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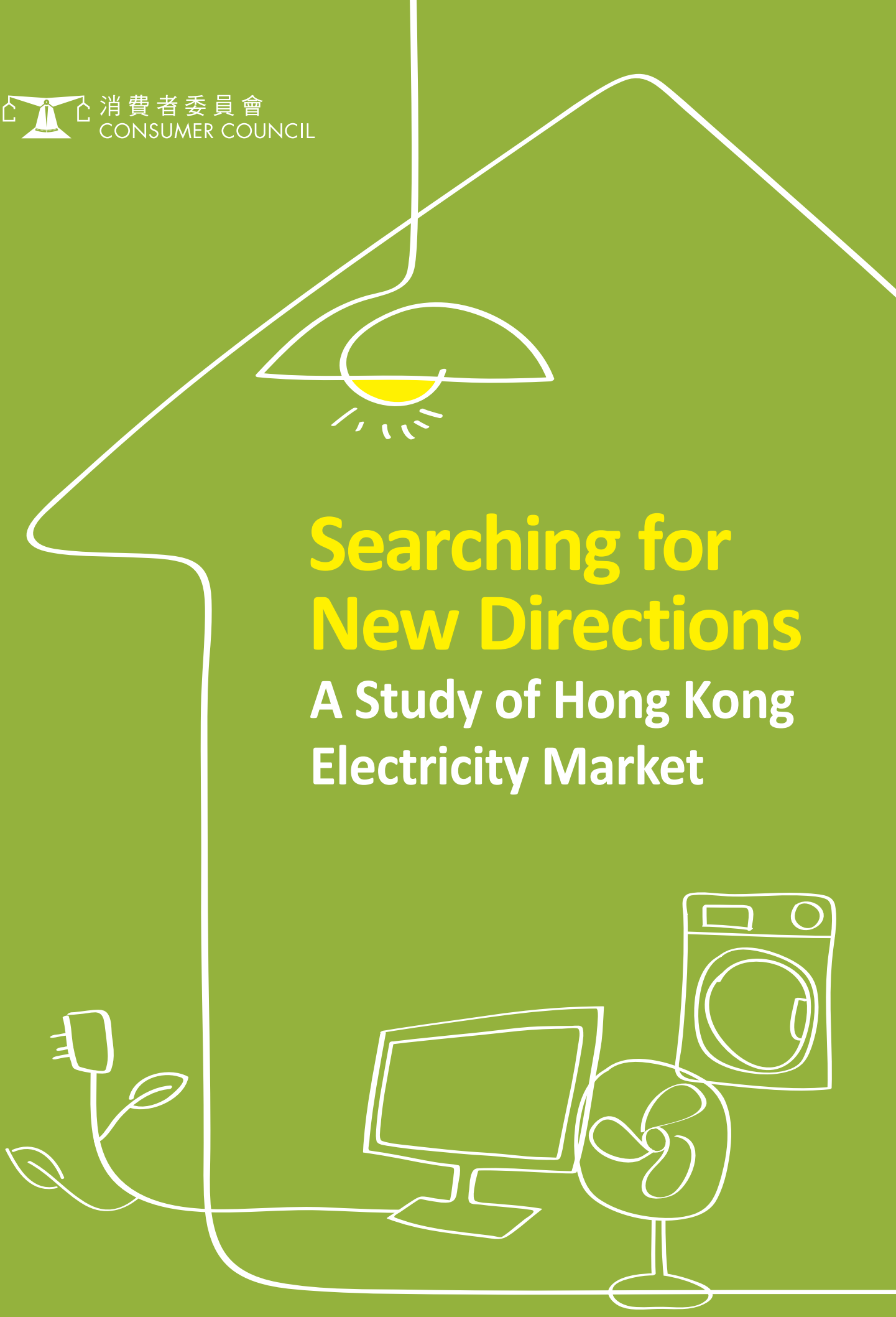
Searching for New Directions

A Study of Hong Kong Electricity Market



SEARCHING FOR NEW DIRECTIONS
A STUDY OF HONG KONG ELECTRICITY MARKET

Hong Kong Consumer Council

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List of abbreviations

CCGT	Combined Cycle Gas Turbine
CLP	CLP Power Hong Kong Limited
EC	European Commission
EdF	Electricite de France
EU	European Union
FiTs	Feed-in Tariffs
HEC	The Hongkong Electric Company Limited
LNG	Liquefied Natural Gas
OECD	Organisation for Economic Co-operation and Development
OFGEM	Office of Gas & Electricity Markets
SCAs	Scheme of Control Agreements
SoC	Scheme of Control
The Council	Consumer Council

Executive Summary

About the Study

1. For many years the electricity market of Hong Kong has been regulated by the Scheme of Control Agreements (SCAs) signed between the Hong Kong Government and the two power companies, namely, the CLP Power Hong Kong Limited (CLP) and the Hongkong Electric Company Limited (HEC) to provide electricity services to consumers living in Kowloon and New Territories by CLP, and Hong Kong Island by HEC. The energy policy objectives of the Hong Kong Government have been to ensure that the energy needs of the community are met safely, reliably, efficiently and at reasonable prices, while minimising the environmental impact of electricity generation. It has expressed the intention to introduce competition upon the expiry of SCAs by 2018 if the requisite market conditions are present, to transform the market of two regulated monopolies.

2. Subsequently the Hong Kong Government released the consultation paper 'Planning Ahead for a Better Fuel Mix – Future Fuel Mix for Electricity Generation' (the Environment Bureau consultation paper) in March 2014 as a first step to invite the market to present views on the desirable fuel mix structure of Hong Kong and to deliberate on the future regulatory regime in 2015.

3. In view of the fact that electricity is a crucial utility service and the future regulatory regime will pose significant implications for consumers, the Consumer Council (the Council) engaged Consumers International (CI), the global federation of consumer organisations, to form an expert group to look into the international experience of electricity regulatory reform in major markets and its implications for consumers. Furthermore, the study also highlights areas of concerns and opportunities that the Hong Kong Government should take into account in the coming regulatory review, and aims to pave the way for a more structured discussion.

4. Apart from desktop research and literature review on international developments from around the world, particularly from Australia, the United States, Mainland China, the United Kingdom and elsewhere in Europe, the Council together with the expert group engaged in May 2014 in a forum, a wide range of stakeholders in Hong Kong, including the professional groups and industry associations, the power companies, the environmental bodies as well as the Hong Kong Government to listen to their views on the current regulatory regime and other key aspects of concern. Despite the very extensive engagement, the Council and the expert group faced limitations in accessing commercially sensitive information for more in-depth analysis. Therefore, suggestions

drawn from this study serve to offer the Council's views on policy directions, but not to propose an ideal or the best regulatory regime model and implementation roadmap.

5. Lessons learnt from international electricity market reform show that there is no perfect model that could address the (sometimes conflicting) objectives of reliability, affordability and cleanliness of energy, without ultimately the needs of a conscious trade-off in policy decisions. Having said that, for the interests of Hong Kong consumers, it is essential to design a regulatory framework that has a much more rigorous focus on consumer welfare and consumer participation as compared with the former review in 2005. Furthermore, this report also discusses on areas which, in the opinion of the Council, requires close attention specifically supply side possibilities, demand side interaction, energy efficiency, policies for disadvantaged consumers, regulation and sustainability.

6. In this report, the Council has sought to consider three principal issues: market liberalisation, sustainability and regulatory development with special emphasis on the protection of low-income consumers. The Council sincerely hopes that the steps taken would be appreciated by all stakeholders and Hong Kong consumers at large, and looks forward to having a constructive, professional and collaborative discussion on the way forward to advise the Hong Kong Government for the most suitable outcome on electricity regulatory reform for Hong Kong.

Key Findings and Suggestions

A Gradual and Progressive Reform

Suggestion 1 – There is a need to change the regulatory system of the Hong Kong electricity market but it should be carried out in a gradual and incremental way ensuring that the strengths of the old system are not lost and new objectives are met. Furthermore, there are trade-offs involved in meeting the objectives of reliability, affordability and environmental sustainability. It is suggested that the sector has to be viewed as a whole and should not be compartmentalised into discrete issues.

7. Hong Kong electricity regulatory system, based on the traditional regulated monopoly structure, has provided consumers with affordable and outstandingly reliable electricity supplies. This is a considerable achievement. By contrast, research from various jurisdictions shows that results with the competitive model have been mixed and sometimes poor, particularly at retail level. A particular and repeated failing with the competitive model has arisen from attempts to transplant whole structures from

countries perceived as having been successful, to other countries, with little recognition of local conditions, resources, priorities, political and cultural traditions.

8. Some experts advised that it would be unwise to abandon the existing model in favour of an unproven and uncertain alternative. This is not to say the existing model cannot be improved or that it will not need to be adapted to meet future challenges, but that change should be incremental and gradual with an emphasis on ensuring that the strengths of the existing system are not lost.

9. The Council opines that a better and more balanced regulatory regime is needed. There are broad reasons for this view. Firstly, the current regulatory regime is not flexible enough to adapt to the new environmental policies, which need to focus on emission reduction over the next 30 years. Secondly, the scheme is not fair to consumers in that the two power companies are allowed to earn a high risk-free permitted rate of return (RoR) on their assets and to transfer to consumers the business risks associated with fuel price fluctuations, operational cost and forecasting error in relation to electricity demand. Further, the current Scheme of Control (SoC) may not provide adequate incentives for power companies to devote their efforts to exploring future development and applications of renewable energy to contribute choices for consumers and to the wider benefits to the environment.

10. Even if the SoC were totally unsatisfactory from this exercise, it would not appear to be legally possible to institute radical short-term change. The processes and time periods built into the SCAs are likely to be enforceable by the owners and there are built-in compensation arrangements should the Hong Kong Government adversely affect the interests of the companies.

11. In addition to the 'traditional' objectives of affordability and reliability long supported by the Council, there is a third pillar of energy policy, sustainability, which is increasingly important as the need to combat climate change assumes greater importance. Energy policy has always involved trade-offs between objectives, for example, greater reliability generally comes at a cost, but meeting sustainability goals as well will make these dilemmas sharper. The working assumption must be that meeting sustainability goals and perhaps increasing world fossil fuel prices will continue to raise the cost of power.

12. The current reform process appears to be based on a fragmented approach, dealing with issues sequentially with, for example, the 'fuel mix' as the first issue to be reviewed by the Hong Kong Government. While this appears to make the task more manageable by dividing it into discrete areas, the issues cannot be compartmentalised in this way.

Choices on the fuel mix will have implications, for example, for affordability and environmental impacts and coherent policies can only emerge from a holistic approach.

Market Liberalisation

Suggestion 2 – Lessons learnt from overseas markets under review indicate that the results of liberalisation were commonly disappointing as compared with the theory, due to reconsolidation of market players, imbalance in bargaining power, malpractices in selling and high switching costs for consumers. For Hong Kong, a degree of liberalisation of the generation market may open a range of opportunities, for example, access to renewables and natural gas, rather better than a drive for retail competition.

13. Three major phenomena observed subsequent to the liberalisation of overseas markets under review are:

    i. Unbundled markets tend to 're-bundle' if left to their own devices; furthermore, they may do so in a competitively damaging way by consolidating generation and retail supply;

    ii. Retail competition imposes additional costs on consumers and is prone to complexity leading to consumer error so that many consumers end up with the 'wrong' deal; and

    iii. Liberalisation elsewhere has conferred more benefits upon commercial consumers than on domestic consumers.

14. This syndrome of market reconsolidation is partly because of the intrinsically uncompetitive nature of electricity, which is an essential product of great technical complexity, cannot be stored and requires supply and demand to be reconciled simultaneously through networks that are natural monopolies. If the experience of other countries has not been promising in this regard, then that is likely to be even less the case in Hong Kong as a result of the limited possibilities for competition in this relatively small and geographically constrained market.

15. The signs are not encouraging regarding the scope for retail competition, which has shown severe flaws in overseas markets where it has been tried for domestic households. Small markets like Hong Kong could be even more vulnerable to such defects. Elsewhere, high proportions of consumers (as much as half of low income domestic consumers switching retail suppliers following bad advice from salespeople)

have been found to make switching errors, thus acting against their own interests. Furthermore, even those consumers who make the right decision for them are imposing costs on the system, for the cost of setting up switching operations is very high.

16. In liberalised markets, the onset of greater freedom for commercial consumers to switch suppliers has been advantageous to them. The effect has been to rebalance cost allocation between corporate customers (such as industry and commerce) and domestic households, to the detriment of the latter. This is not to say there is no scope for competition in the sector. Around the world, the greater gains from competition have come within the generation sub-sector where competition long predates liberalisation and was implicit in the traditional public sector 'merit order' systems. It could also bring benefits within innovative sectors such as renewables, where new entrants are sought, however, regulatory adjustments need to be made to enable market access in this regard.

Sustainability

17. The Hong Kong Government seeks to exert influence over the energy mix as it signals its interest in moving towards a more open market. The Environment Bureau consultation paper, to which the Council has responded, set out two highly specific options, one to import more electricity through purchase from the Mainland power grid and the second to use more natural gas for local generation. The Council concluded that: 'neither option stands as the best possible platform for energy policy to proceed in Hong Kong' and asks for a wider range of possibilities to be considered. What are these possibilities? They encompass both supply side measures and demand side management.

Supply side – use of natural gas for power generation

Suggestion 3 – In connection with liberalising the market, it is suggested that the Hong Kong Government investigates the feasibility and economic viability of broadening the access of Liquefied Natural Gas (LNG) terminal or natural gas pipelines for fuelling new small-scale generation.

18. Use of natural gas as a power station fuel has grown significantly in the past decade, bringing environmental benefits and increasing diversity of energy sources. This has been recognised by the Environment Bureau consultation paper. However, unlike many other developed economies, the use of natural gas apart from power generation remains negligible in Hong Kong. In fact, many developed countries such as the UK, Netherlands and Denmark, have been using natural gas for a much wider range of

applications than just as a power station fuel, including direct use by consumers for cooking and water heating, and small-scale co-generation by users, all at lower cost.

19. In fact, Hong Kong is one of the few jurisdictions still to use town gas (a mixture of hydrogen, carbon monoxide and methane) without capitalising on its existing network to broaden up the deployment of natural gas in the city. Natural gas could also be used as a fuel for small-scale electricity generation for large buildings with use of the 'waste heat', for example, to provide hot water. This would provide a useful addition to generating capacity at high efficiency with benefits to the users.

20. Comments from the incumbent player indicated implementation difficulties and economic unviability to convert town gas into natural gas for direct use by consumers due to the distinct characteristics of people living in high-rise buildings and the cost to consumers for changing the gas appliances. However, the possibilities of enabling commercial small-scale generation have not been explored. In fact, based on the conclusions of the report of the Feasibility Study on Introducing a Common Carrier System for Gas Supply in Hong Kong released in 1997, it was technically viable to convert the existing Towngas network to natural gas network and the introduction of natural gas into Hong Kong was best managed by a market based development programme, with third party access offered. Unfortunately the recommendations were not taken forward due to the uncertainty of securing economic and stable supply of natural gas. Given its rapid increases in the global reserves, presence of more natural gas pipelines connecting to Hong Kong, and technological advancement in small-scale electricity generation, it would be worth considering to conduct a feasibility study to look into the viability for enabling small-scale generation.

21. To increase plant efficiencies and to reduce emissions of greenhouse gases, the gas-fired plants in Hong Kong, which used older technology may consider upgrading to the latest design of combined cycle gas generation.

Supply side – use of renewables

Suggestion 4 – Enabling measures should be taken to test the scope and cost of renewables. This will determine whether there is scope for a large renewables contribution to Hong Kong's electricity mix and will allow, if needed, an efficient local supply industry to emerge. Experience from overseas markets often indicates more scope for renewables and at lower cost than initially anticipated, so the potential for Hong Kong should be further explored.

22. One of the most important options for reducing emissions of greenhouse gases from power generation is a major increase in use of renewable technologies. Each country has its own unique set of resources; there is no universal recipe for successful and cost-effective expansion of use of renewables. The view of both the Hong Kong Government and the utilities is that the scope for renewables is small, perhaps of the order of 1-3% of electricity supply. However, overseas experience shows there are rapidly rising targets, like Germany targeting a 20% market share for renewables by 2020.

23. In studying international experience, in particular the European Union (EU), with the development of renewable energy there is no disguising that it has got off to a difficult start and public realisation is only gradually dawning that, in the short term at least, transition to renewables will mean costs for consumers in the form of higher prices, over and above the underlying forces already moving in that direction.

24. It is clear that if a government wants companies to invest in technologies or fuel sources that are not the cheapest available, it will have to compromise the market by finding a way to reduce or remove the exposure of that asset to the market. Just throwing the promotion of low carbon fuel sources into the mix of the regulatory process on top of measures to promote service wide competition does not resolve this problem, it simply passes the dilemma on to regulators. This has happened in several jurisdictions with predictable confusion resulting. So there is no obvious policy option to move towards cleaner energy from other jurisdictions that can easily be transplanted into Hong Kong. The Council believes, however, that a wide range of approaches can be effective if well designed.

25. Despite specific setbacks, there are positive lessons from experience in other countries. Firstly, if opportunities for renewables to enter the market are created, the scope tends to be far more than expected and at lower cost than forecast. Secondly, large traditional utilities are often not the most effective at deploying renewables in an efficient way. Thirdly, the cost curve for renewables is on a strong downward trend as new technology options are emerging.

26. It is therefore important that the scope for renewables be tested using measures that encourage their emergence. This might be done through ‘Feed-in Tariffs’ (FiTs) under which renewable generators are guaranteed to be able to sell their output at a fixed real price, or by capacity auctions, under which a given amount of capacity is made available and the lowest bids necessary to meet this amount are given long-term fixed price contracts. The initial prices will tend to be high, but should fall as the local industry for renewables matures. FiTs in Germany provide clear evidence for this worldwide trend including in particular China, where FiTs have proven to be successful.

27. Setting a mandated fuel mix may be too rigid an approach if applied fuel by fuel, when there is so much uncertainty about future prices, technology availabilities and policy requirements. Experience in other countries suggests different models have their strengths and weaknesses and their success depends on how well designed they are.

28. Furthermore, other benefits may follow as a matter of course. For example, a generic renewable obligation might reduce the need for detailed regulation of particulate matter in the fuel mix; such problems would become more self-correcting as the overall renewable proportion rises.

29. It is likely that the most useful resources for Hong Kong will be solar photovoltaic, wind and biomass. If installation on Mainland China is included as an option, other resources could make a significant contribution. Moving forward, Hong Kong could build on the considerable work already undertaken by both electricity companies to determine whether the renewables including wind power might be an outcome of the current fuel mix policy setting.

Supply side – other options

Suggestion 5 – Strong national policy and inter-governmental collaboration may clear the uncertainties from importing electricity from China. However, the potential advantages from newly planned nuclear energy are far from clear in price terms given the uncertainties around the evolving technology.

30. One option proposed under the Environment Bureau consultation paper is to purchase electricity from the Mainland power grid i.e. importing electricity from Southern China. There is no doubt that the rapid development in Guangdong has also driven the rapid increase in energy demand which would thus be competing with Hong Kong on electricity generated. Although natural gas and nuclear is heavily used to meet environmental targets, fossil fuels will continue to be the leading source of the region's electricity generation and installed capacity. Therefore, there are uncertainties if cleaner and cheaper fuel could be imported sustainably for Hong Kong. Having said that, the outcome is always subject to national policy and inter-governmental collaboration, and thus, this option should not be left out while Hong Kong reforms its structure to meet demand in future.

31. Nuclear power is a 'low-carbon' generation source (it leads to lower emissions of greenhouse gas than fossil fuels) and therefore should be considered when discussing climate change issues. It brings with it, its own set of environmental issues that need to be factored into the discussion. While Hong Kong has been realising the benefits from

Daya Bay Nuclear Investment, safety concerns with nuclear power translate inevitably into higher costs for new development, which have ultimately to be borne by the consumer. The decision whether to try to expand Hong Kong's use of nuclear power is one that falls under the remit of the Hong Kong Government if it wants to determine the fuel mix. The Council is not arguing for or against utilising of the existing installed nuclear energy, but any decision to commission more new nuclear capacity should be based on a thorough evaluation of its cost and availability and the environmental issues raised by the nuclear option.

Demand side – energy efficiency

Suggestion 6 – A much stronger energy efficiency effort is likely to be a 'no-regrets' policy providing reduced environmental impacts and improving affordability. This may well also improve security of supply and uphold the existing standards as a result of reducing demand, especially at peak times.

32. The security of supply in Hong Kong is at world-leading levels as failure of the electricity system could potentially be catastrophic. However, upholding this high level of supply security by incumbents means cost to consumers, which could in fact be achieved at a lower cost through market reform. The existing plant margin (sometimes it is called reserve margin), which is the amount of capacity kept in operation over and above the maximum demand in order to cover for plant breakdowns and unexpectedly high demand, is about 45%. Although it is gradually reducing with Government's measures, it is highly unlikely that reducing this to about 25% would have any measurable impact on security of supply even if idle capacity would be reduced with market competition.

33. Competitive market measures could be taken to opt for greater use of 'demand side response' to meet peaks in demand. This would involve giving users financial incentives to reduce their demand at peak times, for example, by reducing the air-conditioning load – a particular burden in Hong Kong. The savings from reducing the amount of plant that has to be kept in reserve to meet peak demands could be shared between the specific consumers involved and consumers in general. Such measures are relevant to broader sustainability issues as they reduce overall consumption and may free up revenue for use on energy saving measures.

34. The cheapest energy can be that which is not used. Those 'negawatts' can be unlocked by energy efficiency measures. There is considerable scope to increase the extent of measures to improve the efficiency of electricity use. For domestic consumers, this would include incentives to choose energy efficient appliances, such as lighting and fridges; while for commercial consumers, there is also scope for use of more efficient

equipment. There is likely to be considerable scope to improve the fabric of buildings through better insulation and double-glazing, reducing the heating and cooling demand load. The most cost-effective measures are likely to be for new buildings through ensuring that stringent energy efficiency standards are imposed. Increased energy efficiency measures will have the double benefit of reducing electricity consumption and therefore environmental impacts as well as helping ensure power supplies remain affordable despite rising real prices.

Regulatory Development

Suggestion 7 – The regulatory system needs to be opened up to greater public participation and significantly strengthened so it can meet the demands and expectations that a reformed Hong Kong electricity sector would stimulate.

35. The Council is considering the necessary changes to the regulatory regime to achieve the objectives of enhanced consumer welfare in terms of safety, reliability and affordability. It aims for the regulatory machinery to supervise the integration of the currently distinct geographical markets of Hong Kong Island on the one hand and Kowloon and the New Territories on the other. It also seeks clarification of how mandatory demand side management would work.

36. The existing method of regulation and the 10-yearly SCAs, must take credit for the high standards of affordability and reliability that the Hong Kong electricity industry achieves. However, it has been a long concern in the market for the high RoR it allows the companies and for not being more open and representative. The policy areas outlined above will place a much stronger demand on the regulatory system so given the current SCAs will expire in 2018, a thorough regulatory review coupled with the setting of a roadmap for reform is a timely and opportune exercise.

37. Several times in the past, the Council has taken an interest in the future of electricity/energy regulation, but each time there has been no major change. In 2003, the Energy Advisory Committee reviewed some aspects of RoR on investment but left the SCAs much as before with some reduction in the RoRs. Rather than a scheme for providing a guaranteed RoR on investments, there needs to be a bigger step with wider review and clearer disclosure of the costs of alternative forms of provision of energy services. Modern forms of economic regulation are moving away from the somewhat circular debates about price cap or RoR (reviewed in Chapter 2) and now aim to reward efficiency and cost cutting while also allowing for investment in future needs, such as the development of renewables.

38. There is no clearly superior model that can be transplanted to Hong Kong, but the characteristics of a good system are well known. They include maintaining transparency of corporate information and regulatory analysis, due process in regulation, a fair balance between producers and consumers and between different classes of consumers, and ensuring dominant parties do not exploit their positions.

39. The Council also suggests that economic regulation of the two vertically integrated monopoly networks in particular needs reviewing with a clear statement of future goals and the establishment of operational independence for regulators and full powers to make rules that best serve the interests of consumers, without distorting constraints on the use of regulatory discretion.

Access to networks – a critical enabler

Suggestion 8 – Control of the network should be reviewed to ensure that new generators are able to access the network on the same terms as the incumbents. The cost-effectiveness of a further interconnector between the two systems for Hong Kong should be investigated as a contribution both to greater efficiency and to introducing wholesale market competition.

40. Greater use of renewables and small-scale generation will require these new sources to have fair access to the network at non-discriminatory prices. The possibility of purchase from Mainland China is also an option that requires network access, although, as already indicated, the potential could be constrained by burgeoning demand in Guangdong. Provisions will also be needed for free standing small scale-generations to be able to sell their surplus power to the local network for a reasonable price.

41. With gradual and progressive liberalisation of the generation market, the Council can well envisage that network access in one form or the other has to take place to enable competition. Experience elsewhere suggests incumbent utilities are reluctant to grant access to their networks because they perceive this as a competitive threat. This problem has been addressed by stronger regulation to prevent incumbents freezing out new entrants and by 'unbundling the networks' both to reduce the scope and incentives for keeping new entrants out. At one extreme, unbundling might involve no more than requiring the incumbent to keep separate accounts for their network business and at the other, it might require the network to be sold off as an entirely separate company. An alternative option is to take control (rather than ownership) of the network away from the incumbent utility and put it in the hands of an independent system operator (ISO).

42. Creating a wholesale electricity market could be done on a free market basis, as has been done throughout the EU. However, design of efficient wholesale markets has proved difficult, with many markets subject to manipulation and gaming. A less risky alternative would be a more cooperative approach whereby the savings from ensuring that the cheapest sources of power were used were then shared between the two major companies and with consumers. As with security of supply discussed above, these savings could bring advantages in terms of sustainability.

Interconnections

43. Market liberalisation opens up an opportunity for improved interconnection within Hong Kong. The Hong Kong electricity system comprises two effectively separate parts, Hong Kong Island and Kowloon & the New Territories with a connection only sufficient to provide some degree of security of supply. A much stronger interconnection between the two systems would allow the generation mix to be optimised across both systems, so if cheap generation was available, unused in, say, Kowloon, the power could be transferred to Hong Kong Island, reducing costs for consumers in both systems.

44. So, expanding the interconnector is about improving economic efficiency by being able to reduce reserves while retaining reliability. And, it is also an important step towards wholesale market competition with possibilities as stated. An independent study is required to estimate the actual costs of the interconnector because that depends on the technology used and the decisions on route. The companies may well be apprehensive about such a development as it might limit their monopoly power and perturb their working arrangements as has been the case in Germany and Australia for example as supply from renewable sources has rapidly developed.

Protection for low-income consumers

Suggestion 9 – As the energy cost is expected to rise, a holistic approach in reviewing the current protection for low-income consumers is necessary to ensure that they can afford the power they need to protect their well-being. There is also an urgent need to quantify and locate the extent of 'fuel poverty' in Hong Kong, and to identify gaps in the current approaches (reliance on rising block tariffs and social security benefits) and to formulate mitigation measures such as energy efficiency programmes targeted at low-income consumers to bring them electricity services at lowest cost.

45. There is a need to consider the distributional impact of achieving environmental objectives, with particular emphasis on the impact on low-income consumers. The Environment Bureau consultation paper foresees a doubling of generation costs leading

to a potential increase of 60% in prices charged to small consumers, and more for large consumers. This would undoubtedly cause affordability issues for low-income households. Of particular concern are low-income households living in multi-occupancy dwellings, and households in fuel poverty, i.e. that spend more than 10% of their income on energy with subsequent severe impact on their health as they ration their consumption even under extreme heat or cold weather conditions.

46. Although there are some tariffs to help low-income households, that provide low prices for the initial tranche of consumption, it is not clear how effective and how well targeted these tariffs are. For example, multi-occupancy dwellings may use large amounts of power split between several households who would not benefit from these tariffs.

47. That raises the question of the other conventional form of help to low income households, namely the benefits system. The evidence suggests that there are take-up problems in Hong Kong concerning entitlement to benefit not being exercised by consumers and these problems echo those found in many countries around the world. This in turn suggests that reliance on income support mechanisms can only be partially successful in mitigating fuel poverty.

48. Given the limitations then of a tariff based approach and an income support approach, it is suggested that one measure to deal with this issue should undoubtedly be a well-targeted energy efficiency programme so that low-income households can receive the energy service they need but for a lower consumption of power and cost. For example, the fact that most low income families live in public rented housing (according to the Hong Kong Commission on Poverty), seems therefore to represent a positive targeting of public resources. This in turn, suggests that programmes related not just to income but to building improvement and energy efficiency in this sector of the housing market would be well targeted.

The regulatory body

Suggestion 10 – For proper planning and implementation of the long-term regulatory reform of the electricity sector in Hong Kong, it is of top priority for the Hong Kong Government to establish a full-fledged energy sector regulator which needs to have the 'critical mass' to perform in relation to the structure and size of the industry, and the principles of transparency and consumer representation should be upheld.

49. The current SCAs have a remaining tenure of less than 4 years before their expiry in 2018. It should be a reasonable expectation for all stakeholders concerned, particularly the consumers, that the Hong Kong Government would review, plan and design a

proper and sustainable regulatory model that could fulfil the objectives of delivering safe, reliable, affordable and green electricity services for Hong Kong.

50. As the development progresses, the Council would see the necessary formation of a full-fledged energy sector regulator to tackle the complexity of the issues involved, and in particular to meet the future challenge of competing objectives of the Hong Kong Government's energy policy.

51. Operating under the principles of transparency and impartiality, such a regulator in its design shall mirror the scale and structure of the industry. When designing the system, care must be taken not to create one that is too small to be effective. For example, it might be desirable to consider consolidating relevant functional units under the Hong Kong Government system to form a larger regulatory body that could have stronger empowerment and a career structure that would be more likely to retain the best talents.

52. There is an important distinction to be drawn between representation of consumers as individuals and as a collectivity. The former involves taking complaints and settling disputes between individual account holders and service providers. The latter involves representation of the consumer interest in deciding policy or making regulatory decisions such as setting limits on tariffs or RoR. The Council holds the view that both functions are important and a proper mechanism should be put in place in the new regulatory body to enable both so that one feeds the other. If not housed in the same body, there needs to be a mechanism for complaints to inform policy.

Chapter 1 Introduction

1.1 The two power companies in Hong Kong are regulated by Scheme of Control Agreements (SCAs) signed between them and the Hong Kong Government. The SCAs are not franchises and do not offer the power companies any exclusive right, nor do they define a supply area for either company, or exclude newcomers to the market. In introducing the current SCAs in 2008, the Hong Kong Government said that it would introduce competition to the electricity market as early as 2018 if the requisite market conditions are present. This would transform the electricity sector from a regulated monopoly to a regime where competition is a significant factor. This process is often described as 'market liberalisation'. The form and extent of competition in Hong Kong are yet to be determined but may include the possible introduction of a new regulatory regime and the Hong Kong Government has been urged by the Legislative Council to review permitted returns to the companies, to increase transparency in the sector and facilitate public participation including in the process of tariff setting. Interest was stimulated further by the consultation paper 'Planning Ahead for a Better Fuel Mix – Future Fuel Mix for Electricity Generation' (the Environment Bureau consultation paper)[1] issued in March 2014 to which the Consumer Council (the Council) made submission in June 2014.

1.2 In order to obtain information and advice from consumer experts outside Hong Kong, the Council engaged Consumers International (CI), the global federation of consumer organisations of which the Council is a long standing member[2]. The team assembled by Consumers International includes Professor Stephen Thomas, Director of Research and Professor of Energy Studies at University of Greenwich (United Kingdom), and Allan Asher, who is a visiting scholar at the Regulatory Institutions Network at the Australian National University in Canberra and chairs the Foundation for Effective Markets (Australia). Having also been the Australian Commonwealth Ombudsman, he previously directed Energy Watch, the UK consumer protection watchdog for the energy sector in the UK where he served on the board of the Office of Fair Trading. The team is co-ordinated by Robin Simpson, senior policy adviser at CI who is also a member of the Technical Advisory Panel of the Public-Private Infrastructure Advisory Facility, a Trust Fund of the World Bank. The three experts have worked in many jurisdictions in all continents often with consumer associations and they bring a range of relevant

[1] Consultation Paper of *'Planning Ahead for a Better Fuel Mix - Future Fuel Mix for Electricity Generation'* from the Environment Bureau (2014).

[2] Hong Kong Consumer Council is a member of the elected Council and Executive of Consumers International where it is represented by the Chief Executive of the Consumer Council.

expertise covering law, economics, social administration and engineering. The report is a joint effort of the CI team and the Council's staff with the advice of the Competition Policy Committee and the Working Group of the study[3] in consultation with many Hong Kong stakeholders, including exchanges during the expert consultant team's visit to Hong Kong in May 2014.

1.3 This report looks at international experience and, without trying to transplant structures from other jurisdictions, considers the implications for the Hong Kong market. The Council has considered how competition and regulation have gone together in many sectors and countries in the last quarter century or so. Regulatory or statutory decisions regarding fuel mix are a more recent development, but one which will increase as concern grows over climate change and pollution. The three broad elements of competition, sustainability and regulation that the Council is aiming to examine have a triangular relationship, each one affecting, and being affected by, the other two. The energy policy objectives of the Hong Kong Government have been to ensure that the energy needs of the community are met safely, reliably, efficiently and at reasonable prices, while minimising the environmental impact of electricity generation. Electricity generators tend to choose the cheapest generation option, but a policy to reduce environmental impact by reducing use of fossil fuels for electricity generation, will tend to increase costs and might require additional expenditure to retain supply security. Those costs can increase burdens on consumers particularly the poor. So energy policy requires a trade-off to be made between the objectives of safety, reliability, efficiency, affordability and cleanliness and no single policy can maximise all. This implicit conflict between different objectives causes great indignation, and yet each is legitimate in its own terms. At the end, decisions have to be taken and it is virtually impossible to meet all expectations without any trade-off.

Competitive Electricity Market

1.4 Over the past two decades, hundreds of national and sub-national governments have travelled the path now contemplated by Hong Kong and there are abundant examples available on which observations can be made from international experience in energy market liberalisation. The project team looked at these experiences which range from significant improvements in quality of service and price per unit of electricity on the one hand, to declining service standards, frequent price rises and loss of security of supply on the other. The research carried out by this project examined overseas experience on the following questions:

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i. What are the implications, in terms of impact on consumers, of bringing greater competition into the electricity sector? This includes competition at different levels within the supply chain, ranging from upstream competition in power production or from imports, on to downstream retail competition in supply, plus points in between.

ii. What are the implications, in terms of potential impact on consumers, of decisions on fuel mix? Fuel mix decisions will have knock-on implications for the industry structure and for different regulatory options, eventually feeding through to consumers.

iii. What models of regulation can be envisaged to replace, or evolve from, the existing commercial agreement represented by the Scheme of Control (SoC)? Options could include regulation by a sectorial public regulator on the one hand or by contract on the other, or other variants. The implications would be assessed in terms of their potential impact on consumers and consideration given to mechanisms to assist vulnerable consumers.

1.5 The research also included work on areas such as tariff differences between different categories of consumers, and demand side management issues including whether incentive measures can help in achieving better energy efficiency and in managing overall demand in the long-run.

1.6 One commonly stated objective for market liberalisation is a reduction in the cost of energy[4], to the eventual benefit of consumers, both commercial users and households. In markets such as Hong Kong which are active in global markets for the whole range of traded goods and services, any cost reduction is seen as a great competitive advantage or any unnecessary cost is seen as a competitive disadvantage.

1.7 But this objective can conflict with environmental objectives which have been pressed with ever greater urgency over recent decades with as yet, limited success. As an example, in Hong Kong, the Hong Kong Government stated in the Environment Bureau consultation paper that under the current state of technology, there are limited opportunities for using renewable energy as a major fuel source economically. The target share of renewable energy (1-2% of electricity demand) is below the target adopted by many jurisdictions. The Environment Bureau consultation paper sets out two broad options to which the Council responded with an appeal to consider a wider

[4] It is not necessarily lower cost per unit of consumption. With greater energy efficiency one can achieve lower overall cost for the same unit charge.

range of steps. Some of these are discussed in Chapters 4, 5 and 6, and the Council's response is also available on the Council's website[5].

1.8 Energy is a sector in which each location has its own peculiarities. Local factors, political, social, cultural, geographic and indeed geological, all have to be taken into account, let alone the obvious factor of economics which in Hong Kong is again quite distinct – a small territory (by the standards of electricity jurisdictions), with high population density and high energy usage with a great deal of importance attached to continuity due to social factors (e.g. many high-rise buildings) and economic factors (need for uninterrupted supply for the finance and business sector).

1.9 A concern which emerges by the end of this report is that different policy objectives can conflict. This requires at least, a delicate and complex balance, or much more simply, a decision on which objective should be given priority over the others. It is hoped that this report can bring international experience to bear on these discussions and offer the Council's views on policy directions, but not to propose an ideal regulatory regime and implementation roadmap.

1.10 The Council sincerely hopes that the steps taken would be appreciated by all stakeholders and Hong Kong consumers at large, and looks forward to having a constructive, professional and collaborative discussion on the way forward to advise the Hong Kong Government for the most suitable outcome on electricity regulatory reform for Hong Kong.

[5] http://www.consumer.org.hk/website/ws_en/competition_issues/policy_position/2014061801.html.

Chapter 2 Overseas Experience

2.1 In this chapter, the Council examined overseas experience of meeting environmental objectives, introducing competition and reforming regulation. Our aim is not to identify an optimal system to transplant into Hong Kong, but to learn from this experience and use it to look for directions that are more relevant and effective for Hong Kong. The Council draws observations from this analysis and identifies 'key considerations' from overseas implementation.

Government Environmental Policy

2.2 The main challenges Hong Kong must face result from air-borne emissions from the coal and gas-fired power stations. These include particulates, acid gases, particularly sulphur and nitrogen oxides (SO_X and NO_X) and greenhouse gases, especially carbon dioxide. The first two lead to local impacts on air quality and can be addressed without major changes to the method of generation, for example, by installing electrostatic precipitators (ESP), flue gas desulphurisation (FGD) and low-NO_X burners. These measures would lead to immediate and clear benefits to local air quality.

2.3 The impact of greenhouse gases is global and benefits derived from a successful policy are only marginal at local level. There is no commercially viable way of capturing carbon dioxide emissions so the only ways to reduce emissions are to use less electricity and to move to generation modes that do not produce greenhouse gas emissions.

2.4 The Hong Kong Government has set separate targets to reduce greenhouse gas emissions and to reduce air pollutant emissions. The Council believes they must be dealt with together to avoid misconceived policies. For example, cleaning up the emissions from coal-fired plants might improve local air quality but could increase emissions of greenhouse gases. Measures to meet the Hong Kong Government's air quality targets must be balanced against greenhouse gas emissions targets. In the rest of this chapter, the Council concentrates on the much more intractable problem of reducing greenhouse gas emissions.

2.5 It must be stressed that importing power from Mainland China does not reduce the requirements on the Hong Kong Government. Hong Kong must 'own' the emissions made by any power plants in China that supply Hong Kong. In practice, this means that the emissions of marginal plants in China, (in other words, the plants that would not be operated if power was not exported to Hong Kong), are the responsibility of Hong Kong.

2.6 The Environment Bureau has issued a consultation paper on the fuel mix to which the Council has responded. On the basis of international experience the Council concluded that there are technically feasible technologies for reducing greenhouse gases, but the options vary from country to country according to the resources locally available.

2.7 The policy instruments used elsewhere all have their merits, but they also all have problems. So there is no obvious policy option to move towards cleaner energy from other jurisdictions that can easily be transplanted into Hong Kong. The Council believes, however, that all can be effective if well-designed.

2.8 In a traditional monopoly electricity system, implementing government energy policies is relatively straightforward. State-owned utilities can effectively be instructed to carry out policies while privately-owned utilities operate on an explicit, or more often a tacit, 'regulatory bargain'. Under this, utilities provide a service that meets the Hong Kong Government policy framework and in return, they are allowed to make a 'fair' rate of return (RoR) on money reasonably spent meeting this objective. This raises significant issues, for example, how to determine what a 'fair' RoR would be and how to assess whether the costs incurred are reasonable, in other words, for facilities to be built at the lowest cost consistent with appropriate quality. Nevertheless, there is ample experience of attempts to address these issues.

2.9 In an electricity system organised on competitive lines, this way of aligning investment with policy objectives breaks down. In a competitive market, companies can only be expected to invest in assets that are profitable. If a company invests in a power generation source that is more expensive than the cheapest method, it will be outbid by cheaper options and not used. So if a government wants companies to invest in technologies or fuel sources that are not the cheapest available it will have to compromise the market by finding a way to reduce or remove the exposure of that asset to the market.

