WHY COMPACT CITIES ARE THE FUTURE

With a rapidly increasing urban population, cities have to tap limited natural resources more efficiently than ever. **Jeremy Bentham** from the Shell Scenarios Team draws on Shell's latest research to explain why resource-efficient compact cities are necessary for the future.

The number of people living in urban settings is expected to almost double to over 6 billion by 2050, which will intensify the pressure on vital natural resources, particularly food, water and energy. This will place enormous additional demands on services – both municipal and commercial – that use and supply resources, and require fundamentally new, more efficient, affordable and adaptive delivery models.

The Shell Scenarios Team has been researching these trends to better understand the challenges and opportunities for our business and the world. In a previous article for **URBAN SOLUTIONS** ("Future Cities in a Resource Constrained World", Issue 1, July 2012), I shared insights from our research on energy use in cities. Our analysis suggested that the amount of energy used in cities as a proportion of global energy use would rise from around 66% in 2010, to around 80% by 2040. It also indicated that the increase in global energy consumption over that period would be concentrated almost entirely in cities, especially in regions entering phases of rapid urbanisation.

More than half of global primary energy ends up wasted as lost heat...City planning can significantly improve this...

Our new publication *New Lenses on Future Cities* – to be launched in Singapore during this year's World Cities Summit – highlights the value of compact city development for resource efficiency. In this article, I focus on how the effective management of urban change and infrastructure options could improve resource efficiency. I also highlight a possible model for compact development in existing Chinese cities to accommodate the country's anticipated phenomenal urban growth between now and 2030.

01 Impact of urban density on CO_2 emissions per person in Toronto.

02 Urban density and transport-related energy consumption.

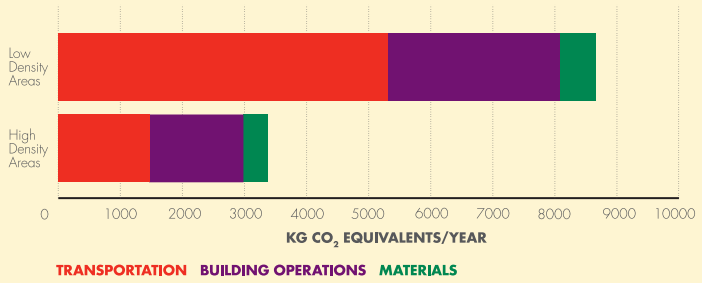
Well-planned Cities are Resource-efficient

An estimated US$57 trillion will be spent on urban infrastructure between 2013 and 2030. The degree to which this growth is well managed and planned will be a central factor in determining how efficiently the world uses vital resources in the future. More than half of global primary energy ends up wasted as lost heat, particularly in the transport and power sectors. City planning can significantly improve this, reducing long-term costs and energy consumption.

Compact and densely populated cities use less energy per person in transport because residents live closer to jobs and amenities. Our research shows that compact city design can reduce average annual car use nationally by as much as 2,000 kilometres per person compared to countries with low density development. Reliable public transport networks and the use of smaller electric or hydrogen-powered cars well suited to shorter distances cut energy demand further. Compact housing and more stringent design and energy efficiency standards also significantly reduce energy use in buildings.

Power sector efficiency can be improved by combining heat/cooling and power generation facilities, which capture waste energy from electricity production and use it in other industrial,

IMPACT OF URBAN FORM ON CO_2 EMISSIONS PER PERSON (TORONTO EXAMPLE)



Source: Journal of Urban Planning and Development (March 2006)

