, further studies that take into account of a representative sample of the Hong Kong population and demographics are needed to find out how much Hong Kong people are actually willing to pay for solar-generated electricity.

> **Quote 17**
>
> 100 蚊，50 蚊都得嘅。因為如果係你對個環保有幫助你都要付出嫁啦。
>
> **R35 // Interview**

Over 75% of Group A and B interviewees (*n* = 51 out of total 68) were willing to pay at least 5%[4] monthly (i.e. $20, $50, $100 or expressed in terms of 5-20% of their electricity bill) to support solar power development **(Figure 9)**, generally citing environmental concerns and the need to initiate solar development **(Quote 17)**. Those who were not willing to pay cited many reasons, some of the most common being that i) government should pay; ii) current electricity tariffs are already high; and that iii) they are not the ones using solar-generated electricity **(Quote 18)**.

> **Quote 18**
>
> 不願意。宜家都好貴嫁喇，仲要比? 支持太陽能發展姐，宜家講緊全香港人用太陽能咁就可以比。但宜家唔係全香港人都用到，而我享用唔到我就緊係唔制。如果係講緊呢 D 太陽能板係可以供到比全香港用戶，我比 100 蚊就可以。但如果係純粹 for D 有得用太陽能板嘅人，咁我就唔可以。全香港人去補貼一少眾人，咁就唔得。
>
> **R11 // Interview**

Over 85% (*n* = 46) of workshop participants were willing to pay at least 5%[4] monthly (i.e. $20, $50, $100) to support solar power development **(Figure 10)**. Prior to deliberation, almost 45% (*n* = 23) of participants were willing to pay around $50/month to support solar power development. After deliberation, there was a slight shift from those willing to pay $20 and $50 to around $100/month.

[3] Only 84 out of a total of 99 project participants were asked of this question either during the interview (n = 28; for non-workshop Group A interviewees) or at the workshop (n = 56; all workshop participants). Post-workshop questionnaire responses were used to capture where project participants stood on their willingness-to-pay to support solar power development after deliberation.

[4] Assuming that the average electricity consumption of a Hong Kong household is about 380 units per month (EMSD, 2017), 5% of their monthly bill would be **HK$16.91** for a CLP household ($0.89/unit), and **HK$17.48** for a HEC household ($0.92/unit).

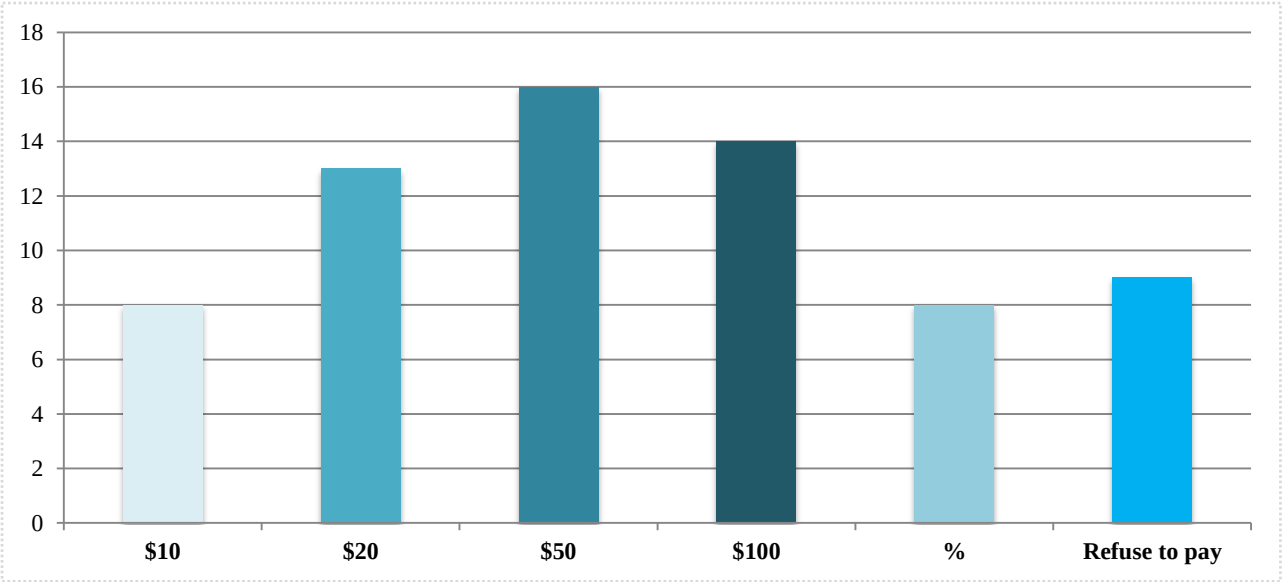

Figure 9. Interviewees and their willingness-to-pay for solar-generated electricity (*n* = 68).

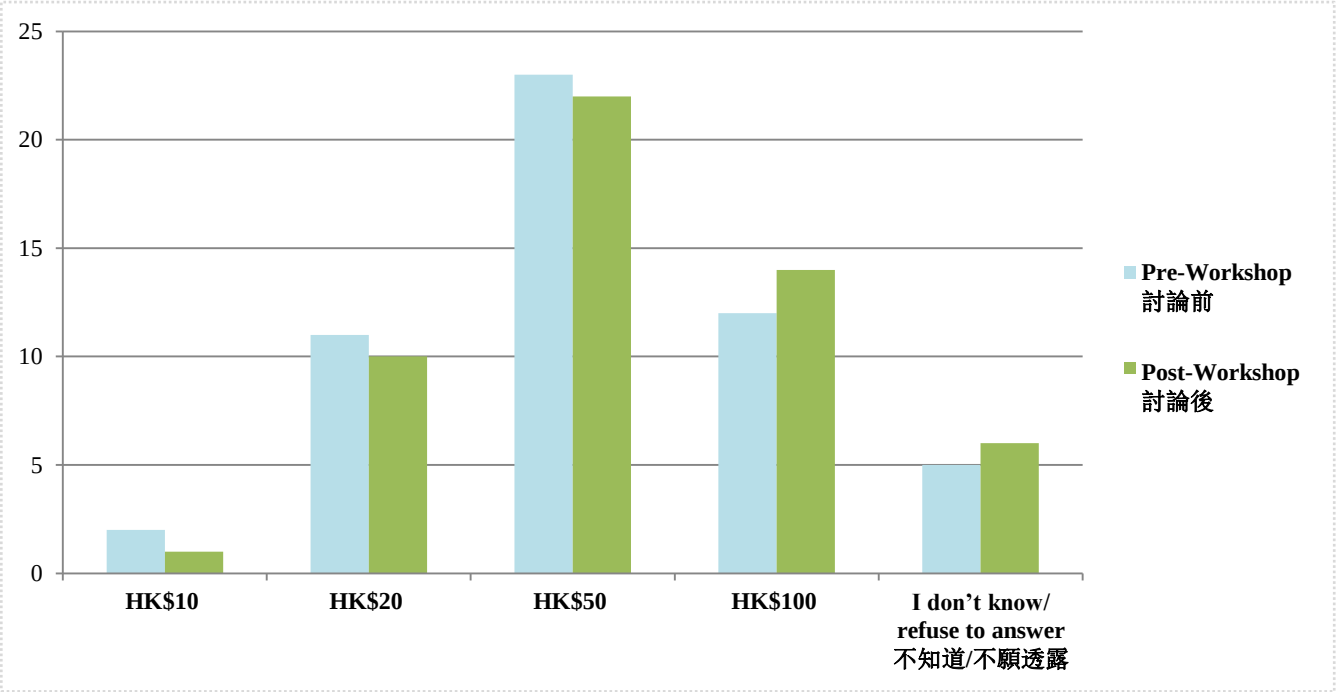

Figure 10. Workshop participants and their willingness-to-pay for solar-generated electricity (*n* = 53).

3.6. Finding 6: While solar PV deployment is possible, many challenges and unknowns remain to be overcome and identified

In addition to geographical challenges due to lack of available rooftop in Hong Kong and cost concerns, we found that building-related technical and institutional barriers, and lack of government action to major challenges. Other unknown factors remain and may need to be identified in future studies.

a) Building-related technical barriers

Building-related technical barriers generally centred on the building type, the rules placed by the management of the buildings prohibiting installing of solar PV panels, and high costs of making plan submissions for exemptions of these installations. One of the workshop expert panellists suggested that as part of Minor Works (e.g. structures which can be exempted from applications for Plan Submission (不用入則)), the government should raise the maximum height for erected solar panels to no more than 2.0 meters rather than the existing 1.5 meters[5] above the rooftop to encourage more installations.

Participants also raised other technical concerns, such as maintenance of solar PV panels, such as the availability of technicians and their costs to conduct this work. Some participants raised concerns regarding the lack of grid connection. Although the solar PV system is fairly simple if it is off-grid, one participant tated that once the system becomes connected to the grid, the system may require a battery and that would mean additional expenses.

b) Building-related institutional barriers

Building-related institutional barriers also prevented solar development. Some participants specified Management Companies and Owners' Corporation (OC) of buildings and multi-owned properties **(Quote 19)** are one of the key actors in creating institutional barriers.

Quote 19

我想阻力主要來自物業管理公司， 或者來自法團…係管業處既原則或者立案法團裏面嘅人覺得呢樣嘢有利益或者影響到全座，我諗呢個係最主要嘅問題。

EP 5 // 4 Nov Expert Q&A

First, rules set around the safety and classification of additional structures make it difficult to legitimize solar panel installations. Fairview Park (錦綉花園) and Hong Lok Yuen (康樂園) have about some 5,000 and 1,000 households respectively and represent major potential sites for community-scale solar. Management companies in these estates however, have set up management rules that literally prohibit household solar.

Fairview Park house-owners have stated that some houses were built by pre-fabrication and that the management company and house/land deed prohibits any structure to be put on rooftops. Even when some house-owners tried to install them, the Management Company had requested that they be removed. In the

[5] http://www.bd.gov.hk/english/services/index_mwcs_items_c17.html

case of Hong Lok Yuen, theoretically a household can make an application for plan submission, but the high cost of hiring a specialist to do so is a disincentive.

Other issues were raised about the classification of solar panels under the Building Ordinance, especially with the handling between homeowners and Management Companies regarding the restriction to install solar PV panels due to fire or typhoon hazard, and the permission to install such structures due to land deed restrictions.

c) The lack of government policy on solar and long term horizon for energy planning

The workshop brought up two particular aspects directed at Hong Kong government's efforts on solar energy planning: the first was the lack of an explicit target and policy made it difficult to jumpstart larger-scale deployment of solar PV systems. The second was the lack of government leadership in setting a clear policy direction in planning.

Participants and utilities agreed that the government should set an explicit RE target. Some participants stated that these should be made in conjunction with a future fuel mix, carbon targets, and supportive policies. There should also be robust review mechanisms to ensure policies are up to date with technological advances every two to three years. Moreover, interviewees suggest that the government can provide financial support through, for example, REFIT subsidies (see details in 3.3.5. in Key Finding 3).

The government could see real differences in solar PV deployment if it set clear solar policies. First, government cross-department collaboration could help address some of the building-related technical and legal problems (e.g. solar panels as illegal structures). Second, a clear position on solar could facilitate ongoing discussions with both utility companies. And third, government policies could ease some of the entry barriers, such as the payback period so that prospective solar PV adopters can become prosumers.

d) Potential social impact: equity issues across sectors of society

The workshop and interviews revealed some of the potential impacts on different stakeholders (Details are provided under Policy Recommendations). One of the reoccurring issues that emerged in this project was the issue of cross-subsidization, which would leave the rest of society having to pay extra on their electricity bills to finance the few who would reap the benefits from having solar PV panels on their rooftops.

Cross-subsidization may also affect different segments of society, particularly vulnerable, low-income households. Even though energy savings rebates are available through the two utilities, relatively less is known about who are and the number of vulnerable, low-income households, and how to address their concerns while aiming to increase the share of RE in the fuel mix.

3.7. Key finding 7: Changes in attitudes before and after deliberation

We examined the attitude changes of workshop participants on questions before and after deliberation. These findings lend support to and confirm that deliberation through the use of the DP method in this workshop can be an effective means to engage participants to discuss key issues surrounding Hong Kong's solar PV development.

3.7.1. Learning of background material and development of new perspectives on solar in Hong Kong

This workshop effectively promoted the participants' learning of material, and enriched their perspectives on solar PV development in Hong Kong.

Participants reported the extent they had read the briefing document provided several days before they attended the workshop. Over 90% of workshop participants (n = 49) read all or more than half of the materials **(Figure 11)** and over 80% of respondents (n = 43) agreed that the briefing document presented competing arguments fairly (see details in appendix 5).

To validate the participant's knowledge of the read materials, the pre- and post-questionnaires asked each of them about how much solar-generated electricity contributes to Hong Kong's total electricity use. Over 80% (n = 44 pre-workshop; 45 post-workshop) answered correctly **(Figure 12)**. Moreover, over 90% of participants agreed that they acquired new knowledge and perspectives into Hong Kong's solar development. 88% of participants agreed that they changed their views after undergoing deliberation **(Figure 13)**. '

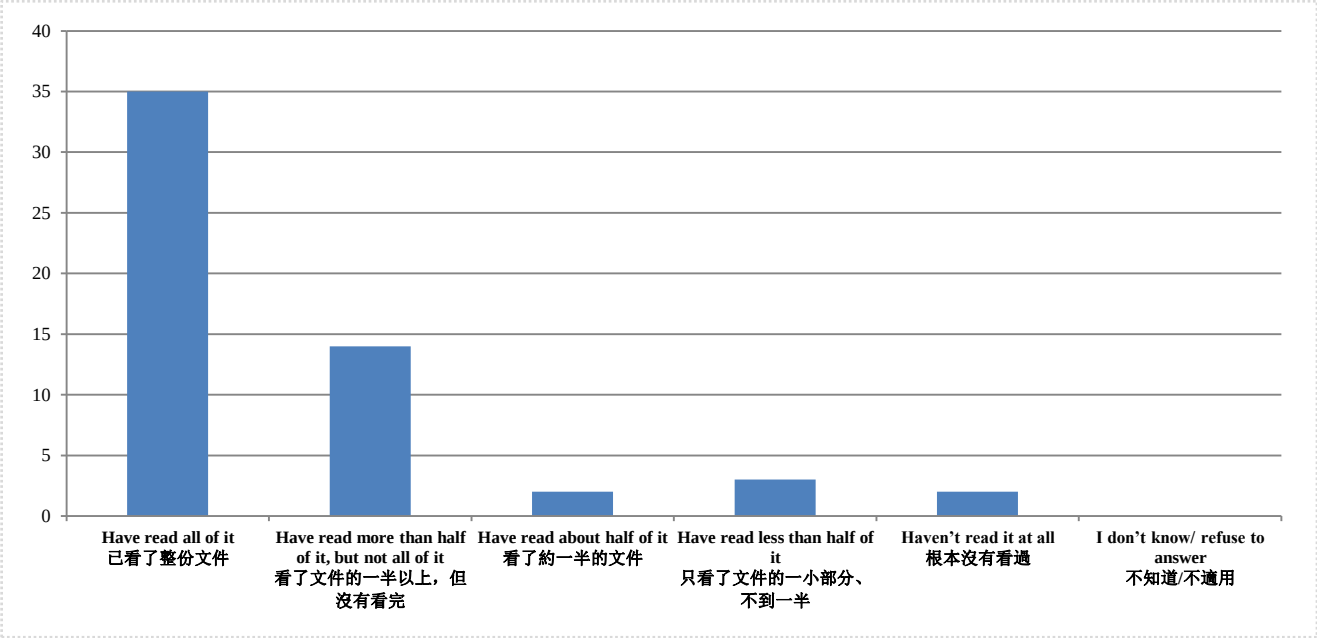

Figure 11. Workshop participants and the extent of their reading of the briefing material (*n* = 53).

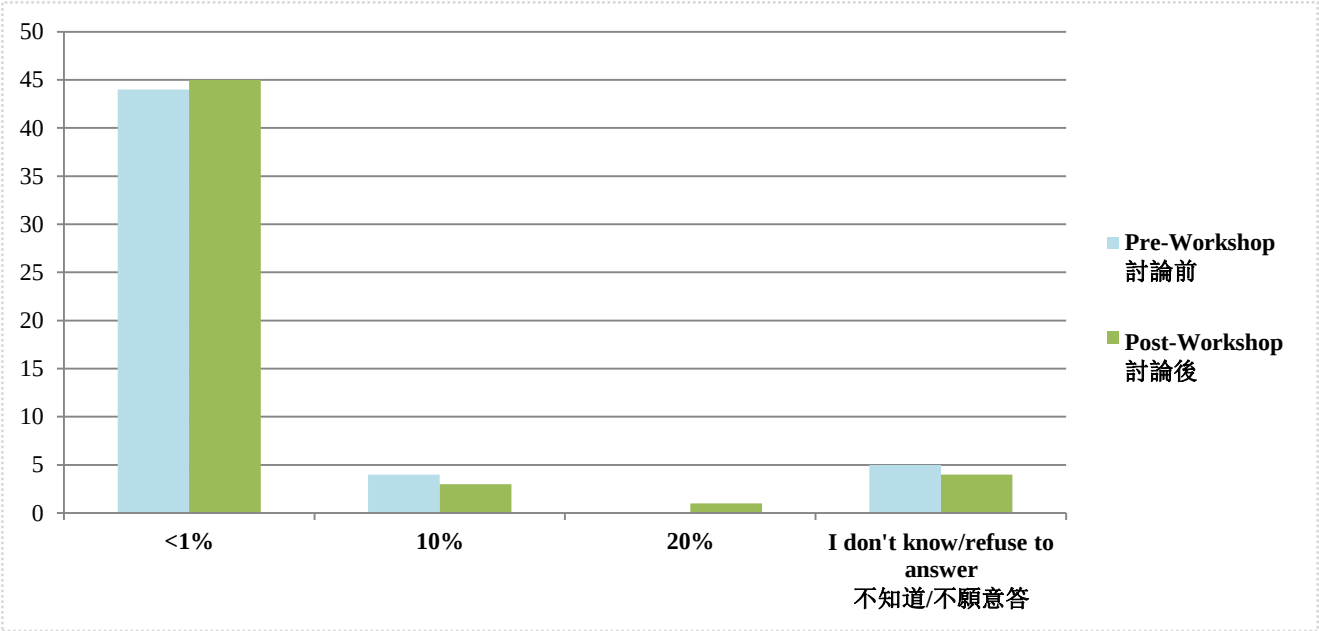

Figure 12. Workshop participants and their response to the amount of solar power in HK's total electricity use (*n* = 53).

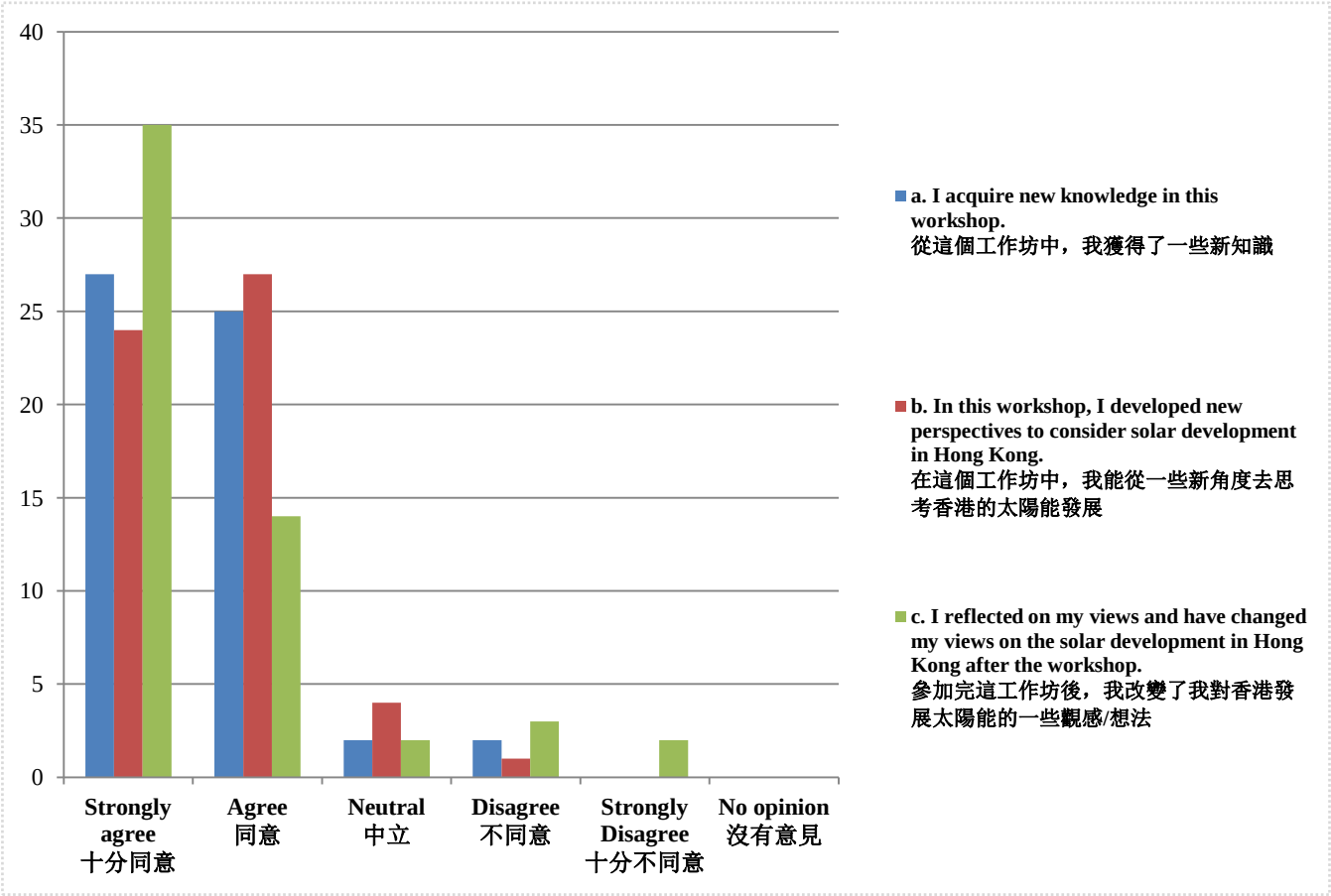

Figure 13. Workshop participants and their reflections on their learning experience from the workshop (*n* = 53).

3.7.2. Support and Reasons for Solar in Hong Kong's energy mix

Before deliberation, most workshop participants (*n* = 50) agreed with the statement *"Solar energy should be part of the energy mix in Hong Kong"*. After deliberation, almost all workshop participants agreed with this statement (*n* = 52) **(Figure 14)** with the view of one Group A participant remaining unchanged.

Among workshop participants who agreed to the above statement, we asked for three plausible reasons for why they would agree to this statement, namely in reducing GHG emissions (**Figure 15a)**, enhancing energy self-reliance (**Figure 15b)**, and creating green jobs **(Figure 15c)**. Prior to the workshop, over half of workshop participants strongly agreed or agreed that the reason for adopting solar into Hong Kong's energy mix is to reduce GHG emissions (*n* = 46), enhance energy self-reliance (*n* = 32) and create green jobs (*n* = 34). After deliberation, the total number of participants who strongly agreed or agreed for reducing GHG emissions slightly increased (*n* = 50), and modestly increased for enhancing energy self-reliance (*n* = 37) and creating green jobs (*n* = 47).

