
Original Article

Users' perceptions of domestic windows in Hong Kong: Challenging daylighting-based design regulations

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Stephen Siu-Yu Lau

is an associate professor in the Department of Architecture at the University of Hong Kong. He is an active researcher, educator and speaker on promoting designing for sustainability. He is also a registered architect both in Hong Kong and Mainland China.

Zhonghua Gou

is a PhD candidate in the Department of Architecture at the University of Hong Kong. His research topic is post-occupancy evaluation and human-oriented design knowledge.

Fuk-Ming Li

is a PhD candidate in the Department of Architecture at the University of Hong Kong. His research interest is window perception in high-density high-rise residential environments. He is also a registered architect in Hong Kong.

Correspondence: Zhonghua Gou, RB Department of Architecture, The University of Hong Kong, 4/F Knowles Building, Pokfulam Road, Hong Kong
E-mail: gouzhonghua@gmail.com

ABSTRACT The authors suspected that the contemporary quantified daylight control on window design is insufficient to satisfy the user expectation in Hong Kong. A survey was carried out from December 2007 to June 2008 to study the human–window interactions in high-rise residential buildings in Hong Kong. The result indicated that daylighting is not the dominant factor for domestic window design because of Hong Kong's sociocultural context; other factors such as dining habit, toilet hygiene, views from living room and privacy for bedroom proved to be more important in the users' perception. This suggested that the current statutory control may not fulfill or match user expectations. Thus, the window design framework should be a qualitative approach with the understanding of space function and user behavior in the sociocultural context in order to provide for a better living environment.

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INTRODUCTION

Hong Kong is a vertical city, in which residential buildings are mostly high-rise with typically 20–40 storeys (Lau *et al*, 2005). Such buildings typically have complicated building geometries and are situated in high-density environments. These conditions stem from population growth and economic expansion since the 1970s, which generated great demand for housing, while available buildable land remains limited to only 21 per cent of total land area in Hong Kong (Figure 1).



Figure 1: The compact residential environment on the limited buildable land in Hong Kong.
Source: Photograph by the authors.

The urban character of Hong Kong favors vertical expansion of the city, resulting in a compact urban environment where living, working and leisure happen in a mixed and combined mode. The urban form takes the shape of urban canyons where living spaces at the lower portion of skyscraper apartment buildings are often deprived of daylight, natural ventilation and views. Therefore, window design is usually assumed to be a challenging issue. To tackle this problem, authorities of the Hong Kong government have adopted a series of design regulations based on daylighting performance in residential window design.

However, window design is quite complex, and goes beyond providing daylighting. The preference for windows is often related to the function of the space and use behavior of the occupant. If these variables are not congruent, people will alter their space to fit their needs. Understanding the complexity of human–window interactions is important in maximizing the fit between places to live and the people who must occupy them.

LITERATURE REVIEW

Window regulations in Hong Kong domestic building design

In Hong Kong, two main housing types are provided for over 6 million people: public housing¹ and private housing.² According to the annual Property Review of the Rating and Valuation Department (2009) and Housing in Figures of the Housing Authority (2009), more than 80 per cent of private housing domestic units are below 70 m² in area; in the public housing sector, most domestic units' areas are below 60 m². However, although these are such small areas, most current residential units are usually independent dwellings with separate cooking facilities and bathrooms (and/or lavatories).

According to the Hong Kong Regulations Building (Planning) Regulations, every room used for habitation or as a kitchen shall be provided with natural lighting and ventilation; such natural lighting and ventilation shall be provided by means of one or more windows, which shall be constructed such that the aggregate superficial area of glass in the window or windows is not less than one-tenth of the area of the floor of the room; and the areas of

operable window at least equal in the aggregate to one-sixteenth of the area of the floor of the room (Building Department, 2001). This regulation presents considerable problems in high-rise residential buildings, one of which is the inadequacy of daylight illuminance in the interiors of some high-rise buildings (Ng, 2003; Lau *et al.*, 2006a).