Market-based instruments

2.10 In Europe, governments are realising that if they are to meet their greenhouse gas emissions targets, they must give financial advantages to low-carbon sources, such as renewables or nuclear. They cannot go back to the fully regulated monopoly model and so there is increasing use of market-based instruments to try to win some of the benefits of competition. This has led to, in various countries: the use of 'Feed-in Tariffs' (FiTs) under which those with low carbon generation are guaranteed to be able to sell all the power they can produce at a non-market, usually fixed, real price for a long period forward; renewable obligations**,** under which retailers are required to source a given

percentage of their power sales from renewable sources; and capacity auctions**,** under which the government calls for bids for a specified amount of generating capacity and gives long-term power purchase contracts to the lowest bidders at the price they bid. The element of competitive pressure with FiTs is produced by reducing the amount payable to new sources regularly so that those supplying renewable power know that to win new contracts, they will have to continually reduce their costs. For FiTs and capacity auctions, the power contracted is usually bought by a central agency and sold on at cost to the retailers, so that if a retailer has, say, 10% of the retail market, it would be required to buy 10% of the power produced under these contracts.

2.11 An alternative and elegant method of reducing use of environmentally harmful generation sources while retaining the competitive wholesale market is to introduce a market that penalises sources that go against the government's objectives. The most ambitious of these is a market across Europe, the European Union Emissions Trading Scheme (EUETS) for emissions of carbon dioxide (main greenhouse gas responsible for global climate change). Under this scheme, put simply, companies that operate facilities that emit CO_2 must buy a permit from a limited and diminishing stock at a price set by a market. The rate of reduction in the amount of permits available will determine the speed of reduction of emissions. The greater the demand for permits, the higher the price and the larger the incentive not to use fossil fuel generation. In theory, the permit price should be equal to the extra cost of renewables compared to fossil fuel so generators would have no economic incentive not to choose renewable sources. The attraction of such a scheme would be that the free market model for power generation could be retained and, if and when renewable sources were competitive with fossil-fuel sources, the carbon price would be zero and the trading scheme would naturally wither away.

2.12 Overall, none of the four options outlined above has been unequivocally successful in stimulating efficient investment in low-carbon sources. Emissions trading is, from a market point of view, the ideal system but in practice, it has totally failed in the European Union (EU) because markets have been distorted by company gaming and market design flaws and the carbon price is a small fraction of the level it would need to be to raise the price of fossil fuel options to the same level as renewables. FiTs have resulted in impressive increases in capacity but are often criticised as being economically inefficient because the price of FiTs is much higher than is needed, resulting in a windfall for those investing in low carbon generation and whose cost would therefore escalate as roll out developed. Capacity auctions have produced low prices but have generally resulted in much less capacity than was expected because a high proportion of the successful bids are not built due to problems of finance and planning consents, while renewable obligations have also proved ineffective because it

is cheaper to pay the fines for missing the target than to meet the target. The hope for all of these schemes is that, over time, costs of the low-carbon technologies would come down so that eventually the need for these market-compromising mechanisms would disappear.

2.13 In Europe, so far the development of renewable energy has got off to a difficult start and public realisation is only gradually dawning that in the short term at least there will be costs for consumers in the form of higher prices, over and above the underlying forces already moving in that direction. If action is not taken to mitigate these underlying price increases, an opposition to climate change mitigation measures will arise that add to consumers' bills. This is evident from the response of the UK Prime Minister during the debates in the UK, in which he has suggested freezing some of the 'green measures' to protect consumers.

Observation 1: It would be difficult to reconcile a mandated fuel mix with a competitive market; market instruments have been used in Europe to meet the need for greenhouse gas reductions and there have been problems.

Nuclear option

2.14 Nuclear power is a 'low-carbon' generation source (it leads to lower emissions of greenhouse gas than fossil fuels) and therefore should be considered when discussing climate change issues. It brings its own set of environmental issues that need to be factored into the discussion. The development of nuclear power to serve Hong Kong in particular is discussed in detail later (Chapters 3 and 5 and in Annex A). The Council concludes that safety concerns with nuclear power translate inevitably into higher costs, which have ultimately to be borne by the consumer.

***Observation 2: The potential advantages from nuclear energy are far from clear in price terms given the uncertainties around the evolving technology*.**

2.15 The decision whether to try to expand the use of nuclear power is one that falls under the remit of many governments if they want to determine the fuel mix. The Council is not necessarily arguing for or against expansion of the nuclear contribution, but any decision to commission more nuclear capacity should be based on a thorough evaluation of its cost and availability and the environmental issues raised by the nuclear option.

Competition

Structure and reform

2.16 Conventionally and particularly where an objective of introducing competition exists, the electricity sector is divided into four major activities: generation; transmission (the high voltage network taking the power from the power stations to the centres of demand); distribution (the low voltage network that takes the power from the transmission network and takes it to consumers' premises); and retail (the purchase of bulk electricity and retail to final consumers including metering and billing).

2.17 Generation is invariably the largest element, perhaps accounting for more than half the consumer bill, distribution is the next largest element accounting for perhaps a quarter of the bill, while transmission and retail are each typically 10% or less.

2.18 The transmission and distribution systems are widely seen as natural monopolies. In other words, the costs of having competing networks would far outweigh any conceivable benefits from making network operators compete for business. However, generation and retail are thought not to be natural monopolies and most electricity liberalisation efforts are based on trying to make these activities competitive. The transmission and distribution systems must remain regulated monopolies and if competition in generation and retail is to be fair, access to the grid should be on equal terms to all potential network users.

2.19 The process of corporate separation of the above functions, characteristic of the reform process, is known as 'unbundling' or 'disaggregation'. In the EU this means that the company that owns and operates the distribution network is legally separate from any generation or retail companies and will have no incentive to favour one company over another. A large parent company, however, could own a distribution company and a legally separate generation company. For transmission, the separation is more rigorous and transmission companies must be subject to 'ownership unbundling' in other words, ownership company with no interest in generation or retail in the same jurisdiction as the transmission company. There is a further option, that the distribution or transmission assets could be owned by an 'integrated' company (one active, for example, in generation) as long as control over operation of the assets, is in the hands of a separate company, the distribution/transmission system operator (DSO/TSO). In England & Wales (the main part of the UK electricity system), the transmission network has been fully ownership unbundled since the system was privatised and reorganised in 1990. In Sweden, there is a TSO, Svenska Kraftnat, while the transmission network is

still owned by the generators. It is difficult to determine which model is more advantageous to consumers because too many other factors determine the service level.

2.20 On the basis of experience around the world, there is a consensus that the key to the success of disaggregation is the establishment of separate and vigorously competing generators with open access to local markets for energy imports. This also calls for regulated transmission and distribution network companies which are not able to participate in upstream or downstream markets.

2.21 The need to set fair and non-discriminatory tariffs for distribution and transmission means that a strong regulatory body will be required to ensure that a company that owns networks as well as generation and/or retail does not give preferential terms for use of the network to its own generation/retail activities. The European Commission (EC) believes a strong regulator alone is not sufficient and requires that distribution companies be 'legally unbundled' from companies generating or retailing electricity.

2.22 As generation is the largest element of the bill, it follows that the benefits of introducing competition are potentially the greatest for this activity. If there is no competition in generation and all retailers pay the same price for their wholesale power the scope for retail competition is limited. Equally, if the market is so efficient that all retailers buy from the market at the same price, there will be little scope for competition. Introducing retail competition brings additional costs, such as switching costs that inevitably fall on consumers. Yet there is a widespread perception that market liberalisation has brought down prices for consumers. The case study of the UK, reproduced in Annex B, indicates why this perception does not stand up to detailed scrutiny. So if there is a case for retail competition, it is unlikely to be based on lower prices for consumers.

Reconsolidation

2.23 Despite the huge attention paid to unbundling, the sector has shown a remarkably consistent tendency to re-consolidate. A common phenomenon in Europe, United States and Australia has been that, following the expensive and time-consuming process of liberalisation, the resulting competitive companies are then subject to mergers and acquisitions raising the prospect that the objectives of the initial reform may be undone. This reconsolidation has not involved the transmission and distribution activities, for which regulation is now effective enough to ensure that ownership of the network cannot easily be used to the advantage of the competitive businesses. Reconsolidation has involved generation and retail. This may be more destructive of competition because integrated generators/retailers have strong incentives to sell their power to

themselves and to discourage new entry by making prices in the wholesale market too unreliable for new entrants.

2.24 An example of the tendency to recombine was in the UK where 14 regional independent retail companies were created at the time of privatisation, but when mergers were allowed, the 14 separate companies were soon taken over by just five companies. Full deregulation and competition in energy markets was introduced in 2000. At that time there were dozens of competing generators and retailers of gas and electricity. Within a few short years substantial re-integration occurred in the industry and today there are just six major retailers all of whom also have substantial generation assets. The UK Consumer Association *Which*'s study *Wholesale Costs & Retail Price* estimates that roughly only 10% of energy goes through wholesale markets and they report that vertical integration has allowed energy companies' *'different business arms to do business with each other behind closed doors'… 'For example if these companies can make more overall profit by increasing their wholesale energy prices-even if they lose retail customers and sell less energy as a result-what incentive is there for them to give customers the lowest possible prices?'*[6]. The level of competition in the overall market is now so limited that a major inquiry by the UK Government's anti-trust body, the Competition and Markets Authority, was launched in mid-2014.

2.25 In a substantial study undertaken in the US market the performance and impact of mergers in the US electricity industry during the period 1994-2003 was reviewed[7]. As in the UK over the past two decades, many states of the US[8] undertook major energy market liberalisation leading to the formation or emergence of many new competing companies at various levels of the industry. Also in common with the UK these reforms spawned a wave of mergers, particularly at the distribution stage. More than 75 mergers were consummated between 1994 and 2002, involving half of the electricity customers of all investor-owned electricity operating companies.

2.26 The International Energy Agency (IEA) has suggested a range of limitations in both the theory and practice of liberalisation, which helps account for the tendency to reconsolidate. The first is that by their nature electricity markets are inherently uncompetitive. This is because economies of scale inevitably lead to large companies that will have the power to act independently of their competitors and determine prices

[6] Which? *Wholesale Costs & Retail Prices.* op. cit.

[7] John Kwoka North-eastern University and Michael Pollitt University of Cambridge, *Do Mergers Improve Efficiency? Evidence from Restructuring the U.S. Electric Power Sector*, April 2007. https://www.repository.cam.ac.uk/bitstream/handle/1810/194705/0725&EPRG0708.pdf;jsessionid=7D961F4317C52FE56613DC3B3CEB4CB7?sequence=1.

[8] In the US, the electricity industry is organised and regulated at a state level rather than by the Federal authorities.

and output most suited to their own strategy rather than to the welfare of consumers. In addition, in markets where there are relatively few competitors, their conducts may be harmonised through actual collusion and price-fixing or through oligopolistic mechanisms which exclude vigorous competition on price and quality of service. In both cases consumer welfare suffers and the underlying goal of market liberalisation is somewhat frustrated. For example, in both the UK and Australian markets, initial liberalisation took the form of splitting up generation into a few competing entities. However in both cases the market power of the largest companies has meant that markets failed to remove barriers that prevent small companies from entering and/or operating and the end result has been a reconsolidated generation sector.

Observation 3: Unbundled markets tend to 'rebundle' if left to their own devices; furthermore, they may do so in a more competitively damaging way by consolidating generation and retail supply.

Retail competition

2.27 In the EU, much emphasis has been placed on consumer choice at retail level. There is heavy emphasis in the relevant directives on providing information for that to happen. So far, the results have been disappointing, and most consumers have chosen to stay with regulated prices where these have been on offer, notably in France. The EC staff paper of 2011 reports that: *'the switching rate is generally low especially at household level with very few exceptions. This can be ascribed to the fact that the prices offered by different suppliers are not sufficiently attractive in economic terms to justify the consumers' effort to move to a new supplier'*[9].

2.28 In other words, the main beneficiaries of consumer choice are likely to be the large industrial or commercial consumers. At the time of the transition to retail liberalisation, in the UK between 1999 and 2002, while residential consumer prices rose by 5%, prices for large consumers fell by 22%[10]. This reflects the much larger resources and stronger negotiating power that large users have compared to small consumers. So the 'rebalancing' that was called for in liberalisation to abolish cross-subsidies, was marked by a shift in costs away from industry and towards domestic consumers. Some argue that this was a correction to long-standing discrimination in favour of domestic consumers, which had previously masked the intrinsic expense of serving large numbers of small consumers as opposed to a few large ones. Without the comparative data, which was often concealed by commercial confidentiality, this argument is hard to test.

[9] 2009-2010 *Report on Progress in Creating the Internal Gas and Electricity Market* Commission Staff Working Document, 9 June 2011, p.10.

[10] Power UK, *Prices Fall for Some but Stay the Same for Others,* March 2002.

In any case, the shift was attributed at the time by some commentators to retailers allocating their expensive power purchases to the residential market. This was based on an assumption by the companies that residential consumers lacked expertise and negotiating power[11].

2.29 A further imbalance at the expense of low income consumers is that, in many markets, differentials have opened up between different classes of domestic consumers according to payment methods, for example, pre-payment meters are much more expensive in unit cost terms than some of the generous discounts available mainly to better off consumers[12]. Differentials in tariffs as a result of such arrangements were recorded as 20-25% in 2005 in the UK with considerable disadvantage to consumers on low incomes who were locked into the more expensive tariff systems[13]. Many such differentials existed when the industry was in the public sector and liberalisation has not shifted them.

Observation 4: Liberalisation has conferred more benefits upon commercial users than on domestic consumers; it has also failed to remove price differentials between different groups of consumers mainly to the detriment of those on low incomes.

2.30 Even without this rebalancing, retail choice still does not necessarily act in the interests of household consumers. The highest ratio of switching to non-switching in the EU is in the UK, where despite about half of households switching providers after 1998, by 2005 less than one eighth of consumers who switched chose the supplier who gave them the best deal[14]. More recent figures show a similar pattern with 40% of consumers making the 'wrong' decision, by which they ended up with a higher bill than if they had stayed with their previous supplier[15]. Most disturbingly the UK Government commissioned report on fuel poverty published in 2012, concluded that 50% of poor households that switched supplier under the influence of 'doorstep selling' ended up with more rather than less expensive deals[16]. Several suppliers, indeed all of the 'Big Six' including Electricite de France (EdF) that supplies the UK market, have been fined for irregular

[11] P Wright, *Competition in Gas & Electricity: Companies Profit, Consumers Pay. Consumer Policy Review*, Vol 17 No 1, 2007.

[12] S Davies, C Waddams Price, C Whittaker, *Competition Policy and the UK Energy Markets.* In *Consumer Policy Review*, 2007, also S Thomas, *Energy Chapter* in *Poor choices: the Limits of Competitive Markets in the Provision of Essential Services to Low Income Consumers*, Energy Watch/PSIRU 2008.

[13] S Thomas et al.

[14] S Davies, C Waddams Price, C Whittaker, *Competition Policy and the UK Energy Markets.* In *Consumer Policy Review*, 2007.

[15] Presented to First Citizens Energy Forum EC. 2008.

[16] J. Hills, *Getting the Measure of Fuel Poverty.* Final report of the fuel poverty review. CASE report 72 Centre for Analysis of Social exclusion, LSE, 2012, p.27.

sales practices despite years of discussion of sales practices and attempts to stamp out abuse[17]. In March 2012, EdF was fined £4.5 million for mis-selling, in May 2013, SSE was fined £10.5 million, in October 2013, Scottish Power was fined £8.5 million, in February 2014, RWE was fined £3.5 million, in May 2014, E.ON was fined £12 million and in July 2014, British Gas was fined £1 million.

2.31 Furthermore, even those consumers who make the right decision for themselves are imposing costs on the system, for the cost of setting up switching operations is very high. In 1990 before retail competition for small customers was allowed in the UK, only 5% of domestic consumers bills went to meet supply costs such as billing and meter reading. By mid-way through the last decade the level was 30%[18]. Effectively, those who stay with their existing suppliers are cross-subsidising those who switch and gain. By way of recognition of this syndrome, the British Energy Minister, Brian Wilson said in May 2003 'The benefits of price falls must not be restricted to those who switch, not least because if everyone starts to switch, the costs of administering this will outstrip the savings', but this is clearly what is still happening[19].

Observation 5: Retail competition imposes additional costs on consumers and is prone to complexity leading to consumer error so that many consumers end up with the 'wrong' deal.

Regulation

Regulatory models

2.32 As with models for energy market reform, models of regulation vary greatly around the world. The key goal for regulation is to recognise that it is not possible to have fully competitive and contestable markets at each stage of production, distribution and consumption and so regulation seeks, as far as possible, to impose the outcomes which would otherwise come from a fully contestable market. Specific goals are to prevent abuse of market power, ensure adequate levels of planning and investment so that levels of output are suitable for future demand and, more recently, to impose environmental goals such as reduction of carbon intensity. No successful energy market reform can be undertaken without the establishment of empowered and adequately resourced economic regulatory agencies independent from the industry being regulated. While it is possible to apply regulation to just one part of the power system

[17] Allan Asher, *It is not Where you Start, it is Where you Finish. Consumer Policy Review*. Vol. 17, No 1. 2007.
[18] Prof S Thomas, *The Grin of the Cheshire Cat.* PSIRU Business School University of Greenwich.
[19] Power UK June 2003 Issue 112, p. 29.

in isolation, such as transmission or distribution, the available evidence is that fails to achieve regulatory goals.

2.33 Throughout the Organisation for Economic Co-operation and Development (OECD) countries, there is an emerging model of independent economic regulation concentrating on the natural monopoly elements of systems with regulation relating to the interconnection of generators and transmission and distribution systems and increasingly extensive regulation of the activities of competing retailers. Early systems of energy market regulation more or less assumed that competition between generators at the production phase and competition between retailers at the consumption phase of the market would mean that neither required much regulation. The overwhelming evidence is that this is not true and that unregulated generators quickly collude or game markets to ramp up prices. So, while in theory, competition should reduce the need for regulatory intervention, in practice, regulators have had to spend a lot of their time monitoring markets (more than half the UK regulator's time during some phases). Meanwhile, at the retail end, anti-consumer conduct occurs through abusive sales practices, as well as poor levels of customer service and failure to serve vulnerable consumers. For that reason regulation needs to take the form of integrated packages of interventions which seek ways of harnessing competitive forces but do not naively assume that such forces will always work in the interests of consumers.

2.34 Four regulatory models have been broadly identified for electricity by Eberhard[20] :

i. Regulation by government, especially where a state owned enterprise is the direct provider. A particular challenge here is the real or potential conflict-of-interest presented by governments both managing and regulating state-owned utilities;

ii. Independent regulation in an autonomous public institution (as is the intention in the UK and US). This approach aims to embody principles of independence of decision-making, institutional with managerial independence and financial independence;

iii. Regulation by contract (as in France, or elsewhere in countries using the Francophone legal tradition, or where French contractors are able to offer such agreements). The contracting parties are normally the operating companies and the relevant responsible public authority may be national, regional or municipal; and

[20] A. Eberhard, *Infrastructure Regulation in Developing Countries: an Exploration of Hybrid and Transitional Models*; PPIAF Working Paper 4 2007, p 10-21.

iv. Outsourced regulation to third parties, e.g. tariff reviews, benchmarking, dispute resolution.

2.35 Whatever model is chosen, the regulatory body cannot be effective unless it has the expertise and resources to know as much about the regulated companies' operations as the companies themselves.

2.36 When electricity industry liberalisation was initially discussed, its advocates suggested that competition would be so effective in forcing prices down that regulation would be a temporary need until markets could take over. This has proved unrealistic and regulatory bodies that had staff initially of perhaps 20-40 have grown to several hundred even though much of the detailed analysis is contracted out. Oversight of the markets, an activity that was not initially expected to be necessary, is the dominant activity for regulators, not price setting for monopolies.

Regulatory methodology

2.37 Currently the most common means internationally for regulating natural monopoly assets is using the capital asset pricing model (CAPM) which is an elaborate mix of asset valuation, demand projections, rewards for operating efficiencies as well as various penalties and incentives. There are methodological sub-variants such as price cap regulation (as was developed in the UK at the time of privatisation) or RoR regulation (as in the US). The US has the most explicitly developed system for regulating investment and this involves calculating a 'regulatory asset base' – the value of the assets built to provide the service – and setting a fair RoR.

2.38 The current method for determining a revenue stream to energy providers in Hong Kong is based on a RoR methodology. This form of price regulation is no longer as popular as it once was.

Price cap regulation

2.39 Price cap regulation[21] was brought in following the UK privatisation programme of the 1990s and used the simple equation RPI-X, where Retail Price Index (RPI) is the general rate of inflation. Under RPI-X, companies supplying monopoly services like transmission and distribution were allowed to raise their prices by the rate of inflation minus X%. This meant that for a company to maintain its profitability, it had to improve its efficiency by X% per year. While the prior assumption was that X would be a positive number, in practice X has often been negative, meaning monopoly companies could raise their

[21] The public transport utilities are also subject to price cap regulation.

prices in real terms. The X factor was to be reset every 4-5 years. It was assumed that determining a single efficiency improvement target would be much simpler than the detailed analysis that RoR regulation required and the regulatory burden would be correspondingly lower.

2.40 While the results are still presented using the RPI-X formula, in effect price cap regulation was abandoned for the UK electricity sector in 1995 in favour of a variant of RoR methodology. The reality is that price caps always did operate on the assumption of RoR principles such as the prudence test, while conversely RoR regulation resulted in price caps. The difference between the two approaches is thus frequently overstated.

2.41 At its most elementary, price cap setting becomes a simple cost-plus formula with little attention paid to asset values. The results can be very crude and static. For example, in the Former Soviet Union, the dominant model carried forward from the Soviet system to the period after the transition was a 'cost plus methodology' by which tariffs were calculated on the basis of an agreed set of costs plus a percentage allowance for profits, usually set by the local government. As capital investment costs were not usually allowed in the 'economically justified tariff' there was little incentive for longer term renovation. A further problem was that the 'economically justified tariffs' did not provide any incentive to greater efficiency. They therefore allowed the costs of current inefficiencies to be passed on to the end consumer with no incentive to change. Regulation then has to instil a certain dynamism to allow for technical innovation and future investment. Otherwise the system will atrophy.

2.42 It has been common for energy experts to attribute to liberalisation the real price reductions of about 25% that took place in the UK in the 12 years following privatisation. In fact the crucial interventions leading to price reductions for household consumers came from the regulator. Nearly all of the price reduction came about because of the reduction in monopoly prices (i.e. in the regulated sector). These price reductions came about because of the abandonment of price cap regulation and the fact that the electricity industry was sold for about a third of its asset value. This effectively wrote off two thirds of the asset value of the electricity industry and allowed price reductions without requiring the privatised companies to improve their efficiency. Very little of the price reduction can be attributed to the operation of markets. Furthermore, three factors had led to significant real reductions in *costs* to generators that could theoretically have been passed on but were not. These were: declines in fossil fuel prices paid by generators, the undervaluation of the electricity industry including the power plants at privatisation and the development of more efficient generating technology, the combined cycle gas turbine (CCGT).The fact that so little of these cost reductions was passed on to small consumers suggests that the wholesale and retail

power markets are not as efficient as has been alleged by advocates of liberalisation[22]. Regulation, however, did have an impact but only because the assets were sold cheaply (see Annex B for details).

Critical mass

2.43 The regulatory body will usually mirror the scale and structure of the industry. When designing the system, care must be taken not to create organisations or companies that are too small to be as effective as they should be. That applies to the regulator as well as to the energy service itself. For example, it might be desirable to consider consolidating relevant functional units under the Hong Kong Government system to form a larger regulatory body that could have stronger empowerment and a career structure that would be more likely to retain the best talents.

2.44 From a corporate standpoint, there might also be similar critical mass issues. From a competition point of view, it might be seen as desirable to unbundle the two large companies into a number of competing generation and retail companies, a number of unbundled distribution companies and a separate transmission company. However, such companies might be too small to have the scope to do what is required and frequently when companies are split up, they quickly recombine through mergers and take overs. A clear example of being sub-optimal was given by the Dutch state-owned company, TenneT, which took over one of the four major German transmission networks. The German grid requires major investment but TenneT claimed they did not have the capacity to finance the required investment[23].

2.45 The Council is not necessarily recommending that the regulatory body should be an all services body nor that the companies should not be unbundled, but the issue of whether any new entities or companies will have the scale to be as effective as they need to be should be a factor in the decision.

Independence

2.46 It is clear that for the regulator to set prices that are fair to consumers and the regulated companies, the regulatory body should be entirely independent of the companies. What is less clear is how far the regulatory bodies should be independent of government. While it is undesirable that government should be able to interfere

[22] See Evans, OECD 2006.

[23] In July 2012, the German regulatory body refused to certify TenneT because it was unable to demonstrate 'a sustainable economic performance and investment capability.' Power in Europe 'German Power TSO Fails Unbundling Test' July 27, 2012.

frequently and in an arbitrary fashion, perhaps for political gain, equally, regulators must be publicly accountable. In short, they must be required to account for their decisions and if they are doing a poor job, there must be scope for them to be dismissed. Government and the elected representatives (perhaps through parliamentary committees), with their democratic mandate, are best placed to exercise this responsibility.

Consumer representation

2.47 Consumer representation is but one dimension of regulatory competence. Some reforms have somewhat naively assumed that under a liberalised regime, consumer representation will not be necessary. In the UK, a public body Energy Watch was set up to act as a 'consumer watchdog', make representations to the UK Government and the regulator and to take complaints and resolve disputes between consumers and providers. It became very effective at doing this, but it has since been closed down by the UK Government.

2.48 The EU's Electricity Directive 2009/72, which sets out the liberalisation requirements for member states is very limited with respect to its requirements for consumer representation, in both tone and substance. The requirements seem to be based on a perception that markets and consumer choice would obviate the need for consumer representation. Although reference is made to '*access to…representation and dispute settlement mechanisms'.* The wording is very ambiguous and passive and the other mentions of consumers in the Directive relate not to representation as such but to information and dispute settlement.

2.49 This emphasis on information and dispute settlement goes along with the view of consumers as protagonists able to exercise choice in an open market, while needing help to do so. One can interpret the drafters' assumptions as being that representation is unnecessary in a free market where consumer choice can be exercised.

2.50 The energy sector has seen less development of consumer representation around the world than the water sector, which is equally vital, less obviously technical and more controversial[24]. Nevertheless there are mechanisms that have been developed by consumer organisations and by public intervention (such as Energy Watch UK) and there is currently a burgeoning of consumer activism in the Indian sub-continent in this sector[25]. In the US and Canada, although practice varies by state and province, it is

[24] Jeff Delmon, PPIAF.

[25] N K Dubash, D Narasimha Rao, *The Practice and Politics of Regulation*, National Institute of public Finance & Policy 2007.

common for price alterations to be approved through a process of 'rate hearings', under the auspices of Public Utility Commissions. Such hearings conducted by the state/province regulators on judicial lines, allow service providers and consumers to present evidence, require disclosure of documentary evidence and cross examine other parties. As the costs of the hearings are passed on to consumers by the providers then it is also permitted for consumer association's costs to be paid by the tribunal. This system has been criticized for its formality, but also praised for its rigour.

2.51 There has been a proliferation of ombudsmen in Latin America to deal with consumer grievances against publicly provided services such as electricity and water, the most well-known being in Argentina, Costa Rica and Peru, carrying the rather Quixotic name of *'El defensor del Pueblo'* (defender of the people). The Peruvian *defensor* became particularly successful and was so popular that he was nominated for President (He declined the nomination). But the ombudsman model is essentially case-based although they increasingly make general assessments of the situation in their jurisdictions. For example, the Macedonian Ombudsman with responsibility for municipal services declared publicly that the practice of collective cut offs of electricity (in the event of say a few families in a block failing to pay) was unconstitutional and should be stopped.

2.52 There is a rich mix of possible approaches to consumer representation and, according to CI[26], the messages to be drawn from experience are that:

i. The structure of consumer representation should shadow the structure of the industry as it impinges on the consumer, e.g. municipal, national or other;

ii. The body representing consumers should ideally deal with complaints so that the complaints work can inform the policy representation function; and

iii. Consumer representative bodies should be outside the regulator's office, thus safeguarding independence.

2.53 CI also argues for:

i. Freedom of information, both access to information and its disclosure to others;

ii. Right of appeal against decisions of the regulator.

[26] M Lazzarini, *Improving Utilities*, guest presentation to the World Bank 2004.

2.54 The Council believes that the model should sit comfortably within the political and cultural traditions of the economy concerned. This would include whether the consumer representation organisation should be a separate body from the regulator, as was the case in the UK with Energy Watch, or as consumer advocacy divisions of the regulator as in some states of the US.

Observation 6: The regulatory agency needs to have 'critical mass' to perform; there is scope for variation in the regulatory structure but it should bear some relation to the structure and size of the industry; it should also allow for representation of the consumer interest in both policy development and consideration of individual complaints.

2.55 Consumer protection policy goes far beyond dispute resolution, a point that is not recognised by the EU Directives. Some practices may be legal or accepted as normal within the industry, but nevertheless prejudicial to consumers taken as a whole. The issue of freedom of information or transparency is vital, for without it, it may be impossible for consumer associations, or even regulators, to work out what is going on at this collective level.

Regulation and consumer protection

2.56 The days of cheap energy are gone, but that does not mean regulators should not be vigilant about price, on the contrary, it is all the more important to be so as the burdens for consumers are becoming greater. So if consumers are going to have to be reconciled to paying more (at least in unit price terms), they have the right to know that they are being treated fairly.

2.57 The EC, incorporated into the 3rd package of Energy Directives basic principle dealing with consumer protection such as disclosure, transparency towards consumers, protection from harsh or arbitrary disconnections including special protections for especially vulnerable groups. However, welcome as they may be to consumers, the measures fight shy of such market related issues as regulation of price levels, which are clearly central to consumers, and which are being abandoned under EC legislation. Instead vague hopes are expressed in the Directives that social services will come to the rescue of particularly vulnerable consumers, using measures to be determined nationally.

Observation 7: Regulation has moved away from direct price controls and towards supervision of markets and consumer transactions and customer care; yet price controls and competition can both play a role in protecting consumers.

Tariff-based measures or social security?

2.58 Regulators have a particular responsibility to monitor whether low-income households are able to afford to pay for the power they need to maintain a decent and healthy life. The broad outline of debate is whether to mitigate the impact of high prices by tariff-based measures or by social assistance measures. In other words, the debate focuses on whether the responsibility for poor consumers should rest with providers or with government, with pricing policy or with direct subsidies to supplement incomes.

2.59 Many countries in the world use increasing block tariff structure or rising block tariff structure to allow for consumers with low consumption levels to benefit from a low price for the first tranche of consumption. Sometimes these tariffs are referred to as 'social tariffs', although this can be misleading as they are charged to all consumers.

2.60 Indeed, some are critical of them for that reason. Tariff based measures have been severely criticised for 'errors of inclusion' (subsidies going to people who are not defined as needy), and 'errors of exclusion' (needy consumers not receiving benefits to which they are entitled[27]). The critiques of the profligate nature of errors of inclusion tend to assume that any help to those above the poverty line is wasted, 'dead wood', so to speak[28]. In fact there may be large numbers just above the poverty line, a line which is highly arbitrary anyway. Recently published work by the International Institute for Environment & Development has been critical of the notion of poverty lines on several grounds[29]. Among them is their 'blindness to living conditions' especially in urban areas where notional higher income levels may be outweighed by poor living conditions and higher costs. The weakness of strict poverty lines is that slight variations can classify very hard pressed people out of the poverty category and thus out of entitlement to assistance.

2.61 The other mechanism, means tested assistance that is operated by the state, a practice favoured by many World Bank experts is frequently undermined by consumer resistance to claiming help. Means tests are invasive, expensive to administer and suffer from widespread failures of take up, frequently going to only a minority of those eligible. For example the much discussed Chilean benefits for public utility services have been

[27] For the most thorough analysis, see K Komives, V Foster, J Halpern & Q Wodon. *Water, Electricity & the Poor: Who Benefits from Utility Subsidies?* World Bank 2005.

[28] This was precisely the term used by a representative of the IEA at the OECD Forum discussion: *Are Subsidies Costing the Earth?* In June 2012.

[29] D Mitlin & D Satterthwaite, *Urban Poverty in the Global South*, IIED 2012.

found to have errors of exclusion as high as 95%[30]. The problem is that such subsidies often do not work partly because people hate to apply for them because they find them humiliating, and partly because of the sheer volume of documentation required. To reach a percentage figure of household income, there has to be a definition of that income. That is not a simple matter. Income needs to be defined over a given period to avoid a misleading picture[31]. And of course if the calculation is based not just on income but also on expenditure on services, then details of those payments are necessary.

2.62 The EU Electricity Directive does not use the term 'social tariff' or equivalent terminology, indeed it seems to discourage such concepts. But that has not prevented EU national Governments applying pressure on service providers to come up with pricing formulae in order to favour vulnerable consumers[32]. In 2010, 10 of the 27 EC member States were reported as providing social tariffs for vulnerable customers[33].

2.63 In 2007, the UK regulator Office of Gas & Electricity Markets (OFGEM) claimed: '*All suppliers currently offer some sort of social tariff and/or rebate to provide cheaper energy to qualifying consumers*'. One supplier aimed to get help to 750,000 vulnerable consumers. EdF, the world's largest electricity supplier, claimed to be the first to launch social tariffs on the UK market[34]. Indeed consumer organisations, some with statutory authority have urged that such systems be devised Europe wide[35]. How far the social tariffs offered by suppliers offer real price benefits to low-income households and how far they are public relations exercises to present the companies in a good light is debateable. In addition, allowing the companies to administer the schemes themselves means that if they are to be targeted accurately, the companies would have to know personal details about their consumers that amount to privacy invasion and could thus lead to non-take up.

[30] M Fay & M Morrison, *Infrastructure in Latin America & the Caribbean: Recent Developments & Key Challenges*, World Bank/PPIAF, 2007.

[31] How long should that of income period be? One month, a year (which increases the risk of inaccurate matches of need and benefit)? Whose incomes should be assessed? The individual, a husband and wife, other household members? Should savings be taken into account? Such questions bedevil 'means tests' worldwide.

[32] Office of Gas & Electricity Markets (OFGEM), *Domestic Retail Market Report*, OFGEM London 2007.

[33] ECOSOC, *Energy Poverty in the Context of Liberalisation and the Economic Crisis*, 14.07.2010. (COM(2009) 115 final).

[34] Lisa Eisenschimmel COO Customers branch, EdF energy, briefing for French journalists 16th March 2007. *'EdF First to Launch a Social Tariff.'*

[35] Allan Asher, (Chief Executive of Energy Watch UK) *An Energy Watch Perspective on 'European Charter for Energy Consumers'.* European Parliament hearing on 'European Charter for Energy Consumers', 2008.

2.64 Until recently, many EU member states continued to operate regulated tariffs (not necessarily 'social tariffs') at the retail level, which applied to the great majority of their household consumers. This was challenged by the EC which initiated a number of infringement procedures in 2009. But in its judgment of 20 April 2010[36], the European Court of Justice stated that regulated prices can be in line with electricity and gas directives provided that they are strictly proportionate and limited in time. The Commission staff paper of 2010 went so far as to suggest that ultimately regulated prices are incompatible with the envisaged open market: *'Open markets with well-functioning competition cannot in the long term coexist with regulated end user prices'*[37]. This statement suggests therefore an outright clash between using tariff-based measures to protect consumers on low incomes and full liberalisation of the market right down to retail level.

2.65 Bearing in mind the shifts in prices could land disproportionately upon the poorer consumers, there are huge social risks in the further shift under way from tariff based subsidies towards state systems that are ill-equipped to cope with this area and are resisted by recipients who, in consequence, avoid claiming their theoretical entitlements. In the context of rising prices and economic recession, the pressures are building up.

Observation 8: Transfer of responsibility for poor consumers to the state social security systems and away from regulated tariffs may face serious consumer resistance and consumer detriment in many countries.

Overall Conclusion

2.66 A common element in consumer commentary on liberalisation of energy markets is that the bulk of benefits, if not all of the benefits, has flowed to the shareholders of the companies and large commercial purchasers while small consumers and those with the least capacity to act in their own interests have ended up worse off. This does not discount the possibility that unreformed sectors may be more economically inefficient than those subject to competitive forces. However it does show a failure of policy implementation where policies favour large users at the expense of individuals.

2.67 There are other characteristics of the sector that inhibit liberalisation from benefiting consumers, including price inelasticity of demand, the essential nature of electricity and its non-storability and requirement for synchronization of supply and demand. These are inherent and should be taken as given.

[36] (C-265/2008).

[37] EC Staff Paper 2010 op. cit.

2.68 In addition to action to reduce greenhouse gases, governments are also seeking to impose competitive market disciplines on their energy sectors. Sometimes the objectives of greenhouse gas abatement and competitive market disciplines are inconsistent, such as where governments seek to prescribe the fuel mix for the generation sector rather than providing economic incentives for them to do so.

2.69 In consequence, the 'reformed' electricity industry is not adequately building in to its cost structures, the external impacts of carbon emissions, pollution and other forms of environmental damage created by the establishment of large scale generation transmission and distribution systems. The twin reforms of liberalisation and climate change mitigation contain their own tensions and at the same time, the protections that are more necessary for vulnerable low income consumers during this difficult transition.

Chapter 3 Development of the Electricity Market in Southern China

3.1 The chapter summarises the current status of the electricity market in Mainland China, the energy policy of the Chinese Government regarding the electricity market and matters related to Guangdong province, including the Chinese Government's policies such as the Power Sector Deregulatory Reform, the 12th Five-year Plan, the Chinese Government's control and regulations, and future developments of the electricity market in Guangdong.

Overview of the Electricity Market in China

3.2 China is the world's most populous country and has a rapidly growing economy. According to the International Monetary Fund, China's real gross domestic product (GDP) grew at an average growth rate of 10% between 2000 and 2012. The economic growth in China is driving up the country's overall energy demand and the quest for securing energy resources.

3.3 China is a developing country. Its income elasticity demand of electricity (percentage increase in demand of consumption corresponding to one percentage increase in national income (GDP) is more than one which is relatively high in comparison with those of Organisation for OECD countries. China's modernisation process relies on urbanisation and industrialisation causing high demand responsiveness for electricity in respect to income growth.

3.4 The Chinese Government's energy policies are dominated by the country's growing demand for electricity, oil and its reliance on oil imports. The National Development and Reform Commission (NDRC) is the primary policymaking and regulatory authority in the energy sector, while some other ministries also oversee various components of the country's oil policy. The NDRC is a department of China's State Council, the highest organisation of executive power in the country.

3.5 The Chinese Government launched the National Energy Administration (NEA) in July 2008 in order to act as the key energy regulator. The NEA, linked with the NDRC, is charged with approving new energy projects, setting domestic wholesale energy prices, and implementing the Chinese Government's energy policies.

3.6 Rapid growth in electricity demand has spurred significant investment in new power stations. Over the last ten years, many new investments in power plant have been

earmarked to alleviate electricity supply shortages. Despite that, China still struggles with insufficient capacity to meet demand.

3.7 Electricity demand typically follows economic cycles. The economic crisis of late 2008 resulted in a lower demand for electricity in subsequent years, reported as down by 7% in 2012. It is expected that it will begin to rebound in future as the Chinese economy resumes its average growth rate. The Chinese Government is still keen on investing in the development of the transmission network, integration of regional networks, and bringing on planned new generating capacity to prepare for the expected future demand.

3.8 On May 21, 2014, the Russian and Chinese Governments agreed to sign the 'Memorandum on China-Russia Natural Gas Cooperation Project at the East Line' and the 'China-Russia Purchase and Sales Contract on the Natural Gas Supply of the East Line' between the two countries. As agreed by the two sides, Russia will supply gas to China via the east line of China-Russia natural gas pipelines from 2018. The volume of gas transmission will increase year by year and finally reach 38 billion cubic meters per year. The contract is for 30 years. Figure 3.1 showed the possible route of the transfer of natural gas to China.

Figure 3.1 Possible Route of the Transfer of Liquid Natural Gas to China[38]

[38] http://www.washingtonpost.com/blogs/worldviews/wp/2014/05/21/map-what-the-epic-china-russia-natural-gas-deal-looks-like/, by Ishaan Tharoor.

3.9 After the Japanese nuclear crisis in 2011, China suspended approvals of new reactors while it conducted safety inspections and drafted new regulations. In June 2012, the Chinese Government indicated that it had lifted its year-long moratorium on new nuclear projects in a move that helped an industry plagued by uncertainty since the disaster at Japan's Fukushima Daiichi reactor. The State Council announced it had approved the 2020 nuclear strategy, finalised new safety standards and finished inspecting the country's existing nuclear plants.

3.10 At the end of 2013, 17 nuclear plants were in operation, with a total capacity of nearly 14.6 gigawatts (GW) of electricity. Nuclear accounted only for 2.11% of China's total supply, in contrast to 80.4% of thermal power and 15% for hydropower.

3.11 In first quarter of 2014 China's Ministry of Environmental Protection approved the construction of two new nuclear reactors in the eastern coastal province of Shandong. The reactors are a type of Westinghouse AP1000 reactor, at an estimated cost of 5.1 billion US dollars, owned by the state-owned utility China Power Investment. China could be the first country to install the latest and safest Westinghouse third generation design.