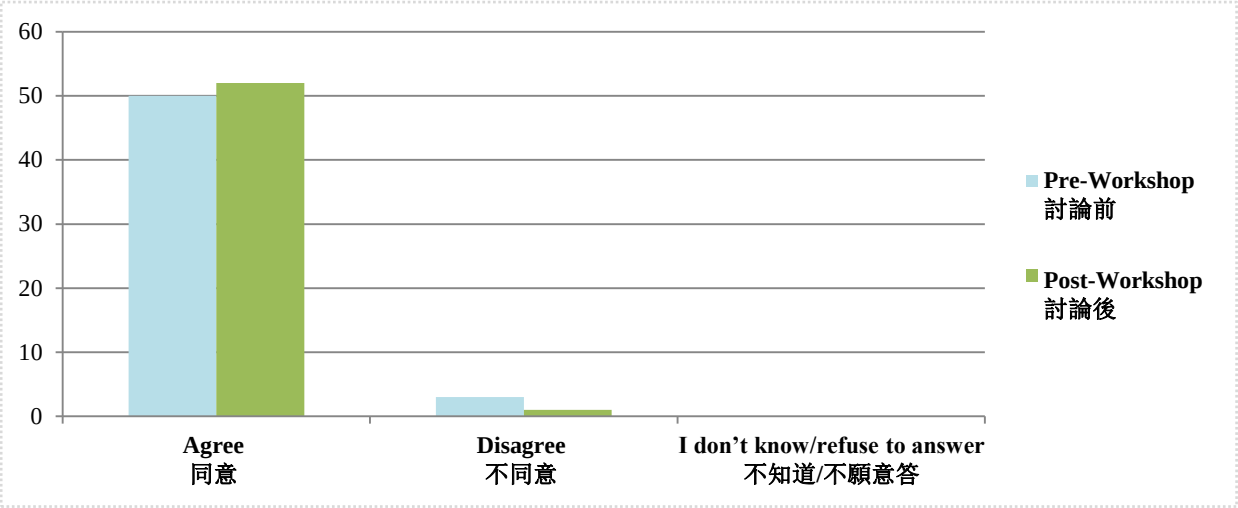

Figure 14. Workshop participants and their response to whether solar should be part of Hong Kong's energy mix (*n* = 53).

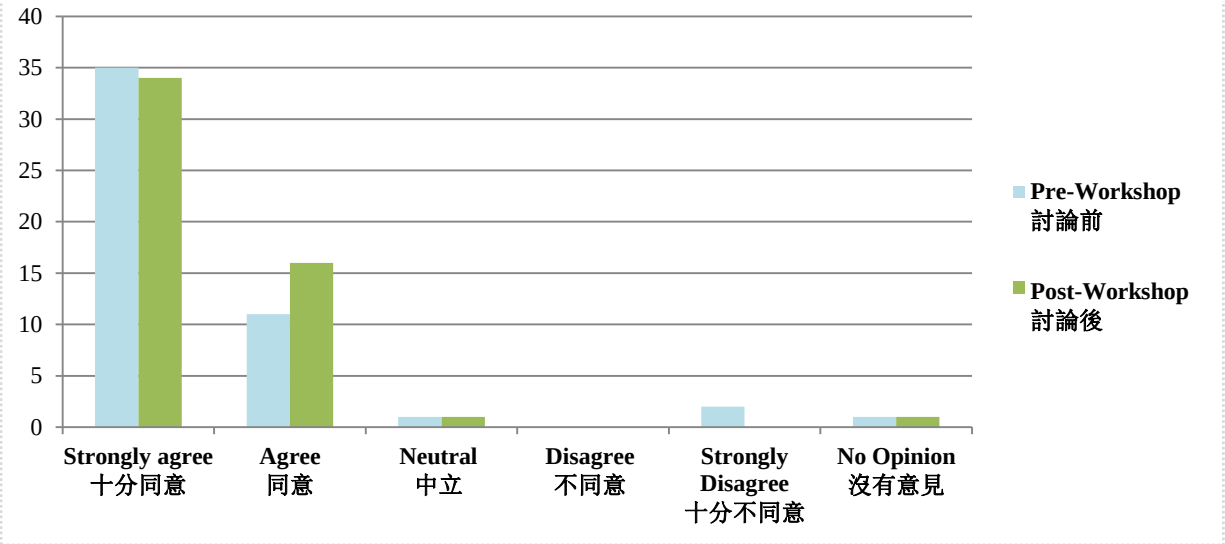

Figure 15a. Workshop participants and their reason to include solar as part of the energy mix because it can reduce GHG emissions (*n* = 52).

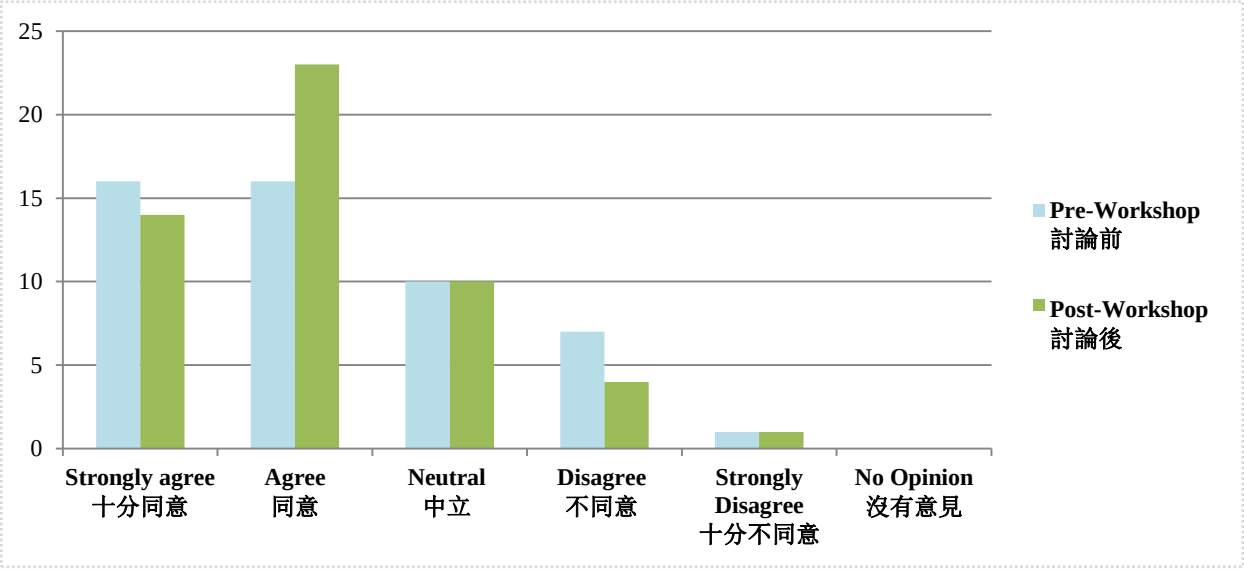

Figure 15b. Workshop participants and their reason to include solar as part of the energy mix because it can enhance energy self-reliance (*n* = 52).

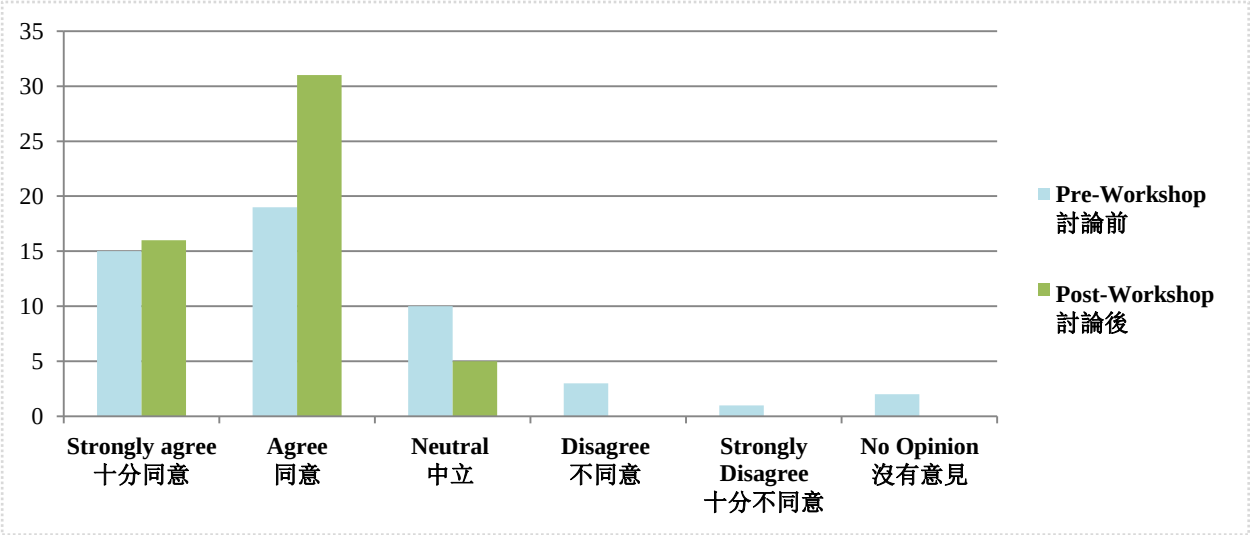

Figure 15c. Workshop participants and their reason to include solar as part of the energy mix because it can create green jobs (*n* = 52).

3.7.3. Workshop Participants' Evaluations of the Workshop: Summary of Findings

Below is a summary of the findings from evaluations of workshop participants on evaluations of the workshop (Figures and details can be found in Appendix 5):

On the overall workshop and workshop sessions:

- *85% of participants (n = 46) agreed the workshop as a whole helped them understand the subject matters.*
- *75% of participants (n = 40) agreed that the small group sessions as being useful for helping participants develop understanding of the issues.*
- *56% of participants (n = 30) agreed that the expert Q&A sessions addressed the questions raised by groups.*

On Small Group Dynamics:

Small groups provided equal opportunity for small group members to join the dialogue.

- over 85% agreed that small group members were provided equal opportunity to participate (n = 50), and participated equally (*n* = 46)
- About (*n* = 31) 58% disagreed that small group discussions were dominated by a few members

Small group moderators remained mostly impartial and ensured opposing arguments were considered.

- Almost 80% (*n* = 42) agreed that moderators ensured opposing arguments were considered
- Over 65% (*n* = 35) disagreed that they tried to influence the group with his or her own view

4. Hong Kong Solar Map

One of the objectives of this study is to develop an online solar map for Hong Kong. By integrating expertise in geographical information systems and energy policies, our team has developed the pilot version of the Hong Kong Solar Map - the first of its kind in Greater China. This endeavor is an effort to use innovative ways to educate and engage the public in Hong Kong about solar developments **(Figure 16)**.

Figure 16. Poster designed by the HKBU Library to promote the Hong Kong Solar Map.

The Hong Kong Solar Map allows users to locate their own buildings, and to use a drawing tool to indicate the size of their rooftops which can be used to install solar panels. Based on the area drawn, the Map immediately calculates the following:

- The potentially installable size and cost of the solar PV system
- The amount of potentially generated electricity
- Annual electricity bill savings
- Payback period
- Avoided annual CO_2 emissions

Moreover, users can view the **various policy scenarios** or adjust the map parameters to calculate a shortened payback period. The aim of these policy scenarios in the Solar Map is to inform users **what would happen if Hong Kong is to implement solar policies** such as REFIT and Net Metering.

Website: **http://digital.lib.hkbu.edu.hk/solarmap/**

5. Policy Recommendations

Based on our project key findings, we develop three policy recommendations for the Hong Kong government and relevant stakeholders to consider when approaching solar PV policies and their implications:

5.1. Recommendation 1: Need to establish the legitimacy of solar

Given the more than favourable solar prospects in Hong Kong, the next step is the need to firmly establish the public and social values of solar for Hong Kong. These include a combination of economic, political and social rationales: the need to incorporate externalities in energy decision-making, the development of a home-grown sector of green jobs and hi-tech industries, the need for engaged citizens to be empowered in shaping a global, low-carbon energy system, and the increase in energy autonomy for energy consumers to source their energy from a range of suppliers. This project has revealed that there is widespread interest and that segments of the public understand not just the financial characteristics, but also the broader values of solar. The question is how to communicate and forge existing public and social values about solar as one of the pillars for effective, potential solar policies in the future.

5.2. Recommendation 2: Engaging stakeholders in solar policy-making

Despite general support to solar policies in Hong Kong, our findings reveal that solar controversies are also foreseeable in the near future. These controversies encompass one of the mainly solar policies discussed, the REFIT. These include the associated impacts with cross-subsidization, setting the right rates of REFIT, and the rising costs not just in tariffs as a result of incorporating RE into the fuel mix but of continuing the use of fossil fuels. Under such conditions, how to best engage the public on evaluating society's willingness-to-pay, the options to mitigate the negative impacts of cross-subsidization, rate-setting, and the future fuel mix are important elements to take into account.

Our project has demonstrated that the DP method used in the workshop can be one good mechanism to solicit stakeholder feedback, and engage as well as empower stakeholders in solar policy making. Sufficient attention needs to be paid to these sets of issues and good engagement approaches when considering innovative solar policies.

5.3. Recommendation 3: Proactive role of the Government

The Hong Kong government's role is one of the pivotal issues in solar PV development in Hong Kong. Our project has attempted to illuminate the proactive role that government leadership can play in solar energy development across major global cities that are often compared with Hong Kong, namely New York City, London, Tokyo, Seoul, and Singapore. This project recommends three specific roles the Hong Kong government can play in facilitating more effective deployment of solar in Hong Kong.

First, the Hong Kong government must set a clear RE target, and formulate a specific solar policy. This includes setting a RE or solar target to be reached by a target year, as well as supportive policy measures for going about achieving this target. Our project findings suggest that REFIT, Net Metering and Solar Leasing are all options the government should seriously consider, and that further work must be conducted to solicit and address the concerns listed in Recommendation 2.

Second, the Hong Kong government must provide regulatory incentives to the utility companies to facilitate solar PV uptake and deployment. This could involve refining the Scheme of Control Agreements such that utilities are able to recover their operating costs through by expanding into other areas of customer service for distributed energy sources, as witnessed under New York State's policies to modify the utility business model (see details under New York City in Appendix 3). At the same time, these discussions must take into account the rising pressure of tariff costs on electricity consumers (and especially vulnerable consumers/households) due to the uptake of RE.

And third, the Hong Kong government should optimize a mix of approaches to facilitate solar PV deployment. Currently, the Hong Kong government has been taking the lead in increasing the scale of solar PV deployment. While this move is important, our project findings reveal that there remain untapped opportunities for business-driven and community-based solar PV deployment. Apart from the government, utilities, the business sector at large, as well as communities can also play an important role in driving the uptake of solar PV **(Table 3)**. These could range from existing quasi-institutional, commercial, and industrial buildings with rooftop spaces (e.g. Airport Authority and MTR stations), and low-density residential estates such as those in Fairview Park and Hong Lok Yuen, as well as village houses. The government needs to first remove some of the technical and legal barriers that impede these opportunities, and provide the policy instruments and financial incentives so as to encourage these sectors to take advantage of solar-generated electricity.

Table 3. Government, utilities, businesses, and communities as the drivers for solar development.

Government	• Provide clear and binding long-term RE/solar targets • Need to make informed decisions on e.g. setting targets (higher or lower), the rate of REFIT • Provide regulatory incentives (SCAs) – on utilities, e.g. solar targets with schools/ residential adopters, or revise tariff structure to include carbon surcharge • Provide economic incentives • Introduce policies to manage cost-related social impacts of REFIT e.g. cross-subsidization • Streamline application procedures and reduce technical and administrative hurdles ("拆牆鬆綁") • Review laws and regulations – e.g. to allow solar panels to be installed above 1.5 meters as part of "Minor Works" • Pilot projects • Install solar on more institutional buildings • Promote solar in "solar schools" and "solar communities": facilitate standardised package for solar installation, which is critical to streamlining solar application procedures and achieving economies of scale • Engage the public and establish political legitimacy and education of solar as a meaningful energy option
Utilities	• Play multiple roles in facilitating solar PV development, e.g. solar PV technicians, backup electricity providers for solar PV users, and utility-scale solar PV installers • Absorb solar PV installations into respective electricity grids • Modify business model to provide utility customer service for solar PV adopters
Businesses	• Large electricity consumers can lead, and create market demand for solar • ESCOs and new business models - to provide technical support, and to make solar financially viable • Green innovators
Communities	• Potential for solar-powered communities • Rooftop owners can lease their rooftops

Key References

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Appendix 1: Methodology – Supplementary Information

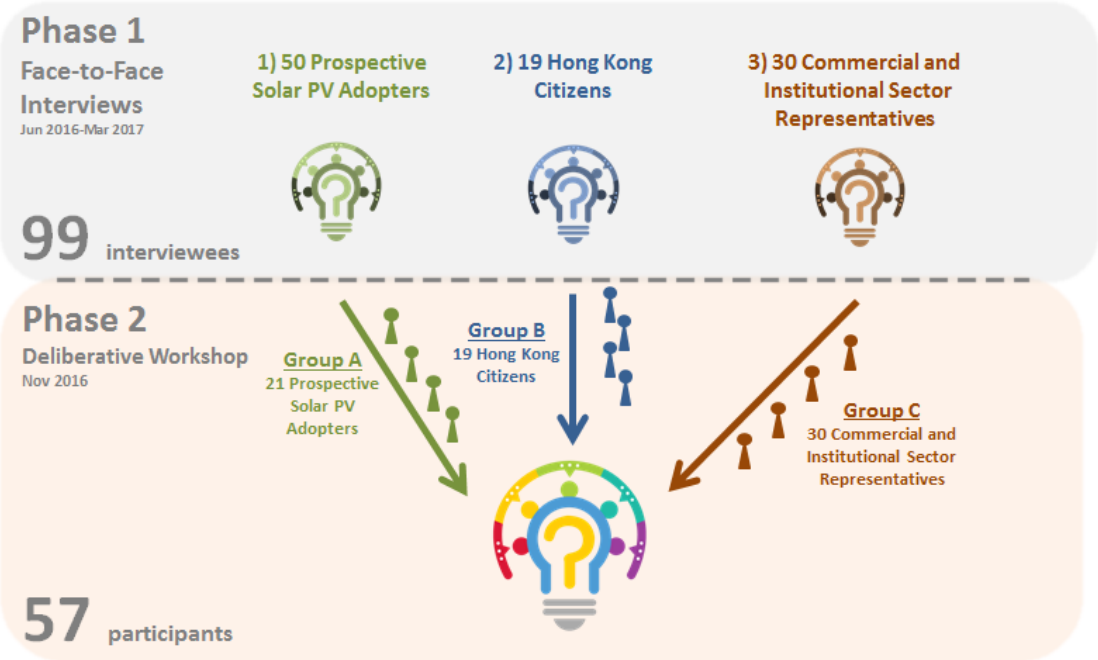


Figure A-1a. An overview of the two project phases.

Group A - Prospective Solar PV Adopters (n = 50)

- Village Contacts from project team
- Sampled homeowners from four major housing estates (e.g. Fairview Park, Palm Springs, Hong Lok Yuen, and Village Gardens); only homeowners from Fairview Park and Hong Lok Yuen participated

Group B - Hong Kong Citizens (n = 19)

- 18 years old and above; gender balanced (10 F, 9 M)
- Recruited via POP from a representative sample of HK population

Group C - Commercial and Institutional Sectors (n = 30)
(18 Commercial; 12 Institutional)

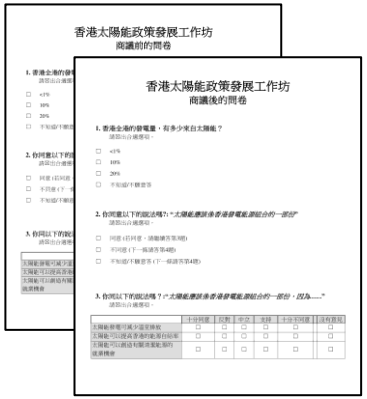
- Contacts from the project team, WWF Hong Kong and Greenpeace East Asia
- Examples of commercial stakeholders: utilities, energy service and RE companies, MTR, property developers, consultant firms, and hotels
- Examples of institutional stakeholders: Airport Authority, academia and university administrative staff, primary and secondary schools, LegCo members, Heung Yee Kuk

Figure A-1b. Description and composition of the three project participant groups.

Briefing Document

Small Group Discussion

Expert Q&A and Plenary Session



Pre- and post-workshop Questionnaires

Figure A-1c. The process of the Deliberative Workshop: participants were provided a briefing document several days prior to the workshop. The workshop held two sessions of small group discussions, one expert Q&A session, and one plenary session. Participants completed pre-workshop questionnaires after reading the briefing document. After the half-day workshop, participants completed post-workshop questionnaires.

Table A-1. Breakdown of workshop participants by Group and Day.

		Group A Potential Solar PV Adopters	**Group B** Hong Kong Citizens	**Group C** Commercial and Institutional Representatives	
Face-to-Face Interview		**50**	**19**	**30**	**99**
Deliberative Workshop	**4 November**	11	11	10	32
	5 November	10	8	7	25
	Total	**21**	**19**	**17**	**57**

Table A-2. List of Expert Panellists.

Code	**Expert Panellist Background**
EP 1	A university professor with background in renewable energy technologies and potential.
EP 2	An officer from a local consumer advocacy agency.
EP 3	A senior officer from a local consumer advocacy agency.
EP 4	A senior officer from local utility company A.
EP 5	A general manager from local utility company B.
EP 6	A CEO from a local renewable energy company.
EP 7	An engineer from a local consultant firm specializing in environmental and sustainability reporting.

