Research Office
Legislative Council Secretariat

Information Note

Feed-in tariff for solar power in selected places

IN04/17-18

1. Introduction

1.1 In spite of support measures introduced a decade ago, renewable energy still takes up less than 0.1% of overall installed power capacity in Hong Kong at present, much less than the average figure of 30% in Asia.[1] To boost further local development of renewable energy under the new Scheme of Control Agreements ("SCAs") to be effective for 15 years as from 2018-2019, the two power companies will be required to purchase electricity generated from renewable sources from residential/business users at a premium feed-in tariff ("FiT") for connection to public grid, in line with the practice seen in 110 places across the world.[2] While the Government is still working out the details of FiT with the two power companies, it pledges to report to the Legislative Council "once ready in 2018".[3] More recently, there have been suggestions in the community that Hong Kong can make reference to overseas experience in setting up its FiT mechanism.

1.2 At the work plan meeting of the Panel on Environmental Affairs held on 7 November 2017, the Research Office was requested to study the practice of FiT for solar energy development in selected places in Asia.[4] Australia and Japan are selected for study because these two countries have achieved high penetration of solar photovoltaic ("PV") amongst households on the one hand, and they are amongst global leaders in renewable energy development on the other.[5] On top of these two countries, Seoul is also studied primarily because

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1 Renewable energy refers to inexhaustible energy from the nature, comprising mainly hydropower, biomass, solar, wind and tidal wave, contrasting against fossil fuel (e.g. coal and gas) and nuclear energy which are more exhaustive or polluting. In Hong Kong, coal and oil accounts for 61.9% of installed power capacity, followed by natural gas (26.6%), nuclear power (11.5%) and renewable energy (less than 1%).

2 A global study shows that 110 of 176 places (63%) in the world had FiT in place. See REN21 (2017).

3 See GovHK (2017a).

4 In Hong Kong, solar energy is widely considered to have much greater development potential than other forms of renewable energy, due to high solar radiation in the local context and its convenient application. As such, this note focuses on application of FiT for solar power development.

5 According to the Renewable Energy Country Attractiveness Index in 2017, Australia and Japan took the fifth and seventh positions out of 40 selected places included in comparison. See Ernst & Young (2017).

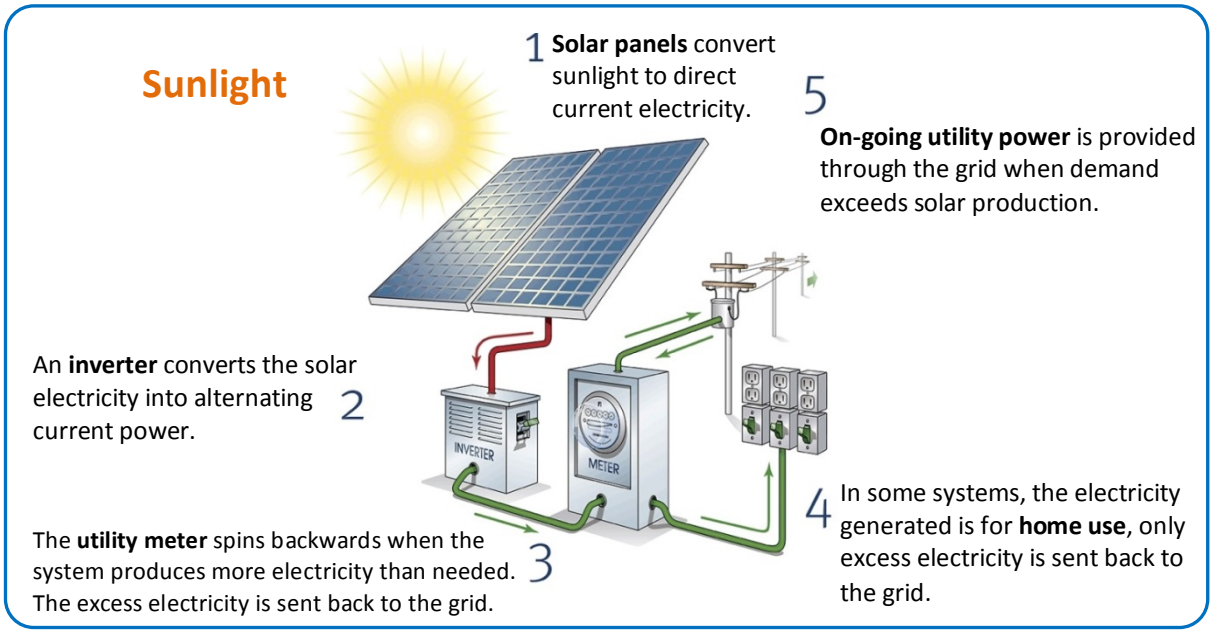
of its community-based policy initiatives on solar power development and energy saving in Asia.[6]

1.3 This information note begins with an overview of global development of renewable energy in recent years, followed by a discussion of key issues faced by Hong Kong in solar power development. It then highlights the salient features of policy measures (including FiT) to foster development of solar energy in Australia, Japan and Seoul, with three summary tables in **Appendices I – III.**

2. Recent global development in solar energy policy

2.1 In a nutshell, FiT is a mechanism to provide incentives to households or businesses to install facilities for generation of electricity from renewable sources. Power companies are required to purchase electricity from these generators at a fixed level of FiT, which is sometimes higher than the standard electricity tariff, for a long duration of 5-20 years. Additional costs incurred in procurement of the renewable power are either subsidized by the government or shared by electricity consumers through higher electricity bills (**Figure 1**).

Figure 1 – Rooftop solar PV system



Sources: Meridian Solar and Solar Craft.

[6] Although nationwide FiT was abolished in South Korea at end-2011, the Seoul Metropolitan Government implemented its city-level FiT in 2013. As such, Seoul (but not South Korea) is selected for further study.

