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Critical Success Factors for integrating renewable energy development in a country with 2 systems: The case of Pearl River Delta and Hong Kong SAR in China

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ABSTRACT

China is well ahead in the renewable energy (RE) sector, both for its manufacturing and installation capabilities, although grid connection is lacking behind. Whilst most generating sites are in the northeastern and northwestern provinces due to geography, the south has a role to play. Zooming down the Pearl River Delta (PRD), with Hong Kong Special Administrative Region at its estuary, complementary effects on RE have been taking place due to "One Country – Two Systems" since 1997, when the latter's sovereignty was reverted to China. A study was carried out on the challenges facing the RE sector in the PRD, its Critical Success Factors and collaborative opportunities. Quantitative survey findings indicate keen competition, grid connection and skilled labour shortage problems. Critical Success Factors include the availability of capital and grid connection incentives, customers' satisfaction, R & D capability, grid stability, safety and competitiveness with fossil power. Qualitative interviews confirm Hong Kong's edge as a market economy having a trusted legal environment, since it can attract mainland RE enterprises in public listing, financing, exhibiting, providing insurance services and a platform for intellectual property protection and trading, both for their domestic and overseas ventures. Maintenance of status quo (i.e., stability) is important.

1. Introduction

In order to reduce the reliance on conventional fossil fuels, which are being depleted but generate green-house gases leading to global warming, many countries are trying to increase the use of renewable energy (RE). Whilst countries such as the US and China have the resources to develop RE projects on their own, synergy (with an estimated economic impact of around 10%) is found when they cooperate in the form of joint policies, technology transfer and mutually developed intellectual property mechanisms (Zhang et al., 2014). Regional collaborations (e.g., cross-state emission trading in North America, the ASEAN Power Grid in Asia and SuperSmart Grid bridging Europe and North Africa) have been proposed for RE such as solar and wind power generation (Kahn, 2016; Chang and Li, 2015; Battaglini et al., 2009). The harvesting of these energy sources relies heavily on geographical advantages but since they vary amongst neighboring countries, and coupled with demand pattern differences, collaboration helps to complement each region/country's strength and shortfall. At the commercial level, calls have been made at the European Union to leverage on Chinese direct investments, especially when downsizing of support policies in the RE sectors are affecting European firms due to the recent financial crises. It is said that small and medium sized firms in Europe can also benefit by offering services to Chinese RE firms when they explore the European market (Lv and Spigarelli, 2015). In the Asian arena, Chang and Li (2015) predicts that energy market integration amongst ASEAN countries via policy co-ordination can reap a "low-hanging fruit" of achieving 30% RE in the participating countries by 2030.

This type of energy market integration is particularly pertinent within a country or region, when complementary effects occur when one region helps another nearby to achieve overall results beneficial to both, such as air quality improvement stemming from tightened emission control, and certainly the increased use of RE. Various studies (Schienstock, 2005; So, 2008) have highlighted the extensive interactions and innovations made possible by proximity and trust amongst neighbours in an inter-regional setting. Mah et al. (2012) expounded on the potential collaborative benefits between Guangdong and Hong Kong SAR and listed out the physical, technical, economic and market complementarities. Whilst perceiving some barriers in the same areas as above (physical: land shortage; technical: grid connec-

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tivity and intermittency of availability; economic and market: upfront capital), political/institutional and social barriers were also envisaged. Several options were considered by participants in their study, including technological options (solar, wind biomass, biofuels and energy storage; and in particular, decentralized technologies are being more applicable to Hong Kong and Shenzhen), financing options (potential collaboration being cross border financing) and governance options (introducing Renewable Portfolio Standards), but practicable details were not available.

Since 2012, rapid economic development has taken place in the Pearl River Delta (PRD), which is about one-third of Guangdong province in size but having a GDP per capita of 1.5 times and urbanisation rate of 1.24 times over the latter's averages (Qing, 2014), a more focused study is warranted. At the same time, a fast progression of RE adoption has occurred in the whole of China, in that many supportive directives have been issued in the mainland, particularly on distributed photovoltaic projects (Yuan et al., 2014). This study was therefore undertaken with the objective to examine the collaboration undertaken between the PRD and Hong Kong SAR (since Hong Kong SAR is situated at the estuary of the Pearl River and hence relates better with the 9 major cities of the PRD than the eastern and western districts of Guangdong province) and identify the Critical Success Factors for enhancing further collaboration. Readers may refer to Zhang et al. (2015) for a comprehensive listing of mainland directives, which are not repeated here, except by way of updating in the rest of this paper.

As the title indicates, discussion will be centered on how 2 systems (put simply: socialism with Chinese characteristics vs. capitalism; or stated differently: Planned Economy vs. Market Economy or Laissez-faire) can collaborate within one country (i.e., China), and where the beauty and limitations are with such collaboration. Readers who are interested in the "One Country – Two Systems" arrangement, which is a political and public administration topic outside the scope of this paper, may refer to literature such as Chen (2003) and Yang (2006), etc.

The paper contributes to a better understanding on the important issues surrounding RE collaboration on a regional basis, particularly in the context of different economic and social-political developments. The discussion will be of benefits to policy-makers contemplating broad regional collaboration in RE. A special interest is explicated in this case in that the collaborators happen to be within the same country having 2 different social-economic-political systems. This unique feature adds to the existing literature which largely contains deliberations on collaboration at different sovereign levels.