In order to overcome this problem, the Buildings Department commissioned a consultancy study to review the standards of lighting and ventilation requirements in buildings. On the basis of the findings from a consultancy study, the Buildings Department issued an alternative performance-based approach for the provision of natural light for habitable rooms and domestic kitchens. This new approach has been issued in the Practice Notes for Authorized Persons (PNAP) 278 (Building Department, 2009). PNAP 278 requires a minimum Vertical Daylight Factor³ (VDF) of 8 and 4 per cent for habitable rooms and kitchen, respectively. Under PNAP 278, where the aggregate superficial area of glass in the window or windows (that is, actual glazing area excluding window frames) is equal to 10, 15 or 20 per cent of the usable floor area of the room, the total unobstructed vision area shall not be less than the corresponding area according to respective use and the height of façade in which the window or windows is provided (Building Department, 2009).

The performance-based approach is a great improvement in daylighting compared to the prescriptive regulation, and it also allows architects more flexibility in their design. However, following the literature review, the authors will show a rather complicated relationship between the occupant, space and windows in different sociocultural contexts. But human–window interactions are seldom considered in the regulations.

Human–window interactions studies

Windows are an important element in residential buildings, and are the source of natural lighting, sunlight, natural ventilation and view. The role of windows in health and well-being has long been assumed in conventional wisdom and supported in the scientific literature (Farely and Veitch, 2001). Windows are usually investigated within the context of human–environment relationships. These studies are usually conducted both in field surveys and chamber experiments, which facilitates the comprehension of interaction between occupants and windows.

Early research found that windows provided many more functions for people than just sources of light and air. Windows provided a view to the outside; knowledge of the weather and time of day; relief from feelings of claustrophobia, monotony or boredom; and a change of focus, as well as lending character or beauty to a room. They also ‘furnished an indication of status or wealth’ (Collins, 1975). As for the window size, Ne’Eman and Hopkinson found that participants preferred wider windows for views. They suggested that increased height did not provide as much visual information as did increased width, and this may account for the observed differences (Ne’Eman and Hopkinson, 1970).

When it comes to the relationship between space function and window use behavior, studies showed an interesting phenomenon. In a windowless office, people often decorate the space with posters of outdoor scenes (Heerwagaen and Orians, 1986), but in a computer room, people tend to cover up existing windows (Butler and Binder, 1989). Tabet-Aoul believes that occupants’ attitudes towards window preferences are influenced by previous experiences, which means that the differences in social and cultural factors lead to different expectations and responses (2001).

In Hong Kong, the authors carried out a survey to determine user response to kitchen design, including the quantitative and qualitative approaches of 2002. The result of this

survey has been reported by Lau *et al*, who noted that daylight quality of a kitchen is perceived by most families to be not as important as building control officials and designers thought it would be. Instead, it is found that social and cultural factors are more important parameters for users in Hong Kong (Lau *et al*, 2006a, c).

In summary, windows play a significant role in residential environments. Window design needs to take into consideration not just basic daylighting performance, but should include all the benefits and psychological functions provided by windows. In most cases, the importance of function and activity of the space seem more related to the perceptions of window design. The study observed that in Hong Kong, designers rely on physical and quantitative approaches such as daylight factor, window size and window-to-room area ratio to qualify a design solution, and ignore the sociocultural parameters. In order to have a deeper understanding of human–window interactions in Hong Kong, a survey that includes all rooms in high-rise and high-density residential buildings was carried out. The survey tries to find answers to the following research questions: How do residents in Hong Kong evaluate windows in terms of space function and user behavior? and What sociocultural factors contribute to these perceptions? The answers to these questions will enlighten architects designing windows with an understanding of human–window interactions in Hong Kong.

A QUESTIONNAIRE SURVEY

The current residential buildings in Hong Kong are designed as typical units in which all flats share the same design principle, where the only variation is the area of each living unit (Figure 2). The target sample should be those who live in one of the typical residential units. In addition, both the private and public residential buildings should be covered and balanced. The limited domestic unit size that controls parameters and constraints of window design for both private and public housing should be the same.