Appendix 2: Face-to-Face Interview and Workshop Questionnaires

Face-to-Face Interview Questionnaire (Residential Sector)

香港主要持份者對太陽能政策的認知和態度

訪談指南

（香港居民適用）

香港浸會大學　地理系
香港大學　嘉道理研究所

一、你對於太陽能政策嘅瞭解

1. 你有無聽過以下呢幾個有關太陽能發展的政策？
   - 可再生能源上網電價補貼
   - 淨計量電價
   - 太陽能板租借服務
   - 可再生能源證書
   - 可再生能源債券

太陽能政策解釋與經驗分享 依家我想同你介紹一下我 D 研究團隊點樣理解呢 D 太陽能政策，同埋一 D 國家嘅例子。係聽完呢 D 介紹之後，我會請你再分享多 D 你個人對於太陽能政策其他方面嘅意見。

二、你對於一 D 太陽能政策嘅睇法

聽完呢 D 介紹之後，我想請你分享多 D 你個人對於太陽能政策其他方面嘅意見。

2. 以你個人睇來，呢 D 政策能唔能夠符合香港社會的實際情況？點解？

3. 你個人會唔會支持係香港推行呢 D 政策？點解？
   - 可再生能源上網電價補貼
   - 淨計量電價
   - 太陽能板租借服務
   - 可再生能源證書
   - 可再生能源債券

4. 依家請你綜合考慮下呢 D 政策嘅可行性、可能嘅執行效果同埋影響，你認為邊個政策應該優先係香港推行？可唔可以幫我排一個優先次序？順便解釋下點解咁排？
   A. 可再生能源上網電價補貼
   B. 淨計量電價
   C. 太陽能板租借服務
   D. 可再生能源證書
   E. 可再生能源債券

_____ _____ _____ _____ _____

最優先嘅選擇 ← → 最後嘅選擇

5. 係推行呢五種政策嘅時候，其實係唔同嘅國家會有唔同嘅具體做法。跟著我會向你介紹其中幾個具體做法，然後我想請你同我分享下你對唔同嘅做法係點睇嘅。
   - 首先，譬如係推行***可再生能源上網電價補貼***政策嘅時候，會有兩種唔同嘅做法：
     - 第一種做法：全民加電費，所有收入係用去補貼返可再生能源發電者，譬如日本就係甘做嘅。
     - 第二種做法：全民唔加電費，而係由政府係財政預算果度，摞一舊錢出來，用於補貼俾可再生能源發電者。

     咁你點睇呢兩種唔同嘅做法？

   - 第二個政策，係推行***太陽能板租借服務***嘅時候，亦都有兩種唔同嘅做法：
     - 第一種做法：電力公司（譬如中電或者港燈）買左太陽能發電系統之後直接出租俾有興趣嘅用戶，用戶每個月俾租金俾電力公司。
     - 第二種做法：由可以提供一條龍服務嘅能源服務中介公司將太陽能發電設備租俾用戶，用戶俾租金俾中介公司，然

後中介公司再同電力公司商議有關賣電嘅安排。

咁你點睇呢兩種唔同嘅做法？

6. 個人來講，你願意**每個月係電費中**俾幾多錢去支持香港發展太陽能？

☐ 港幣$10　☐ 港幣$20　☐ 港幣$50

☐ 港幣$100　☐ 其他（請註明）_____

☐ 不願意　☐ 我唔知每個月電費單幾多錢，稍後補返

第三部份：你認為係香港推行呢 D 太陽能政策會有乜阻力同埋佢地嘅可行性會係點？

7. 你覺得係香港推行呢 D 政策，可能會遇到邊 D 困難？對於你頭先所提及嘅困難，你有沒有一些建議嘅解決方法？
   - 可再生能源上網電價補貼
   - 淨計量電價
   - 太陽能板租借服務
   - 可再生能源證書
   - 可再生能源債券

個人資料

1. 性別

☐ 男　☐ 女

2. 年齡

☐ 18-35 歲　☐ 36-45 歲　☐ 46-55 歲　☐ 56-65 歲

☐ 66 歲或以上

3. 教育程度

☐ 小學或以下　☐ 中學　☐ 預科　☐ 專上非學位

☐ 專上學位　☐ 研究院或以上

4. 家庭情況

(1) 請問你屋企總共有幾位家庭成員（包括您自己）？

_____（請填寫具體數字）

(2) 請問你屋企每月嘅家庭收入大約有幾多？請選擇一個大概範圍。

☐ 5,000港幣或以下　☐ 5,001-10,000港幣

☐ 10,001- 20,000港幣　☐ 20,001- 30,000港幣

☐ 30,001- 40,000 港幣　☐ 40,001- 50,000港幣

☐ 50,001 港幣或以上

(3) 你依家居住嘅地區/區域係？

☐ 香港　☐ 九龍　☐ 新界

5. 電費

你的家庭對上一期電費幾多錢（兩個月為一期）？

_____

6. 住宅情況

(1) 你嘅房屋屬於以下邊一種種類？

☐ 公寓大廈　☐ 排屋　☐ 公共屋邨　☐ 村屋

☐ 獨立屋　☐ 居屋

(2) 你屋企所在嘅樓宇有無業主立案法團？

☐ 有業主立案法團　☐ 無業主立案法團

(3) 你嘅房屋係自置辦嘅物業或者系租嘅？

☐ 自置物業　☐ 租賃樓宇

☐ 其他，請闡明_____

多謝你接受我嘅訪問。如果你對呢個訪問有任何疑問，可以係辦公時間致電 3411 7753 聯絡研究項目負責人——香港浸會大學地理系**馬雅燕博士**。

為左多謝你抽時間接受我地嘅訪問，我地就有一張 50 蚊嘅超級市場現金券送俾你。咁麻煩你幫我簽收。

謝謝，拜拜！

Face-to-Face Interview Questionnaire

(Commercial and Institutional Sector)

香港主要持份者對太陽能政策的認知和態度

訪談指南

（商界/機構受訪者適用）

香港浸會大學　地理系
香港大學　嘉道理研究所

一、你對於太陽能政策嘅瞭解

8. 你有無聽過以下呢幾個有關太陽能發展的政策？
   - （如果回答為“有”）你可不可以同我講下呢 D 政策具體的做法是咩？
   - （如果回答為“無”）照字面上的意思，你點樣理解呢個政策？
     - 可再生能源上網電價補貼
     - 淨計量電價
     - 太陽能板租借服務
     - 可再生能源證書
     - 可再生能源債券

太陽能政策解釋與經驗分享 依家我想同你介紹一下我 D 研究團隊點樣理解呢 D 太陽能政策，同埋一 D 國家嘅例子。係聽完呢 D 介紹之後，我會請你再分享多 D 你個人對於太陽能政策其他方面嘅意見。

二、你對於一 D 太陽能政策嘅睇法

9. 以你個人睇來，呢 D 政策符唔符合香港社會的實際情況？點解？
   - 可再生能源上網電價補貼
   - 淨計量電價
   - 太陽能板租借服務
   - 可再生能源證書

- 可再生能源債券

10. 依家請你綜合考慮下呢 D 政策嘅可行性、可能嘅執行效果同埋影響，你認為邊個政策應該優先係香港推行？麻煩你幫我排一個優先次序。可唔可以解釋下點解咁排？

F. 可再生能源上網電價補貼
G. 凈計量電價
H. 太陽能板租借服務
I. 可再生能源證書
J. 可再生能源債券

____ ____ ____ ____ ____

最優先嘅選擇 ← → 最後嘅選擇

11. 係推行呢五種政策嘅時候，係唔同嘅國家會有唔同嘅具體做法。跟著我會向你介紹其中幾個具體做法，然後我想請你同我分享下你對唔同嘅做法係點睇嘅。

- 首先，譬如係推行***可再生能源上網電價補貼***政策嘅時候，會有兩種唔同嘅做法：
  - 第一種做法：全民加電費，所有收入係用去補貼返可再生能源發電者，譬如日本就係甘做嘅。
  - 第二種做法：全民唔加電費，而係由政府係財政預算果度，摞一舊錢出來，用於補貼俾可再生能源發電者。

  咁你點睇呢兩種唔同嘅做法？

- 再譬如，係推行***凈計量電價***嘅時候，都會有兩種唔同嘅做法：
  - 第一種做法：法律（或者發展計劃）規定咗，應用凈計量電價的可再生能源裝置嘅總數有一個上限。當總數達到呢個上限嘅時候，就唔可以再增加呢 D 甘嘅裝置，譬如美國加州，就設定咗甘嘅一個上限。
  - 第二種做法：凈計量電價的總裝機容量不設定一個上限，即係某一區域，例如假設未來東湧新市鎮有一個太陽能社區，此類裝置可無限制甘發展。

  咁你點睇呢兩種唔同嘅做法？

- 第三個政策，係推行***太陽能板租借服務***嘅時候，亦都有兩種唔同嘅

做法：

- 第一種做法：電力公司（譬如中電或者港燈）買左太陽能發電系統之後直接出租俾有興趣嘅用戶，用戶每個月俾租金俾電力公司。
- 第二種做法：由可以提供一條龍服務嘅能源服務中介公司將太陽能發電設備租俾用戶，用戶俾租金俾中介公司，然後中介公司再同電力公司商議有關賣電嘅安排。

咁你點睇呢兩種唔同嘅做法？

12. 從業界嘅角度來睇，你地會歡迎點樣嘅太陽能政策？點解？*（商界受訪者適用）*

13. 從政府決策者嘅角度來睇，制定太陽能政策嘅時候，你地會考慮邊啲相關因素？點解？*（政府機構受訪者適用）*

14. 你覺得係點樣嘅情況/條件下，香港市民願意接受電費加價去支持太陽能發展？點解？

第三部份：你認為係香港推行呢 D 太陽能政策會有乜阻力同埋佢地嘅可行性會係點？

15. 你覺得係香港推行呢 D 政策，可能會遇到邊 D 困難？對於你頭先所提及嘅困難，你有沒有一些建議嘅解決方法？
    - 可再生能源上網電價補貼
    - 淨計量電價
    - 太陽能板租借服務
    - 可再生能源證書
    - 可再生能源債券

16. 你覺得香港本身有無資源同埋條件發展太陽能？
    （1）無，點解？
    （2）有，咁具備咗乜優勢/條件可以促進太陽能嘅發展？

17. 你覺得係香港，政府、電力公司、企業，包括市民，可以做 D 乜去推動香港發展太陽能？

個人資料

1. 教育程度

☐ 小學或以下　☐ 中學　☐ 預科　☐ 專上非學位

☐ 專上學位　☐ 研究院或以上

2. 職位情況

(4) 您的姓名：_____

(5) 所屬機構：_____

(6) 現履職務：_____

(7) 專業領域：_____

(8) 現已在本組織/機構/公司工作_____年

多謝你接受我嘅訪問。如果你對呢個訪問有任何疑問，可以係辦公時間致電 3411 5941 聯絡研究項目負責人——香港浸會大學地理系馬雅燕博士。謝謝，拜拜！

Pre-Workshop Questionnaire

香港太陽能政策發展工作坊

商議前的問卷

1. 香港全港的發電量，有多少來自太陽能？

請☒出合適選項。

☐ <1%

☐ 10%

☐ 20%

☐ 不知道/不願意答

2. 你同意以下的說法嗎**?: "***太陽能應該係香港發電能源組合的一部份***"**

請☒出合適選項。

☐ 同意 (若同意，請繼續答第3題)

☐ 不同意 (下一條請答第4題)

☐ 不知道/不願意答 (下一條請答第4題)

3. 你同以下的說法嗎？**:"***太陽能應該係香港發電能源組合的一部份，因為*****.....*****"**

請☒出合適選項。

	十分同意	同意	中立	不同意	十分不同意		沒有意見
太陽能發電可減少溫室排放	☐	☐	☐	☐	☐		☐
太陽能可以提高香港的能源自給率	☐	☐	☐	☐	☐		☐
太陽能可以創造有關清潔能源的就業機會	☐	☐	☐	☐	☐		☐

4. 你願意每個月付多少錢去支持香港發展太陽能?

請☒出合適選項。

☐ 港幣$10

☐ 港幣$20

☐ 港幣$50

☐ 港幣$100

☐ 不知道/不願透露

5. 你支不支持在香港推行以下的太陽能政策，或推動有關方面的發展呢?

請☒出合適選項。

	十分支持	支持	中立	不支持	十分不支持		沒有意見
a. 上網電價補貼	☐	☐	☐	☐	☐		☐
b. 淨計量電價	☐	☐	☐	☐	☐		☐
c. 太陽能板租借服務	☐	☐	☐	☐	☐		☐
d. 可再生能源證書	☐	☐	☐	☐	☐		☐
e. 可再生能源債券	☐	☐	☐	☐	☐		☐

6. 你認為香港政府應在未來數年推行以下的太陽能政策，或推動有關方面的發展嗎?

請你在合適的空格☒出號，每項政策只能選一個選項。

	政府應*即時行動，在未來一至兩年內*推行這政策/推動這方面的發展	政府應在*未來三至五年*推行這政策/推動這方面的發展	政府應在*五年之後*推行這政策/推動這方面的發展	不知道/不願透露
a. 上網電價補貼	☐	☐	☐	☐
b. 淨計量電價	☐	☐	☐	☐
c. 太陽能板租借服務	☐	☐	☐	☐
d. 可再生能源證書	☐	☐	☐	☐
e. 可再生能源債券	☐	☒	☐	☐

完!

謝謝您的參與!

[電子版本] 若您是填寫電子版本的問卷，請您於11月3日或之前，將填好的問卷，電郵給馬文怡小姐**mamanyi@hkbu.edu.hk**。

[印刷版本] 若您是填寫**印刷版本**的問卷，請您於**工作坊當日登記**時，親自交給我們的工作人員。

若您對問卷內容有任何疑問，歡迎您聯絡馬雅燕博士(3411- 7753)
或於辦公時間聯絡香港浸會大學研究院道德規範及安全守則委員會(3411-5127)。

Post-Workshop Questionnaire

香港太陽能政策發展工作坊

商議後的問卷

1.全港的發電量，有多少來自太陽能？

請☒出合適選項。

☐ <1%

☐ 10%

☐ 20%

☐ 不知道/不願意答

2. 你同意以下的說法嗎?: "*太陽能應該係香港發電能源組合的一部份*"

請☒出合適選項。

☐ 同意 (若同意，請繼續答第3題)

☐ 不同意 (下一條請答第4題)

☐ 不知道/不願意答 (下一條請答第4題)

3. 你同意以下的說法嗎？:"*太陽能應該係香港發電能源組合的一部份，因為*....."

請☒出合適選項。

	十分同意	同意	中立	不同意	十分不同意		沒有意見
太陽能發電可減少溫室排放	☐	☐	☐	☐	☐		☐
太陽能可以提高香港的能源自給率	☐	☐	☐	☐	☐		☐
太陽能可以創造有關清潔能源的就業機會	☐	☐	☐	☐	☐		☐

4. 你願意每個月付多少錢去支持香港發展太陽能?

請☒出合適選項。

☐ 港幣$10

☐ 港幣$20

☐ 港幣$50

☐ 港幣$100

☐ 不知道/不願透露

5. 你支不支持在香港推行以下的太陽能政策，或推動有關方面的發展呢?

請☒出合適選項。

	十分支持	支持	中立	不支持	十分不支持		沒有意見
a. 上網電價補貼	☐	☐	☐	☐	☐		☐
b. 淨計量電價	☐	☐	☐	☐	☐		☐
c. 太陽能板租借服務	☐	☐	☐	☐	☐		☐
d. 可再生能源證書	☐	☐	☐	☐	☐		☐
e. 可再生能源債券	☐	☐	☐	☐	☐		☐

6. 你認為香港政府應在未來數年推行以下的太陽能政策，或推動有關方面的發展嗎?

請你在合適的空格☒出號，每項政策只能選一個選項。

	政府應*即時行動，在未來一至兩年內*推行這政策/推動這方面的發展	政府應在*未來三至五年*推行這政策/推動這方面的發展	政府應在*五年之後*推行這政策/推動這方面的發展	不知道/不願透露
a. 上網電價補貼	☐	☐	☐	☐
b. 淨計量電價	☐	☐	☐	☐
c. 太陽能板租借服務	☐	☐	☐	☐
d. 可再生能源證書	☐	☐	☐	☐
e. 可再生能源債券	☐	☐	☐	☐

你對這個工作坊的評價

7. 你對這個工作坊有何看法？

請☒出合適選項。

	非常有用					中立					根本沒有用		沒有意見
	10	9	8	7	6	5	4	3	2	1	0		99
a. 整個工作坊	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐
b.小組討論	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐
c. 專家答問環節	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐
d. 全體及互動環節	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐

8. 你同意以下的說法嗎？

請☒出合適選項。

	十分同意	同意	中立	不同意	十分不同意		沒有意見
a. 小組主持人提供機會讓每個人都參加討論	☐	☐	☐	☐	☐		☐
b. 小組所有成員都有差不多的參與程度	☐	☐	☐	☐	☐		☐
c. 小組主持人有時試圖以自己的觀點影響小組成員	☐	☐	☐	☐	☐		☐
d. 小組主持人確保一些反對的意見都會被考慮	☐	☐	☐	☐	☐		☐
e. 小組討論被少數成員所主導	☐	☐	☐	☐	☐		☐
f. 小組成員都能尊重對方的意見	☐	☐	☐	☐	☐		☐
g. 工作坊的簡介文件客觀地反映了不同的意見	☐	☐	☐	☐	☐		☐
h. 專家答問環節解決了我們小組的討論問題	☐	☐	☐	☐	☐		☐
i. 總的來說，這個過程有助於我理解整個問題	☐	☐	☐	☐	☐		☐

9.你同意以下的說法嗎？

請☒出合適選項。

	十分同意	同意	中立	不同意	十分不同意	沒有意見
a. 從這個工作坊中，我獲得了一些新知識	☐	☐	☐	☐	☐	☐
b. 在這個工作坊中，我能從一些新角度去思考香港的太陽能發展	☐	☐	☐	☐	☐	☐
c. 參加完這工作坊後，我改變了我對香港發展太陽能的一些觀感/想法	☐	☐	☐	☐	☐	☐

10. <u>參加今天這個工作坊前</u> ，你有閱讀過主辦單位所提供的「簡介文件」嗎？

請☒出合適選項。

☐	已看了整份文件
☐	看了文件的一半以上，但沒有看完
☐	看了約一半的文件
☐	只看了文件的一小部分、不到一半
☐	根本沒有看過
☐	不知道/不適用

完!

謝謝您的參與!

請檢查一下您是否已填妥所有選項，然後呈交問卷。

再次非常感謝您的支持!

若您對問卷內容有任何疑問，歡迎您聯絡馬雅燕博士(3411-5941)或於辦公時間聯絡香港浸會大學研究院道德規範及安全守則委員會(3411-5127)。

Appendix 3: Case Studies of Major Global Cities

New York City

Urban area: 789 km^2

Population (Jul 2015): 8.5 million

Population Density: 10,800/km^2

Solar PV Progress

96 MW (2016) → **1 GW by 2030**

Solar PV system in Brooklyn.

Background and Barriers

In the last decade, solar PV provided a negligible amount of electricity to NYC due to technical and policy barriers, as well as lack of incentives, standardization or cohesion among agencies and utilities. In 2006, the City University of New York (CUNY), convened stakeholders to collaborate in the drafting and implementation of solar plans for the city. Working together with the New York City's Mayor Office of Sustainability, the New York City Economic Development Cooperation, local utilities, state authorities, and over 30 partners, they formed the NYC Solar Partnership in 2006. NYC's was the recipient of The Solar America Cities Award in 2007 in multiple policy measures to facilitate solar PV adoption.

Solar Policies Available

- **Net Metering**
- **Solar Leasing**
- **RECs**
- **RE Bonds**

Policies and Highlights

- **Earning Adjustment Mechanisms** that reward utilities make-up revenue losses from traditional costs of service such as through achieving peak load reduction and savings, distributed energy sources interconnections, and customer engagement
- **Net Metering** is available through the local utility, ConEdison
- **Renewable Energy Certificates*** have been in use since 2012, under the Renewable Portfolio Standard for New York State to support a voluntary market for tradeable RECs and green power market through a state-administered tracking system
- **Green Bonds** are being developed by the City's Comptroller, which aims to expand the investor base available to the city, and provides investors an opportunity to participate in financing green projects towards climate change adaptation, advancing renewable energy or energy efficiency
- **NYC Solarize** is a program aims to reduce barriers for communities that have limited access to solar by reducing acquisition costs through aggregate purchasing campaigns. To startup a campaign, financial support, marketing materials, technical assistance and connections to local partner installers are provided

*Note: a national-level policy

London

Urban area: 1,572 km^2

Population (2015): 8.6 million

Population Density: 5,500/km^2

Solar PV Progress

82.7 MW (2016)

8,850GWh (2026) of energy from RE sources (equivalent to 21.3% of 2014 electricity consumption)

Community solar PV installation in Brixton.

Background and Barriers

Unlike the many regions of the UK which have increased their solar PV installed capacity, London has fallen behind, with the lowest amount of installed solar PV capacity in the UK. London faces unique challenges in large-scale solar PV deployment, such as its terraced housing and thin, tall building cityscape, transient housing population, and low interest in solar PV. A recent publication by the Greater London Assembly has vocally criticised the Mayor's office for its lack of leadership and direction in tapping into this underutilized potential.

Solar Policies Available

- **REFIT**
- **Solar Leasing**
- **RECs**
- **RE Bonds**

Policies and Highlights

- **REFIT*** is available at the national level for small-scale solar PV and other RE
- **Renewable Obligation Certificates***, under the Renewable Obligation requires electricity suppliers source a portion of electricity from renewable sources, and renewable obligation certificates are issued renewable plant operators
- **RE:NEW** is an award-winning energy efficiency programme, and has encouraged domestic solar PV installation. Since its inception in 2009-2010, solar PV has been installed on over 4,300 homes. Since 2014, more human resources and technical support has been provided towards solar PV projects to help organisations quantify costs and returns, and establish a new framework of suppliers

*Note: a national-level policy

Seoul

Urban area: 605 km^2

Population: 10.3 million

Population Density: 17,000/km^2

Solar PV Progress

84.3 MW
(end 2014)

200 MW
(2020)

PV system on the rooftop of Gang Agro-Fisheries Market.

Background and Barriers

In 2011, Seoul's electricity self-reliance and reserve margin was 2.8% and 5.5% respectively, with 31% of its electricity from nuclear power. The city also consumed around 10% of South Korea's total energy and was forecasted to rise. Seoul's large-scale blackout in September 2011 and the wake of the Fukushima nuclear accident provided good ground for the Seoul Metropolitan Government to set targets to increase its energy self-reliance. Subsequently in 2012, they announced "The Comprehensive Plan for One Less Nuclear Power Plant" which aims to reduce energy consumption by 2 million (tons of oil equivalent), introduce energy efficiency and conservation measures, and increase renewable energy production. Phase 1 of this Plan was fulfilled in June 2014, 6 months ahead of schedule, and it has now entered into Phase 2 which aims to increase the city's electricity self-reliance to 20% by 2020.

Solar Policies Available

- **REFIT**
- **Net Metering***
- **Solar Leasing**
- **RECs***
- **RE Bonds***

Policies and Highlights

- **Seoul-type REFIT** is city-wide REFIT provides KRW100 (HK$0.68)/kWh for up to 5 years
- **Government subsidies and support measures** lease of idle public lands and offer municipal land to cooperatives to install solar PV systems, provide loans with a preferential annual interest rate of 1.75% for PV systems of up to 150kW, reduce PV licensing period from 60 to 30 days and distribute solar PV panels to small apartment households for electricity production
- **Renewable Energy Certificates*** are available in South Korea which is similar to the US, by way of an obligatory renewable portfolio standard for major power producers

*Note: Available at the national level.

Tokyo

Urban area: 2,191 km^2
Population (2015): 13.5 million
Population Density: 6,200/km^2

Solar PV Progress

260 MW
(Fiscal Year 2012)

1 GW
(2024)

Solar carport in Tokyo.

Background and Barriers

Since the 2011 Fukushima accident, the local government has been implementing both demand-side and supply-side measures to ensure energy security, and realise an energy-efficient economy and a low-carbon energy system, firstly by adopting the Vision of Smart Energy City in 2012. The local government has also emphasised the transition towards distributed generation through solar energy and other renewable energy sources (TMG, 2013). It also has a number of supportive policies to encourage solar PV uptake.

Solar Policies Available

- **REFIT**
- **Solar Leasing**
- **RECs***
- **RE Bonds***

Policies and Highlights

- **REFIT(since 2012)*** is available for Solar PV and other RE, and since its implementation, had initially resulted in a large increase in residential solar PV uptake (2011 and 2012) before overtaken by non-residential solar PV uptake in 2013
- **Renewable Energy Certificates*** are used in a national renewable portfolio mandated for electricity power companies since 2003. A voluntary Green Power Certificate scheme is also available for the private sector
- **Subsidies for solar PV systems (Fiscal Year 2013-17)** are provided in combination with other RE subsidies (eg. combined heat and power and building energy management system (BEMS) for small to medium buildings) to secure distributed energy sources and to realise the smart energy city vision. A total of roughly 10 billion yen (equivalent to about HK$ 750 million) has been allocated for these subsidy programs
- **"Roof power" Solar Project** combines low-interest loans with low-cost retail plans, making it easy for Tokyo residents to install solar PV systems with modest initial investment

*Note: a national-level policy

Singapore

Urban area: 605 km^2

Population: 10.3 million

Population Density: 7,600/km^2

Solar PV Progress

71.3 MW (Q1 2016)

350 MW (2020)

Solar PV system on a Housing and Development Board building.

Background and Barriers

Despite Singapore's geographical constraint along with high population density and need to manage grid stability with large solar PV penetration, Singapore has begun to tap into vast solar resources, which can help the country meet its emissions targets, import less energy, and reduce peak electricity demand. The government has launched several government-led initiatives to increase solar PV penetration.

Solar Policies Available

- **Net Metering**
- **Solar Leasing**
- **RE Bonds**

Policies and Highlights

- **SolarNova** is a government-led programme that **utilizes a solar leasing business model**, by aggregating solar demand across government agencies, inviting a private energy company to install, own and operate the system, and selling the electricity back to the agencies through a power purchase agreement (EDB, 2016). The first tender of a total solar PV capacity of 76 MW will cover Housing & Development Board blocks and other government ministries
- **Regulatory changes** were made enhance the existing market and regulatory framework, such as raising the capacity threshold for solar energy, clarifying the licensing framework and streamlining market registration and settlement procedures

Appendix 4: List of Original Quotations and Translations

Quote 1

我住在錦繡花園的，我不想付款支持綠色能源，但我想在綠色能源裏拿一些著數，我提出的方案是，我把我的屋頂租給一些投資者，我只收租，其他問題你幫我解決，包括地契公契，或者技術和後面一連串保養等，我只是收租。

I live in Fairview Park. I don't want to pay to support green energy, but I want to reap the benefits from green energy. My suggestion is to lease my rooftop to an investor. I will collect the rent, and as for other problems, [the investor] will solve them, including the land and public deeds, technical and maintenance issues etc. I just want to collect the rent.