2. "Renewable" interplay between the PRD and HKSAR

2.1. Mainland situation

If one looks at the sky of any Chinese populous city on a smoggy day, one would understand the determination of the mainland government in trying to tackle the problem caused by human activities (BBC, 2016). Climate change is another culprit, which prompts the establishment of policy directions towards a green economy through a successive series of national plan, notably the more recent 12th and 13th 5-year plans of China. Much hope is being put on the increased though partial substitution of RE for conventional fossil fuel energy. Under the 12th 5-year plan, the adjusted target share of non-fossil fuel was 11.4% by 2015 (Lewis, 2011). The recently unveiled 13th 5-year plan (for 2016–2020) lays an even more ambitious target on energy consumption cap and a 15%-goal for the share of non-fossil-based fuel in China's energy mix (the country has been relying heavily on coal as the primary energy source) (Ma, 2017a). Whilst the former target was well exceeded, at least on paper, commentators (e.g., Ma, 2017b; Winglee, 2016) predicted that achievement of the latter target depends on whether the transmission grid bottleneck is resolved. Currently, grid connection delays and the resultant curtailment of solar and wind power production in some parts of China would reduce the mitigating effect of using renewable energy against global warming. These installations are mainly concentrated in the northeast and northwestern regions of China based on their geographical advantages, but which have relatively less populations than the eastern coastal areas. Under the policy driven directives, partly due to the abovementioned environmental reasons and partly due to overcapacity of the solar and wind industries arising from resistance of a trade friction nature in foreign importing countries, there has been a boom in the said industries locally but an inability to digest fully the energy produced in those less populous areas. Hence, to mitigate against the higher cost of RE generation leading to its wider use, various incentives have been provided by the mainland government, including the provision of differential provincial subsidies (Feed-in-Tariff ranging from around RMB 0.47 kW h to RMB 0.98/kW h – which is subjected to annual reviews with a downward trend in line with falling equipment cost) to solar plant owners to balance off regional differences (Bischof, 2016); and specific additional subsidies for the distributed type of photovoltaic (PV) installations (currently at RMB 0.42/kW h – NDRC, 2016), against a conventional on-grid thermal power tariff ranging from RMB 0.25–0.47/KW h (depending on location, KVA and use type) in accordance with a study by the North China Electric Power University (2016). Due to the high cost of power transmission over long distances, the current strategy is to encourage local consumption (including self-use and selling to the local grid) of RE as much as possible, with a new policy similar to Renewable Portfolio Standard being practised in western countries coming on stream in mainland China (Chang, 2017).

Owing to the resistance against allegedly subsidised imports from the traditional markets of America and Europe, mainland Chinese RE equipment manufacturers are venturing further afield (e.g., in Brazil) – Bradbury (2014). They also eye on the massive downstream market of solar farms and distributed PV systems, as well as wind farms in those fast developing countries. Often, mergers and acquisitions of indigenous firms or projects are the means to this end. To do so, they need substantial capital and business expertise to reap the fruits of the world trend moving towards the increased use of RE.

The Pearl River Delta (PRD) region of China is one of the three major metropolis groups of the country (the other two being the Yangtze River Delta and the Bohai Rim), consisting of 9 major competing mainland cities (such as Guangzhou, Shenzhen, Zuhai, Fushan, etc.) and vast river hinterland abutting the South China Sea. As a Special Administrative Region (SAR) after return of sovereignty from British rule since 1997, Hong Kong also forms part of the Pan Pearl River Delta. Politically and economically, China promised Hong Kong SAR 50 years of maintenance of its status quo after the handover under the "One Country – Two Systems" concept. Despite being laden with limitations in terms of shortage of land and natural resources, Hong Kong SAR has special significance to China and the world under the "Two Systems" arrangement. This paper depicts how this works in the RE arena.

In the renewable energy market, different business entities operate along a value chain ranging from research and development, raw material extraction, assembly, manufacturing, distribution, development and installation. Various business models prevail, creating different business relationships, financing and ownership patterns, together with different ways of approaching the market and adding values to customers. Some firms retain their expertise and activities at a certain point, for example, manufacturing at the upstream, or project development/installation at the downstream. Other firms integrate activities vertically along the value chain, with an increased span of control and efficiency of scale. Horizontal integration sometimes takes place via geographical diversion or mergers/acquisitions between capable entities and their weaker counterparts, especially in a market consolidation scenario, as happened in China in 2010–2013. In other words, some firms disappeared, amidst financial difficulties (Ip, 2014).

2.2. Hong Kong SAR ("Hong Kong" in short) situation

Before the economic opening up of China in the 1980s, Hong Kong owed its economic success to light goods manufacturing (such as electronics, clothing and watches) and subsequently to real estate and financial developments. Due to the scarcity of land and the availability of cheaper labour in the PRD, many manufacturers moved their plants there whilst Hong Kong acts as headquarters, where planning, design, coordination and marketing vis-à-vis the world market take place. The city is densely populated with over 7 million people over about 1000 ha of hilly landform, who are mostly descendants from early migrants from cities in the PRD, except that they have been exposed to the western style of education, management and governance. Infrastructure is well in place, especially transport and communication.

