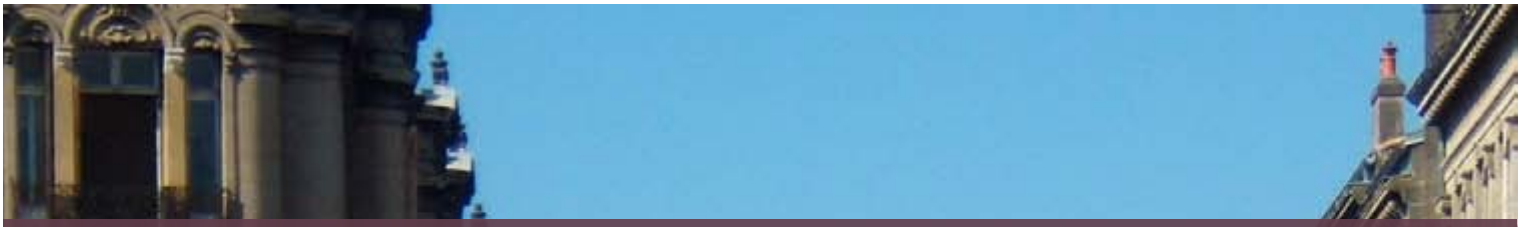


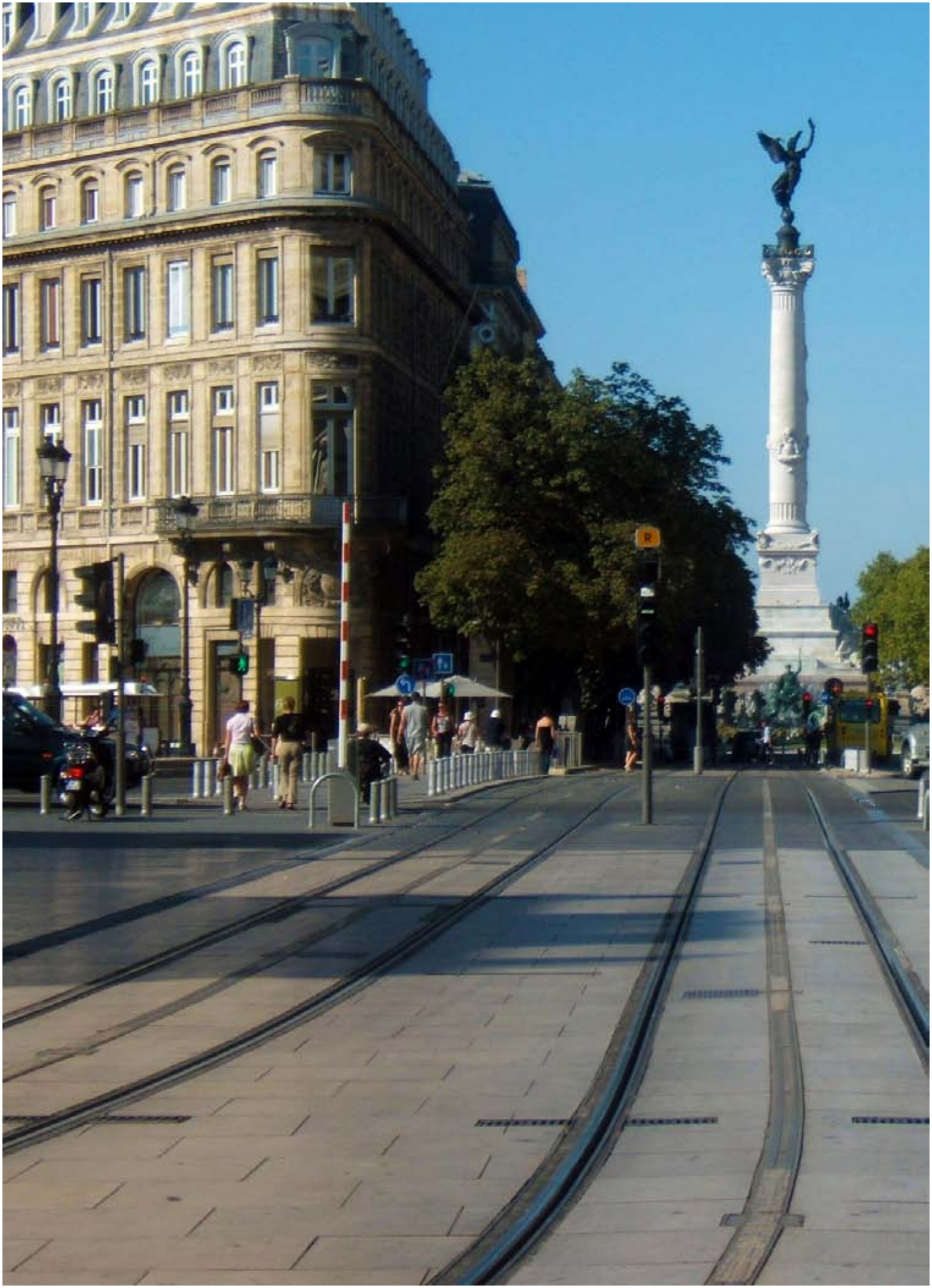
THE KNOWLEDGE ARC LIGHT RAIL: SECTIONS F AND G

DELIVERING TODS

By Peter Newman, Mark Bachels and Jan Scheurer

Curtin University of Technology

PB 125 YEARS PARSONS BRINCKERHOFF



THE KNOWLEDGE ARC LIGHT RAIL: SECTION F

TOD ZONING, COMMUNITY ENGAGEMENT AND GOVERNANCE

By Peter Newman, Mark Bachels and Jan Scheurer

Transit-oriented developments (TODs) are happening across the world, especially in highly car-dependent cities like Australian and US cities (Curtis, Renne and Bertolini 2009). The household economics of this approach have been assessed by Parsons Brinckerhoff's PlaceMaking group, which has found around 50% less car use per household by those who live in a TOD and the residents save around 20% on household income as they need one less car per household (data collated and presented by Center for Transit Oriented Development 2004). In Australia a similar calculation showed this would save some $750,000 in superannuation over a lifetime for an average household with

The value of TODs is that they save governments substantial money through infrastructure and transport costs, as well as providing greenhouse and health benefits (Trubka, Newman & Bilsborough 2008). Fundamentally, TODs are able to overcome car dependence, an issue that confronts every city in the world (Newman & Kenworthy 1989, 1999). Despite the promise of New Urbanism to modify greenfield developments into less car dependence, the evidence for success is not good (Falconer, Newman & Giles Corti 2009). However, the evidence about TODs is much better (Curtis, Renne & Bertolini, 2009).

In all Australian cities there is a strategic plan that sets out why the city would like to build centres around transit stations, where the city would like these to be and, in most cases, when they would like to see increased numbers of residents and jobs in those centres. In addition there are numerous recent Australian Government initiatives regarding the importance of planning in our cities to meet future population growth and improving integrated infrastructure delivery, including development of centres and transit investment.[1]

But so often proposed TOD projects strike trouble in delivery.

[1] Refer Prime Minister Rudd's recent speeches on population growth and the need for improved infrastructure (e.g. http://www.pm.gov.au/node/6282), and a report from Infrastructure Australia on the State of Australian Cities 2010 (Major Cities Unit).

Why TODs fail to be delivered

The TOD delivery process fails for many reasons:

(1) *Town planning schemes are not adequately adapted to reduce car dependence.* GB Arrington from PB PlaceMaking has found this a problem in nearly every single TOD he has worked on across the USA and Australia. He says, 'Every TOD is illegal.' This is because they are not consistent with town planning scheme codes and traffic engineering standards. These codes have been devised to adequately build suburbs and shopping areas on the assumption of car dependence — that is, that each dwelling or building will be serviced by car use alone. This assumption means that buildings and road spaces are required to accommodate the car rather than being designed around a transit station and walkable linkages across the centre.

(2) *Contracting arrangements are not able to provide the land use – transport link between government agencies and through the private sector.* The power of TODs is that they can be built in close cooperation with the private sector so that transit systems can not only be made to work better but indeed help to pay for the transit system. This close synergy is being demonstrated today in most US cities, and it is a requirement of Infrastructure Australia to create public–private partnerships (PPPs) around the urban rail projects they have funded ($4.6 billion in 2009). These projects require equity arrangements to enable funding. Thus, contracts are needed that enable transit systems to be built using close links between operators, land developers, financiers and the three levels of government. This is a challenge for everyone as it is new territory.

(3) *Community processes are inadequate.* The community is not happy about car dependence and likes the idea of TODs, but it is usually not so keen when it comes to having a TOD nearby. Ideas about density, traffic congestion and intense urban activity generate fear of reduced real estate values and amenity, and increased crime and noise, rather than the opportunity to be part of an exciting and visually appealing city-building process. In Melbourne this led to a reaction that stopped most of the state government's TOD plans, and finally this meant that local government's powers in these areas were stripped away.

(4) *Land assembly in station precincts is too difficult.* A major challenge for private-sector development in assuring commercial viability, particularly in existing urban areas, is assembly of disparate parcels of land to ensure adequate size and scale for development around transit. Aside from inconsistent and somewhat random government intervention, at present there is a lack of incentives or consistent mechanisms for land assembly.