2.2 Taking a local household living in a typical village house with a floor area of around 70 m^2 as an illustration, it could install a small solar PV system with capacity of 1.6 kilowatt ("kW") costing some HK$50,000-55,000 on its rooftop.[7] The system can generate about 1 560 kilowatt hour ("kWh") of electricity per year, equivalent to about one-third of the average power consumption of local households.[8] Without FiT, this solar PV system could achieve monthly cost savings of about HK$150, taking about 30 years for the investors to recoup the investment (**Figure 2**). However, if power companies have to purchase the electricity at a premium rate of FiT above the standard tariff (i.e. HK$1.14 per kWh on average in 2018),[9] the cost recovery period could be shortened, depending on the level and duration of gross FiT[10] to be announced in 2018.

Figure 2 – Cost recovery for a small solar PV system in Hong Kong without FiT

Electricity consumption of an average household	
(a) Annual electricity consumption	4 800 kWh
(b) Average net tariff	HK$1.14 per kWh
(c) Annual electricity bill [= (a) x (b)]	HK$5,500
Electricity generation by a small solar PV system*	
(d) Installation cost	HK$50,000-55,000
(e) Annual solar power generated	1 560 kWh
(f) Annual saving [= (b) x (e)]	HK$1,800
(g) Number of years for cost recovery [= (d) ÷ (f)]	**28-31 years**

Note : (*) Applicable for rooftop with a floor area of about 70 m^2.
Data source: Hong Kong Baptist University.

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7 While solar PV system became more affordable to households after a cumulative decline in the price of solar PV modules by 77% during 2010-2015, there are only few village houses with on-grid solar power in Hong Kong. The cost estimate here is based on a local study of limited samples, and hence, is subject to a larger variability. More recently at mid-2016, WWF-Hong Kong has launched the "Solarizing Communities" project in Tai O, installing on-grid solar PV systems on the rooftops of three stilt houses. The combined capacity was 6 kW, generating electricity amounting to 6 000-7 000 kWh each year. See IRENA (2017a), WWF (2017), SCMP (2015) and Hong Kong Baptist University (2017).

8 A household in Hong Kong on average consumes about 400 kWh of electricity per month, with average monthly electricity bill of HK$460. See Electrical and Mechanical Services Department (2017).

9 Under the new SCAs with effect from 2018-2019, the net tariffs for HKE and CLP will be set at HK$1.125 per kWh and HK$1.154 per kWh respectively.

10 FiT can appear in two forms. Under **gross FiT**, electricity retailers purchase all renewable electricity from the generators at FiT, and sell the electricity back to generators for the amount they consumed from the grid at the standard tariff. Under **net FiT**, electricity retailers buy only the unused or surplus electricity from generators at FiT. Gross FiT will be introduced in Hong Kong under the new SCAs.

2.3 Several global trends are noteworthy before discussion of local policy developments. First, ***installed capacity of solar power has been growing rapidly to displace traditional fossil fuels in recent years, along with proliferation of solar PV systems among households upon implementation of FiT***.[11] During 2006-2016, global capacity of solar energy has surged at a trend rate of 46%, almost six times the respective growth of 8% in overall renewable power and 11 times the growth of 4% in electricity generated from fossil fuel (e.g. coal and gas).[12] With this robust penetration of solar PV systems, the global share of solar power within overall renewable energy has surged from 1% to 14% during 2006-2016 (**Appendix I**).

2.4 Secondly, ***Asia has outpaced other regions in solar power development***. Over the past decade, solar power capacity in Asia has surged at a trend rate of 53%, faster than the global rate of 46% and accounting for 47% of global total in 2016. To a certain extent, this could be attributable to robust expansion of solar power capacity in the Mainland**,** which has become the largest generator of solar power in the world in 2015 after introduction of FiT in 2011.[13] However, more than 90% of the solar capacity in the Mainland is large-scale solar farms, not the distributed system of small-scale solar PV systems intended for development in Hong Kong.[14]

2.5 Thirdly, ***economic viability of solar power has improved considerably in recent years, although its unit cost is still higher than conventional energy sources***. Taking solar PV as an illustration, the cost of electricity generated from solar energy has plunged by a cumulative 62% in six years. As at 2015, the average cost of rooftop solar power was US$0.26 per kWh, still at least 50% more than the respective cost of below US$0.1 per kWh for fossil fuel power. As such, various forms of subsidy are still required to promote solar power development in many places.

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[11] To a certain extent, this rise in importance of renewable energy can be attributable to (a) growing concerns over greenhouse gases emissions and global warming especially after the Kyoto Protocol in 1997, Copenhagen Climate Change Conference in 2009 and Paris Agreement in 2016; and (b) policy initiatives made by many places to explore alternative energy sources in response to multi-fold increase in annual average crude oil prices from US$25 (HK$195) per barrel in 2002 to a high of US$112 (HK$878.7) per barrel in 2012.

[12] As global investment in solar power has increased by four times to US$113.7 billion (HK$882.5 billion) over the past decade, solar power experienced an upsurge by 44 times in terms of installed capacity during 2006-2016 and by 55 times in terms of electricity generation during 2005-2015.

[13] The Mainland introduced FiT for large-scale solar farms in 2011 and extended it to small-scale generators in 2013.

[14] The Mainland is not selected for further study in this note because (a) some of the administrative measures adopted there may not be applicable to Hong Kong; (b) policy implementation could vary widely across provinces in the Mainland; and (c) distributed small-scale solar PV systems took up less than 10% of solar PV projects in the Mainland.

