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1. STUDY OBJECTIVES AND SCOPE

1.1 Study Objectives and scope

1.1.1 The objectives and scope of this Study were to:

- assess the operational feasibility of operating a trolleybus system in Hong Kong;
- formulate the design and operational features of, and develop planning guidelines for, a trolleybus system;
- assess the environmental implications of using trolleybuses as compared with diesel motor buses in specified study areas of Hong Kong;
- develop the relevant regulatory, institutional and broad legal frameworks for a trolleybus system; and
- recommend priority areas for further work and the way forward.

1.2 Case Studies

1.2.1 Three case studies were conducted to assess and compare:

- the operational and financial feasibility; and
- the environmental implications

of operating trolleybuses instead of diesel buses in different operational environments.

1.2.2 The selected areas for the case studies were:

- a corridor route in Central and Wan Chai, representing a built up area with heavy traffic (ten existing routes, involving 134 trolleybuses) ;
- Aberdeen, which is an existing built-up area with medium traffic density (eight existing local routes, involving 47 trolleybuses); and
- the South East Kowloon Development (SEKD), which will be a new development area (five proposed routes, requiring 70 trolleybuses).

2. TECHNICAL AND OPERATIONAL FEASIBILITY

2.1 What is a Trolleybus?

2.1.1 A trolleybus is an electric bus. Energy is supplied via a pair of positive and negative wires strung above every road intended for trolleybus operation.

2.1.2 Trolleybuses are 'route captive' to their overhead wires and they cannot deviate by more than a single traffic lane to either side of the lane above which the wires are hung. Nevertheless, most trolleybuses have a limited capability to travel 'off-wire' by deploying 'auxiliary power units' or 'traction batteries'. Some operators use dual-mode vehicles with both electric and diesel-mechanical drive offering full performance under either form of traction.

FIGURE 1
A contemporary 12-metre single-deck trolleybus in Lyon with wheel hub motors, a low floor throughout, plus air-conditioning.
(*T.V. Runnacles*)

2.2 Components of Trolleybus Systems for Hong Kong

2.2.1 Any trolleybus system introduced in Hong Kong would require three basic components:

- those that are common to any bus system, including vehicles, depots, termini and stops;
- a power distribution network, comprising substations, feeder cables, overhead wires and traction poles; and
- a regulatory and legal framework for operation of the service and its power supply.

Operating and Institutional Circumstances

Elsewhere and in Hong Kong

2.2.2 The operating and institutional circumstances of most trolleybus systems operating elsewhere differ significantly from the current situation in Hong Kong. In particular:

- the average trolleybus system has only about 110 vehicles, whereas each of Hong Kong's main franchised bus companies operates between about 700 and over 4,000 buses;
- hourly line flows seldom exceed 100 trolleybuses each way, whereas some local bus corridors support hourly flows of about 300 buses; and
- most trolleybus systems are owned and operated by municipal or regional governments,
- most trolleybus systems require capital grants and/or operating subsidies, whereas in Hong Kong, franchised buses are run commercially by private-sector companies on the expectation that they should make a reasonable rate of return.

2.3 Trolley Vehicles

2.3.1 The Consultant developed indicative specifications for three low-floor, air-conditioned trolleybus variants to suit Hong Kong's needs, namely: a three-axle double-decker; a two or three-axle single-decker; and an articulated single-decker. They would all have an auxiliary power unit for off-wire operation.

2.3.2 The single-deck and articulated trolleybuses were discarded for most applications because the former would have a relatively low capacity whilst the latter would be too long for existing stops and depots. Hence, the preferred trolleybus would be a double-decker standing about 4,190 mm high over the roof panels and propelled by an electric motor rated at about 250 kW.