(5) *Governance for delivering TODS is haphazard.* Lastly, without vehicles for integrated planning and delivery, TODs are currently left 'to fend for themselves', in often discrete and haphazard governance processes. A more holistic governance approach is required between councils, state government agencies and funding authorities to ensure more accountable and responsive governance arrangements are established that ensure TODs receive greater priority in planning, delivery and approval. Without a concerted and integrated effort across all urban areas of Australia, the same random and inefficient process will continue, making greenfield suburban sprawl the undesirable but default 'winner' in meeting our future population growth targets.

Is there not a better way? Can we not create TODs without these problems?

Delivering TODs

TOD zoning

The first step in creating a TOD is getting it through a town planning scheme (TPS). Most TPSs have been set up to deliver car-dependent suburbs and shopping centres. Across Australia, the USA, Canada and New Zealand, the suburbs we build look almost identical. This is not by chance; it is due to the requirements that are set in TPSs that have been copied by planners across the English-speaking world.

To deliver a TOD requires a new, separate and distinct zoning. This will enable any new TOD to be immediately recognised. With improved TOD zoning, any group of developers attempting to formulate a TOD will not have to go to the local council and seek a political decision to over-ride the 'normal' TPS; it will be normal to have a TOD. For state and federal governments seeking to develop cities by using TODs, the provision of TODs in a TPS and within the development and zoning codes will enable decision makers to see whether they are being serious at the local level. Too often the local authority agrees in theory but in practice does not allow TODs.

Improving the process

How do you enable a cumbersome and ill-fitting statutory planning framework to include TODs? In some cases local TPSs will not allow mixed-use developments or will require high car-parking rates that would undermine the principles of a good TOD. Mostly they would not accept the densities which are seen as necessary. Thus, often TODs are, strictly, illegal but can be accepted by political intervention; they are not able to be accepted 'as of right'. Improving our planning schemes by introducing TOD zoning is therefore critical.

While state-sponsored regional planning frameworks are generally supportive of TODs, there is no example of an explicit TOD zoning district set forth in Australia in the state model codes.

In Denver, Colorado, a Transit Oriented Development Strategic Plan was adopted in 2006 to guide land use planning, development and delivery, to better support Denver's massive investment in a new transit system — a new metro system of 119 miles (190 km) and 70 new stations. The FastTracks metro system will aim to fundamentally reshape growth patterns in the region and the Denver TOD Strategic Plan is a key tool in that process. The TOD Strategic Plan is being used by city council, the Planning Board, the Mayor's administration, management, staff and others to:

- define priorities for choosing where city resources should be directed in the short and long term
- identify effective implementation tools and strategies for TOD
- ensure close coordination among city departments, staff and others as they undertake planning and implementation activities related to transit and transit-oriented development.

A visionary zoning reform in Australia is required to have a lasting impact on the delivery of TODs. The lack of TOD-friendly zoning is not a new problem but one which continues to undermine the ability to transform our urban areas into more sustainable cities. Even in the USA, Jeer (1994) identified over a decade ago that alternative zoning techniques are required to achieve TOD. TOD-supportive planning schemes can serve as a blueprint for sustainable development if a new, separate zoning approach and distinct zoning codes are implemented.

Implementation of TODs is often the responsibility of local government but based on model TPSs established by state governments. In areas where TODs are desirable as a state-level policy objective, such as those mapped by the Western Australia Planning Commission (WAPC 2006) and South Australia Department of Planning and Local Government (DPLG 2009), the responsibility for zoning currently remains

with the local government. Queensland refers both the mapping and adoption of supportive zoning to the local governments.

Placing responsibility for delivery of TODs on local councils is counterproductive. Many councils face financial and technical resource limitations (Bajraccharya 2009). Negative community perceptions about density and mixed use lead to tremendous political pressure against TODs, placing local councils at odds with the desired state policies (Quality Growth Alliance 2009). Bajraccharya (2005) also noted the impediment created by the amalgamation of councils requiring a state review of planning legislation created by the combined super-councils in Queensland.

Planning legislation in Western Australia (WA) requires local governments to prepare a TPS for the entire council based on the Western Australia Planning CommissionWAPC's model scheme text (MST). The TPS establishes the policies to determine planning approvals, identifies and maps the suite of zoning districts, and includes a table of land uses and densities by zoning district. The MST is accompanied by the Planning Schemes Manual which identifies the potential zoning districts for possible inclusion in the TPS based on the MST. While the MST does not require standardised zones, the suggested categories of zones do not explicitly include a TOD zone.

Existing model districts, such as the activity centres and mixed-use zones, could be theoretically adapted via the scheme requirements (e.g. setbacks), but few councils have explicitly sought to create TOD-focused scheme requirements in their zones. Carey and Low (2009) noted a significant 'implementation gap' in their systematic review of the policies and outcomes for the integration of land use and transport in 69 local councils in WA.

In some locations in WA, TODs have been the result of an alternative governance model of a development authority (e.g. Subiaco Redevelopment Authority and East Perth Redevelopment Authority — see 'Case study: East Perth and Subiaco TODs' and Figure F-2) in lieu of the conventional town planning process. However, the burden clearly falls to the individual local governments to craft TOD-supportive zoning.

The South East Queensland Regional Plan 2009 (SEQRP) expresses a number of TOD principles and outlines high-level TOD typologies, yet defers to local councils to identify appropriate locations for TOD when preparing their local plans. Under this approach, the SEQRP identifies activity centres (where prospective TODs could go) but does not provide specific guidance about scale, intensity or mix of uses, and instead relies upon the local councils to develop these details in the local plans.

The WA and SEQ approaches utilise the statutory regional planning framework combined with local planning schemes to provide policy support for TODs. The resultant approval framework and multiple levels of assessment inadvertently discourage the creation of TODs. An alternative approach, currently under development by the South Australia Department of Planning and Local Government may prove more useful (see 'Case study: South Australia').

Case study: South Australia

The Plan for Greater Adelaide (Draft 2009) supports the creation of TODs and transit corridors aimed at promoting greater infill development. As important as these objectives is the proposal to ease the creation of TODs and infill by altering the conventional development approval process. Under this approach, in designated areas of state significance, structure plans will be prepared by the state to set the land use priorities and directions for large areas such as the transit corridors. The large-area plans will establish the key land use objective, permissible uses, and design principles and guidelines. The desired locations for TODs within the corridors will also be identified. The structure plans will be a precursor to changing local council development plans to facilitate the development of TODs.

In designated areas of state significance, precinct requirements for areas such as TODs will also be created by the state government. These will be the provisions that developers are required to address in development applications. Precinct requirements might include detailed design parameters of the area, numbers of dwellings and densities, urban design requirements, detailed designs and elevations for large buildings and transport linkages. The development application will include a precinct plan which responds to the required outcomes of the structure plan and precinct requirements. Compliant projects will be eligible for approval, avoiding the need to amend local council development plans.

While the actual provisions of this approach are in formation at this time, the intent is to resolve the major policy and zoning issues and main objectives and outcomes for an area early in the planning process, and thus facilitate greater use of complying development provisions in the development plan. This approach aims to speed up the land development process and give certainty to investors about the types of activities that are allowed in an area.

The process for fostering TODs may also be improved through the Department of Planning and Local Government's Better Planning Library, which provides the template for local council development plans and zoning schemes. While the details have not yet been set forth, the possibility exists to create and incorporate an explicit zone for TODs rather than relying on the ad hoc adaption of activity centre and mixed-use zones. In turn, this would enable proactive local councils to more easily set forth development plans that support the desired state policies.

Case study: Expedited development approvals for affordable TODs in Austin, Texas

Expedited permitting is akin to a zoning incentive that accelerates a development through the development application process in return for meeting certain use or design considerations. In Austin, Texas, the city created a special program to promote affordable TOD, called the SMART (safe, mixed-income, accessible, reasonably priced, transit-oriented) Housing program, which provides projects incorporating at least 10% affordable homes with development fee waivers and expedited development reviews. In this case, affordability is defined as affordable to households earning 80% or less of average monthly income. Between 2000 and 2006 the program produced over 4,000 single-family and multi-family units, including nearly 3,000 reasonably priced units, with an average assessment completion time approximately half the time of conventional reviews. The city has brought together many city departments to both fund the fee waivers and consider the impact of zoning and other regulatory processes on affordability. Among the fees waived are zoning, site plan, subdivision, building permit, construction inspection and capital recovery fees. During the first three fiscal years of the program, the City of Austin waived over $3.5 million in fees for SMART Housing developments, with waivers done on a sliding scale – from 25% fee waivers for 10% reasonably priced units up to 100% fee waivers for 40% reasonably priced units. For more information, see http://www.ci.austin.tx.us/ahfc/smart.htm

Principles for TOD

Necessary components or general principles of TOD zoning are:

(1) No density or height limits. The goal of this is to enable as much activity as possible in the centre. Developers should be able to determine appropriate heights in discussion with councils and financiers, but the standards need not be set before the economics is done, which is the problem with most TODs now. Heights may need control in most residential areas but in TODs they need to be able to respond to market demands as these sites are only a small part of any city's available land.

Many conventional TPSs specify maximum densities and/or height limits, and this principle has been transferred to some early TOD examples, such as in Perth. While maximum allowable densities were increased over conventional practice to enable TOD outcomes, it was found that the sites in question were not always developed to these densities. In Clarkson, the terminus of Perth's northern rail line, a yield of only around 40–45 dwelling units per hectare was achieved in the TOD precinct despite a planning scheme that permitted up to 80 dwelling units per hectare (Johnson 2008).