A questionnaire was designed to study users’ perceptions and acceptance of living conditions in kitchens, toilets, living rooms and bedrooms, focusing on the design parameters of windows. Survey questions were classified into four major areas as follows: (a) Background information, (b) Lifestyle and living habits, (c) Design of windows and

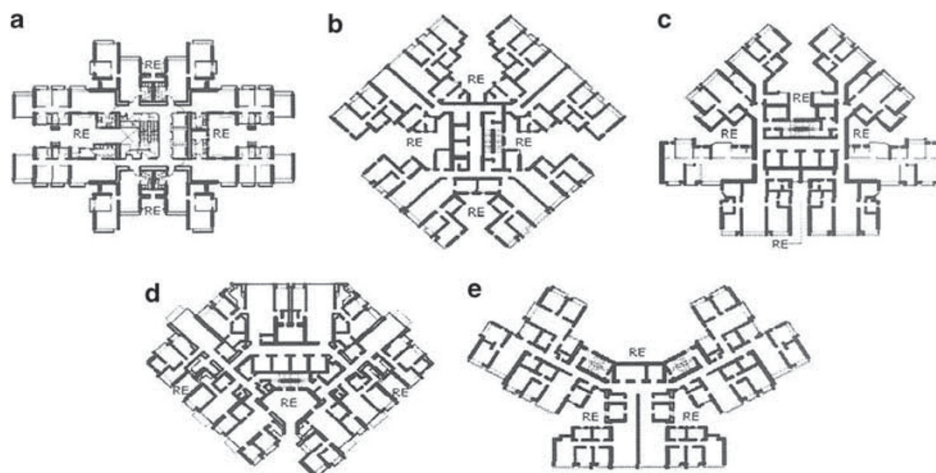


Figure 2: Common forms of an 8-unit plan: (a) cruciform; (b) pinwheel; (c) combination of cruciform and pinwheel; (d) and (e) the latest trend of an 8-unit or 6-unit plan with numbers of re-entrants reduced to 3 or 2 only. Source: Lau (2006a).

(d) Window evaluation. Starting in December 2007, 300 questionnaires were sent out to both private and public housing households in Hong Kong. The filled questionnaires were later returned to the authors by hand. We received a set of 200 filled questionnaires, out of which only 173 were valid for further analysis. Although the sample quantity is limited, the authors feel that they are typical cases and can be used for a descriptive analysis.

About 53.2 per cent of the sample lived in public housing, which was generally consistent with the government statistics that about half of the population lives in public housing. The age of the sample ranged from teenagers to sixty-year-olds, for which the range of 21–30 years was 42.8 per cent and 31–40 years was 15.6 per cent of the overall sample. Those in the age range of 21 to 40 were either university students or those at work, who were expected to spend most of their day at college, university or in the office. The family size of 53.7 per cent of the sample ranged from 3 to 4 members, and 74.6 per cent of them had a family size of four members or less. Among this section of the sample, only 43.9 per cent had unemployed family members. The small family size and the low unemployment rate suggested that most of the families were composed of two generations and the family members were either students or workers. Thus, the empty-home phenomenon was commonly expected and commonly found in the author's previous studies (Lau *et al*, 2006a, b).

The empty-home phenomenon was supported by the result of 32.9 per cent of the sample having more than 7 hours daytime empty-home situation, and 42.7 per cent having more than 6 hours, which is a result of lifestyle changes. The physical living environment should also follow the changes to fulfill the current needs. In addition to the time-spent pattern, the activities at home were also changing. Of the sample, 38.2 per cent indicated that their most popular activities at home were accessing the Internet and 20.8 per cent indicated watching television. It was surprising that only 2.9 per cent of the sample included family chatting and social gatherings at home. The popularity of daily activities reflected the sociocultural changes in society, while the communication among family members was challenged.

WINDOW EVALUATION

Kitchen windows

With the suspected insufficiency of daylighting owing to the small kitchen window, the authors expected that the users were generally not satisfied with window performance, and expected that there would be deficiency in certain aspects. However, the survey indicated that 55 per cent of the sample have no problem with their current conditions, and that only 22 per cent and 15 per cent, respectively, considered the daylight and natural ventilation insufficient (Table 1).

Table 1: Response on kitchen window problems question: 'Which of the following problems do you find in your kitchen window'

<i>Problems in kitchen window</i>	<i>Frequency</i>	<i>Per cent</i>
No problem	95	55
Insufficient daylight	38	22
Poor ventilation	26	15
No outdoor view	14	8
Total	173	100

Table 2: Users' responses on the most important kitchen design criteria: 'Please prioritize the kitchen design criteria'

<i>Kitchen design criteria priority</i>	<i>Frequency</i>	<i>Per cent</i>
Area	77	45
Natural ventilation	41	24
Interior layout	22	13
Daylight	11	6
Location	7	4
Storage	6	3
View out	5	3
Interior finishes	4	2
Total	173	100

The importance of kitchen design criteria was studied by prioritizing eight parameters, namely area, interior layout, storage, natural ventilation, daylight, view, interior finishes and location. Forty-five per cent of the sample expressed the most important parameter as area, which probably resulted from the small size of the living units (Lau *et al*, 2006a). Twenty-four per cent considered natural ventilation as the most important parameter, while only 6 per cent preferred daylight. It was quite surprising that the concern about natural ventilation was four times higher than that about daylight. Also, more users considered that the interior layout was more important than the daylight (Table 2).