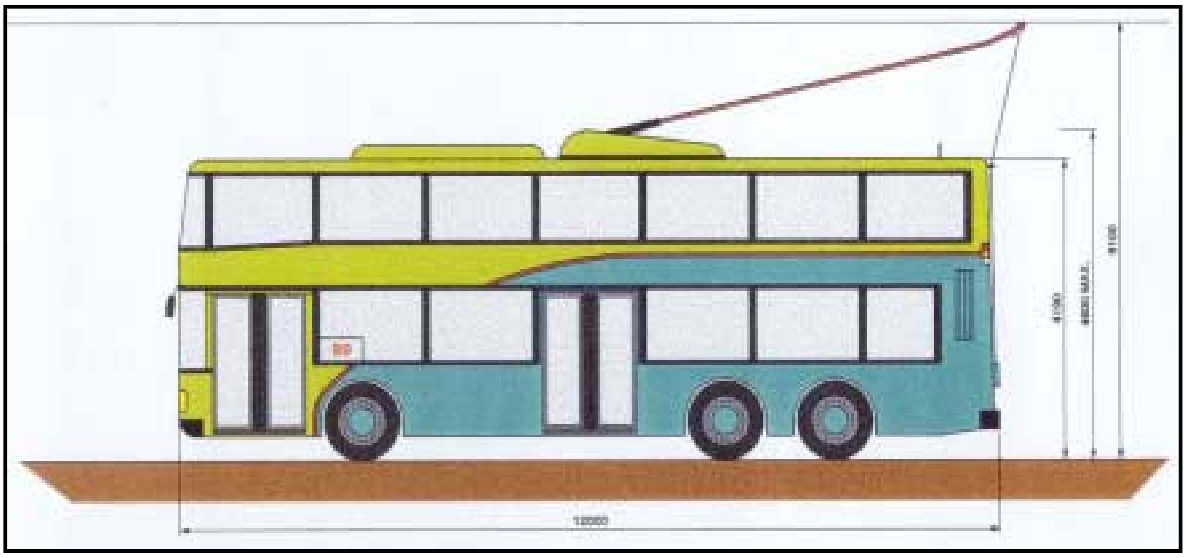

FIGURE 2
The Consultant's preferred vehicle would be a low-floor air-conditioned double-deck trolleybus up to 12 metres long.

FIGURE 3
An example of the last double-deck trolleybus vehicle in revenue service. Porto (Portugal) 1995.
(*T.V. Runnacles*)

2.3.3 Whereas no low-floor air-conditioned double-deck trolleybus has ever been built, two manufacturers would be prepared to supply them. However, an order of about 40 to 50 vehicles would be needed for bus manufacturers to justify the development costs.

2.3.4 Diesel buses could be converted into trolleybuses. Whilst retrofitting is not recommended for large-scale application, it might cost-effectively enable small fleets to be created for initial schemes.

2.4 The Power Distribution System

2.4.1 By their very nature, trolleybuses require a power distribution system to supply electric traction current. The main components comprise:

- substations to receive, transform and rectify the local 11 kV a.c. electricity supply from the power grid;
- feeder cables, feeder pillars and line taps to convey the traction current to 'the overhead';
- apparatus to support the overhead, including traction poles, brackets and building attachments; and
- those elements that constitute the overhead itself, including trolley wires, span wires, and special work for junctions and crossings.

Voltage

2.4.2 The most efficient voltage would be 750 V d.c. Whilst most trolleybus systems traditionally used 600 V d.c., the higher voltage would reduce the need for substations. This could be especially important in Hong Kong to save costs and to reduce potentially expensive land requirements.

FIGURE 4
A line tap where the electric current for trolleybus operation is connected to the overhead wires.
(*Furrer + Frey AG*)

Substations

2.4.3 Substations should ideally be placed within about 330 metres of the overhead. Their size, capacity and number increases along with the number and power rating of the vehicles using each section. A typical 2.5 MW capacity substation would occupy a footprint of about 105 m^2.

2.4.4 Subterranean primary feeder cables connect substations to a trolleybus network. Most trolleybus routes also require parallel feeders to augment the trolley wires' current carrying capacity. They are either installed underground or overhead.