R40 // 4 Nov Expert Q&A

Quote 2

我想回應返, 就算你們不斷裝，不斷裝，會超出我們的發電量的 1%的機會率很低，所以我們不會擔心你安裝得多，會影響我們的生意或令我們不能裝發電機，我想現時看不到這個趨勢。

I would like to respond. Even if you continually install [solar PV panels], the chance of exceeding 1% in electricity generation [of solar energy] is very low, so we are not worried that you will over-install solar PV panels, affect our business or prevent us from installing generators. Right now, I do not see this trend.

EP 5 // 4 Nov Expert Q&A

Quote 3

其實係大戶嚟嘅，我一年用幾千萬度電咁，其實當我係一個大戶嘅時候我每年嘅電費都比緊兩三千萬咁，其實而家好多企業 Apple 咁樣啊，佢講到自己好 carbon neutral。可能企業佢有空間去製造一個 demand，我講到明我係用太陽能發電或者可再生能源，我願意每度電付出多一蚊。 咁我就製造咗一啲 demand 出嚟。咁個 demand 又真係好有 demand，好有需求，我要去購入既電力係黎自一個清潔能源嘅時候，咁咪製造左一個龐大市場囉。因為真係大戶先有能力做到個 demand 出嚟既時候，咁但係依家個市場上就唔存在我哋有得揀去選擇用咩能源。咁變相靠呢啲，慢慢靠啲村屋一塊一塊咁樣裝裝到下世都未有一個好大嘅 impact 去 drive 到一個 change。

Assume that I am a large electricity user: I would spend about HK$20 million on electricity bills. Actually, a lot of large corporates like Apple are like that where they claim to become carbon neutral. Some corporates may have the room to generate demand, in indicating that I will generate solar PV electricity or RE electricity, and I will be willing to pay HK$1 more for each kWh (of solar) electricity. This is how I can create some sort of demand. This demand [for solar/RE electricity] will in turn generate [consumer] demand. When I want to purchase electricity from clean energy sources, I am creating a large market, because large electricity users are in the position to generate such demand…but right now, the market does not allow for us to select what kind of energy sources we can use. We gradually rely on the

installation of solar panels on village houses although this may take forever and cannot make the impact needed to drive the change.

CI 16 // 5 Nov Group C Session 2

Quote 4

其實我會認為我們之間討論了很久，討論了一些我自己來看，是關於錢和安裝的問題，其實共通的都是這些問題，其實會不會反而有一些政策，例如樓宇維修或樓宇安裝的一些政策上面去放寬，或在一些價格方面的政策，其實如果你解決了這些，便已經可以實行得到。

Actually I think we've been talking about the issues of money and installation for a long time. These are actually problems we all face from these questions. Can we see the laxing of some policies, such as policies on building renovation or building installations, or policies on pricing…if we can solve these [problems], then we can proceed.

Group A participant // 4 Nov Expert Q&A

Quotes 5

A1: 是不是應該由政府去補貼或由政府先行推行在某些公眾的地方，看台也好，行人路也好，休憩地方也好，在那些地方先行去實行一個…
A2：我同意 A1 的說法，除了政府應該首先推行外，它還應該有一個政策在多少年後…

A1: Shouldn't the government subsidise or take the lead installing [solar PV panels] in public places, observer stands, sidewalks, leisure areas, etc….
A2: I agree with A1's idea. Other than the government taking the lead, on some policies, they can in some years down the road…

Group A // 4 Nov Session 1

Quote 6

B1：…其實睇返全世界咁多個地方點解會成功呢？第一有政府帶頭…
B2：其實我好同意頭先一位小姐所講嘅嘢。首先由政府帶頭，我喺政府嘅建築物、學校、醫院、機場、政府大廈所有地方，你問屋宇署、消防處邊啲地方係可以裝到太陽能板嘅。行咗第一步先。
B1: …taking a look again, why are there so many places around the world that succeeded? The first is that the government takes the lead…
B2: I agree with what the lady just said. First, the government should take the lead, such as on government buildings, like schools, hospitals, airports, government buildings. You can ask the Building Department, Fire Department etc. to install solar PV panels: they can take the first step.

Group B // 4 Nov Session 1

Quote 7

C1: I think policy must be established and developed to facilitate the individuals to get into the market. I think I agree with the roadmap. Here we describe [the] feed-in tariff subsidy and the net production calculation, whatever, and the leasing market for the solar panel is encouraging to individuals. They don't need to invest upfront a lot of money. I think this is the basic thing we could start with.

C2: Yes, exactly, especially in Hong Kong….

C3:…If the government hope[s] for RE [to become a] certain percentage of overall electricity generation, let's say, not aggressive, say 1%, then they can have different sources of input, one is from utility-scale RE system, just like our solar power system. The second may be [from the] individual customer.

Group C // 4 Nov Session 2

Quote 8

C1:…我想你已經看畢這份文件，它是建議由電燈公司開始做起，完全是錯誤的。 其實應該由自己自發，私人去做。 因為如果由電燈公司去做的話，成本一定高 。
C2: 這我有保留。
C1: 無錯，你電燈公司地方係多…一定比普通 commercial 為多 一定…
C2: 點會呢? 唔會囉。
C1:所以，我覺得這點可有討論空間。

"**C1:** …I think after reading the briefing document, it suggests that the utility companies should start installing solar PV panels. I think this is wrong. Actually I think each person should generate his/her own electricity for his own use. If the utility companies take this on, the costs would definitely be high.
C2: I have reservations about that.
C1: Of course, your utility company has lots of space…they must have more than commercial property owners…
C2: How come? I don't think so.
C1: So, I think on this point there is room for discussion."

Group C // 5 Nov Session 1

Quote 9

除了政策外，技術支援也是一個難題，剛才跟 EP 5 討論過，太陽能板需有一定的斜度，如一間 700 呎的房子，未必有空間放置太陽能板以及其安裝架，還有維修方面。其實當中涉及很多技術上的問題，一般市民是很難掌握到。如只有政策單方面推行以作方便安裝，但安裝時出現的技術問題需要有技術人員支援才可行。

Aside from policies, technical support is also a challenge. I just discussed this with EP 6: solar PV panels must be tilted when placed, like on a 700 square feet house. You may not have the space to place a solar PV panel and the support structure. There's also the issue of maintenance. This process is highly demanding on the technical aspects. The average citizen

does have a hard time grasping this. If there was a policy that could make it more convenient to install, and upon installation, that there is technical support, then that would work.

R32 // 4 Nov Group A Session 2

Quote 10

就即係推動呢個太陽能呢佢自己嘅資料根本係睇到做唔到…最後去到 2012 年呢，大致上都係估計只有五點幾個百分比。開始就估計有三十幾個百分比，實際上仲有呢個 2012-2016 再會減會 downgrade 喎，咁實際上就冇乜用。

The information they have for promoting solar energy makes [the technical potential] impossible….the last one was in 2012, and estimated about five point something percentage. At the beginning they estimated about thirty something percentage. Actually, from 2012 to 2016, it may get reduced again. Frankly speaking, [solar power] cannot really contribute much.

R57 // 4 Nov Session 1

Quote 11

我只是曾經在家自行安裝太陽能板，但是被管理處拒絕。因為我們那裏的樓有的是預建式，有的是自行建造。管理處應該是想減低風險， 其實我自己也有研究過太陽能板，我知道不只是簡單地安裝幾塊板在天台就能發電，而是可能要把水、電、喉重新安裝。

I tried to install a solar PV panel at my home, but the management office prohibited it. Because some of the houses there are pre-fabricated, and some are built there, the management wanted to reduce the risks. Actually, I did some research into solar PV panels. I know it’s not as simple as installing a few panels on the rooftop to generate electricity. Water pipes and electricity wires need to be re-installed.

R49 // 5 Nov Group A Session 1

Quote 12

其實如果單從利益方面來說， 無論怎樣補貼，也不能做到收支平衡。 因為我已經在家中自行安裝了太陽能板，也曾把輸出的電輸送上電網。所以很多人問我，你回本了嗎？還是這個月的電費節省了多少？我可以告訴你，這是不可能的。 即使你指出在村屋的空間比較多，但是我們能把整個天台也變成太陽能板，還是把整個花園也變成太陽能板，你也不可能做到收支平衡。所以如果從個人方面去看，我們的目標並不是要賺錢，所以政府提供的補貼並不是讓我們賺錢，而是鼓勵更多的人去進行太陽能發電。

I think from a purely [financial] benefits standpoint, no matter how much subsidy there is, I cannot break even. This is because at home I have installed a solar PV panel and am sending electricity back to the grid. So many people ask me, can you get a return on this? Or do you save your electricity bill this month? I can tell you, this is impossible. Even if you point out the fact that there are a lot spaces on small house rooftops, and you cover either your entire rooftop or garden into solar PV panels, you cannot break even. So from this perspective, our

goal is not to earn money. The subsidy the government provides is not for us to make money: it is to encourage more people to take up and generate solar energy.

R47 // 5 Nov Group A Session 1

Quote 13

其實我自己公司 office 的天台擺放了十個 kilowatts 的太陽能板，其實在個過程裏面，是一個很艱苦的過程，我是要找 structural engineer 去計數入則，我要同保險公司 傾，我特地找一個有天台的 office，好老實講我當一個 showcase，但我的保險費增加了很多…我是 encounter 了很多很多問題。

Actually on the rooftop of my office, I have displayed a solar PV system of 10 kW. However, it was a difficult process. I had to find a structural engineer to do the calculations and conduct the Plan Submission and talk with the insurance company. I specified that I wanted to find an office with a rooftop. I wanted to use [the solar PV system] as a showcase, but my insurance premium increased a lot…I encountered many problems…

CI19 // 4 Nov Plenary

Quote 14

We have explored the potential of having solar panels installed at the airport…financially, they are concerned about the payback...without any financial subsidy, measures here, it is talking about over 40 years than their threshold. So relatively, they would rather invest in other energy saving measures that is more financially feasible… We are also looking forward to see if the government can offer some kind of incentives to make it feasible.

CI15 // 4 Nov Group C Session 1

Quote 15

因為有個設施，方便啲，唔使自己處理，我只需要搵返相關公司佢就比到 services 我地，搞掂哂所有野。又唔使承擔風險，唔使擔心。
Because [the installers] have the equipment and facilities, it is convenient and I don’t need to take care of it. I just need to find the company and they can service me and take care of it all. I don’t need to take on the risks, and I don’t need to worry.”

R09 // Interview

Quote 16

因為自從有 ibonds 之後，大家對債券認識多左，咁我諗都係錢問題。可能就算係唔話係為左可再生能源，只要有債券個名，都有人去買。買買下認識多左都會了解原來個債券係對可再生能源有用，咁 D 人先從中認識多 D 認同多左。然後先做到下一步嘅野。
Since the creation of iBonds, everyone has become more familiar with bonds. I don’t think it is an issue of money. Even if it is for renewable energy, just knowing that it is a bond will make people want to go buy it. The more they buy, the more they learn that bonds can help

renewable energy development. Then, more people will learn and recognise it. Then, we can move onto the next step.

R33 // Interview

Quote 17

100 蚊，50 蚊都得嘅。因為如果係你對個環保有幫助你都要付出嫁啦。

$100 or $50 is acceptable, because if you want to help out the environment, you have to pay your part.

R35 // Interview

Quote 18

不願意。宜家都好貴嫁喇，仲要比? 支持太陽能發展姐，宜家講緊全香港人用太陽能咁就可以比。但宜家唔係全香港人都用到，而我享用唔到我就緊係唔制。如果係講緊呢 D 太陽能板係可以供到比全香港用戶，我比 100 蚊就可以。但如果係純粹 for D 有得用太陽能板嘅人，咁我就唔可以。全香港人去補貼一少眾人，咁就唔得。

No, I am not willing to pay. Right now, [the electricity tariff] is already expensive. Why give more? Although it is to support solar energy development, right now we are talking about everyone in Hong Kong to support solar energy and thus have to pay. But right now, not everyone in Hong Kong can do so. If I cannot use it, then of course I won't pay. If we are saying that these solar PV panels can supply electricity to all of Hong Kong households, then I can pay $100. But if it is for simply those who have solar PV panels, then I will not. I don't want all of Hong Kong to subsidise only a handful of people.

R11 // Interview

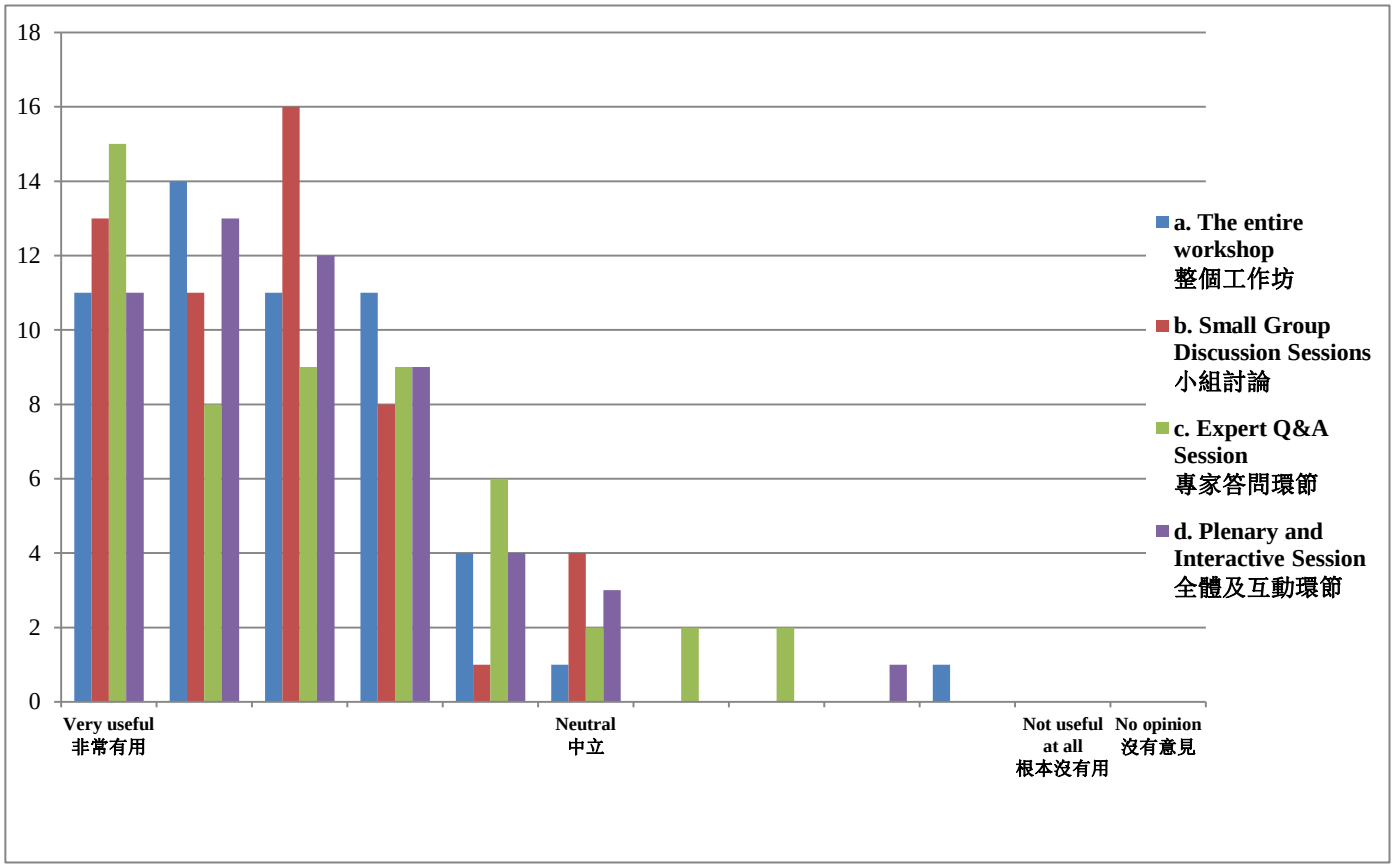
Quote 19

我想阻力主要來自物業管理公司，或者來自法團…係管業處既原則或者立案法團裏面嘅人覺得呢樣嘢有利益或者影響到全座，我諗呢個係最主要嘅問題。
I think the resistance is coming from the property management company, or the Owners' Corporation …it is the property management company's rules or people within the Owners' Corporation that think that the interests of [solar PV panels] may affect the entire housing block. I think this is the main problem.

EP 5 // 4 Nov Expert Q&A

Appendix 5) Workshop Participants' Evaluations of the Workshop

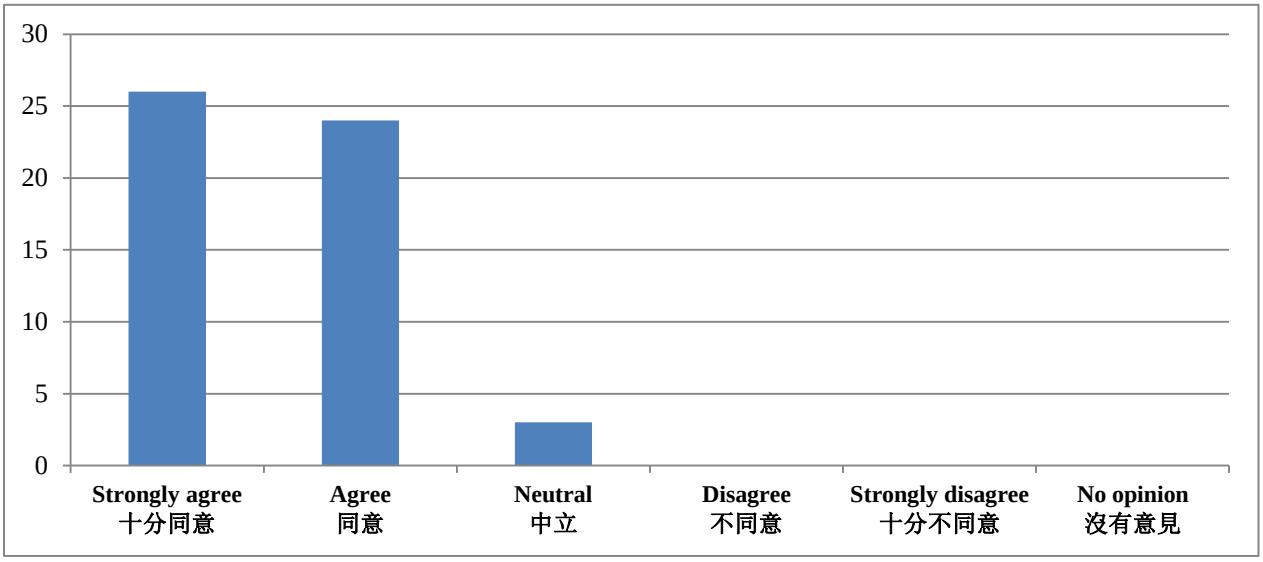
(i) Usefulness of the workshop and workshop sessions



(ii) Small Group dynamics

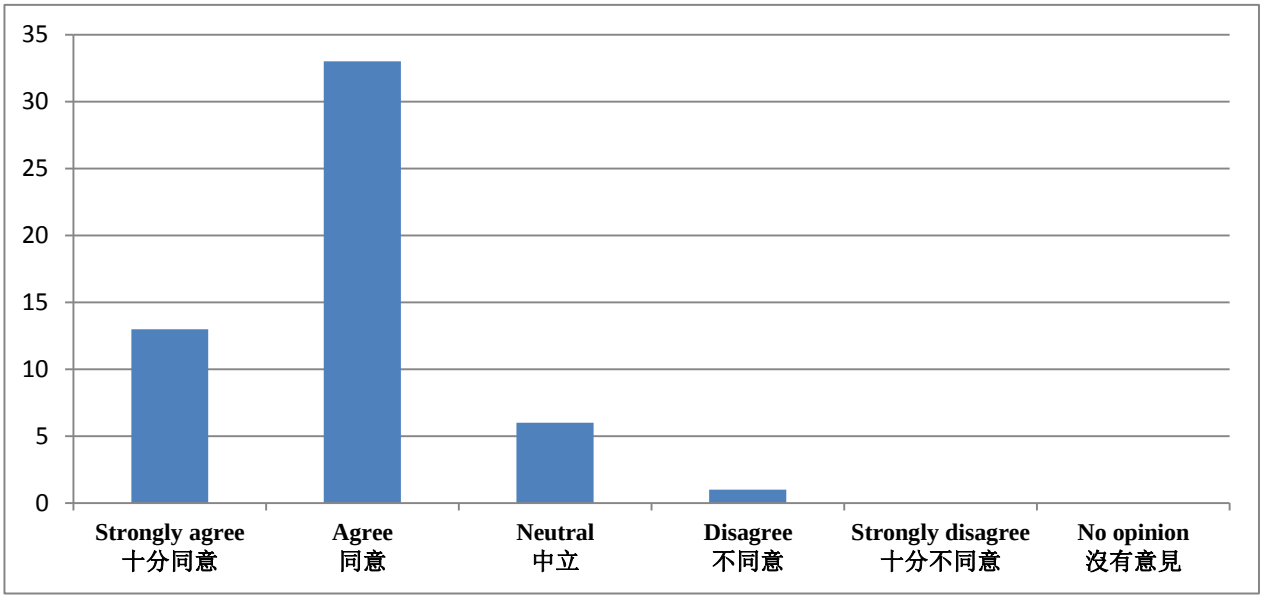
1) Equal Opportunity to Participate

Question: "My small group moderator provided the opportunity for everyone to participate in the discussion."