2.6 Fourthly, ***the level of FiT has been adjusted downward over time, along with easing solar PV module prices***. Taking four selected places in Asia (e.g. Australia, Japan, South Korea and Taiwan) as an illustration, the initial level of FiT about a decade ago was set at a more generous level of 171%-823% relative to the standard electricity tariff to speed up the cost recovery in solar investment. However, the respective ratio of FiT has been consecutively lowered to 21%-441% in 2016, partly reflecting the 77% decline in the price of solar PV modules during 2010-2015. Also relevant are concerns over increased electricity bills faced by consumers for renewable energy development in some of these places.[15] In South Korea, as procurement of renewable power under FiT was funded by the government, the exponential growth in solar power had resulted in heavy fiscal burden.[16] In 2012, the South Korean government replaced the nationwide FiT by the renewable portfolio standard ("RPS"), requiring the power companies to generate a specified share of renewable energy each year instead.[17] The target share of renewable energy under RPS has been progressively raised from 2% in 2012 to 4% in 2017 (**Appendix II**).

3. Recent developments of renewable energy in Hong Kong

3.1 In Hong Kong, a total of 527.5 gigawatt hour ("GWh") of renewable energy was produced in 2015. Biogas from landfill sites and sewage treatment plants[18] is the largest category of renewable energy (with a share of 85%), followed by bio-diesel (12%),[19] solar energy (2%) and others (less than 1%). While biogas and bio-diesel are site-specific and cannot be produced on a distributed basis, solar power is believed to have the highest development potential on the back of high solar radiation in Hong Kong (with potential solar power of 1 333 kWh/m^2). That said, given that solar power takes up just 0.1% of local electricity consumption and most of existing solar power facilities are

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[15] As additional cost arising from FiT is borne by consumers in Japan, the Japanese government has been looking for an effective way to reduce the burden on consumers. See Japan Times (2016).

[16] As additional cost of renewable energy development in South Korea was borne by the government through subsidy, coupled with a 30-fold increase in solar power generation during 2006-2011 to 917 GWh, the respective government spending leaped by 33 times in four years to 262.6 billion won (HK$1.6 billion) or 0.1% of total government expenditure in 2009. See Lee et al (2014).

[17] RPS is a mechanism that requires power companies to produce a specified proportion of electricity from renewable sources. At present, a total of 100 places have set their RPS. See REN21 (2017).

[18] Three landfills in Hong Kong utilize landfill gas for power generation mostly for on-site usage in offices, pumping stations and wastewater treatment facilities. See Environmental Protection Department (2014).

[19] Bio-diesel is a form of diesel fuel manufactured from vegetable oils, animal fats, or recycled restaurant greases. In Hong Kong, wasted cooking oil is the major raw materials for biodiesel production.

installed on government sites or buildings, it suggests that private sector initiatives are not fully deployed for solar power development.

3.2 In 2008, the Government launched two major initiatives to boost the use of renewable energy in private sector. ***First***, profits tax deduction of 20% on the capital expenditure incurred on renewable energy installations for five years was introduced. ***Secondly***, financial incentives were provided to the two power companies to develop renewable energy when the current SCAs came into effect in 2008-2009. In short, the permitted rate of return for investments in renewable energy of the two power companies would be fixed at a higher rate of 11%, compared with that of 9.99% for conventional energy.

3.3 Yet the boosting effect on renewable energy development appeared to be insignificant in the last decade, with just 50 on-grid renewable power systems comprising 46 solar PV systems and four wind power systems installed by the private sector (including the two power companies) during 2008-2017. There were just around 9-20 applications for tax deduction for renewable energy installations annually between 2009-2016, involving annual tax deduction between HK$21.3 million and HK$40.8 million.

3.4 More recently in April 2017, the Government entered into new SCAs with the two power companies for the next 15 years from 2018-2019 to end-2033, with the following new provisions to boost renewable energy:

(a) **Introduction of FiT:** As discussed above, the Government plans to announce the FiT mechanism in 2018 for promotion of renewable energy on a distributed basis where FiT will be payable by the two power companies in respect of "each unit of electricity generated" by renewable sources. The level of FiT will take into account factors like (i) system investment; (ii) cost of renewable power facilities; (iii) commercial attractiveness of the proposed FiT; and (iv) implication on the electricity tariff;

(b) **Incentives to two power companies:** Extra permitted rate of return capped at 0.05% per annum[20] will be provided to the two

[20] Permitted rate of return is fixed at 8% for conventional energy under the new SCAs. For renewable energy, extra annual rate of return will be capped at: (a) 0.05% for renewable power generated by the power companies or their customers; and (b) 0.005% for making new connections of renewable power systems. Moreover, there will be an additional 0.01% of return on a five-year basis for renewable power generated by the power companies while incentives are equivalent to 10% of the sales revenue from renewable energy certificates. See Environment Bureau (2017c).

power companies for renewable energy produced by them or their customers; and

(c) **Selling renewable energy certificates:** Power companies are allowed to sell certificates for units of electricity generated from renewable sources so that certificate buyers can claim that their business operation or activities are carbon-free. Revenue from these certificates will help alleviate the overall tariff impact on consumers due to the introduction of the FiT scheme.

3.5 According to a study on development potential of rooftop solar PV applications in Hong Kong, 75% of 310 000 buildings could install solar panels on their rooftops, with a potential to generate electricity equivalent to 10.7% of annual local consumption at most.[21] It is conceived that those 40 000 village houses in the New Territories will be most benefited from the FiT initiative, largely because of their exemption from seeking regulatory approval for erection of the solar PV facilities on the rooftop of such houses.[22] So far only nine on-grid solar PV systems have been installed in such village houses during 2012-2017. It is expected that more village houses will follow suit if the FiT mechanism to be announced in 2018 can provide attractive incentives.