Traction poles and rosettes

2.4.5 Traction poles support trolley wires, either by span wires strung between opposite pairs or by cantilevered bracket arms. The poles are either planted in a two-metre pit or bolted onto a foundation slab. Poles are generally placed about every 30 metres along the roadside, but on straight roads, with simple bi-directional 'elastic' overhead, poles may be spaced up to 60 metres apart. In all cases closer spacing is necessary on curves, at junctions and to support additional wires.

2.4.6 To reduce the potential clutter of traction poles and to save costs, span wires could be supported from wall anchors attached to buildings, which are also known as 'rosettes'.

Trolley wires

2.4.7 Of the two basic forms of trolley wire suspension, the 'elastic' type, with slanted pendulum suspension, is preferable because trolley wires can remain taut across all normal temperature ranges, as well as enabling trolleybuses to run at up to 80 km/h. Nevertheless, the traditional 'rigid' type of overhead may offer cost and space savings where trolleybuses operate at low speed, such as within depots and termini.

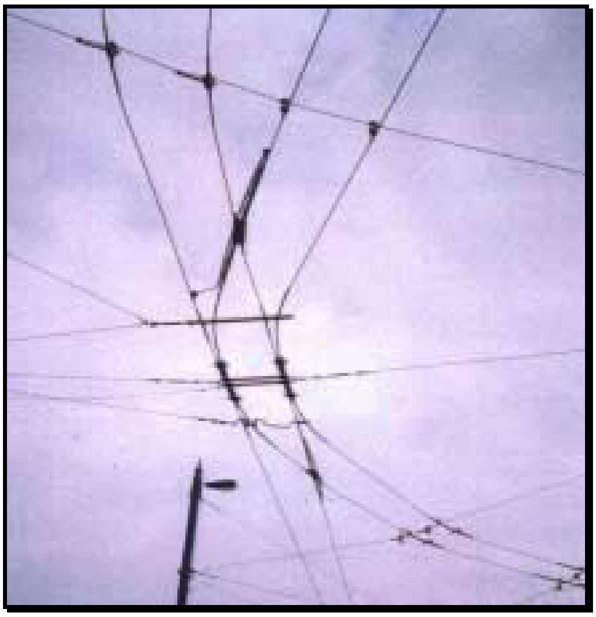

FIGURE 5
An array of modern overhead equipment in the United Kingdom. Rigid suspension is seen in the foreground (top of photograph) with elastic suspension in the background and a facing 'frog' in between.
(*Peter Price*)

Special work

2.4.8 'Special work' comprises overhead switches and crossings used wherever trolleybus routes diverge, converge and intersect. The switches are known as 'frogs' and take two forms, facing and trailing. For route selection, facing frogs have powered switch-blades which are remotely controlled from the trolleybus. Springs normally set trailing frogs for the major route.

Parallel running and intersections with tramways

2.4.9 Trolleybuses could not use the existing overhead wires used by Hongkong Tramways and the LRT system. These systems use their rails as negative polarity return conductors, whereas trolleybuses require both positive and negative wires. Nevertheless, it would be feasible for trams and trolleybuses to run along the same streets.

2.5 Infrastructure and Planning Requirements

Suitability of various types of road for trolleybus operation

2.5.1 It is relatively easier to install trolleybus routes along new roads than existing ones. Trolleybuses would not be particularly suited to expressways because most expressway bus routes are long-distance, non-intensive services. Moreover, high-speed traffic weaving is not desirable for trolleybus operation. On the other hand, trolleybuses would offer better climbing-ability than buses on hilly routes.

Trolleybus operation beneath bridges and in tunnels

2.5.2 The recommended normal height of the trolley wires above the road would be about six metres, as for Hongkong Tramways. However, beneath over-bridges (and within road tunnels) constructed according to the Government's standard headroom of 5,100 mm, trolley wires would have to be dropped to about 4,900 mm above the road.

2.5.3 Some trolleybus operators or regulators (or both) impose speed restrictions on trolleybuses when passing beneath low clearances to reduce the chance of dewirements and potential damage to the trolley shoes and booms. Such speed restrictions are unlikely to be acceptable in Hong Kong because they would delay following traffic.