Such shortfalls have motivated a call to include minimum rather than maximum density requirements in future TOD planning schemes (Johnson 2008), especially in suburban greenfield locations such as Clarkson where the dominant subregional development pattern is low-density housing.

The removal of height limits from planning schemes further contributes to facilitating increased density, but it also poses additional challenges. Firstly, high-rise building proposals, particularly in established areas otherwise characterised by relatively uniform, low-rise development, tend to raise residents' concerns about 'inappropriate redevelopment' (Lewis 1999) and thus have the potential to delay or unravel TOD projects in the political arena (Dovey, Woodcock & Wood 2009a). While such concerns and the associated political resistance sometimes bear an element of outright hostility to any physical or social change (Dovey, Woodcock & Wood 2009b), it is frequently also driven by real and tangible threats to urban amenity, such as overshadowing and microclimatic effects, and the impacts of increased traffic and parking where these are not sufficiently addressed as part of the densification agenda (Woodcock et al., 2009).

Secondly, a lack of prescription in building height has been identified as an encouraging factor for property speculation, to the detriment of actual construction (Woodcock et al., 2009a). In Melbourne's performance-based system of planning control where density or height limits are no longer mandated (Buxton & Tieman 2005; Dovey, Woodcock & Wood 2009b), an open height limit prompts some developers to submit ambit claims for out-of-scale development which, even after some subsequent trimming by the planning tribunal, provide the proponents with higher capital gains for selling the property, including its favourable planning approval, rather than developing it. As a somewhat paradoxical result of this trend, the take-up of densification projects in Melbourne's established, transit-oriented suburbs such as Brunswick trails significantly behind the policy intention (Woodcock et al. 2009).

Thirdly, open height limits and consequently a relative lack of constraints to the number of high-density apartments subject to planning approval may contribute to a real or perceived oversupply of a specific housing product in a given area, thus reducing investor confidence in its commercial viability. As a result, the take-up rate for actual construction of densification projects may drop below the level that would have been likely if greater planning constraints, including height limits, had been in place (Woodcock et al. 2009).

To overcome these shortfalls, Adams et al. (2009) recommend that planning schemes in TODs should identify an appropriate height limit (four to eight storeys are considered suitable for Melbourne's activity corridors) as an as-of-right development standard. Woodcock et al. (2009) further suggest that planning permits in TODs should be non-transferable in order to discourage speculation in densification precincts and instead encourage their speedy implementation.

In order for a city to increase the proportion of its population having easy access to public transport — a policy goal that few would dispute — there will probably need to be a lot more TODs, with considerably

more density than four to eight storeys in some of them. Thus if good designs can be developed the problems in Melbourne that have led to this kind of suggested restriction would probably be avoided and attempts to improve designs and community concerns would be addressed rather than restricting densities and heights unnecessarily.

(2) Mixed use. The best TODs have plenty of activities for locals to walk to, as well as having a good transit service. Both are achievable when density and mix are enabled.

Mixed use can be achieved in a vertical or horizontal fashion. A vertical mix means that different functions (residential, offices, retail, services etc.) are accommodated within the same building. A horizontal mix means that these functions each occupy separate buildings, which are in turn mixed into a finely grained built pattern at a neighbourhood scale. Both forms of mixed use have a place in TODs, but they are not necessarily equally attractive to the regional development industry. Some developers are accustomed to realising economies of scale by erecting large monofunctional structures on consolidated sites, a trend that should be resisted in TODs. Conversely, a critical mass of small-scale developers capable of delivering a variety of building types and uses across small sites within a reasonable timeframe may not exist or be sufficiently capitalised everywhere. These circumstances are likely to vary from one TOD project to the next, highlighting that there is no one-size-fits-all regulatory approach to encouraging the best mix of uses.

However, one overarching regulatory element of encouraging mixed use in a TOD, as well as a pedestrian-friendly public realm, is a requirement for active street frontages throughout the precinct (Whyte 1988; Gehl 2001; Carmona et al. 2003). In vertically mixed buildings, this means that ground floors are retail capable — that is, offering an active interface with the public realm. In residential or office buildings, this requires an uninterrupted sightline from the buildings into the streets to provide passive surveillance. Adams et al. (2009) recommend that a minimum of 80% of the street frontage of any building in a TOD should fit this definition.

Further regulation may be required to encourage particular land uses in a TOD, depending on the market environment in the region and at the time of implementation. Where the office market is slower than the residential market, as was the case in Perth's Subiaco (Howe, Glass & Curtis 2009), a mandatory minimum proportion of non-residential space can help provide functional diversity, which was the approach taken in that example. A sluggish residential market could be supported by a reverse requirement, and/or government investment in affordable housing schemes (see item 3 below). It is essential, however, that the regulating authority has the capacity to target and continuously revise its approach to such market fluctuations, as well as to changing community expectations. The Redevelopment Authority in charge of Subiaco's transformation appeared to be well placed to engage in such a process and facilitate good outcomes.

(3) An affordable housing component. This could be 15% based on housing association and/or state housing that guarantees affordability in perpetuity.

Affordable housing in TODs is regarded as a contribution to counteracting the social-spatial polarisation occurring in cities (Randolph 2004), and to allow a greater proportion of low-income earners to live in areas with high accessibility, which is often critical to social and labour market participation. It also represents a form of value capture in the context of above-average property price gains often associated with the implementation of TODs. The most common mechanism for the inclusion of affordable (or special-needs) housing in English-speaking developed countries is mandatory developer contributions for a specified proportion of affordable dwelling units, also known as inclusionary zoning regimes (Gurran et al. 2008). In continental Europe, outright social housing programs in the rental sector and the dominance of owner-developers in the homeowner sector play a greater role (Lawson & Milligan 2008; Massot 2007). In Freiburg's most well-known TOD of Vauban, such owner-developers formed numerous cooperatives to construct apartment buildings and thus save on most costs otherwise associated with profits to commercial developers (Scheurer & Newman 2009).

(4) Permeability and pedestrian design. Creating a village precinct necessary for successful TODs requires designing for the pedestrian. Walkable catchments, slower traffic, more permeable and better connected streets are critical toward making centres active, community friendly places. Integrated transport networks to civic spaces, retail, office and housing makes for reducing car dependence, activating streets with more walking and cycling, and thus increasing both foot traffic for retail and civic spaces.

Streets can be designed to favour pedestrians and cyclists and wherever this is done, centres and cities invariably become surprised at how much more attractive and business-friendly they become (Gehl and Gemzoe, 2000; Gehl et al., 2006).

Sustainable mobility management is about 'streets not roads'; the streets are used for a multiplicity of purposes, not just maximising vehicle flow. The emphasis is on achieving efficiency by maximising people movement, not car movement, and on achieving a high level of amenity and safety for all street users. This policy also picks up on the concept of integration of transport facilities as public space. One of the ways that United States and European cities are approaching this is through what are called 'complete streets' or, in the United Kingdom, 'naked streets'. This new movement aims to create streets where mobility is managed to favour public transport, walking and cycling, as well as lower speed traffic. The policy often includes removing all large signs for drivers which means they automatically slow down: in Kensington High Road in London the traffic accident rate has halved because of this.

Copenhagen, Portland, Toronto, Vancouver and Zurich all have built much more in recent times with cycleways, pedestrian facilities and traffic calming. As a result the associated urban development land usage has begun to emerge that reflects these more human qualities. All these cities had citizen groups that pushed for a different, less car-oriented city and a political process was worked through to achieve their innovations. They usually did not foresee this outcome but it has now made these cities much more aware of the need to build integrated development incuding knowledge economy strategies around sustainable transport (Newman and Kenworthy, 1999).

Freeways have blighted the centres of many cities and today there are cities that are trying to remove them. San Francisco removed the Embarcadero Freeway from its waterfront district in the 1990s after the Loma Prieta earthquake. It took three ballots before consensus was reached, but the freeway has been rebuilt as a friendlier tree-lined boulevard involving pedestrian and cycle spaces. As in all cases where traffic capacity is reduced, the city has not found it difficult to ensure adequate transport, because most of the traffic just disappears. Regeneration of the land uses in the area has followed this change of transportation philosophy including a number of successful TODs built along the new LRT line (Gordon, 2005). Another great example is in Seoul which removed from its centre a large freeway that had been built over a major river. A five-year programme entailed dismantling the freeway, rehabilitating the river, restoring a historical bridge, restoring and rehabilitating the river foreshores as a public park, restoring adjacent buildings and extending the underground rail system to help replace the traffic. The project has been very symbolic, as the river is a spiritual source of life for the city. Now other car-saturated Asian cities are planning to replace their central city freeways (http://www.metro.seoul.kr/kor2000/chungaehome/en/seoul/2sub.htm/).

What these projects have shown and encouraged is to 'think of transportation as public space' (Burwell, 2005). With this changed approach to city planning, the small-scale systems of pedestrian movement and cycling become much more important. Pedestrian strategies enable each centre in a city to give priority to the most fundamental of human interactions: the walking-based face-to-face contact that gives human life to a city and, in the process, reduces its ecological footprint.

Cycle-oriented strategies can be combined with the development of greenways that improve the green agenda and lower ecological footprint. Enough demonstrations now exist to show that pedestrian and bicycle strategies work dramatically to improve city economies and to integrate the green and brown agendas. Pedestrian and bicycle strategies in Copenhagen, most Australian cities, London, New York,

San Francisco and Bogota, as well as the dramatic changes in Paris with the Velib bicycle scheme and the growing awareness that it works in developing country cities as well, are all testament to this new approach to cities including successful centre and Transit Oriented Developments (Newman and Kenworthy, 2007)..