3.12 The need to resolve the environmental problems in China that have led many large cities to be choked in smog prompted the search for cleaner sources of power and the closure of some coal plants. China has ambitious plans for nuclear power. While China only has 14.6 GW of nuclear capacity as of 2013, it plans to scale up nuclear reactors to a combined installed capacity of 58 GW by 2020. It then hopes to nearly triple that figure to 150 GW by 2030. It has 28 reactors under construction and about 8.6 GW are expected to come online in 2014[39] (see also Annex A).

Electricity capacity and production in China

3.13 China had an estimated total installed electricity generating capacity of 1,155 GW in 2012, according to FACTS Global Energy (FGE)[40], giving it the largest power capacity in the world (see Table 3.1). The generation capacity between 2000 and 2012 grew by 280% with an average annual growth of about 12%. Installed capacity is expected to grow continuously over the next decade to meet rising demand, particularly from main urban areas in the east and south of the country. FGE expects installed capacity will double to 2,390 GW by 2030 as gas-fired capacity expands significantly.

[39] http://oilprice.com/Energy/Energy-General/China-Moves-Forward-with-New-Nuclear-Reactors.html by Nick Cunningham.

[40] FGE: A global energy consultancy firm.

Table 3.1 Installed Capacity in China (2000 – 2012)[41]

Year	% of Total Installed Capacity							Total Installed Capacity (per GW)
	Thermal	Nuclear	Hydro	Wind	Biomass	Solar	Geo-thermal	
2000	73.5	0.7	25.3	0.1	0.3	-	0.008	303.9
2001	74.1	0.7	24.8	0.1	0.3	-	0.008	320.5
2002	74.3	0.9	24.4	0.1	0.3	-	0.007	340.7
2003	74.0	1.4	24.0	0.2	0.4	-	0.007	358.7
2004	72.3	1.4	25.7	0.2	0.4	-	0.006	421.4
2005	75.4	1.3	22.6	0.2	0.4	-	0.005	518.9
2006	77.3	1.1	20.8	0.4	0.4	-	0.004	626.1
2007	77.2	1.3	20.6	0.6	0.4	-	0.003	720.6
2008	75.7	1.1	21.7	1.1	0.4	-	0.004	796.2
2009	74.1	1.0	22.3	2.0	0.5	-	0.003	878.7
2010	73.0	1.1	22.2	3.0	0.6	0.0	0.003	971.9
2011	71.8	1.2	21.8	4.3	0.7	0.2	0.003	1069.4
2012	70.9	1.1	21.5	5.4	0.7	0.3	0.003	1155.4

3.14 China's net power generation was 4,980 Tetrawatt-hours (TWh) in 2012, increased by 70% during the 11th Five-year Plan (2006-2010) period. About 80% of generation is from coal (see Table 3.2). US Energy Information Administration (EIA)[42] predicted that total net generation in China will increase to 9,583 TWh by 2035, near double the amount in 2012. Heavy and light industries account for over three-quarters of China's electricity consumption.

3.15 China's energy production largely depends on thermal power, which includes burning of coal, petroleum and natural gas. Coal continues to dominate the fuel mix. In 2012, 77.8% of electricity was produced by thermal power plants, 17.4% by hydropower and only 2.0% by nuclear power (see Table 3.2).

[41]施鵬飛-2006 年中國風電場裝機容量統計，Undata，電力工業統計資料彙編 2011，2013 年中國能源供需預測報告.

[42] EIA: A principal agency of the U.S. Federal Statistical System.

Table 3.2 Electricity Generation in China (2000 – 2012)[43]

Year	% of Total Electricity Production							Total Electricity Production (per GWh)
	Thermal	Nuclear	Hydro	Wind	Biomass	Solar	Geo-thermal	
2000	82.2	1.2	16.4	0.0	0.2	-	0.007	1,358,231
2001	79.8	1.2	18.8	0.0	0.1	-	0.007	1,474,321
2002	80.8	1.5	17.5	0.0	0.1	-	0.006	1,643,206
2003	82.7	2.3	14.8	0.0	0.2	-	0.005	1,911,312
2004	81.5	2.3	16.0	0.0	0.1	-	0.005	2,203,723
2005	81.8	2.1	15.9	0.0	0.2	-	0.004	2,499,727
2006	83.2	1.9	14.5	0.1	0.2	-	0.004	2,853,330
2007	83.2	1.9	14.4	0.2	0.3	-	0.003	3,270,540
2008	80.9	2.0	16.3	0.4	0.4	-	0.003	3,465,615
2009	81.4	1.9	15.4	0.7	0.6	-	0.003	3,701,897
2010	80.3	1.8	16.1	1.2	0.6	0.0	0.003	4,252,396
2011	81.9	1.8	14.0	1.6	0.7	0.0	0.003	4,759,246
2012	77.8	2.0	17.4	2.0	0.8	0.1	0.003	4,980,146

3.16 Renewable energy only accounts for 20.2% of electricity production in 2012 (see Figure 3.2). The hydropower serves steadily as the key renewable energy supply over the past decade, but could have little potential to increase its capacity in future as the water resource is increasingly scarce in China. Besides, electricity generated by wind, solar and biomass has limited application given their low productivity with existing technologies.

3.17 In terms of actual fuel usage, fossil fuel consumption for generation of electricity in 2012 accounts for 90.4% of the total energy consumed (66.2% from coal, 18.8% from petrol and 5.4% from natural gas, see Figure 3.3). The majority of the generation plants are coal-fired power plant and some of them are very inefficient and outdated power generators.

3.18 Fuel consumption of producing electricity from coal and petroleum caused air pollution[44]. In achieving better air quality standards with limited supply of renewables in future, the Chinese Government only can set the target share of non-fossil fuel consumption at 11.4% by 2015 and aimed at replacing inefficient coal-fire electricity

[43] 施鵬飛-2006 年中國風電場裝機容量統計，電力工業統計資料彙編 2011，能源數據手冊 2012，2013 年中國能源供需預測報告.

[44] Air quality is affected by the concentration of particulate matter (PM), nitrogen oxides (NO_x), carbon monoxide (CO), and sulphur dioxide (SO_2) emitted under coal-fire electricity production to atmosphere.

generators with more natural gas generators, which has relative low emission on NO_x, CO and SO_2 and are more efficient.

Figure 3.2 Electricity Generation in China 2012[45]

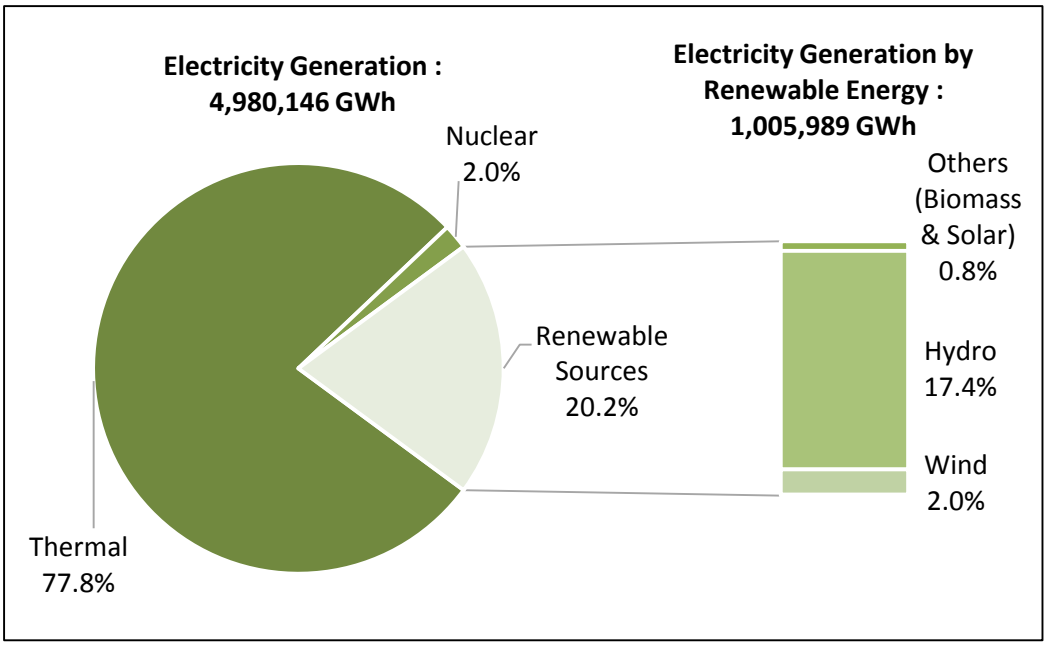
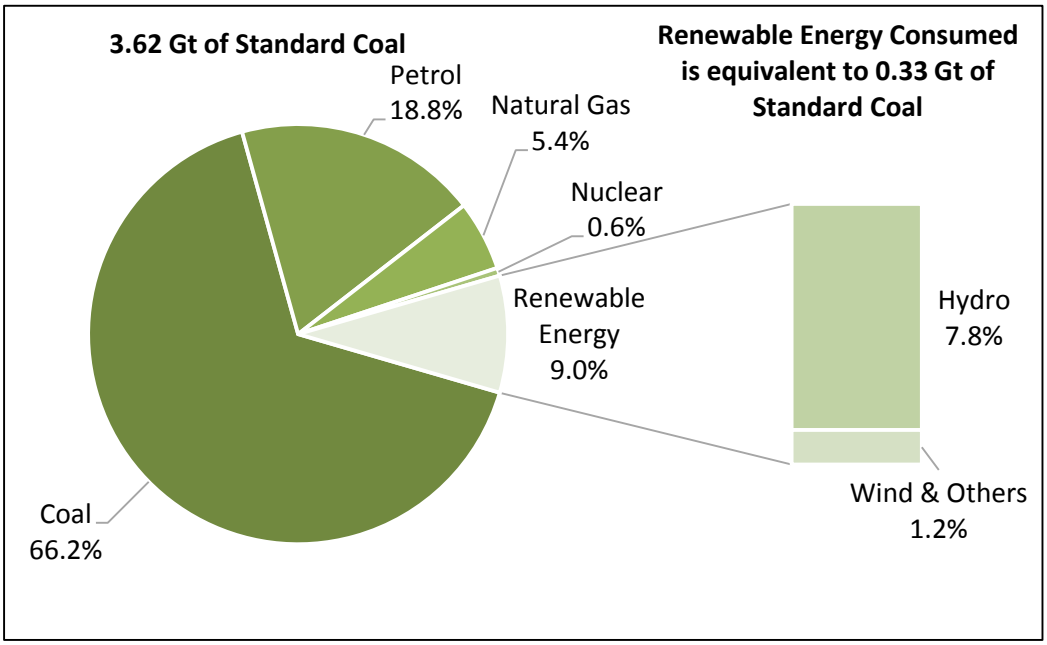


Figure 3.3 Energy Consumption in China 2012[46]



[45] 施鵬飛-2006 年中國風電場裝機容量統計，電力工業統計資料彙編 2011，能源數據手冊 2012，2013 年中國能源供需預測報告.

[46] 施鵬飛-2006 年中國風電場裝機容量統計，電力工業統計資料彙編 2011，能源數據手冊 2012，2013 年中國能源供需預測報告.

Reform in the Electricity Sector

Structural reform

3.19 In 2002, the Chinese Government approved the Power Sector Deregulatory Reform (the Reform). The Reform aimed to:

i. Improve efficiency, reducing costs and optimising allocation of energy resources;

ii. Improve the pricing mechanism in the electricity sector;

iii. Terminate the monopoly and introduce a fair competition market environment;

iv. Promote the national network facilitating electric power industry development; and

v. Ensure healthy development of the electricity market system.

3.20 In 2002, it started off the separation of power generation and the grid under the operation of different state-owned enterprises.

3.21 In 2012, the separation of operation (or 'ownership') of major and auxiliary work in power grid business was finished. There are plans to further separate the transmission and distribution networks after 2013. Over the last ten years, the policy has encouraged participation of semi-public owned enterprises and joint venture businesses in the power generation business.

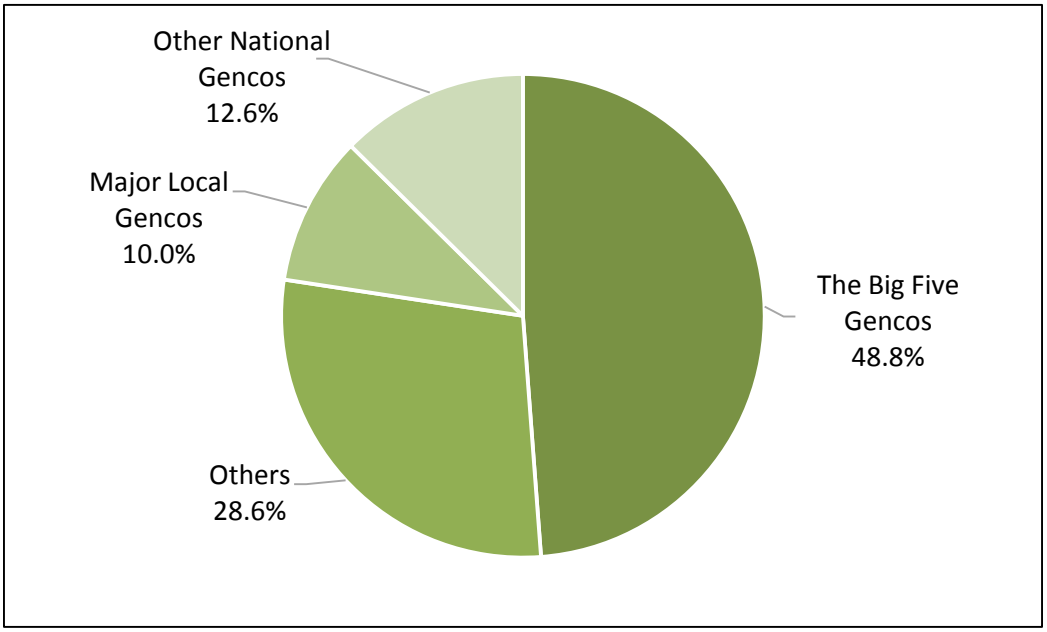
3.22 There are 6 super-grids in China, namely North China, North Eastern, East China, Central China, North Western and Southern. The Southern region which covers the Guangdong, Guangxi, Yunnan, Guizhou and Hainan provinces operate under the China Southern Power Grid Company (CSG). All remaining regions are operated under the State Grid Corporation of China. Power networks are strictly controlled under the National Development and Reform Commission (NDRC) and are natural monopolies therefore not intended for market competition.

3.23 The Big Five generation companies (gencos) account for only 48.8% of the total generation capacity in 2008[47] (see Figure 3.4). The Government's policy encourages joint ventures with provincial or municipal governments and private investors to

[47] 張忠會、餘知敏、王玉，*淺談中國電力市場結構及運營模式[J]*，電力與能源，2008.

increase power generation and supply. As a result, local gencos are increasingly important in the power generation industry. For example, the Guangdong Yudean Group Co., a joint venture of the Guangdong Government, Huaneng Group (one of the Big Five gencos) and private investors, is the largest genco in the province in terms of generation capacity in 2012[48].

Figure 3.4 Capacities of Power Generation Companies in China 2008



Market reform

3.24 The regulator, NEA as mentioned above, formerly the State Electricity Regulatory Commission (SERC), formulates tariff policy and sets tariffs, reviews and approves power projects and provides guidance in market reform.

3.25 A plan covering reform of market structure is taking shape and the regulator is exploring ways to increase transparency in the transmission and distribution business. The market reform is far from completed. Currently the transition is taking place to fully utilise market power of the players and establish incentives in the price formation mechanisms and allocation of electricity production.

3.26 In December 2013, South China Energy Regulatory Bureau (SCERB) of the NEA was established to fulfill legal requirements for Guangdong, Guangxi, Yunnan, Guizhou, Hainan provinces, as well as electrical safety supervision and management responsibilities.

[48] Guangdong Yudean Group Co. Ltd. (2013). The Annual Report (2012).

3.27 Although many sectors of China are governed by market mechanisms, planned arrangements still accounted for the majority of the electricity transactions between grid companies and generators. Each year, all major gencos submit their offers to the two grid companies on what amount they will supply to the system with state approved prices. Amounting to 2,740 TWh in 2010, over 80% of the direct dispatch of electricity is planned and administration-led.

3.28 Competitive transactions in the electricity sector are gradually emerging. They include direct power purchase by big users, trading on inter-regional electricity supply and on generation rights of inefficient reserved power plant. Although direct power purchase was introduced in 5 provinces including Guangdong in 2011, the amount of the market transaction only amounted to 8.2 TWh in 2011 (less than 1% of the total consumption) and remains an insignificant part of total demand of electricity in the market.

3.29 Electricity is a household necessity and is a major component of household expenditure. Its tariff is strictly regulated by SERC in China. The Electricity Bill is composed of three components:

i. On-grid tariff (the price paid to the generator for each unit of electricity);

ii. The network charge; and

iii. Government funds and surcharges (for example: contribution to renewable energy development).

3.30 Since the retail price of electricity is regulated, it may not fully reflect the fuel cost fluctuation. Many coal-fired gencos suffered significant loss as a result of surging coal prices between 2008 and 2011. In addressing coal price fluctuations, the Coal-Electricity Price Linkage Mechanism was established in 2004 – a built-in adjustment mechanism in the on-grid tariff whenever the coal price varies more than 5% within 6 months. However, NDRC has seldom implemented it. As a result, many gencos have serious financial problems[49].

[49] Williams J. H., & Fredrich K., Electricity Reform and Sustainable Development in China, *Environmental Research Letters*, December 2008.

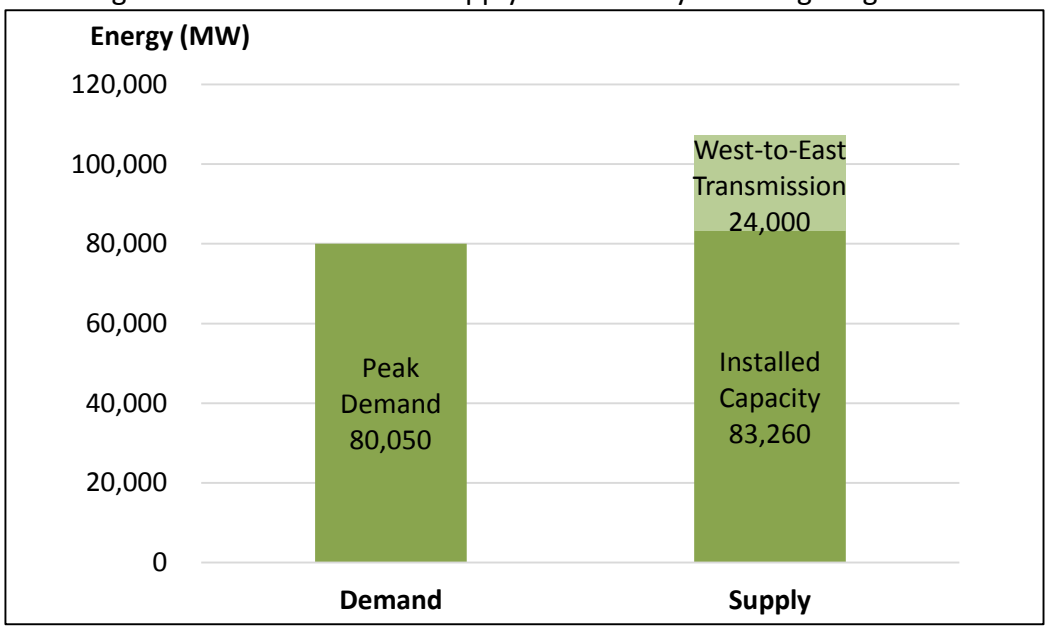
Electricity market at Guangdong province

3.31 The Five-year Plans of the Chinese Government, the blueprints of national development strategy, placed emphasis on energy efficiency and pollution reduction. The 12th Five-year Plan (2011-2015) set out the national pollution reduction targets over the Five-year Plan period: 8% reduction of SO_2 emission, 10% reduction of NO_x emission and 17% reduction of CO_2 emission. The Plan also focused on enhancing energy transmission efficiency and promoting efficient use of energy. It set out a target of 16% reduction of the energy cost per GDP.

3.32 Guangdong has the highest GDP in China. The average annual GDP growth was over 8% for the last 5 years, which is highest among the 31 provinces and districts[50]. 50% of its GDP were contributed by manufacturing, construction and mining, which are typically energy intensive sectors. Unsurprisingly, Guangdong has the highest demand within the Southern Grid.

3.33 Total electricity consumption of Guangdong was 462 TWh and was 60% of total consumption of the Southern Grid region in 2012. Local production was insufficient for the demand and Guangdong had to import a significant amount of electricity from Yunnan and Guizhou. In 2012, Guangdong used up 24000 MW of electricity capacity installed in the Western Provinces[51] (see Figure 3.5).

Figure 3.5 Demand versus Supply of Electricity in Guangdong 2012



[50] Statistical Bureau of Guangdong Province, *'Guangdong Statistical Yearbook 2012'*, http://www.gdstats.gov.cn.

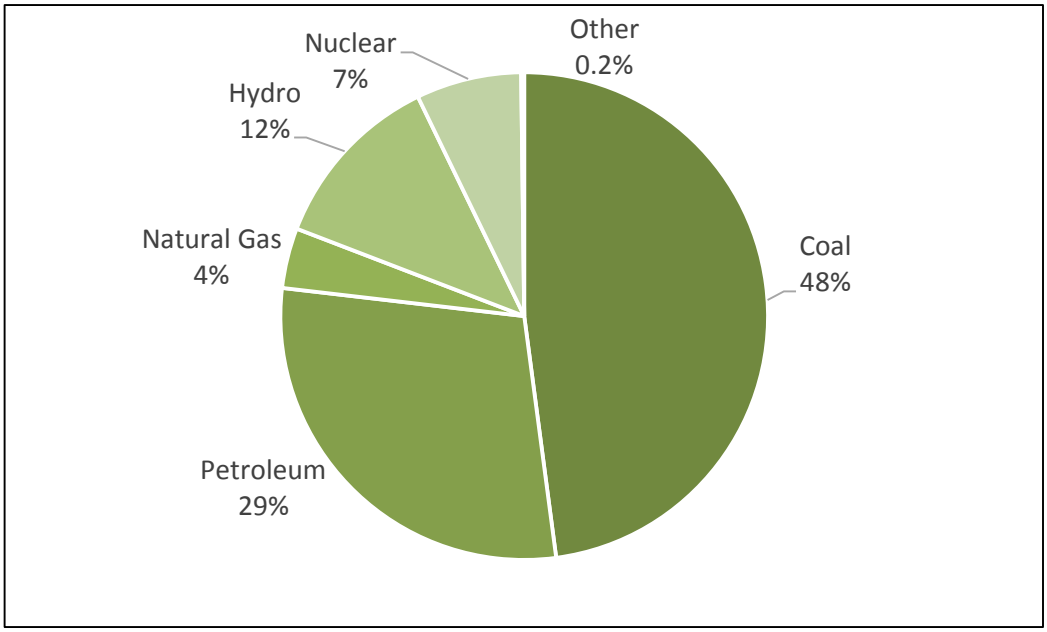
[51] National Bureau of Statistics (2011), *China Energy Statistical Yearbook 2011*.

3.34 It is noted that the installed capacity in Guangdong could barely surpass the peak consumption in 2012. In order to improve on imbalance supply and demand and to avoid major service disruption due to power shortage during summer, power rationing was implemented during the peak demand where power supply for factories would need to be stop operating in turns[52]. Due to expected low hydro power supply from the West and the shutdown of inefficient coal power plants, it is estimated that there was a shortage of 2860 MW of electricity in summer 2013[53].

3.35 Guangdong, being one of the most developed provinces in China, charged itself with better environmental objectives than the national standards. The target of 12th Five-year Plan for Guangdong province is more demanding than the national target i.e. reducing SO_2 emission by 14.8%, reducing NO_x emission by 16.9%, lower CO_2 intensity by 19.5% and to lower energy intensity by 18% from 2011 to 2015[54].

3.36 Although Guangdong's electricity generation is still highly dependent on coal (48% in 2010 see Figure 3.6), it is significantly less so than the national average due to its strict emission targets. Despite that the actual consumption of energy in Guangdong is still reliant on fossil fuel (75% in 2010 see Figure 3.7).

Figure 3.6 Fuel Mix in Guangdong 2010[55]



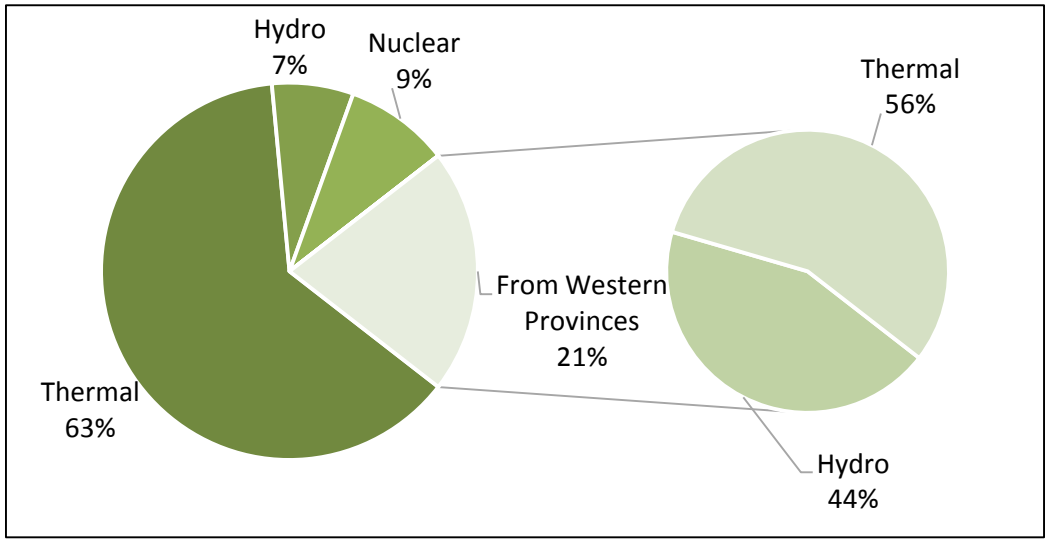
[52] South China Morning Post, (2012) *'Shanghai Guangdong Adopt Power Rationing'*, 04 August 2012. http://www.scmp.com/article/423399/shanghai-guangdong-adopt-power-rationing.

[53] Guangdong Yudean Group Co. Ltd. (2013). The Annual Report (2012).

[54] State Council of PRC (2012), *'Notice on the 12th Five-year Plan for Greenhouse Gas Control'*, 31 January 2012. http://big5.xinhuanet.com/gate/big5/news.xinhuanet.com/2012-01/13/c_111436437.htm.

[55] National Bureau of Statistics (2011), *China Energy Statistical Yearbook 2011*.

Figure 3.7 Energy Consumption in Guangdong 2010[56]



3.37 In 2006, Guangdong stopped coal extraction within the province and therefore all coal used was imported[57]. In order to meet the target of reduction of carbon emission, a higher share of electricity capacity of renewable sources and nuclear power is planned in Guangdong.

Future developments in electricity market in Guangdong

3.38 There are plans to build nuclear plants and renewable energy plants that will hold a higher percentage in the fuel mix to comply with the targets set in the 12th Five-year Plan for Guangdong. With installation of new nuclear plants, the installed capacity for nuclear power is expected to be almost double from 2012 to 2015[58] (see Table 3.3). However, policies are in place to replace the inefficient coal plants with natural gas plants, and, under the current policy, thermal power will continue to be the key component of electricity supply in Guangdong

Table 3.3 Planned Installed Capacity for 2015

Power Type	Planned Installed Capacity of 2015 (MW)	% of Total Installed Capacity of 2015	% of Total Installed Capacity of 2012
Thermal	70,000	68.0%	74.0%
Hydro	15,400	14.9%	16.0%
Nuclear	13,800	13.4%	7.0%
Wind & Others	3,800	3.7%	3.0%
Total	103,000	100.0%	100.0%

[56] China Electricity Council (2010), Electric Power Industry Statistical Compiled 2010.

[57] National Bureau of Statistics (2011), *China Energy Statistical Yearbook* 2011.

[58] People's Government of Guangdong Province. (2012). 廣東省能源發展「十二五」計劃. 15 March 2013.

3.39 Guangdong provincial government needs to reconcile increasing electricity demand, the aggressive emission requirements and energy efficiency requirements in the 12th Five-year Plan. Nuclear power plant development has become an important regional energy strategy of Guangdong[59].

3.40 Although hydro power can be a major source of energy in Guangdong in future with minimal adverse effect on air quality, the productivity of hydropower is seriously affected by rainfall and the site location of hydropower plants is highly dependent on water resources and other geographical factors. Potential sites for further development are said to be limited[60].

3.41 It is claimed that nuclear power is relatively reliable and efficient in electricity generation despite concerns on safety issues. Guangdong, together with Zhejiang, is the first province in China equipped with nuclear power stations. The Daya Bay Nuclear Power Plant (Daya Bay), with two 984 MW reactors, were in full service in 1994, with 70% of its output exported to Hong Kong (see Table 3.4). The Lingao Nuclear Power Plant (Lingao) is just 1 km away from Daya Bay. Four reactors of Lingao, about 1000 MW capacity each, also commenced their production starting from 2002 and were fully operational in 2011.

3.42 Three nuclear plants are under construction and will soon be in service. The total capacity for Yangjiang I & II Nuclear Plant is 6480 MW and Taishan I Nuclear Plant is 3500 MW. The construction for Yangjiang I & II site is expected to be completed by 2017. There are another three new plants providing 9500 MW of electricity to be built. Locations of the sites are shown in Figure 3.8 and other six more nuclear power plant developments were proposed by local authorities[61].

[59] The People's Government of Guangdong Province of PRC, 'The 12th Five-year Plan for Energy Development of Guangdong'. http://www.stats.gov.cn/tjsj/ndsj/2011/indexch.htm.

[60] China Electricity Council (2010), *'Electric Power Industry Statistical Quick Report'*.

[61] Proposed nuclear plants in Guangdong are located in Taishan, Shaoguan (northern boundary of Guangdong), Lufeng & Haifeng & Jieyang (eastern boundary of Guangdong) and Zhaoquing (near Guangzhou).

Figure 3.8 Locations of the Approved Nuclear Sites

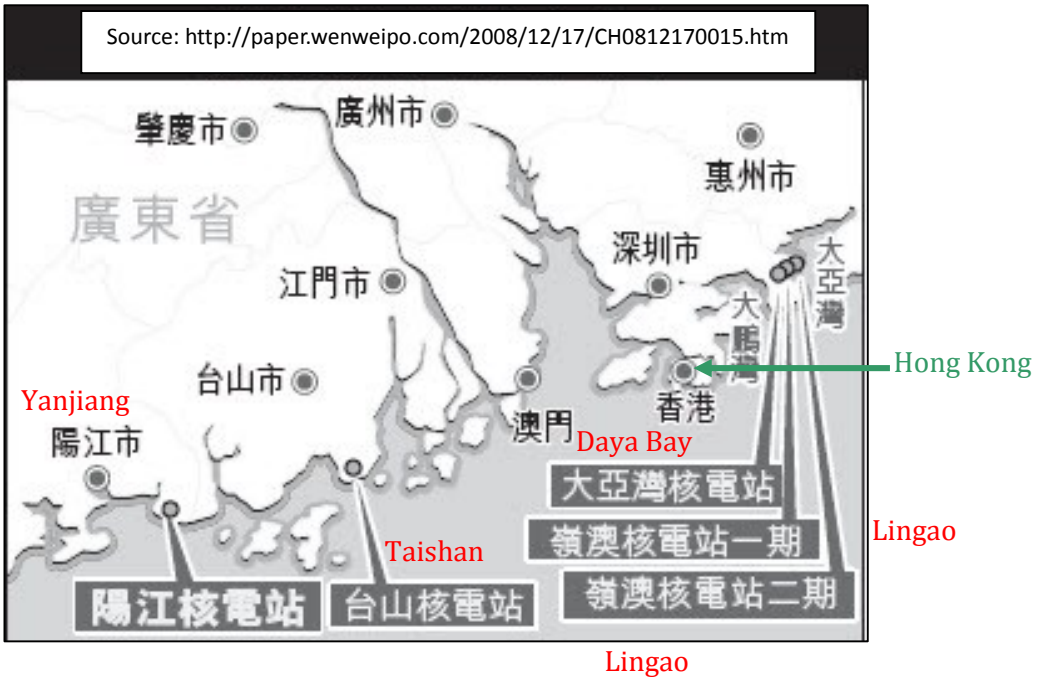


Table 3.4 Nuclear Power Plants in Guangdong[62]

Location	No. of Reactors	Total Capacity (MW)	Year of Commercial Operation
In Operation (3 sites)			
Daya Bay	2	1968	1994
Lingao I	2	1980	2002 and 2003
Lingao II	2	2160	2010 and 2011
Under Construction (3 sites)			
Yangjiang I & II	6	6480	(Expected) In phases, from 2013 to 2017
Taishan I	2	3500	(Expected) 2013, 2014

3.43 In supporting Guangdong to invest and develop on nuclear energy and renewable energies, NDRC also approved Guangdong to have pilot schemes on electricity market reform. Guangdong now has discretion on power rationing and direct power purchase, where large customers can negotiate their tariffs and make their direct purchases from an assigned power plant through the Southern Grid.

3.44 The implementation of energy conservation policy and the replacement of the polluted and less efficient power generation units with cleaner and more efficient power generation units are in place. Power companies with inefficient units at Guangdong are allowed to trade their generation rights with other more efficient power generation

[62] http://www.dbcp.gov.hk/eng/safety/plants.htm.

units. These schemes are expected to enhance competition, more efficient production and less emission production in the electricity market.

3.45 Guangdong, being one of the most developed provinces in China, shoulders a greater responsibility in energy market reform as well as energy saving and emission reduction. To achieve these targets, it is expected that Guangdong will continue to develop and install natural gas power plants and nuclear power generation over the next two decades. Although the renewable sources such as wind and solar powers are being promoted, their shares in the overall energy mix are expected to be insignificant, playing only supplementary roles in 12th Five-year Plan and power sector regulatory reform in future.

3.46 There is potential for the development of a non-hydro renewable energy industry. The long coastal line and sea front and many less populated areas in the province suggest considerable geographical advantages for the development of wind energy supplies and solar power supplies. As the technologies of renewable energy improves, the economic factor becomes more favourable, and so the contribution of solar and wind energy to total power production in Guangdong will be significantly increased in future.

3.47 Data of IEA showed that China passed the US to become the world's biggest energy consumer in 2010. This milestone reflects both China's decades-long period of rapid economic growth and its rapidly expanding clout as an industrial giant.

3.48 Southern China has a high energy demand. Fossil fuels, particularly coal, continue to be the leading sources of the region's electricity generation and installed capacity. Rapid development in Guangdong also drove the rapidly increasing energy demand. As the Chinese Government tightens the measures by the law on energy conversation[63], the need to shift to clean fuel means that natural gas is often the fuel source used to meet demand growth. Although the Chinese Government has made large infrastructure investments in the natural gas pipeline linking Central Asia to the coastal cities and in a LNG terminal, the increasing availability of natural gas is not sufficient to turn round the upward pressure on gas prices, driven as they are by growing demand. A future fuel mix policy relying heavily on natural gas could make delivering affordable tariffs to consumers difficult if price increases do not moderate.

3.49 Turning to nuclear, as of September 2014, there were 28 nuclear reactors under construction in China. Additional reactors are planned, so that nuclear would provide 58 GW of capacity by 2020. Despite these ambitious plans, which, as noted above,

[63] PRC Law 'Law of the People's Republic of China on Energy Conservation', 中華人民共和國節約能源法.

involve the near tripling of nuclear capacity by 2030, the Chinese Government still only expects the percentage of its electricity produced by nuclear power to increase from the current 2% to 6% by 2020[64]. In other words, strenuous efforts for expansion will still result in a fairly modest proportion. However, for Guangdong nuclear power accounts for 8% of installed capacity. It would be difficult to get permission for any additional new nuclear plant development in Guangdong by the Chinese Government as it needs to satisfy the demand for non-fossil fuel sources of other regions to meet national standard energy conversation.

3.50 Guangdong realises it needs to decouple its energy related carbon emission in meeting the demands of national energy conservation standards and its continuing economic growth. Although the local government took many measures to reduce carbon emissions, for example, eliminating lagging productive capacity and shutting down part of the high energy consumption factories such as small thermal power in the 11th Five-year Plan period, these measures were not sustainable[65].

3.51 In conclusion, the availability of cheap and clean energy sources in this region is not that favourable. Rather than relying on the neighbourhood to provide sustainable and affordable electricity, Hong Kong may need to reform its rigid structure, impose measures and introduce flexible market incentives to adopt to the new market environment with its limited supply of relative clean fuel. Having said that, the outcome of it is always subject to national policy and inter-governmental collaboration, and thus, this option should not be left out which Hong Kong reforms its structure to meet demand in future.

[64] World Nuclear Association, Nuclear Power in China October 2014. http://www.world-nuclear.org/info/Country-Profiles/Countries-A-F/China--Nuclear-Power/.

[65] Wenxiu Wang, Yaoqiu Kuang, Ningsheng Huang, and Daiqing Zhao, *Energy Empirical Research on Decoupling Relationship between-Related Carbon Emission and Economic Growth in Guangdong Province Based on Extended Kaya Identity*, Scientific World Journal Volume 2014, Article ID 782750.

Chapter 4 Hong Kong Electricity Market

4.1 Energy is crucial to the development of modern society. With the scarcity of flat land accommodating a high and ever increasing population, Hong Kong needs to secure energy resources to create a habitable indoor environment inside its high-rise commercial and residential buildings. Continuous power supplies are needed to drive infrastructure machinery-water supply, drainage systems and road networks.

4.2 Hong Kong has no indigenous energy resources. Energy is either imported directly (as in the case of oil products and coal products), or produced through some intermediate transformation processes using imported fuel inputs (as in the case of electricity and town gas). Only a small amount of energy is produced by renewable energy sources such as solar and wind energy.

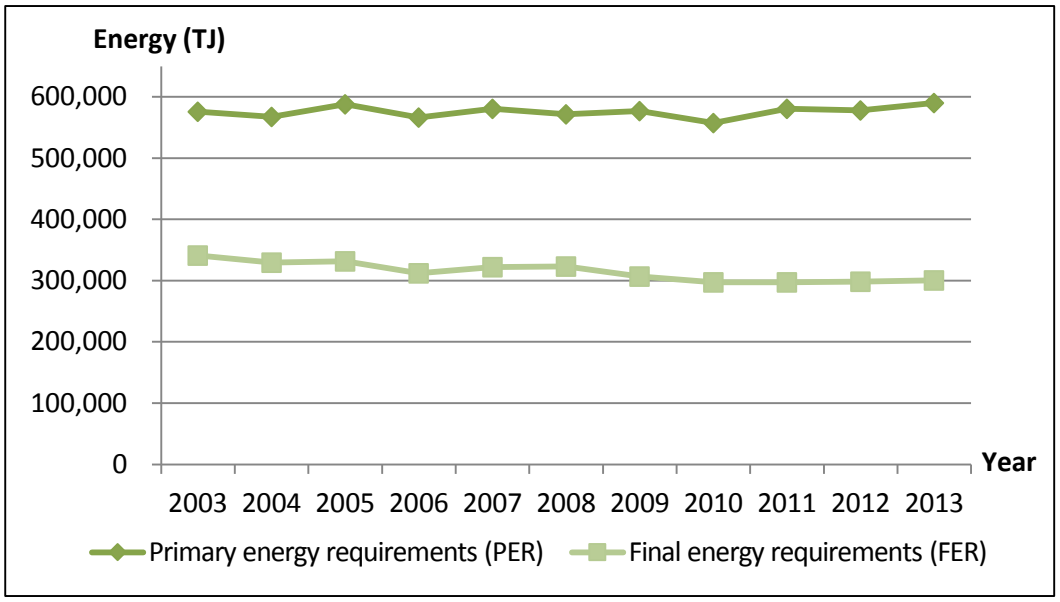
4.3 The energy scene of Hong Kong can be illustrated by two major aggregate energy indicators: the 'Primary Energy Requirements' (the equivalent of 'Total Primary Energy Supply (TPS)' of other economies) and the 'Final Energy Requirements' (the equivalent of 'Total Final Energy Consumption (TFC)' of other economies).

4.4 'Primary energy requirements' (PER) refers to the overall energy consumption within the geographic territory. It represents the total supply of energy available to the territory, which supports all the requirements for energy transformation and final consumption in that territory, and includes both indigenous energy sources and imported energy commodities consumed within the territory. In the case of Hong Kong, it is calculated from retained imports of coal and oil products as well as electricity, net of bunker is usage, after adjustment for supply from stock.

4.5 'Final energy requirements' (FER) refers to the amount of energy consumed by final users for all energy purposes such as heating, cooking and driving machinery. It differs from PER in that the latter includes all energy used or lost in the energy transformation and the distribution process.