2.5.4 Suitable overhead and power collection equipment would have to be identified or developed before trolleybuses could be considered for widespread introduction in existing built-up areas because of numerous low-bridges. Furthermore, two particular situations would present greater difficulties:

- the Cross-Harbour Tunnel's ceiling is only 4,900 mm above the road, lower than the current Government standard of 5,100 mm; and
- for temporary structures meeting the Government standard clearance of 4,700 mm, the operation of double-deck trolleybuses would not be possible. Remedies could include temporary diversions, the use of auxiliary engines, or temporary replacement by diesel buses. These measures could be difficult and/or costly.

Other planning requirements

2.5.5 As with buses of all types, trolleybuses would require terminus facilities at the end of their routes, *en route* stops and depots. The general requirements of trolleybuses would resemble those of ordinary buses.

Hanging signs and fire-fighting

2.5.6 Overhead trolleybus wires would conflict with hanging signs. Trolleybuses require both positive and negative trolley wires, so those signs hanging directly above trolley wires would have to be relocated, re-orientated or removed. Existing legislative provisions are inadequate to deal with the area-wide treatment of signs as required by the installation of a trolleybus system. Thus any new ordinance dealing with trolley vehicle power distribution should cover the raising, removal, or re-alignment of hanging signs at the request of a specified authority. There should also be reasonable terms to cover the cost of relocation, or to compensate owners.

2.5.7 It is possible that the presence of trolley wires, span wires or traction poles might prevent aerial appliances from tackling fires on certain floors of a building, especially in narrow streets with tall and dense buildings. Therefore, it would be imperative to develop acceptable solutions during the preliminary and detailed design of any trolley wire layouts. Moreover, the responsibilities of the relevant parties should be specified for the situation where it is necessary to isolate traction current, or cut trolley wires, to expedite fire fighting.

2.6 Operating a Trolleybus System

Safety

2.6.1 Safety should be a core value in the design and operating culture of any trolleybus system. Protective shields should guard wires beneath pedestrian over-bridges to discourage malicious damage to the overhead. Likewise, hanging signs and similar objects should be kept safely away from the structural envelope of the wires and the path of trolley booms.

2.6.2 Any overhead defects should be reported immediately by trolleybus drivers or inspectors. The overhead should be inspected, and repaired if necessary, before services resume after a typhoon, when collapsed scaffolding or broken tree branches could have damaged the overhead.

Trolleybuses in traffic

2.6.3 Vehicle performance is not a constraint for trolleybuses, but their inability to overtake one another without appropriate overhead-wiring passing loops would contribute to potential traffic delays.

2.6.4 In most situations trolleybuses would probably have minimal impact on buses and other traffic. However, they could delay, or be delayed by, traffic when queueing for berths at bus stops, after dewirements, or when slowing to negotiate junctions and curves. The impacts would depend on the trolleybus volumes involved and specific locational characteristics. Temporary arrangements for road works could present additional challenges to trolleybus operation.

2.6.5 The impact of trolleybus operation on kerb capacity would relate entirely to bus stop requirements. Certain busy bus stops would require lengthening to accommodate trolleybus operation, thus reducing the space for kerbside activities by other road users. This could present problems in urban areas where kerb space is limited and in high demand.

Dewirements

2.6.6 If trolleybuses were to lose contact with the overhead trolley wires, they would both delay their passengers and vehicular traffic behind them. Data from six trolleybus systems indicated that each trolleybus could dewire across a range from almost once daily to once every nine months. The average dewirement takes between one and three minutes to rectify. The avoidance of dewirements requires top-quality initial design, compatible overhead and trolley boom specifications, careful preventative and remedial maintenance, and the exercise of proper driving skills.

Line capacities

2.6.7 It was assumed that trolleybuses would require up to 15 per cent more time than buses to enter and clear bus stops, because of their need to negotiate overhead special work. On this assumption, realistic trolleybus line capacities would range from 111 to 236 vehicles an hour, which is substantially less than the existing bus flows in some of the busiest corridors.