(5) Reduced parking. One space per unit is the growing standard in the USA (Shoup 2005). TOD dwellers and users, on average, are characterised by lower car use and ownership than their counterparts in conventional urban areas (Friedman, Gordon & Peers 1995). However, translating this finding into lower car-parking requirements has been a slow process, as exemplified by Perth's Subiaco (see 'Case study: East Perth and Subiaco TODs') where after much deliberation, a conventional standard for car-parking provision was adopted (Howe, Glass & Curtis 2009). Such practice, however, leads to spatial and functional conflicts where large amounts of car parking as well as entry/exit points to multistorey garages need to be accommodated in a high-density environment, and where the associated volume of vehicle traffic impacts on the amenity of the streetscape for pedestrians and stationary users.

As with zoning standards for maximum density (elaborated above), it is arguable that the conventional practice of mandating a minimum of parking spaces per dwelling, or proportional to floor area of office space, is not a suitable approach for TODs (Shoup 2005). Instead, maximum levels of parking provision should be stipulated, coupled with incentives to compensate for the shortfall, such as the provision of car-sharing vehicles, quality improvements to the public realm and boosts to public transport service standards. Since lower parking provision reduces construction costs, such measures could be funded as part of a value capture package through developer contributions. They will also contribute to enhancing housing affordability (Scheurer 2001).

Woodcock, Dovey & Wollan (2009) strongly advise that parking standards in transit-oriented neighbourhoods be reduced, for all the abovementioned reasons and in order to discourage the take-up of 'drive in, drive out' lifestyles by new residents, who are otherwise able to accommodate and access their (multiple) vehicle(s) with such ease and at no specific cost that they forego the opportunity to adapt their mobility behaviour to the superior conditions for walking, cycling and public transport. In Melbourne's Brunswick, this group has been found to engage least with local community networks, contributing to resistance against densification projects among more established residents (ibid.).

In Freiburg-Vauban, a market-based approach to parking management has been taken. The sale or lease of housing units and parking spaces has been completely separated, with the physical provision of off-street parking as part of residential structures actually banned in about half the development. Instead, car-owning residents are obliged to purchase or rent a parking space in one of two multistorey garages at the edge of the precinct, at a greater distance on foot from most houses than the nearest tram stop. The explicit cost of these facilities works as a powerful disincentive to car ownership, with nearly half of all households not owning a vehicle at all and the number of multiple-car-owning families having dropped to zero (Scheurer & Newman 2009). It also improves housing affordability for non-car owners.

Case study: Using TOD typologies to guide TOD and station planning

As applied in the Denver TOD Plan (2006), a TOD typology serves two important functions. First, the place types provide enough detail so that if development proposals are submitted to the city prior to completion of a detailed station area plan, there is some basis for evaluating the proposal to determine its appropriateness, given the general vision. Second, the place types provide the starting point for the station area planning process so that all of the participants in the planning process have a shared global vision from which they can work on developing the specifics of the plan itself, including an appropriate implementation strategy.

(6) Green TODs. TODs need to provide incentives and development patterns which achieve far greater sustainability outcomes including reductions in energy and water use, and greenhouse gas emissions. This could be five or six green-star-rated buildings, though increasingly there will be a carbon standard for the whole development to meet. Some TODs should have smart grids with electric plug-ins and renewables associated with the development (Went, James & Newman 2008). Water-sensitive urban design (WSUD) and water cycle management should be elements of any future development. This is expanded in Section G.

These Green Centres need to be walkable, dense, and mixed as outline in other sections of this report – providing the human basis of an interactive, centre of innovation. They need to be smart with a smart grid and smart metering to enable the latest in feed-back and control systems for clever digital management. And most of all they need to be models of renewable developments with green buildings and green infrastructure as these will enable them to display the 21st century technologies that can enable them to set the model for urban development in the next 50 years. As set out below this can also save money as has been shown across the world.

Most power and water systems for cities over the past 100 years have become bigger and more centralized. While newer forms of power and water are increasingly smaller scale, they are often still fitted into cities as though they were large. The movement that tries to see how these new technologies can be fitted into cities and decentralized across grids is called 'distributed power and distributed water systems' (Droege, 2006).

'Water sensitive urban design' should be incorporated in TODs to more efficiently use the complete water cycle, i.e., using rain and local water sources like groundwater to feed into the system and then to recycle 'grey' water locally and 'black' water regionally, thus ensuring that there are significant reductions in water used. This system can enable the green agenda to become central to the infrastructure management of a city; stormwater recycling can involve swales and artificial wetlands that can become important habitats in the city. Grey water can similarly be recycled to irrigate green parks and gardens, and regional black water recycling can be tied into regional ecosystems. All these initiatives require 'smart' control systems to fit them into a city grid and also require new skills among town planners and engineers, who are so far used to water and energy management being a centralized function rather than being a local planning issue (Benedict and McMahon, 2006).

Renewable low-carbon TODs should aim to develop more decentralized energy production systems, where production is more on a neighbourhood scale and both line losses and power shedding can be avoided. Whether from a wind turbine, small biomass combined heat and power plant (as in London's new distributed energy model), or a rooftop photovoltaic system, renewable energy is produced closer to where it is consumed and, indeed, often directly by those who consume it. This distributed generation offers a number of benefits, including energy savings, given the ability to better control power production, lower vulnerability and greater resilience in the face of natural and human-made disaster (including terrorist attacks). A number of such small-scale energy systems are being developed to make centres and cities more resilient in the future (Sawin and Hughes, 2007).

There are now many cities that are able to demonstrate small-scale local water systems that are very effective. The new Armstrong Creek project in Melbourne has been studied in detail by Sustainability Victoria as a model for doing this distributed, green infrastructure. It was shown to save $500 million net present value over 10 years compared to a business-as-usual approach to infrastructure (Sustainability Victoria, 2009).

Biophilic centres also need to be explored which use landscaping to enhance every building using green roofs, green walls and water sensitive urban design to 'air condition' the whole urban area. This concept developed from cities that were already finding that the urban heat island effect and global warming was

impacting on their citizens, so they decided to use natural systems to help cool their cities including in Chicago, Toronto and Singapore.

Green TODs in Toronto and Malmo

In Toronto, communities have formed 'buying-cooperatives' to pool buying power to negotiate special reduced prices from local photovoltaic companies that had offered an incentive to buy solar photovoltaic panels. The first cooperative was the Riverdale Initiative for Solar Energy. In this initiative, 75 residents joined together to purchase rooftop photovoltaic systems, resulting in savings of about 15% in their purchase cost. This then spread across the city. The Toronto example suggests the merits of combining bottom-up neighbourhood approaches with top-down incentives and encouragement. This support for small-scale distributed production — offered through what are commonly referred to as standard offer contracts (often referred to as 'feed-in tariffs' in Europe), has been extremely successful in Europe, where they are now common. The same can be done with new technologies for water and waste, such as rain water tanks and grey water recycling.

Another model example is the redevelopment of the Western Harbour in Malmö, Sweden. Here the goal was to achieve distributed power and water systems from local sources. This urban district now has 100% renewable power from rooftop solar panels and an innovative storm water management system that recycles water into green courtyards and green rooftops. The project involves local government in the management and demonstrates that a clear plan helps to drive innovations in distributed systems (City of Malmo, 2005).

Distributed infrastructure is beginning to be demonstrated in cities across the globe. Utilities are beginning to develop models with city planners of how they can carry out local energy and water planning through community-based approaches and local management – such models need to be thought through and applied along the Knowledge Arc.

With these codes it is possible to enable a TOD to have special accelerated development rights (e.g. as applied in Austin — see 'Case study: Expedited development approvals for affordable TODs in Austin, Texas); these are what the TPS and strategic planners are most hoping to enable.

Some of these principles were used in developing TOD typologies for planning the new FastTracks rail and stations in Denver (see 'Case study: Using TOD typologies to guide TOD and station planning', Table F-1 and Figure F-1).

Case Study: Using TOD Typologies to Guide TOD and Station Planning in Denver

As applied in the Denver TOD Plan, (2006), a TOD typology serves two important functions (refer Table 1). First, the place types provide enough detail so that if development proposals are submitted to the City prior to completion of a detailed station area plan, there is some basis for evaluating the proposal to determine its appropriateness given the general vision. Second, the place types provide the starting point for the station area planning process so that all of the participants in the planning process have a shared global vision from which they can work on developing the specifics of the plan itself, including an appropriate implementation strategy.