4. Solar power development in Australia

4.1 The Australian government has embarked on its national strategy to combat climate change since 1997, setting mandatory renewable energy target ("RET").[23] Leveraging on its excellent geographical position with the highest

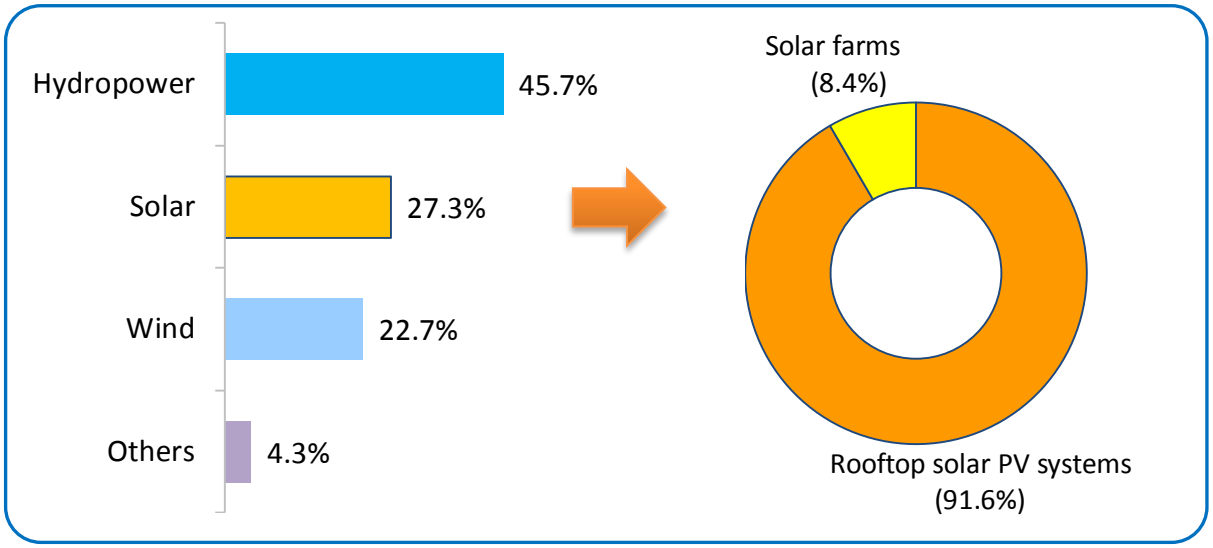
[21] The study was funded by the Central Policy Unit. See Hong Kong Polytechnic University (2015a).

[22] Village houses in the New Territories complying with the stipulated requirements under the Buildings Ordinance (Application to the New Territories) Ordinance (Cap. 121) are exempted from certain provisions of the Buildings Ordinance (Cap. 123) and its subsidiary regulations. Small-scale solar PV facilities meeting the specified requirements (e.g. size, weight) could be installed in these houses without seeking the permission from the Lands Department or the Buildings Department. See GovHK (2017b).

[23] Under the Renewable Energy (Electricity) Act 2000, the Australian government introduced the RET scheme aiming to (a) increase the proportion of electricity generated from renewable sources; (b) reduce the emissions of greenhouse gases from electricity generation; and (c) promote the development of a renewable energy industry in Australia. After the most recent review in 2015, RET was set to generate an additional 23.5% of electricity from renewable sources by 2020, compared with 1997 levels. See Parliament of Australia (2014) and Department of the Environment and Energy (2015).

unit solar radiation in the world,[24] coupled with proactive government policies, renewable power as a proportion of total installed capacity in Australia has leaped from 27% in 2000 to 44% in 2016.[25] In particular, installed capacity of solar power is now the second largest source of renewable power in the country, with a share of 27.3% in 2016, next to hydropower only (45.7%) (**Figure 3 and Appendix III**).

Figure 3 – Share of renewable power capacity by energy source in 2016



Data source: IRENA.

4.2 More recently, the Australian government has adopted a multi-pronged approach for solar power development, comprising the following major measures:

(a) **Grants and loans for installation of solar PV systems:** Some local governments in Australia offer financial support and incentive schemes to foster installation of solar PV systems. Taking the central business district of Adelaide in South Australia as an illustration, residents and businesses can enjoy a grant up to A$10,000 (HK$57,800) since 2015 for installing solar PV panels and battery-based energy storage systems offered by an Adelaide City Council programme.

[24] See Australia Renewable Energy Agency (2017).
[25] See IRENA (2017a) and Australian Energy Regulator (2017).

In Queensland, the state government has set aside A$21 million (HK$121.4 million) for provision of interest-free loan to households for installation of rooftop solar PV systems in early 2018. To complement the loans, the government will provide a cash rebate of A$1,300-2,000 (HK$7,514-11,560) for battery system installations; and

(b) **Leasing solar PV systems to households:** As tenants tend to be unwilling to purchase a rooftop solar PV system for the property they do not own, the Australian government injected a sum of A$120 million (HK$693.6 million) in 2014, helping businesses provide "solar leasing" programmes to residential customers. Under the programme, the solar PV systems are owned by the "investors" and leased to residential customers. The investors are responsible for the cost of installation and system maintenance for 20-25 years. At the end of the leasing contract, ownership may be made available to the customers.