2.7 Network Planning

2.7.1 Not all bus routes would be suitable for trolleybus operation. For example, there would be insufficient vehicles to justify the electrification of low-density routes, rural routes and airport services. Conversely, urban trunk routes, busy suburban and hilly routes, rail feeders and new town routes could all offer possibilities, subject to resolving any problems of high frequency trolleybus operation in congested urban corridors.

2.7.2 There would be several constraints to trolleybus operation on cross harbour tunnel routes. These include low headroom in the Cross-Harbour Tunnel, joint operation of routes by two franchisees, expressway operation and the need to wire two urban areas — and possibly parts of the New Territories.

2.8 Conclusions

2.8.1 Trolleybus operation would be technically feasible in most circumstances in Hong Kong. However, various important technical and operational issues would need to be resolved before high-density trolleybus operation could be introduced in busy urban areas. These issues include trolleybus speeds beneath low vertical clearances, traffic impacts, hanging signs, fire-fighting, the planting of traction poles, the insertion of underground feeder cables and the siting of depots and sub-stations. No single issue would stand in the way of trolleybus operation, but collectively they could present important risks in the busiest urban areas.

3. FINANCIAL VIABILITY

3.1 Introduction

3.1.1 Financial viability analyses were undertaken within each Case Study. In each case financial viability was assessed over 30 years to reflect the likely economic life of the power distribution system.

3.1.2 An internal project rate of return (IRR) of 13 per cent after tax was adopted in conformity with the threshold rate of return for private sector financial viability. Double-deck trolleybuses priced in Hong Kong Dollars at 4.0 million and 5.0 million were assumed in all of the analyses whereas a price of 3.1 million was also tested for the Central and Wan Chai and Aberdeen case studies to represent a possible cheaper price that could be achieved with bulk purchase.

3.2 South East Kowloon Development

Base Case

3.2.1 The SEKD 'base case' analysis assumed that trolleybus services would start in 2011 to coincide with the scheduled opening of the Sha Tin to Central Link railway and housing expansion on the former runway peninsula. The system would be completed by 2016. A critical assumption was the lack of competition from other road based public transport modes.

3.2.2 The total capital investment by 2016 would be about HK $550 million in year-2000 prices.

3.2.3 The base case analysis confirmed that the system would be financially viable over a 30-year period, partly because it would be a compact, high-density and well-utilised network. However, the paramount reason for the base case's financial viability was the absence of competition from other transport modes. Nevertheless, trolleybuses would require a fare premium of between 24 per cent and 33 per cent above minimum equivalent motor bus fares in order to achieve the same level of return.

Effects of competition

3.2.4 Because of its high capital and operating costs, a trolleybus system would be sensitive to competition. Even modest competition with external buses capturing 25 per cent of the short-distance trip demand would render a double-deck trolleybus system financially non-viable. If external buses were to capture 50 per cent of the short-distance trip demand, the financial position of trolleybuses would become even worse.

2006 start-up

3.2.5 If the trolleybus system opened in 2006, it would only be financially viable over a 30-year project period if it were carefully staged to balance investment against population and passenger growth — and if there were no competition from other road based public transport modes.

3.3 Central and Wan Chai

3.3.1 Analysis showed that if the ten-route Case Study Network were to be converted to trolleybus operation, with fares similar to buses, trolleybuses would barely meet their operating costs, let alone cover their financing costs.

3.3.2 Fares, or patronage, would need to rise by between 54 per cent and 65 per cent to achieve financial viability[1]. This reflects the extra capital costs of the trolley vehicles and power distribution, as well as greater operating costs. If fares were held at current levels in real terms, it would take between 27 and 30 years to pay back the initial investment, which would be unacceptably long.