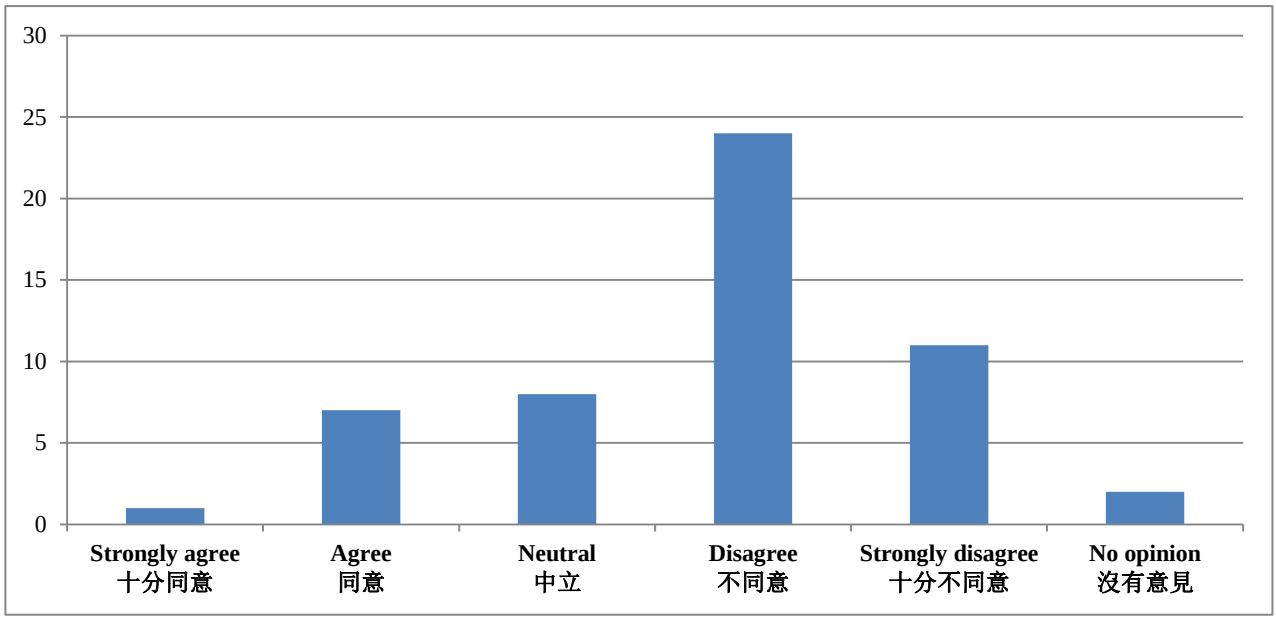
2) Equal Participation of Small Group Members

Question: "The members of my small group participated relatively equally in the discussions"



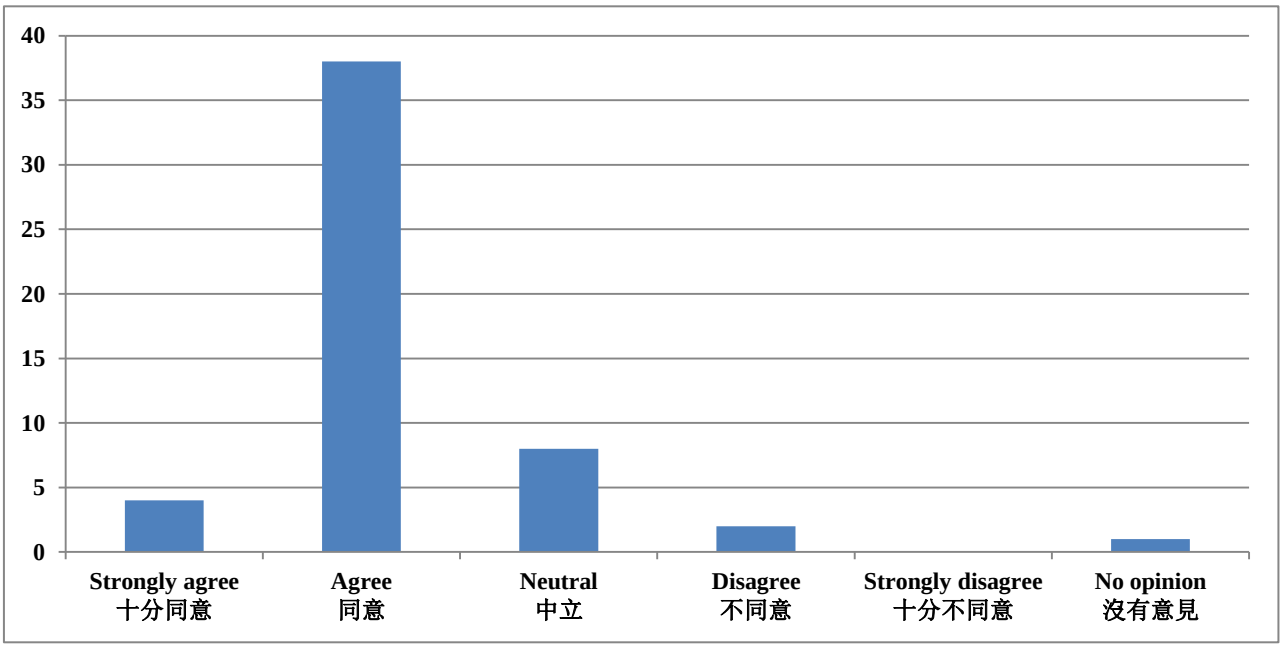
3) Impartiality of the Small Group Moderator

Question: "My small group moderator sometimes tried to influence the group with his or her own views."



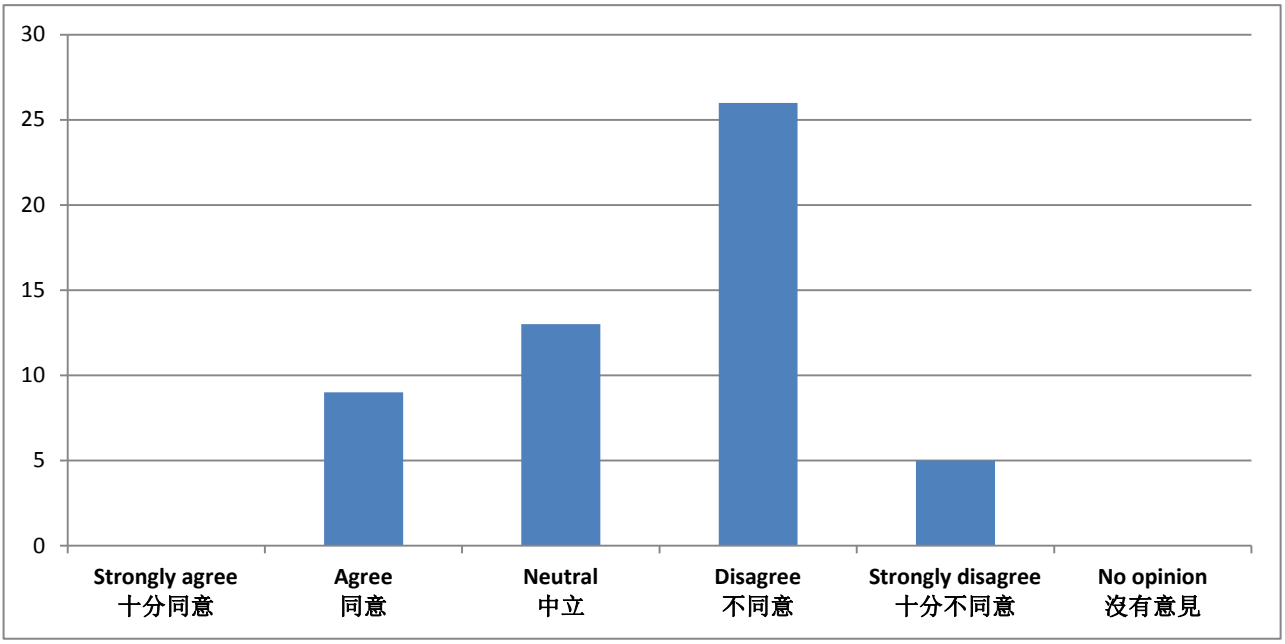
4) Moderator Ensuring the Consideration of Opposing Arguments

Question: "My small group moderator tried to make sure that opposing arguments were considered."



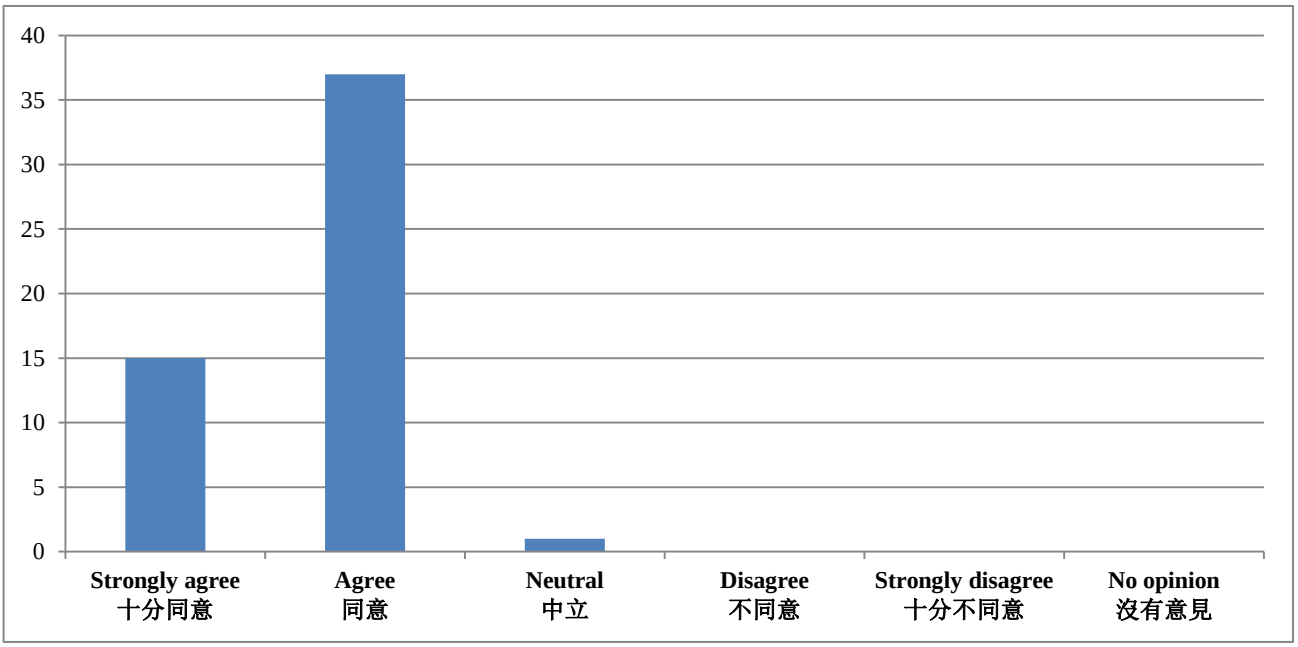
5. Dominance of Members in Small Group Discussions

Question: "My small group discussion was dominated by a few members."



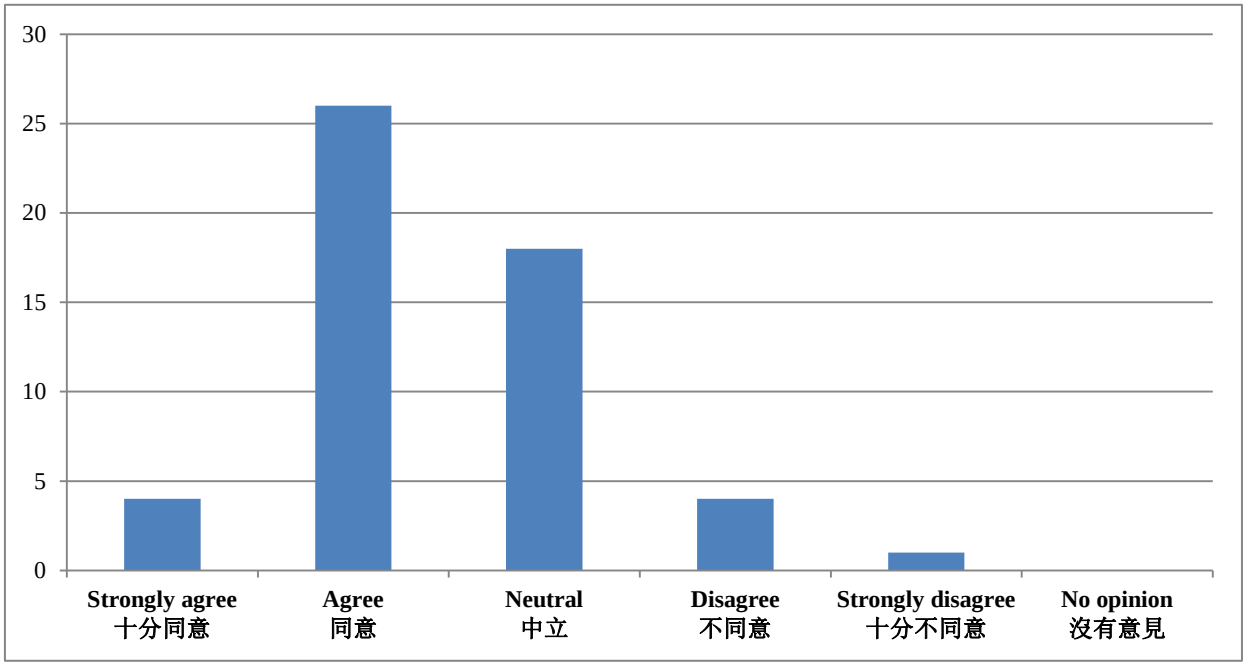
6. Respect for Others' Points of View

Question: "The members of my small group did respect each other's views."



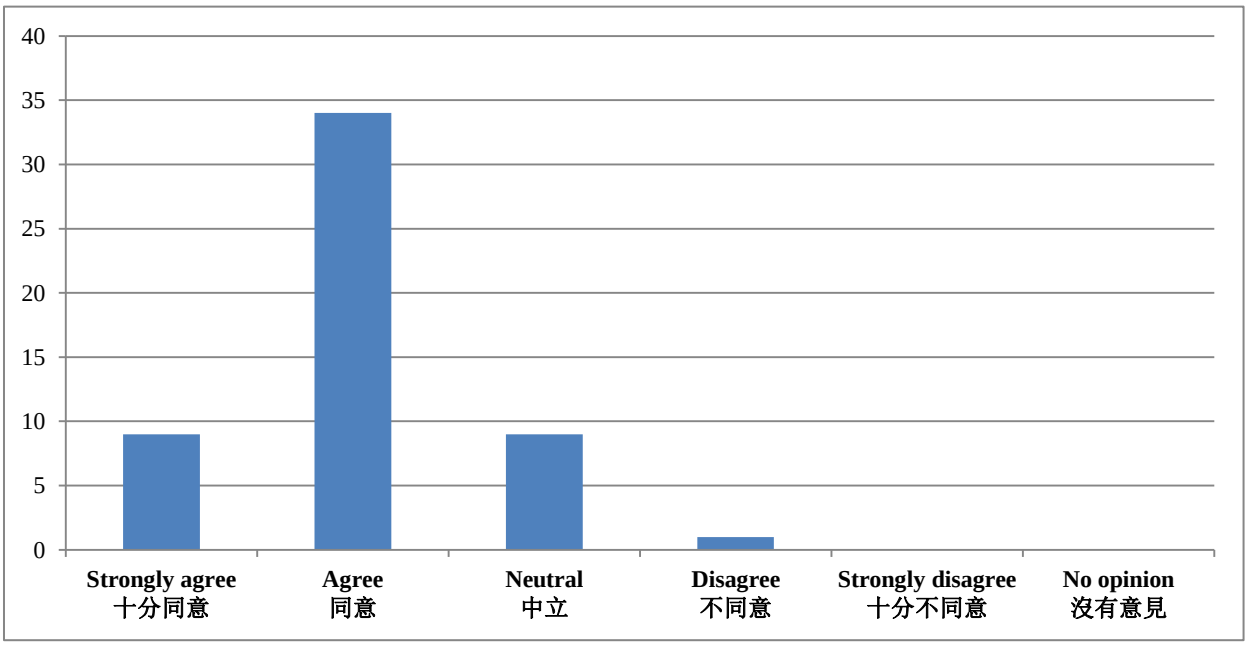
(ii) Expert Q&A Session

Question: "The Expert Q&A Session addressed the questions raised by my group."



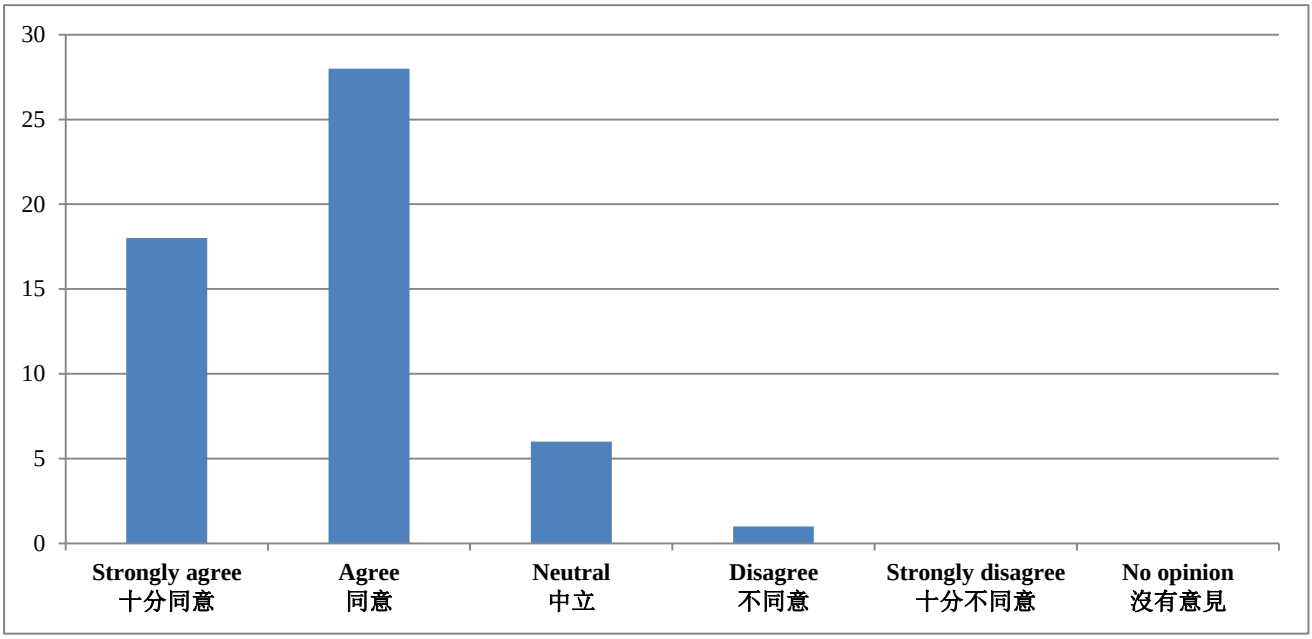
(iii) Balanced Presentation of Arguments in Briefing Document

Question: "The briefing document presented competing arguments fairly."



(iv) Workshop as a whole in improving participants' understanding

Question: "This workshop as a whole has helped me understand the subject matters."



Appendix 6: Briefing Document (In Chinese)

香港太陽能政策發展工作坊

簡介文件

工作坊(第一場): 2016 年 11 月 4 日 (星期五)， 上午 9:30-下午 1:00

工作坊(第二場): 2016 年 11 月 5 日 (星期六) ， 下午 2:00 – 5:30

地點: 香港浸會大學

贊助機構

GREENPEACE 綠色和平

WWF

主辦機構

Asian ENERGY STUDIES CENTRE

協辦機構

Center for Deliberative Democracy

Geography

香港城市大學 City University of Hong Kong 能源及環境學院 SCHOOL OF ENERGY AND ENVIRONMENT

DEPARTMENT OF GEOGRAPHY

支持機構

思匯 CIVIC EXCHANGE

目錄

附件

1. 引言

1.1 前言

能源，尤其是電力，深入社會各個階層並發揮着重要的影響力。然而全球能源需求不斷增長，令碳排放量持續上升，造成氣候變化，帶來很多環境、經濟以及社會的問題。近年隨着太陽能發電的規模越來越大，太陽能發電的成本已大為下降，不少海外城市(例如紐約、倫敦、新加坡)正以創新的模式，配合積極的相關政策，大力推動太陽能發電。在香港，太陽能的發展雖經長期討論，但其應用規模卻仍然十分有限，現時只佔全港電力裝機總容量的 0.02%。太陽能對香港的可持續發展可以起着舉足輕重的作用，但我們如何在香港獨特地理及城市條件下，可以有效地促進太陽能發展呢?

此工作坊目的是邀請來自各個界別的市民，分享您們對於「香港發展太陽能」這一重要議題的寶貴意見。

作為香港特別行政區政府能源諮詢委員會的現任主席， 我熱烈歡迎大家參與這次商議式工作坊。透過這工作坊，政府將會聆聽到您的寶貴意見，您的建議將可能影響日後相關政策的制定。

我衷心希望您們享受今次商議式的討論過程。

「作為香港特別行政區政府能源諮詢委員會的現任主席， 我熱烈歡迎大家參與是次商議式工作坊。透過本次工作坊，政府將會聆聽到您的寶貴意見，您的建議將可能影響日後相關政策的制定。」

蘇偉文教授

蘇偉文教授
大會主席
香港特別行政區政府能源諮詢委員會主席
香港浸會大學持續教育學院院長

1.2 歡迎辭及鳴謝

今天這場工作坊正正因為有您們的參與，才變得重要。我們衷心感謝您們每一位，感謝您們願意抽空來到這個工作坊，與我們一起商討太陽能發電在香港未來的角色。

這工作坊的設計，是採用了美國史丹福大學開發的「商議式民意調查」方法。顧名思義，商議就是商量、議論。我們將透過小組討論、專家答問交流、大會互動等環節，讓您與其他參與者討論各自不同的意見，您亦可以向專家提問、或者邀請專家為您澄清一些重要的資料或觀點。究竟太陽能發電在香港有何角色、機遇和政策挑戰? 這工作坊的目的，是提供一個讓大家共聚一堂的平台，讓您們及其他持份者就這些重要問題，進行討論和商議，經過深思熟慮後再作出自己的結論。

這份「簡介文件」是這次工作坊的關鍵組成部份，這文件為您們提供一個簡要的概覽，幫助您們了解太陽能發電在全球及本地的發展概況、發展過程中遇到的障礙、各大太陽能政策的利與弊等。請大家在出席前抽空細閱這簡介文件，在工作坊期間亦可隨時拿出來參考。

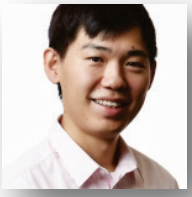
最後, 我們衷心感謝在這個行業的專家們， 為這份簡介文件的初稿給予意見。 另外，我們也感謝綠色和平、世界自然基金會香港分會和香港浸會大學學術研究委員會的撥款支持。

籌備委員會敬啟

籌備委員會

馬雅燕

香港浸會大學
亞洲能源研究中心主任
地理系助理教授



盧笛聲

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姚思

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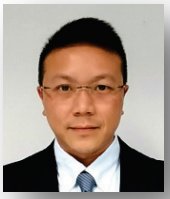
地理系教授

蕭敏瑩

史丹福大學
商議式民主中心
副總監



梁國熙

香港城市大學
能源及環境學院
副院長及教授

盧宇航

香港大學
地理系
助理教授

1.3工作坊概覽及程序

香港太陽能政策發展工作坊

工作坊(第一場): 2016年11月4日 (星期五)， 上午 9:30 – 下午1:00 // AAB 1312

工作坊(第二場): 2016年11月5日 (星期六) ， 下午 2:00 – 5:30 // AAB 505

地點： 九龍塘香港浸會大學教學及行政大樓 (AAB)

時間及場地		環節
工作坊(第一場) **11 月 4 日 (五)** 上午 **9:30** -下午 **1:00**	工作坊(第二場) **11 月 5 日 (六)** 下午 **2:00 - 5:30**	
上午 **9:15-9:30** *AAB 1312 室外*	下午 **1:45-2:00** *AAB505 室外*	登記 *茶點招待*
9:30-9:45 *AAB 1312 室*	**2:00-2:15** *AAB 505 室*	致歡迎辭及簡介
9:45-10:30 *請參閱下列小組房間表*	**2:15-3:00** *請參閱下列小組房間表*	小組討論（一）
10:30-11:30 *AAB 1312 室*	**3:00-4:00** *AAB 505 室*	專家答問環節 *主題一：太陽能的發展潛力與技術挑戰* *主題二：太陽能發電成本及其對電費影響* *主題三：政策與規管*
11:30-11:35 *AAB 1312 室*	**4:00-4:05** *AAB505 室*	簡介「香港太陽能地圖」
11:35-11:45 *AAB 1312 室外*	**4:05-4:15** *AAB505 室外*	小休
上午 **11:45**-下午 **12:30** *請參閱下列小組房間表*	**4:15-5:00** *請參閱下列小組房間表*	小組討論（二）
12:30-1:00 *AAB 1312 室*	**5:00-5:30** *AAB 505 室*	全體互動環節 *總結*
		工作坊完結
1:00-1:30 *AAB 1214 室*	**5:30-6:00** *AAB 1214 室*	「香港太陽能地圖」體驗工作坊——自願參與 *（有興趣的參與者在工作坊結束後請留步）*

小組房間	工作坊(第一場) **11 月 4 日 (五)**	工作坊(第二場) **11 月 5 日 (六)**
小組 **A**	*AAB 1312 室*	*AAB 505 室*
小組 **B**	*AAB 1217 室*	*AAB 506 室*
小組 **C**	*AAB 704 室*	*AAB 507 室*