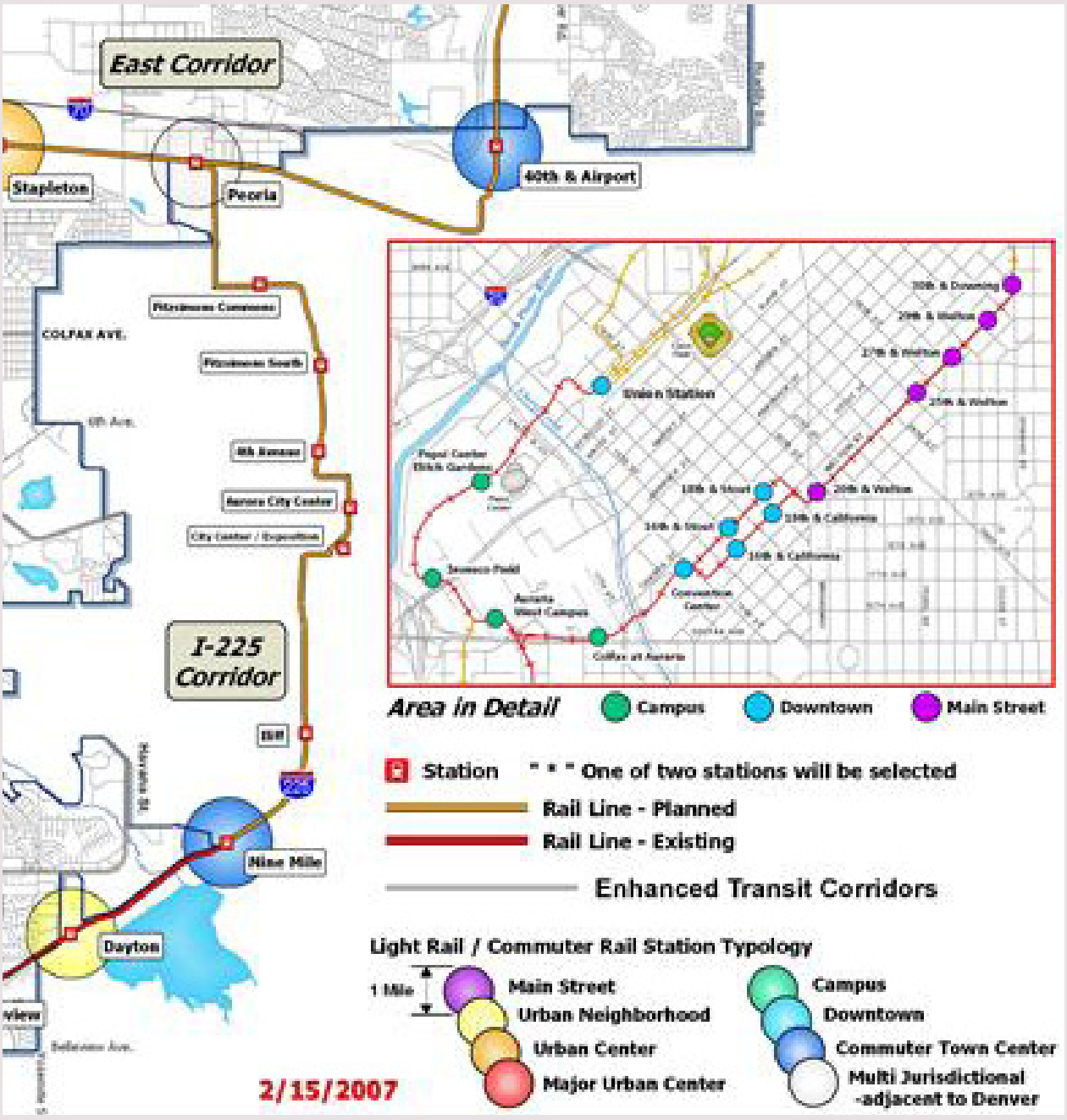
Table F-1: TOD typologies for the Denver TOD plan

TOD typology	Desired land use mix	Desired housing types	Commercial/ employment types	Proposed scale	Transit system function
Downtown	Office retail, residential, entertainment and civic uses	Multi-family and loft	Prime office and shopping location	5 stories and above	Intermodal facility/transit hub. Major regional destination with high-quality feeder bus/streetcar connections
Major urban centre	Office, retail, residential, entertainment	Multi-family and townhouse	Employment emphasis with more than 250,000 office & 50,000 sq ft retail	5 stories and above	Subregional destination. Some park-and-ride. Linked with district circulator transit and express feeder bus.
Urban centre	Office, retail, residential	Multi-family and townhouse	Limited office. Less than 25,000 sf office. More than 50,000 sf retail.	3 stories and above	Subregional destination. Some park-and-ride. Linked with district circulator transit and express feeder bus.
Urban neighbourhood	Residential, neighbourhood retail	Multi-family townhouse, small-lot single-family	Local serving retail. No more than 50,000 sf	2-7 stories	Neighbourhood walk-up station. Very small park-and-ride, if any. Local bus connections.

TOD typology	Desired land use mix	Desired housing types	Commercial/ employment types	Proposed scale	Transit system function
Commuter town centre	Office, retail, residential	Multi-family townhouse, small-lot single-family	Local and commuter serving no more than 25,000 sf	2-7 stories	Capture station for in-bound commuters. Large park-and-ride with local and express bus connections.
Main street	Residential, neighbourhood retail	Multi-family	Main street retail infill	2-7 stories	Bus or street car corridors. District circulator or feeder transit service. Walk-up stops. No transit parking.
Campus/ special events station	University campus, sporting facilities	Limited multi-family	Limited office/ retail	Varies	Large commuter destination. Large parking reservoirs but not necessarily for transit.

The TOD typologies were used in corridor planning and TOD station area planning as shown in Figure F-1.

Figure F-1: Denver Station area typologies



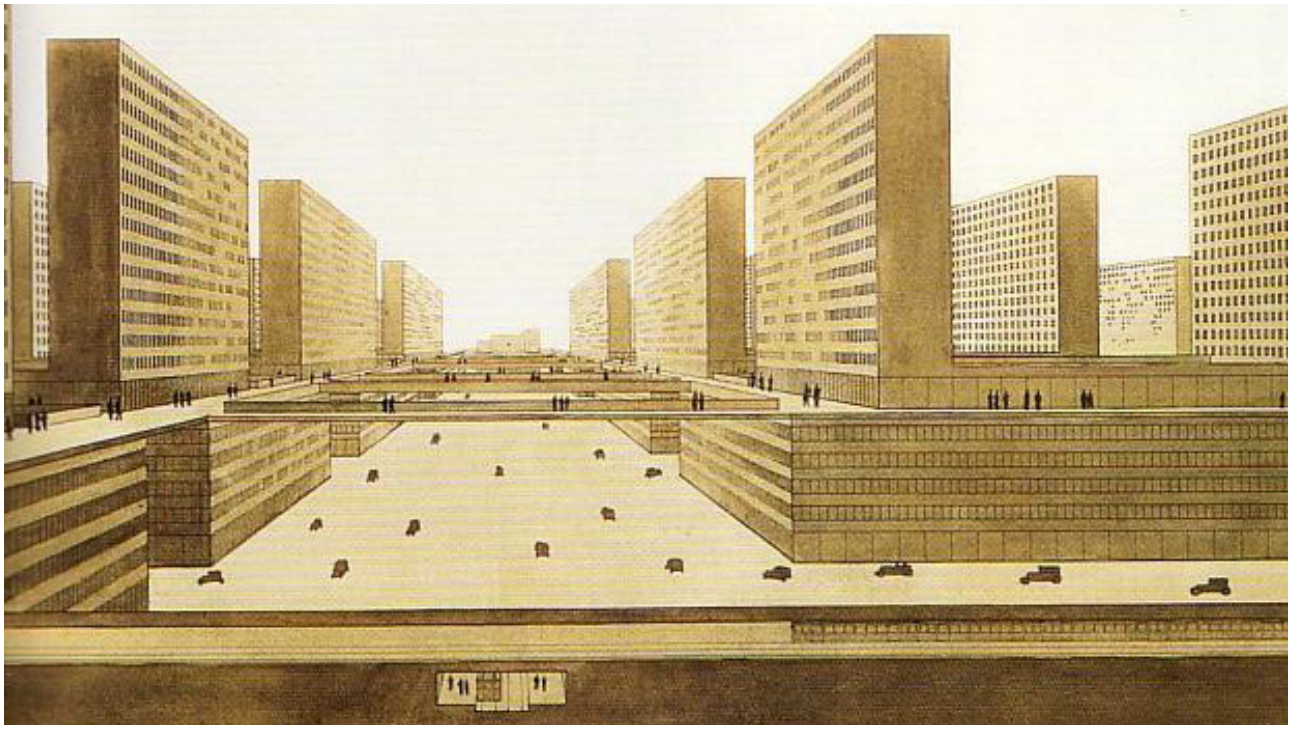
Case study: Vancouver TODs

The City of Vancouver has around 20 TODs that have all been built in association with their Skytrain light-rail service. These have been done in partnership with the strategic planning agency (Greater Vancouver Regional Planning District), the City of Vancouver, private developers and the local community. The zoning of the areas around stations is highly contained so that high density is kept to the walking distance radius around stations (see photo of Joyce Collingwood station in Figure F-3 and the clear distinction between high-rise areas and surrounding low-rise suburbs). The process of building a TOD began well before the sky train came to most areas and a clear set of guidelines was given to developers, including the need to provide affordable housing in up to 15% of the development and that 5% of the value of the development would need to be used for social infrastructure. This money was directed into the projects that the local community saw as being its highest priority, including street landscaping, cycleways, child care centres and even an art house cinema (see Figure F-4). The success of the Vancouver zoning system is also a reflection on its success in being able to deliver good contracts and to engage the community in a positive way.

Figure F-3: Joyce Collingwood TOD, Vancouver

Figure F-4: Social infrastructure at Coal Harbour TOD, Vancouver, delivered through the 5% social infrastructure requirement (community centre at the left and landscaped boardwalk were built with these funds).

