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Evaluation on energy transition in East Asian cities: Case studies of Kyoto, Seoul, and Hong Kong

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Abstract

Energy transition has become more than urgent in recent years and has been widely discussed in face of global climate crisis and threat of energy sustainability. This paper offers an overview to examine the current implementation of energy transition by taking three East Asian cities as case examples: Kyoto, Seoul, and Hong Kong. By comparing different city context, this paper evaluated different components including city background, electricity mix, governance model, electricity market, prosumer business models, solar goal, current installation capacity, solar prosumer initiatives' features, and existing case communities in the process of energy transition. In general, it is observed that government support determines the major progress, especially the organization of policy dissemination and resource allocation reflect success of project implementation. Among the three cities, different experiences can be observed. Seoul takes active approach in accelerating energy transition from nuclear energy to renewable energy through gathering grassroot neighborhoods to be the solar prosumer. Kyoto government cooperate with power company in opening up blockchain-based distributed energy market, in order to seek for opportunities for new market prosumer. In Hong Kong, the government introduced Feed-in-tariff policy to advocate public participation in energy transition. All in all, respective policies are designed to situate current city condition and governance operation.

1. Introduction

This paper offers a general evaluation about energy transition in Kyoto, Seoul, and Hong Kong. Table 1 illustrated the energy background of the three cities and implementation of solar prosumer development.

2. Evaluation on Kyoto

Until June 2020, the population of Kyoto has reached 1,462,454. In 2017, the GDP was US$ 62.5 billion. In 2018, Japan was ranked the 5th in global rank of GHG emissions by country. It emitted 1.16 metric gigatons of GHG (Union of Concerned Scientists, 2020).

In 2019, energy mix of major sources in Kyoto is distributed as natural gas 41%, coal 33%, RE 12%, nuclear 7% and solar 2%. In Kyoto, the national governance mode adopts developmental state of being democratic and deliberative.

The local electricity market is highly liberalized with new retailers. The retail market was liberalized since 2016.

For prosumer business models, Kyoto takes “prosumer-embrace model”. It is a post-FiT business models that the Kansai Electric engaged with the prosumer to open up a cooperated commerce.

The city government has set solar target of achieving 475 GWh from residential solar PV by 2020. In March 2020, the solar installation capacity has attained 140 MW.

For solar prosumer initiatives’ features, local government set up Keihanna Science City as the demonstration project for smart solar prosumers. It aims to develop new prosumer market opportunities of a blockchain-based distributed energy markets with the Kansai Electric being the key actor. There are two case energy communities in Kyoto. The first one is the Seikadai. It is a government-led high income smart solar community demonstration project. Another one is the Hikaridai. The setting is a residential-commercial mix of solar houses and solar shops.

3. Evaluation on Seoul

In June 2020, the population in Seoul was 9,985,652. City's GDP was US$ 367.7 billion. The country was ranked for the 8th in the global rank of GHG emission in 2018 with 0.65 metric gigatons GHG emission (Union of Concerned Scientists, 2020). In 2017, the distribution of electricity mix (major sources) was revealed as coal 45%, nuclear 30%, natural gas 17%, and RE which also include solar occupied 6%. In Seoul, the national governance model adopts developmental state which is being technocratic yet participatory. Various policies agenda were established to implement energy transition at different phases. For example, the Energy Self-reliant Village program (known as ESV) which targets for installing small solar PV in neighborhood, is funded by the SMG (Seoul Metropolitan Government). The SMG offers financial support and proficient consultation service to help with solar system installation. The participation of ESV relied on community effort and co-interest in concerning energy issue and community-based development. For example, one of the participated sites, Sungdaegol, achieves to boost community economy by initiating energy market to sell solar panels and LED products. Moreover, they introduced solar loan in cooperation with a local bank, so that it offers an affordable alternative to residents who are interested in installing solar system. Residents do not need to bear interest or will only be charged for the lowest 2% interest rate (Kim, 2017). While this act responses to energy transition, it also enhances public awareness on monitoring how the government formulate energy policies in a bottom-up way.