4.3 On top of the above measures, FiT has also been introduced in most states of Australia since 2008-2010, in spite of the absence of a nationwide FiT. Here are major features of FiT:

(a) **Purchase obligation of electricity retailers:** Electricity retailers have the obligation to purchase electricity generated from renewable sources and grant it the access right to the grid;

(b) **Duration of FiT:** FiT duration varies widely across states in Australia, with the agreements ranging between 7-20 years;

(c) **Level of FiT:** As discussed above, the level of FiT has been trending down across states of Australia in recent years, along with easing prices of the solar PV systems. When FiT was introduced in 2008-2010, the FiT rates for new entrants throughout the agreements were around A$0.4-0.6 (HK$2.3-3.5) per kWh, representing 191%-286% relative to the standard tariff. Most recently in 2016, the FiT rates for new entrants have been much reduced to around A$0.068-0.20 (HK$0.45-1.16) per kWh, with its ratio to standard tariff significantly down to 21%-102%;

(d) **Incidence of cost for solar power development:** Throughout Australia (with the exception of West Australia), additional costs of development of renewable power under FiT were mostly shared by electricity consumers.[26] It is estimated that such "green costs" accounted for some 5% of total electricity bill for a typical household in 2015; and

(e) **Mechanism of reviewing FiT:** FiT scheme and level are usually reviewed every year by the local governments, bearing in mind (i) whether the governments have achieved renewable energy target and their fiscal affordability;[27] and (ii) whether residential and small business generators have received fair and reasonable values for the renewable power generated.

4.4 Together with some 150 000 new installations of rooftop solar PV system in 2016-2017, as many as 1.7 million dwellings in Australia have already installed rooftop on-grid solar PV systems, contributing to 92% solar power in Australia. With a remarkable penetration rate of 21% amongst residential dwellings, Australia is a global leader in development of distributed solar PV systems.

5. Solar power development in Japan

5.1 Conventional fossil fuel used to be the largest source of energy in Japan (with a share of 60%), followed by nuclear power (30%), hydroelectric power (9%) and other renewables (1%). Yet the Fukushima nuclear incident in March 2011 and the subsequent power shortage marked a turning point in the energy policy of Japan. The Japanese government has then become keener to promote renewable energy, including introduction of FiT for the first time in 2012. As solar power is well-suited for land-scarce Japan, solar power has grown by leaps and bounds over the past five years, taking up 89% of renewable power capacity excluding hydroelectric power in 2016. With an installed capacity of 41.6 gigawatt ("GW"), Japan overtook Germany to become the second largest generator of solar power in 2016, next only to the Mainland.

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[26] Western Australia is the only state in Australia in which the government paid for the renewable power subsidies.

[27] For example, the government of Western Australia has suspended all new applications for FiT since 1 August 2011, citing the expenditure of the scheme as the reason. See Government of Western Australia (2011).

5.2 Since the 2000s, the Japanese government has introduced the following measures to promote solar energy:

(a) **Subsidy for installation of solar PV system at home:** The Japanese government put in place a subsidy scheme in 2009, providing subsidy of ¥30,000-35,000 (HK$2,500-2,900) to households for installation of residential solar PV systems till 2014. The subsidy could be used for buying solar PV modules, peripheral equipment, distribution lines, lithium-ion batteries and installation works;

(b) **Tax incentives for solar installation:** Since 2009, the Japanese government has introduced tax deductions for home renovation to improve energy efficiency including installation of solar PV systems. A total of 10% of the installation cost can be deducted from income tax; and

(c) **Mandatory target in renewable electricity:** During 2003-2012, electricity retailers in Japan were obliged to use a specified amount of electricity generated from renewable sources under an RPS programme. Yet the RPS programme was terminated in 2012 because such renewable energy accounted for just 1% of overall electricity generated.

5.3 As the above measures were considered too modest for promotion of renewable energy after the Fukushima Incident, the Japanese government introduced FiT to replace RPS as from July 2012.[28] Here are the main features:

(a) **Purchase obligation of electricity retailers:** Power utilities in Japan are obliged to purchase surplus electricity generated from small-scale solar PV systems at a fixed FiT rate and to grant the grid access right.

That said, grid operators can curtail renewable electricity without compensation up to 30 days per facility annually for the sake of

[28] According to the Japanese government, the FiT scheme was to "help reduce uncertainty in the recovery of capital invested in power generation using renewable energy, and thereby encourage investment in the use of renewables more widely and at an accelerated pace". See Ministry of Land, Infrastructure, Transport and Tourism of Japan (2015).

balancing electricity supply and demand. Grid operators can also refuse connection agreements when curtailment is anticipated to go over 30 days;

(b) **Duration of FiT:** The guaranteed tariff rate will last for 10 years for small-scale solar PV system with capacity below 10 kW;[29]

(c) **Level of FiT:** Initially, FiT was set at a generous level of ¥42 (HK$4.1) per kWh between July 2012 and March 2014, representing 171% of standard electricity tariff.[30] With attractive internal rate of return of 3.2%, this resulted in a robust growth of solar energy and "bubble-like phenomenon".[31]

However, similar to Australia, the level of FiT has been adjusted downwards more recently to ¥31 (HK$2.2) per kWh in 2016, with its ratio to standard tariff reduced to 120%. The Government has announced that the FiT rate will fall further to ¥24 (HK$1.7) per kWh in 2019, achieving parity with the standard electricity tariff;

(d) **Incidence of cost for solar power development:** Additional cost incurred by power utilities for purchasing renewable electricity is recovered through a surcharge on consumers proportionate to their amount of electricity consumption. For an average household with monthly electricity consumption of 300 kWh, the monthly surcharge was estimated to be ¥675 (HK$48.3) or 10% of its monthly electricity bill in 2016; and

(e) **Mechanism of reviewing FiT:** In review of the FiT scheme, the Japanese government first considered the amount of renewable power generated and the impact on the overall electricity supply. In adjusting the rate of FiT, the Japanese government generally takes into account the cost of generation of renewable energy, aiming to maintain a modest profit for the generators.[32]

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[29] If the power capacity of solar PV system is greater than 10 kW, which is usually provided by solar farms or large-scale systems, the guaranteed purchase period will last for 20 years.