3.4 Aberdeen

3.4.1 Aberdeen's eight domestic diesel bus routes achieve a post-tax project internal rate of return (IRR) of less than 13 per cent. If the fares were set at a level which would yield a post-tax project IRR of 13 per cent and

[1] The above range of fare premium is based on a vehicle cost of $4 million and $5 million. The range would be between 44 per cent and 65 per cent, if a lower vehicle cost of $3.1 million (which requires bulk purchase) is assumed.

trolleybuses were to change the same fares, the post-tax project IRR for trolleybuses would only range from 1.5 per cent to 4.1 per cent, depending on vehicle costs. At such fare levels the trolleybus project payback period would range from 18 to 30 years as compared with the payback period of about nine years for a comparable diesel bus network.

3.4.2 To achieve a post-tax IRR of 13 per cent without cross-subsidy, the average trolleybus fare, or patronage, would have to be increased by between 42 per cent and 52 per cent above the equivalent fare level for diesel buses[2].

3.5 Conclusions on Financial Viability

3.5.1 Because trolleybuses would require much greater capital investment than equivalent bus services, the impact on fares would be substantial if the extra costs had to be met from fare revenue alone. However, merely raising fares to meet the extra costs of trolleybuses would not work in situations where cheaper parallel transport services of comparable quality would capture trolleybus patronage. Such situations would be found in all existing built-up areas.

3.5.2 If trolleybuses were introduced in new development areas, competition should be restricted to preserve their viability, whilst service commencement should match population intake as closely as possible.

3.6 Possible Means to Achieve Viability

3.6.1 If trolleybuses were to be introduced, the extra costs would have to be met by some means; otherwise the payback periods would be unacceptably long and the services would not be financially viable. To secure financial viability, the Case Studies showed that fares would have to increase by between 24 per cent and 65 per cent above the fares for similar bus services. However, substantially higher fares would not work because passengers would merely switch to competing and cheaper modes.

3.6.2 Possible means to help to achieve financial viability are listed below, but all would raise questions of private sector and passenger acceptance. Moreover, they have policy implications:

- restricting competition from other road based public transport modes;
- cross-subsidy of trolleybus services from diesel bus services;
- cross-subsidy of trolleybus power supplies from the general electricity supply; and/or
- provision of the power distribution by a private developer within a major new 'green' development, through cross-subsidy from property rents and sales.

3.6.3 Two additional options would require substantial changes to current policies:

- imposing, and possibly increasing, diesel bus fuel duty (the 'polluter pays' principle) to narrow the bus/trolleybus fare differential, thus enhancing the competitive edge of the latter; and/or
- providing direct Government subsidies for trolleybuses.

4. ENVIRONMENTAL ASSESSMENT AND ISSUES

4.1 Air Quality Assessment Methodology

4.1.1 For each Case Study network, the potential air quality achievable with trolleybuses was examined in terms of reducing emissions of respirable suspended particulates (PM_{10}), nitrogen oxides (NO_x) and hydrocarbons (HC). Trolleybuses were assumed to replace equivalent numbers of diesel buses. Emission calculations assumed that all diesel buses would have Euro III engines, burn ultra low sulphur diesel (ULSD) fuel and be equipped with continuously regenerating traps (CRTs).

[2] The above range of fare premium is based on a vehicle cost of $4 million and $5 million. The range would be between 35 per cent and 52 per cent, if a lower vehicle cost of $3.1 million (which requires bulk purchase) is assumed.

4.2 South East Kowloon Air Quality Assessment

4.2.1 In the SEKD Case Study, year-2016 predictions were made for percentage reductions in pollutants on the primary distributor spine road along the former runway peninsula. Two situations were assessed, assuming high and low traffic flows and different proportions of goods vehicles in the traffic stream. The analysis showed that operating trolleybuses instead of 'clean' diesel buses would yield small additional reductions in PM_{10} and HC emissions ranging from one to five per cent, whereas there would be some useful additional reductions in NO_x, ranging from 9 per cent to 20 per cent of the total emissions from all road traffic.