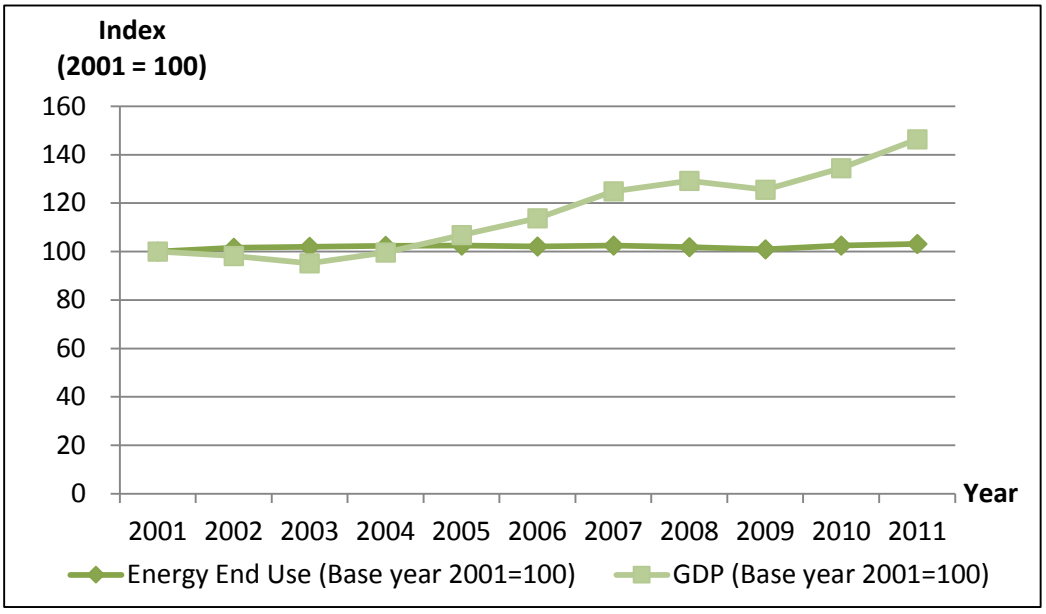
4.6 According to the Hong Kong Government's statistics, the overall energy balance (see Figure 4.1) showed that the primary energy requirements (PER) increased by 2.5% between 2003 and 2013. Over the same period, the final energy requirements (FER) decreased by 12.0%. The input of coal and oil products for electricity generation accounted for about 68.9% of PER in 2013, compared with 59.8% in 2003.

Figure 4.1 PER and FER from 2003-2013[66]



4.7 During the period between 2001 and 2011 the increase in real deflated GDP was much larger than the corresponding energy end use increase, with a GDP increase of 46.4% equivalent to an annual increase of 3.9% corresponding to the increase of energy end use of only 3.1%, equivalent to an annual increase of 0.3% over the same period. The decoupling relationship between GDP and energy end use can be observed reading Figure 4.2.

Figure 4.2 Decoupling of Hong Kong Energy End Use from GDP 2001-2011[67]



[66] Hong Kong Energy Statistics Annual Report 2003-2013

[67] Energy end use data were obtained from the EMSD website (2013) and data on Hong Kong's GDP from 2001—2013 were from the C&SD website (2013).

4.8 Although the energy/GDP ratio as measured by TJ/GDP was improved, other relevant energy intensity measures (e.g. energy use for the residential sector) may not necessarily exhibit the same trend. A more detailed study is needed.

Hong Kong Current Energy Policy

4.9 Electricity supply has all along been provided by the private sector. Energy policy is under the policy bureau of the Environment Bureau and the energy policy objectives are as follows:

i. To ensure that the energy needs of the community are met safely, reliably, efficiently and at reasonable prices; and

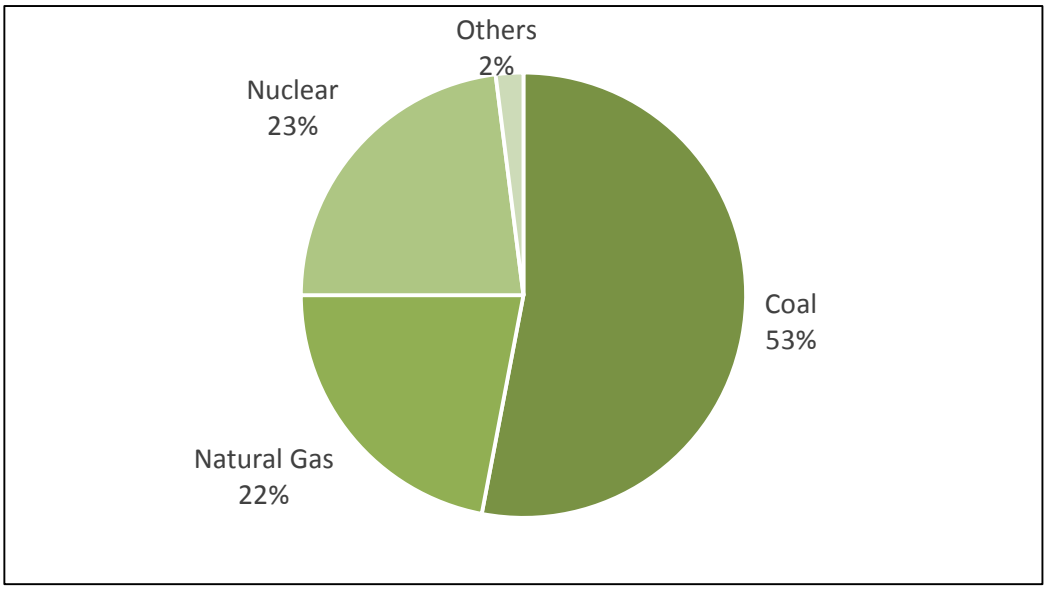
ii. To minimise the environmental impact of energy production and use and promote the efficient use and conservation of energy.

4.10 Electricity is supplied by the CLP Power Hong Kong Limited (CLP) and Castle Peak Power Company Limited (CAPCO) and the Hongkong Electric Company Limited (HEC) which are privately owned and vertically integrated. They do not have a franchise. On a de facto basis, CLP supplies electricity to Kowloon and the New Territories, including Lantau, Cheung Chau and several other outlying islands, whereas HEC supplies electricity to Hong Kong Island and the neighbouring islands of Ap Lei Chau and Lamma.

4.11 The performance of the power companies is regulated under the SCAs agreed by both the Hong Kong Government and the power companies, which among other things also require the power companies to promote energy efficiency and undertake energy saving measures.

4.12 At the end of 2006, Hong Kong had a total installed electricity generating capacity of 12,644 MW (including 70% of the capacity of units 1 and 2 of the Guangdong Nuclear Power Station at Daya Bay and 50% of Phase 1 of the Guangzhou Pumped Storage Power Station). The fuel mix for power generation is shown in the following Figure 4.3. In 2012, coal still dominated the fuel mix for power generation in Hong Kong (about 53%), followed by nuclear power (about 23%) and natural gas (about 22%).

Figure 4.3 Fuel Mix for Electricity in 2012[68]



4.13 The Electricity Ordinance (Cap 406) regulates the safe supply of electricity and the safety of household electrical products. Among other things, it covers the registration of generating facilities, contractors and workers for electrical installations, wiring installation standards and safe distribution and use of electricity.

4.14 The Electrical Products (Safety) Regulation was enacted in 1997 and its main provisions, including specified safety requirements for household electrical products, came into effect in May 1998. The remaining provisions concerning certificates of safety compliance requirements commenced operation in December 2000. The Electricity Supply Lines (Protection) Regulation was enacted in April 2000 to deter damage to underground electricity cables and overhead electricity lines. It commenced operation on 1 April 2001.

4.15 A non-statutory Energy Advisory Committee (EnAC), was set up in July 1996 to advise the Hong Kong Government on energy policy, including policy matters concerning energy supply and demand, energy conservation and efficiency. The Hong Kong Government brought issues to the attention of EnAC for its members to give advice such as the mid-term review of the SCAs, initiatives to enhance energy efficiency, review of future fuel mix for electricity generation, the 2014-18 Development Plans for power companies, etc.

[68] Consultation Paper of *'Planning Ahead for a Better Fuel Mix - Future Fuel Mix for Electricity Generation'* from the Environment Bureau (2014).

4.16 EnAC is chaired by a non-official and comprises non-official members representing different sectors of the community and official members from relevant policy bureaux and departments. The Chairman and members are appointed by the Secretary for the Environment. EnAC is now chaired by Prof Raymond SO Wai-man.

Scheme of Control

4.17 Electricity supply in Hong Kong is regulated through the SCAs signed between the Hong Kong Government and individual power companies, namely, HEC and CLP. The SCAs set out the rights and obligations of the power companies and provide a framework for the Hong Kong Government to monitor the power companies' financial affairs and technical performance. To achieve the policy objective of providing reliable, safe and efficient electricity supply at reasonable prices, the SCAs include the following key features:

i. An obligation for the power companies to provide sufficient facilities to meet present and future electricity demand;

ii. An obligation for the power companies to supply electricity at lowest possible cost; and

iii. Provision for periodic development plan review and annual tariff review, and for annual audit of the technical and financial performances of the power companies.

4.18 Before the previous SCAs with the two power companies expired in 2008, the Hong Kong Government conducted a two-stage public consultation on the 'Future Development of the Electricity Market in Hong Kong' in 2005 and in 2006 gauging public views on the electricity market in Hong Kong. There was support from the public in the two rounds of public consultation, for the Hong Kong Government's stance on the core terms of reducing the permitted RoR of the power companies to lower the electricity tariffs charged to customers, shortening the duration of the SCAs from 15 years to 10 years to allow for greater flexibility for introducing competition, and linking the permitted RoR of the power companies to their achieving the emission caps stipulated under the Air Pollution Control Ordinance (Cap 311) so as to provide the companies with further incentive to reduce emissions and to improve air quality.

4.19 The existing SCAs were entered into between the Hong Kong Government and individual power companies on 7 January 2008. It is a cost plus approach and the following changes to the previous SCAs were made:

i. The duration of the SCAs was shortened to 10 years, with an option exercisable by the Hong Kong Government to extend for 5 years, i.e. until 2023, after a review of the prevailing market conditions including whether new supply sources were available;

ii. The annual permitted RoR was reduced from 13.5-15% to 9.99% on the average net fixed assets (ANFA);

iii. A linkage mechanism between the permitted RoR and the emission performance of the power companies was introduced. The penalty level was set at 0.4% and 0.2% reduction of return on all non-renewable energy fixed assets for exceeding any of the emission caps of 30% and 10% respectively;

iv. A smaller financial incentive was provided for over-achievement of the emission caps (i.e. 0.1% and 0.05% points increase of RoR for over-achievement to the extent of 30% and 10% respectively);

v. Financial incentives were provided to encourage more usage of renewable energy;

vi. The portion of the net asset value on mechanical and electrical equipment relating to new generating facility, if found to be excessive upon commissioning to meet the latest electricity demand and to be excluded from the company's ANFA for calculating the return, would be set at 50% for both power companies (previously 40% for CLP and 50% for HEC);

vii. The threshold above which the Executive Council's approval was required for adjustment of the Basic Tariff was lowered from 7% to 5%, limiting the room for the power companies to adjust their tariffs; and

viii. The cap on Tariff Stabilization Fund (TSF) balance, which was maintained for the retention of net revenue in excess of the agreed return for the power companies, was reduced to 8% of annual local sales from 12.5% under the previous SCAs.

Tariff adjustment mechanism

4.20 Hong Kong electricity tariff is made up of two parts, namely, the Basic Tariff and the fuel clause charge. To ensure that any tariff adjustment is reasonable, the Hong Kong Government plays a gate-keeping role. This means that costs relating to the Basic Tariff are controlled to ensure that any necessary developments and service improvements of the power companies proceed in line with their five-year development plans

approved by the Hong Kong Government. Furthermore, in the context of the annual tariff review, individual expenditure items, including capital investment by the two companies, are vetted to screen out items that are excessive, premature or unnecessary.

4.21 As to the fuel clause charge, the Hong Kong Government would require the two power companies to use, as far as practicable, the Fuel Clause Recovery Account (FCA)[69] and TSF[70] as buffers to mitigate the cost impact of any switch from old fuel contracts to new contracts, and any significant fuel price fluctuations in the international market. The Hong Kong Government would also examine whether any special income of the two companies can be used to offset cost increase.

4.22 The Hong Kong Government conducted tariff reviews with the two power companies annually and the average net tariffs charged by HEC and CLP since 2004 are set out in Table 4.1.

Table 4.1 Average Net Tariff in Hong Kong from 2004-2014[71]

Year	HEC (HK$/kWh)	CLP (HK$/kWh)
2004	1.033	0.872
2005	1.100 (+6.5%)	0.873 (+0.1%)
2006	1.174 (+6.7%)	0.871 (-0.2%)
2007	1.202 (+2.4%)	0.872 (+0.1%)
2008	1.274 (+6.0%)	0.911 (+4.5%)
2009	1.199 (-5.9%)	0.892 (-2.1%)
2010	1.198 (-0.1%)	0.916 (+2.7%)
2011	1.231 (+2.8%)	0.942 (+2.8%)
2012	1.309 (+6.3%)	0.987 (+4.8%)
2013	1.349 (+3.1%)	1.045 (+5.9%)
2014	1.349 (0%)	1.108 (+6.0%)

Supports from Mainland China to Hong Kong energy market

4.23 As authorised by the Central People's Government (CPG), the National Development and Reform Commission and Administrator of the NEA has an agreement with the Hong

[69] FCA is operated on a rolling basis. It is an account maintained by the two power companies through which the difference between the standard fuel cost (as reflected in the Basic Tariff) and the actual fuel cost is captured and passed on to consumers by way of rebates or charges.

[70] The purpose of TSF is to accumulate the excess of net revenues of the power companies over the permitted return, so as to provide funding, where necessary, to ameliorate the impacts of tariff increases on consumers.

[71] Consultation Paper of *'Planning Ahead for a Better Fuel Mix - Future Fuel Mix for Electricity Generation'* from the Environment Bureau (2014).

Kong Government regarding supply of electricity and natural gas from Mainland China. CPG supports energy cooperation between the Mainland and Hong Kong on the long term and stable supply of nuclear electricity and natural gas to Hong Kong, so that Hong Kong can make greater use of clean energy.

4.24 CPG and the Hong Kong Government agreed to support China Guangdong Nuclear Power Holding Company Limited (CGNPC) to renew its supply agreement to Hong Kong for a further term of 20 years. The supply quantity would not be less than the current level and pricing would be agreed on commercial principles between CLP and CGNPC.

4.25 CPG also facilitates the supply of natural gas to Hong Kong. CPG supported the China National Offshore Oil Corporation to renew its supply agreement to Hong Kong for a further term of 20 years, the pricing of which would be determined on commercial principles. It was agreed in principle that the feasibility of supplying natural gas to Hong Kong via the Second West-East Natural Gas Pipeline and an LNG terminal would be jointly built in the Mainland for supply to Hong Kong. In 2013, the agreement was signed and the LNG terminal was in operation.

4.26 It was also agreed that further support would be given to the relevant parties which coordinate and consider the supply of offshore gas, piped gas and LNG and agree on the supply quantity, pricing and implementation plan if available.

Development of Renewable Energy in Hong Kong

4.27 The use of renewable energy has been explored and developed in Hong Kong. The Hong Kong Government and tertiary institutes conducted various studies and completed a number of renewable energy installations to study the feasibility of their applications in Hong Kong.

Solar energy

4.28 Hong Kong is abundant with sunlight. Solar energy can be used to produce hot water or directly transform into electrical power. The systems related to solar energy application include solar thermal systems (solar water heating, solar refrigeration) and photovoltaic (PV) system.

4.29 Early application of solar energy in Hong Kong is mainly used for water heating. In 1978, a Solar Hot Water Plant was installed in Tsim Sha Tsui to supplement domestic hot water supply in a hotel complex. Apart from using solar energy for heating purpose, solar energy was also utilised by PV systems to generate electrical energy. Since the 1980s,

solar cells have been employed to generate power for weather stations in remote locations in Hong Kong. In 1983, a PV system was installed in a drug addiction treatment centre on the remote island Hei Ling Chau.

4.30 In addition to small and stand-alone applications, PV systems can also be integrated with building procedures known as Building Integrated Photovoltaic (BIPV) systems. In recent years, a number of BIPV systems in both Government and private projects have emerged. These projects include installations at the power plant on Lamma Island of HEC, EMSD Headquarters at Kai Tak, Science Park, Wanchai Tower and Science Museum, etc.

4.31 The project of EMSD Headquarters at Kai Tak was completed in 2005. The total capacity is 350 kW. It comprises a solar array made up of more than 2,300 mono-crystalline silicon PV modules which together has a total area of around 3,180 m^2. Currently the largest solar PV system in Hong Kong was installed at the power plant on Lamma Island in July 2010. This system has a capacity of 550 kW, comprises 5,500 thin-film PV modules. It is expected to generate 620,000 kWh of electricity annually. This system is not only the largest one in Hong Kong, but also it is the first large scale project applying amorphous silicon thin-film technology.

Wind energy

4.32 The first wind/solar hybrid system in Hong Kong was installed at the Shek Kwu Chau Drug Rehabilitation Centre. The first commercial-scale combined PV and wind turbine renewable energy power station at 200 kW capacity was completed on Town Island in 2011.

4.33 Since 2000, Hong Kong Observatory began to use wind power as an energy source in some remote automatic weather stations which have been relying on solar power. The sunshine on cloudy days may not be sufficient to keep the system in operation. Wind turbine generators have been employed to provide an alternative energy source. The first commercial-scale wind power station was completed in February 2006 on Lamma Island. The rotor diameter is 50 meters with a rated output power of 800 kW.

Waste-to-energy

4.34 The adoption of waste-to-energy in Hong Kong as a source of electricity supply would depend on the potential of developing waste-to-energy facilities. Municipal waste generated as a result of urban life in Hong Kong can be used for electricity generation. As promulgated in the 'Hong Kong Blueprint for Sustainable Use of Resources 2013-

2022' and 'A food Waste & Yard Waste Plan for Hong Kong 2014-2022', specific measures to promote waste-to-energy include the operation of a sludge treatment facility (STF), an integrated waste management facility (IWMF), and a number of organic waste treatment facilities (OWTF).

4.35 With regard to the projects already completed and being planned, the share of renewable energy from waste is unlikely to be significant and may at the most make up about 1% of total electricity demand by the early 2020s.

Initiatives of demand side management from power companies

4.36 In July 2014, CLP became the first utility company in Asia to launch a pioneering home energy management scheme aimed at encouraging customers to reduce consumption and cut down on their electricity bills. Individual reports are being mailed to 56,000 selected residential customers on a bi-monthly basis. Each targeted household will receive a personalised analysis showing how their recent energy use compares to that of 100 households with similar profile in the neighbourhood, including the most energy efficient households. As well as comparisons with other households, the reports provide individual household electricity usage comparison with their own previous year's usage as well as detailed energy efficiency advice.

4.37 In the fourth quarter of 2014, apart from 56,000 report recipients, the pilot scheme is expanded to all the 2.1 million residential customers of CLP. Customers will be able to access the CLP's web portal and log on to obtain their tailored energy consumption comparison along with customised energy saving solutions to help them save on their bills.

Government Future Energy Policy

4.38 The Hong Kong Government is now reviewing the long term development of electricity market in Hong Kong and its regulatory framework after the expiry of the current SCAs. According to the SCAs, the Hong Kong Government has to discuss with the power companies the mechanism to allow the power companies to recoup the costs for the assets that would become stranded (i.e. have not been recovered and cannot in future be recovered in the market) as a result of a change implemented by the Hong Kong Government to the electricity supply market structure causing material impact to the relevant power company in respect of its 'electricity-related' activities. The amount of stranded costs that could be recovered from the market and the mechanism are to be agreed between the Hong Kong Government and the power companies.

4.39 In 2012, the Legislative Council urged the Hong Kong Government to create a sustainable and open electricity market which establishes an energy management authority to explore Hong Kong's long-term energy demand, formulate and execute an energy policy, as well as monitor power companies, gas companies, liquefied petroleum gas companies and fuel supply companies. They also urge the Hong Kong Government to review the permitted returns of the two power companies and increase transparency of the relevant information and accounts and the development plan, so as to facilitate public participation, in particular the processes for the formulation of SCAs and tariff adjustments, so as to facilitate public monitoring and ensure fair and reasonable tariff adjustment rates.

4.40 Having regard to the pros and cons of various fuel types and Hong Kong's local situation, the Hong Kong Government proposed two specific fuel mix options in the Environment Bureau consultation paper. One option is to import more electricity through purchase from the Mainland power grid and the other is to use more natural gas for local generation. The composition of the two fuel mix options is shown in Table 4.2.

Table 4.2 Existing Fuel Mix Ratio and Possible Ratios under the Two Proposed Fuel Mix Options[72]

<table>
<tr><th colspan="2" rowspan="2">Fuel Mix</th><th colspan="2">Import</th><th rowspan="2">Natural Gas</th><th rowspan="2">Coal (& Renewable Energy)</th></tr>
<tr><th>Nuclear (DBNPS)</th><th>Grid Purchase</th></tr>
<tr><td colspan="2">Existing (2012)</td><td>23%</td><td>-</td><td>22%</td><td>55%[73]</td></tr>
<tr><td rowspan="2">Option 1</td><td rowspan="2">Importing more electricity through purchase from the Mainland power grid</td><td>20%</td><td>30%</td><td rowspan="2">40%</td><td rowspan="2">10%</td></tr>
<tr><td colspan="2">Total : 50%</td></tr>
<tr><td>Option 2</td><td>Using more natural gas for local generation</td><td>20%</td><td>-</td><td>60%</td><td>20%</td></tr>
</table>

Reasons for the fuel mix review

4.41 Underpinning the options is the need to replace local thermal generation units while meeting the projected demand. The majority of the existing local coal-fired generating units came into operation in the 1980s and are scheduled to retire from 2017. The Hong Kong Government estimated that total electricity consumption will increase from about 43 billion kWh in 2012 to about 48 billion kWh in 2020 and about 50 billion kWh in 2023.

[72] Consultation Paper of *'Planning Ahead for a Better Fuel Mix - Future Fuel Mix for Electricity Generation'* from the Environment Bureau (2014).

[73] Inclusive of a small percentage of oil.

4.42 The Hong Kong Government announced in November 2012 the targets to reduce emission of air pollutants in Hong Kong including sulphur dioxide, nitrogen oxides and resizable suspended particulates by 15-75% by 2020 when compared to 2010. As electricity generation is a major source of air pollutant emission, improving the fuel mix for electricity generation is a major measure to achieve the 2020 reduction targets.

4.43 The Hong Kong Government proposed in a consultation exercise in 2010 to reduce carbon intensity in Hong Kong by 50-60% by 2020 as compared to 2005[74]. As the Mainland adopted a nation-wide goal to reduce carbon emissions, reducing the carbon component in local electricity generation will be in line with national policy.

4.44 Beyond 2023, coal-fired power plants would be completely phased out in a gradual manner. The proposed share of different fuel types or mode of supply under the two options essentially provides a basis for planning necessary infrastructure. Based on the four energy policy objectives (Safety, Reliability, Affordability and Environmental Performance), the proposed options are also evaluated against some other relevant considerations with longer-term implications on Hong Kong's electricity landscape. This report reaches conclusions on the merits of the options in Chapter 7. The Hong Kong Government's assessment of the two fuel mix options' performance is shown in Table 4.3.

[74] As a non-Annex I Party under the Kyoto Protocol, China (including Hong Kong) is not required to meet any mandatory greenhouse gas (GHG) emission limits or reduction targets. This notwithstanding, the Central People's Government announced in November 2009 a voluntary national target to reduce its carbon intensity by 40% - 45% by 2020 as compared with the 2005 level. Hong Kong proposed in 2010 a higher target for itself in combating climate change with regard to its state of economic development. Carbon intensity is the amount of GHG or carbon emission per unit of gross domestic product.

Table 4.3 Summary of the Relative Performance of the Proposed Options[75]

Safety	Both options pose no specific safety risks to Hong Kong.
Reliability	**Option 1:** large-scale grid purchase is untested in Hong Kong, but our assessment suggests that it is technically feasible. Hong Kong should be able to benefit from the strong support provided by CSG's entire power grid with multiple sources of supply. Arrangements can be made to retain local back-up generation capacity to cater for emergencies. Detailed technical studies are required. **Option 2:** local generation has a proven track record of reliability.
Affordability	No substantial difference in average unit cost of electricity based on information available and current projections. A preliminary estimate is that they will roughly double the unit generation cost over the five years from 2008 to 2012. Actual tariff implications cannot be ascertained at this stage. **Option 1:** there may be concerns on Hong Kong becoming a captive buyer. **Option 2:** heavy reliance on natural gas as a single fuel type will increase the susceptibility of tariffs to price volatility of natural gas.
Environmental performance	Both options can meet the 2020 environmental targets for better air quality and carbon emission performance. **Option 1:** it would lower local emissions further when the cross-boundary infrastructure is fully completed in around 2023 and may facilitate access to more diversified and greener fuel types otherwise not available to Hong Kong. **Option 2:** the prospect of any further significant improvement to our environment may be rather limited over a long period of time after commissioning of new generation facilities.
Implications for the post-2018 electricity market	**Option 1:** it may enhance interconnection between the two local power grids, and hence provide more room to introduce competition at the generation level. **Option 2:** the extent to which new suppliers may take part in local generation is affected by the availability of land for any new generation facilities. Allowing existing power companies to construct new generating units may add to the potential stranded costs that consumers will have to bear if we are to open up the electricity market in future.

[75] Consultation Paper of *'Planning Ahead for a Better Fuel Mix - Future Fuel Mix for Electricity Generation'* from the Environment Bureau (2014).

Diversification	**Option 1:** it will allow us to tap into various types of cleaner fuels which would otherwise not be available to Hong Kong. **Option 2:** it will increase the risk of heavy reliance on a particular fuel type.
Flexibility in scaling up future supply	**Option 1:** it offers a more viable and sustainable option in the longer run in meeting the electricity demand of Hong Kong, as it does not require any new land sites in Hong Kong to accommodate new generation facilities. **Option 2:** there may not be the flexibility to catch up with rising demand because of difficulty in identifying suitable sites for building new power plants.
Other social implications	Pursuing **Option 1** would mean that the scale of local generation currently operated by the two power companies may be reduced. Impact on local employment to be carefully managed with regard also to the outcome of the review of post-2018 electricity market.

Overall Conclusion

4.45 It is noted that the Hong Kong Government will review the arrangements of the SoC for the Hong Kong electricity sector, and it is also believed that the Hong Kong Government commits to maintaining robust oversight of the arrangements into the future. The Hong Kong Government's broad policy has always been to enhance competition in the economy, but, for historical reasons, SCAs form the regulatory framework which encourages the power companies to provide reliable service to commercial and residential consumers. It is anticipated that the current regulatory regime will not be flexible enough to adopt to the new environmental policy focusing on emission reduction over the next 30 years. The scheme is not fair to consumers in that the two power companies are allowed to earn a high risk-free permitted RoR on their Average Net Fixed Assets and to transfer to consumers all business risks associated with fuel price fluctuations, operational cost and forecasting error in relation to electricity demand. The general public view is that a better regulatory scheme is needed.

4.46 It is expected that the actual demand for electricity will be well below the predicted demand forecasted by the two power companies in the last 5 years. Regarding the demand management methods, power companies and the Hong Kong Government have important roles to play. Measures should be considered to use demand management to curb the increasing demand for electricity, and a fair system should be in place so that users would benefit equally from the resultant cost savings.

4.47 Further, despite the financial incentives provided under the SCAs for the two power companies to have more resort to renewable energy, there has been very little progress

in adopting renewable energy in the last 6 years. Some stakeholders the Council contacted argued that the current SoC may not provide adequate incentives for power companies to devote their efforts to exploring its future development and application. The Council also views that the two power companies also need to provide more information about their commitments.

4.48 If the Hong Kong Government expects to introduce competition to the electricity market, it is believed that some obligations should be imposed on the two power companies to publish a comprehensive range of performance and financial data for public scrutiny. Critical structural issues should be considered in order to tackle economic barriers and seek market opportunities to step up progress towards reform of the electricity market beyond 2018.

4.49 There is no doubt that the rapid development in Guangdong has also driven the rapid increase in energy demand which would thus be competing with Hong Kong on electricity generated. Although natural gas and nuclear is heavily used to meet environmental targets, there are uncertainties if cleaner and cheaper fuel could be imported from Mainland sustainably for Hong Kong. As mentioned in Chapter 3, the national policy and inter-governmental collaboration could facilitate the import of cleaner and cheaper energy from Mainland but Hong Kong could also opt for the option to reform its structure to meet the challenges of environmental objectives in future.

Chapter 5 Key Issues of Market Structure Reform

5.1 Having concentrated so far on a factual description of the systems in Hong Kong and South China and the experience of overseas markets, the Council now turns to the analysis of possible developments in the Hong Kong market, looking forward.

Hong Kong Context

5.2 Countries with a large manufacturing sector tend to have lower peaks and troughs in the 24-hour electricity consumption curve than those whose economies are dominated by services. Hong Kong, in common with other service-based economies with significant domestic demand has very high demand at certain times of the day and low demands overnight. The estimate provided by the professional engineers to the Council is that daytime electricity usage is almost double that of night-time [76]. The negative consequence of this is that transmission and distribution systems have to be built to cope with the highest peak demand even though those peaks might only be realised occasionally. For example it is estimated that around one third of the entire cost of the provision of electricity in New South Wales, Australia, comes from maintaining networks at peak levels of demand which are meant only for a few hours a year. Billions of dollars are spent on those few hours. Likewise, generation capacity has to be kept available to ensure continuity of supply that will only be occasionally used.

5.3 As average incomes rise throughout the world with China and in particular Hong Kong, as examples, consumption of energy of hungry air-conditioners and large screen TVs and other household appliances will exacerbate the problem of reconciling demand and supply and strategies to cut peaks will become very important. In relation to demand side management, this then leads on to consideration of energy efficiency. In Hong Kong, this is important in as much as demand is widely dispersed among a large number of households and service industries[77]. There is no one 'big hit' to reduce demand that can be achieved by focussing on a few large industrial consumers, nor sudden reductions in demand such as characterised Eastern Europe during the 1990s due to economic collapse. Those circumstances facilitated the 13% reduction in greenhouse gas emissions in the EU since 1990 albeit with considerable welfare costs to the public[78]. In contrast, in Hong Kong, a policy of reducing energy consumption must take in the

[76] Consumer Council Focus Group Meeting 2013.

[77] Consumer Council op. cit.

[78] EC Commissioner Connie Hedegaard, *Empowering Consumers in the Green Economy.* Keynote speech to CI World Congress, Hong Kong May 4 2011.

commercial and office sector as well as millions of domestic consumers and the multiplicity of service industries which are the backbone of the local economy.

5.4 In her keynote speech to the CI World Consumer Congress in Hong Kong hosted by the Council, EC Commissioner Connie Hedegaard insisted on the feasibility of energy saving, and its economic return: '*There is no cheaper energy than the energy we don't use'.* Regarding overall economic feasibility, she pointed to a US study that *'found that every dollar invested in renewable sources of energy generates 3-5 times more jobs than a dollar invested in fossil fuel energy sources'.* As to feasibility for domestic consumers she reported that: '*Low energy bulbs emit less than one fifth of the classical light bulbs. And the energy savings for a consumer who install the most efficient light bulbs in his house amounts to 430 US dollars per year'.* In the same vein: '*a consumer, who 14 years ago bought the most efficient fridge, has saved almost 1500 US dollars on the electricity bill over the life-time of the fridge'.* Globally, heating, cooling, cooking and lighting alone account for 11% of global energy consumption and in Europe, buildings alone are responsible for 40% of total emissions according to the Commissioner[79].

5.5 The question to ask is: how are gains from energy savings to be achieved in Hong Kong sufficient to avoid having to meet ever greater gross demand for energy, or at least to achieve a flattening of the demand peaks that are so expensive to cater for? In the same vein, the World Bank has commented[80] that giving *'greater attention to decreasing consumption – through end use efficiency improvement and energy conservation – and increasing supply efficiency… (are) not only equivalent to adding more capacity, but can also lower end use prices – thereby enhancing affordability – and contribute to environmental sustainability'.* It is perhaps not fully appreciated in the public debate on sending price signals to consumers that reducing peak time demand in particular, can bring about such a 'win-win' situation.

5.6 It should be noted that Hong Kong, which has in recent years been found to have high energy consumption per capita[81], higher than the UK for example, has already witnessed a steady trend in decoupling energy consumption from income growth. GDP growth of 4.3% per year between 1990 and 2007 greatly exceeded growth in energy end use which rose by only 1.4% per annum[82]. The professional engineers' focus group discussion at the Council has pointed to Mainland China experience of a 40% reduction in peak demand as a result of reducing household consumption[83].

[79] ibid, p. 57.
[80] World Bank Group. Sustainable development Network, *Energy Strategy Approach Paper*, October 2009.
[81] S Thomas, D Hall & V Corall, Electricity Privatisation and Restructuring in Asia-Pacific, PSIRU 2004.
[82] Consumer Council op. cit.
[83] Consumer Council op. cit.

5.7 The current SoC which is the primary instrument through which the Hong Kong Government regulates the activities of the electricity companies is a light handed regime. It prescribes a pricing formula and provides through contractual terms general parameters of performance for the companies. Environmental controls and other dimensions of regulation concerning customer care and market behaviour are dealt with through other means. The 2008 SCAs were amended to link rates of return to emission levels. Should the Hong Kong Government wish to bring about substantial demand reduction or an alteration in the fuel mix for generation in Hong Kong, it will be necessary to use other instruments to bring about this. The recent Environment Bureau consultation paper does not deal in depth with the demand side of the marketplace nor measures which are able to decrease aggregate demand and so further enquiry would appear to be necessary. Some ideas are put forward in Chapter 6 for consideration.

Supply Side Context and Measures

Introducing competition to the Hong Kong electricity sector

5.8 Hong Kong does not have competition or contestability in the energy sector. Two vertically integrated companies operate distinct monopoly businesses in different parts of Hong Kong and the details are discussed in Chapter 4.

5.9 CLP, founded in 1901, generates, transmits, distributes and retails electricity to Kowloon and the New Territories. CLP has 2.43 million customers, the larger of the two companies in terms of both customer base and maximum demand, with 6.86 GW in 2012 compared with 2.5 GW in HEC. In addition to its own generation capacity, CLP has contracted to purchase 70% of the power generated at the Daya Bay nuclear power station in Guangdong and also has access to pumped storage generating capacity sited in Mainland China.

5.10 HEC supplies electricity to Hong Kong Island from the Lamma power station and has just under 600,000 customers. As with CLP, HEC owns and operates the transmission and distribution system and directly bills its own customers.

5.11 Though operating as separate monopoly businesses the CLP and HEC systems are connected via an interconnection in the form of a cross harbour alternating current (AC) link with a capacity of 720 MVA which provides emergency back-up and some sharing of generating capacity reserve between the two systems.

5.12 In answer to a question asked in the Legislative Council in May 2012, Former Acting Secretary for the Environment, Dr. Kitty Poon, said that:

'In signing the existing SCAs [Scheme of Control Agreements] with the two power companies, the Government has undertaken to study the open market structure and regulatory framework, and enhancement of interconnection, etc. within the regulatory period.'

5.13 Under the present structure and regulation there is no scope for competition between the two companies nor is there a possibility of new entry at the generation or retail level.

5.14 Should the Hong Kong Government wish to pursue a more open market structure it would first need to clearly elaborate a set of goals for the market structure and redesign the regulatory system to enable changes to occur. Competition could be introduced at two levels, wholesale and retail. Their introduction would imply the breaking of the monopolies of the two incumbent companies in their territories and perhaps increased system interconnections between the two Hong Kong systems and perhaps the Mainland China system.

Wholesale competition

5.15 The justification for most electricity liberalisation policies is that the creation of a wholesale market would open the largest element of electricity bills, generation, to competition, which would bring down prices to the benefit of consumers. A well-functioning wholesale market would be similar to normal commodities markets and would serve three main functions:

i. It would set the price for wholesale electricity purchase;

ii. By providing a neutral platform for generators to sell their power and for retailers to buy their power on the same terms as their competitors, it would allow easy entry for new companies to challenge the existing companies; and

iii. It would provide investment signals to ensure new generating capacity was built in time. In a free market, there are no central system planning procedures.

5.16 While this ideal has intuitive merits, in practice, it has proved very difficult to implement and, arguably, no wholesale market anywhere in the world meets these three requirements. Hong Kong would have particular difficulties meeting these requirements because of the small size of the system and because of the weakness of the

interconnection between its two parts. The maximum demand of the system is essentially supplied by just three large power stations, so even if these were owned by separate owners, this would not provide a basis for effective competition.

5.17 One option, which would require the expansion of the interconnector would be to create a Hong Kong 'electricity pool' so that if cheaper power was available in, say, Kowloon, than on Hong Kong Island, power could be transferred between the systems, reducing costs for consumers. This sort of pooling arrangement could be done via a market or could simply be done on a bilateral basis with the two companies and their consumers sharing the benefits.

Retail Competition

Retail competition between CLP and HEC

5.18 Under this model, the Hong Kong Government would need to remove the retail monopoly of the two companies in their franchise territories. This would require the Hong Kong Government to set up systems to allow consumers to switch from one company to another and would require the companies to expand their sales and services functions outside their existing territories.

5.19 From a practical point of view, it would be easiest to extend competition to the relatively small number of very large consumers and, in terms of sales volumes, this could open up a large proportion of the market[84]. Such consumers have very large electricity bills and the additional costs of competition – marketing, switching systems etc. – would represent a very small proportion of the bill and might be covered by the benefits bringing in competitive forces. If a partial opening of the market was allowed, regulatory surveillance would be required to ensure the companies were not using their captive consumers to cross-subsidise their competitive customers.

5.20 Allowing all consumers to switch would be much more complex, expensive and time-consuming. For example, in Britain, the process of setting up the systems necessary to allow consumers to switch took 3-4 years and cost consumers about £1 billion.

5.21 From the point of view of the capital assets of the companies, access to the transmission and distribution systems would have to be opened up so that, for example, CLP was guaranteed access to HEC's network on the same terms as HEC gave itself. Verifying that this was happening would require significant regulatory oversight. With the existing

[84] For example, in 1990 in Britain, the 5000 largest consumers out the 25 million consumers were allowed to choose supplier and this opened up about 30% of the market.

interconnection between HEC's and CLP's systems, it would not be viable for CLP to supply consumers in HEC's territory using its own power plants and vice versa. In the short term, HEC and CLP could be required to sell each power on the same terms as they sell the power to themselves. Again, verifying this was happening would be a major regulatory task. In practical terms, it is hard to see what the companies would be able to compete over if they were paying the same for generation, distribution and transmission.

5.22 More far-reaching alternatives would be to allow the two companies to build new generation in each other's territories, or expand the capacity of the interconnection between the systems so that it was available for trade rather than just security of supply. A more radical option would be to increase the capacity of connections from both parts of the Hong Kong system to China and allow the two companies to buy additional supplies from China if they were cheaper than local production.

5.23 In terms of tariffs, the transition to a competitive market would have to be carefully managed. For the incumbent company, there would be an incentive to offer sub-economic prices to customers at risk of being lost to choke off competition, while for the new entrant, there would be an incentive to offer sub-economic prices to new customers to build market share. Getting the right balance between the offer of enough regulatory oversight to prevent predatory pricing and leaving things to allow the markets to operate would be challenging.

5.24 The planning system would have to be relaxed somewhat to allow companies the freedom to use their commercial judgement when to build and to be able to build outside their former territories.

5.25 Whether the two companies would see any value in trying to compete outside their own territories is questionable. The risk is that any increase in market size would have to be paid for by reduced margins and the companies may choose to do no more than offer token competition rather than provoking full-scale price competition between each other.

New entrant option

5.26 The option above could be expanded to reduce the risk of the two existing companies operating as a duopoly by allowing new retail entrants. As in the previous option, the networks would have to be open to new entrants on non-discriminatory terms and the two existing companies would have to be required to sell power to new competitors on the same terms as they sell to themselves. In the longer term when new entry is well-

established and the new entrants have achieved the size necessary to justify owning their own generation, this latter requirement might be relaxed. However, in a relatively small system such as that of Hong Kong with limited demand growth, building new generation capacity will be a major risk unless it can be planned to replace existing capacity. As with the previous options, increasing the capacity of the connection between the two systems and/or increasing the capacity of connections to China might facilitate this option.

5.27 Former Acting Secretary for the Environment, Dr Kitty Poon, told the Legislative Council that:

'We would make preparation in the current regulatory period, introduce competition to the electricity market when the market conditions are in place, and carry out relevant studies and explore related matters. In accordance with the timetable stipulated in the SCAs, the Government will discuss with the two power companies market readiness, potential future changes to the electricity supply regulatory framework and transition issues before 2016.'

5.28 Given the requirements for notice under the SoC and in the absence so far of any government decision to proceed with a competitive market structure, it is most unlikely that any of the market opening activities described in this section are feasible in time for implementation before the expiry of the SoC. Even more importantly, the net benefit to Hong Kong consumers for any of the options suggested above has to be thoroughly assessed.