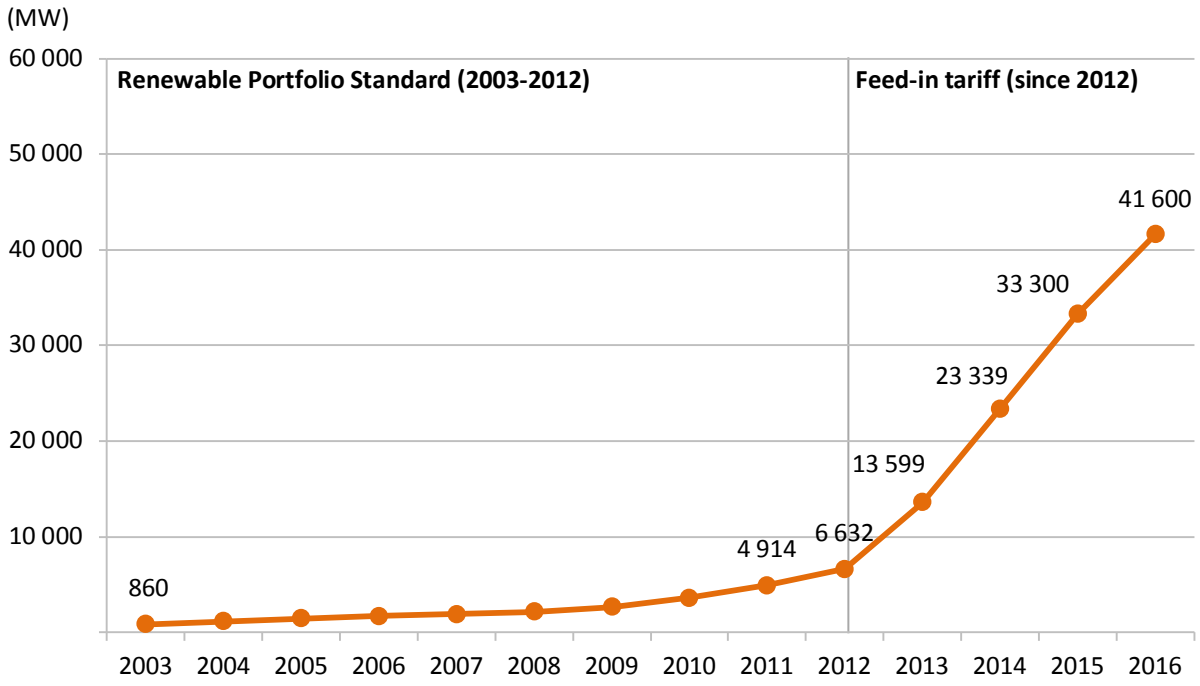
[30] As the FiT rate in Japan was almost twice the rate in Germany, it was generally regarded as attractive. See Japan Times (2012) and OECD (2008).

[31] See Japan International Cooperation Agency (2016).

[32] See Ministry of Economy, Trade and Industry (2011 and 2017).

5.4 FiT appears to be more effective than RPS in boosting solar power in Japan. Reflecting this, the installation capacity of solar power hit 41.6 GW for the five-year period during 2012-2016 after introduction of FiT, representing more than fivefold increase (**Figure 4**). There are more than two million households having solar PV systems at home in Japan, with a penetration rate of 7% in 2016.

Figure 4 – Capacity of electricity generated from solar PV system, 2003-2016



Data source: IRENA.

6. Solar power development in Seoul

6.1 As discussed above, the decade-long nationwide FiT was terminated at end-2011 and was replaced by RPS in 2012 in South Korea.[33] To a considerable extent, the policy shift was due to looming fiscal burden brought

[33] In South Korea, fossil fuel took up the largest share of 70.4% of installed capacity in 2016, followed by nuclear power (17.7%) and renewable energy (11.8%). As for renewable power capacity, hydropower accounted for 43.8%, solar power contributed to one third (33.8%), followed by wind power (7.4%). With effect from 2012, all electricity suppliers were obligated to produce a certain portion of electricity by renewable energy, from 2% in 2012 to 10% in 2022. See Korea Energy Management Corporation (2017a).

by FiT and the intention of creating a market-based environment less dependent on government subsidy.[34]

6.2 However, in the wake of the Fukushima Incident in 2011, the Seoul Metropolitan Government ("SMG") rolled out its own city-based FiT scheme in 2013, along with launching the campaign of "One Less Nuclear Power Plant ("OLNPP")" in April 2012.[35] By and large, OLNPP aimed at (a) reducing energy consumption in the capital city by two million tons of oil equivalent (i.e. annual output of a nuclear plant in 2014); and (b) raising self-sufficiency ratio of electricity supply from 3% in 2011 to 8% in 2014 and further to 20% in 2020. This could be done through development of renewable energy on the one hand, and implementation of community-based initiatives to reduce energy consumption on the other.[36]

6.3 Here are the major community-based initiatives introduced by SMG to promote solar power and energy savings in recent years:

(a) **FiT for solar power:** The city-based FiT scheme introduced by SMG in 2013 is rather modest, with its level fixed at 50 won (HK$0.34) per kWh for electricity generated from small-scale solar PV system with capacity 3-50 kW. The FiT represents just 39% relative to standard tariff of Seoul and lasts for five years only. The FiT payment is shared by consumers. However, the FiT doubled to 100 won (HK$0.68) per kWh in 2016, representing 82% of the standard tariff.

Meanwhile, SMG also provides subsidies for installation of mini-solar panels with just 260 watt on their apartment windows or on rooftop, reducing the cost of such a solar panel by as much as 80% to just about 100,000 won (HK$670). For the past 15 years during 2003-2017, about 34 000 or 1% households in Seoul were reported to have installed solar panels;

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[34] The nationwide FiT was introduced to South Korea in 2002, with a generous FiT rate of 716.4 won (HK$4.51) per kWh for solar power guaranteed for 15 years, implying a premium ratio of 823% relative to standard electricity tariff. The nationwide FiT scheme was terminated at end-2011 in view of the fiscal pressure. See OECD (2017a).