4.2.2 It is worth noting that the local benefits would be most evident in the potential pedestrian zones of Kai Tak and the Town Centre, where zero-emission trolleybuses would help to assure exhaust-free roadside environments.

4.3 Central and Wan Chai and Aberdeen Air Quality Assessments

4.3.1 In the Case Studies, the percentage of total bus-kilometres assumed to be operated by trolleybuses was 17 per cent for the Central and Wan Chai Study Corridor and 35 per cent in the Aberdeen Study Area. Compared with the 1997 situation, the additional benefits of trolleybuses over clean diesel buses would comprise small local reductions for PM_{10} and HC emissions (one or two per cent) and some useful local additional reductions in NO_x emissions ranging from four per cent to six per cent of the total emissions from all road traffic[3].

4.4 Other Air Quality Issues

4.4.1 The Study did not address issues of public health and quality of life. It would be very difficult to attribute individual cases of illness or lost productivity to the air pollution specifically produced by buses, even though this may have been a contributory factor in such cases. Hong Kong's reputation abroad as a tourist destination and a workplace would also be a relevant consideration.

4.4.2 Although trolleybuses produce no emissions at the roadside, they would not be entirely pollution-free because Hong Kong's electricity is generated at thermal power stations fired by coal and gas. These air pollutant emissions could however be controlled and managed more easily.

4.5 Noise Levels

4.5.1 There would be noise reduction benefits from running trolleybuses instead of diesel buses. The effect of such reduction on the overall traffic and noise situation depends on the traffic mix and volume, and ambient noise levels.

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3 Under the extremely hypothetical situation of having all diesel buses in the two case study areas switched to trolleybuses, the reduction in PM_{10}; NO_x and HC would be increased by five times and three times respectively. The operational and technical feasibility and financial viability of such a proposal has not however been examined in the study. Furthermore, in the busy urban areas there would be serious operational, financial and political concerns.

FIGURE 6
This picture indicates the appearance of a traction substation beneath Fleming Road flyover. (Base photograph: *Townland Consultants Limited*)

4.6 Landscape and Visual Assessment

4.6.1 The appearance of the overhead and traction poles was assessed by means of photomontages, as well as landscape and visual assessments of particular 'character areas'. The results showed most impacts would range from 'moderately negative' (Central and Wan Chai Study Corridor) to 'negligible' (in the Aberdeen Study Area). However, they would be greater at some individual locations, or in relation to particular sensitive receivers. Public acceptability of the visual intrusion imposed by the overhead wires and traction poles could be an important consideration.

FIGURE 7
This picture indicates the likely appearance of elastic overhead and traction poles in Des Voeux Road Central, looking east from the Prince's Building footbridge towards the Legislative Council Building. (Base photograph: *Barnaby P. Smith*)

5. REGULATORY AND LEGISLATIVE FRAMEWORKS AND THEIR IMPLICATIONS

5.1 The Granting of Franchises

Preferred franchise periods

5.1.1 The preferred duration of a trolleybus franchise would be primarily affected by four factors, namely the payback period, asset lives, flexibility to replace unsatisfactory operators, and current legislation on franchise periods.

5.1.2 From a financial perspective, the useful life and franchise period for trolleybuses should preferably be coterminous, so that assets could be life expired. Franchises would need to cover the transfer of assets, and the franchisee would have to keep the assets in reasonably good working condition until the end of the franchise. Preferably the franchise periods should be 15 years for trolleybus operation and 30 years — either for the power distribution system alone, or for a vertically integrated system covering both trolleybus operation and power distribution.

Selection of franchising options

5.1.3 The Study examined three franchising options:

- separate franchises for trolleybus operation and power distribution;
- a common franchise for both buses and trolleybuses; and
- the vertical integration of trolleybus operation and power distribution.

5.1.4 Each would have advantages and disadvantages. No single option would be best for every situation. In particular, the recommended institutional structure might vary, depending on whether trolleybuses were being proposed for a new development area or along an existing urban corridor. Specific studies of each proposed network would be required to ensure operational and administrative efficiency.