Interconnection of CLP and HEC

5.29 As noted earlier, the Hong Kong power supply system comprises two interconnected systems, the system for Hong Kong Island, operated by HEC and the system covering Kowloon and Lantau Island, owned and operated by CLP. The two systems are 'synchronised' and are connected by an AC subsea cable with a capacity of 720 MVA (equivalent to 720 MW of generating capacity or about 20% of the capacity of the Lamma power station), so if there is a shortage of power, say, on the Island, power will automatically be drawn from the Mainland system to compensate (as far as possible). This link has relatively limited capacity and its function is to improve security of supply. For example, in the event of a failure of a power station in either of the systems, power can flow from one system to the other. It is not suitable for bulk routine power transfers between systems – if the cable is being used for this, it cannot be available for emergency transfers. Clearly one option would be to increase the capacity of the interconnection to allow routine trade between the systems. This could be done via a

larger AC link or via a direct current (DC) link. The decision between the options would be a technical one, but, generally, a DC link is more controllable than an AC link. A failure in a system linked by an AC link to another is much more likely to lead to failure of the second system, so the two systems are more intimately connected. The extent of interconnections between the two systems is a policy decision that should be taken by the Hong Kong Government. Box 5.1 describes the experience of the Scotland-Ireland interconnector and the implications for Hong Kong.

Box 5.1 The Scotland-Ireland Interconnector

It is difficult to generalise about the cost of subsea electricity interconnectors. The cost will depend on factors such as:

- The length and nature of the seabed the cable must cross;
- The capacity of the cable; and
- Whether it is an AC or DC link.

The capacity of any new interconnector, whether it was AC – cheaper but higher losses over longer distances – or DC, and its length, would all have to be determined to meet the requirement to significantly strengthen the connection between Hong Kong Island and Kowloon.

However, some indication of the order of magnitude of the costs can be gained from looking at recent examples of interconnectors, such as the subsea interconnector in the UK between Scotland and Northern Ireland.

A subsea 500 MW DC cable from Scotland to Northern Ireland of 57 km was completed in 2002 at a cost of £150 million or about HK$3 billion. In real terms, as utilities increasingly seek to connect with adjacent systems, real prices have probably come down since then. Depending on the route chosen, Hong Kong would probably need a much shorter link, although for a DC link, much of the cost is in the converters required at either end of the cable. A 500 MW cable would be equivalent to a medium-sized power station but significantly cheaper. Such a cable would allow the power station mix for the whole of Hong Kong to be optimised minute by minute, would save money by reducing the power station capacity needed to generate at very short notice and would increase security of supply.

5.30 A more far reaching decision would be on how far to interconnect with the much larger Chinese system, specifically, the Guangdong system. This might allow access to cheaper power. However, because it would tend to increase dependence on China, it would have

implications for security of supply and the Hong Kong Government would have little influence on how the power they imported was generated, unless a particular power plant was contracted to supply the Hong Kong system, as is the case now with the Daya Bay nuclear power plant. Furthermore, as shown in Chapter 3, Guangdong province has its own problems of peak capacity and had to introduce rationing in 2013. It cannot be taken for granted then, that it will have spare capacity. To put it another way, contractual agreements would have to be put in place to guarantee supply to Hong Kong – these could put consumers in South China in a position of competition with those in Hong Kong. As with interconnections between Hong Kong Island and Kowloon, this is a political decision, not one that should be taken by commercial interests.

The nuclear option

5.31 Imported nuclear power accounts for 23% of Hong Kong's electricity fuel mix, and Hong Kong has, for two decades, imported 70% of the output from the first two major nuclear power plants in China, the two Daya Bay nuclear reactors (984 MW each) sited in the adjoining Guangdong Province. These reactors started operation in 1993 and 1994 and CLP owns 20% of the plants. The company's power system has been interconnected with the Guangdong power system since April 1979 and electricity is exported to Guangdong Province. 80% of the profit for these exports is given back to CLP, so how far CLP is dependent on the output of Daya Bay is not clear. Nor are the terms of the import contract clear, although the price is clearly low.

5.32 One option for Hong Kong would therefore appear to be to commission the construction of nuclear power plants in China, mostly or wholly dedicated to export power to Hong Kong. However, the common perception that China is in a position to build nuclear plants easily to export cheap power to Hong Kong may not be accurate and the option under the imports from China scenario of building a dedicated plant to export to Hong Kong appears to have been excluded.

5.33 The details of China's policies and position with nuclear power are examined in the more detailed discussion in Annex A and referred in Chapters 3 and 4. To summarise our analysis, most of the plants China is building now are of a design dating back to the 1960s and for some years now, China has been trying to phase in more modern designs, first as imports and more recently using indigenous designs. However, the imported designs now appear to be too expensive to form the basis of large scale ordering, while the indigenous designs appear to be some way away from being fully developed and are far from proven yet. There must also be concerns about how stretched the China's nuclear industry is in building the large number of plants ordered between 2007 and 2010. For example, one of the Commissioners with the French safety authority, ASN,

has said: *'Unfortunately, collaboration isn't at a level we would wish it to be'* with China. The commissioner went on to say: *'One of the explanations for the difficulties in our relations is that the Chinese safety authorities lack means. They are overwhelmed'*[85].

5.34 It should be noted that the current installed nuclear plants in China do not share the same technology as Chernobyl and Fukushima. China has invested a large amount in attempting to retrofit safety equipment to plants. Nonetheless safety concerns with nuclear power remain, which translate into costs, which have ultimately to be borne by the consumer. So the deal announced in the UK in October 2013 for a consortium led by EdF of France and involving two Chinese firms, to build two nuclear reactors at Hinkley Point, guarantees for the owners, a wholesale price of almost twice the current one, and involves underwriting by the UK Government of the £24.5 billion cost, an estimate which itself rose fourfold during the course of the project proposals. The financial risks to consumers (through tariffs) and taxpayers (through government guarantees), could cost very dearly in due course, and this has led one City analyst, Liberum capital, to describe the deal as 'economically insane' describing Hinkley Point as the world's most expensive power station[86]. The point has been made in answer to the above that the true comparator should not be with current prices but with future prices from non-CO_2 producing fuels. This is a valid point in theory, but the length of time to elapse before the station comes on stream, (9 years) means that all estimates are uncertain. The decision has echoes of the ongoing dispute between EdF's construction partner Areva and the Finnish Government, thanks to cost overruns on a similar plant in Finland whose latest cost estimate was 250% more than the initial estimates, with four years still to go before completion.

5.35 Should Mainland China, as seems likely, seek to cut the amounts of particulate pollution as well as carbon, no doubt there will be some expansion in the nuclear industry. However, these changes come over decades not years and do not provide the environmental and reliability panacea that people through generations have claimed. It is worth noting that nuclear energy only provided 2% of China's energy requirements in 2012 and China has its own urgent requirements of course. In Guangdong the proportion was higher (7%) and is planned to reach 13.4% by 2015[87].

[85] Bloomberg 'Nuclear Regulators 'Overwhelmed' as China Races to Launch World's Most Powerful Reactor' June 19, 2014. http://www.bloomberg.com/news/2014-06-18/french-nuclear-regulator-says-china-cooperation-lacking.html.

[86] http://www.theguardian.com/environment/2013/oct/30/hinkley-point-nuclear-power-plant-uk-government-edf-underwrite.

[87] Consumer Council op. cit.

5.36 The decision whether to try to expand Hong Kong's use of nuclear power is one that falls under the remit of the Hong Kong Government if it wants to determine the fuel mix. The Council is not necessarily arguing for or against expansion of the nuclear contribution, but any decision to commission more nuclear capacity should be based on a thorough evaluation of its cost and availability and the issues raised by the nuclear option.

Renewable Sources of Energy

5.37 Worldwide, there is increasing concern about greenhouse gas emission and fossil fuel depletion. As a result, there is an increasing perception that renewables and, perhaps, use of nuclear power will have to play an increasing and perhaps dominant role in power generation. But as the Council has seen above, this last assumption should not be taken for granted.

Hong Kong's resources

5.38 Every country has its own unique set of renewable resources, but globally, the most widely used resources are hydro-electric[88], wind (on-shore and off-shore), solar PV and biomass. Other potentially significant technologies include concentrated solar power (CSP), tidal power and wave power. New and more advanced resources, such as BIPV, under which the fabric of the building becomes a solar panel, and third generation biofuels that use algae rather than crops as their feedstock, are emerging that will further increase the scope for renewable energy. Although not reviewed in detail here, it is likely that the most useful resources for Hong Kong will be solar PV, wind and biomass. If installation on Mainland China is included as an option, other resources could make a significant contribution.

5.39 Solar PV has seen rapid expansion throughout the world and China now dominates the world market, both in terms of supply and installed capacity. Generally PV panels are installed on the roofs of building, although in regions with large amounts of available land, they can be installed in arrays of large numbers of panels. Solar PV is particularly clearly well-suited to warm, sunny countries, partly because the output will be higher (albeit solar panels do not need direct sunlight to produce power) but also because power output will be high when air-conditioning demand will also be high. The high

[88] Large-scale hydro-electric resources are generally fairly fully exploited and they often have environmental and social consequences, such as displacement of local populations and flooding of land that make them controversial. There is scope for 'mini-hydro' schemes, and a design-shift towards 'run of the river' plants, both of which developments are much less controversial, but there is probably little scope in Hong Kong.

proportion of tall buildings in Hong Kong means roof space will be limited but availability of BIPV technology could significantly increase the scope.

5.40 On-shore wind is well-established, mature technology with several decades of commercial experience using modern turbines. It is generally the cheapest source of renewable power provided the wind resource is reasonable, although the availability of the resource, as measured by the load factor (actual output as a percentage of output that would be produced if the turbine ran uninterrupted at full power) can be low, e.g., 20%. Off-shore wind is more expensive to install but because it is generally windier at sea than on land, its load factors may be twice as high as on-shore facilities. While turbine technology is well-established, siting wind farms off-shore is a recent development and costs are falling significantly. Box 5.2 elaborates in greater detail and considers the long term implications for Hong Kong.

5.41 Biomass is a more diverse resource and, typically, natural material such as crops, waste from crops or human waste, wood chips are used to produce methane which can be burnt in a conventional power plant.

Box 5.2 Wind as a Component of Renewable Energy for Hong Kong
In a major report published in October 2014, The Global Wind Energy Council and Greenpeace International conclude that in an increasing number of markets, wind power is now the least cost option when adding new capacity to the grid, and prices continue to fall. The report, *Global Wind Energy Outlook 2014*, notes there are now commercial wind power installations in more than 90 countries with total installed capacity of 318 GW at the end of 2013, providing about 3% of global electricity supply last year. A key factor in recent growth and future projections for major expansion of wind energy is that the capital cost of turbines has been decreasing at a considerable rate for many years. Technology improvements in the design, construction and operation of wind turbines have further decreased the cost of the technology itself. According to the American Wind Energy Association, the cost of the turbine accounts for 70% of the entire cost of a land-based project. Installation costs make up the remainder[89]. According to the US department of energy, the cost of wind energy deployment in the US has fallen by 90% since the early 1980s[90].

[89] AWEA 'Get the facts' cost of wind energy in the US. http://www.awea.org/Resources/Content.aspx?ItemNumber=5547.

[90] US Department of Energy: *Revolution now: the Future Arrives for Four Clean Energy Technologies*, Sept 2013.

On the global scale, projections by energy analysts suggest that by 2020, wind turbines will be responsible for between seven and 8% of global electricity production while this could increase to almost 15% by 2030.

Broader economic impacts

As governments and policymakers around the world struggle to balance both environmental and social and economic objectives in their energy policies, there is a renewed interest in wind power as an industry which creates a large volume of skilled, semiskilled and unskilled work.

Environmental impact

While a key outcome of the installation of renewable energy from wind power is the substantial reduction of CO_2 emissions, other significant environmental benefits come from the near zero water consumption and elimination of particulate pollution which is a major problem in Hong Kong. By way of illustration, it is estimated that on present trends, China will achieve a major improvement in its carbon emissions balance by 2015. A recent estimate suggests that wind power will help save 173 million tons of CO_2 every year and this figure could grow to 784 million tonnes by 2030.

Wind power in China

According to the Global Wind Energy Outlook 2014, China added new annual installed wind power capacity of 16.1 GW bringing the national installed capacity to over 91 GW with China leading the world in terms of installed wind power capacity. According to China's NEA in 2011, under the latest Five-year Plan for renewable energy, projections were made for a contribution of wind power of some 100 GW by 2015.

It should be noted that the rapid growth of wind power in China has been underpinned by a significant Feed-in Tariff (FiT) which has been in operation since 2009 and divides the country into four different regions for different wind resources. Future growth of installed wind power in China may be reduced somewhat as there are plans for reduction of the FiT but also because equipment prices have been falling considerably the need for the FiT is not seen to be so strong.

Onshore & Offshore

In developing future energy policies for Hong Kong, it must be noted that much of the global analysis and discussion of the economics and operation of wind power relate to onshore installations. Hong Kong has very limited scope for significant onshore development and detailed study is needed concerning the economics of offshore wind. As noted elsewhere in this report, both electricity companies in Hong Kong have undertaken a degree of research and made proposals for the construction and

operation of offshore wind farms which have met with negative results from the Hong Kong Government. This caution is understandable in the light of the US Department of Energy report that indicates significant variations between on shore and offshore costs[91]. Meanwhile it should be noted that China has an offshore wind development target of 5 GW by 2015 and 30 GW by 2030.

As with onshore wind, the growth of offshore renewable energy from wind in China will be dependent to some extent on the FiT regime employed. Recent reports suggest that the Shanghai municipal government is also providing financial subsidies to offshore wind developers on top of the Chinese Government FiT. Actual details of the subsidies are not currently published.

Methods to stimulate investment

5.42 In most cases, renewable resources are still more expensive than the cheapest (fossil-fuel) generation sources so would not be chosen by utilities without some incentives. However, the expected increase in fossil fuel prices, expected reductions in renewable prices and the environmental damage, such as climate change, caused by burning fossil fuels has caused many governments to introduce incentives to install renewables.

5.43 By comparison with the existing power plants, renewables, especially of the kind that might be exploited in Hong Kong, are intrinsically small in scale. The capacity of solar PV panels is in the order of a few hundred watts per panel, wind turbines are up to 8 MW, while biomass can be larger but is generally constrained by the size of the resource, for example, the crop or the waste product used to fuel the plant. Experience suggests that large traditional utilities are not always well-suited to exploit such small resources, so stimuli for renewables often include measures, such as guaranteed access to the network and guaranteed purchase of any output offered to the network, that make it easier for small, new-entrant generators or even individual consumers to install renewables.

5.44 As discussed earlier in Chapter 2, the most widely used method is FiTs, under which a central purchasing authority guarantees to buy all the output at a fixed price from renewable facilities for a period of, perhaps, 15 years. This minimises the investment risk because the income is largely predictable and independent of any market. The price offered is set for the period of the contract, but the price for new schemes will vary over time. The price offered must be sufficiently high to make it feasible for renewable schemes to be viable but not so high as to give very high profits. It would be expected

[91] Report of the US Energy Information Administration, DOE, 2013. Levelised cost estimates.

that the real price offered would fall over time as the technologies mature and local experience and expertise with them increases.

5.45 Other methods used include capacity auctions and renewable obligations. Under capacity auctions, a central authority specifies the capacity it wants installed and invites bids. The lowest bids necessary to meet the required capacity are chosen and awarded long-term contracts for the supply of power at the highest successful bid price. Under renewable obligations, electricity retailers are required to source an increasing percentage, specified by a central authority, of their supplies from renewable sources and are fined if they fail to meet the required percentage.

5.46 All three methods have their pros and cons and identifying which would be most appropriate for Hong Kong would require further study. Box 5.3 considers the impact on consumer electricity prices of renewables.

Box 5.3 Impact of Renewables on Consumer Electricity Prices

There is a common perception that renewables are expensive and introducing them will cause large increases in electricity prices. As with any new industry, prices will tend to start at a high level but experience elsewhere suggest prices will come down significantly. For example, the first mobile phones were expensive and inefficient but they are now far cheaper and more useful. Effects such as 'learning' – the more you do something the better you get at doing it – 'scale economies' – the greater the level of production, the cheaper – and 'technical change' – innovations that improve the industry's performance – should reduce prices. This has already been demonstrated in the case of solar panel manufacture, notably in Mainland China.

However, the impact on prices of testing the market to see if renewables can become competitive will be limited. The consumer price of electricity is made up of three main components: the cost of generation; the cost of use of the network of cables and wires that take the power from the power station to the consumers; and the retail costs including meter reading and billing. These second two costs, which typically account for at least 40% of the consumer price, will be essentially the same however the power is generated so renewables will just impact on the generation cost.

If the Council assume the cost of generation from renewables is initially as much as 3 times that of the existing generation and 10% of generation comes from such sources, it is easy to calculate this should only lead to a 12% increase in consumer electricity prices. This is not insignificant, but movements in the world price of gas and coal could

easily cause a similar price increase and this testing of the market will identify the potential for renewables in the Hong Kong market.

Conclusion on renewables

5.47 There is wide disagreement about the scope for renewables. The recent Environment Bureau consultation paper foresees little use of renewables in the period under review. Furthermore, it does not include any of the measures such as FiTs that, elsewhere, have been effective in stimulating investment in renewables (see Box 5.4 on the German experience). The Environment Bureau consultation paper and the companies are somewhat dismissive (calculating a 1-3% potential market share), while other studies are more optimistic (more than 10%). There is a need to test the market, perhaps with FiTs as experience elsewhere suggests that the scope is often larger in practice than initially expected. Technical changes, for example, new building materials, might increase the scope and establishing access for new providers will allow these new options to be utilised quickly and efficiently. For larger renewables, e.g. off-shore wind, consideration may be given to a call for tenders with a maximum specified price. It may be that the pessimistic forecasts of the scope for renewables for Hong Kong given by the Hong Kong Government and the utilities – just a few percent of electricity – are realistic. However, experience elsewhere suggests that if the opportunity is given, for example, by offering FiTs, the response in terms of capacity and price is often much better than expected. Serious thought should therefore be given to introducing incentives, such as FiTs, which would test the market to see what the scope really is as well as developing local capabilities. China is the world leader in most renewable technologies and Hong Kong is likely to be able to benefit from its proximity.

Box 5.4 The Development of Feed-in Tariffs in Germany

The first large-scale deployment of modern renewables such as wind farms took place in the 1980s in California. This was the largely unexpected consequence of federal legislation (the PURPA act of 1978). This required utilities to buy power from small power generation facilities on long-term contract at a price that reflected the cost the utility would have had to incur if it had generated the power using its own facilities – the 'avoided cost'. At the time, California was completing some very expensive nuclear power plants and regulators took the price of power from these plants as the avoided cost. This led to a rapid expansion of wind power and meant that a wind power industry was built stimulating improvements in the technology and cost reductions. Solar PV generation was also becoming available commercially for the first time.

Germany used this experience to bring in concerted government policies to stimulate the installation of renewables in Germany with the passing of the Feed-in Law in 1990[92]. This bill required utilities to connect renewable energy generators to the grid, and to buy the electricity produced at a rate of 65-90% of the average tariff charged per unit to end users. These prices were not sufficient to stimulate much solar PV but they did lead to a significant expansion of wind power from about 20 MW in 1990 to 1100 MW by 1995. This experience was built on and in 2000, a new law, the Renewable Energy Sources Act was passed. This replaced the percentage-based pricing with a fixed rate and guaranteed purchase of the power for around 20 years. It also introduced different rates for different technologies, for example, the highest rate went to PV of 99 pfennig/kWh (equivalent to about €0.5/kWh). Rates for new schemes could be reviewed every two years although the rate paid under existing contracts remained the same. This meant that cost reductions could be reflected in new contracts but for existing contracts, the income was guaranteed reducing the investment risk.

In 2004, the 2000 Act was amended and included a target of a 12.5% market share for renewables by 2010 and 20% by 2020. By then, the rate paid to wind (€0.0539/kWh) was only 10% of that paid to renewables. Rates for new schemes fell every year by between 1% and 6.5%.

The European Parliament identifies six key lessons from German experience. The report (ref) concludes that governments/regulators should:

- Impose a priority purchase obligation;
- Determine which technologies and plants will be covered by the laws;
- Determine a good tariff rate;
- Guarantee the tariff rate over a specific period of time;
- Determine an effective way of financing the FIT law; and
- Reduce the tariff rate each year.

In 2001, legislation had been passed requiring that nuclear power be phased out by about 2030. In 2009, the rate of phase-out of nuclear power was reduced although there was no prospect of new nuclear orders. The Fukushima disaster led to an acceleration of the phase-out so that all nuclear capacity would be closed by 2022 providing new impetus for the introduction of renewables through the 'Energiewende' (energy change) process.

[92] For more details see http://www.e-parl.net/eparliament/pdf/080603%20FIT%20toolkit.pdf.

Amendments to the Energy Act came into force on 1 August 2014 setting even more ambitious targets so that 'the share of the energy generated from renewable energy sources increases from 40% to 45% until 2025, from 55% to 60% until 2035, and to 80% until 2050'. By then renewables were accounting for about 30% of Germany's electricity mix and, reflecting the success of the FiTs programme, renewables were no longer seen as an 'infant industry' that needed strong support. So measures were introduced to make arrangements for renewables more market related, for example, by capping the amount of each source that was eligible for FiTs contracts. These measures are controversial but they do reflect that FiTs have been very successful in turning a high cost electricity source into one that can play a dominant role in electricity generation at affordable prices.

The Role of Gas

5.48 Based on overseas experience, there is a dual possibility for gas to contribute to solving the problems of the energy sector in Hong Kong. If conversion to direct use of natural gas is feasible, it opens the way to lower costs for cooking, water-heating, with obvious benefits for consumers. It may also provide scope for 'embedded' generation, for example, with large buildings generating some of their own power supply and providing the building's hot water needs. There may therefore be a need to review third party access to gas imports. This is particularly the case in the light of the rapid development of LNG in the region.

5.49 The Environment Bureau consultation paper sets out two scenarios for future fuel mix:

i. Importing more electricity through purchase from the Mainland power grid; and

ii. Using more natural gas for local generation[93].

5.50 Both options envisage a significant increase in the use of natural gas as a power station fuel. As a fuel, it has major advantages, especially over coal. The world market is developing strongly, the supply market is diverse, it can be used with much higher efficiency than other fuels and while its use does produce greenhouse gases, its emissions per unit of electricity produced are much lower than coal or oil. Most other countries expect to use natural gas for a much wider range of applications than just as a power station fuel, including direct use by consumers and small scale co-generation by users. By contrast, for Hong Kong there appear to be no plans to use natural gas on a large scale other than for power generation and for manufacturing 'town gas', which

[93] op. cit. at para. 4.12 and 4.13.

is supplied to Hong Kong consumers. A less restrictive view of the role of gas might bring benefits to consumers not only through cheaper electricity supplies, but through cheaper energy supplies in general.

5.51 In this section, the Council first reviews the existing town gas network and the use of natural gas as a feedstock for town gas in Hong Kong and looks at natural gas as a power station fuel and as a fuel for co-generation.

Town gas

5.52 The company supplying town gas to Hong Kong, Hong Kong and China Gas Company Limited (Towngas)[94], was established in 1862. It has a network of 3,500 km of gas pipes and supplies town gas to more than 1.76 million customers. This would provide an excellent basis for direct use of natural gas and for small-scale co-generation. There is ample experience worldwide of conversion of town gas networks and appliances to natural gas.

5.53 Town gas is a gas manufactured from coal, oil or natural gas and comprises methane (CH_4), hydrogen (H_2) and a small percentage of carbon monoxide (CO). It was originally manufactured from coal and was used widely in Europe for lighting, cooking, space and water heating, and even refrigeration. As a gas delivered by pipeline that did not require stocking and that burnt very cleanly, it was attractive to consumers. More efficient, cleaner production processes were introduced, after World War II using oil and natural gas as a feedstock. However, when an international market in natural gas began to emerge and a number of European countries, such as UK, Netherlands and Denmark found indigenous supplies of natural gas, town gas was generally phased out and the existing infrastructure, including pipelines and appliances, converted to use natural gas directly. Inevitably, the manufacture of gas uses a significant proportion of the energy of the basic fuel and adds cost compared to direct use of natural gas. As a result, town gas has been replaced by natural gas in nearly all systems worldwide.

5.54 For example, in the UK, direct use of natural gas began in 1969. By 1975, the network had been converted almost entirely to natural gas in an operation known for its efficiency (see Box 5.5). By 1980, the use of gas by residential consumers was nearly 3 times as high as only a decade earlier and by 2010 its use was more than 4 times that of 40 years earlier, bringing substantial welfare benefits to consumers in the form of higher levels of comfort, lower energy bills and convenience because there was no need to hold expensive, space-consuming stocks of coal and oil. Direct use of natural gas by

[94] http://www.towngas.com/Eng/Cust/index.aspx.

residential consumers is 70% higher than the use of gas for power generation. This and other experience suggests a potentially important role for natural gas using the town gas distribution network adapting and renovating as appropriate to ensure high standards of safety are maintained.

5.55 The Hong Kong Government conducted a feasibility study of adopting a 'common carrier' system in Hong Kong for transmission and distribution of natural gas or liquefied petroleum gas in 1997. The study concluded that the pre-requisite for the introduction of a natural-gas based common carrier system in Hong Kong was the availability of reliable, stable, sufficient and reasonably priced natural gas supply to meet public demand. At this stage, Hong Kong is one of the few jurisdictions still to use town gas[95].

5.56 Comments from incumbent player indicated implementation difficulties and economic unviability to convert town gas into natural gas for direct use by consumers due to the distinct characteristics of people living in high-rise buildings and the cost to consumers for changing the gas appliances. However, the possibilities of enabling commercial small-scale generation have not been explored. In fact, based on the conclusions of the study, it was technically viable to convert the existing Towngas network to natural gas network and the introduction of natural gas into Hong Kong was best managed by a market based development programme, with third party access offered. Given the rapid increases of natural gas in the global reserves, presence of more natural gas pipelines connecting to Hong Kong, and technological advancement, it would be worth considering to conduct a feasibility study to look into the viability for enabling small-scale co-generation.

Box 5.5 Conversion from Town Gas to Natural Gas: UK Experience
The UK, like many European countries started building up a network of gas supply in the 19th century providing gas manufactured from coal. This so-called 'town gas', a mixture of hydrogen, carbon monoxide and methane, was manufactured in local facilities typically one for each large town. By the 1960s, this process was increasingly seen as polluting and inefficient. New processes, especially the Lurgi process, which used oil or natural gas as the feedstock began to emerge. In the 1960s, Britain began to replace its town gas plants using coal by plants using natural gas, imported from Algeria as liquefied natural gas, and oil products (naphtha). However, the discovery of large quantities of natural gas in the North Sea in 1965 meant these new plants were short-lived and a decision was taken to convert the gas network from town gas

[95] There were two independent studies by Changqi Wu and Francis T Lui 'Introducing Natural Gas to Hong Kong' Center for Economic Development, Hong Kong University of Science and Technology 2002, and Larry Chow 'The Future of Gaseous Fuel in Hong Kong' OPEC, Volume 25, Issue 1, p. 79–103, March 2001

to direct use of natural gas (methane). From 1970 to 1976, the whole British network was converted from town gas to natural gas in a remarkable operation that was completed to time and cost and with no significant accidents.

As a result, in the period 1965-1985, the number of gas consumers increased from 12.9 million to 16.8 million but consumption of gas increased more than 5-fold, despite a net reduction of employees in the gas industry. In that same period, the real price of gas halved and this increased consumption allowed a major increase in welfare in UK consumers from the installation of affordable central heating systems.

The savings from replacing town gas with natural gas paid for the conversion process and still allowed these large real reductions in gas prices. The conversion process was carried out in small geographical zones of one or two streets and was in two stages. In the first, gas company officials visited all premises with gas appliances to establish what appliances existed and whether conversion was feasible. The small number of appliances that could not be converted were replaced at no cost to the consumer. The majority could be converted and during this visit the parts required were established and ordered. In the second phase, the gas supply to that area was shut off and all the appliances there converted, for example by fitting new burners. The gas supply was then reconnected, this time with natural gas. Consumers found little or no difference in performance of their appliances. There was little need to dig up the streets because the existing pipes could be used, often by inserting plastic liners in old metal pipework.

In addition to the lower cost, consumers received a number of other benefits. The surveying of gas-burning equipment identified old and potentially dangerous appliances and ensured they were replaced. Town gas, which is very poisonous, was replaced by non-toxic natural gas, indeed a small amount of gas with an odour had to be added to the natural gas so that consumers were alerted if they failed to turn off an unlit appliance. The polluting gas-works were closed and the energy wasted in converting the coal, oil or gas feedstock to town gas was avoided.

Natural gas as a power station fuel

5.57 Prior to about 1990, worldwide use of natural gas in power stations was highly restricted, indeed, in the EU, use in power stations built after 1975 was illegal. This was because of the perception that natural gas was a ‘noble fuel’ that was a relatively limited resource and should be used where its special characteristics of convenience and cleanliness in use, for example, use by residential consumers, were important. However, rapid

increases in the global reserves of natural gas and the emergence of a new technology, combined cycle gas generation, led to a sharp increase in its use as a power station fuel.

5.58 With CCGT technology, gas is burnt in a gas turbine that is used to generate electricity. The exhaust gas from the gas turbine is hot and can be used in a 'waste heat boiler' to generate steam that can be used to power a conventional steam turbine. By 1990, advances in gas turbine technology had increased the thermal efficiency of CCGTs to about 50%[96], compared to the level of about 40% that would be achieved if gas was burnt in a conventional steam power plant, such as those at Castle Peak. The plants were much cleaner in terms of emissions of acid and greenhouse gases and the equipment was also much cheaper, less than half the price of an equivalent sized coal-fired plant. The technology quickly came to dominate markets for new power plants and, for example, in the UK, 15 GW of new CCGT capacity (equivalent to about 20% of total UK generating capacity) was ordered in a period of only 18 months. Technology progress was rapid and about 5 years later, efficiencies of about 60% were on offer. Ironically, this meant that most of the capacity ordered around 1990 became obsolescent because the savings in natural gas that could be obtained with the higher thermal efficiencies were enough to pay for more efficient replacement capacity. Since then, the rate of technical progress has slowed down, but the technology is mature and well-proven.

5.59 Hong Kong's gas-fired plants, Lamma and Black Point (see Table 5.1) may now be rather old technology and it may be that replacing them with current designs would be economically attractive as well as reducing emissions of greenhouse gases.

Table 5.1 Hong Kong's Gas-fired Power Plants

Plant	Owner	Output (MW)	Year of Commissioning
Black Point	CLP	8 x 312	1996-2006
Lamma Extension 1	HEC	1 x 345	2002
Lamma Extension 2	HEC	1 x 335	2006

Note: Lamma Extension 1 comprises two gas turbines, each of 125 MW, that were converted to combined cycle operation by the addition of a single waste heat boiler.

Co-generation

5.60 With any form of power generation in which fuel is burnt, a significant proportion of the energy, as much as 60-70% for conventional power plants such as Castle Peak and up

[96] The thermal efficiency depends on the ambient temperature and in cold conditions, the efficiency will be somewhat higher than in warmer conditions.

to 50% for CCGTs of the energy in the fuel is lost as 'waste heat' in the form of hot water and low-temperature steam. If this hot water/steam can be used, for example for space- or water-heating or process steam for industry, the efficiency of the power station fuel use can be dramatically increased. Such systems are usually known as co-generation of combined heat and power (CHP). Natural gas is an ideal co-generation fuel because it does not require user storage and because of its cleanliness in use. Gas produced from waste, for example from 'digesters' could be used to supplement supplies of natural gas.

5.61 For Hong Kong where there is minimal industry and minimal need for space-heating, the scope for cogeneration is likely to be in the commercial sector in the form of 'tri-generation'. In this form, electricity is generated in an engine or a gas turbine and the waste heat is used in part to provide hot water for the building and, via an absorption chiller, cooling for the building. If this technology was adopted in Hong Kong, it would reduce electricity demand from the network for cooling and water-heating and would increase the efficiency of fuel use.

Reliability Dimension

5.62 While the overall level of reliability is not for negotiation, there is scope for review of measures that might be taken to maintain reliability but at lower cost to consumers. Elsewhere, the Council have point to the potential for maintaining reliability through high levels of maintenance (although this is already at a high standard) and Chapter 6 deals with demand management techniques through which expensive and risky spikes in demand may be avoided. Other measures, such as plant margin could be reduced without having any impact on reliability as actually experienced, while there may be cheaper ways of achieving the standards, for example, demand side management might substitute for spinning reserve. Closer integration of the two systems in Hong Kong and connection to the South China grid might reduce the cost of achieving the required standard. Other options such as smart meters for the commercial sector's large consumers could be considered.

5.63 All electricity industry actors in Hong Kong – the Hong Kong Government, utilities and consumers – are acutely aware of the need for the high levels of reliability that Hong Kong's unique characteristics imposes. The utilities are rightly proud of the very high levels of reliability achieved and there is no willingness in Hong Kong to contemplate reducing these standards. However, very high levels of reliability come at a significant cost and it is therefore important to continually monitor security measures to ensure that the required standard is being achieved at the lowest cost to consumers.

5.64 There are two main elements to traditional discussions of the security of supply: generation adequacy and network reliability. Most attention is paid to generation adequacy because shortage of generation will cause problems over the whole system until enough capacity is available. In practice, supply is more usually lost because of failures in the network and while the impact is still serious, it is more localised and once the fault is repaired, should not recur. The considerations for these two elements are very different and they must be discussed separately. In addition there are other influences on supply security, such as the reliability of fuel supplies that must be considered.

Generation adequacy

5.65 Generation adequacy is seldom the cause of loss of supply to consumers in developed countries with mature electricity systems like Hong Kong and the breakdown of a power station is unlikely to have any significant repercussions. However, while network failures are generally one-off events and can be quickly repaired, generation shortage, perhaps because of demand forecasting error, could lead to repeated generation shortages and perhaps rota cuts. This could be highly damaging economically and, as a result, utilities generally err on the high side with demand forecasts because the penalties for over-forecasting are low while the penalties for under-forecasting are high.

5.66 The adequacy of generation is generally expressed as the 'plant margin', the percentage of plant on the system above the maximum system demand, so, for example, if there is 12,000 MW of plant on the system and maximum demand is 10,000 MW, the plant margin is 20%. The out-turn plant margin is inevitably different from the target plant margin because demand forecasts are inevitably not accurate.

5.67 The target plant margin typically contains two elements:

i. Plant breakdowns. Power plants inevitably breakdown and allowance must be made for that. In most systems, the months when peak demand occurs are predictable and maintenance can be scheduled to avoid these times; and

ii. Unusual weather conditions. Demand forecasts will be made on the assumption of average weather conditions. However, in a summer-peaking system where demand is influenced by air-conditioning demand, if the weather is hotter than normal, demand will be higher.

5.68 In practice, there may well be compensating errors and, for example, in a hot year, plant availability may happen to be better than normal. The overall plant margin is set to meet

the required 'reliability standard'. This is often expressed as the number of years per 100 that demand is not fully met and disconnections are required, and the number of years when disconnections are avoided by voltage reductions. As societies become more dependent on constant electricity supplies, required reliability standards are becoming higher.

Plant breakdowns

5.69 Some level of plant breakdown is unavoidable but the better the maintenance practices of the plant owner, the lower this should be and if maintenance is thorough, there is no reason for the availability of plant at peak times to deteriorate as the plant gets older. One should not make the lazy assumption that age equals disfunctionality.

Weather conditions

5.70 Weather conditions are clearly outside the control of the utility and if climate change does make extreme weather conditions more common, there might need to be a small increase in plant margin.

Available capacity

5.71 For thermal power plants (those that burn fuel and nuclear power plants), there is no resource reason for them not to be available at peak times. However, for some renewable options, such as hydro-electric, wind and solar, their assured availability at peak may be resource constrained. However, there are well-established methods to estimate the reliable peak capacity for such sources, so that, for example, the reliable wind capacity may be 25% of the gross wind capacity. For solar power, the fit between high availability of solar and high demand, typically in the middle of a sunny, hot day is very close and the reliable availability of solar power at peak time in Hong Kong would be very high.

Alternative ways to meet peaks

5.72 Plant margin is usually expressed as the amount of utility-owned (or controlled) capacity above expected peak demand. Short lead-time options, such as open-cycle gas turbines can brought on line quickly and cheaply (albeit with high running costs) and might be a useful contingency for the utility to reduce the forecasting error term.

5.73 However, there are a range of other measures not directly involving the utility that can supplement utility generating capacity, including demand side management and stand-by generators.

5.74 Consumers, especially large consumers, are likely to be prepared to reduce their demand at peak times in exchange for a share of the savings made. In the Hong Kong context where there is little manufacturing the large users are large commercial premises and, at relatively short notice, large consumers can, for example, somewhat reduce their air-conditioning demand for an hour or less with little or no impact on comfort levels. In the US, regulators have accepted demand side bidding of this type as 'firm' capacity at peak times[97]. This is likely to be a much cheaper way to meet peak demand than to build extra capacity that might be needed for only 1 hour or 2 per year. It might also be a cheaper way to meet demand spikes than having plant in hot readiness to generate – 'spinning reserve' – at a matter of seconds' notice. The case study in Annex D shows how a considerable reduction in demand could be achieved with just a small alteration in the temperature controls**.**

5.75 Many buildings have stand-by generators to cover for failure of grid supplies. Such generators are typically engines of some sort and can produce power at much shorter notice than a large utility plant which might require several hours of notice. The owners of such generators are likely to be happy to make them available to supplement grid supplies at peak times and at short notice in return for their costs being covered and a share of any savings from their operation.

5.76 It is worth noting that the cost of emergency back-up can be very high and is thus best used sparingly – hence the importance of maintenance. In Africa, back up supply has become a major cost factor as it has become routinised. The Africa Infrastructure Country Diagnostic found that the cost of back up electricity was $0.20-0.30/kWh, even $0.40, compared with about $0.18 from functioning networks[98]. If it is just a matter of a few hours a year then the cost is moderate and less than keeping capacity unused, but it should remain the exception and not the rule.

Network failures

5.77 Whilst the failure of a power plant is a regular event that utilities are well used to dealing with and causes no tangible problems if back up is available as is the case in HK, a failure in the network could have much wider reaching consequences. While the adequacy of generation can easily be discussed with reference to the plant margin, there is no similar

[97] See for example, http://www.enernoc.com/.

[98] V Foster & C Briceno- Garmendia; Africa Infrastructure Country Diagnostic 2010; Eberhard et al 2011.

simple indicator of the security of the transmission system (the high voltage network) and the distribution system (the low voltage network). Clearly the two utilities have built, maintained and operated the network to a high standard and any reforms to the Hong Kong system should not in any way reduce the incentives on these companies to continue to achieve these standards.

Other influences on supply security

5.78 Hong Kong's historic reliance on imported coal has meant that security of fuel supplies has not been a major issue. Coal is readily available from a range of suppliers in a competitive market that has typically been over-supplied. It is readily and cheaply stored in large quantities and does not require expensive dedicated facilities. Gas is not so simple. A world market is developing but generally gas is sold under long-term contracts, often on a 'take-or-pay' basis[99]. Gas needs specific infrastructure such as a long dedicated pipeline or a LNG terminal. Storage is feasible but relatively expensive and the low emissions of greenhouse gases compared to coal mean that at world level, a buyer's market cannot be expected on a consistent basis. So if the option to increase gas use for generation was chosen measures such as diversifying supply sources, increasing storage capacity and stocking back-up fuels, for example, gas oil, would need to be adopted.

5.79 The option of large scale imports of power from China presents a different set of challenges, which would depend on how the power was contracted, for example, a dedicated power plant or imports from the grid. Whichever option was chosen, there would be an element of loss of control as the reliability of imports would depend on infrastructure not owned or controlled by Hong Kong companies. There is no reason, *per se*, why this should lead to any reduction in security of supply provided the contractual agreements were strong and comprehensive.

5.80 Decentralised generation, for example generation by users in large office buildings might also have an impact on security of supply. The wide-spread adoption of renewables is often portrayed as being likely to reduce supply security because the wind does not always blow and the sun does not always shine. However, there is rapidly accumulating experience in Europe from countries such as Denmark, Germany and Spain, which now obtain up to 40% of their power from renewable sources on an annual basis and, at certain times, demand is fully met by renewables. So the adoption of renewables does raise issues of security of supply but at the levels of renewables

[99] Under a take-or-pay contract, the volume of purchases is specified and if buyers are unable to use the contracted volume, they must still pay for the full volume.

contemplated for Hong Kong, or even significantly higher levels, there is ample experience from elsewhere to allow these issues to be dealt with.

5.81 The influence of demand side measures could also be important. Meeting very steep and short-lived peaks is expensive and stresses the system, so measures that reduce peaks are likely to improve security of supply as well as reducing costs. Demand management, that is, encouraging consumers to reduce demands, particularly at peak time, has been discussed above. However, energy efficiency measures could also reduce the size of peaks. For example, in the UK demand at peak times includes a higher proportion of lighting demand than at other times. The adoption of efficient LED lighting has massively reduced lighting demand and, as a result, peak demand is actually falling in the UK whilst overall demand is still rising slowly. It may be that an energy efficiency programme targeted at uses that make up a high proportion of peak demand could reduce costs and improve security of supply.