As close geographical neighbours, Hong Kong and its sister cities in the PRD share the same atmospheric and environmental conditions. Following China's mandate to mitigate the impacts of climate change, Hong Kong has expanded its previous focus on air quality improvement stemming from economic growth motivation alone to tackle climate change problems (Ng, 2012). The increased use of RE (from the current level of 2% up to only 4% towards 2030) is put on "Hong Kong's Climate Action Plan 2030+" (EB, 2017). Yet, due to the physical constraints and the building form being predominantly of high-rise structures (Zhang et al., 2012), solar and wind power facilities are mostly installed for a supplementary purpose to-date, since electricity is reliably supplied by 2 monopolistic utility companies divided by the users' locations, burning coal or gas fuels (currently at a mix of 53% and 22% respectively) (EB, 2014). Since 1994, the Daya Bay Nuclear Power Station in Shenzhen began to supply electricity via a dedicated transmission line to meet at least 23% of Hong Kong's needs of 43,000 GW h (as in 2012), owing to a concomitant investment by one of the Hong Kong-based utility companies (EB, 2014). As an incentive for investment by the utility companies, the Hong Kong government allows a 9.9% return on asset employed (11% in the case of renewable energy generation) under two separate "Scheme of Control" (SoC) agreements with them, which are due to expire or to be renewed in 2018 (EB, 2014). The latest announcement of an upcoming SoC indicates that the overall rate of return will be reduced to 8%, with no distinction between renewable and other investments after the current one expires. For the first time in Hong Kong, a feed-in-tariff arrangement and Renewable Certificates will be introduced (HEC, 2017).

2.3. RE Collaborations between PRD and Hong Kong SAR

As mentioned, Hong Kong's manufacturing sector has moved to the PRD since the 1970s, contributing to the economic growth of the latter. After products were made, they were containerised and exported through the efficient port facilities of Hong Kong. Foreign traders felt more comfortable to visit and carry out transactions in Hong Kong due to their familiarity with the Common Law system. Hence, Hong Kong used to act as a window of China to the foreign world even in the immediate years after the handover in 1997. People described this relationship as "front shop, back factory" (Segal, 2010). More recently, however, there has been a great leap in the infrastructure and build-up of talents in the PRD alongside the rapid economic development of the mainland, notably in coastal cities such as Shenzhen and Dongguan. Research and development resources have been strengthened, to the extent that questions have been raised as to whether Hong Kong would ever have the R & D capabilities required to play an active role in the upgrading of the PRD (Segal, 2010). In any event, the dense web of policies, institutions, business and personal rapports cultivated to-date, as well as ongoing collaborations in research, educational exchange, and innovation activities form the backdrop of the close relationships between the localities.

In the realm of RE, the technological advancement of the mainland is closely watched by Hongkongers, if not drawing a parallel due to resources (in particular land) constraints. Interestingly, up to 2014, it has been noted that out of 19 non-conventional/RE companies listed in the Hong Kong Stock Exchange, 18 have mainland origins and 1 is local (HKEx, 2014). Apart from raising capital in Hong Kong, investment banks there are serving in a number of capacities to facilitate the listing process (such as taking up the roles of global coordinators, joint sponsors, book-runners, etc.) of mainland RE entities. To reflect the importance of mainland RE entities to the economy of Hong Kong, one upstream thin film PV manufacturer and several PV developers have been incorporated as constituent shares of the composite Hang Seng Index (an important stock market indicator in Hong Kong) in 2012 and 2015 respectively. Hong Kong companies are also actively investing in RE projects in the mainland. For example, one local utility company has invested a total of 3190 MW in PV and wind projects (CLP, 2015a). When mainland RE enterprises carry out acquisitions of counterparts overseas, Hong Kong financial or securities firms are often engaged as consultants (AAStocks, 2016).

Apart from the contributions from Hong Kong investors and financial intermediaries, Hong Kong manufacturers owning plants in the PRD have joined the mainland's move of installing distributed PV systems at their roof tops. One such soya sauce manufacturer has such installations on 47,000 sq m of its roof space in Sanhui since 2014, which, together with their geothermal facilities, claim an utilisation rate of 80% of RE (PR Newswire, 2015). This is followed by another Taiwanese food manufacturer listed in Hong Kong, which plans to install 100 MW-rated PV panels in their factory roof space throughout China (Reuters, 2015).

In respect of wind power, the cumulative grid connected capacity in Guangdong province (no separate statistics available for the PRD) has doubled from 933 MW in 2011 (Li, 2012), to 1810 MW in 2013 (CREIA et al., 2014), but it is only in the mid-range within the whole of China. Hence, the investment from Hong Kong has been more focused on wind farm projects in other more wind-intensive areas until the recent wind curtailment due to over-capacity in those areas. For example, one local utility company wholly own wind farm projects in Laizhou, Laiwu, Penglai, Qian'an, Sandu and Xundian, with other co-ownerships elsewhere, totally owning around 1261 MW of plant installed (CLP, 2015a). The recent adjustment will see a transient move of wind farm development towards the south until the over-capacity in the northern districts is digested (kknews, 2016).