Figure F-5: The public's frequent perception of a TOD



Case study: Christchurch Bus Xchange TOD

In the late 1990s the Canterbury Regional Council and Christchurch City Council established a Public Transport (PT) Advisory Group, made up of approximately 20 members representing key agencies, interest groups, users and non-users. The PT Advisory Group met over the course of one year to establish an overall public transport strategy for Christchurch. It identified a number of strategic improvements the councils and community needed to make to significantly improve public transport, including better integrated land uses, increasing frequency, improving transit priority, better ticketing and new bus interchanges.

After the adoption of the PT strategy by both councils and agreement to significantly increase investment in the PT system, there was an immediate increase in patronage and hence pressure to expand the system. As part of the redevelopment of a major city centre retail development (known as The Crossing), an opportunity arose for the integration of a new city centre bus interchange within the mixed-use CBD shopping centre. The developer came to council during construction and indicated there was a limited time window to explore options for integrated public transport into the development.

The Christchurch Bus Xchange involved successful public engagement and governance between multiple agencies and the developer to produce a modern bus station, integrated with two floors of retail; a new primary school was located on the levels three and four of the development; an over-street bridge was built to better integrate with a major department store across the main street; and short-term car parking was built to better support the enhanced retail activity. The entire development and Bus Xchange was encased behind and within a heritage building. The project also required significant investment in smart-card ticketing and real-time information systems, which galvanised system-wide major investments. Patronage since the Bus Xchange development (and a number of other projects) has more than doubled throughout the system.

The Bus Xchange set new standards for the quality of public transport passenger facilities, particularly in the off-street component, with carpeted, airconditioned waiting lounges separated from buses by sliding glass doors and supported by real-time passenger information; the Bus Xchange also directly connects at numerous points to the surrounding retail. As a result of these qualities, the Bus Xchange has been the subject of international interest since its opening.

The public engagement side was critical to success of the project as the long-standing public transport advisory group (of users and non-users) was used in both leveraging approval for the project, identifying and designing into the project social/community benefits (e.g. the schools — see below in this case study) and with achieving significant additional council funding and regulatory approval. In addition, the group was used in detailed design review of the actual facility during the design process, to ensure legibility throughout the mixed-use development, as well as design safety.

So, what made the Bus Xchange work, and what lessons does the project have for other cities?

The first reason is that it is a rare example of a successful public-private partnership and this, in our view, is because all the players could see the benefits of integrating public transport with a major city centre revitalisation project. In this case, the developer was an active champion of the bus interchange and an initiator of its integration with the retail development, rather than having a public transport facility imposed on the project. In competing with the growth of suburban shopping

malls, improving public transport access to city centre retail developments was recognised as an important contributor to success, particularly where car-parking provision is constrained.

Integration with the primary central city retail contributed to high-quality passenger facilities. In most transport interchange projects, the quality of passenger facilities is often compromised when budgets are under pressure. Because the Bus Xchange was seen as part of The Crossing development, the quality of fittings and finishes in the public spaces had the potential to influence perceptions of the whole development. This encouraged the use of high-quality passenger seating and fit-out in the Bus Xchange. The airport-quality look and feel of the passenger lounges is one of the immediate positive public impressions, and consistent finishes and signage between public spaces also contribute to a sense of integration (see Figure F-7).

The Bus Xchange, although primarily designed as a bus passenger facility, applied TOD principles to ensure integration with the retail redevelopment (see Figure F-8). The successful integrated planning directly catalysed additional mixed uses in the development. A new primary school was established on the top two floors of the building, partially due to the excellent bus facility and opportunities for children to travel directly to the school; in addition, the same school established a new high school within a block of the Bus Xchange, again partially because of the success of the Bus Xchange. Finally, in the adjoining block across the street, the council was able to facilitate a major retail redevelopment as a direct result of the success of the Bus Xchange and successfully integrated the retail redevelopment with adjoining car parking. Thus the synergies of a TOD were enabled through this whole process.

Figure F-7: Interior of Christchurch Bus Xchange passenger lounge

Figure F-8: Christchurch Bus Xchange, Lichfield Street

Case study: Vauban — a PPCP

In Freiburg, Germany, a TOD has been built in a redeveloped military base called Vauban. The TOD is home to 5,000 residents and features perhaps the best example of green technologies, such as solar housing, 100% renewable energy for electricity, water-sensitive design, and a car-free approach based on light rail and bicycles being allowed into the development whilst cars are discouraged through a variety of means. The result has been a highly popular development, as families have been attracted to the site due to its car-free safety. Children can be seen running through the area with a freedom rarely seen in a car-dependent suburb (see Figures F-9 and F-10).

The significance in terms of community engagement and governance is that it was a PPCP — a public–private community partnership. The local government was keen to see the site redeveloped using community values associated with green technologies and design but did not know how best to do it. The Forum Vauban, a community association, was contracted by the city to lead resident participation, the elaboration of sustainability goals and public relations work. They were able to establish a range of funds that the local government alone could not have done in order to establish the project as a demonstration. Private-sector involvement followed as each phase was put out to tender. The real benefit was that the community drove the development, as they had such a large stake in the outcome. Similar projects are beginning to happen through community housing associations that are able to tap local community values and enable affordable housing to be part of the TOD.

Figure F-9: Vauban TOD in Freiburg, built as a public-–private community partnership

Figure F-10: TOD freedom for children in Vauban

Case study: East Perth and Subiaco TODs

The two best TODs in Perth were both developed through a statutory authority (the East Perth Redevelopment Authority) that was given full planning powers over the sites and the ability to fund the preliminary infrastructure. They were not given a TOD zoning as such, but instead a structure plan was produced for each area with clear guidelines that set out what developers were required to achieve. These had strong design guidelines to ensure a quality and coherent design. The result is two TODs that have changed the perceptions of the development industry and the general public about the value of mixed-use, medium-density development in Perth. The WA Government was able to collect hundreds of millions of dollars in return for the development; the land at Subiaco, for example, increased in value five times in a few years and changed the nature of Subiaco. The patronage at the Subiaco station increased by 100% in the year that the TOD was opened, with its new station built as part of the development. The guidelines could have been adapted for any other TOD in Perth but that has not happened, as the statutory planning system is shaped by a model town planning scheme that has no TOD zoning category. This will need to change if TODs are to become mainstream, not just on government projects on government land as in East Perth and Subiaco.

Figure F-2: East Perth TOD

TOD engagement

A necessary step in delivering a TOD is to bring the public along on the journey. This must be enabled through a public engagement process as most of the public still believe that a TOD is likely to be a high-density block of flats, such as in Figure F-5 below.

Birrell et al. (2005) were strongly opposed to the Melbourne 2030 Plan with its Transit Cities around rail stations. However, the public opposition that developed was mostly based on ignorance and fear (see Newman 2005 for a response to the Melbourne anti-TOD campaign).

In order to break this kind of log-jam that can sweep away even the best urban policy, it is necessary to engage the public from the beginning, to enable them to sit in the seat of the planners and understand all the trade-offs, benefits and opportunities. This will inevitably involve deliberative processes (see Hartz-Karp & Newman 2006).

As shown in Table F-3, there is a spectrum of public participation.

Table F-3: IPA2 Spectrum of public participation

	Inform	Consult	Involve	Collaborate	Empower
Example tools	Fact sheets Websites Open houses	Public comment Focus groups Surveys Public meetings	Workshops Deliberate polling	Citizen advisory committees Census building Participatory decision making	Citizen juries Ballots Delegated decisions

As with most projects which involve change, TODs often involve a degree of perceived threat unless there are clear, identified community benefits. Achieving greater public participation will usually deter a NIMBY (not in my backyard) response and instead enable projects to contribute significantly to the long term welfare of the local community.

It is best if the public are integrated into the other planning processes, as occurs in Vancouver (see 'Case study: Vancouver TODs' and Figures F-3 and F-4). In Vancouver the town-planning process requires, for TODs, a 5% contribution from the developer for social infrastructure (e.g. child care centres, open-space landscaping, cycleways) that is decided by the local community in consultation with the council. Such "developer" contributions need to be tied to the development to ensure monies collected are spent on the development and not absorbed in to a larger government fund, thus ensuring local needs are met.

In Christchurch, New Zealand, there was significant 'collaboration and empowerment with the creation of an advisory group in the design and delivery of a new public transport system, including a new central-city TOD and bus interchange. Such developer contributions need to be tied to the development to ensure monies collected are spent on the development and not absorbed in to a larger government fund, thus ensuring local needs are met.

Most TODs can easily stand up to public scrutiny, but they are best enabled through processes that can visualise their architecture and their design at ground level and which can clearly show a local benefit.

Case study: Varsity Station Village

The Varsity Station Village project illustrates some of the best practices in engaging and communicating to the public about a TOD. The Gold Coast project will transform an old tip site previously earmarked for industrial development, next to a freeway. With the extension of the railway the project will delivery a vibrant and attractive urban village (Queensland Transport 2009) (see Figure F-6).

Figure F-6: Varsity Station Village Master Plan (Source: Queensland Transport 2009)

Both the public and the development industry were involved in the design plan, which was based on the principles of TOD, from the very beginning. The Varsity Station Village project team undertook a range of consultation activities that generated community interest, with large volumes of responses, enquiries, attendance at community displays and visitors to the project website. As a result, the Varsity Station Village Master Plan collated submissions and took into consideration the feedback from the community mainly on access for pedestrians; parks and public space; traffic flow; parking; and the mix and types of activities.

The process was started well before the trainline extension, thus enabling the ideas to be fed into the design process and community ownership to be achieved.