Conclusion on reliability

5.82 The discussion of security of supply in Hong Kong is dominated by the plant margin and generation adequacy. However, security of supply is a much wider ranging topic than this and to maintain the very high standards being achieved now requires a much broader discussion. Hong Kong's plant margin of about 40%-45% is very high by international standards and typically, less than 20% is generally seen as more than adequate. How far this is a deliberate choice and how far it is the result of over-forecasting of demand is not clear, but it seems likely that the plant margin could be substantially reduced with no loss of supply security and some cost savings.

5.83 The factor that is leading to the Hong Kong electricity system's high level of reliability is the strength of the networks and any changes to the electricity system must be sure not to compromise this. The options of greater use of gas for generation and importing power from China bring their own implications for supply security and these must be fully considered.

5.84 However, supply security can be strengthened by other measures, not typically discussed under security of supply, such as demand side management including energy efficiency. The implications of the Environment Bureau consultation paper that supply security was non-negotiable and therefore not part of the debate is misconceived. The consultation paper also excludes options such as making the emissions of specific facilities more explicit for purposes of emission control and does not specify the marginal generation fuels, as well as references to existing hydro capacity. Other important information includes cost, DC or AC, subsea or overland, how power would

be made available to both systems, whether the power would be base-load or despatchable. The existing supply standard can remains unchanged but there is a range of measures that might mean this standard can be met more cheaply with benefits for consumers.

5.85 As an illustration of what sees as a certain excessive (and expensive) caution in Hong Kong regarding reliability, in Box 5.6 enclosed an account of the calculations made in the UK which illustrate acceptance of a far lower plant margin. A significantly higher margin would still be considerably lower than those which have prevailed in Hong Kong.

Box 5.6 The Plant Margin in the UK

In order to ensure that electricity supply is reliable, electric utilities maintain more generating capacity than is needed to meet the expected maximum demand during the year. The extra capacity over maximum demand is to cover the risk of power station equipment failures and higher than expected demand. This extra capacity is expressed as a percentage of maximum demand and is known as the plant margin.

The other element of electricity supply security is the reliability of the network. In practice, most supply interruptions result from failures of the network. However, network failures are usually localised and can be quickly solved albeit with severe disruption and risk to health for those affected. In addition, there is no simple measurement equivalent to the plant margin that gives an indication of how secure supplies are from network failure. The reliability of the network will depend on it having sufficient capacity but will also be determined by the quality of the equipment and maintenance standards. A shortage of power stations means that there is not enough electricity being generated to meet all the demands, so blackouts become a daily occurrence, doing great damage to public health and our economy. So while network failure is the most likely cause of loss of supply, ensuring that generating capacity is sufficient also has a high priority.

In practice, the target plant margin is seldom the actual plant margin, because, for example, demand forecasting errors might lead to more plant being built than was needed. In 2014, the plant margin in Hong Kong was about 45%, with the expectation that this would fall to 35% when some coal-fired capacity was retired. It is not clear what the target plant margin for Hong Kong is.

Historically, there have been three main elements to the plant margin in the UK:

- The expected availability of plant at peak time. Inevitably some plants will not be available, usually because of equipment failures but for systems with intermittent sources such as wind, solar and hydro because of resource unavailability. Utilities use historic experience to determine what percentage of plant will be available at peak time;

- The variability of demand according to weather conditions. For example, in Hong Kong, an unusually hot summer will increase maximum demand over the forecast level because of the higher air-conditioning load. In the UK, peak demand is in winter due to lighting and electric space-heating; and

- The desired security standard. It would be very expensive to carry such a large surplus of plant that no conceivable combination of exceptional weather and an unusually high level of plant unavailability could be met. As a result, governments usually specify to the utilities what standard they want them to achieve.

In the past, utilities used only surplus plant to make up the plant margin, but it is increasingly being recognised that 'demand side management' is often a cheaper way to provide reserve capacity. Under this approach, medium and large consumers are given financial incentives to reduce their demands at peak times, usually with no significant impact on their operations.

The plant margin will vary from country to country, depending on factors such as: the extent of dependence of demand on weather conditions; the size of the system because in a small system where the largest generation plant represents a significant proportion of demand, the margin will have to be higher; the degree of international interconnection, so that a country with strong interconnections will be able to rely on neighbouring countries to export at peak times; and the desired security standard which may vary according to the importance attached to high reliability levels.

In the UK, at the time of privatisation in 1990, the target plant margin was about 20%. At that time, the required security standard was that supply should be sufficient to ensure there were no black-outs in 98 winters out of 100 and that voltage reductions (which reduce demand without disconnecting consumers) would only be required in 24 winters per 100.

Since then, there has been some reduction in the desired plant margin but also an increase in the required security standard. Generators have a strong incentive to have their plants available at peak times because prices are high at that time and demand

side management measures are used much more. The security of supply standard is now expressed as the Loss of Load Expectation (LOLE). This is the average number of hours per year that supply is insufficient to meet demand and in UK, this target is set at 3 hours per year (0.03%).

The National Grid Company, the owner and operator of the transmission network, has a responsibility for the short-term adequacy of supply and can, for example, give incentives for mothballed plants to be brought back into service and for demand side response. However, it cannot commission the construction of new generating capacity and long-term capacity adequacy is largely left to market forces.

For some years in the UK, the plant margin has been falling. Old coal-fired plant has been forced to retire for environmental reasons and the market has failed to stimulate new investment. In addition, some existing plant is not profitable and has therefore been mothballed or retired. In October 2014, National Grid assumed that total capacity on the system in winter 2014 would be 71.2 MW and winter peak demand would be 53.6 GW[100]. The overall plant margin is therefore 33%. More than 10% of total capacity is wind power, the availability (at peak) of which depends on weather conditions, while some of the coal plant can only operate for a restricted number of hours per year. The availability of the 71.2 MW of total capacity was expected to be about 82% or 58.4 MW, somewhat lower than in the past because of the restricted availability of wind and coal. Taking account of the expected amount of plant that would not be available at peak, this leaves a margin of 4.8 GW or 8% over expected winter peak demand of 53.6 GW to cover colder than normal weather conditions. National Grid calculates that this will result in a LOLE of 1.6 hours, comfortably inside the government's required security standard. Nevertheless, to increase security of supply further and because of concerns about the risk of forced closure of some of the nuclear capacity, National Grid has procured an additional 1.1 GW of demand side response and this brings the LOLE down to 0.6 hours or 0.007%.

[100] For more details, see http://www2.nationalgrid.com/media/Resources/PDFs/reports/WinterOutlookReport2014.pdf.

Chapter 6 Consumer Perspectives

Participation with Respect to the Environmental Objective

6.1 The foreword of the Environment Bureau consultation paper succinctly sums up well the dilemma facing Hong Kong in relation to maintaining quality of life and supporting economic competitiveness:

'For our city to thrive, we cannot do without safe and reliable electricity provided at an affordable price. Alongside these objectives, we also want a cleaner environment. We are considering how the fuel mix for electricity generation may be changed to better serve our population and economy in future having regard to the need to strike a balance among these competing policy objectives...

Regardless of the fuel mix that we would collectively decide upon for Hong Kong, electricity tariffs will likely increase due to wider use of cleaner but more expensive fuel, and as existing electricity generation facilities are to be retired. Nevertheless, we believe Hong Kong can afford to pay more for cleaner electricity in order to further improve our environment'[101].

6.2 In considering the above, it is worth bearing in mind that rising energy prices will increase the pay-off for energy efficiency schemes in terms of consumer costs, social welfare and environmental impacts. That is: the higher the price, the greater the value of any reduction in consumption.

6.3 This chapter seeks to address measures to make it possible for Hong Kong to have both affordable prices and a cleaner environment, objectives which the Council have already identified as being in potential conflict. It is within the power of the Hong Kong Government to develop and introduce policies which can bring about dramatic savings in energy use and consequently energy cost. The measures proposed here are not short-term ones nor can they be achieved without the support from stakeholders.

6.4 To achieve environmental objectives, energy policy makers must engage all participants in the chain from system design and policy through generation, transmission, distribution and retail. A common error is to target just one sector in the chain and to ignore the vital role which consumers play in achieving environmental objectives. Unfortunately, a common feature of energy efficiency programmes is that consumers

[101] Consultation Paper of *'Planning Ahead for a Better Fuel Mix - Future Fuel Mix for Electricity Generation'* from the Environment Bureau (2014).

are treated as passive recipients of expensive advertising campaigns or poorly designed information strategies.

6.5 The most obvious reason for engaging with consumers is that they meet all the costs of the energy sector and are also the involuntary 'consumers' of pollution and the negative consequences of climate change. Unlike other sectors of the economy, however, the adverse consequences either financially or through environmental impacts are not readily or quickly apparent. The consequences of high levels of consumption of greenhouse gas intensive fuels are spread around the world while even pollution from coal-fired generation often affects consumers far distant from the site of generation.

Motivating Consumers

6.6 In addition to regulatory measures affecting fuel mix and environmental strategies, it is necessary for policymakers to construct interesting or even mandatory ways of influencing consumers, both domestic and commercial, to recognise the impact that their actions may have on the environment, and to make it easy for them to adapt their behaviour. It is one thing for consumers to be told that they need to rein back their consumption, it is quite another for the price signals to be clear to that effect and for them to have the possibility to benefit directly at the household level.

6.7 One common syndrome in densely populated cities like Hong Kong with a high level of apartment dwelling, is for bills to be integrated into other charges, particularly rent, and even 'collectivised' thus causing conservation efforts by individual households to have very little direct effect on their expenditure. Another is that if consumers wish to adjust their air-conditioning at household or even at room level, they may not have the possibility to make the necessary adjustments because systems are centrally controlled. An important element of the strategy is first to establish how many households or commercial establishments face these obstacles and then to set about remedying them. For example, in the case of residents in multi-occupied buildings, access to metering information at household level is not always available and so it should become an obligation of landlords in such circumstances to provide it. Without such 'disaggregation' of billing and discrete physical controls, the motivation for consumers both commercial and household will be attenuated. There is extensive experience of such problems from Eastern Europe in particular where communal billing and centralised temperature controls (in those cases heating of course) have made it impossible for individual consumers to make the necessary decisions. The result has been huge wastage of energy.

6.8 Specific tools which can be used to influence consumers can be divided roughly between demand side management through behavioural adaptation on the one hand

(demand shifting through time, reduced air conditioning intensity) and energy efficiency by mandatory hardware efficiency (improved performance of appliances).

Energy efficiency

6.9 Energy labelling schemes relating to household appliances such as water heaters, television sets and air-conditioning need to be subject to constant monitoring to ensure that information is accurate and that serious and demanding targets are presented to manufacturers. Too often, schemes relating to energy efficiency labelling are outdated and there is a migration of all or most available products towards the top energy efficiency band. This effectively removes the incentive from manufacturers and consumers alike to keep pushing the levels of efficiency to higher levels.

6.10 An important part of behavioural change is to recognise that short-term cost reductions achieved by virtue of better energy efficiency can readily be used up through the spending of these resources on even more energy intensive applications such as additional air-conditioning or lighting. Gains need to be 'captured' and so a repeated upward revision process of standards is needed.

6.11 There is cause for optimism. According to a report published in July 2014 by the UK Department of Energy and Climate Change[102], EU-wide standards and energy labels are making domestic appliances more energy efficient. Energy labels indicate relative performance in terms of efficiency, steering consumers towards the most efficient models, while minimum performance standards progressively remove the least efficient products from the market. The UK Government has estimated that by 2020, the annual net savings to the UK economy resulting from these standards and labels will be in excess of £850 million per year, with reductions in greenhouse gas emissions of more than 7 million tonnes per year.

6.12 The report examined the effect and likely impacts of energy efficiency standards and labels for common products and appliances that the vast majority of homes contain: refrigerators, washing machines, televisions and light bulbs. The report indicates that for regularly used products such as white goods, energy efficiency is a key factor in purchasing decisions, but for goods such as consumer electronics (e.g. TVs) it is not. There have been reductions in both the purchase cost of key appliances and running

[102] United Kingdom Government *'Energy Efficient Products: Helping us Reduce Electricity Consumption'*, Department of Energy and Climate Change, 2014. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/328083/Energy_efficient_products_-helping_us_to_cut_energy_use_-_publication_version_final.pdf.

costs for selected white goods and TVs as a result of improved energy efficiency since the turn of the century.

6.13 The report examined the total cost of ownership of products for different energy labelling classes. While more efficient products will have reduced running costs compared to less efficient ones, these savings only offset differentials in purchase price for some products.

6.14 The report concludes with projected energy savings resulting from a replacement of the total UK stock of fridges, washing machines and TVs with appliances meeting current EU minimum standards. For example, complete replacement of the washing machine stock is projected to save around 300 GWh per year by 2030 relative to pre-legislation energy-efficient products.

Demand side management

6.15 More direct means of modifying consumer behaviour can be found through methods of electricity pricing. Hong Kong already makes wide use of rising block tariffs (further discussed later), in which prices per kWh of electricity increase after a certain consumption threshold to provide an incentive for users to keep consumption below critical levels. A more complex and now widely used system internationally is time-of-use pricing.

6.16 Time-of-use pricing seeks to levy charges for the consumption of electricity which either impose extra costs on users at peak times or to provide discounts for use of electricity at times when demand and system load are low.

6.17 The most common means of giving effect to time-of-use charging has historically been the use of multiple electricity meters where off-peak or low demand and discounted electricity is separately metered and billed.

6.18 More recently some electricity supply organisations have moved to charging systems which vary each half-hour dependent on the demand supply balance. Variable time-of-use charging is not possible to achieve without metering systems which can accommodate precise (usually half hour) measurements of the amount of electricity used. The wide implementation of such a scheme would require the replacement of the vast stock of current electricity meters in use.

Smart meters

6.19 Many jurisdictions around the world have mandated the installation of forms of 'smart meter'. For example, the EC has made it mandatory for member states to install smart meters in at least 80% of consumer premises by 2020, subject to a favourable cost-benefit analysis.

6.20 Smart meters have three essential features which distinguish them from conventional electromechanical 'spinning disc' meters and from standard interval or accumulation meters:

i. The meter records electricity consumption data at frequent intervals, typically half-hourly;

ii. The meter transmits that information regularly to the electricity suppliers, typically at least daily; and

iii. The meter can facilitate remote control – that is, energy suppliers can perform some functions from a distance such as connection and disconnection or controlling power supply.

6.21 Much has been made of the ability of smart meters to read consumption in real time and feed that information to consumers. Devices are already available at reasonable price, which can identify which appliances are having greatest impact on electricity use that clearly is a valuable adjunct to consumer education and information. The technology also exists for remote readings (removing the need for home meter reading). The truly distinctive feature of smart metering is the direct link to the service provider and the consequent potential for time-of-use pricing. And it is that link which constitutes the main cost, not so much the meter itself as the information systems to support the continuous connection to a central data point dealing with huge amounts of information to implement time of day pricing. And that cost appears to be very high and the potential savings for domestic consumers very modest and unreliable. For example, the UK Government estimates that the average customer will make net savings on their energy bill of only £25 per annum by 2020. And this does not face the issue of the history of serious cost overruns, as in Australia (Annex C goes into greater detail).

6.22 Despite the enthusiasm generated by the technology, in practice this has been found to come at a very high cost, setting in train a certain disappointment as the Council have already seen for example, in the UK. In addition, in Victoria, Australia, the government

has halted the rollout of smart meters some years into an installation programme mainly due to adverse consumer reactions from the high costs involved. The German federal government also decided in July 2013 not to install smart meters as a result of their poor cost-benefit analysis results[103].

6.23 The absence of a clear-cut cost and effort equation for ordinary domestic consumers, however, should not be a barrier to smart meter installations in the commercial and office sectors of Hong Kong. As noted elsewhere in this report (see Annex D), a large proportion of Hong Kong's electricity consumption (around 30%) is down to the use of air-conditioning, two thirds of that in commercial and office environments. So, remote control and real time pricing of large units of this nature raise far fewer implications than do the same tools applied to domestic consumers.

Domestic household consumers

6.24 For domestic users, other demand side management tools are available, building on the prior requirement for 'disaggregation' as described above. They include :

i. Information tools including quantitative and qualitative information about consumers' current uses of energy that can be gathered and presented in graphic or other meaningful ways to enable consumers to better understand their consumption patterns. Display devices can be used in real time to let consumers know how their current consumption can vary as a result of appliance use;

ii. The use of social media and social research tools can be a useful way of providing community peer pressure for reduction of consumption or the shifting of consumption from times of peak demand where more polluting forms of generation are required to shift them to periods of lower demand where typically more efficient and cleaner generation can be employed. Schemes involving Facebook, Twitter, YouTube and web-based collaborative tools can be initiated at relatively low cost to bring about significant results; and

iii. Household billings include the availability of accurate, up-to-date and relevant information about consumption and measures in reducing usage. Good international practice requires that prior period consumption and consumption compared with similar residences also be included on the bill. As a document which is going to attract consumer attention, the bill also provides a useful place for brief

[103] Bloomberg, *'Germany Rejects EU Smart-Meter Recommendations on Cost Concerns'*, August 1, 2013. http://www.bloomberg.com/news/2013-08-01/germany-rejects-eu-smart-meter-recommendations-on-cost-concerns.html.

energy efficiency messages and references to information resources or websites which consumers can access to let them know what is possible. As noted in Chapter 4, a start has been made on the provision of information to consumers in Hong Kong.

Commercial consumers

6.25 As relatively large consumers, (for example, 68% of air-conditioning electricity is consumed in the non-domestic sector), it is the commercial sector from where the 'big wins' can be achieved in terms of energy saving per account. As is shown in Annex D, a relatively small adjustment in temperature controls can result in a large saving, particularly for a large entity like a shopping mall.

6.26 In Hong Kong, the consumption of electricity in the commercial sector is very high with heavy loads used to maintain extensive air-conditioning and illumination in commercial spaces. For high energy users, there is a very strong case for advanced metering systems which collect a wide range of data about consumption and present to users in a systematic way. Some options include:

i. Interactive energy dashboards which display energy use statistics for an entire enterprise including buildings or parts of buildings; and

ii. Measurements that can be built into such schemes to disclose energy savings over the past periods or compare to other businesses or areas of the business in kilograms of CO_2 equivalent, or quantities of gas and coal consumed.

6.27 Establishment across Hong Kong of best practice sites for energy saving by commercial and office building managers could be a highly productive step. Elements of best practice systems could include:

i. Ensuring that regular relevant feedback is visible for all units of the enterprise such that awareness of results is common and serves to influence norms of behaviour;

ii. Application of financial incentives such as higher prices or sanctions for excessive use or rebates on rent or other costs for savings to provide a greater incentive effect;

iii. Application of high-level metering systems which measure in an accurate and timely way and provide graphical or other feedback to users;

iv. Regular monitoring of occupant behaviour and feedback loops built upon monitoring; and

v. Measures which are synergistic with staff induction, social activities and training and assessment used to emphasise the energy-saving or demand shifting goals as well.

6.28 Best practice models ensure that savings goals are not seen as one-off processes. Goals need to be continually reassessed and targets increased as successes are achieved in order to become fully embedded within the behaviour of an enterprise.

Summary on demand side management

6.29 Below, Table 6.1 is a summary of the different approaches discussed above laid out in terms of the desirable criteria, namely, affordability, reliability and sustainability, also providing some information the time-scale for such measures to have an effect.

Table 6.1 Summary of Potential Impact of Demand Side Measures

	Reliability	Affordability	Sustainability	Time-scale	Comments
Energy efficiency	Some benefit due to reduced fuel requirements	Higher upfront costs balanced by lower operating costs giving welfare benefits	Likely to produce lowest environmental impact of new supply options. Should stimulate improved appliance efficiencies to produce lasting benefits	Scope for quick impact	No loss of service quality. Scope for government action to help smooth higher upfront costs. Need for regulatory action to ensure energy efficiency measures can compete against supply side options (such as new generation)
Demand side management	Significant benefit from dealing with peak demands. Important option if more intermittent sources are utilised	Significant reduction in system costs that should be passed on to consumers	Some benefit from avoiding using inefficient peaking plants and reducing the need for spinning reserve	Scope for quick impact	Marginal loss of service quality. Need for regulatory action so demand side measures can compete against supply side options (spinning reserve and peaking capacity). Smart meters are future option but cost and welfare issues mean they are not ready for deployment in the household sector
Building standards	Some benefit due to reduced fuel requirements	Relatively small extra upfront costs for long-term welfare benefits	Substantial long lasting benefits. Scope to cheaply integrate renewables into new buildings	Long-term impact	No loss of service quality. Need for government action to enforce high and increasing standards
Upgrading existing buildings	Some benefit due to reduced fuel requirements	Higher upfront costs and some short-term disruption but lower operating costs	Substantial long lasting benefits. Scope to retrofit renewables	Potentially quicker benefit	No loss of service quality. Important where building rates are not very high

Consumer Welfare – Energy Poverty Dimension

6.30 There is a need to consider the distributional impact of achieving environmental objectives, with particular emphasis on the impact on low income consumers. The current Environment Bureau consultation paper foresees a doubling of generation costs, perhaps an increase of 60% in prices charged to small consumers, and more for larger consumers. This would undoubtedly cause affordability issues for low-income households. It is an important element of Hong Kong energy policy that electricity is an essential utility. The recent Environment Bureau consultation paper puts it this way: *'As electricity is an essential utility for all walks of life, we must strive to ensure that it is provided at a reasonable price'*[104]. But in a somewhat contradictory vein the paper goes on to state that: *'Households in Hong Kong on average spend less than 2% of their expenditure on electricity supply'*[105]. Though no doubt true, such a generalisation masks the fact that Hong Kong has serious social problems with tens of thousands of families living with high costs of accommodation and energy consuming a very large proportion of income. In 2006, the Council[106] identified a study[107] which stated that 89% of low income families surveyed considered their utility bills high. Welfare agencies have estimated that as many as 200,000 customers spend more than 10% of household income on electricity recently. If the overall percentage is 2%, it suggests that there is some room for manoeuvre and the most disadvantaged are to be helped.

6.31 Positive features of the existing system exist, such as the low level of disconnections due to non-payment. However, there is a need for research and surveys into the extent of problems, such as those caused by multi-occupancy. These include:

i. The extent of multi-occupying families paying the higher tariff as they move into the high consumption categories and thus pay a higher tariff;

ii. The potential for exploitation by landlords, for example, by charging more to their tenants than the amounts actually billed; and

iii. The inability of tenants to get a clear picture of their actual consumption.

6.32 These issues are discussed in some detail in Annex E. There is also a need to investigate health effects of the under-consumption of electricity that may result from

[104] op. cit. at p. 5.
[105] op. cit. at p. 5.
[106] Consumer Council Submission on Stage II Consultation Future Development of Hong Kong Electricity Market - Executive Summary April 2006 http://www.consumer.org.hk.
[107] Society for Community Organizationhttp://www.soco.org.hk/publication/publication_index.htm.

fear of incurring the higher tariff. This was brought to our attention by social welfare groups.

Fuel poverty

6.33 The concept of fuel poverty is increasingly gaining traction in Hong Kong. The term is used in Europe and Australia to identify households that spend more than 10% of their income on all household energy fuels to heat or cool their homes. In the UK, the main issue is the impact on health and increased mortality rates during winter, while in Hong Kong and Australia the problem is extreme heat.

6.34 In the UK, the Warm Homes and Energy Conservation Act 2000 formally recognised fuel poverty as a major public health issue and required the government 'to publish and implement a strategy for reducing fuel poverty and set targets for its implementation'. The fuel poverty strategy, launched in 2001, expressly aimed to introduce policies to eradicate fuel poverty in vulnerable households by 2010 and all English and Welsh households by 2016 (2018 for Scotland). Policies to meet these targets were grouped under three headings:

i. Energy efficiency measures — a combination of programmes delivered by suppliers obligations on local government to improve housing stock and advice;

ii. Energy market measures — essentially by ensuring energy affordability through freeing energy markets and promoting competition; and

iii. Social-inclusion measures — supplementing income through the benefits system.

6.35 As this report indicates, the Council is having reservation regarding the experience of retail competition so far, but shares the view that energy efficiency and social inclusion measures should work in harmony.

6.36 To track the progress of the UK strategy against its targets annual reports are issued. These provide updates on programmes, as well as describing new developments and the impact of energy prices. Since 2000, the average household power bill has increased by 80%, so that fuel poverty has risen, with five million households (almost a fifth) in the UK now classified as fuel poor. This increase has shown how price rises can quickly override benefits from energy efficiency or social-inclusion measures.

6.37 To help develop policies, a Fuel Poverty Advisory Group (FPAG) for England was created. Although the group is sponsored by government, it remains independent and is made up of members representing suppliers, charities, consumers and local government. FPAG has consistently stated that efforts to reduce fuel poverty have been hindered by the problems in developing programmes that accurately identify and target measures to those that most need help. Ongoing monitoring is needed.

Social tariffs

6.38 Social tariffs should be considered to address the impact of rising bills on vulnerable households in Hong Kong. These have been offered voluntarily in the UK market since 2008 and were made mandatory in 2011. Eligible customers (those who receive social benefits) can apply for tariffs that guarantee the lowest price. A reconciliation mechanism allows for the costs of the tariffs to be shared equally among participating suppliers. It remains to see whether the value and effectiveness of the government's decision to mandate social tariffs in the UK market is helpful to resolve the issue.

6.39 Low user tariffs are often confused with social tariffs in that poorer families tend to use less electricity and so can remain on the low tariff if consumption remains low. But low user tariffs face the problem of being indiscriminate in that the range of beneficiaries is the totality of all consumers for the first tranche of their consumption. And the Council has already identified that one cannot assume that low consumption equates with low income, as is shown by the problem of multi-occupied apartments.

6.40 Both electricity companies in Hong Kong employ a rising block tariff structure which charges for the initial tranche of consumption at a lower rate than subsequent tranches. There are 7 tiers in the rising block tariff structure for both electricity companies. The basic tariff is made up of a basic charge per unit together with a variable Fuel Clause Adjustment (FCA) which will apply when the fuel price rises or falls (see Table 6.2 and 6.3). Both companies make additional discounts available for certain groups defined as vulnerable such as the elderly, disabled or unemployed or single parents. The levels of discount while substantial, (for example, 50% in CLP, 60% in HEC) are applicable to relatively low levels of consumption, such as the first 400 kWh consumed in two months in one scheme, 200 consumed in one month in another. This is similar to the scheme identified in recent work by the World Bank in Serbia, as being quite protective of low income consumers (350 kWh per month in that case)[108]. What is notable is that the twin track principle of low user tariffs and eligibility for additional discounts based on registration for social benefits is applied. Evidence put forward by the Hong Kong

[108] A Cojocaru & C Ruggeri Laderchi, (Poverty Reduction & Economic Management unit – World Bank ECA) 2011. *Electricity Reforms and Energy Affordability in Serbia*, p.3.

Commission on Poverty suggests that there is non-take-up of benefits which reduces the effectiveness of such mechanisms[109]. But more information is required to make a definitive judgement.

Table 6.2 Block Tariff Structure of CLP[110]

Total Bimonthly Consumption Block	Basic Charge (cents/unit)	FCA (cents/unit)	Net Rate (cents/unit)
Each of the first 400 units	81.7	22.4	104.1
Each of the next 600 units (401-1000)	94.5	22.4	116.9
Each of the next 800 units (1001-1800)	109.8	22.4	132.2
Each of the next 800 units (1801-2600)	139.6	22.4	162.0
Each of the next 800 units (2601-3400)	161.8	22.4	184.2
Each of the next 800 units (3401-4200)	171.8	22.4	194.2
Each unit from 4,201 units and above	173.0	22.4	195.4

Table 6.3 Block Tariff Structure of HEC[111]

Total Monthly Consumption Block	Basic Charge (cents/unit)	FCA (cents/unit)	Net Rate (cents/unit)
Each of the first 150 units	60.2	33.1	93.3
Each of the next 150 units (151-300)	74.1	33.1	107.2
Each of the next 200 units (301-500)	88.0	33.1	121.1
Each of the next 200 units (501-700)	111.6	33.1	144.7
Each of the next 300 units (701-1000)	125.5	33.1	158.6
Each of the next 500 units (1001-1500)	139.4	33.1	172.5
Each unit from 1,501 units and above	153.3	33.1	186.4

Company initiatives

6.41 It is worth considering those schemes that are being introduced in Hong Kong to subsidise the purchase of energy-efficient appliances, thus linking social inclusion and energy efficiency. In June 2014, CLP announced that it was to launch a $10 million subsidy programme for energy efficient electrical appliances[112]. The company said that it is distributing energy efficient electrical appliances to the needy as part of the company's ongoing effort to promote energy saving. Sets of energy saving electrical appliances will be given out to 4,000 households including low income families,

[109] Government of HKSAR, *Hong Kong Poverty Situation Report 2012*, 2013 para. 5.10.

[110] http://www.clponline.com.hk/myhome/customerservice/tariffoverview/domestic/pages/default.aspx?lang=en.

[111] http://www.hkelectric.com/web/DomesticServices/BillingPaymentAndElectricityTariff/TariffTable/Index_en.htm.

[112] CLP website seen August 2014.

residents of subdivided flats, single elderly people and other families and individuals. To give effect to the programme, CLP said it will work with the 14 District Councils in its supply area as well is non-governmental organisations. The project which commenced in mid-May 2014 seeks to assist those in most need.

Energy saving rebate scheme

6.42 CLP also renewed its commitment to The Energy Saving Rebate Scheme to assist low consumption customers and encourage energy conservation. CLP claims that the new package is expected to result in 33% or around 700,000 domestic customers and 43% or around 133,000 small business customers seeing no tariff increases for 2014. The overall commitment to an energy efficiency fund is Hong Kong $70 million over the period 2014 to 2018. Subsidies will be given to non-commercial building owners to carry out improvement works to enhance the energy efficiency of their buildings.

The benefit route

6.43 The Hong Kong Government and both electricity suppliers provide a measure of help to low-income households, although relatively little of that help is directly linked to energy consumption (see Annex E). Chapter 2 identifies two broad approaches to help with fuel poverty. One is to try to direct help to poor households through the tariff structure as just described. The other is to take high fuel bills as a given and to try to provide social assistance targeted on the fuel poor. There is a hybrid version which uses receipt of state benefits as a 'passport' to lower tariffs. So for example, receipt of the Comprehensive Social Security Assistance (CSSA) entitles recipients to further benefits without having to go through a new round of applications. While clearly efficient in many ways, this policy raises a major issue, for many poor families may fall out of the range of social benefits system. (The reasons for this are discussed in greater detail in Annex E). There is a need to discover to what extent the issues that exist in other jurisdictions also lead to reluctance to claim social benefits or ignorance of their existence in Hong Kong too. Evidence emanating from the Hong Kong Commission on Poverty suggests that these problems do exist. If prior receipt of benefit is the 'passport' to help with fuel bills, and there is a problem of non-take-up of benefits, then fuel poverty is likely to be under-estimated and insufficiently addressed.

Conclusion on fuel poverty

6.44 As perusal of Annex E will show, design of a system of help to poor consumers is not simple and needs to be grounded in local conditions. The first step in a successful programme of help to poor consumers facing difficulties paying their bills, is

collaborative research with government and welfare agencies to determine the extent and sources of fuel poverty and to find effective interventions to remove the root causes of the problem. For Hong Kong, a well-known and growing source of fuel poverty is rising energy prices and likely future escalation striking especially low income households and consumers in multi-occupied or subdivided apartments.

6.45 Steps which could be taken to minimise prices are identified elsewhere in the report. They include tighter control over future price rises and closer scrutiny of current costs and prices. One suggestion is the removal or restructuring of the fuel surcharge. This allows the companies to pass through to consumers any increase in fuel costs without having to share in the pain of feedstock price rises. This removes incentives to adapt to new fuel price trends and to improve efficiency to offset such cost increases. A further step which could help poor consumers in due course, would be reducing the current overly generous return on investment allowed to the electricity companies. This involves the supply side issues that are dealt with in the main report and include also such matters as competing fuels, dealt with in Chapter 5. Whatever the problem, rising prices make it worse and energy efficiency make it less severe. That is why social inclusion and energy efficiency must work together.

Consumer Engagement

6.46 Is the SoC the appropriate regulatory regime to engage consumer participation, what are the alternatives? It has attracted criticism for its closed nature, the rigidity of its processes and the apparently high rates of return it allows the companies. The Council suggests consideration be given to opening the process to a wider range of interests, a greater degree of independence from government for the review team and a move towards performance based measures. The use of consultation processes to engage the public in the planning of the system is welcome, but there appears to be room for improvement, for example, giving more information on how the Environment Bureau consultation paper fits into the whole process of sector reform.

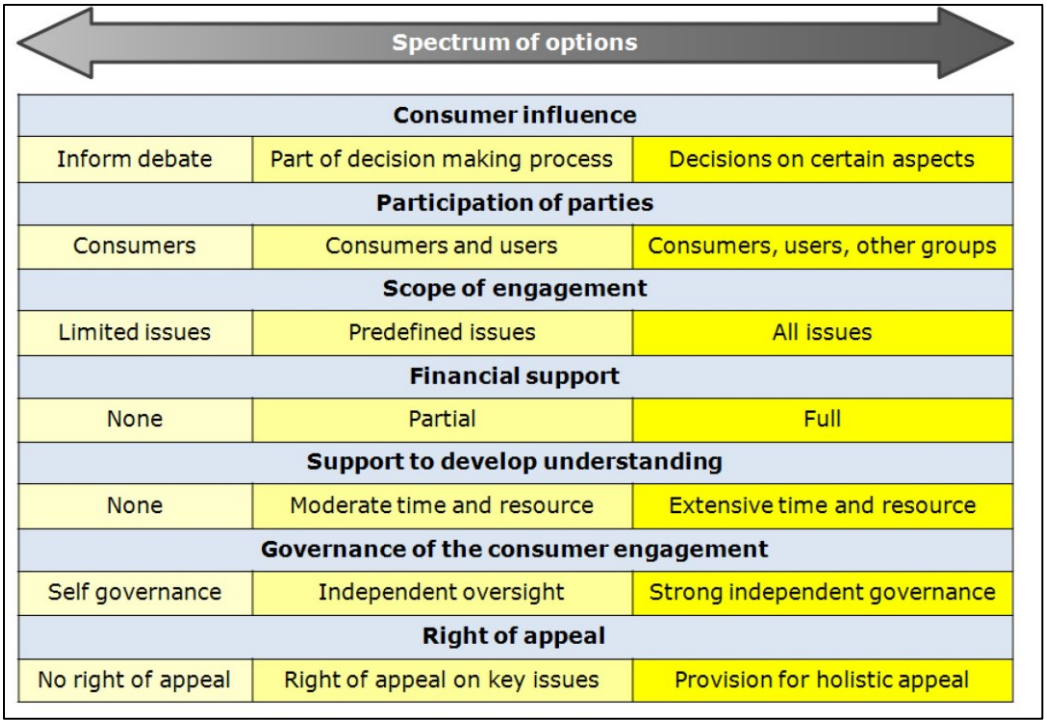
6.47 The current regulatory arrangement in Hong Kong based on the SoC provides almost no scope for consumers to engage, or influence, regulatory outcomes[113]. This degree of disconnection between the supply-side and demand side is not a healthy situation.

6.48 Even when consumers' views are sought through surveys, willingness-to-pay and cost-benefit analysis, they are rarely directly engaged in the process themselves. The regulatory emphasis on the consistent application of price-control settlement processes

[113] CLP has Customer Consultative Group and Local Customer Advisory Committees engaging their users.

reduces the incentive for companies to actively engage with users and discourages opportunities to consider local circumstances and requirements. Best practice energy regulation involves increasingly more significant levels of consumer participation in regulatory processes. In 2009, OFGEM, the UK energy regulator set out a useful process for consumer engagement. There is considerable scope in future regulatory determinations for Hong Kong to incorporate some elements of the scheme. Figure 6.1 sets out the range of options.

Figure 6.1 Spectrum of Options for Consumer Engagement[114]



Consumer influence		
Inform debate	Part of decision making process	Decisions on certain aspects
Participation of parties		
Consumers	Consumers and users	Consumers, users, other groups
Scope of engagement		
Limited issues	Predefined issues	All issues
Financial support		
None	Partial	Full
Support to develop understanding		
None	Moderate time and resource	Extensive time and resource
Governance of the consumer engagement		
Self governance	Independent oversight	Strong independent governance
Right of appeal		
No right of appeal	Right of appeal on key issues	Provision for holistic appeal

6.49 A criticism which has been directed at the Hong Kong SoC model for regulation is that it fails to provide incentives to companies for greater levels of efficiency in delivering electricity or environmental savings while consumers have little role in the process. A move to more incentive-based network regulation is arguably the key to delivering more active involvement of consumers. It also allows regulators to expand their role to facilitate negotiations rather than make all decisions themselves. The consumer's ability (or their representatives) to say what service levels they want and how much they are willing to pay helps regulators with market discovery processes in the absence of competition.

6.50 The Office of the Public Counsel (OPC) in Florida was created in 1974 to give consumers legal representation in utility matters, including price control settlements. The OPC

[114] Delivering outcomes—Consumer Engagement in the Regulatory Process, OFGEM. March 2009.

undertakes independent analyses, presents testimony of expert witnesses, cross-examines utility witnesses, and files recommendations and briefs in these cases. Together with customer advocacy groups it has negotiated many settlements. The OPC website includes full transcripts of all cases argued in the last 18 months, showing a high rate of success in reducing utility rates from telecommunications, water and energy.

6.51 In the wake of dissatisfaction with earlier price-settlement outcomes, the British Civil Aviation Authority (CAA) established 'constructive engagement' processes, bringing airports and airlines together for work usually done by the regulator. The CAA was still responsible for assessing operating expenditure, cost of capital and the final price control, but it ensured that the interests of passengers and future airlines were considered. Its preference was for agreements that had been reached between parties. While there is some sense in these arrangements they pose a dilemma, as when a large consumer or class of consumers with market power comes to a settlement with the supplier, this may adversely affect all other customer groups, particularly individual consumers or households vis-a-vis large business. It must be borne in mind that the consumer interest is rarely monolithic, one group's gain may be another group's loss. Moreover, where consumer interest and engagement in system planning and pricing is understandably very low (this is unlikely to change), this approach, while desirable, is unlikely to be possible or successful.

6.52 During its development of the price settlement process the UK regulator, OFGEM looked at how effective consumer engagement could be delivered. It acknowledged that consumer representative resource was limited and that this hindered their engagement in the regulatory process. There was limited support for creating an advocacy panel fund, as it was not clear how such a body would be funded. Consumer advocates claimed that limited resources would be better directed towards other areas. But the UK regulator did create the Consumer Challenge Group, made up of paid consultants to advise on the 2005-2010 electricity distribution price-control settlement. Experts were appointed to challenge the regulator's assumptions that consumers would benefit from its approach to price settlement. Specific issues included the weighting and calibration of incentives and how OFGEM should apply return on required equity analysis to determine the cost of capital for operators. Such mechanisms of scrutiny of the regulator's work embody the principle that regulation of a vital sector such as electricity is too important to be left to the implicated professionals.

Summary on consumer engagement

6.53 The Council suggests better consumer engagement in the development of energy policy and market rules. In particular, policy makers and regulators need to acknowledge that consumer interests in the energy market are disparate and may even conflict, for example, between commercial and household consumers and between different income levels among household consumers. Sufficient resources are needed to ensure that such conflicts can be resolved at the policy level and that consumers are able to participate in system planning and pricing.

Chapter 7 Key Considerations for the Future

Context

7.1 For 50 years, energy policy in Hong Kong has relied on light-handed regulation in an effort to drive efficiencies and improve outcomes for consumers. In more recent times, the impact of energy price rises, particularly on residential households on low and fixed incomes, coupled with a growing concern to reduce particulate and greenhouse gas pollution, have together widened the focus of all stakeholders and raised awareness of the need to deliver for consumers.

7.2 It is clear that both cost and price increases are far from abating. Key drivers for increased energy prices include:

i. The need for new investment to replace ageing infrastructure;

ii. The current policy goal to keep a relatively high generation capacity margin to meet peak demand;

iii. The escalation in price of fuel inputs;

iv. The current contract based form of regulation through the Scheme of Control Agreements (SCAs) for the regulation of monopoly infrastructure, and the limited ability of the regulatory framework to limit ongoing price rises; and

v. Policies to reduce the use of high sulphur coal and to reduce carbon emissions by electricity generators in Hong Kong's effort to respond and adapt to climate change.

7.3 In the main, Hong Kong does not rely on the rubric of the market to deliver energy services. Market based approaches can, if well designed and effectively implemented, facilitate efficient and low-cost outcomes for consumers. However, growing concerns about energy price rises and achievement of environmental objectives indicate that the limitations of both regulatory frameworks and free market mechanisms have not been well understood. The Council hastens to add that Hong Kong is not alone in this.