The findings called for a review of the necessity and contribution of daylight to kitchen. One of the reasons may be the daily time-spent pattern in the kitchen. Among the surveyed sample, 47 per cent spent less than 15 min in the kitchen and only 23 per cent spent more than 30 min. The result indicated that most of the sample spent a very short period of time in their kitchen, usually after they arrived home from office or school. Within a duration of 15–30 min in the kitchen, they could probably carry out very simple tasks such as boiling or drinking water, reheating food from the microwave oven or getting food from the refrigerator. Therefore, most of the users had not critically evaluated their current living conditions because of limited spare time in the kitchen. But occupants still mind the small area of the kitchen. This may be because of the kitchen's storage function. In addition, as the limited space makes cooking difficult, this can explain, to some extent, people's preference of dining out.

Toilet windows

The toilet was another area of study. The Hong Kong building regulation required all rooms containing waste fittings, such as water closets, basins and urinals, to have window provision. The building professionals followed the rule until 1997, when the government allowed windowless toilets in all new domestic buildings according to PNAP 241 (Building Department, 2001). The change of building code on toilet windows did not compromise the quantitative parameters of lighting and ventilation, where lawmakers accepted the windowless toilet with the provision of artificial lighting and mechanical ventilation. The quality and performance of the windowless toilet should be equivalent to the traditional toilet equipped with windows, as the physical quantitative parameters were provided, but the survey indicated a contrasting result.

Only 15 per cent of the sample expressed their acceptance of windowless toilets, whereas 75 per cent did not accept windowless toilets (Table 3). The occupants had different levels of acceptance of the statutory-allowed windowless toilet, which indicated that the users' expectations and acceptance had not been taken into the legislation

Table 3: Users' responses on windowless toilet acceptance: 'Do you accept windowless toilet?'

<i>Windowless toilet acceptance</i>	<i>Frequency</i>	<i>Per cent</i>
No	130	75
Yes	26	15
No preference	17	10
Total	173	100

Table 4: Users' response on toilet window problem: 'Which of the following problems do you find in your toilet?'

<i>Toilet window problem</i>	<i>Frequency</i>	<i>Per cent</i>
No problem	63	36
Poor ventilation	46	27
Insufficient daylight	43	25
No outdoor view	21	12
Total	173	100

process; even the quantitative physical parameters of lighting level and air flow were performing equally to the natural provision. The merit of natural daylight and ventilation apparently could not be substituted or replaced.

Over half of the sample considered that the major problems with toilet window were insufficient daylighting and ventilation provision (Table 4). These findings indicated that contemporary toilet design had not provided good hygiene conditions, and did not satisfy the users' needs.

In other studies, privacy may be important in the bathroom because many of the actions performed there are viewed as private ones, such as showering or bathing. For example, Butler and Binder surveyed students in the United States about residential windows. Students were often opposed to having windows in their bathroom (1989). However, Hong Kong residents care about the window provision and daylight and ventilation conditions of bathrooms.

Living room windows

In this survey, the performance of living room windows was generally satisfied, with 53 per cent of the sample expressing that they have no significant problem with their living room windows. Ten per cent separately expressed suffering from poor daylight and natural ventilation because of small windows, and 12 per cent complained of lack of privacy, glare and overheating problems because of large windows (Table 5).

The result also indicated that an outdoor view is the most valued benefit of windows (Table 6), which is consistent with previous studies. The outdoor view, especially a view with natural elements, is usually proved to have psychological restorative effects for people under pressure. This should be evaluated and reflected in the design process, as the weighting of various parameters were unknown.

In a high-density high-rise environment, those who live on the lower floors of a building might not be able to see the sky from the interior of their flat. This is also proved in previous studies across the world. Previous research (Kaplan, 2001) showed greater satisfaction with the neighborhood when residents of apartment complexes could look out onto an unobstructed view. Satisfaction was far greater when residents could see more natural rather than more built settings. All these findings indicated that view was an

Table 5: Users' responses on living room window problem: 'Which of the following problems do you find in your living room window?'