Land assembly in station precincts

A major challenge for private-sector development in assuring commercial viability, particularly in existing urban areas, is assembly of disparate parcels of land to ensure adequate size and scale for viable development around transit. Aside from what is generally inconsistent government intervention across

Australia, at present there is a lack of incentives or consistent mechanisms for private-sector land assembly in TOD precincts.

There are numerous site-specific examples of government intervention, where redevelopment authorities established both land assembly and government agency integration to ensure greater commercial viability to redevelopment areas around public transport (e.g. Subiaco and East Perth). However, without a more consistent mechanism and incentives for land assembly, to amalgamate sites as well as reduce the uncertainty of long-term holding costs, the private sector is often reluctant to take on the challenges of major TOD area redevelopment. From our experience, it tends to be the 'boutique' developer who is willing, passionate and sufficiently persevering to take on such challenges in the face of numerous obstacles. Instead, most 'traditional' developers are attracted to the concept of transit-oriented development, but in inner-city areas they often shy away from the prospective land amalgamation and development risks. To truly galvanise the significant opportunities around transit stations and along transit corridors in Australia, an improved land amalgamation incentive and process needs to be developed.

Although not explored in detail in this paper, land assembly incentives could occur through a combination of such measures as:

- zoning policies which encourage site amalgamation (e.g. bonus development incentives, increasing plot ratios), also known as progressive zoning in the USA
- facilitating site amalgamation via a convenor or facilitator for an area (this is sometimes led by government agencies in lieu of private sector integration)
- faster development approvals for amalgamated, good-quality TOD projects
- infrastructure delivery programs, including transit investment that is integrated (and funded and committed) to delivery with increasing density in TOD locations
- financing incentives, where developer financing arrangements could be more amenable to amalgamated sites in TODs
- improving home loans for residential developments in TODs that have lower transportation costs and can therefore pay more (and borrow more) toward housing costs; in the USA, these are known as location efficient mortgages.

Governance for delivering TODs

The obvious conclusion from the above TOD challenges of delivery is the need for a governance system to enable these to happen. Most governance systems at local government and state government level are not suited to enable the strategic and statutory land use planning, the transit operations, the public-private contracting and the community engagement processes to be integrated. Thus a separate body needs to be created that has a built-in process to enable this integration.

Without improved governance vehicles for integrated planning and delivery, TODs are currently left "to fend for themselves" in often discrete and haphazard governance processes. A more holistic governance approach is required between councils, state government agencies and funding authorities to ensure more accountable and responsive governance arrangements are established which ensure TODs receive greater priority in planning, delivery and approval. Without a concerted and integrated effort across all urban areas of Australia, the same random and inefficient process will continue – making greenfield suburban sprawl the undesirable but default "winner" in meeting our future population growth targets..

State governments can create a separate organisation with statutory powers, like a Redevelopment Authority, which was used to create Subiaco and East Perth in Western Australia. Planning authorities can also set up special powers around a TOD that can enable them to be subject to state powers alone, such as in Melbourne's Transit Cities projects. This allows teams of people to focus on the TOD and then hand back to the local area after the TODs are completed. Partnerships can be established through the

contract-alliancing process that can provide a public-private partnership group with the powers to do all the necessary work, including the design, community engagement and delivery. The next phase of the Gold Coast Light Rail project includes elements of all these governance processes, as it has a Queensland Government team that has been working together with the Gold Coast City Council on all the design and planning, including its major financing; this group will now enable an alliance contract to be created, with an operator, engineer and developer consortium to take the project to the next stage.

However, setting up a separate organisation for each individual area or project would defeat the purpose of making TOD delivery easier. A more holistic approach would be to have an agency which is in charge of integrated agency collaboration for TODs across the city – lending its authority and ability to pull disparate state and local agencies into a more integrated platform for supporting delivery of TODs.

The key issue is that of integration and if this is not happening then TODs are not going to be delivered. Improving governance is a precursor to successful delivery of TODs, as a good governance model will directly assist in improving town planning, contracting, community engagement and land amalgamation challenges facing most TODs.

The key issue is that of integration, and if this is not happening, then TODs are not going to be delivered.

Conclusions

TOD's are an important part of urban policy. They are however not being delivered at anything like the rate at which city and state governments and strategic planners had hoped. The resultant threat is that continued suburban sprawl with its commensurate impacts and costs will continue to dominate our cities. Conversely, improvements in integrated TOD delivery can significantly improve the performance of our cities to meet the challenges of the 21st century.

Although improving delivery of TODs should not be considered a panacea or saviour for city development, making it easier for successful TODs throughout Australia can meet a significant proportion of future development in both existing urban areas and new greenfield developments. Reducing car dependence, improving quality of life, delivering more sustainable communities, and making more efficient infrastructure investments can all be part of successful transit oriented development.

There are a number of actions required which this paper explores including improvements in:

- TOD Zoning and Planning
- TOD Contracting
- TOD Engagement
- TOD Land amalgamation and
- TOD Governance

The process of delivery now needs some clear demonstrations based on this new approach. Importantly, a governance system that enables improvement in these processes to be integrated seems to be a precursor.

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THE KNOWLEDGE ARC LIGHT RAIL: SECTION G

ENABLING THE GREEN KNOWLEDGE ECONOMY THROUGH THE LRT-TOD CONCEPT

By Peter Newman

The rationale for building the Knowledge Arc Light Rail is to help link together a series of knowledge economy precincts to enable them to function better. In the process there will be a lot of development that will be built around the LRT in and around stations — the so-called TOD sites. These sites can also play an important role in helping Perth to play an even bigger role in the developing green knowledge economy. Thus the Knowledge Arc Light Rail is a both way of solving a transport problem with LRT — something we could probably have suggested anytime in the past 20 years — and equally a way of creating a Green Knowledge Economy Centre as the basis of the new economy.

Green Knowledge Economy Centres

These Green Centres need to be walkable, dense, and mixed as outline in other sections of this report – providing the human basis of an interactive, centre of innovation. They need to be smart with a smart grid and smart metering to enable the latest in feed-back and control systems for clever digital management. And most of all they need to be models of renewables, green buildings, and green infrastructure as these will enable them to display the 21st century technologies that can enable them to set the model for urban development in the next 50 years. As set out below this can also save money as has been shown across the world.

The concept is for a design to be drawn up for each of the key station precincts as part of the planning for each site – this is planning that has in some instances been well advanced but with the LRT a new opportunity presents itself for each development site to be part of the green knowledge economy as well.

Curtin University and UWA need to be leaders in how this is done. But so too should the State Government through Technology Park, through Landcorp's Riverside development and through EPRA's Northbridge Hub, not to mention the three hospital sites at RPH, PMH and the new redeveloped Sir Charles Gardiner site where a hospital will be built to last at least 100 years. All these sites are building deep into the century

where all fossil fuels will be phased out and green technologies will be a matter of everyday use. As shown below the time to be part of this economy is now otherwise we will not make the most of this growth opportunity. If we do we could attract so much more in the way of expertise and thus export services from these essential professional activities that must become part of every city throughout the dynamic areas of China and India.

This brings together a much more coherent vision for doing the LRT.

It brings leadership and opportunity to the Knowledge Arc as the facilitator of a city-building vision that is a model for 21st century city-building (Newman, Beatley and Boyer, 2009).

Green development features of the Knowledge ARC centres:

1. Distributed, green infrastructure centres.

Most power and water systems for cities over the past 100 years have become bigger and more centralized. While newer forms of power and water are increasingly smaller scale, they are often still fitted into cities as though they were large. The movement that tries to see how these new technologies can be fitted into cities and decentralized across grids is called 'distributed power and distributed water systems' (Droege, 2006).

The distributed water system approach is often called 'water sensitive urban design'. It includes using the complete water cycle, i.e., using rain and local water sources like groundwater to feed into the system and then to recycle 'grey' water locally and 'black' water regionally, thus ensuring that there are significant reductions in water used. This system can enable the green agenda to become central to the infrastructure management of a city; stormwater recycling can involve swales and artificial wetlands that can become important habitats in the city. Grey water can similarly be recycled to irrigate green parks and gardens, and regional black water recycling can be tied into regional ecosystems. All these initiatives require 'smart' control systems to fit them into a city grid and also require new skills among town planners and engineers, who are so far used to water and energy management being a centralized function rather than being a local planning issue (Benedict and McMahon, 2006).

In large cities, the traditional engineering approach to providing energy has been through large centralized production facilities and extensive distribution systems that transport power relatively long distances. This is wasteful because of line losses; also, because large base-load power systems cannot be turned on and off easily, there is considerable power shedding when the load does not meet the need. Renewable, low-carbon cities aim at developing more decentralized energy production systems, where production is more on a neighbourhood scale and both line losses and power shedding can be avoided. Whether from a wind turbine, small biomass combined heat and power plant (as in London's new distributed energy model), or a rooftop photovoltaic system, renewable energy is produced closer to where it is consumed and, indeed, often directly by those who consume it. This distributed generation offers a number of benefits, including energy savings, given the ability to better control power production, lower vulnerability and greater resilience in the face of natural and human-made disaster (including terrorist attacks). Clever integration of these small systems into a grid can be achieved with new technology control systems that balance the whole system in its demand and supply from a range of sources as they rise and fall and link it to storage, especially vehicle batteries through vehicle-to-grid, or 'V2G', technology. A number of such small-scale energy systems are being developed to make cities more resilient in the future (Sawin and Hughes, 2007).