About biomass, due to the urbanisation of the PRD, the raw materials are not so plentiful as in more inland regions. As an example, one Hong Kong listed company has invested in Hubei and Anhui provinces on waste-to-energy and biomass power plant using agricultural waste and straw on Build-Operate-Own basis, with at least 60 MW of installed capacity (Everbright, 2015, 2016). The use of straw also helps to avoid it being burned by farmers, which is also banned by local regulations.

A year before the time of writing, Hong Kong has carried out a territory-wide consultation on the future development of its energy market with the option of increasing the supply of power from the mainland up to 30% by 2023 (including the nuclear power mentioned earlier), but the majority of feedback collected (especially from the business community) indicates that this is not favoured due to various reasons, including worries on the reliability (at 99.96% compared with Hong Kong's at 99.999%) of mainland's supply owing to Macau's (another SAR nearby receiving 92% of its power needs from the mainland) blackout experience (Fan, 2014), as well as the undesirable notion to "transfer" pollution to the mainland by buying electricity from there since it would not be easy to guarantee that the supplied energy is from RE sources (Cheung, 2014). Some environmental organisations support the import of renewable energy from China to Hong Kong, although they also advocate for enhanced energy efficiency and demand side management to curb consumption growth locally (WWF, 2016). According to the Environmental Bureau of Hong Kong, a detail plan on the way forward has yet to be worked out, but the

Schemes of Control with existing utility companies will expire in 2018 (EB, 2015). While still on the subject of feedback on the consultation, some comments cited statistics (C & S Dept, 2013) about an export of surplus power (4–10% of local production over a 5-year period) from Hong Kong to the mainland, hence there were calls to trim down on the reserve generation capacities of the former to reduce local pollution. In this connection, some experts questioned if China would spare its already-strained power capacity to Hong Kong. Government officers passed comforting remark that the export proportion would be just around 2% of China's own need (Cheung, 2014).

Lastly, there are some cross share-holdings between mainland energy enterprises and Hong Kong utility companies (or their associated companies). The two utility groups, whilst investing in mainland's energy projects, have sold small but not insignificant parts (18–30%) of their shares (or that of their subsidiaries owning generating assets) to mainland energy entities. In 2013, a mainland grid company acquired 30% stake of 3 sizeable Hong Kong's power plants from a US energy group, which redeployed their investment elsewhere (Song, 2013). This move sparked the concern of the SAR's legislators as to whether its electricity market would be subject to control by mainland entities (LEGCO, 2012). This concern is an intricate social-political feature of the "1-Country; 2-Systems" arrangement. Again, interestingly, in Hong Kong, the utility companies own both the generating plant and the transmission network, but there used to be separate ownerships of these assets in the mainland's case. Although there are existing transmission lines connecting the mainland to Hong Kong, additional investment needs to be made for an enhanced network if additional mainland's power (including RE) is to be transmitted to Hong Kong. Hence, the issue of RE import is still in conundrum, whilst the way ahead seems to be that of increasing the proportion of gas fuel to 50% (CLP, 2015b) and keeping the nuclear proportion unaltered (both sources are from the mainland) as an aftermath of the Fukushima nuclear incident. Environmentalists remain skeptical on the increased use of gas due to its emission intensity and citizens fear the fluctuating gas fuel prices and increased gas plant investment would result in tariff hikes. Being weighed against the desire for energy self-sufficiency, this dilemma is expected to continue for some time to come. A close examination was thus carried out to probe further into the possible venues of RE collaboration between the mainland and Hong Kong SAR.

3. Research methods

A questionnaire survey was carried out in late 2015 on practitioners (including upstream and downstream enterprises) of the RE sector in the PRD and Hong Kong using cluster sampling based on the trade directories published in the 2 districts. A sample of the questionnaire can be viewed at the Appendix, which is a translated version of the original Chinese version sent. Out of 285 questionnaires mailed (PRD: 192; Hong Kong: 93), 39 replies were received respectively (PRD: 28; Hong Kong: 11) after reminders being sent to those with email addresses available. The response rate is 13.6% overall, which is relatively low but considered satisfactory having regard to the uncommon practice of mainland personnel answering questionnaires from non-mainland sources and the relatively small number of Hong Kong firms working on mainland RE projects currently. The overall test of reliability using SPSS yields a Cronbach's Alpha of 0.3 for the questionnaire design, which is "excellent" according to Nunnally (1978). A Kendall Coefficient of Concordance is also calculated for each group of questions to assess the consistency of the answers (given in the discussion of results below) – Siegel and Castellan (1988).

The questionnaire was designed after a comprehensive literature review in order to capture a longitudinal view of the RE market in the mainland in terms of the potential collaboration areas with Hong Kong and distil the critical success factors in such collaboration. A pilot trial was carried out before mass mailing to ensure proper understanding (especially on the Chinese terminology being used in the mainland). Section 1 of the questionnaire solicits basic information about the respondents and their firms, such as their job nature, years of experience, main business presence, plant and power consumption locations, number of employees, position in the value chain (e.g., upstream manufacturing, mid-stream assembly or downstream installation, etc.), type of RE generation and geographical sources of capital.