<i>Living room window problem</i>	<i>Frequency</i>	<i>Per cent</i>
No problem	91	53
Lack of privacy	21	12
Excessive heat gain	19	11
Poor daylight	18	10
Poor ventilation	17	10
Others	7	4
Total	173	100

Table 6: Users' responses on living room window preference: 'What is your preference on the living room window?'

<i>Living room window preference</i>	<i>Frequency</i>	<i>Per cent</i>
Outdoor view	60	35
Natural ventilation	46	26
Daylight	33	19
Safety	19	11
Privacy	15	9
Total	173	100

important criterion for window design from the user perspective, which was not analyzed in the design process. Moreover, as little research has been carried out on this topic in Hong Kong, it is essential to analyze the actual meaning, interpretation and merit of the view criteria.

Bedroom window perception

The survey findings on bedroom window performance were similar to those on the living room, where 45 per cent of the sample expressed that they have no significant problems with their bed room window. Twelve per cent expressed that they suffered from poor daylight, and 12 per cent who complained about the poor ventilation (Table 7).

Curtains and blinds were commonly found in most of the residential flats in Hong Kong. Seventy-seven per cent of the sample installed curtains or blinds in the bedrooms (Table 8). Fifty-seven per cent considered that curtain provision improved their privacy, whereas 23 per cent considered that it improved shading (Table 9).

In the Butler and Binder survey, the two most important window-related factors for the bedroom are view of the outside and sunlight (1989). In contrast, the findings suggested that the window design could not satisfy the users' expectations of both shading effect and privacy, which also suggested that the aforementioned findings on window area might be incorrect. As a result, large windows and additional measures for improving shading and privacy became necessary. The use of curtains could simply reflect that most window design has not taken the orientation and visual privacy into the design process and consideration.

WALKTHROUGH AND FINDINGS

Although the typical residential units show little variation in layout, the different interior spatial functions for different users require various combinations of design solutions to

Table 7: Users' response on a bedroom window problem: 'Which of the following problems do you find in your bedroom window?'

<i>Bedroom window problem</i>	<i>Frequency</i>	<i>Per cent</i>
No problem	77	45
Lack of privacy	26	15
Excessive heat gain	23	13
Poor daylight	20	12
Poor ventilation	21	12
Others	6	3
Total	173	100

Table 8: Users' responses on 'Have you installed curtain or blind in your bedroom window?'

<i>Curtain or blind used</i>	<i>Frequency</i>	<i>Per cent</i>
Yes	134	77
No	39	23
Total	173	100

Table 9: Users' responses on 'The major reason for using curtain in your bedroom window is'

<i>Major reason for using curtain</i>	<i>Frequency</i>	<i>Per cent</i>
Privacy	98	57
Shading	40	23
Others	35	20
Total	173	100

suit various users' needs. A flexible mix of different design options would be viable to fulfill different needs. The survey illustrates the difference between the window perception and actual function of space usage. To prove this, the authors carried out a field walkthrough among the surveyed subjects. The relationships between space functions and user behavior are found as follows.

Kitchen function

The kitchen is found to be a storage place rather than a traditional cooking and food preparation place. Although having a window is compulsive in a kitchen design, daylighting seems to be of little use to occupants for a very short stay (Figure 3). This finding suggested that the changes in lifestyle and behavior are also changing the meaning of the physical space. The changes in living habits resulted in low kitchen usage, wherein the actual function and meaning of kitchen deviated from tradition.

The authors' large-scale shows that most domestic kitchens in Hong Kong are limited to within 5 m² (Lau *et al*, 2006a). Given the limited space, residents who cook at home have to hang utensils on the windows, and thus daylighting performance is significantly reduced. According to the Chinese Design Code for residential buildings, kitchen size should never be smaller than 5 m²; otherwise, cooking is difficult to carry out (Mohurd, 2003). Therefore, it is necessary to appropriately enlarge the kitchen size, which in turn improves people's use behavior, and benefits people with daylight and sunshine in this space.



Figure 3: Left: young couples usually choose to dine out and the kitchen is used for storage function; right: occupants hang utensils on kitchen windows, and do not care about daylighting performance in kitchen.
Source: Photograph by the authors.