[35] The electricity consumption of Seoul accounted for 10.9% of the national total. However, the power self-sufficiency ratio of Seoul was only 2.95% in 2011.

[36] SMG expected that 46% of the self-sufficiency rate of electricity supply would be achieved through renewable energy, while 54% would be achieved through improved energy efficiency and energy saving. See Seoul Urban Solutions Agency (2017a).

(b) **Rental concessions for solar power cooperatives:** In October 2014, there were 12 solar power cooperatives in Seoul, installing small-scale solar PV systems on unused spaces leased out from SMG at a low rental rate. These cooperatives run small solar plants with total solar power capacity up to 22.8 megawatt ("MW");

(c) **Solar Power Generation Citizens' Fund:** To mobilize public participation, SMG set up the government-backed citizens' fund for solar projects in 2015. Seoul citizen can subscribe to the fund to earn a guaranteed annual return of 4%. By mid-2017, the total fund value was 50 billion won (HK$345 million);

(d) **Energy Self-Reliant Village:** SMG launched the Energy Self-Reliant Village ("ESV") Program in 2012, attempting to inspire a shared vision over energy self-sufficiency in communities located in both urban and rural areas of Seoul.[37] There are 75 ESVs in 2017, practicing activities ranging from individual installation of solar panels to collective energy saving activities. SMG offered education/training programmes on the ESV Program to local residents. Furthermore, the communities could also request SMG to introduce professional consultants, if needed, in the course of implementing their ESV plan. In 2014, SMG trained 95 energy system designers and 250 energy consultants;

(e) **Financial support to ESVs:** An ESV could receive an annual subsidy for three years from SMG, totalling 14.6 million won (HK$0.98 million). Furthermore, communities could apply for financial support through OLNPP campaign for building retrofit projects and mini-solar PV installation in the ESVs; and

(f) **Energy saving under Eco-Mileage:** In 2009, SMG launched the Eco-Mileage system, providing incentives to member households and organizations to cut back their usage of electricity, water and gas by at least 10% compared to the monthly average figure of the previous two years. The "mileage points" will be converted to the coupons for buying LED lamps, energy-saving taps or

[37] Aside from boosting the self-sufficiency rate of electricity supply, the ESV Program also "suggested some meaningful visions to the SMG". For instance, Seokgwan Dusan Apartment ESV replaced lighting in 25 apartment parking lots by LED lights. Savings in electricity expenses were then used to increase the wages of apartment security guards. See Sejong University (2017).

transportation cards.[38] At end-2017, there are 1.98 million registered members, accounting for 20% of population in Seoul. SMG estimated that the effect of reduction in carbon emission since 2009 is equivalent to "planting 270 million pine trees".

6.4 Broadly speaking, the community-based initiatives especially the ESV Program was effective in mobilizing the citizens to participate in energy saving programmes.[39] At end-2016, more than half of the communities which joined the ESV Program located in multi-unit residential buildings. During 2011-2015, solar PV systems have been installed in 28 154 locations in Seoul, and 90% of which were mini-scale systems. Solar power capacity in Seoul now amounted to 105 MW, sufficient to power 36 000 households. Contrasted against the 4.9% rise in the nationwide electricity consumption during 2011-2014, electricity consumption in Seoul fell by 4% over the same period.

7. Concluding remarks

7.1 FiT is a common policy initiative taken in 110 places across the globe to incentivize households and businesses to install small-scale solar PV facilities for generation of electricity connected to grid. Reflecting its effectiveness, installed capacity of solar power in Australia and South Korea witnessed robust growth of 36 times and 15 times respectively in five years after introduction of FiT and that for Japan by four times in three years.

7.2 FiT is usually set at premium rate above the standard electricity tariff especially during early years of introduction, helping investors to recoup the high cost of investment. Yet the level of FiT has been trending down across the globe in recent years due to (a) sharp decline in the cost of solar facilities by 77% during 2010-2015; and (b) exponential growth in solar PV system installations exerting pressure on government spending or electricity bills of consumers. Taking Japan as an illustration, its ratio of FiT to standard tariff for rooftop solar power has been reduced from 171% in 2012 to 120% in 2016.

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[38] A member household or an organization under Eco-Mileage system can monitor its energy consumption converted into carbon emissions through an online platform. With a 10% reduction, the member will receive 50 000 mileage points (worth around 50,000 won (HK$335)). See OECD (undated) and Seoul Metropolitan Government (2017a).

[39] See Sejong University (2017).

For Australia, the respective ratio of FiT across states fell from 191%-313% in 2008 to 21%-102% in 2016.

7.3 Seoul is a pioneer in Asia for its community-based initiatives on solar power development and energy saving. Although its FiT pitches at a modest level for development of mini-solar PV systems, it seems to be effective in mobilizing citizens to get involved in community activities, resulting in energy savings of 4% during 2011-2014.