Section 2 solicits rankings based on a Likert scale of 1 (demand not being satisfied) to 3 (surplus supply) the supply and demand situation of the mainland market of upstream, mid-stream and downstream production capacities, as well as the grid infrastructure capacity.

Section 3 requests rankings based on a Likert scale of 1 (insignificant) to 3 (too much) the current business challenges or barriers (including land resources, financing, grid connection, labour supply, etc.) being faced by the RE entities.

Section 4 lists a number of Success Factors of RE business in the PRD, grouped under the sub-headings of finance, policy, customer relations, company operation, technology and others. Respondents were requested to rank their relative importance based a Likert scale of 1 (unimportant) to 5 (very important).

Section 5 explores the collaborative aspects between the PRD and Hong Kong, again sub-divided into headings of finance, investment mode, external assistance, professional services and others. Respondents chose rankings from a Likert scale of 1 (not useful) to 5 (very useful).

Although the Likert scale was used, no intermediate descriptors were used, indicating to respondents that they could choose within the stated continuum.

The results of the quantitative questionnaire survey were triangulated with literature review findings, the written comments made by the respondents under Sections 3 and 5 (see Table 1), as well as a series of qualitative semi-structured interviews conducted face-to-face or via phone with 7 RE practitioners (see Table 2 for their profile, which also indicates the modes of interviews and those who also completed the survey) in Feb-Mar 2017. The interviewees included R & D personnel as well as business managers in the mainland, utility company managers and PV installers in Hong Kong. Hence, they covered the major areas of practice in the RE field for the purpose of this paper. Structured questions were centered at the need, potential areas and possible barriers of RE collaboration between the PRD and Hong Kong,

Table 1
Summary of written comments by Survey Respondents to supplement their answers.

- Insufficient user support with many adopting "wait and see" attitude, whilst overall environmental consciousness is not high;
- Use of building integrated PV not very positive;
- Insufficient credit support; loans to the PV industry is highly selective;
- Overseas demand is hampered by trade friction in US and Europe, whereas markets in South East Asia (e.g., Indonesia) are booming; however knowledge of policy and cultural dimensions in those market is lacking;
- Government incentive still insufficient for sustainable businesses, especially high tech ones;
- Low energy prices in China are not conducive to the development of renewable energy;
- Sometimes, land resources are lacking due to allocation policy mismatch in meeting solar farms' topography needs;
- Choice of offshore wind farms not easy due to complex technological requirements; installation is particularly challenging;
- Grid connection bottlenecks exist due to infrastructure investment not in tandem with renewable energy development and resistance from local utility and grid companies; sometimes renewable energy developers need to invest in grid construction to solve the bottleneck problem;
- Due to the rapid development of wind power, skilled worker supply is very tight, especially for installation and operation;
- R & D personnel for thin film PV is not sufficient; leading to many areas needing imports of foreign technology. They are also needed for acquisition of overseas firms.
- Despite fast development, the use of renewable energy is still not comparable with conventional power in China

Table 2
Interviewees' profile.

Interviewee's role	Location of practice	Nature of enterprise	Yr. of experience	Face-to-face (F)/ phone (P)	Answered questionnaire Yes (Y)/No (N)
Director	Qinghai, PRC	Concentrated solar thermal plant	25	P	N
Technical Engineer	Shenzhen, PRC	PV ground station operation and R & D	15	P	Y
Director	PRC and Hong Kong	Solar technology company (R & D and technology support)	30	P	Y
RE manager with mainland project portfolio	PRC and Hong Kong	Utility Company	30	P	N
Business Strategy Director	Hong Kong	Utility Company	35	F	N
Managing Director	Hong Kong, SE Asia	RE (PV and wind) Design & Build Company	30	F	Y
Business Director	Hong Kong	PV Installer	20	F	N

whereas interviewees were encouraged to express other opinions freely. The dialogue was recorded in writing and the process took half-hour each. The written comments obtained in the survey (Table 1) and interviewees' responses (see the following section) largely match and help to elaborate the survey results with additional insight provided.

4. Discussion of results

4.1. Questionnaire survey

Respondents' profile: As Fig. 1 shows, 54% of the respondents were management personnel, whilst the rest belong either to the technical or "other" categories. On average, they have eight years of working experience. More than 70% has business presence and plant in China, where the power generated is provided to in 79% of the cases. In Fig. 2, a good spread of positions in the value chain is seen, covering design, manufacturing, assembly, installation, marketing and maintenance with multiple roles taken by about half of the respondents. Regarding RE type, Fig. 3 shows that 23 respondents were involved with PV installation (more on ground installation than the building integrated type), 6 with wind (more on ground than offshore) and 6 with biomass (equal split between power, gas and fuel productions with overlaps). A negligibly small percentage is engaged with hydropower and geothermal facilities. Nineteen of the mainland firms were funded internally, mostly state-owned. A small number (1–2) were either mainland-HK joint ventures, listed in Hong Kong or abroad.