There are now many cities that are able to demonstrate small-scale local water systems that are very effective. **The new Armstrong Creek project in Melbourne has been studied in detail by Sustainability Victoria as a model for doing this distributed, green infrastructure. It was shown to save $500 million net present value over 10 years compared to a business-as-usual approach to infrastructure (Sustainability Victoria, 2009).**

Distributed power and water provision in cities needs community support. In Toronto, a possible model similar to those outlined above in developing cities has been created. Communities began forming 'buying-cooperatives' in which they pooled their buying power to negotiate special reduced prices from local photovoltaic companies that had offered an incentive to buy solar photovoltaic panels. The first cooperative was the Riverdale Initiative for Solar Energy. In this initiative, 75 residents joined together to purchase rooftop photovoltaic systems, resulting in savings of about 15% in their purchase cost. This then spread across the city. The Toronto example suggests the merits of combining bottom-up neighbourhood approaches with top-down incentives and encouragement. This support for small-scale distributed production — offered through what are commonly referred to as standard offer contracts (often referred to as 'feed-in tariffs' in Europe), has been extremely successful in Europe, where they are now common. The same can be done with new technologies for water and waste, such as rain water tanks and grey water recycling.

Another model example is the redevelopment of the Western Harbour in Malmö, Sweden. Here the goal was to achieve distributed power and water systems from local sources. This urban district now has 100% renewable power from rooftop solar panels and an innovative storm water management system that recycles water into green courtyards and green rooftops. The project involves local government in the management and demonstrates that a clear plan helps to drive innovations in distributed systems (City of Malmo, 2005).

Distributed infrastructure is beginning to be demonstrated in cities across the globe. Utilities are beginning to develop models with city planners of how they can carry out local energy and water planning through community-based approaches and local management – such models need to be thought through and applied along the Knowledge Arc.

In Perth there are two examples where small cities are being planned using the distributed, green infrastructure model: Stirling City Centre and North Port Quay. Stirling City Centre is examining how it could build a city centre around the Stirling Station for 30,000 residents and 30,000 jobs. It wants to completely regenerate an area that is very run down and do it with 21st century technology. It is looking at zero carbon, zero scheme water and zero waste concepts. North Port Quay is a city planned off Fremantle Harbour for 20,000 dwellings which would be zero carbon, zero scheme water and zero waste with a house, land and electric vehicle package. Although not yet at a project stage this development, and Stirling's concept, shows that Perth's development community is preparing for the next stage in urban development using distributed, green infrastructure.

2. Biophilic centres

Biophilic centres use landscaping to enhance every building using green roofs, green walls and water sensitive urban design to 'air condition' the whole urban area. This concept developed from cities that were already finding that the urban heat island effect and global warming was impacting on their citizens, so they decided to use natural systems to help cool their cities (Beatley, 2010).

Chicago was the first city to pioneer the technology of green roofs when the city lost many citizens during a heat wave. Mayor Daly has created special funds to facilitate green roofs in new buildings. As a result there are now over 400 green roofs that are cooling the city in summer and slowing down the release of stormwater in winter. Toronto has now mandated that all new buildings will have green roofs.

Singapore has made a strong commitment to being a biophillic city. Every space that does not contain buildings is being landscaped with trees and all kinds of subsidies are given to enable green roofs, green walls and even sky gardens that link between buildings. The vision of the city for the future is a city draped in green; it wants to move from being the garden city to being the city in a garden.

Providing amenity in a city is essential for its economic health and community well being; biophillic city elements are going to help create this amenity. In Perth the denser suburbs like South Perth, Crawley and Subiaco are also the most extensively landscaped with trees. If the city develops more centres that

are higher in density then it will be essential to make these places where biophillic elements are also very obvious.

3. Sustainable transport centres

Not only should the Knowledge Arc be a model for light rail connecting them together, it should also be a model for how each green knowledge economy centre can be a model for other green modes of transport: walking, biking and electric vehicles.

a. Street planning for walking and biking

Streets in each of the knowledge centres need to become an important part of the sustainable transport system. Streets can be designed to favour pedestrians and cyclists and wherever this is done, cities invariably become surprised at how much more attractive and business-friendly they become (Gehl and Gemzoe, 2000; Gehl et al., 2006).

Sustainable mobility management is about 'streets not roads'; the streets are used for a multiplicity of purposes, not just maximising vehicle flow. The emphasis is on achieving efficiency by maximising people movement, not car movement, and on achieving a high level of amenity and safety for all street users. This policy also picks up on the concept of integration of transport facilities as public space. One of the ways that United States and European cities are approaching this is through what are called 'complete streets' or, in the United Kingdom, 'naked streets'. This new movement aims to create streets where mobility is managed to favour public transport, walking and cycling, as well as lower speed traffic. The policy often includes removing all large signs for drivers which means they automatically slow down: in Kensington High Road in London the traffic accident rate has halved because of this.

Copenhagen, Portland, Toronto, Vancouver and Zurich all have built much more in recent times with cycleways, pedestrian facilities and traffic calming. As a result the associated urban development land usage has begun to emerge that reflects these more human qualities. All are far more knowledge economy-oriented as a result as people like to meet where it is busy with people not cars. All these cities had citizen groups that pushed for a different, less car-oriented city and a political process was worked through to achieve their innovations. They usually did not foresee this outcome but it has now made these cities much more aware of the need to build knowledge economy strategies around sustainable transport (Newman and Kenworthy, 1999).

Freeways have blighted the centres of many cities and today there are cities that are trying to remove them. San Francisco removed the Embarcadero Freeway from its waterfront district in the 1990s after the Loma Prieta earthquake. It took three ballots before consensus was reached, but the freeway has been rebuilt as a friendlier tree-lined boulevard involving pedestrian and cycle spaces. As in all cases where traffic capacity is reduced, the city has not found it difficult to ensure adequate transport, because most of the traffic just disappears. Regeneration of the land uses in the area has followed this change of transportation philosophy (Gordon, 2005).

Seoul has removed from its centre a large freeway that had been built over a major river. The freeway had become controversial because of its blighting impacts on the built environment as well as the river. After a mayoral contest where the vision for a different kind of city was tested politically, the newly elected mayor began a five-year programme that entailed dismantling the freeway, rehabilitating the river, restoring a historical bridge, restoring and rehabilitating the river foreshores as a public park, restoring adjacent buildings and extending the underground rail system to help replace the traffic. The project has been very symbolic, as the river is a spiritual source of life for the city. Now other car-saturated Asian cities are planning to replace their central city freeways (http://www.metro.seoul.kr/kor2000/chungaehome/en/seoul/2sub.htm/).

What these projects have shown and encouraged is to 'think of transportation as public space' (Burwell, 2005). With this changed approach to city planning, the small-scale systems of pedestrian movement and

cycling become much more important. Pedestrian strategies enable each centre in a city to give priority to the most fundamental of human interactions: the walking-based face-to-face contact that gives human life to a city and, in the process, reduces its ecological footprint.

Cycle-oriented strategies can be combined with the development of greenways that improve the green agenda and lower ecological footprint. Enough demonstrations now exist to show that pedestrian and bicycle strategies work dramatically to improve city economies and to integrate the green and brown agendas. Pedestrian and bicycle strategies in Copenhagen, most Australian cities, London, New York, San Francisco and Bogota, as well as the dramatic changes in Paris with the Velib bicycle scheme and the growing awareness that it works in developing country cities as well, are all testament to this new approach to cities (Newman and Kenworthy, 2007).

b. Electric vehicle strategies

An LRT-TOD strategy can reduce the need for cars by 50% in the area that it runs. But, even if we manage to reduce car use by 50%, we still have to reduce the oil and carbon in the other 50% of vehicles being used. The question should therefore be asked: what is the next best transport technology for motor vehicles? The growing consensus seems to be plug-in electric vehicles (PEV). Plug-in electric vehicles are now viable alternatives due to the new batteries such as lithium ion which are much lighter, longer lasting and cheaper as well as not having the pollution issues of Lead Acid batteries. Thus PEVs they are likely to be attractive to the market. The key issue here is that plug-in electric vehicles not only reduce oil vulnerability but may become a critical component in how renewable energy is incorporated into a city's electricity grid. The PEVs will do this by enabling renewables to have a storage function.

After electric vehicles are recharged at night, they can be a part of the peak power provision next day when they are not being used but are plugged in. Peak power is the expensive part of an electricity system and suddenly renewables are offering the best and most reliable option. Hence the resilient city of the future is likely to have a significant integration between renewables and electric vehicles through a Smart Grid. Thus electric buses, electric scooters and gophers, and electric cars have an important role in the future city, both in helping to make its buildings renewably powered and in removing the need for oil in transport (Went et al. 2008).

Electric rail can also be powered from the sun either through the grid powering the overhead wires or in the form of new light rail (with these new Li-Ion batteries) that could be built down highways into new suburbs without requiring overhead wires. Signs that this transition to electric transport is underway are appearing in USA-based demonstration projects such as those in Boulder and Austin, in Google's 1.6 megawatt (MW) solar campus in California (with 100 PEVs) and by the fact that oil companies are acquiring electric utilities. The Obama and Rudd stimulus packages contained support for this technology. The real test of a city will be how it can simultaneously be reducing its global greenhouse and oil impact through these new technologies whilst reducing the need to travel by car through the policies outlined on LRT and TODs.

By investing in the Knowledge Arc Light Rail the community of Perth will be helping to create a greener future, a better future for local communities and a smarter economy with long term jobs in the knowledge economy.

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