2. 太陽能發電：為什麼和香港息息相關？

重點：

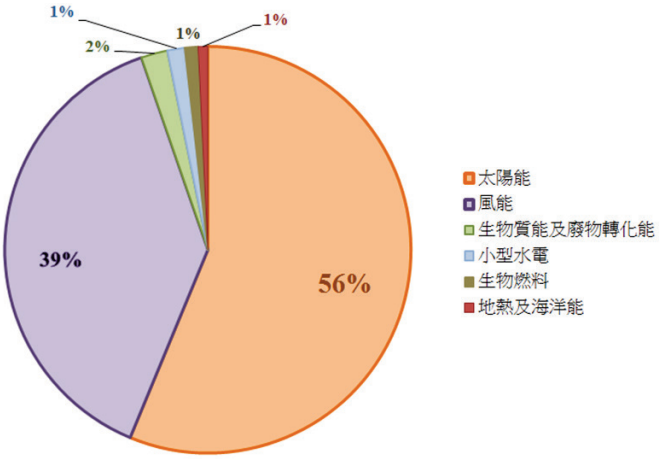
- 太陽能發電科技曾經是昂貴的科技，其成本近年已大幅下降，科技亦發展得更加成熟，預料它的成本將進一步降低。
- 太陽能近年成為可再生能源投資的主要組合。估計到了本世紀中，太陽能發電系統將供應全球四分之一電力。
- 太陽能是清潔能源，其發電系統較化石燃料的發電系統排放更少溫室氣體，帶來較少污染。太陽能發電系統在生產至退役期間，或會產生一些環境影響，現時有不同的方法來處理有關問題，例如循環再用一些零部件。
- 雖然香港發展太陽能已有多年歷史，但其應用規模卻仍然十分有限，現時只佔全港電力總裝機容量的 0.02%。

2.1 太陽能的全球發展趨勢及與香港之關係

趨勢 1：預計全球的太陽能發電系統在未來十年可產生顯著的發電量，預計小型太陽能發電系統容量也會上升。

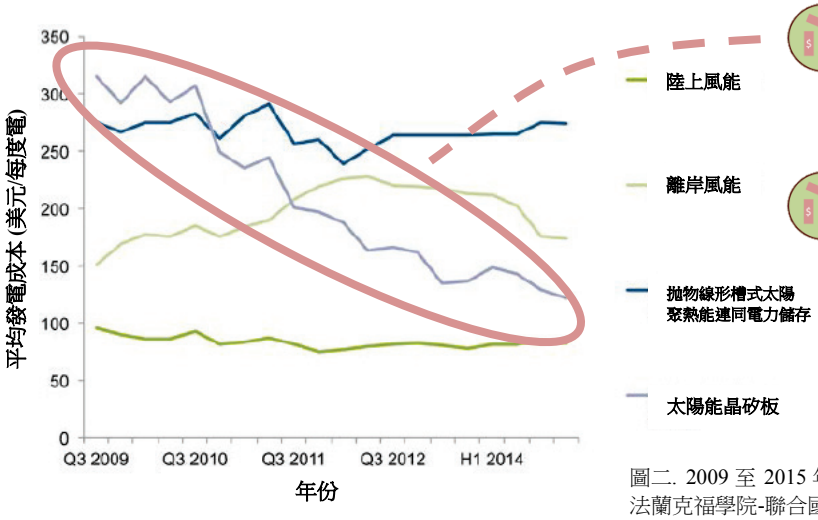
國際能源署(International Energy Agency)預測到了 2050 年，太陽能將為全球提供 22%的電力供應。此外，彭博新能源財經預計，到了 2040 年，全球超過 10%的太陽能發電裝機容量將來自小型太陽能發電系統。

你知道嗎？2015 年，太陽能發電只佔全球發電裝機容量的 2.9%，但是預計這百分比在未來數十年間將會大幅上升。



圖一. **2015 年，超過一半的可再生能源總投資由太陽發電組成 *(1,610 億美元)***，節錄自法蘭克福學院-聯合國環境規劃署和 BNEF 的作者們 (2016)

趨勢 2：最近數十年間，太陽能發電系統的成本已大幅度下降，成為具經濟競爭力的能源科技。

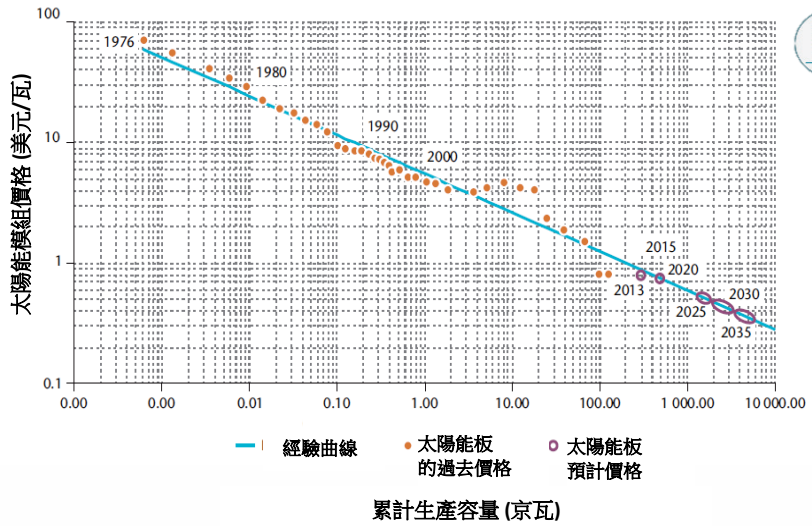


由 2009 至 2015 年，矽晶製太陽能板的平均發電成本(Levelised cost of electricity)下降超過一半，由每兆瓦時剛逾 300 美元降至每兆瓦時 150 美元。

當公用發電規模的太陽能發電系統越來越具競爭力，小型太陽能發電系統的售電價格在已發展的經濟體系可與電網看齊 (grid parity)，即是太陽能發電用戶的太陽能發電成本， 相等於或低於向電網購電的價格。

圖二. 2009 至 2015 年間全球風能及太陽能的平均發電成本 (美元/每度電) 轉載自法蘭克福學院-聯合國環境規劃署和 BNEF (2016)

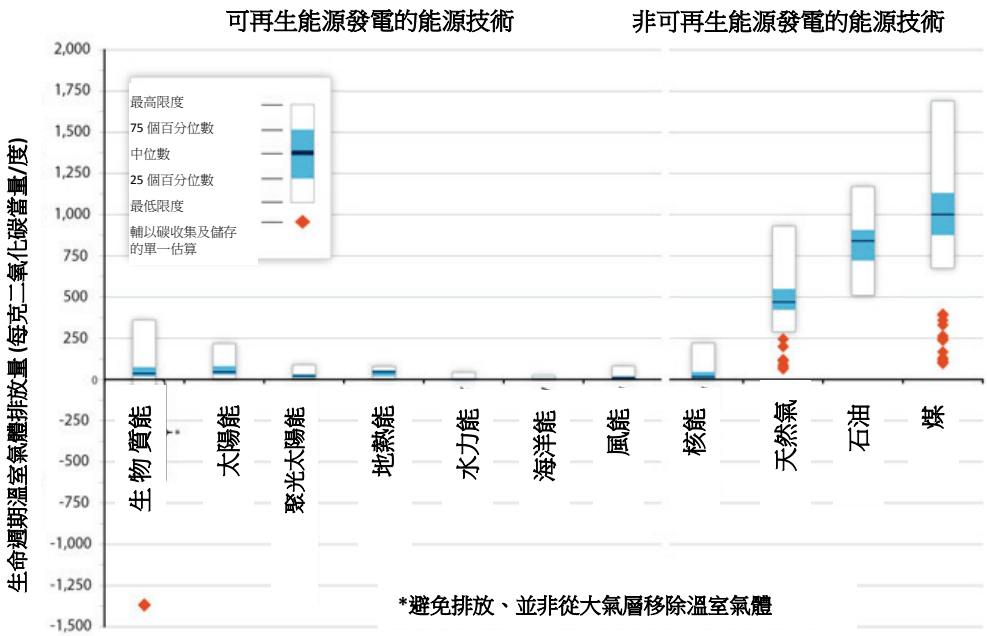
趨勢 3：預計在未來 20 年太陽能發電板的成本將會減半。



根據國際能源署和倫敦帝國學院的研究，太陽能發電板的成本預計在未來 20 年將會繼續下調，由 2015 年大約每瓦 1 美元降至每瓦 0.3-0.5 美元 (圖二)。

圖三. 以往太陽能板的價格及基於國際能源署提供的學習曲線預測太陽能板於 2035 年的價格轉載自 Nelson, Gambhir and Eikins-Daukes (2014)

太陽能發電的環境影響



太陽能資料:
太陽能板用什麼材料製成的?

大部份晶化矽太陽能板(c-si)主要由玻璃組成， 其他物料包括聚合物，鋁、鈔、銅及其他金屬。

圖四. 估算各種能源發電科技在其生命週期所產生的溫室氣體排放轉載自政府間氣候變化專門委員會 (Intergovernmental Panel on Climate Change)

太陽能發電是其中一種低溫室氣體排放的能源科技，比化石能源科技例如煤或天然氣更能減少污染 (圖四) 。

太陽能發電板可能產生環境影響，在其運作前及後也可能產生生命週期排放。這些排放包括開採原材料和製造太陽能板和太陽能系統時所耗用的能源。

太陽能板生命週期完結後的潛在環境影響可藉著妥善的棄置方法或進行部件回收得以緩解，一些地區例如歐盟已制定專門的指引來處理這類廢棄物。

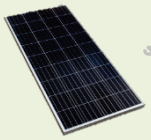
太陽能發電：香港的現況

太陽能發電在香港的規模有限。 直至 2012 年，在香港安裝的太陽能發電系統有 **2.2** 兆瓦，僅佔全港電力系統的總裝機容量 **0.02%** (圖五) 。

香港現有的一些太陽能系統，坐落於專上學院的建築物、商業大廈和住宅樓宇，主要作為教育、研究和示範用途，如圖六 a 至 d 所見。

雖然香港目前缺乏一個明確的可再生能源目標 ，但香港政府在近年出版的能源和氣候諮詢文件中，均有提及發展可再生能源(圖七) 。

小型可再生能源並網系統的數目

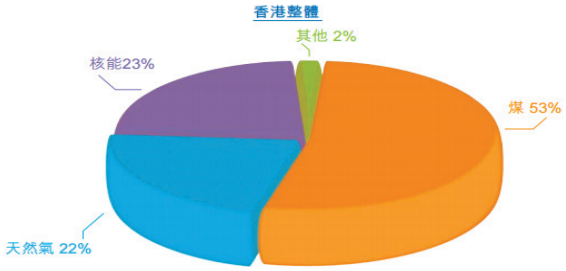


超過 230

超過 60

CLP 中電

港燈 HK Electric



圖五. 2012 年香港的發電能源組合(環境局，2014)

*香港的發電系統總容量為 12,645 兆瓦，主要由化石燃料 (超過 70%) 和核能 (23%)組成，餘下的2% 來自可再生能源和油。*香港的兩家電力公司計劃在未來數年以天然氣發電機組取代部分燃煤發電機組。

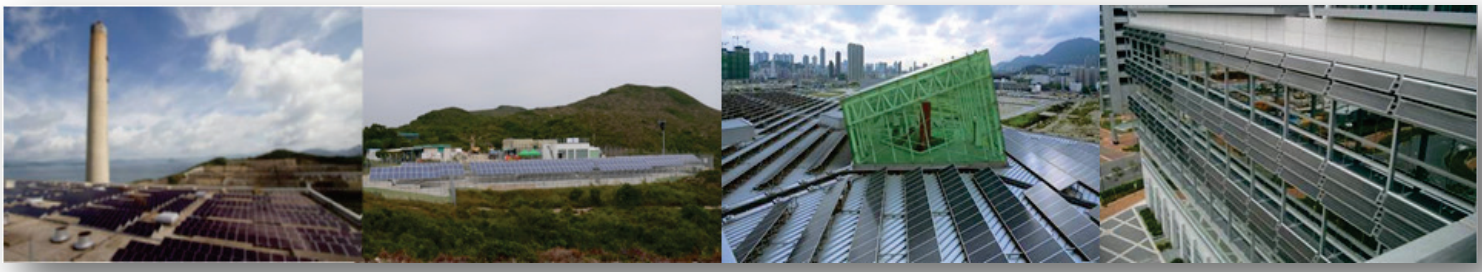


圖 六 a. 港燈位於南丫島發電廠的 1 兆瓦系統

圖六 b. 中華電力公司位於西貢附近火頭墳洲的 180 千瓦 系統

圖六 c. 九龍灣機電工程署新總部大樓的 350 千瓦系統

圖六 d. 科學園內與建築物整合的 198 千瓦系統

圖七. 香港近年的能源和氣候諮詢文件和報告書

出版日期	2010年9月	2014年3月	2015年3月	2015年5月	2015年11月
諮詢文件和報告書	香港應對氣候變化策略及行動綱領：公眾諮詢文件	未來發電燃料組合諮詢文件	電力市場未來發展公眾諮詢文件	香港都市節能藍圖 2015~2025+	香港氣候變化報告2015

2.2 香港發展太陽能的若干關鍵議題

重點：

- 香港有不錯的太陽能發電潛力，太陽能電力除了可減少溫室氣體排放，亦有可能供應用電高峰期的部份用電需求。
- 香港電力系統的穩定性屬世界一流，備用發電容量亦維持在高水平。目前，香港的太陽能發電系統僅佔全港總發電裝機容量的 0.02%；一般來說，即使區域性電網有 15%的發電來自分佈式的可再生能源，其電網穩定性亦不會受到影響。香港將來若進行大規模的太陽能發展，有可能會影響電網的穩定性，我們可以考慮採用不同的方法，來處理這問題。
- 太陽能發電有可能令電價上升，但有研究顯示香港市民願意付較高的電費來支持可再生能源的發展。
- 大規模發展太陽能需要政策和規管來克服不同的障礙。

香港大力發展太陽能發電的關鍵議題和障礙

香港發展太陽能發電的規模視乎很多因素，若果要進行大規模及高速發展需要檢視以下四大議題：

太陽能潛力

成本及其對電費影響

技術挑戰：
間歇性的供應和接駁電網限制

政策及規管

關鍵議題一：香港的太陽能潛力

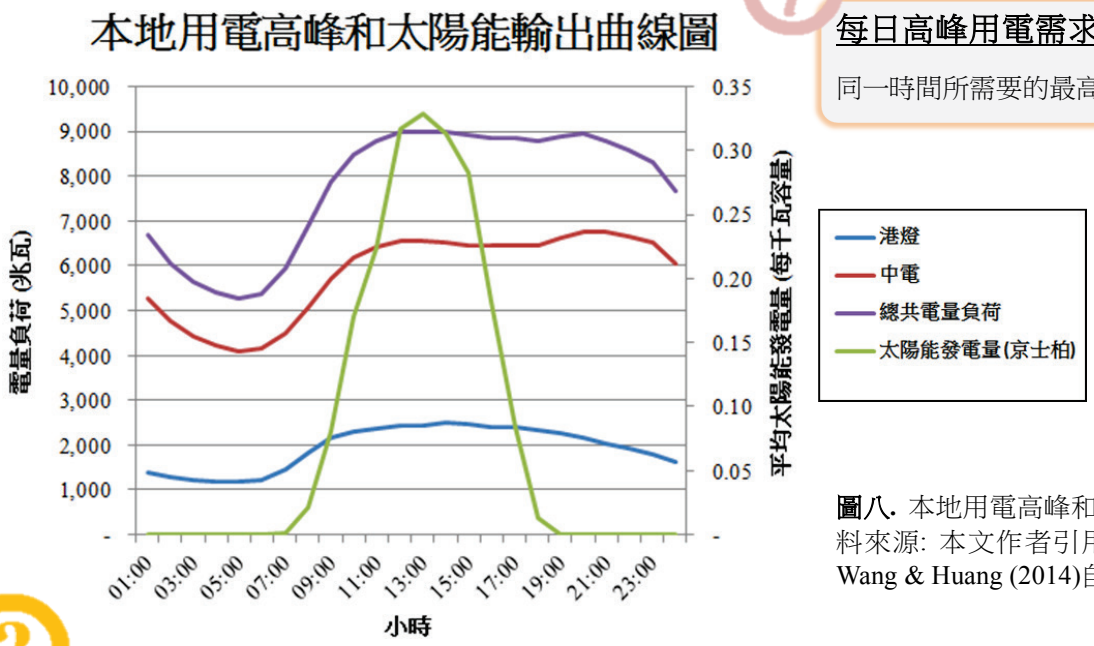
這議題為何重要？

每一個國家、城市、地區的太陽能的技術潛力(technical potential)，均可透過科學的研究方法作出客觀評估。這些客觀數據，有助政府及能源政策的持份者(包括電力公司、市民)評估當地的太陽能發展前景，以及訂立具體的太陽能發展目標。

我們已經知道什麼？

- **香港有良好的太陽能潛力**。本地的研究顯示香港的太陽能發電潛力介乎 5.9% 至 35% 之間(詳情請參閱附件一)。您可以參閱附件二，比較一下香港和其他海外大城市的太陽能發電潛力。
- **香港的每日高峰用電需求與中午時段太陽能發電量高峰期吻合 (圖八)**。2012 年, 在香港高用電量的日子中，高峰用電需求於下午二時(9,001 兆瓦)和晚上八時出現 (8,936 兆瓦) 。圖八顯示中午用電高峰與太陽能產電高峰同時出現，而一些本地研究及模擬研究也指出在高峰或接近高峰用電期間，太陽能系統能夠發揮最高的產電能力，顯示兩者可以相配合。
- **香港具備良好的全年日照量**，根據香港天文台資料，香港全年皆接收太陽幅射，並在夏季錄得較高的日照量。

每日高峰用電需求: 指所有電力用戶在每日的同一時間所需要的最高用電量。



圖八. 本地用電高峰和太陽能輸出曲線圖. (資料來源: 本文作者引用香港政府 (2013a) and Wang & Huang (2014)自行製作)

我們還需要知道什麼？

- *太陽能發電在香港是否一個可行的能源選擇?*
- *香港地少人多，如何善用我們的土地、天台和空間發展太陽能?*

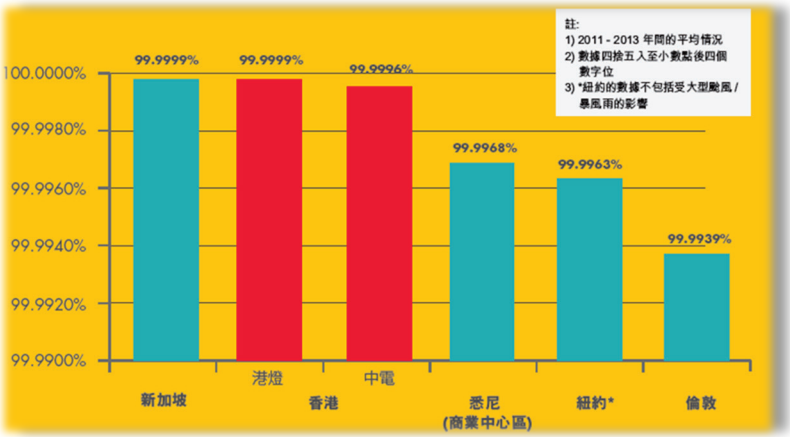
關鍵議題二：技術挑戰：間竭性的供應 (intermittency) 及接駁電網的限制

這議題為何重要？

- 如何把大量太陽能電力接駁入電網同時確保電網的穩定，是影響太陽能發展的其中一項最關鍵的議題。
- 太陽能發電的間歇性供應(例如在陰天，太陽能系統的發電量會下降)，有可能令電網的穩定性下降。
- 在太陽能發電高滲透率的情況下，電網可能由於接收太多或太少電力， 導致電力供求錯配。

我們已經知道什麼？

- 香港電力系統的穩定性屬世界一流(圖九) 。
- 香港電力系統的備用發電容量亦維持在高水平，港燈和中電於 2014 年的後備發電容量分別是 52% 和 26%。
- 目前，香港現有的太陽能發電系統，僅佔全港總裝機容量的 0.02%；而一般來說，地區電網可容納達 15% 的可再生能源，其電網穩定性亦不會受影響。香港將來若進行大規模的太陽能發展，有可能會影響電網的穩定性，我們可以考慮採用不同的方法，來處理這問題(圖十) 。

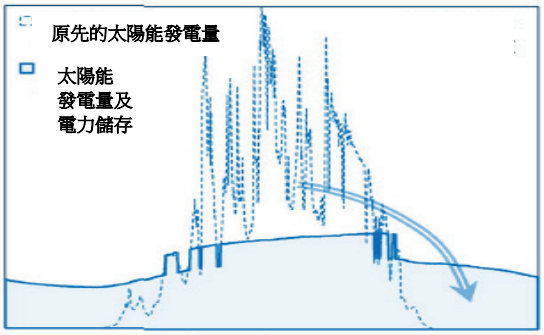


圖九. 香港和海外城市供電可靠性比較 (環境局，2015)

後備發電容量 是電力系統內預留備用的發電容量，以應付發電機組有計劃作出檢修、又或者有機組發生事故障的發電需要，以免影響供電的穩定性。

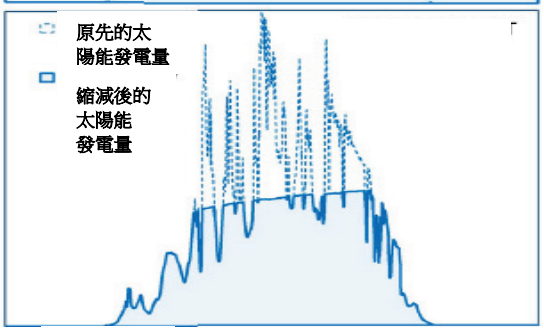
間歇性的供電 (intermittency) 指太陽能的電力供應隨著季節、天氣、或每天不同時間而有所不同，因此出現供應不穩定的情況。

大規模使用太陽能對電網的穩定性可能構成的不良影響: 有何對策?