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Appendix I

Installed power capacity by energy source in selected places in Asia in 2016

	World	Asia	Mainland	Taiwan	South Korea	Japan	Australia	Singapore	Hong Kong
(a) Installed power capacity (GW) and share* by energy source in 2016									
Total	6 637.8 (100.0%)	2 893.5 (100.0%)	1 649.0 (100.0%)	49.9 (100.0%)	124.8 (100.0%)	295.2 (100.0%)	43.2 (100.0%)	13.3 (100.0%)	12.1 (100.0%)
Fossil fuel (e.g. coal/gas)	4 156.9 (62.6%)	1 946.7 (67.3%)	1 044.0 (63.3%)	37.8 (75.7%)	87.9 (70.4%)	196.4 (66.5%)	24.1 (55.8%)	13.1 (98.1%)	10.7 (88.5%)
Nuclear	352.0 (5.3%)	67.3 (2.3%)	32.4 (2.0%)	5.1 (10.3%)	22.1 (17.7%)	1.8 (0.6%)	- -	- -	1.4 (11.5%)
Renewables	2 128.9 (32.1%)	879.5 (30.4%)	572.6 (34.7%)	7.0 (14.0%)	14.8 (11.8%)	97.0 (32.9%)	19.1 (44.2%)	0.3 (1.9%)	<0.1 (<0.1%)
(b) Renewable power capacity by major type of energy source in 2016 (GW)									
Total capacity of renewable power	2 128.9 (100.0%)	879.5 (100.0%)	572.6 (100.0%)	7.0 (100.0%)	14.8 (100.0%)	97.0 (100.0%)	19.1 (100.0%)	0.3 (100.0%)	Information not available
Hydropower	1 245.7 (58.5%)	518.0 (58.9%)	333.7 (58.3%)	4.7 (66.9%)	6.5 (43.8%)	50.2 (51.7%)	8.7 (45.7%)	- -	
Wind	467.1 (21.9%)	184.6 (21.0%)	149.0 (26.0%)	0.7 (9.7%)	1.1 (7.4%)	3.0 (3.1%)	4.3 (22.7%)	- -	
Solar	295.9 (13.9%)	139.7 (15.9%)	77.8 (13.6%)	1.2 (17.3%)	5.0 (33.8%)	41.6 (42.9%)	5.2 (27.3%)	0.1 (49.5%)	
Others	120.1 (5.6%)	37.3 (4.2%)	12.2 (2.1%)	0.4 (6.1%)	2.2 (15.0%)	2.3 (2.3%)	0.8 (4.3%)	0.1 (50.5%)	

Note: (*) Figures in parentheses denote the percentage share in the respective total.

Appendix II

Renewable power policy and feed-in tariff for distributed solar power in selected places in Asia in 2017

	Mainland	Taiwan	South Korea		Japan	Australia	Singapore	Hong Kong
			National	Seoul				
(a) Policies to promote renewable power								
Feed-in tariff ("FiT")	✓	✓	Ended in 2011	✓ since 2013	✓	✓	×	×
Renewable portfolio standard	✓	×	✓	✓	Ended in 2012	✓	×	×
Renewable energy certificates	✓	×	✓	✓	✓	✓	✓	×
Tax concessions on renewable power system installation	✓ (business)	✓ (business)	×	×	✓ (household)	✓ (business)	✓ (business)	✓ (business)
Grants/loans or other subsidies	✓	✓	✓	✓	✓	✓	✓	✓
(b) Basic information on FiT							Not applicable	
Contract duration (years)	20	20	15	5	10	7-20		
Incidence of additional cost	Government				Consumers	Consumers*		
(c) FiT for new entrants at the beginning (i.e. initial stage)								
Year of introduction	2013	2010	2002	2013	2012	2008-2010		
Initial rate of FiT (per kWh)	RMB0.42	NT$8.5394	716.4 won	50 won	¥42	40-60c		
Standard residential tariff (per kWh)	RMB0.56	NT$2.6098	87.01 won	127.02 won	¥24.51	14.73-20.98c		
Level of FiT to standard tariff	75%	327%	823%	39%	171%	191%-313%		
(d) FiT for new entrants in 2016								
Recent rate of FiT (per kWh)	RMB0.42	NT$6.4813	-	100 won	¥31	6.8-20c		
Standard residential tariff (per kWh)	RMB0.55	NT$2.6159	-	121.52 won	¥25.91	19.57-32.04c		
Level of FiT to standard tariff	76%	248%	-	82%	120%	21%-102%		

Note: (*) Western Australia is the exception, where the government bears the additional cost of FiT.

Appendix III

Key features of feed-in tariff for rooftop solar PV systems in Australia, Japan and Seoul

	Australia[1]						Japan	Seoul
	SA	ACT	Qld	VIC	NSW	WA		
(a) Basic information								
Year of introduction	2008	2009	2008	2009	2010	2010	2012	2013
Contract duration (years)	20	20	10	15	7	10	10	5
Grid access rights and purchase obligation	✓	✓	✓	✓	✓	✓	✓	✓
Frequency of review of FiT	Every year							
Incidence of additional cost	Consumers					Government	Consumers	Government
(b) FiT rate for new entrants at the beginning (i.e. initial stage)								
Initial rate of FiT (per kWh)	54c	40.04c	44c	60c	60c	40c	¥42	50 won
Standard residential electricity tariff (per kWh)	20.98c	14.73c	18.26c	19.2c	20.98c	20.96c	¥24.51	127.02 won
Level of FiT to standard tariff	257%	272%	241%	313%	286%	191%	171%	39%
(c) Recent FiT rate for new entrants in 2016								
Recent rate of FiT (per kWh)	6.8c	20c	7.448c	11.3c	20c	20c (2011)[2]	¥31	100 won
Standard residential electricity tariff (per kWh)	32.04c	19.57c	24.68c	27.49c	22.19c	27.17c	¥25.91	121.52 won
Level of FiT to standard tariff	21%	102%	30%	41%	90%	74%	120%	82%
(d) Penetration of solar PV system in 2016								
Number of households with system installed	200 213	17 185	485 794	294 815	343 930	211 091	2 011 142	34 000
Penetration ratio amongst households[3]	30%	14%	30%	15%	15%	24%	7%	1%

Notes: (1) South Australia (SA); Australian Capital Territory (ACT); Queensland (Qld); Victoria (VIC); New South Wales (NSW); and Western Australia (WA).
(2) In Western Australia, the FiT scheme was suspended in 2012.
(3) As at end-2016, some 1.7 million dwellings, accounting for 21% of Australian households, had a solar PV system installed.

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