The electricity market in Seoul remains moderately liberalized. It is liberalized in the generation and transmission domains, yet it is restricted for retail. For the prosumer-utility relationships, it adopts "prosumer-challenger model". As FiT started to be phasing out, the KEPCO (Korea Electric Power Corporation) has announced that changes are limited to response sudden and crucial challenges such as blackouts occasionally.

Up till 2017, Seoul was equipped with 84 MW of solar installation capacity. The target is to achieve 1 GW by 2022. Seoul Mayor Park Won Soon announced a continuous plan in expanding solar installation in the city. The project "2022 Solarcity Plan" will expect to put solar in force at more public facilities and housing buildings (Chung, 2017). In addition, to promote renewable development, the city government is injecting supplementary subsidies to finance households for solar panel installation at their residence. For one solar panel which is measured in 0.9m height x 1.6m width will be funded for US$ 363 and extra subsidy can be applied from the district office if needed (Kim, 2017).

On the other hand, the solar prosumer initiatives target on grassroot prosumers. For example, the case community Sungdaegol, is a self-initiated solar community which actively promote solar prosumption. It receives subsidy from the ESV program which is supported by the Seoul Metropolitan Government. The program mainly targets grassroot prosumer where the neighborhood is located at potential area for developing solar project and possess strong public awareness about energy safety (Kim, 2017). In addition, WATTMALL, a social

enterprise which is a community-based energy trading market, was set up as a community-based and peer-to-peer energy trading market.
Sungdaegol also serves as a local peer-to-peer energy trading platform and an active energy cooperative to promote solar prosumption. Another case community is the Sindaebang Hillstate Apartment Complex. The building type belongs to apartment-type energy self-reliant village.

4. Evaluation on Hong Kong

In June 2020, Hong Kong gained population of 7,509,200 (C&SD, 2020). In 2018, city's GDP was US$ 343.6 billion. On the 2018 global rank of GHG emissions by country, China was ranked the 1st for emitting 10.06 metric gigatons GHG (Union of Concerned Scientists, 2020).

The energy mix of Hong Kong is distributed as follows: coal 50%, natural gas 25%, nuclear 25%, RE and solar get less than 0.1% respectively.

The governance mode adopts authoritarian state, yet at city-level the market environment is neoliberal.

The electricity market in Hong Kong is vertically integrated. The prosumer-utility relationship adopts "basic prosumer model". It is monopolized by power companies, the China Light and Power Company Limited and Hong Kong Electric. The FiT (subsidy)-dependent business model with the two electricity monopolies involvement adopt incremental traditionalist changes.

The city government has set a goal to attain solar installation capacity of 6.29 MW by 2017. Moreover, Hong Kong is one of the cities that offers the highest Feed-in-tariff policy around the world. For RE system that generates less than or equal to 10kW can be paid with HK$5 FiT rate; more than 10kW to less than or equal to 200kW can earn HK$4 FiT rate; and with system that can power more than 200kW to less than or equal to 1MW electricity can be offered HK$3 FiT rate.

There are two case communities for solar implementation. The first site is Fairview Park. The community is composed with 5,000 flats of high-income low-rise housing. As the setting receive rich solar resources, it was selected to be the demonstration site. Another testing site is Rhythm Garden. It is an apartment-type solar community. The property office acts actively in prosuming solar implementation. About 900 solar panels were installed in the community. The estate had participated in the FiT scheme. It is estimated that every participated household could make around HK$ 65 every year by selling electricity to CLP (Chow, 2018, 2019).

Table 1. Summary of smart energy transitions of three East Asian cities and their rise of development in residential solar prosumers.