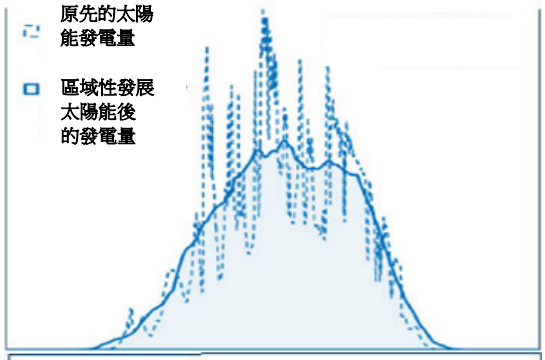
方法 1：電力儲存

把日間產量過剩、無法被電網吸納的太陽能電力，用電池技術儲存起來，留待晚間使用，這可有助削減用電的峰值。



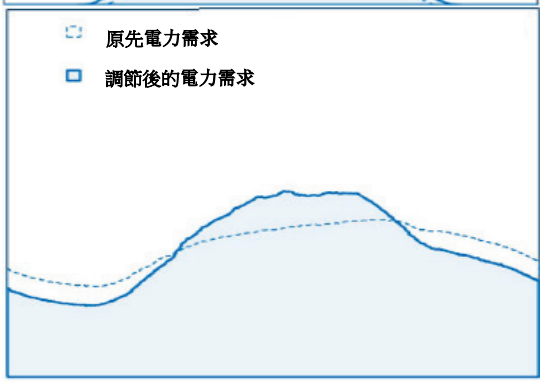
方法 2：縮減

減少太陽能發電量，即停開部份太陽能發電系統以減少其過量的、間歇性輸出對電網造成的影響。



方法 3：區域性發展太陽能的協調作用

透過區域性的太陽能發展，太陽能發電系統能散佈於不同地方或地區，覆蓋的地域面積大、地域多樣化較高，這有利於平衡太陽能發電的輸出量，亦有助降低發電系統因天氣而引致的間歇性電力輸出。



方法 4: 調節用電高峰

通常透過引入浮動的電費價格就可以做到，從而達到「調峰」的效果(即是令電力用戶在高峰時段的部分用電需求，轉移到非高峰時段)，我們減低用電量的同時，利用太陽能的電系統 提供高峰期的用電量。

圖十. 一些應對電網不穩定性的常見措施

我們還需要知道什麼？

- *不同程度的太陽能滲透率對香港的電網有什麼影響？*
- *太陽能發電怎樣影響電網的供電穩定性？*

關鍵議題三：對電費影響及成本

這議題為何重要？

- 普遍來說，可再生能源電力的成本較傳統電力高。
- 太陽能發電有可能減低高峰電力的需求，因而減少增建新電廠的需要，進而減少電費加價壓力。 這是由於最高用電需求，是電力公司規劃所需發電廠容量、以及備用發電容量的最重要指標之一。
- 可再生能源是否物有所值?雖然用更多可再生能源發電，我們的電費可能會上升，但可再生能源可以減少空氣污染和溫室氣體排放，又可以減低一些經濟損失和社會成本(例如公共醫療系統的開支) 。

我們已經知道什麼？

- 與其他海外大城市比較，香港的電費相對便宜。 (請參閱圖十一)
- 發展太陽能發電的其中一個障礙，是不知道它對電價有什麼影響，以及市民是否樂意付較高的電費來購買可再生能源電力。
- 消費者委員會的初步研究顯示，若香港推行 **5%** 的可再生能源上網電價補貼，電費增幅將不超過 **3%**。
- 一些本地研究顯示香港人支持並普遍樂意購買可再生能源電力(詳情請參閱附件三) 。
- 太陽能發電系統的價錢已經顯著下降: **2010** 年至 **2015** 年期間，太陽能發電系統價格共下跌 **60%**，同期的全球太陽能發電系統容量亦因此由 **5** 千兆瓦增加至 **227** 千兆瓦。(請參閱第 **2.1** 節)， 但在香港安裝太陽能的成本仍然高企，這是由於安裝及維修成本仍十分昂貴，令回本期十分長。
- 在香港一間標準村屋(約 700 平方尺)的天台安裝一套太陽能發電系統，大約需要**港幣 $55,000** [1]。

[1] 估計在一間標準村屋(約 700 平方尺)的天台，可以安裝 6 塊太陽能板 (太陽能板普遍尺吋為 1.65 平方米)，以現時市場價格估算，安裝總成本為港幣 55,000 元。該太陽能系統年產電量為 1,560 度 (每天產電 4.27 度)，假設以每度電費港幣 1 元計算，每年可節省 1,560 元，回本期約為 35 年。

您知道每月要繳交多少電費嗎？

電費一覽(每度電)

CLP 中電　　港燈 HK Electric

客戶	每度電收費	客戶	每度電收費
住宅供電	$0.89-$2.01*	住宅供電	$0.92-1.85#
非住宅供電	$1.06-1.23*	商業、工業及雜項供電	$1.30-1.48
高需求供電 大量供電	視乎需求及電力用量	最高負荷供電	視乎負荷及用電量

註:中電和港燈的電力用戶是按用電總量級別計算電費 (a block tariff system)

***中電對低用電量客戶提供回扣，住戶及非住宅客戶電費可以節省每度電約港幣 15.2-17.2 仙。2015 年，約 35%的住宅客戶和 44%的非住宅客戶受惠**

 # 港燈於 2013 年推出「最『惜』節能優惠」，若住宅客戶每月用電不超過 100 度，可享有電費 95 折優惠

註:
- 基於住宅用戶每月平均耗用275度電以作比較。[5]
- 香港的數據採用2015年的淨電費計算。
- 其他國家的數據採用2014年11月的電費及相關貨幣兌換率計算。
- 中電及港燈在2015年的平均電費分別為1.14元及1.35元。

圖十一. 香港和其他海外城市的電費比較 (環境局，2015b)

我們還需要知道什麼？

- ***若香港以較大規模地使用太陽能發電(例如佔香港的發電容量 5-10%)，對電費和電力成本帶來什麼響？***
- ***政府如何更能有效地規管有關的電費影響？例如，香港若推行上網電價補貼政策，政府如何處理交叉補貼的問題?***

*交叉補貼: 即一般的電力用戶(即沒有安裝太陽能發電系統的電力用戶)未能享受這補貼，反而變相要付較高的電費來津貼太陽能發電。

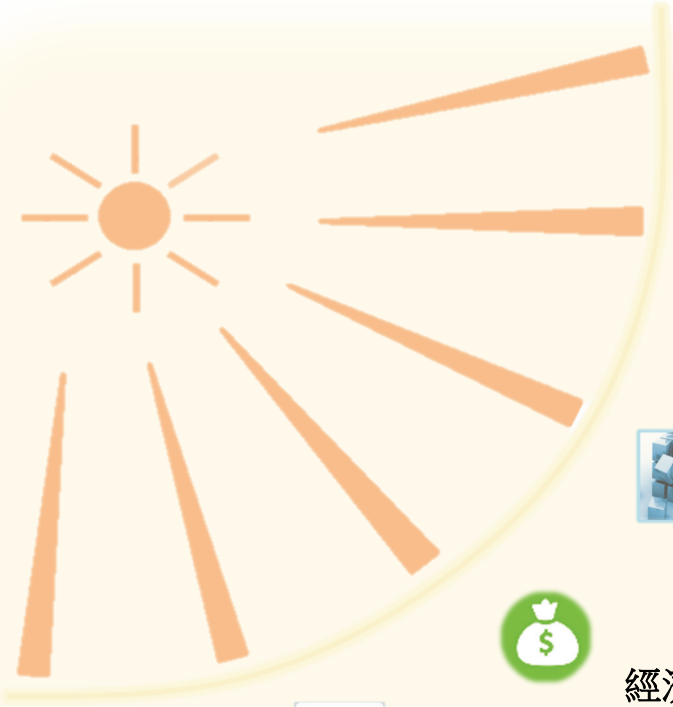
關鍵議題四：政策與規管

這議題為何重要？

- 政策支持能幫助太陽能發展消除不少障礙，令太陽能更有條件與傳統能源發電科技例如煤及天然氣進行競爭。 (請參閱第 *2.1 節*)
- 環顧世界各地，很多政府都積極地推出不同的政策，以推動太陽能的發展。 *(詳情請參閱第 3 節)*

我們已經知道什麼？

- 數項本地研究指出，太陽能的發展在香港面對多種障礙 (參閱圖十二) 。
- 中華電力及香港電燈 --- 兩間地域性壟斷的電力公司(參閱圖十三) --- 受管制計劃協議規管，准許回報根據他們的固定產淨值計算，有不少評論指這規管機制未能為分散式電力生產例如太陽能發電提供足夠誘因 。
- 不少大城市例如紐約、新加坡，都已訂立了發展太陽能的目標，這些城市為推動太陽能發電，訂立了具體的計劃和政策(參閱圖十四; 詳情請參閱附件四)。在香港，我們幾乎完全沒有任何太陽能政策。



體制及規管障礙
缺乏規管誘因

社會障礙
缺乏社區
及持份者參與

市場障礙
基礎服務設施
不足

經濟障礙
回本期長
及投資成本高

技術障礙
空間限制
可再生能源接駁到電網的技術問題

圖十二. 在香港發展太陽能需要面對的多種障礙

電力公司服務區域

圖十三.中電及港燈各自的服務區域

圖十四. 其他大城市的經驗：怎麼運用政策克服發展太陽能的障礙

我們還需要知道什麼？

- *如何強化政策及規管制度，以克服那些障礙以促進太陽能的發展？*
- *例如，規管兩間電力公司的利潤管制協議，能否進行優化，從而為推動太陽能發展提供足夠的激勵？*

3. 五項可能適用於香港的太陽能政策

我們在這部份為您簡單介紹五項香港可能推行的太陽能政策的優點、弱項及其潛在風險。我們稍後在工作坊中碰面時，將圍繞這五大政策進行較深入的討論。附件五將這些政策的優點、弱項和潛在風險表列出來，方便您能對這些政策有概括的了解。如果您想更詳盡的了解所提及的重點，可參考附件六。

五項可能適用於香港的太陽能政策概覽

上網電價補貼

政府與可再生能源發電者簽訂一份長期合約(例如 10 至 20 年)，合約期間發電者每發 1 度電，就可獲得定額且高於正常電價的補貼，即為***每 1 度電提供長期的定額回購價。***

淨計量電價

這是一種計算電費的機制，讓擁有可再生能源發電設備的電力用戶，可以在智能電錶(具備雙向計量功能)的幫助下，將可再生能源的發電量與電力/電網公司的供電量相互抵消。若產生的電力超過實際使用量，則可賣電給電力/電網公司，或累計撥入下個月帳單中(即只計算「淨消費」量)

太陽能板租借服務

用戶不需要購買太陽能發電板，可以透過不同的太陽能板租借的服務模式，例如只需向電力公司(或能源服務中介公司)租借太陽能板及相關設備，每月向其支付固定的設備租金，自發自用，有餘電時賣電給(或存入)電網，不足時從電網買電。政府可以為這綠色行業創造一個健康的市場環境讓其發展，例如政府可要求政府樓宇安裝太陽能系統，從而激發太陽能的本地市場需求。

可再生能源證書

可再生能源證書是一種能源商品，每張證書代表一定數量的可再生能源電量，用戶可將可再生能源證書賣給電力公司賺取收益。這類證書亦可用來審核電力公司是否遵行可再生能源份額制度，以及証實自願購買綠色電力的用戶(例如企業用戶)所宣稱的是否屬實。

可再生能源債券

由政府(或電力公司)以公開發行債券的形式，籌募社會各界的資金，來建立一個「可再生能源債券基金」，專門投資於可再生能源技術的項目，例如大型的太陽能發電場項目。

3.1 上網電價補貼

什麼是上網電價補貼？

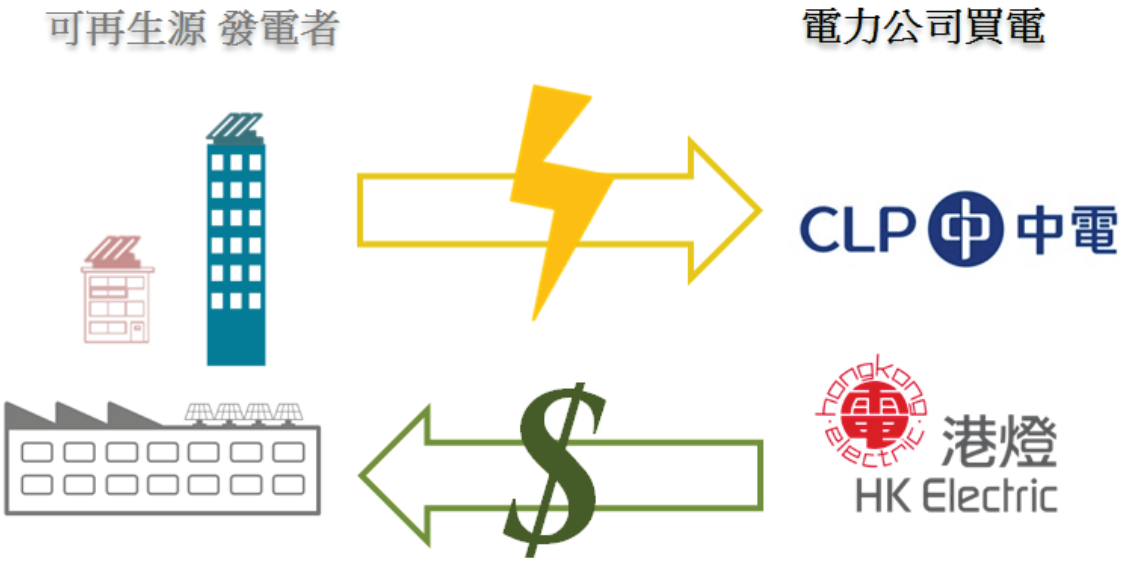
政府與可再生能源發電者簽訂一份長期合約(例如 10 至 20 年)，合約期間發電者每發 1 度電，就可獲得定額且高於正常電價的電價補貼，即為*每 1 度電提供長期的定額回購價。*

特點

① 發電者將每度可再生能源電以固定的價錢賣給電網*譬如每度電港幣 2 元*

② 發電者可有長期穩定的收益

③ 發電系統一般都可以接駁到電網



優點

- 能有效提高太陽能的發電規模、開拓市場、孕育本土工業，帶來社會、經濟、環保和能源安全等益處
- 太陽能的投資者有較長期的保障，固定價錢和減低的投資風險
- 可鼓勵投資者(包括工業及住宅的電力用戶)發展中小型的太陽能發電系統
- 交易成本低，並且容易融資及參與

弱項

- 難於設定補貼電價；隨着市場的發展(例如當太陽能發電的成本明顯下降)，政府及電力企業需調整上網電價，否則用戶可能需繳付不合理的高電費

潛在風險

- 有可能令電費上升
- 這政策實施後，一旦要下調上網電價的補貼，太陽能投資者及一些持份者有可能會反對，為政府帶來政治風險
- 交叉補貼：一般的電力用戶(即沒有安裝太陽能發電系統的電力用戶)未能享受這補貼，反而變相要付較高的電價來津貼太陽能發電的投資者
- 政策要執行到位; 上網電價補貼成功與否，很視乎政策推出後太陽能投資者的實際投資行為

註：您可於附件五中比較這五大政策的優點、弱項和潛在風險。

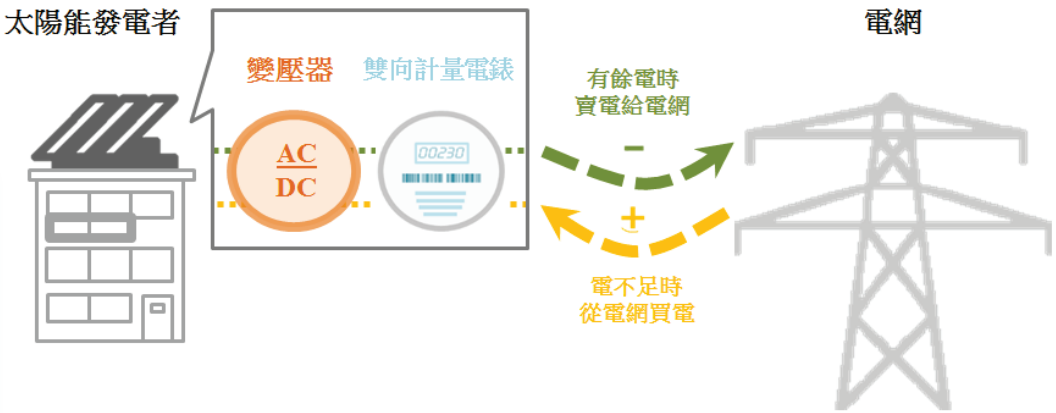
3.2 淨計量電價

什麼是淨計量電價？

這是一種計算電費的機制，讓擁有可再生能源發電設備的電力用戶，可以在智能電錶(具備雙向計量功能)的幫助下，將可再生能源的發電量與電力/電網公司的供電量相互抵消。若產生的電力超過實際使用量，則可賣電給電力/電網公司，或累計撥入下個月帳單中(即只計算「淨消費」量)。

特點

①自發自用，多餘電量上網
② 發電售電並存
③ 需要智能電錶的輔助
④ 發電系統接駁到電網
⑤ 對小型的家居太陽能發電設施尤其重要



優點

- 太陽能產電用戶(例如家居或商業用戶)，若有剩餘的太陽能電力，可以賣電給電力公司，從而抵銷部分的電費開支
- 較容易管理
- 長遠來說，有助促進太陽能電價的制訂
- 可鼓勵投資者(包括工業及住宅的電力用戶)發展中小型的太陽能發電系統

弱項

- 推動發電廠規模的太陽能系統的效果較低
- 非太陽能發電的電力用戶可能交叉補貼太陽能發電用戶
- 通常單憑淨計量電價不能大幅增加可再生能源(例如太陽能發電) 的市場滲透率

潛在風險

- 有可能令電費上升
- 投資保障較低
- 電力公司的收入或會減少，因為自行產電的用戶會減少從電網購電
- 電力公司可能面對增加從標準電費收回成本的風險 (隨著時間降低發電資產的價值)

註：您可於附件五中比較這五大政策的優點、弱項和潛在風險。

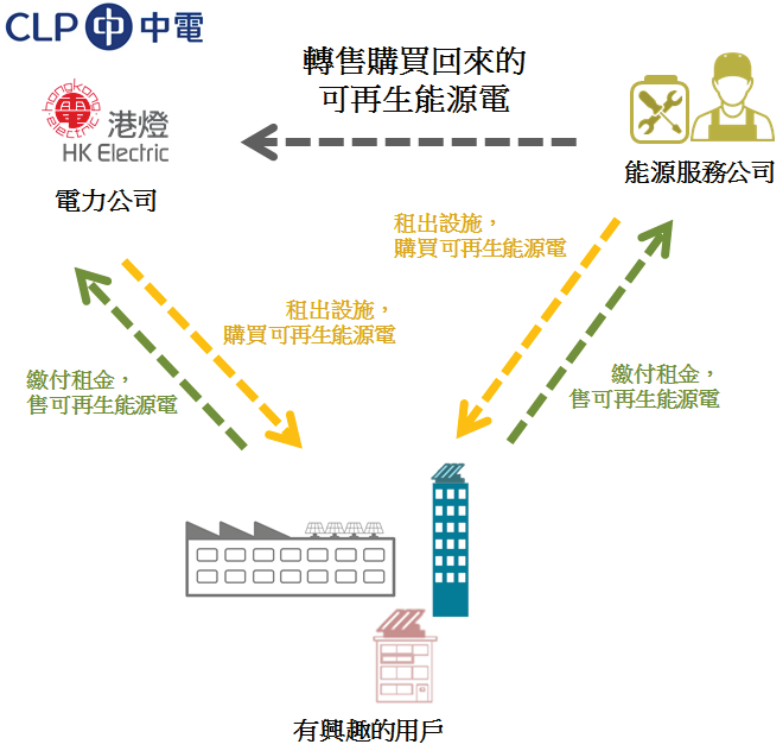
3.3 太陽能板租借服務

什麼是太陽能板租借服務？

用戶不需要購買太陽能發電板，可以透過不同的太陽能板租借的服務模式，自發自用，有餘電時賣電給(或存入)電網，不足時從電網買電。政府可以為這綠色行業創造一個健康的市場環境讓其發展，例如政府可要求政府樓宇安裝太陽能系統，從而激發太陽能的本地市場需求。

特點

① 承租人不需要購買太陽能設備
② 承租人擁有太陽能設備使用權
③ 承租人每個月可能獲得收益，亦可能蝕錢



優點

- 很多海外經驗印證了太陽能板租借服務能有效促進天台太陽能項目的發展
- 減低安裝太陽能發電系統的成本
- 大廈業主毋須購買或擁有太陽能發現系統，仍然可以享有太陽能帶來的好處
- 大廈業主只承擔低至接近零的系統運行及維修責任，租借安排能大大減低大廈業主面對的技術風險
- 由於租借安排降低安裝太陽能系統的「入場門檻」，因此能更有彈性地容讓不同收入的住戶、不同樓宇類型來參與太陽能的發展
- 太陽能的投資者可從中獲得潛在的稅收優惠 (例如稅收減免)

弱項

- 小型的太陽能發電系統，可能仍需面對項目本身財務可行性的問題
- 由於合約是長期，短期租屋住戶可能未必適合

潛在風險

- 零部件風險，例如部件使用期間受到破壞或屋頂受到破壞
- 有市場風險，例如有可能出現違約及不付款的問題，以及小型能源服務公司可能倒閉；進入這市場的太陽能服務公司，需要達到良好的信用，又或者達到最低信用要求
- 持份者可能面對一系列問題，包括太陽能發電系統的產電能力較預期低、 意想不到的運作和維護成本

註：您可於附件五中比較這五大政策的優點、弱項和潛在風險。

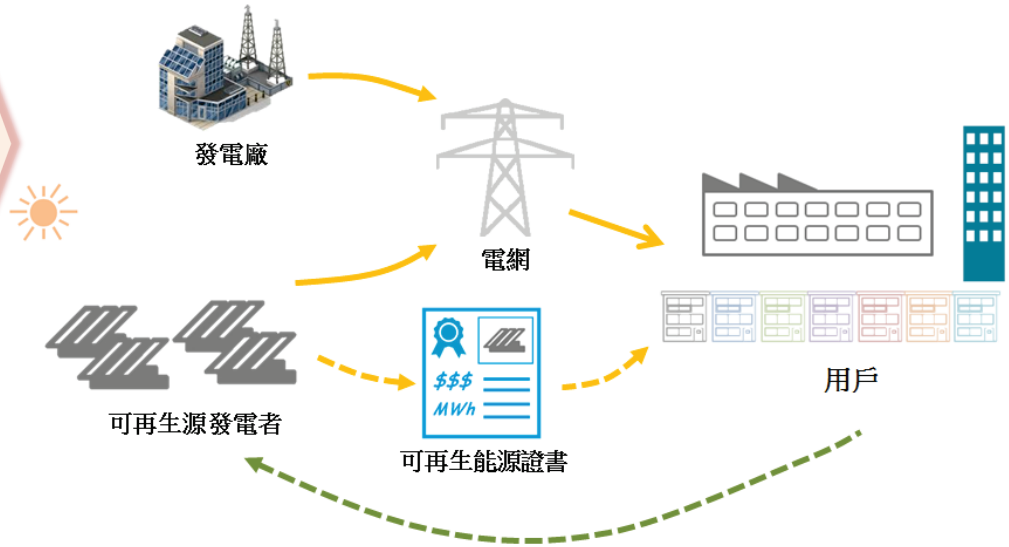
3.4 可再生能源證書

什麼是可再生能源證書?