5.1.5 In general terms, a single trolleybus operator, responsible for both trolleybus operation and power distribution, would be preferable in new development areas. In existing corridors, it would be preferable to combine trolleybus and bus franchises.

5.2 Legislative Requirements

5.2.1 The existing law does not permit the operation of a trolleybus on the roads of Hong Kong. Thus new and amended legislation would be necessary to regulate trolley vehicle construction and maintenance standards, and the safe operation of such vehicles on roads. In addition, there would be a need to legislate for the construction of the power distribution network and its operational safety, as well as to regulate trolleybus service quality and route changes.

5.2.2 The preferred legislative structure would require the promulgation of a new ordinance and subsidiary regulations for the safe and efficient construction, maintenance and operation of the power distribution network. In addition, the *Road Traffic Ordinance* and the *Public Bus Services Ordinance* would have to be amended to cater for trolley vehicles.

6. THE WAY FORWARD

6.1 Introduction

6.1.1 Trolleybuses cost considerably more than motor buses and are less flexible in use, but they offer potential environmental benefits with respect to air quality and noise. The financial, operational, technical and institutional issues of trolleybus operation would be more difficult in dense urban areas than in new development areas. If it were decided to continue pursuing trolleybus options, consideration should be given to conducting a pilot scheme, investigating unresolved operational issues, and pursuing additional studies.

6.2 On-road and off-road trials

6.2.1 Neither on-road nor off-road trials would be particularly useful at this stage. The potential costs and the time required to enact legislation would limit the usefulness of on-road trials in comparison with a pilot scheme. Off-road trials within Hong Kong would not be essential because, if a commitment were made to introduce a pilot scheme, manufacturers would necessarily conduct their own equipment trials.

6.3 Requirements of a Pilot Scheme

6.3.1 A pilot trolleybus scheme would help deliver experience of trolleybus operation on roads and in traffic. Whereas it should be sufficiently 'realistic' to demonstrate typical situations which trolleybuses would encounter under local conditions, it should avoid localities where any initial problems might disrupt traffic, inconvenience passengers or attract unwelcome publicity. Because a pilot scheme would have to be large enough to demonstrate economies of scale and encourage manufacturers to supply vehicles, it would probably comprise several routes. It would also need to be implemented in a location where financial viability would be feasible.

6.4 Locational Options for a Pilot Scheme

6.4.1 Congested urban corridors characterise the environments where roadside pollution is most severe and pedestrian movements are densest. However, they would present the greatest physical and operational challenges to trolleybus operation, whilst their institutional context would be complicated. Hence congested urban corridors are not recommended for a pilot scheme.

6.4.2 A pilot scheme in a new development area would be relatively easy to implement in operational and technical terms. It would enable trolley system technology and operation to be tested, and public acceptability could be assessed. Compared with an existing urban area, it may be easier to restrict competition to ensure financial viability.

6.4.3 A pilot scheme in a medium density area may be considered, but financial viability could be a key issue. The search for suitable locations should focus on such characteristics as steep hills, over-bridges and a busy town centre.

6.5 The Implementation Process

6.5.1 The implementation of any new system would involve several steps to cover such matters as detailed feasibility, preliminary and detailed design, legislation and consultation, and tendering, construction and testing.

6.5.2 The time taken to implement a trolleybus system would depend critically on the system's size and the length of time required for public consultation. Another important factor would be the time required to frame and enact the requisite legislation to facilitate trolleybus operation. Overall, it could take four to five years from a decision to adopt trolleybuses to the start of revenue service.

6.6 Additional Investigations

6.6.1 The Case Study findings were sufficiently detailed to enable an informed decision on whether or not to proceed with a pilot scheme. In the case of a pilot scheme for new development areas, preliminary investigations should be carried out on the feasibility of introducing trolleybuses vis-à-vis other environmentally-friendly modes to determine the best choice of transport mode for the areas concerned. If further investigations on existing built-up areas were undertaken, they could review specific areas or circumstances which this Study did not examine in detail.