7.4 The Council, together with the expert group engaged, consider in detail whether the existing energy policies and the regulatory framework that applies to them, including the ability for consumers to participate meaningfully, operate in a way that best serves the interests of consumers. The report provides an overview of policy and regulatory

developments with a specific focus on areas that require attention. Supply side possibilities, demand side interaction, energy efficiency, policies for disadvantaged consumers, regulation and sustainability are all considered.

7.5 The report identifies the central challenge facing the energy sector in Hong Kong—the need for it to deliver energy services that are at once affordable, reliable and sustainable. The report draws on international developments from around the world, particularly from Australia, the US, Mainland China, the UK and elsewhere in Europe. It finds that, in many energy markets, the goals of efficiency and competition have not usually benefited consumers in these three key areas.

7.6 Throughout, the report makes a number of suggestions to formulate a policy and regulatory framework that has a more rigorous focus on the interests of consumers. It is hoped that the steps suggested will help the Council to engage stakeholders concerned and consumers on reform measures that will best serve the interests of consumers.

7.7 Energy companies need to build consumer trust, i.e. to move from being a source of bills to becoming energy service providers. This will require quality services, together with accurate, timely and comprehensible bills, as well as swift dispute resolution schemes and accessible administrative systems. Also needed is a remit that widens out from supply of energy to take in energy advice that should result in a reduction in consumption. Suggestions are made to move in those directions.

A Gradual and Progressive Reform

7.8 The Council finds that the Hong Kong electricity market regulatory system, based on the traditional regulated monopoly structure, has provided consumers with affordable and outstandingly reliable electricity supplies. This is a considerable achievement. By contrast, research from various jurisdictions shows that results with the competitive model have been mixed and sometimes poor, especially at retail level. A particular and repeated failing with the competitive model has arisen from attempts to transplant whole structures from countries perceived as having been successful, to other countries, with little recognition of local conditions, resources, priorities, political and cultural traditions. This is not to say that lessons cannot be learnt from other countries. On the contrary it is our duty to bring them to wider attention. But these lessons have to be applied sensitively.

7.9 The Council concludes therefore, that it would be unwise to abandon the existing model immediately in favour of an unproven and uncertain alternative. This is not to say the

existing model cannot be improved or that it will not need to be adapted to meet future challenges, but that change should be incremental and gradual with an emphasis on ensuring that the strengths of the existing system are not lost.

7.10 There are two broad reasons for this view. Firstly, as the Council points out the current regulatory regime is not flexible enough to adopt the new environmental policies which need to focus on emission reduction over the next 30 years. Furthermore, the scheme is not fair to consumers in that the two power companies are allowed to earn a high permitted RoR on their assets and to transfer to consumers the business risks associated with fuel price fluctuations, operational cost and forecasting error in relation to electricity demand.

7.11 Secondly, even if the Scheme of Control (SoC) were totally unsatisfactory, it is not legally possible to institute radical short-term change. The processes and time periods built into the SCAs are likely to be enforceable by the owners and there are built-in compensation arrangements should the Hong Kong Government adversely affect the interests of the companies.

7.12 In addition to the 'traditional' objectives of affordability and reliability, long supported by the Council, there is a third pillar of energy policy, sustainability, which is assuming increasing importance as the need to combat climate change assumes greater importance. Energy policy has always involved trade-offs between objectives, for example, greater reliability generally comes at a cost, but meeting sustainability goals as well will make these dilemmas sharper. The working assumption must be that meeting sustainability goals and perhaps increasing world fossil fuel prices will inevitably increase the cost of power.

7.13 The fundamental objective of the competitive model was to improve affordability because of the perception that the monopoly model led to inefficiencies. It is debatable whether the competitive model has improved affordability in practice, but in any case it appears ill-equipped to deal with the issue of climate change. The challenge is to find solutions that retain the control over outcomes that a monopoly structure brings while imposing greater competitive pressures to ensure prices to consumers are kept as low as possible within the constraints of cost recovery.

7.14 The current reform process appears to be based on a fragmented approach, dealing with issues sequentially with, for example, the 'fuel mix' as the first issue to be reviewed by the Hong Kong Government. While this appears to make the task more manageable by dividing it into discrete areas, the issues cannot be compartmentalised in this way.

Choices on the fuel mix will have implications, for example, for affordability and environmental impacts and coherent policies can only emerge from a holistic approach.

7.15 The Council has considered three principal issues: market liberalisation, sustainability (including fuel mix) and regulatory development, including the protection of low income consumers.

Market Liberalisation

7.16 The Council identified in Chapter 2 three broad conclusions about liberalisation in other countries that have implications for Hong Kong. What all have in common is disappointment with the practical results of service liberalisations as compared with the theory. The three key observations from overseas experience are the following:

Observation 1: Unbundled markets tend to 'rebundle' if left to their own devices; furthermore, they may do so in a competitively damaging way by consolidating generation and retail supply.

7.17 This syndrome is partly because of the intrinsically uncompetitive nature of electricity, which is an essential product of great technical complexity, cannot be stored and requires supply and demand to be reconciled simultaneously through networks that are natural monopolies. If the experience of other countries has not been promising in this regard, then it is likely to be even less promising in Hong Kong as a result of the limited possibilities for competition in this relatively small and geographically constrained market.

7.18 This is not to say there is no scope for competition in the sector. Around the world, the greater gains from competition have come within the generation sub-sector where competition long predates liberalisation and was implicit in the traditional public sector 'merit order' systems. It could also bring benefits within innovative sectors such as renewables, where new entrants are sought. Regulatory adjustments need to be made to enable market access in this regard.

Observation 2: Retail competition imposes additional costs on consumers and is prone to complexity leading to consumer error so that many consumers end up with the 'wrong' deal.

7.19 The signs are not encouraging regarding the scope for retail competition, which has shown severe flaws in overseas markets where it has been tried for domestic households and relatively small markets such as Hong Kong could be at risk. In the UK,

high proportions of consumers (as much as half of low income domestic consumers switching retail suppliers following bad advice from salespeople) have been found to make switching errors, thus acting against their own interests. Furthermore, even those consumers who make the right decision for themselves are imposing costs on the system, as the cost of setting up switching operations is very high.

Observation 3: Retail competition has conferred more benefits upon commercial users than on domestic consumers.

7.20 In competitive markets, the onset of greater freedom for commercial consumers to switch suppliers has been advantageous to them. The effect has been to rebalance cost allocation between corporate customers (such as industry and commerce) and domestic households, to the detriment of the latter. One justification advanced for this tendency is that in the past domestic consumers often gained from a price discrimination in their favour which has been 'corrected' as a result of the 'rebalancing' between domestic and commercial prices. Some argue that this earlier discrimination in favour of domestic consumers had masked the intrinsic expense of serving large numbers of small consumers as opposed to a few large ones. Without the comparative data, which has often been concealed by commercial confidentiality, this argument is hard to test.

7.21 The Hong Kong Government has signalled an interest in price rebalancing to move away from the alleged cross-subsidy from commercial to domestic consumers in the current pricing system. While there does need to be an Inquiry into actual costs and benefits, it is by no means clear that this cross subsidy exists or at least that it exists in the form thought by many. As indicated above, the experience from the rest of the world following liberalisation indicates movement in the other direction. This shift has been attributed by some commentators to retailers allocating their more expensive power purchases to the residential market. This strategy was said to be based on an assumption by the companies that residential consumers lacked expertise and negotiating power.

Sustainability

Security of supply

7.22 In Hong Kong, great emphasis is placed on security of supply because of its unique characteristics that would make the consequences of failure of the electricity system potentially catastrophic. The security of supply in Hong Kong is at world-leading levels. However, this insistence on security of supply may be standing in the way of measures

that would maintain existing standards but achieve them at a lower cost. For example, the existing plant margin, which is the amount of capacity kept in operation over and above the maximum demand in order to cover for plant breakdowns and unexpectedly high demand, is about 45%. It is highly unlikely that reducing this to about 25% would have any measurable impact on security of supply. This would be especially so if measures were taken to include greater use of 'demand side response' to meet peaks in demand. This would involve giving users financial incentives to reduce their demand at peak times, for example, by reducing the air-conditioning load – a particular burden in Hong Kong (see Annex D).

7.23 The savings from reducing the amount of plant that has to be kept in reserve to meet peak demands could be shared between the specific consumers involved and consumers in general. Such measures are relevant to broader sustainability issues as they may free up revenue for use on energy saving measures. The Council thinks security of supply standards must be maintained but a thorough review is required to identify measures that would allow the existing standards to be met, but at lower cost.

7.24 Having signalled its intention to move towards a more competitive market, the Hong Kong Government has expressed interest in exerting some influence over the energy mix. Hence the Environment Bureau consultation paper sets out two highly specific options, one to import more electricity through purchase from the Mainland power grid and the second to use more natural gas for local generation. Responses from the Council concluded that: 'neither option stands as the best possible platform for energy policy to proceed in Hong Kong' and asks for a wider range of possibilities to be considered. The Council believes they should encompass both supply side (including renewables), and demand side measures (including energy efficiency).

Supply side – use of natural gas for power generation

7.25 Use of natural gas as a power station fuel has grown significantly in the past decade, bringing environmental benefits and increasing diversity of energy sources. This has been recognised by the Environment Bureau consultation paper. However, unlike many other developed economies, the use of natural gas apart from power generation remains negligible in Hong Kong. Many developed countries such as the UK, Netherlands and Denmark, have been using natural gas for a much wider range of applications than just as a power station fuel, including direct use by consumers for cooking and water heating, and small-scale co-generation by users, all at lower cost.

7.26 Hong Kong is one of the few jurisdictions still to use town gas (a mixture of hydrogen, carbon monoxide and methane) rather than converting its network to natural gas.

Natural gas could also be used as a fuel for small-scale electricity generation for large buildings with use of the 'waste heat' for example to provide hot water. This would provide a useful addition to generating capacity at high efficiencies and with benefits to the users.

7.27 Comments from the incumbent player indicated implementation difficulties and economic unviability to convert town gas into natural gas for direct use by consumers due to the distinct characteristics of people living in high-rise buildings and the cost to consumers for changing the gas appliances. However, the possibilities of enabling commercial small-scale generation have not been explored. In fact, based on the conclusions of the report of the Feasibility Study on Introducing a Common Carrier System for Gas Supply in Hong Kong released in 1997. It was technically viable to convert the existing Towngas network to natural gas network and the introduction of natural gas into Hong Kong was best managed by a market based development programme, with third party access offered. Unfortunately the recommendations were not taken forward due to the uncertainty of securing economic and stable supply of natural gas by then. Given its rapid increases in the global reserves, presence of more natural gas pipelines connecting to Hong Kong and technological advancement in small-scale electricity generation, it would be worth considering to conduct a feasibility study to look into the viability for enabling small-scale generation.

7.28 To increase plant efficiencies and to reduce emissions of greenhouse gases, consideration should be given to upgrading the gas-fired plants in Hong Kong to the latest design of combined cycle gas generation.

Supply side – use of renewables

7.29 One of the most important options for reducing emissions of greenhouse gases from power generation is a major increase in use of renewable technologies. Each country has its own unique set of resources, there is no universal recipe for successful and cost-effective expansion of use of renewables. The view of both the Hong Kong Government and the utilities is that the scope for renewables is small, perhaps of the order of 1-3% of electricity supply.

7.30 In studying international experience, in particular in the EU, with the development of renewable energy, it is clear there have been initial problems and transition to renewables will tend to increase costs for consumers.

7.31 It is clear that if a government wants companies to invest in technologies or fuel sources that are not the cheapest available it will have to compromise the market by finding a

way to reduce or remove the exposure of that asset to the market. Just throwing the promotion of low carbon fuel sources into the mix of the regulatory process on top of measures to promote service wide competition does not resolve this problem, it simply passes the dilemma on to regulators. This has happened in several jurisdictions with predictable confusion resulting.

7.32 It would be difficult to reconcile a mandated fuel mix with a competitive market; market instruments have been used in Europe to meet the need for greenhouse gas reductions and while there have been problems, experience should provide useful lessons for Hong Kong to determine which method to use and how to design it.

7.33 Despite early problems, there are positive lessons from experience in other countries. Firstly, if opportunities for renewables to enter the market are created, the scope tends to be far more than expected and at lower cost than forecast. Secondly, large traditional utilities are often not the most effective at deploying renewables in an efficient way. Thirdly, the cost curve for renewables is on a strong downward trend as new technology options are emerging.

7.34 It is therefore important that the scope for renewables be tested using measures that encourage their emergence. This might be done through 'Feed-in Tariffs' (FiTs), under which renewable generators are guaranteed to be able to sell their output at a fixed real price, or by capacity auctions, under which a given amount of capacity is made available and the lowest bids necessary to meet this amount are given long-term fixed price contracts. The initial prices will tend to be high, but should fall as the local industry for renewables matures. Boxes 5.2 (wind power) and 5.4 (FiTs in Germany) provide clear evidence for this worldwide trend including in particular China, where FiTs have been particularly successful.

7.35 Setting a mandated fuel mix may be too rigid an approach if applied fuel by fuel, when there is so much uncertainty about future prices, technology availabilities and policy requirements. Experience in other countries suggests there is no clearly superior method of introducing renewables. All have strengths and weaknesses and their success depends on how well designed they are. A methodology for obtaining fuel mix changes does not have to come from precise specification of the renewable sources. For example, in October 2014, the EC has just announced that by the year 2030 it expects 40% of all power supply to come from renewable sources. While this is higher than might be contemplated for Hong Kong for the immediate future, it may not be out of the question to consider successive targets of say, 10%, 15% and even 20% by 2025 or 2030. As Box 5.2 shows, wind alone is projected to account for 15% of global electricity production by 2030.

7.36 Furthermore, other benefits may follow as a matter of course. For example, a generic renewable obligation might reduce the need for detailed regulation of particulate matter in the fuel mix, such problems would become more self-correcting as the overall renewable proportion rises.

7.37 This report is not able to provide an accurate forecast of future installed wind power costs per GW for Hong Kong. However, it is suggested that policymakers should keep the option of renewable energy from wind power as an active part of future scenario planning. Box 5.3 demonstrates how use of renewable as part of the fuel mix has a limited effect on overall costs of electricity. The example of China (see Box 5.2) has shown what deliberate government action can bring about and suggests that with aggressive growth targets and falling costs plus the will to confront huge environmental issues, wind power is an important option.

7.38 Hong Kong could build on the considerable work already undertaken by both electricity companies to determine whether a future including wind power might be an outcome of the current policy processes. It should be borne in mind that in calculating the capital cost, Hong Kong's small land surface should be taken into account for land-based wind power versus its offshore equivalent. Enabling measures should be taken to test the scope and cost of renewables. This will determine whether there is scope for a large renewables contribution to Hong Kong's electricity mix and will allow, if needed, an efficient local supply industry to emerge.

Supply side – other options

7.39 One option proposed under the Environment Bureau consultation paper is to purchase electricity from the Mainland power grid i.e. importing electricity from Southern China. There is no doubt that the rapid development in Guangdong has also driven the rapid increase in energy demand which would thus be competing with Hong Kong on electricity generated. Although natural gas and nuclear are heavily used to meet environmental targets, fossil fuels will continue to be the leading source of the region's electricity generation and installed capacity. Therefore, it is uncertain whether cleaner and cheaper electricity could be imported to Hong Kong. Having said that, the outcome is subject to national policy and inter-governmental collaboration, and thus, this option should not be left out while Hong Kong reforms its structure to meet demand in future.

7.40 Nuclear power is a 'low-carbon' generation source (it leads to lower emissions of greenhouse gas than fossil fuels) and therefore should be considered when discussing climate change issues. It brings with it, its own set of environmental issues that need to be factored into the discussion. The development of nuclear power to serve Hong Kong

in particular is discussed in Chapters 3 and 5 and in Annex A. Safety concerns with nuclear power translate inevitably into higher costs, which have ultimately to be borne by the consumer. The recent deal announced in the UK in October 2013 for a consortium led by EdF of France and involving two Chinese firms, is not encouraging in this regard. It guarantees a wholesale price to the plant owners of almost twice the current one, and underwriting by the UK Government (i.e. the taxpayer) of a sum whose estimates increased fourfold during the course of the project proposals. The point has been made in answer to the above that the true comparator should be not with current prices but with future prices from non-CO_2 producing fuels. This is a valid point in theory, but the length of time to elapse before the station comes on stream, (9 years) means that all estimates are uncertain. As a result of cost overruns, a similar plant in Finland is estimated to cost 250% more than the initial estimates, and the project is now 9 years late. The potential advantages from nuclear energy are far from clear in price terms given the uncertainties around the evolving technology.

7.41 The decision whether to try to expand Hong Kong's use of nuclear power is one that falls under the remit of the Hong Kong Government. The Council are not necessarily arguing for or against expansion of the nuclear contribution, but any decision to commission more nuclear capacity should be based on a thorough evaluation of its cost and availability and the environmental issues raised by the nuclear option.

Demand side – energy efficiency

7.42 As stated earlier, the cheapest energy is that which is not used. Those '*negawatts*' can be unlocked by energy efficiency measures. There is considerable scope to increase the extent of measures to improve the efficiency of electricity use. For residential consumers, this would include incentives to choose energy efficient appliances, such as lighting and fridges, while for commercial consumers, there is also scope for use of more efficient equipment. There is likely to be considerable scope to improve the fabric of buildings through better insulation and double glazing, reducing the heating and cooling demand load. The most cost-effective measures are likely to be for new buildings through ensuring that stringent energy efficiency standards are imposed. Increased energy efficiency measures will have the double benefit of reducing electricity consumption and therefore environmental impacts as well as helping ensure power supplies remain affordable despite rising real prices.

7.43 A much stronger energy efficiency effort is likely to be a 'no-regrets' policy providing reduced environmental impacts and improving affordability. This may well also improve security of supply as a result of reducing demand, especially at peak times.

7.44 The draft fourth technical Memorandum, recently issued by the Secretary for the Environment, attaches relatively little significance to demand side management. It stops short of specifying other energy savings measures such as incentivising consumers to save electricity through the tariff structure or through mandatory energy efficiency labelling schemes to encourage consumers to use energy efficient appliances. This could include, for example, switching from high consumption lighting to more efficient lighting technologies, phasing out of incandescent light bulbs and implementing district cooling systems.

7.45 The fourth technical Memorandum, in common with the first three, does not impose any mandate for significant capital expenditure and attempts to prevent significant price effects. In consequence, the overall ambitions for Hong Kong in both cleaning the air and reducing carbon pollution are not advanced very far. A more ambitious policy could be to consider the earlier than planned phasing out of one or more of the oldest and least efficient coal-fired power plants. The kind of dramatic savings that could come from the kind of sustained energy efficiency programme that this report suggests could possibly make this objective attainable.

Regulatory Development

7.46 The Council is considering the necessary changes to the regulatory regime to achieve the objectives of enhanced consumer welfare in terms of safety, reliability and affordability. It aims for the regulatory machinery to supervise the integration of the currently distinct geographical markets of Hong Kong Island on the one hand and Kowloon and the New Territories on the other.

7.47 The Council acknowledges that the existing method of regulation, the 10-yearly SCAs, must take some of the credit for the high standards of affordability and reliability that the Hong Kong electricity industry achieves. However, as discussed in several parts of the report including Chapter 4, concerns exist for the high RoR it allows the companies and for not being more open and representative. The policies outlined above will place a much stronger demand on the regulatory system and a thorough regulatory review coupled with the setting of a roadmap for reform is opportune.

7.48 Several times in the past, the Council has taken an interest in the future of electricity/energy regulation, but each time there has been no major change. In 2003, the Energy Advisory committee reviewed some aspects of RoR on investment but left the SCAs much as it was before with some reduction in the RoR. Rather than a scheme for providing a guaranteed RoR on investments, there needs to be a bigger step with wider review and clearer disclosure of the costs of alternative forms of provision of

energy services. Modern forms of economic regulation are moving away from the somewhat circular debates about price cap or RoR (reviewed in Chapter 2) and now aim to reward efficiency and cost cutting while also allowing for investment in future needs, such as the development of renewables.

7.49 There is no clearly superior model that can be transplanted to Hong Kong, but the characteristics of a good system are well-known. They include: transparency of corporate information and regulatory analysis; due process in regulation, maintaining a fair balance between producers and consumers and between different classes of consumers; ensuring dominant parties do not exploit their position.

Access to networks – a critical enabler

7.50 Greater use of renewables and small-scale co-generation will require these new sources to have fair access to the network at non-discriminatory prices. So this is one form of increased liberalisation that the Council can well envisage and would support taking place. Experience elsewhere suggests incumbent utilities are reluctant to grant access to their networks because they perceive this as a competitive threat. This problem has been addressed by stronger regulation to prevent incumbents freezing out new entrants and by 'unbundling the networks' both to reduce the scope and incentives for keeping new entrants out. At one extreme, unbundling might involve no more than requiring the incumbent to keep separate accounts for their network business and at the other, it might require the network to be sold off as an entirely separate company. An alternative option is to take control (rather than ownership) of the network away from the incumbent utility and put it in the hands of an independent system operator (ISO). For relatively small jurisdictions like Hong Kong, creating separate network companies might be expensive and would result in rather weak companies not able to finance significant network investment.

7.51 The evidence discussed in Chapter 5 suggests that the development of renewables and small-scale co-generation in particular will require network access to be facilitated. Therefore control of the network should be reviewed to ensure that new generators are able to access the network on the same terms as the incumbents.

Interconnections

7.52 If the option of importing electricity from Southern China is pursued, new transmission links to Hong Kong are a must. However, there is also a need to consider improved interconnection within Hong Kong. The Hong Kong electricity system comprises two effectively separate parts, Hong Kong Island and Kowloon & the New Territories with a

connection only sufficient to provide some degree of security of supply. A much stronger interconnection between the two systems would allow the generation mix to be optimised across both systems, so if cheap generation was available, unused in, say, Kowloon, the power could be transferred to Hong Kong Island, reducing costs for consumers in both systems.

7.53 So, expanding the interconnector is about improving economic efficiency by being able to reduce reserves while retaining reliability. If offshore wind development were to go ahead, that would also require for benefit from interconnection between the two systems. As Box 5.1 demonstrates, it is difficult to estimate the actual costs of the interconnector because that depends on the technology used and the decisions on route. This requires independent study. The companies may well be apprehensive about such a development as it might limit their monopoly power and perturb their working arrangements as has been the case in Germany and Australia for example as supply from renewable sources has rapidly developed.

7.54 Creating a wholesale electricity market could be done on a free market basis, as has been done throughout the EU. However, design of efficient wholesale markets has proved difficult, with many markets subject to manipulation and gaming. A less risky alternative would be a more cooperative approach whereby the savings from ensuring that the cheapest sources of power were used were then shared between the two major companies and with consumers. As with security of supply discussed above, these savings could bring advantages in terms of sustainability. The cost-effectiveness of a further interconnector between the two systems for Hong Kong should be investigated.

Protection for low-income consumers

7.55 The Council has dealt in some detail with the issue of fuel poverty which is discussed in Annex E. There are some tariffs to help low-income households, that provide low prices for the initial tranche of consumption but it is not clear how effective and how well targeted these tariffs are. For example, multi-occupancy dwellings may use large amounts of power split between several households who would not benefit from these tariffs.

7.56 That raises the question of the other conventional form of help to low income households, namely the benefits system. The evidence suggests that there are take-up problems in Hong Kong concerning entitlement to benefit not being exercised by consumers and these problems echo those found in many countries around the world. This in turn suggests that reliance on income support mechanisms can only be partially successful in mitigating fuel poverty.

7.57 Given the limitations then of a tariff based approach and an income support approach, the Council suggests that the preferred measure to deal with this issue should be a well-targeted energy efficiency programme so that low-income households can receive the energy service they need but for a lower consumption of power, rather than just be compensated for and thus locked into inefficient systems.

7.58 Most low income families live in public rented housing, which seems therefore to represent a positive targeting of public resources and that suggests that programmes related not just to income but to building improvement and energy efficiency in this sector of the housing market would be well targeted.

7.59 With the expectation that electricity prices will have to rise, it is important that thorough investigation of the extent and location of 'fuel poverty' is undertaken to ensure that low-income households are able to consume the electricity they need to ensure their well-being. There is an urgent need to quantify and locate the extent of 'fuel poverty' so that policies can be put in place that will ensure low-income households can afford the power they need to protect their well-being.

7.60 To this end the Council very much welcomes the re-establishment of the Hong Kong Commission on Poverty and its comprehensive Situation report for 2012 on which the Council have drawn extensively (see postscript at end of Annex E). However, the specificities of fuel poverty policy require further factual questions to be asked that have been set out at the end of the main text of the Annex. These matters need to be clarified before a definitive policy is arrived at.

7.61 In scoping and defining the fuel poverty issue of Hong Kong, it would be highly desirable to put the welfare of low income consumers as an explicit obligation of the regulatory system. Among the many advantages of improved energy efficiency is that it reduces the acuteness of the dilemma by reducing consumption relatively painlessly. It is important to reiterate that the three elements of affordability, reliability and sustainability need to be taken together.

The regulatory body

7.62 The current SCAs have a remaining tenure of less than 4 years before their expiry in 2018. It should be a reasonable expectation for all stakeholders concerned, particularly the consumers, that the Hong Kong Government would review, plan and design a proper and sustainable regulatory model that could fulfil the objectives of delivering safe, reliable, affordable and green electricity services for Hong Kong.

7.63 As the development progresses, the Council would see the necessary formation of a full-fledged energy sector regulator to tackle the complexity of the issues involved, and in particular to meet the future challenge of competing objectives of the Hong Kong Government's energy policy.

7.64 Operating under the principles of transparency and impartiality, such a regulator in its design should mirror the scale and structure of the industry. When designing the system, care must be taken not to create one that is too small to be effective. For example, it might be desirable to consider consolidating relevant functional units under the Hong Kong Government system such as regulators of other public services, to form a larger regulatory body that could have stronger empowerment and a career structure that would be more likely to retain the best talents.

7.65 There is an important distinction to be drawn between representation of consumers as individuals and as a collectivity. The former involves taking complaints and settling disputes between individual account holders and service providers. The latter involves representation of the consumer interest in deciding policy or making regulatory decisions such as setting limits on tariffs or RoR. The Council holds the view that both functions are important and a proper mechanism should be put in place in the new regulatory body to enable both so that one feeds the other. If not housed in the same body, there needs to be a mechanism for complaints to inform policy.

Annexes

Annex A: China's Nuclear Power Capability

A.1 For several decades, China was forecasting a rapid expansion of its nuclear power capacity. However, until 2008, these forecasts were not supported by orders and it only had 11 reactors in operation, several of which were small. However, in 2008, China started construction on 6 reactors, in 2009, it started construction on 9 reactors and it started building 10 reactors in 2010. In this 3-year period, it accounted for two-thirds of the nuclear reactor construction starts worldwide.

A.2 However, the technology that dominated these orders was an old technology, M310, licensed from the French company Areva (to be precise, its predecessor company, Framatome), who first started building the basic design in 1971. Areva had in turn licensed this basic design from the US Company, Westinghouse, who had started building it in the 1960s. Whilst some updates to the design had been made, it is still fundamentally a very old design that would not be licensable for new build in Europe or the US. Indeed, the French government has refused to allow Areva to permit the Chinese licensors to export their version of this design. The Chinese government acknowledged this old design was not a long term option and is now looking to start building the latest generation designs, so-called Generation III+, and has imported two new western designs. However, these new designs may well be too expensive.

A.3 The generation design of a nuclear power plant is not a precise concept. Broadly, Generation I designs are the early prototype and demonstration units, Generation II designs include the majority of operating reactors and were designed from the late 1960s to about 1980. Generation III designs are those produced after the Three Mile Island accident. There are relatively few such reactors in service. Generation III+ are designs made taking account of the Chernobyl disaster. There have been orders for 12 reactors of this type, either the AP1000 or the EPR, but none of these was in service by mid-2014. Table A.1 shows that up to 2008, ordering in China was sporadic and distributed between a number of suppliers with more than half imported, including reactors from France (M310), Canada (CANDU6), and Russia (V428). Two designs for small reactors were ordered from China National Nuclear Corporation (CNNC), while China General Nuclear (CGN) collaborated with Framatome building four reactors of the M310 design in the Guangdong region, including the two-unit Daya Bay plant, which exports its output to Hong Kong. CGN received its first three orders for its own version of the M310, the CPR1000, under licence from Areva from 2005 onwards.

Table A.1 Reactors Ordered before 2008[115]

Design	Type	No. Ordered	Supplier	Size (MW)	Year of Construction Started	Year of First Operation
CNP300	PWR	1	CNNC	300	1985	1991
CNP600	PWR	4	CNNC	600	1996, 1997, 2006, 2007	2002, 2004, 2010, 2011
CANDU6*	PHWR	2	AECL	600	1998, 1998	2002, 2003
M310*	PWR	4	Framatome/ CGN	950	1987, 1988, 1997, 1997	1993, 1994, 2002, 2003
CPR1000	PWR	3	CGN	950	2005, 2006, 2007	2010, 2011
V428*	VVER	2	Rosatom	1000	1999, 2000	2006, 2007

Note: Designs marked * are primarily imported

A.4 Around 2007-2008, there was a clear change of gear for nuclear. Six new construction starts were made, four for the CGN CPR1000 version of the M310, and two supplied by CNNC using its own version of the M310, the CNP1000. Recognising that the M310 was too old a design to be a basis for long-term ordering, China negotiated with Westinghouse, for the AP1000, and Areva, for the EPR, to import reactors and transfer the technology so that China could build its own version of these designs. The contest was won by Westinghouse who collaborated with a third Chinese nuclear vendor, State Nuclear Power Technology Corporation (SNPTC), which at that time, had not supplied any reactors. A year later, Areva won two orders for its EPR in collaboration with CGN although there was no expectation of further orders for the EPR and AP1000 was expected to take over nuclear orders in China. China was increasingly mentioned as a potential exporter of nuclear power plants, for example, to South Africa and even the United Kingdom (UK), but the French government made it clear they were not prepared to allow Areva to sanction exports by CGN and CNNC of their versions of the M310 design.

A.5 The Fukushima disaster led to a moratorium on reactor orders in China and no construction starts took place in the period from December 2010 to November 2012. How far this was purely a result of the need to reflect on the implications of the Fukushima disaster and how far it was down to internal issues is not clear. There was a result of an increasing perception that AP1000 (and EPR) were too expensive and the three Chinese vendors were all developing their own advanced designs, expected to provide a comparable level of safety to the AP1000. There may also have been logistic and supply chain problems of providing the human and manufacturing resources for the ordering rate that had applied in 2008-2010, which exceeded even that of France in its peak ordering years of the late 1970s.

[115] http://www.iaea.org/PRIS/CountryStatistics/CountryDetails.aspx?current=CN.

Table A.2 Reactors Ordered from 2008[116]

Design	Type	No. Ordered	Supplier	Size (MW)	Year of Construction Started	Year of First Operation
CPR1000	PWR	13	CGN	950	4 x 2008, 3 x 2009, 5 x 2010, 1 x 2012	1 x 2012, 1 x 2013
CNP1000	PWR	6	CNNC	950	2 x 2008, 2 x 2009, 1 x 2010, 1 x 2012	-
AP1000	PWR	4	Westinghouse /SNTPC	1100	3 x 2009, 1 x 2010	-
EPR	PWR	2	Areva/CGN	1600	1 x 2009, 1 x 2010	-
CNP600	PWR	2	CNNC	600	1 x 2010, 1 x 2010	-
V428	VVER	2	Rosatom	1000	1 x 2012, 1 x 2013	-
ACPR1000	PWR	2	CGN	1000	2 x 2013	-

A.6 In November 2012, CNNC and CGN both started construction of one new reactor and a month later, a third reactor imported from Russia also started construction, but it was not until September 2013 that the next construction start occurred.

A.7 Three advanced Chinese designs were under development[117]: one by CGN in collaboration with Areva, ACPR1000, which appeared to be a scaled down EPR; one by SNPTC in collaboration with Westinghouse, CAP1400, which is a scaled up AP1000; and one by CNNC, ACP1000.

A.8 However, in July 2013, the Chinese government required CNNC and CGN to merge their new designs[118]. The merged design is known as the Hualong design, although CNNC and CGN would have their own distinctive versions. Nevertheless, in September and in December 2013, construction starts were made using CGN's ACPR1000 design. CNNC was reported to have received an order for its ACP1000 design for Pakistan. First orders for the Hualong design are not expected until 2015. No orders have been placed for the CAP1400 by August 2014 but it has been mentioned as a potential candidate for South Africa. The situation on nuclear technology choice for China is therefore evolving rapidly and it is far from clear what design will dominate orders. Whether any of the indigenous

[116] http://www.iaea.org/PRIS/CountryStatistics/CountryDetails.aspx?current=CN.

[117] http://www.iaea.org/PRIS/home.aspx.

[118] Nuclear Intelligence Weekly, *CNNC and CGN Struggle to Work Together on Gen-3 Design — at Beijing's Behest*, July 12, 2013, p. 3.

Chinese designs will avoid the problems of high cost that appear to have made the AP1000 and the EPR non-viable is far from clear.

A.9 China's reputation of building their nuclear power plants to time was damaged by the admission by a Chinese official that all 26 reactors on which construction started between August 2007 and December 2010 were behind schedule by between 1 and 24 months[119]. Information on costs is less freely available but the four AP1000s are about 20% over budget.

[119] Nuclear Intelligence Weekly, *Sanmen — Two-Year Delay Pushes Costs Higher*, March 14, 2014.

Annex B: Case Study – Why Did Prices Come down in the UK after Privatisation?

B.1 It is not difficult to isolate the main factors behind the price reductions that benefited small consumers in the UK following privatisation in 1990. The first point to note is that in the run up to privatisation in 1988 and 1989, the UK Government increased electricity prices by 7% above that required by the electricity industry, in order to improve the attractiveness of the industry to investors[120]. Reductions since 1990 should be seen in the light of these increases.

B.2 However, the two dominant elements of the price reductions since 1990, (standing in real terms at about 30% by around 2004), were clear and neither was the direct result of the operation of markets. Firstly, the removal of the nuclear subsidy in 1996 (mentioned earlier) reduced prices overnight by 10%.

B.3 But an even larger part of the price reductions came about because of the reduction in monopoly prices (i.e. in the regulated sector). For example, from 1990-2003, the distribution price charged in the Southern region of Britain (not untypical) fell by 50% and the national transmission price fell by 40%. Given that in 1990, distribution and transmission accounted for about 25% and 5% respectively of consumers' bills, these price reductions alone would have reduced the overall price by about 15%.

B.4 However the prices paid for assets at privatisation had a continuing effect on the price regulation process. When the change from 'price cap' to 'rate of return' methodology occurred in 1995, (see main report) the regulator had to set a value on the assets built before privatisation. The regulator chose to use the privatisation price as the value of the assets. Since this was only about a third of the accounting value of the assets, this led to immediate, large, one-off price reductions. In 1997, the transmission prices were reduced overnight by 20%, while in 1995/96, distribution prices were reduced by about 25% varying from region to region.

B.5 In this light, the reductions of 30% in prices to household consumers over more than a decade do not look so impressive. Very little of the price reductions can be attributed to the operation of markets. Yet, three main factors had led to significant real reductions in costs to generators, that could theoretically have been passed on:

i. Fossil fuel prices paid by British generators had fallen substantially in real terms

[120] G Yarrow (1992), *British electricity prices since privatisation*, Studies in regulation, no 1, Oxford Regulatory Policy Institute, Oxford.

since 1990[121], by about 50% for coal and 30% for gas;

ii. The electricity industry had been privatised for only about a third of its asset value. This meant that the generators effectively bought their power stations for only a third of their value; and

iii. New and more efficient generating technology, the combined cycle gas turbine (CCGT) became available.

B.6 The fact that so little of these cost reductions was passed on to small consumers suggests that the wholesale and retail power markets are not as efficient as has been alleged by advocates of liberalisation[122]. This example is important because of the significance that the UK has taken on in the debate about the future of the sector. Beneficial results have been attributed to the British model which do not stand up to closer scrutiny and which have been then used as the model to emulate elsewhere in the EU, and indeed the world.

[121] From 1992 to 2000, the price paid by generators for coal fell by 50% and the price paid for gas fell by nearly 30%. See P Wright and S Thomas (2001), *Empirical reflections on the liberalisation of the UK electricity supply industry*, Economia delle Fonti di Energia e dell'Ambiente', no 2, pp 7-24.
[122] See Evans, OECD 2006.

Annex C: Smart Meters

C.1 To meet the growing demand for time-of-use metering and as a means of providing users with a wide range of consumption information, many jurisdictions are now installing more sophisticated metering systems. These are sometimes known as smart meters.

C.2 Smart meters have the potential to assist households with the issue of rising electricity prices by redressing the balance of power between the energy industry and consumers. Smart meters are designed to provide customers with information about their energy consumption that allows consumers to better manage their energy needs. Customers may also take advantage of on- and off-peak tariffs by adopting time-of-use pricing. Smart meters have three essential features which distinguish them from conventional electromechanical 'spinning disc' meters and from standard interval or accumulation meters:

i. The meter records electricity consumption data at frequent intervals, typically half -hourly;

ii. The meter transmits that information regularly to the electricity suppliers, typically at least daily; and

iii. The meter can facilitate remote control, that is, energy suppliers can perform some functions from a distance such as connection and disconnection or controlling power supply. Some schemes provide that a supplier may in extreme circumstances remotely switch off electrical appliances such as air-conditioners or to reduce their level of consumption.

C.3 Many jurisdictions around the world have mandated the installation of forms of smart meter, but this comes at a very high cost. In the UK, the regulator, Office of Gas and Electricity Markets (OFGEM) has found the cost-benefit calculation in relation to general household rollout of smart metering provides very few benefits over the substantial costs. In Victoria, Australia, the Australian Government halted the rollout of smart meters some years into an installation program mainly due to adverse consumer reactions from the high costs involved.

C.4 The absence of a clear-cut cost and effort equation for ordinary domestic consumers, however, should not be a barrier to smart meter installations in the commercial and office sectors of Hong Kong. As noted elsewhere in this paper a large proportion of Hong

Kong's electricity consumption (around 30%) is down to the use of air-conditioning and two-thirds of that in commercial and office environments.

C.5 For the purposes of this paper, the following possible benefits of smart meters describes potential benefits in the commercial and office sector rather than a rollout to all consumers.

C.6 Smart meters may create more informed commercial consumers and enable energy companies to offer more innovative deals for customers to choose from. Although smart meters will not solve energy supply issues such as peak demand or rising prices simply by virtue of their existence, they are a necessary step to enable the movement towards a more effectively and efficiently managed network supply.

C.7 Smart meters can, when used properly, lead to better pricing outcomes, including:

i. Consumption (or demand side) management to optimise the use of networks and generation, particularly by varying the times of consumption. This reduces the pressure for new investment in network and generation infrastructure;

ii. Enabling pricing options that recognise the benefits for consumers in managing their power usage; and

iii. Enhanced information for use by the network operator, such as power quality; and safety and fault monitoring information, such as neutral fault detection.

C.8 Smart meters are also a key component in increasing the information and control capabilities for commercial consumers, possibly through local area networks, which enable advanced capabilities such as the remote control of machines and appliances. A local area network can be used to turn off certain appliances at times of peak consumption, show the consumer the real time cost of consumption and enable consumers to manage their consumption to save money.

Annex D: Case Study – Air-conditioning and Consumer Behaviour

D.1 When the Government said that a cleaner environment is an important priority for Hong Kong, it was referring specifically to issues relating to energy mix. While substituting lower carbon energy sources for coal will be a vital step in reaching environmental objectives, there are additional options which involve changes to consumer behaviour which can also bring about dramatic environmental improvements. Perhaps most important area to consider is whether the current and future impacts of air-conditioning in Hong Kong can be mitigated through changes to the information regime and well-targeted incentives. This case study examines the case for social intervention in Hong Kong's consumption of air-conditioning.

D.2 Perhaps the most extreme example of energy consumption and air-conditioning can be found in the city of Mumbai in India where air conditioners use about 40% of all electricity consumed. Not far behind however is Hong Kong where air-conditioning currently accounts for around 30% of the total electricity consumption of which 68% is taken up in non-domestic premises[123]. This compares with about 5% of all the electricity produced in the UK where two-thirds of all homes have air conditioners. Just about every visitor to Hong Kong will notice or comment on how cool it is in commercial centres and office buildings. Research shows that where air-conditioning is available the result is that summer temperatures inside buildings tend to be lower than winter temperatures. Not only is this perverse intuitively, but in biological terms it pushes against the human body's natural ability to adapt.

D.3 During summer building owners set their air-conditioning at a lower temperature than the average lows of 25°C during winter. It is common to find temperatures well below 20°C or even 18°C.

D.4 Energy efficiency consultants and health experts agree that for maximum comfort, the thermostat should be set between 23-25°C in summer and 18-21°C in winter. Additional heating or cooling results in considerable additional energy use. In summer, increasing the thermostat temperature of air-conditioning system by just 1°C can reduce related energy consumption by around 10%, it could help to reduce about 3% of electricity consumption[124] and significantly reduce carbon pollution as well[125].