可再生能源證書是一種能源商品，每張證書代表一定數量的可再生能源電量，用戶可將可再生能源證書賣給電力公司賺取收益。這類證書亦可用來審核電力公司是否遵行可再生能源份額制度，以及証實自願購買綠色電力的用戶(例如企業用戶)所宣稱的是否屬實。

特點

① 可交易的、無形的能源商品
② 需由第三方機構認證
③ 證書價格隨市場供需變化而浮動具不確定性
④ 交易規模一般是地區性的（即只限於一個國家、或地區的內部交易），但也有一些是跨國、跨州／省市的，如在瑞典與挪威，美國的跨省交易



優點

- 免卻可再生能源生產者即時為用戶輸電
- 依靠市場力量容許可再生能源證書購買方尋求最低格價的證書
- 提供準確和可靠的可再生能源生產和交易紀錄
- 可減低遵行可再生能源份額制度的成本
- 促進跨地區交易

弱項

- 通常需要一個前設條件：政府需先規定電力公司採用一定比例的清潔能源用於發電(例如引入可再生能源份額制)
- 這類證書制度，對制度的設計、管理和執行有嚴格要求，同時必須具備一個穩健的監管體系來核實可再生能源證書
- 市場力量有可能令太陽能的發展集中於某些太陽能資源較充沛的地區，因而引起持份者的反對
- 不能確保有長期合約
- 交易機制一旦實行，即使發現有一些漏弊，很難在短時間內調整交易機制的設計

潛在風險

- 制度複雜，市場接受程度可能較低
- 供應不確定，可能出現市場上價格波動、缺乏交易誘因(例如市場上只有買家、沒賣家)等問題
- 有可能產生斷斷續續的發展週期

註：您可於附件五中比較這五大政策的優點、弱項和潛在風險。

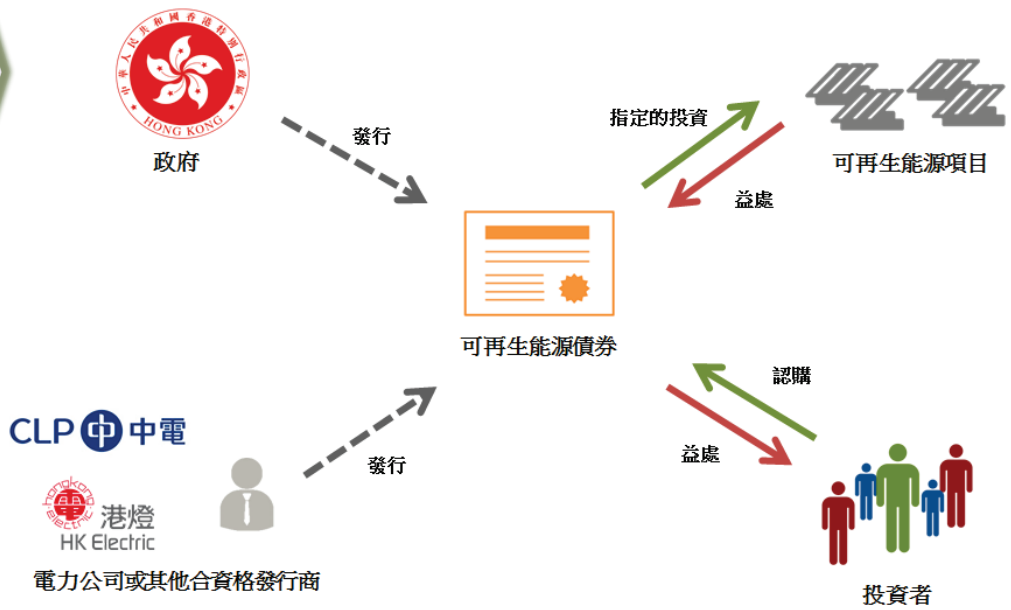
3.5 可再生能源債券

什麼是可再生能源債券？

由政府(或電力公司)以公開發行債券的形式，籌募社會各界的資金，來建立一個「可再生能源債券基金」，專門投資於可再生能源技術的項目，例如大型的太陽能發電場的建設。

特點

① 目標清晰：推動可再生能源的發展
② 需由第三方認證機構對債券予以信用評級認定
③ 債券基金必須有清晰和透明的管理機制，及發表相關年度財政報告
④ 對債券投資者的本金及收益有保障



優點

- 將債券市場上可用的資金，引導至為可再生能源融資
- 較靈活
- 企業可透過認購這類債券，來對沖企業面對氣候變化的風險
- 發債券的機構可藉此提高聲譽，並吸引新的投資者

弱項

- 承擔發行和管理費用

潛在風險

- 企業認購這類債券，只是漂綠行為(greenwashing; 門面功夫)
- 發債者承擔債券表現風險
- 可能出現市場發展規模有限、債券發行量少等問題
- 現金流不穩定
- 法律體制以及資訊披露的機制若不完善，有可能增加投資風險

註：您可於附件五中比較這五大政策的優點、弱項和潛在風險。

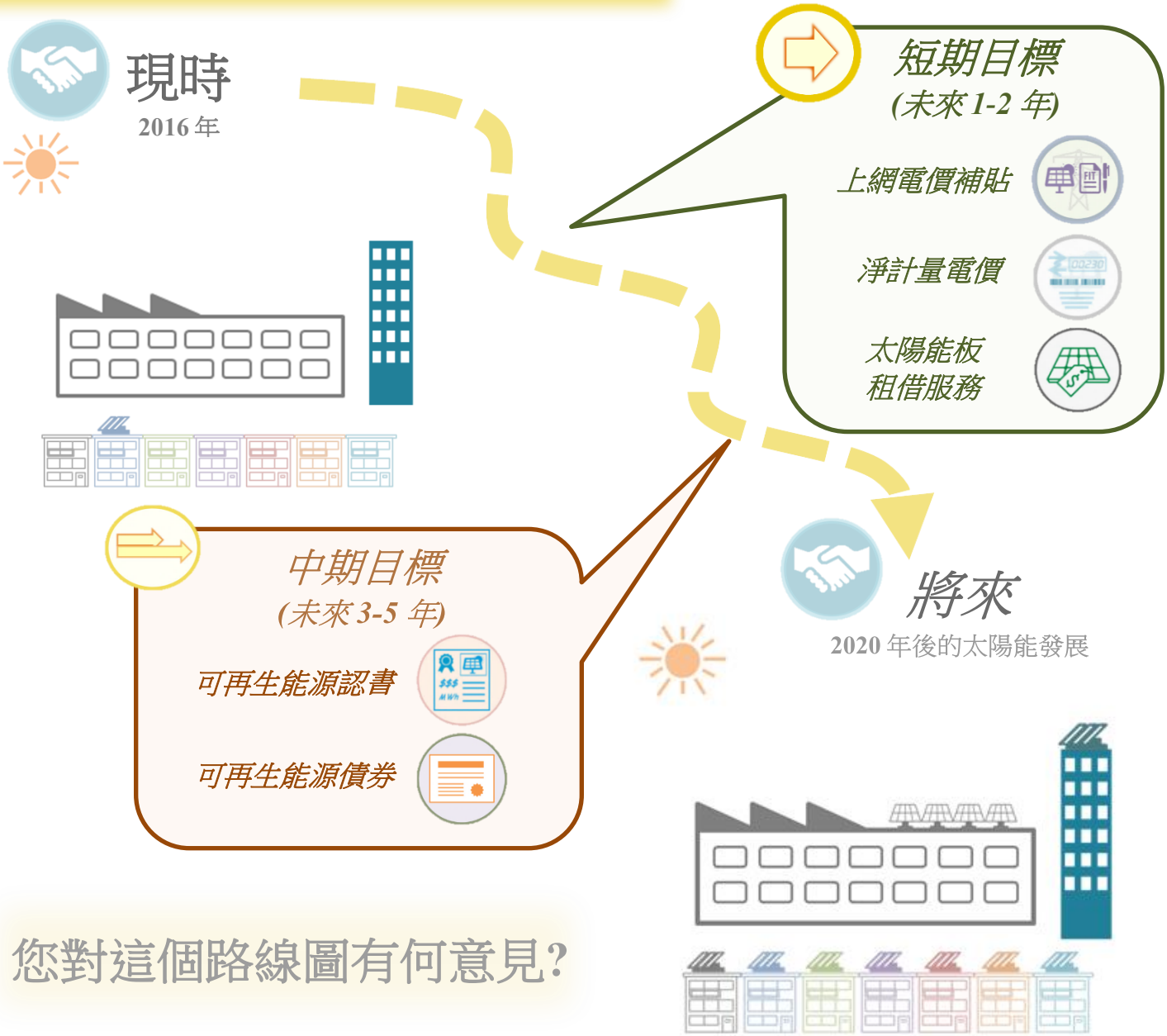
4. 集思廣益:
香港的太陽能發展路線圖 – 你有何看法?

香港政府應全力推動發展太陽能發電政策

短期目標(未來 1-2 年): 香港政府立即推動上網電價補貼、淨計量電價在香港落實，以及太陽能板租借服務的發展。

中期目標(未來 3-5 年): 香港政府應推動可再生能源證書和可再生能源債券的發展。

香港的太陽能發展路線圖



您對這個路線圖有何意見?

期待您在工作坊踴躍發言，與大家分享您的看法!

附件一
香港太陽能發電潛力

年份	作者	估計的太陽能發電(%)佔總耗電量 (年份)	方法 /備註
1997	You and Yang (1997)	**35% (1995)**	• 包括與建築物整合的太陽能發電系統 (住宅、商業、學院)，例如屋頂及向南、向東及向西的外墻，但不包括高樓大廈受遮擋的外墻
2002	機電工程署 (2002)	**17% (1999)**	• 包括與建築物整合的發電系統 (住宅、商業、學院) 及非建築物整合的太陽能發電系統，例如空地、馬路及火車路軌、機場及沒有建築物覆蓋的地方例如草地和郊野公園。但這估算沒有考慮雲遮或遮光等因素
2013	Peng and Lu (2013)	**14.2% (2011)**	• 包括屋頂太陽能發電系統 • 有考慮部份遮光因素
2015	Lu (2015)	**10.7% (2014)**	• 包括屋頂發電系統 • 沒有考慮遮光因素
2015	Wong (2015)	**5.9% (2012)**	• 這潛能是指屋頂太陽能發電系統；該文獻同時提出在空曠地方和政府、學院及社區設施安裝太陽能發電系統，於 2012 年分別可供應 6.4% 和 1.1% 的電量 • 以遙感方法進行，把雲遮因素考慮在內

附件二
香港和海外大城市的屋頂太陽能發電潛力

城市	估計可用面積 (百萬平方米)	估計太陽能發電潛在的安裝容量 (千兆瓦或峰值百千兆瓦)	估計太陽能發電潛力佔總用電需求 (如適用, 年份)	資料來源
紐約市	57	5.8	**40%**[1]	(Byrne *et al.*, 2015)
倫敦	34.9	2.1-9.2	**4.4-19.2% (2008)**	(Byrne *et al.*, 2016)
首爾	90	11.25	**30%**	(Byrne *et al.*, 2015)
東京	93.4	-	**26.5%**[2]	(Stoll *et al.*, 2013)
新加坡	27-45	5-10	**6-30% (2050)**	(Luther and Reindl, 2014)
香港	28.6-97.5	4.67-5.97[3]	**5.9-35%**	請參考附件 一

[1] 滿足 40% 高峰用電需求。
[2] 電力相等於核能產電容量。
[3] 這是由 Peng and Lu (2013)和 Lu (2015)估計的裝機容量。另外， You and Yang (1997) ，機電工程署(2002) 和 Wong (2015)的報告指出以發電輸出計算的總太陽能光伏潛能分別為 10,500 千兆瓦時， 5,944 千兆瓦時 及 1224 千兆瓦時，但由於這三項研究所採用的計算單位與 Peng and Lu (2013)和 Lu (2015)所採用的單位不同，因此這三項研究的數據並未包括在附件 2 中。

附件三

香港市民支持可再生能源嗎? 本地有關研究的結果摘要

受訪者: 505 人

2012，馬雅燕博士及其團隊的學術論文

消費者對智能電網發展的看法:於香港進行的問卷調查結果及其政策啟示

- 超過 80% 受訪者同意以下陳述：我願意購買「綠色」電力 (即由可再生能源生產的電力)

受訪者: 1,002 人

2013，思匯政策研究所報告

香港人對能源和氣候變化取態的民意調查摘要

- 幾乎所有(93%)受訪者表示，他們「十分支持」或「支持」持香港以太陽能發電
- 「十分憂慮能源價格」的受訪者(總受訪者的百分之六)表示，他們支持五項有關應對氣候變化的政策：讓風能和太陽能接駁電網、運輸電氣化、節能建築、樓宇改造、及政府在建築節能方面擔當領導角色

受訪者: 1,030 人

2015，世界自然基金會香港分會委託的問卷調查

可再生能源意見調查

- 超過 83%受訪市民認為政府應該開放電網，從而鼓勵兩電以外的投資者參與發展可再生能源
- 大約有 66% 受訪者表示兩電應該向現有運用太陽能及生物柴油發電的機構或團體回購電力 (即上網電價補貼)
- 大約有 65% 受訪者同意高用量用戶(例如港鐵、大型商場、主題公園等)應付更高電費以分擔可再生能源發電的成本；只有 24% 受訪者同意住宅用戶應付更高電費

附件四

海外大城市的經驗： 如何利用政策克服太陽能發展的障礙

紐約市

市區面積: 789 平方公里
人口 (2015 年 7 月): 850 萬
人口密度: 10,425 人/平方公里

太陽能發電進展

30 兆瓦
(2014)

1,000 兆瓦
(2030 年)

位於布克林的太陽能發電系統，轉載自美國能源部

背景和障礙

在過去十年，紐約市的太陽能發展乏善可陳，主要由於問題來自技術和政策障礙、缺乏誘因和行業標準、以及政府部門和電力公司間不協調。2006 年，紐約城市大學召集各持份者一起為紐約市草擬及實施一份太陽能計劃。他們與市長可持續辦公室、紐約市經濟發展合作社、當地電力公司、州政府和超過 30 個合作伙伴，於 2006 年成立「紐約市太陽能合作夥伴」。紐約市憑著多項促進太陽能發電的政策措施，榮獲 2007 年的美國太陽能城市大獎。

紐約市的太陽能政策

- 淨計量電價
- 太陽能板租借服務
- 可再生能源證書
- 可再生能源債券

政策及亮點

- 當地電力公司 ConEdison 提供**淨計量電價**
- 自 2012 年起使用**可再生能源證書***，這證書機制建基於紐約的可再生能源份額制，並設有一個由國家管理的追蹤系統，以支持一個自願性質的可再生能源證書交易市場和綠色電力市場
- **紐約市綠色債券計劃** 目標是要吸納更多的投資者到當地投資應對氣候變化、推進可再生能源或節約能源等綠色項目
- **紐約市太陽能計劃** 目的是透過集體採購的方法，以降低收購成本，為發展太陽能有限制的社區移除障礙。政府協助啟動這計劃，提供了財務支持、營銷資訊、技術援助、本地承辦商的聯繫資料

*註: 國家級政策

倫敦

市區面積: 1,572 平方公里
人口 (2015): 860 萬
人口密度: 5,510 人/平方公里

太陽能發電進展

82.7 兆瓦
(2016)

8850 千兆瓦時 (2026)
能源來自可再生能源(相等於 2014 年 21.3%的電力消耗量

位於布理克斯頓的社區太陽能發電系統轉載自大倫敦議會

背景和障礙

倫敦是全英國太陽能發電容量最低的地區，這國際都會在太陽能發展方面，亦面對一系列挑戰，包括例如高樓林立、居住人口流動性大、以及大眾對太陽能發電不感興趣。最近一份由大倫敦議會發表的刊物開腔批評市長辦公室缺乏領導能力和方向，因而未能充份開發和利用太陽能的潛能。

倫敦的太陽能政策

- 上網電價補貼*
- 太陽能板租借服務
- 可再生能源證書*
- 可再生能源債券

政策及亮點

- 為小型太陽能發電和其他可再生能源提供**上網電價補貼***
- **可再生能源義務證書*(Renewable Obligation Certificates)**，這證書機制要求電力供應商的一部份電力，必須來自可再生能源，可再生能源生產商向電力供應商發出可再生能源義務證書
- **RE:NEW** 是一個獲獎的節約能源計劃，鼓勵家庭安裝太陽能發電系統。該計劃自 2009-2010 年成立以來，已鼓勵超過 4,300 家庭用戶安裝太陽發電系統。到了 2014 年，這計劃為太陽能發電項目提供更多人力和技術支援，幫助機構量化太陽能項目的成本和回報，以及成立一個新的供應商框架

*註: 國家級政策

首爾

市區面積: 605 平方公里
人口: 1,030 萬
人口密度: 17,000 人/ 平方公里

太陽能發電進展

84.3 兆瓦
(2014 年尾)

200 兆瓦
(2020)

位於 Gang 漁農市場頂部的太陽能光伏系統 轉載自首爾都市政府

背景和障礙

2011 年，首爾的電力自給能力和後備餘量分別為 2.8%和 5.5%，31% 電力來自核能。同年首爾耗用全國 10% 總能源，根據預測，其能源耗用量將會持續上升。2011 年 9 月首爾廣泛地區停電，以及同年 3 月的福島核事故，為首爾市政府提供充足的理由訂立目標，決心提升能源自給自足的能力。因此首爾於 2012 年公佈了《減少一座核能電廠》的綜合計劃，目標是透過提升能源效率、推行節能措施、並增加可再生能源的電力生產以減少能源耗用達二百萬噸 (以相等的石油量計算)。這計劃的第一階段目標已於 2014 年 6 月達成，比預期進度提前 6 個月完成；現在已進入第二階段，目標是到 2020 年增加首爾市的電力自給率至 20%。

首爾的太陽能政策

- 上網電價補貼
- 淨計量電價*
- 太陽能板租借服務
- 可再生能源證書*
- 可再生能源債券*

政策和亮點

- **首爾式上網電價補貼** 是全市適用的上網電價補貼，提供長達五年每度電 100 韓圜 (約港幣 0.68 元)的上網電價補貼
- **政府補貼及其他支持措施** 出租空置公用土地和提供都市土地，讓合作社安裝太陽能發電系統；為 150 千瓦以內的太陽能發電系統提供 1.75%的優惠利率貸款；申請太陽能發電許證的時間由 60 天縮短至 30 天和分發太陽能發電板給小別墅式住戶用作發電
- **可再生能源證書***南韓的可再生能源證書機制與美國的相似，均要求電力生產商以義務形式遵行可再生能源份額制

*註: 國家級政策

東京

市區面積: 2,191 平方公里
人口 (2015): 1,350 萬
人口密度: 6,158/平方公里

太陽能發電進展

260 兆瓦
(2012 財政年度)

1 千兆瓦
(2024)

太陽能車棚轉載自東京都環境局

背景和障礙

自從 2011 年福島意外後，東京政府率先於 2012 年采用智能城市的願景，同時實行電力需求側管理(demand-side management)和電力供應側管理(supply-side management)的措施，以確保能源安全和實現一個高效節能的經濟體系和低碳能源系統。當地政府同時強調，將透過發展太陽能和其他可再生能源，向分佈式發電模式轉型。它同時推出一系列扶持政策以推動太陽能發展。

東京的太陽能政策

- 上網電價補貼*
- 太陽能板租借服務
- 可再生能源證書*
- 可再生能源債券

政策和亮點

- **上網電價補貼 (自 2012 年起)*** 適用於太陽能發電和其他可再生能源，自從該補貼實施後，成功推動了大批住宅用戶安裝太陽能發電系統 (2011 及 2012)；直至 2013 年，非住宅的太陽能發展規模才反超前住宅用戶的規模
- **可再生能源證書***日本自 2003 年便採用這證書機制。同時，商界亦提供一個讓企業自願參與的綠色電力證書計劃
- **為太陽能發電系統提供資助 (2013-17 財政年度)** 政府向太陽能與其他可再生能源 (例如熱電聯產和用於中、小型樓宇的能源管理系統) 一併提供資助，以推動分散能源科技的發展和實現智慧能源城市的願景。 政府已為這些補助計劃撥備大約 100 億日元 (約港幣 7 億 5 千萬元)
- **「屋頂發電」 太陽能項目** 合併低息貸款和低成本零售計劃，令東京居民以較低的成本，便能在屋頂安裝太陽能發電系統

*註: 國家級政策

新加坡

市區面積： 719 平方公里
人口： 550 萬
人口密度： 7,700 人/平方公里

太陽能發電進展

71.3 兆瓦
(2016 年第一季度)

350 兆瓦
(2020 年)

房屋及發展局大廈上的太陽能光伏系統轉載自新加坡能源市場管理局

背景和障礙

新加坡雖然面對地理環境和人口密度高的限制，但政府已牽頭推出一系列措施，提高太陽能發電的滲透率，以達到減排目標和降低高峰用電需求。

新加坡的太陽能政策

- 淨計量電價
- 太陽能板租借服務
- 可再生能源債券

政策和亮點

- **太陽能新星(SolarNova)**是一個以政府牽頭、<u>運用太陽能板租借服務</u>的計劃，透過集合各政府所屬樓宇的的太陽能需求，邀請私營能源公司來安裝和運作系統，系統歸能源公司擁有，並通過購電合約把電力賣回給各政府機關。第一份合約涉及總容量達 76 兆瓦的太陽能發電項目，將會涵蓋新加坡房屋及發展局和其他政府部門的樓宇
- **強化規管制度**，改善現有的市場和規管框架，例如提高太陽能系統的行業標準、建立明確的發牌制度，以及簡化市場登記和調解程序

附件五　五項可能適用於香港的太陽能政策之優點、弱項和潛在風險 – 對比一覽表

	優點	弱項	潛在風險
上網電價補貼	• 能有效提高太陽能的發電規模、開拓市場、孕育本土工業，帶來社會、經濟、環保和能源安全等益處 • 太陽能的投資者有較長期的保障，固定價錢和減低的投資風險 • 可鼓勵投資者(包括工業及住宅的電力用戶)發展中小型的太陽能發電系統 • 交易成本低，並且容易融資及參與	• 難於設定補貼電價；隨着市場的發展(例如當太陽能發電的成本明顯下降)，政府及電力企業需調整上網電價，否則用戶可能需繳付不合理的高電費	• 有可能令電費上升 • 這政策實施後，一旦要下調上網電價的補貼，太陽能投資者及一些持份者有可能會反對，為政府帶來政治風險 • 交叉補貼：一般的電力用戶(即沒有安裝太陽能發電系統的電力用戶)未能享受這補貼，反而變相要付較高的電價來津貼太陽能發電的投資者 • 政策要執行到位; 上網電價補貼成功與否，很視乎政策推出後太陽能投資者的實際投資行為
淨計量電價	• 太陽能產電用戶(例如家居或商業用戶) ，若有剩餘的太陽能電力，可以賣電給電力公司，從而抵銷部分的電費開支 • 較容易管理 • 長遠來說，有助促進太陽能電價的制訂 • 可鼓勵投資者(包括工業及住宅的電力用戶)發展中小型的太陽能發電系統	• 推動發電廠規模的太陽能系統的效果較低 • 非太陽能發電的電力用戶可能交义補貼太陽能發電用戶 • 通常單憑淨計量電價不能大幅增加可再生能源(例如太陽能發電) 的市場滲透率	• 有可能令電費上升 • 投資保障較低 • 電力公司的收入或會減少，因為自行產電的用戶會減少從電網購電 • 電力公司可能面對增加從標準電費收回成本的風險 (隨著時間降低發電資產的價值)
太陽能板租借服務	• 很多海外經驗印證了太陽能板租借服務能有效促進天台太陽能項目的發展 • 減低安裝太陽能發電系統的成本 • 大廈業主毋須購買或擁有太陽能發現系統，仍然可以享有太陽能帶來的好處 • 大廈業主只承擔低至接近零的系統運行及維修責任，租借安排能大大減低大廈業主面對的技術風險 • 由於租借安排降低安裝太陽能系統的「入場門檻」，因此能更有彈性地容讓不同收入的住戶、不同樓宇類型來參與太陽能的發展 • 太陽能的投資者可從中獲得潛在的稅收優惠 (例如稅收減免)	• 小型的太陽能發電系統，可能仍需面對項目本身財務可行性的問題 • 由於合約是長期，短期租屋住戶可能未必適合	• 零部件風險，例如部件使用期間受到破壞或屋頂受到破壞 • 有市場風險，例如有可能出現違約及不付款的問題，以及小型能源服務公司可能倒閉；進入這市場的太陽能服務公司，需要達到良好的信用，又或者達到最低信用要求 • 持份者可能面對一系列問題，包括太陽能發電系統的產電能力較預期低、 意想不到的運作和維護成本
可再生能源證書	• 免卻可再生能源生產者即時為用戶輸電 • 依靠市場力量容許可再生能源證書購買方尋求最低格價的證書 • 提供準確和可靠的可再生能源生產和交易紀錄 • 可減低遵行可再生能源份額制度的成本 • 促進跨地區交易	• 通常需要一個前設條件：政府需先規定電力公司採用一定比例的清潔能源用於發電　（例如引入可再生能源份額制） • 這類證書制度，對制度的設計、管理和執行有嚴格要求，同時必須具備一個穩健的監管體系來核實可再生能源證書 • 市場力量有可能令太陽能的發展集中於某些太陽能資源較充沛的地區，因而引起持份者的反對 • 不能確保有長期合約 • 交易機制一旦實行，即使發現有一些漏弊，很難在短時間內調整交易機制的設計	• 制度複雜，市場接受程度可能較低 • 供應不確定，可能出現市場上價格波動、缺乏交易誘因(例如市場上只有買家、沒賣家)等問題 • 有可能產生斷斷續續的發展週期
可再生能源債券	• 將債券市場上可用的資金，引導至為可再生能源融資 • 較靈活 • 企業可透過認購這類債券，來對沖企業面對氣候變化的風險 • 發債券的機構可藉此提高聲譽，並吸引新的投資者	• 承擔發行和管理費用	• 企業認購這類債券，只是漂綠行為(greenwashing; 門面功夫) • 發債者承擔債券表現風險 • 可能出現市場發展規模有限、債券發行量少等問題 • 現金流不穩定 • 法律體制以及資訊披露的機制若不完善，有可能增加投資風險

附件六

五項可能適用於香港的太陽能政策之優點、弱項和潛在風險 - 主要參考資料

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