	Kyoto	**Seoul**	**Hong Kong**
Population by city (Jun 2020)	1,462,454	9,985,652	7,509,200
GDP (city; in billion US$)	62.5 (2017)	364.7 (2018)	343.6 (2018)
Global rank of GHG emissions by country (2018; Metric gigatons)	Japan: 5th (1.16)	South Korea: 8th (0.65)	China: 1st (10.06)
Electricity mix by country (major sources)	2019 Natural Gas (41%); Coal (33%); RE (12%); Nuclear (7%); Solar (2%)	2017 Coal (45%); Nuclear (30%); Natural Gas (17%); RE, including Solar (6%)	2019 (Hong Kong) Coal (50%); Natural Gas (25%); Nuclear (25%); RE (<0.1%); Solar (<0.1%)
National governance mode	Developmental state; Democratic and deliberative	Developmental state; Technocratic yet participatory	Authoritarian state; with a neoliberal market environment at city-level
Electricity market	Highly liberalised with new retailers (Retail markets also liberalised since 2016)	Moderately liberalised (Generation and transmission liberalised ,but not yet retail)	Vertically integrated; monopolies
Prosumer business models (prosumer-utility relationships)	"Prosumer-Embracer Model": Post-FiT business models in which Kansai Electric engages prosumers for changes.	"Prosumer-Challenger Model" FiT Phasing-out business models, with KEPCO introduces changes only in face of major challenges such as blackouts.	"Basic Prosumer Model": Basic, FiT (subsidy)-dependent business model with which the two electricity monopolies adopt incremental traditionalist changes.
Solar targets by city	475 GWh from residential solar PV by 2020	1GW by 2022	660MW by 2030*
Solar installation capacity	140 MW (March 2020)	84 MW (2017)	6.29 MW (2017)
Solar prosumer initiatives' features	• Government-led Keihanna Science city as a demonstration project for smart solar prosumers • Emerging new prosumer market opportunities of blockchain-based distributed energy markets with Kansai Electric as a key actor	• Grassroots prosumers' communities supported by city government • WATTMALL, a community-based energy trading market (a social enterprise) • Community-based P2P market being set up	• One of the highest Feed-in tariff policies around the world
Case communities (tentative)	Case Community 1: Seikadai (精華台; government-led high income smart solar community demonstration) Case Community 2: Hikaridai (光台; residential-commercial mix of solar houses and solar shops)	Case Community 1: Sungdaegol (Local P2P energy trading platform; active *energy co-operatives* promoting dsolar prosumption Case Community 2: Sindaebang Hillstate Apartment Complex (Apartment-type Energy Self-Reliant Village)	Case Community 1: Fairview Park (5,000 flats high income low-rise housing estate with rich solar resources) Case Community 2: Rhythm Garden (Apartment-type solar community with some 900 panels with *a property management office* played an active role in prosuming

Sources:
Hong Kong (C&SD, 2019, 2020; Chow, 2018; Chu & Schroeder, 2010; Environment Bureau, 2017; Mah et al., 2020; Meinhardt, 2019)
Kyoto (Agency for Natural Resources and Energy, n.d.; Energy Policy Division of Environment Bureau, 2015; Kyoto City Official Website, 2019, 2020; Kyoto City Statistical Analysis, 2019; Masukawa, 2018; Saito, 2020)
Seoul (Chung, 2017; Kim, 2017a; Kim, 2014; Kim, 2017b; Kim, 2020; Korean Energy Economics Institute, 2018; Seoul Open Data Plaza, 2019; Statistic Korea, 2019)
Others (Chu, 2016; Union of Concerned Scientists, 2020; World Bank, 2018)

4. Conclusion

In summary, three cities share similar features, such as rapid urban development, population density, GDP, world ranking of GHG emission, and distribution of energy mix. However, local government focus on different domains to scale up energy transition. For instance, Government of Kyoto focus to work with power company to emerge new energy market which engages new prosumer market opportunities that is operated in block-chained distributed manner. Government of Seoul provide financial support to encourage public participation in joining ESV program, which serves as the foundation for RE expansion that starts at grassroots level.

Therefore, city government of Kyoto, Seoul, and Hong Kong adopts various RE policies to promote energy transition. Kyoto targets to develop RE by setting up demonstration sites; Seoul targets to utilize human resource among grassroots neighborhood to accelerate solar system development in the city; Hong Kong government introduced Feed-in-tariff policy to promote renewable energy popularity.

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