[123] http://www.emsd.gov.hk/emsd/e_download/wnew/conf_papers/Climate_Change_Conference_Paper_WACS.pdf.
[124] http://powersmart2013.foe.org.hk/eng/?tips.
[125] http://www.originenergy.com.au/4397/Heating-ventilation-and-air-conditioning.

D.5 While it is not possible to precisely quantify the saving in energy consumption for a given increase in temperature setting, it is nonetheless a worthwhile exercise to consider the consequences of a failure to act:

i. Most facilities consume more energy than necessary;

ii. Over-consumption of energy with consequent expenses incurred; and

iii. Air-conditioning can increase a building's energy consumption and associated carbon emissions by up to 100%[126].

D.6 Heating, ventilation and air-conditioning can account for the majority of money spent by an organisation on energy. Even small adjustments to these systems can significantly improve the working environment and at the same time, save money[127].

Community Health Issues and Air-conditioning

D.7 Changing consumer behaviour is not a simple matter. Even if policymakers in Hong Kong decided to embark on a social change programme aiming at persuading consumers and property owners to modify air-conditioning practices it will take time, regulatory interventions and a strong social campaign.

D.8 In addition to the obvious incentives of a major saving in money and pollution, there is evidence of significant adverse health effects of excessive exposure to air-conditioning. Among commonly accepted health issues arising from lives lived in air-conditioning are:

i. Dry skin and nasal passages – Long hours of being exposed to central air-conditioning can dry out the skin[128];

ii. Colds and other respiratory illnesses – Your mucus membranes will also dry out, which can leave you vulnerable to upper respiratory infections, fatigue and other illnesses[129];

iii. Heat intolerance – Spending long hours in an air-conditioned home may cause heat intolerance when outside;

[126] http://www.carbontrust.com/resources/guides/energy-efficiency/heating,-ventilation-and-air-conditioning-(hvac).
[127] https://www.carbontrust.com/media/7403/ctv046_heating_ventilation_and_air_conditioning.pdf.
[128] http://www.centralhtg.com/blog/avoid-health-risks-from-air-conditioning-overuse.
[129] http://www.centralhtg.com/blog/avoid-health-risks-from-air-conditioning-overuse. The authors acknowledge the help of Leah Heath in the preparation of this Annex.

iv. Air-conditioning systems can promote the growth and spread of micro-organisms; and

v. Allergies and ear irritations – For people who suffer from allergies during the summer months, running air-conditioning constantly can worsen symptoms.

Annex E: Fuel Poverty in Hong Kong and Possible Remedial Measures

E.1 This study, commissioned from Consumers International by the Hong Kong Consumer Council, envisages that electricity prices will be an increasing burden on disadvantaged domestic consumers as prices have to rise to pay to meet environmental goals and higher fossil fuel prices. Furthermore, there is a conflict of objectives in reducing or keeping down electricity prices for social reasons on the one hand, and providing price incentives to consumers to keep down their consumption for environmental reasons on the other. The central dilemma then, is how to move away from cheap but polluting energy resources, while protecting the poorer consumers. This is a challenge that every country has to face.

E.2 The Council wants to see a reduction in 'inefficient cross-subsidies' between different categories of consumer. The issue of differential trends varying between business and household consumers is dealt with in the main report which shows how, worldwide, businesses, in their capacity as consumers, have gained by using their greater bargaining power to lever low electricity prices at the expense of households. Our analysis here deals rather with differences between populations of household consumers.

E.3 This Annex sets out a broad classification of assistance to consumers and how current policies pursued in Hong Kong by companies and by the Hong Kong Government fit into this classification and to what extent they can be improved to resolve the dilemma referred to above. The Council welcomes the re-establishment of the Hong Kong Commission on Poverty (CoP) and its comprehensive Hong Kong Situation Report 2012 on which the Council has drawn extensively (see postscript at and of this note). However, the specificities of fuel poverty policy require further questions to be answered and the Council sets these questions out at the end of the main text of this Annex.

E.4 The crux of the debate is over whether to mitigate the impact of high prices by tariff-based measures or by social welfare measures. In other words, the debate focuses on whether the responsibility for low income consumers should rest with electricity providers or with the Hong Kong Government, with pricing policy or with direct income subsidies. Below is a rough typology of measures divided three ways between tariff-based measures, social welfare measures and hybrids of those two approaches. The criteria by which the Council considers different options (and list in Table E.1) are:

Conservation: The tariff structure should provide incentives for consumers to control their consumption;

Progressivity: It should not impose greater burdens on lower income households compared with those higher up the income scale;

Revenue: It should not undermine revenue so that the service requires further subsidy or runs at a loss;

Administration: The administration of the system should not be so complex as to outweigh the benefits nor so oppressive as to discourage consumers from using the help available; and

Transparency: The pricing structure should be understandable by policy makers and should reflect costs.

Tariff-based Measures

E.5 Tariff-based measures provided by service providers to help low income consumers usually take the form of an initial tranche of consumption charged at below cost price (or even sometimes at zero price) in an increasing/rising block tariff structure (IBTs or RBTs). Such measures have been criticised for 'errors of inclusion' (subsidies going to people who are not defined as needy), and 'errors of exclusion' (needy consumers not receiving benefits to which they are entitled)[130]. The critiques of the profligate nature of errors of inclusion tend to assume that any help to those above the poverty line is wasted, 'dead wood', so to speak[131]. In fact help to families just a little over the poverty line helps to ease the loss of social benefits as incomes rise.

E.6 Ideally, the cost of below-cost tariffs below the RBT threshold is recouped by above-cost tariffs further up the consumption scale. So there are sometimes three RBTs: below-cost, at-cost and above-cost. In practice, experience from around the world has shown how difficult it is to raise the above-cost tariff sufficiently to compensate for the loss of revenue from the below-cost tariff, with the result that the totality of pricing has tended to be below cost. This in turn necessitates either a subsidy paid by the taxpayer or the service running at a loss resulting in system failures. This is unsustainable in the long run and therefore undesirable. The RBT threshold is best situated somewhere around average consumption for poor households. Setting it at a higher level makes it more difficult to recoup revenue from consumers, such as large families, whose consumption may be above the threshold but who may nevertheless be hard-pressed.

[130] For the most thorough analysis, see K Komives, V Foster, J Halpern & Q Wodon, *Water, electricity & the poor: who benefits from utility subsidies?* World Bank 2005.

[131] This was precisely the term used by a representative of the IEA at the OECD Forum discussion: *Are subsidies costing the earth?* June 2012.

E.7 To avoid the problem of revenue loss, there is a variant sometimes called a volume differentiated tariff (VDT) under which consumers lose the benefit of the low cost tranche the moment they pass the low cost threshold. This is also known as the 'disappearing first block'. The problem is that a tiny increase in consumption above the threshold can wipe out the benefit of the first tranche below cost and penalise poor families who have 'strayed' over the line. The VDT approach is diminishing worldwide and is not considered as a serious option.

E.8 The rationale for RBTs is that they provide incentives for consumers to keep their consumption down to avoid having to pay the higher tariff and, the argument goes, they can help the poor who tend to have lower consumption per household. This can of course result in discomfort. Furthermore, as the Council has seen in Hong Kong, where there is a low use tariff and RBT, its 'progressive' intentions (i.e. to help low income families) are largely undone in multi-occupied households that share a single meter because they become classified as high users, indeed taken together they are high users. The numerical dimensions of this issue are discussed later in this Annex.

E.9 There are examples of well targeted RBT thresholds which have sheltered consumers from the problem of rising tariffs without unduly undermining the revenue of the service provider. One example on which the Council worked is Serbia[132]. But, to be accurate and progressive in social terms, that requires a reasonable correlation between low income and low energy use. To what extent this is the case in Hong Kong needs to be clarified.

E.10 Most electricity tariff structures, including Hong Kong, have some form of standing charge, namely a flat fee for connection and/or maintenance irrespective of actual consumption. Standing charges do reflect the fact that some costs are incurred regardless of the level of consumption of the household, but they are often accused of being regressive. In the Hong Kong context they could possibly mitigate, at least in part, the difficult problem of multi-occupied homes being classified as high users. If the standing charge is a significant proportion of the total bill then a single standing charge is a considerable advantage for multiple occupants compared with single family occupants. It may be a rough and ready form of equalisation, but in the absence of other mechanisms it restores a degree of parity.

[132] World Bank. Ipsos strategic marketing, *Qualitative assessment of vulnerable households-energy use and patterns and strategies to cope with tariff increases*. Serbia March 2011; A Cojocaru & C Ruggeri Laderchi, (Poverty reduction & economic management unit – World Bank ECA) 2011. *Electricity reforms and energy affordability in Serbia,* p.3.

E.11 There is a perceptible trend worldwide for system cost recovery to shift from actual consumption towards standing charges. This is likely to intensify. For example, in Australia, for more than five years demand across the grid has been falling, leading distribution companies to seek to switch the charging method. This has been given extra impetus in Australia because 10% of households have now installed rooftop photovoltaic systems which cut household consumption and yet still require grid connection as backup. The more the grid becomes the provider of last resort and tariff revenue declines, then the more pressure will increase for a block payment to reflect that shift, most likely through a higher standing charge. Even if the standing charge is already correctly set in terms of reflecting fixed costs, it will increase as a proportion of household bills if they fall as a result of energy efficiency measures.

E.12 Uniform tariffs (as opposed to RBTs) have some merit in this context in that they are simple and thus easy for consumers to understand. The absence of a low user tranche allows the company to mitigate all tariffs and thus avoid the 'boundary problems' associated with multi-occupied dwellings. However, when combined with standing charges they probably show a regressive pattern for low income users not in multi-occupied dwellings.

Social Welfare Based Measures

E.13 An alternative to attempting to assist poorer households through prices is to do so through their incomes, a practice favoured by World Bank and other experts, who prefer a neat differentiation between service provisions on the one hand, and income support on the other. The argument is that 'poverty is not the fault of the service provider' and is the responsibility of the government to address. It also means that the price of electricity remains cost-reflective and does not encourage excessive consumption.

E.14 An issue around sector-specific income support mechanisms is that they only deal with a relatively small proportion of a consumer's disposable income. If fuel poverty is taken to mean that more than 10% of household income is taken up by expenditure on energy then clearly measures to deal with energy poverty are generally only going to deal with a small proportion of a family's poverty issues. Moreover, a multiplicity of measures to deal with all variants of 'hyphenated poverty' (fuel-poverty, food-poverty, water-poverty) is intrinsically inefficient if each one involves complex assessments of both expenditure and either income or category (see below). The advantage of 'pure' (i.e. income related) social security measures is that they deal with the problem of poverty at source – i.e. low income. But if fuel poverty is the result of the inefficiency of the appliances and the quality of the housing, neither tariff-based measures nor income

support do anything to deal with this fundamental problem and simply condemn the public purse to continue to pay for the income support. The option of allowing consumers to receive the same service at a lower level of consumption by implementing energy efficiency measures faces the obstacle of poor consumers being the least likely to be able to afford the higher upfront cost of energy efficiency measures.

E.15 Should social assistance be consumption related? Social security systems are more commonly applied to supporting entire family incomes regardless of consumption patterns, rather than specific aspects of consumption such as energy use. Indeed consumption-specific mechanisms such as 'food stamps' in the US are often regarded as extremely stigmatising. In recent years some jurisdictions have tried to develop more 'dignified' consumption-specific measures such as 'water stamps' in Chile, to assist with water bills as Chile moved towards cost-recovery in that sector. And one can envisage 'energy stamps' being used as a form of legal tender and being purchased by any consumers for their own purposes such as saving to pay bills, as well as being distributed to poor households as sector-specific help. However, 'consumption-relation' suggests that help should be attached to actual evidence of expenditure such as bills. This creates a new layer of administrative complexity. But without such a procedure, how well targeted would such assistance be?

E.16 An alternative to relating assistance to expenditure on energy is 'category related' assistance, based on age or family status, the presumption being that certain categories of household have higher fuel needs. The draft report for the Council gives the example of the UK winter fuel allowance which is given to all consumers over the age of 62 (£200 per person over 62 living alone). At its outset it was 'universal', that is, based on age and not income and was payable even to those individuals not dependent on state benefits. It thus has virtually 100% take up, there being no stigma attached to age and it is cheap to administer. But the 'virtue' of good take up is linked to the 'vice' of being both expensive in public expenditure terms and indiscriminate. It includes anyone with a National Insurance record (which states their age); and it also goes to all, rich and poor – the Queen of England is entitled as well as the poverty-stricken pensioner. And meanwhile, many poor working families get nothing. Criticisms of the universal nature of the scheme in the UK, led it to be amended so that extra amounts are paid to those who are over the age of 80, who live alone and/or receive certain means tested benefits and amounts for others reduced. The initial simplicity of the scheme has thus been complicated to make it more targeted on the poor and thus less expensive in aggregate. This epitomises the dilemma of such policies – the more targeted they are, the greater the complexity and risk of stigma. This is intrinsic to their selectivity.

E.17 A further issue regarding such category-based payments is that in practical terms, they are not related to energy use at all other than through their name which reflects the broad propensity for certain groups to have higher fuel requirements. In the UK they are paid during the onset of winter and so could equally be described as 'Christmas allowance' (in fact, a modest benefit supplement at Christmas has existed in the past for pensioners).

E.18 Nevertheless, if certain categories can be identified as specifically facing difficulties with energy, such as multi-occupiers, then this kind of group eligibility might be helpful. For example, in the UK 'cold weather payments' are payable to recipients of means tested benefits when temperatures drop below zero for seven consecutive days – the analogy with Hong Kong would obviously be the onset of unusual heat waves. A further issue then becomes the form of payment: through stamps or other 'reserved currency' to ensure their use on energy, or through cash in which case there is no energy specific intervention. (The hybrid version described below provides a variant of these options). But identifying groups is not a simple matter, if undertaken on criteria other than age. For example, single parenthood requires a definition and may drift towards a 'cohabitation rule' by which one ceases to be a single parent if living with an unmarried partner; equally, a single parent living with parents may be less needy than one living alone. In contrast, registration as disabled may be a relatively straightforward process. So such categorisation varies in its complexity and indeed its invasion of privacy.

E.19 Faced with the difficulties in the above mechanisms governments have been driven towards 'income related' mechanisms, which involves some kind of means test, and one which, to be related to need, involves some assessment of family size. This means inevitably that there is not one poverty line but many, based on different family sizes (see note to Figure E.1). Means tests are invasive, expensive to administer and suffer from widespread failures of take-up, frequently going to only a minority of those eligible. For example the much discussed Chilean benefits for public utility services have been found to have errors of exclusion as high as 95%[133]. The issues around means tests worldwide are discussed in Chapters 2 and 6 of the main report. In addition to them, it should be borne in mind that, as stated above, the schemes may relate to only 10% of household income to take the usual definition of fuel poverty. Such a level is a serious problem for consumers of course, but one that requires a solution which is proportionate in cost terms.

[133] M Fay & M Morrison, *Infrastructure in Latin America & the Caribbean: recent developments & key challenges,* World Bank/PPIAF, 2007.

Hybrid Measures

E.20 Both sets of measures outlined above have their problems in terms of the theoretical evidence presented so far. Is there scope for hybrid measures that combine the advantages of each type of assistance? The classic hybrid is to use entitlement to certain social welfare allowances as 'passports' to specific help with a specific kind of expenditure, such as electricity. That help can take the form of either a discount (e.g. a percentage reduction) or a lower tariff for a given category of consumer. One system, currently in use in Hong Kong is eligibility of certain groups for a discount up to a certain level of consumption, a reinforcement as it were of the RBT. This has the advantage of being distributed fairly automatically after the initial registration of entitlement, but also being directly related to energy consumption, while not removing entirely the incentive to conserve.

E.21 Any RBT-type system will encounter the problems of multi-occupation, as families get classified wrongly as 'large' consumers. A uniform lower tariff, in contrast, would place a premium on families being classified as entitled to help as they would get a lower tariff for all their consumption compared with other consumers paying a higher tariff. A rebate system, with a cash limit rather than a separate tariff, avoids the help becoming too open-ended.

E.22 All of the above options and features are complex to some degree except for uniform tariffs, standing charges and the broadest form of age-based categorisation. That complexity may well translate into non-take-up. What is striking is the difficulty of reconciling the interests of the inhabitants of multi-occupied dwellings and other low income consumers. Another contrast is between the poor in receipt of 'passport benefits' and the working poor earning a few dollars more and so not entitled to help. The consumer interest is not monolithic, not even among poor consumers.

E.23 The limitations of the options, which are set out schematically in Table E.1, indicate that on their own, such schemes cannot 'solve' the problem of fuel poverty just as they have not elsewhere. For example, the Hong Kong Council of Social Service has proposed a low income family supplement. Those below the poverty line would receive the full supplement. Those above the line would see that subsidy reduced by $0.5 for every dollar of earnings, rather similar to the Family Income Supplement introduced in the UK during the 1970s. Such wage support measures have their own problems such as the high marginal rate of withdrawal which generates the 'poverty trap' and the potential effect on wages. So their implementation or not, will be decided on the basis of issues far wider than fuel poverty.

Table E.1 Options & Features for Dealing with (or Avoiding) Fuel Poverty
(Note: Multi-occupiers = M-Os)

	Conservation	Progressivity	Revenue	Administration	Transparency
Uniform tariff	Neutral	Neutral but improved for M-Os	Positive	Positive	Positive
Rising block tariff (RBT)	Positive	Negative for M-Os; Positive for poor single households with meters	Depends on threshold; Large 'errors of inclusion'	Feasible with meters; Exists already	More complex than uniform tariff, but can be understood
Standing charge	Neutral	Can be positive for M-Os; Negative for single poor households	Positive-cost reflective	Simple; Exists already	Simple
Consumption-related state help	Slightly negative	Positive but may be indiscriminate depending on eligibility	Positive for service; Negative for taxpayers	Negative	Negative
Category-related state help	Slightly negative	Errors of inclusion	Ditto above	Positive for some, negative for others; Exists already on small scale	Negative
Income-related state help	Slightly negative	Progressive, but errors of exclusion	Ditto above	Extreme complexity; Exists already on small scale	Negative
Hybrid (tariff)	Neutral	Positive for eligible groups; Errors of exclusion	Negative	Requires registration so may be complex; Exists already on small scale	Negative
Hybrid (rebate)	Neutral	Ditto above	Less negative than hybrid tariff	Ditto above	Negative

E.24 Poverty will always punch a hole in the best designed schemes. But they can make a difference in combination with energy efficiency policies. Among the very interesting schemes promoted by the current services in Hong Kong is assistance to certain categories of consumers to invest in energy saving. The great virtue of energy saving schemes is that, even if they have a wider 'trawl' in social terms than direct assistance

through incomes or tariffs, there is a benefit to all in terms of reduced energy consumption and hence reduced pollution and reduced cost to cover peak output.

E.25 The Council suspects that the best policy mix will be a combination of demand reduction through greater efficiency, price control through regulation and targeted measures of assistance. The Council moves on then to examine to what specific dimensions of a multi-strand policy can be applied in the prevalent conditions in Hong Kong.

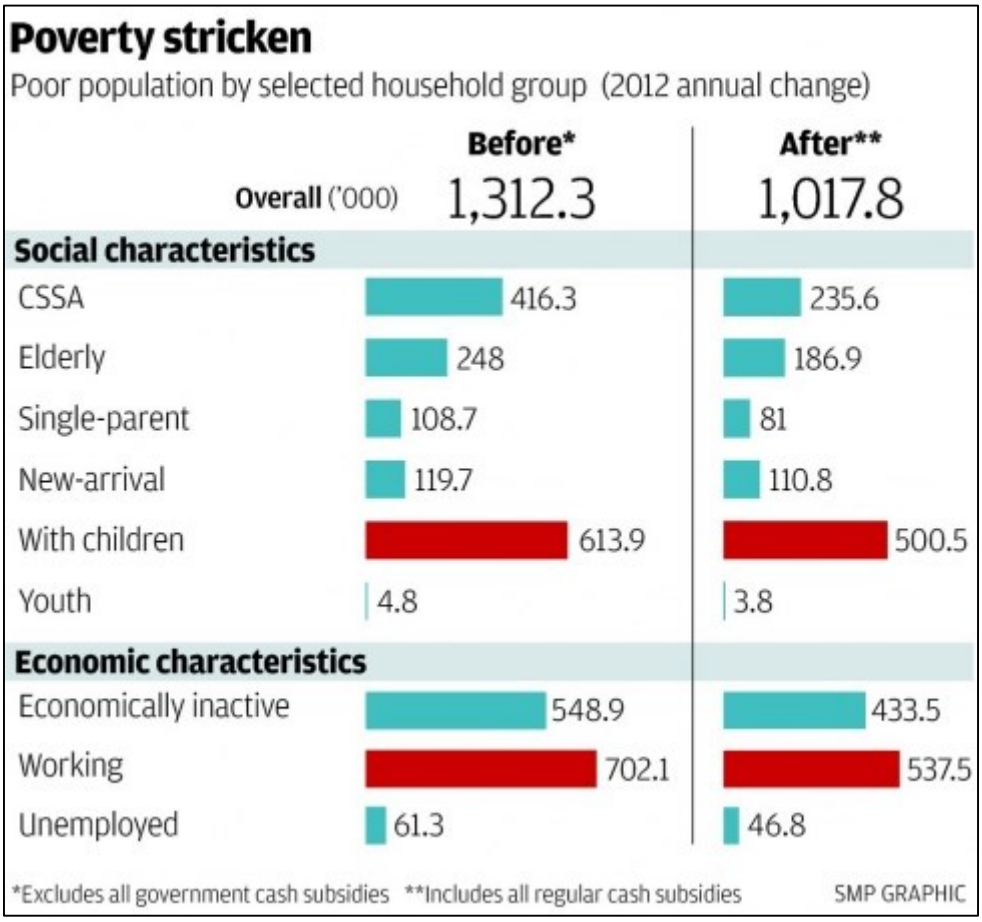
Hong Kong Conditions

E.26 In September 2013, the CoP, convened by the Government, formally adopted 'the concept of relative poverty' for purposes of definition and assessment of poverty[134]. Set at half of the median household income, by this measure more than one million Hong Kong residents are deemed to live in households below the poverty line (about one fifth of all households), taking into account cash subsidies received.

E.27 A table, reproduced here as Figure E.1, published in September 2013 issue of the South China Morning Post, based on the data gathered by CoP for the Hong Kong Poverty Situation Report (2012 CoP Report), shows the original composition of the poor population by selected household groups as well as changes attributable to Government intervention. So the figures in the left hand column show the original composition and those in the right-hand column take into account a range of regular cash subsidies provided by the Government to households notably the Comprehensive Social Security Assistance (CSSA).

[134] Hong Kong Poverty situation report 2012, the Government of Hong Kong, Census & statistics Department, September 2013, para. 2.1.

Figure E.1 Poor Population by Selected Household Group (2012 Annual Change)[135]



(Note: The actual poverty line is not a single figure, but varies according to household size. A one-person household with less than $3,600 per month will be considered poor, under 2012 statistics. For two-person households, the amount is $7,700 and for four-person households $14,300. The median monthly household income in Hong Kong is $20,000[136]).

E.28 The effect of social security allowances is to mitigate poverty but by no means to eliminate it. The 2012 CoP Report using the data set out above, demonstrates how, before government intervention, almost 20% of the population were in poverty. This fell to 15% after recurrent cash transfers are taken into account, and to 12% after non-recurrent interventions were factored into the analysis. This category may include occasional help with electricity bills and is deemed by CoP to be less effective, dollar for dollar, than recurrent benefit, going as it does on many non-poor households[137]. It could be said then to suffer from 'errors of inclusion'.

[135] South China Morning Post (Sunday, 29 September, 2013).
[136] 2012 CoP Report op. cit. Fig. 3.7.
[137] 2012 CoP Report op. cit. Box 4.1.

E.29 Finally the proportion of the population in poverty falls from 20% to 10% as a result of all of the above plus help in kind, the principal element of which is public rental housing (PRH), let at below market rents[138]. In summary, public policy intervention halves the proportion of the population in poverty, a significant outcome. The fact that most low income households reside in PRH suggests that approaching fuel poverty through housing status may provide a route to quick results for a significant proportion of the target population[139].

E.30 Also noteworthy is the prevalence of families with children and the overlapping category of working poor, the latter being less likely to be eligible for receipt of benefit, while accounting for over a half of the poor population[140]. CoP reports that, despite the reasonably well targeted help from government schemes: '*...there are still poor households in various household sizes that do not enjoy any Government's recurrent cash assistance. Even among those who are beneficiaries of cash benefits, some of them are still below the poverty line. This is a matter of concern, and it is therefore necessary for us to conduct an in-depth study on these households and population in poverty*'[141]. Even while waiting for the results of such study, this suggests that relying on existing benefits to 'passport' help with electricity may miss significant numbers.

E.31 The CSSA, described as the 'safety net of last resort' is by far the most significant benefit in terms of poverty alleviation[142]. CoP reports that among households and persons lifted out of poverty through recurrent cash transfer, some 60% had been so lifted as a result of CSSA. Similarly, around three-quarters of the total poverty gap reduced by recurrent cash benefits was attributable to CSSA. So while reliance on passport benefits has its weaknesses, use of CSSA seems the most direct route for some categories but not for others. For example, CoP reports that low paid workers account for only 5% of recipients, the majority of CSSA payments (56%) being paid to the elderly[143]. The take-up rate of CSSA among working poor is low, (8.4% compared with 68% for single parents) and CoP recommends consideration of 'further assistance on top of the existing cash assistance system'[144].

[138] 2012 CoP Report op. cit. para. 4.18 *NB: one should bear in mind that the final element of the calculation, namely benefit in kind, is not a cash figure but, for example, the value of the difference between market rent and PRH rent.*
[139] 2012 CoP Report para. 3.10.
[140] 2012 CoP Report op. cit. para. ES 11.
[141] 2012 CoP Report 3.17.
[142] 2012 CoP Report para. 4.10.
[143] Hong Kong monthly digest of statistics, *Statistics on CSSA 2001-11,* September 2012.
[144] 2012 CoP Report op. cit. para. 5.10.

E.32 A recognised limitation of income supplement programmes however is that, around the world, low income families are reluctant to opt into income support schemes because of the social stigma which attaches to them. In particular, the CSSA is both means tested and, for people of working age, conditional on recipients taking part in the Support for Self-reliance (SFS) Scheme with a view to seeking employment. It also goes to low paid workers, but as the Council has seen, the take-up is low.

E.33 There is research from the University of Hong Kong which suggests that fear of stigma is also present in Hong Kong among the elderly[145]. The 2012 CoP Report concludes that while many families have indeed benefited from intervention, '*…a considerable number of households remain poor after policy intervention. Some of these households are even found to receive no benefits*'[146]. The crucial point to note is that while it is possible to measure the successes of CSSA payments in poverty alleviation (as above), it is far harder to measure its failures to reach all of those entitled to receive it. Even if more government resources were found, it is unlikely that income supplement measures alone could be used to solve fuel poverty issues.

Keeping prices as low as sustainably possible

E.34 While there is no accurate research as to the incidence of poverty amongst energy users, there is a notional value acknowledged internationally that suggests once a households expenditure on energy exceeds 10% of available income, the family is regarded as living in fuel poverty. At a meeting in Hong Kong, of five social welfare agencies, the consultants were informed that up to 200,000 households spend more than 10% of their income on energy.

E.35 So, measures to reduce the impact of fuel poverty generally include aiming for the lowest sustainable electricity prices. While all consumers would benefit from keeping prices at their lowest sustainable level, this would be of particular benefit to low income consumers because they spend a much higher overall proportion of their income on electricity. These measures go beyond the remit of this Annex and are dealt with in the main report.

Construction of social tariffs?

E.36 As there is no current competitive market for any of the components of electricity prices in Hong Kong, many of the market-based mechanisms used in other parts of the world for price reductions are not available. Some governments tender for low-priced or

[145] Ming Pao, University of Hong Kong, *Why some seniors are unwilling to apply for CSSA.*
[146] 2012 CoP Report ES6.

discount power to sell on to classes of consumer with particular welfare needs but the absence of a market make such tendering of no merit.

E.37 A more interventionist approach, as described in E.20, could be for the Government to mandate a social tariff or a tariff applicable to households receiving other welfare benefits such as the CSSA. Such tariffs could be determined by a thorough cost of service review or perhaps just by mandating a 10% or 20% discount from ordinary residential tariffs. However, the issue with this approach is the 'cliff edge' problem. That is what happens if a recipient of CSSA benefits from a small rise in income and ceases to be eligible for help. Would the payable tariff rise by 20%? What if some low paid workers do not claim CSSA even though entitled to do so, as seems to be the case? They will be paying 20% more for their electricity than recipients of the benefit. Energy Watch UK considered this issue and highlighted the importance of allowing a transition period before the consumer is 'migrated' from the social tariff back to a standard tariff when their entitlement/eligibility expires. A transition period of not less than three months was recommended[147]. This is the kind of 'cliff edge' issue which has led to the gradual withdrawal from the 'disappearing first block' that was mentioned earlier in E.7. But the buffer zone does not help the consumers who do not claim CSSA in the first place.

Ensuring benefits reach households

E.38 A risk which is likely to arise from any price reduction measures aimed specifically at households in fuel poverty is that the benefits of the reductions might flow disproportionately to landlords and never reach consumers. When the consultants visited multitenant properties, it was argued by social welfare groups that past rebates or subsidy systems had led to disproportionate benefits to landlords at the expense of consumers. However, it should be noted that CoP reports that the proportion of low income families in private rented properties is low. For households under $5,000 per month, the proportion is 9%, while for those between $5,000–10,000 it is 12%[148]. The 2012 CoP Report also identified only 12,000–15,000 households in 'rooms, bed spaces, cocklofts and temporary housing, around a half a percent of all households'[149]. While their precariousness is not in question, over half of them had pre-intervention incomes of less than $10,000, the size of this problem is important to define.

E.39 For the Council was informed by social welfare groups that the number of families in multi-occupied households was of the order of 30,000 at the low end of the range of estimates and 280,000 at the upper end. These disparities in estimates are very large

[147] R Bates, *A social responsibility?* Energy watch, May 2007.
[148] Our extrapolation from 2012 CoP Report Fig. 3.3.
[149] 2012 CoP Report para. 3.10.

and the effectiveness of the measures agreed depends to some extent on the scale of the problem. There may be a problem of some families within larger households being unwilling to register their presence as a result of their immigration status or other reasons and this may depress the estimates. In any event, families form and reform all the time, so such estimates are bound to be fluid.

E.40 The Council suspects that given that there is a high prevalence of poor families in PRH, there may be an issue for multiple occupation in public sector housing which should therefore be amenable to solution at a policy level. A solution proposed by a number of social welfare workers was to insist that every individual family – including those in multi-tenanted residential units – should have their own meter and separate account so that benefits could flow to them individually. Such an approach would mean that the current regressive impact of the increasing block tariffs system would be alleviated. However, this would require some kind of registration of families as joint tenants, and could involve re-metering when family composition changes. If that proves to be too complex then another approach is for the meter reading to be made available to all the families concerned and for the bill to be broken up so that each family could benefit from the lower rate.

E.41 In future, it may be that another way round this problem is to charge a uniform tariff so that the transition through the rising blocks does not take place, thus solving this particular 'cliff-edge' problem, and then multi-occupied families could gain from having a single standing charge.

Conclusion

E.42 The above analysis is not simple but some broad elements emerge. It is built on information made available to us. More definitive conclusion will require answers to the questions listed below.

E.43 The Council suspects that the problems with means tested allowances that exist throughout the world exist in Hong Kong too. This is not to take credit away from the system of social allowances that does seem to mitigate poverty but would seem to be difficult to adapt to the needs of the fuel-poor through a system of further allowances. The complexity of any such system could turn out to be disproportionate for the resolution of problems surrounding a relatively small proportion of household expenditure. Even if it is as high as 10%, the solutions could well be costly in administrative terms and also in terms of the cost of compliance by consumers who may well consider the benefit to be too meagre to justify going through the process of application.

E.44 While the CSSA seems to provide reasonable contact with some social groups, and is the predominant benefit, there are poor people who do not apply or do not receive it when entitled and thus who will lose out on any 'passported' system (i.e. those benefits linked to the prior granting of another benefit such as CSSA). This seems to be the case particularly regarding the working poor.

E.45 The fact, reported by CoP[150] that most low income families live in public rented housing, suggests that programmes related not just to income but to building improvement and energy efficiency in this sector of the housing market would be well targeted.

E.46 The existing company schemes for rebates attached to energy efficiency could perhaps be developed to bring about not only reductions in energy expenditure but long term benefits to the whole community in terms of improved housing stock and reduced pollution. They merit further investigation.

E.47 The vexed question of multi-occupied housing is unclear in that there are sharply diverging estimates of the numbers of households concerned. A basic principle which would help matters would be to allow all resident families the right to divide the bill between them in order not to be wrongly classified as major users.

E.48 In the long term it may be that the existing RBT is overtaken by events if the grid distributed energy becomes a lower proportion of the total and the standing charge increases in proportion. This would mitigate the problems of multi-occupation but there may then need to be measures taken to assist the poor not in multiple occupation. One advantage of standing charges is that, being constant and not varying with consumption, they are relatively easily integrated into social assistance systems and could for example be wrapped up in rent assistance, which as has been demonstrated by the 2012 CoP Report, is rather well targeted. It could be that help with standing charges could be given under current arrangements, by being treated as part of rent (albeit distinctly billed).

E.49 Finally, it seems clear that the approach taken has to be integrated and must help low income consumers to benefit from energy efficiency measures rather than just be compensated for and thus locked into inefficient systems. This approach will also help to 'spring' some consumers who are trapped in fuel poverty as a result of poor housing and inefficient appliances rather than simply low incomes. Likewise social policy measures taken on their own merits and not as an extension of energy policy, will also help to resolve issues of fuel poverty.

[150] 2012 CoP Report op. cit. para. 3.10.

Future Household Expenditure Research

E.50 To be effective, government policies for management of fuel poverty should be based on sound and current research. Issues of fuel poverty have been overlooked or minimised in the Environment Bureau consultation paper through references to aggregate levels of consumer expenditure on energy is being just a few percent of income. As indicated above this contrasts with what the Council has been told by social welfare agencies who report considerable numbers paying far higher proportions of their incomes. To complete the picture, further detailed knowledge is needed to set out workable options. The Council therefore lists the questions to which answers are required for a more clear judgment to be made:

i. How does the existing low user threshold fit with the average consumption for low income households?

ii. Is average consumption for low income households known, and if so, is it available by family size?

iii. To what extent is low electricity use a surrogate measure for low income in Hong Kong?

iv. What is the number of families in multi-occupied premises? (Note: families not individuals). The consultants are puzzled by the divergence in estimates and wonder to what extent multi-occupation is prevalent in public rented housing, where it may be more amenable to public policy than in the private sector.

v. Do means tested benefits for low income families in Hong Kong suffer from low take-up and/or social stigma? The evidence suggests the answer is yes but estimates of the numbers not receiving benefit payments to which they are entitled would be very helpful in the design of appropriate measures.

vi. Do consumers have control over appliances at apartment or room level (e.g. individual thermostats for air-conditioning)?

vii. Is it feasible to 'disaggregate' accounts in multi-occupied premises or at least to oblige landlords to allow tenants access to accounts in order to verify the division of bills between families?

Postscript

E.51 In December 2012, the new reconstructed CoP commenced operation. The overall terms of reference are:

i. Examine the current poverty situation and causes of poverty in Hong Kong with a view to identifying favourable conditions for personal development, self-reliance and social mobility; and set poverty line as a tool for gauging the poverty situation and assessing the effectiveness of poverty alleviation policies;

ii. Review existing policies and formulate new policies to achieve the objectives of preventing and alleviating poverty and social exclusion, promoting social mobility as well as providing an appropriate safety net to better help the disadvantaged overcome material deprivation and improve livelihood;

iii. Co-ordinate and monitor the implementation of poverty prevention and alleviation policies and evaluate measures funded by the Community Care Fund, the Social Innovation and Entrepreneurship Development Fund and other relevant government funding sources as appropriate;

iv. Engage stakeholders and advise on ways to promote tripartite partnership among the Government, the business sector and community organisations in poverty alleviation, including the development of social enterprises;

v. Promote district-based poverty alleviation measures to better meet the specific needs of local residents; and

vi. Monitor the poverty situation in Hong Kong.

E.52 CoP has been very active in studying the incidence and impact of intervention in family poverty but there has been no specific work on the contribution of increasing energy prices to growth in poverty in Hong Kong.

E.53 A future dimension of the work programme for CoP should be to assess questions of fuel poverty and in particular in relation to consumers living in multi-tenanted properties. There is a need for greater research and that the next household expenditure study should break down actual expenditure into more detail with a view to informing future decisions regarding energy policy and public income support.

Annex F: Biographies of Consumers International Experts

Allan Asher

Allan Asher, a Barrister and Solicitor is a lifelong campaigner for consumer protection, human rights, fairness and equitable development.

Currently serving as Chair of The Foundation for Effective Markets and Governance and as a visitor at the Australian National University Regulatory Institutions Network, Allan is involved in consumer protection and governance projects across Asia the Pacific and Southeast Asia.

Allan has special interest in energy market reform and was responsible for approval of the competitive structure of Australia's energy markets. He has worked throughout the world and in particular in India and Bangladesh on energy market issues. For five years Allan was Chief Executive of Energy Watch, a government established body focusing on energy policy and consumer protection in the UK.

Allan was Deputy Chair of the Australian Competition and Consumer Commission and a senior executive of The Australian Consumers Association (Choice Magazine), a board member of the UK Office of Fair Trading and Commonwealth Ombudsman.

Robin Simpson

Robin Simpson is senior policy adviser for Consumers International, and has been with CI since 2002 having previously worked as head of policy for the UK National Consumer Council, where he worked extensively on consumer protection in public utilities, including energy, in the aftermath of privatisation. This work included useful exchanges with HKCC. He represents CI in international forums, currently the OECD Committee on Consumer Policy, ISO technical committees, and the UN where he is one of CI's negotiating and drafting team for the current redraft of the UN Guidelines on Consumer Protection.

He has taken part in CI regional programmes on public utilities in Latin America, the EU accession process in Central/Eastern Europe, (most recently in Serbia, 2014) and EU consumer protection programmes in the former Soviet Union. He represented the consumer interest on the EU Energy Advisory Committee (now discontinued). He has worked with the World Bank in several countries regarding the role of civil society public utilities reform. He has in his seventh year as member of the Technical Advisory Panel

of the Public Private Infrastructure Advisory Facility, a trust fund housed in the World Bank. He has taken part in the development of ISO standards in water and energy and other network services.

Most recently in the East Asian region, in addition to working for the Hong Kong Consumer Council on energy sector reform, he is working with Korean Standards institute and Consumers Korea to develop standards for customer service in energy. In 2013, he helped to establish the centre for international consumer law in Wuhan, China, where he has lectured at the university on consumer protection issues. In 2014 he has worked with the Taipei Consumers Federation.

His academic background is geography and social administration.

Stephen Thomas

Stephen Thomas is Professor of Energy Policy and Director of Research in the Business School of the University of Greenwich, London, where he has led the energy research since 2001. He has a BSc in Chemistry (Bristol). He has worked as an independent energy policy researcher for 35 years. From 1979-2000, he was a member of the Energy Policy Programme at SPRU, University of Sussex and in 2001, he spent a year as a visiting researcher in the Energy Planning Programme at the Federal University of Rio de Janeiro.

He has published extensively on reforms to electricity industries worldwide and on the corporate policies of energy companies.

He was also a member of the team appointed by the European Bank for Reconstruction and Development to carry out the official economic due diligence study for the project to replace the Chernobyl nuclear power plant (1997). He was a member of an international panel appointed by the South African Department of Minerals and Energy to carry out a study of the technical and economic viability of a new design of nuclear power plant, the Pebble Bed Modular Reactor (2001-02). He was part of an independent team appointed by Eletronuclear (Brazil) to carry out an assessment of the economics of completing the Angra dos Reis 3 nuclear power plant (2002). He has published extensively on economics and policy on nuclear power.

Annex G: Stakeholder Engagement – List of Stakeholders

- Baptist Oi Kwan Social Service
- British Chamber of Commerce in Hong Kong
- Caritas Hong Kong
- CLP Power Hong Kong Limited
- Concerning CSSA and Low Income Alliance
- Environment Bureau
- Federation of Hong Kong Industries
- Friends of the Earth (HK)
- Greenpeace East Asia
- HKSKH Lady MacLehose Centre – Group and Community Work Unit
- Hong Kong Baptist University – Department of Geography
- Hong Kong Council of Social Service
- Hong Kong General Chamber of Commerce
- Hong Kong Institution of Engineers – Electrical Division, Environmental Division, Gas & Energy Division and Nuclear Division
- Hong Kong Women Workers' Association
- The Hongkong Electric Company Limited
- The Hong Kong Polytechnic University – Research Institute for Sustainable Urban Development
- The 30SGroup – Environment and Energy Working Group
- The University of Hong Kong – Centre for Electrical Energy Systems
- World Green Organisation
- WWF Hong Kong

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