Section 2 (Supply and Demand for RE): Kendall Coefficient equals 0.141 at a 0.03 significance level, indicating consistent answers by respondents in this group of questions. Demands were considered to meet supply conditions for upstream manufacturing, mid-stream

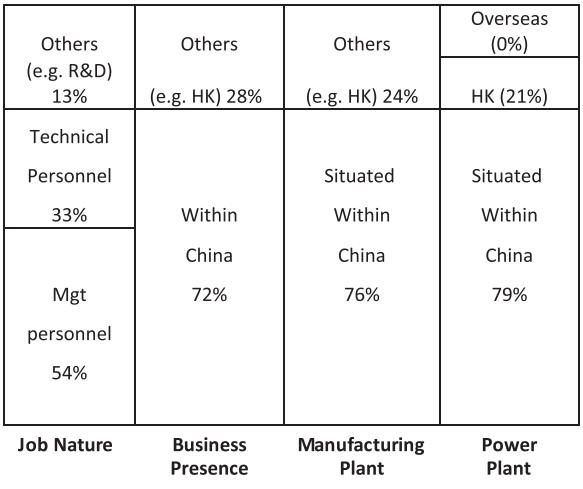

Fig. 1. Profile of respondents.

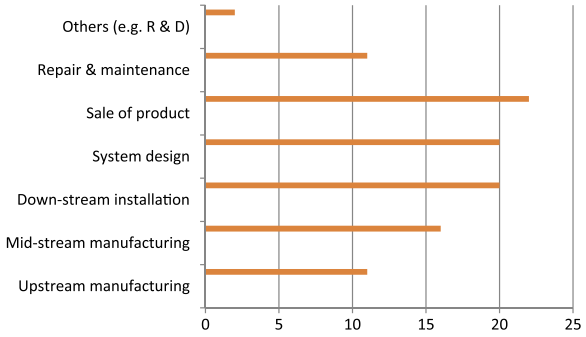

Fig. 2. Organisation nature of respondents.

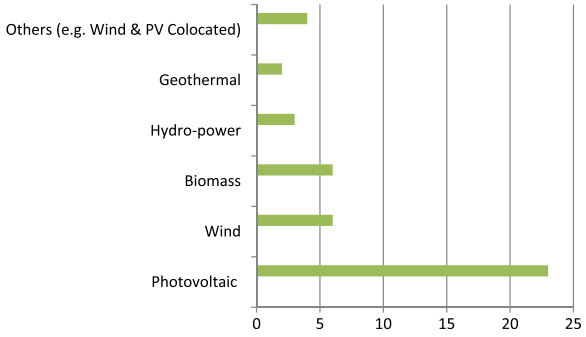

Fig. 3. Renewable energy type under responsibility of respondents (in Nos.).

assembly and downstream installation (all having average scores around 2). Grid infrastructure was regarded as insufficient to meet requirements (average score lower than 2). Whilst the over-capacity situation in upstream manufacturing is not reflected well, the inadequate grid connection problem can be seen from the survey.

Section 3 (RE Business Challenges and Barriers): Kendall Coefficient needs to be interpreted by Chi-square value since the number of items is greater than 7. The calculated Chi-square value (52.394) is larger than the critical value of (26.30) with a degree of freedom at 16 and significance level < 0.001, indicating that the respondents answered this group of questions with consensus. The bigger challenges are the keen competition for business, inadequate supply of skilled workers, lack of public support and the grid connection bottleneck.

Section 4 (Success Factors): On "Finance", Kendall Coefficient equals 0.13 at 0.001 significance level (< 0.05), indicating consistency of replies. Stable income is the most important (mean score at 4.35 out of 5), implying that profitability affects long term sustainability of RE businesses. On "Policy", Kendall Coefficient equals 0.08 with significance level at 0.035 (< 0.05), indicating consistent answers. Timely government's subsidy in the form of feed-in-tariff is the most important (mean score at 4.472). Regarding "Customers' Relations", Kendall

Coefficient is at 0.052 with significance at 0.123 (> 0.05), indicating lack of consensus. Meeting customers' quality requirement is the most important (mean score at 4.263). Regarding "Business Operation", with Kendall Coefficient being at 0.132 and significance level less than 0.001, answers were consistent. R & D capability is the most important (mean score at 4.308) under this group. As for "Technology" aspects, Kendall Coefficient is at 0.153 (significance level = 0.001 < 0.05), indicating consistency. Stability and safety of grid connection is the most important (mean score at 4.394) in this group. As for "Other Aspects", which is not so consistent with Kendall Coefficient at 0.102(significance level = 0.071 > 0.05), RE being competitive with fossil fuel energy is the most important (mean score at 3.694). This indicates the importance of achieving grid parity. The most important factors as mentioned above are regarded as the Critical Success Factors for the purpose of this study.