Hygiene conditions for toilets

The recent legislation supports the windowless toilet based on developers' reference to the practices in the Western world. The natural daylight and ventilation provision was replaced by the prescriptive standard of artificial lighting and mechanical ventilation, where performance is supposed to be equivalent to the natural provision.

Some studies in Western countries proved that there may be some often-used spaces for which people do not have a strong desire for windows, especially considering privacy (Butler and Binder, 1989). Residents in Hong Kong think the psychological benefits of windows cannot be substituted, while when windows are provided, people are more concerned about physical environment, such as ventilation and daylighting. The authors find that this is because most toilet windows usually face the re-entrant (Figure 4), where the bacteria easily spread through the stack effect.

In this survey, the low acceptance of windowless toilets illustrated that the legislature process has not paid thorough attention to people's concerns. Windows are important in toilets, for their psychological benefits. When windows are provided, daylighting and ventilation are of great importance for providing hygienic conditions. However, the current design regulations only require daylighting and ventilation in all habitat rooms, and not in bathrooms. This study proposes that future design regulation accentuate the hygienic design of the windows in toilets.

Living room outdoor view

The findings also suggested an interesting result where there were high expectations on view-out in living rooms. The view-out consideration has never appeared in the Hong Kong statutory control, but it has long existed in users' expectations and considerations. The importance of having a good view can be easily found in flat-selling brochures or advertisements, in which developers always emphasize views as a major selling point. Flats with a nice view have a significantly higher price. A better view has always been



Figure 4: Toilet windows usually face the re-entrant, where the bacteria easily spread through stack effect.
Source: Photograph by the authors.



Figure 5: Good views are important for daily living activities in the living room.
Source: Photograph by the authors.

considered a better living environment by the general public (Figure 5). However, there has been little discussion on the view criteria or their true meaning.

Most people in Hong Kong simply interpreted views as the windows facing an unobstructed external environment, either sea-view or park-view, which was actually facing the sea, harbor, parks, greenery or natural environments. It is essential to analyze the actual meaning, interpretation and merit of the view criteria in designing living room windows.

Bedroom privacy

Findings have indicated that the importance of privacy dominates the window design in the bedroom. In our surveyed residential units, seen both from the outside and inside, most bedrooms are shaded by curtains (Figure 6).

Again, daylight provision was not so important and in this particular rating study. This finding contrasts with the assumption that larger windows are always preferred in all domestic living spaces. The survey inculcates the extensive use of curtains and blinds for bedroom, where there is a significant concern about privacy. With such a consideration,



Figure 6: Frequently used curtain on bedroom windows for privacy (left: from outside; right: from inside).

it is justified to reduce the window size in a privacy-sensitive situation in order to avoid invasions of privacy.

CONCLUSION

In sum, daylighting is a very important issue in people's daily lives. But window design goes far beyond daylighting performance-based design, especially in a compact city like Hong Kong. The survey reveals that users' preferences encompass a wide spectrum of design variations in spatial requirements because of people's lifestyles and past experience in Hong Kong. Sociocultural factors such as dining habits, toilet hygiene, views from living room and privacy of bedroom are proven to be more important in designing windows for residential units.

Current residential building design is mainly governed by the statutory control guidelines, which are dominated by daylight provision. The effectiveness, acceptance and actual performance of the building design and spatial quality from the users' perspective have not been reviewed and examined. Without the feedback mechanism on the design evaluation, the designer, developers and lawmakers are not able to formulate the best design solution to cater for the users' need.

Although this study tries to understand the human–window interactions in the Hong Kong residential environment, the deficiency of the questionnaire design and sample quantity was that they could not produce a new design regulation on windows. The difference between actual performance and perception should be further verified in order to formulate the design guidelines for actual needs.

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NOTES

- 1 Public housing is a major component of the housing in Hong Kong. About half of Hong Kong residents now live in public housing estates and other tower blocks with some form of subsidy.

- 2 Private housing is a term in Hong Kong that refers to a housing estate developed by a private developer, as opposed to a public housing estate built by the Hong Kong Housing Authority or the Hong Kong Housing Society.
- 3 This VDF value is measured or calculated at the center of the tested window plane. VDF is the ratio of the illuminance that falls onto the vertical surface of a building to the unobstructed horizontal illuminance excluding direct sunlight.

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