Section 5 (Collaborative Areas between the PRD and Hong Kong): In respect of "Finance", Kendall Coefficient is 0.155 at a significance level of 0.009 (< 0.05), showing that consensus was present amongst the respondents in this group of questions. They considered that it would be most useful for mainland RE entities to have Initial Public Offerings (IPOs) in Hong Kong (mean score at 3.966). As for "Investment Mode", Kendall Coefficient is at 0.158 with a significance level of 0.033 (< 0.05), indicating weak consensus. It seems that preference is for joint investment over direct investment by Hong Kong enterprises (mean scores at 3.688 and 3.50 respectively). When it comes to "External Assistance", again no consensus was achieved, given that Kendall Coefficient is at 0.058 with significance level at 0.134 (> 0.05). Exhibiting in Hong Kong to promote RE business was perceived as the most useful for mainland entities (mean score at 3.771) Regarding "Professional Services", again consensus was not present, with Kendall Coefficient and significance level at 0.04 and 0.266 (> 0.05) respectively. Having the highest mean score (3.727) in this group, it could be that the provision of specialized insurance services by Hong Kong companies was perceived as the most useful aspect. In the last group of "Others", consensus was also not demonstrated, since Kendall Coefficient is at 0.036, whilst significance level is at 0.337 (> 0.05). By the highest mean score at 3.72 respondents seem to regard the protection offered by Hong Kong law on intellectual property as the most important.

4.2. Interviews

In order to obtain more interactive insights into the questionnaire results and to supplement the sample size, a series of face-to-face/phone semi-structured interviews were carried out (the profile of the interviewees being shown in Table 2). Important points captured are reported below for triangulation with the main themes of the earlier survey findings.

At present, there is a surplus of RE generation in northwest China but shortage in eastern and southern provinces, including the PRD, where larger populations live and manufacturing activities take place. In general, the access of people to RE depends on government policy more than their inherent geographical advantages. For example, poor regions will have higher priority for RE projects.

Hong Kong utility companies are building RE facilities in the mainland, mainly from the investment perspective. Consumption of RE from such plants in the mainland fluctuates, depending on local government policies, coal price levels and weather conditions (less demand for solar and wind power if heavy rainfall gives higher yield to hydro-power plants). Transmission to Hong Kong is a possibility technically, but getting sufficient grid capacity is a major constraint at the moment. As to the question of enforcement in transmitting RE (and not conventional power) to Hong Kong, utility companies in the latter are optimistic using the "Additionality" concept in emission trading (see, for example, Lam et al., 2015), in that RE generated due solely to Hong Kong investment may be earmarked for Hong Kong if the investors sit on the boards of the mainland entities, as it happens to the nuclear power situation at Daya Bay. After all, they perceived that lower emission stemming from RE generation in the neighboring region would improve air quality in Hong Kong, having similar effects as RE being used there.

Regarding possible collaborations, mainland practitioners take pride in the quality standards of their RE products and cited the recent presence of internationally accredited testing agencies in the country. They do see the benefits of Hong Kong's contribution in the research and development of leading edge technology as well as training of RE professionals. Insurance of PV component and system performance is another area they welcome Hong Kong's participation since they regard the latter's products as being innovative and matching international business trend.

As to the utilisation of roof space in Hong Kong for PV installation, Hong Kong's contracting organisations see a better market potential if the government resolves bottlenecks such as building control (currently taking 3–6 months for successful applications and most of the time only site-fabrication is allowable; whilst the supporting structures need to resist wind and kept at a maximum height of 1.5 m if the minor work submission route is followed). As such, cost is much higher than the mainland and there is no feed-in-tariff as an incentive. For the distributed type of installation, Hong Kong's roofs for low density development are mostly pitched roofs owned by upper class of the society, making them smaller in scale; whereas in the mainland, even ordinary factory buildings have flat roofs with easier configurations for PV installations. Hong Kong flat roofs for multi-storey buildings tend to have more building services such as air-conditioning, posing some limitations on PV installations from the economy of scale perspective. The use of mainland RE products is common, reflecting the presence of an integrated supply chain.

5. Reflection on the main findings

Having identified the Critical Success Factors for RE businesses, it is of utmost importance for business models to focus on achieving them. Currently, new models have emerged in China, involving leasing of roof tops for distributed PV installation, energy performance contracting, third party ownership, etc. (Lam et al., 2015). For delivering added value to customers in the existing and new business models, the quality of RE installation and services are essential through the improvement of technology by R & D. Together with policy incentives such as Feed-in-Tariff (details yet to be announced) and assurance of grid reliability/safety, a stable life cycle income stream will bring about the success of RE ventures. In the context of the PRD and Hong Kong collaboration, Hong Kong is still attractive as a preferred place for financing for mainland RE entities, particularly through IPOs, due to its listing rules and cost being reasonable, compared with the mainland and abroad. Major investment banks are actively pursuing commissions by taking up the necessary roles of global coordinator, sponsor, book-runner and underwriter in IPOs, as well as being financial consultants in mergers and acquisitions when overseas deals are targeted, due to their expertise and worldwide connections. In this regard, Hong Kong, however, is facing stiff competition from eminent financial centers nearby such as Singapore. Another major advantage of Hong Kong is the efficient listing time frame, and the Hong Kong Stock Exchange was the largest IPO market globally in 2015 and about half of its daily share transactions are with mainland-connected entities. Mainland and Hong Kong investors can trade shares both ways via mutual channels in Shanghai and Shenzhen (part of the PRD). However, part of this edge may be lost when the mainland moves from the currently practised Approval System to the Registration System in the share listing regime. This may take some time, according to commentators, to mature in line with the legal system development in China (Shen, 2013; hket, 2015). Until then, it will be up to the Hong Kong Exchange and

the local capital market to innovate and progress in order to retain a competitive edge.

In terms of financing, debt issuances by mainland RE entities are also on the rise (Ng and Tao, 2016), and this is met by Hong Kong being an efficient offshore and the world's biggest Renminbi Settlement Centre at the footstep to China. The volumes of issuance and transaction of the so-called "Dim Sum" bonds (bonds denominated in Renminbi issued outside the mainland) are definitely advantages for Hong Kong, which has a huge deposit base of Renminbi (RMB 711.5 billion yuan as in Jun 2016, making it the largest liquidity pool of Renminbi outside the mainland – HKMA, 2016), to act as a source of debt finance without the need for borrowers to face foreign exchange risk. Foreign lending is also facilitated by over 70 of the 100 largest international banks having offices in Hong Kong. Prospects are even better when solar assets are securitised for refinancing in future, with Hong Kong's financial institutions helping in the trading and management of such securities (Michael et al., 2014).

An area of collaboration closely related to financing, as identified in the survey, is the provision of specialist insurance services. A recent business model development for the PV sector in the mainland is the taking up of quality and power generation insurances by PV system developers at the request of financiers. As indicated by a mainland interviewee, these insurances are highly specialised and Hong Kong insurance service providers have hitherto enjoyed credibility in actuarial, loss adjustment and claim settlement activities.

Apart from its well trusted independent judiciary system, Hong Kong is gearing up to position herself as a hub for transacting intellectual property rights (IPD, 2016), with Singapore as a strong competitor. As the respondents in the survey indicate, this can well be another fruitful area of collaboration between mainland entities and Hong Kong law firms since the RE sector is relying on innovations to excel.

Last but not least, other professional services of Hong Kong companies such as accounting and testing are respected for their efficiency and independence. In respect of the latter, Hong Kong accredited testing laboratories are starting to make an inroad into the mainland by pairing up with local laboratories for taking on assignments under the China Compulsory Certification scheme, which sees RE and low carbon products as targets of voluntary certification (HKTDC, 2014). The usual CE certification for products to enter the EU market is also a strength of Hong Kong testing agencies, although such standards as UL have already established accredited testing laboratories in the mainland themselves.

6. Conclusions

Earlier works by Battaglini et al. (2009) expounded on the broad issues surrounding RE integration for the SuperSmart Grid bridging continents, and Chang and Li (2015) calls for institutional and systematic solutions to RE barriers with regional collaboration in the ASEAN electricity market. This study extends their works by identifying similar challenges but more specific barriers facing the RE sector in the PRD, in which Hong Kong SAR is situated. Keen competition, grid connection and skilled labour shortage problems top the list. Since the 2 places belong to the same country China but have different political and economic systems, there are existing and potential complementary effects in the generation and use of RE, which may benefit both places. Hong Kong, as a window to the mainland with worldwide connections, a hitherto trusted legal environment and a laissez-faire economic policy (which, unlike a planned economy, is not easily subject to administrative maneuvering), is endowed with an efficient and deep-pocketed financial market with global players. As for the identified challenges and barriers, the study finds out that Hong Kong may help in providing or assembling the needed capital for the RE sector in the PRD to expand both locally and overseas. Part of the grid connection bottleneck may be relieved by additional capital investment for the needed infrastructure, although the resistance of local grid entities to allow RE connection is another matter needing attention of the mainland authority, which is being stepped up. For the skilled labour shortage, Hong Kong may help by its education and training programmes in engineering, business and marketing, which have already attracted a lot of mainland students.

Apart from sufficiency of capital, the Critical Success Factors identified in this study include the need to meet quality requirements of customers, building up of technology and R & D capabilities, as well as reaching parity of competition with conventional power. Hong Kong may not be able to offer too much in the latter two factors (although R & D is catching up with efforts by the Science & Technology Park, the newly established Innovation & Technology Bureau, etc.), quality assurance is a strength of Hong Kong, through its accredited testing facilities and talent, meeting world standards with trust.

Areas of potential collaboration have also been identified, including capital market listing of mainland RE entities, joint ventures, promotion/exhibition for overseas market expansion, insurance services and intellectual property protection as well as rights-trading. These collaborative areas are worth nurturing and strengthening.

Despite the specificity of barriers facing PRD and Hong Kong SAR, they illustrate important aspects of investment, financial/technological/policy uncertainties, transmission constraints and import dependency, which pertain even to broader collaboration/integration efforts. However, before one can generalize the findings of this study which are limited by the small sample size, the complementary effects of collaboration must be fostered with caveats in mind. Market fluctuations, such as those leading to transitional disturbances in the pricing of PV cells and thin films, can be ridden over with endurance of little pain. However, for longer term sustainability in the context of the region discussed, the "One country – Two systems" promise must be genuinely implemented to instill a true spirit of cooperation. Hongkongers need to ensure political stability and observance of law and order, so as to maintain its competitive edge. After all, a long-lasting integration of the RE market and, in a more important sense, economic success and environmental well-being in the region, depend on mutual recognition of the Critical Success Factors and the conditions conducive to their achievement. Future research is also needed on how current dilemma arising from conflicts between sustainability, desirable self-sufficiency, reliability and tariff level can be resolved.

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Appendix A. Supporting information

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