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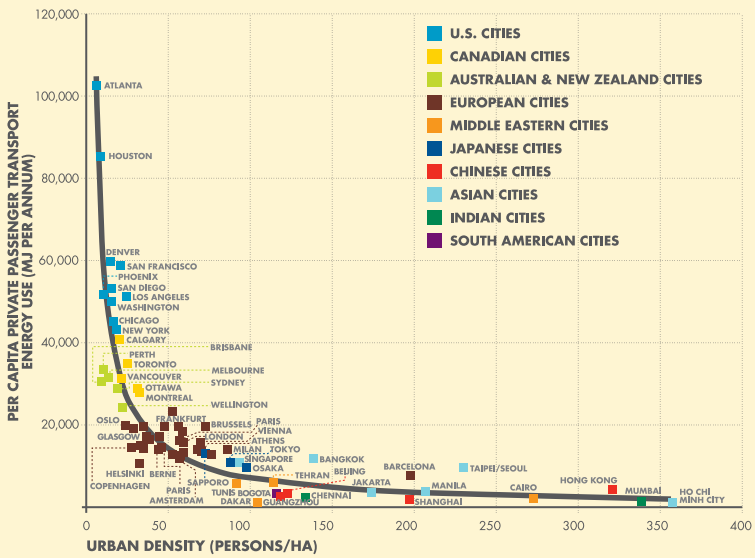
URBAN DENSITY AND TRANSPORT-RELATED ENERGY CONSUMPTION



Source: Newman and Kenworthy, 1989, *Atlas Environnement du Monde Diplomatique 2007.*

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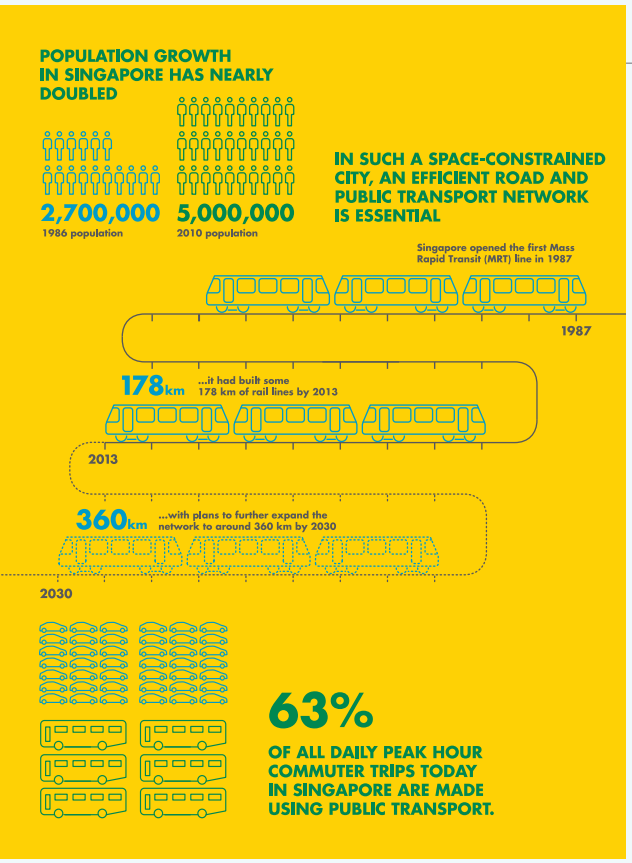

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commercial and residential settings. Switching from coal to gas-fired power stations also reduces emissions and increases efficiency. Gasification of fuels, such as coal, biodegradable waste and biomass, produces a synthetic gas that combusts at higher temperatures, generating more heat and power. If combined with carbon capture and storage technology, the power it produces would be low-carbon, and if the original fuel is biomass, this would actually remove carbon dioxide from the atmosphere.

Through integration of water, sewerage, waste and power management, the substantial cooling-water demands for power generation and the substantial energy demands for water treatment and pumping can be met more efficiently. Waste products become a source of energy rather than, for example, a landfill burden.

From a resource perspective, the ideal evolution is for cities to become increasingly compact with more efficient, integrated infrastructure and effective public transport. Cities such as Singapore, London, Tokyo and New York have demonstrated that compact cities can be attractive to residents. This can be done, for example, by providing green spaces, which studies have suggested produce a positive impact on mental health.

Creating 'Room to Manoeuvre'

Shell partnered with the Centre for Liveable Cities (CLC) in Singapore to investigate the factors that shape the capacity of cities to plan and manage growth effectively. Singapore is widely recognised as having successfully managed rapid population growth whilst improving the liveability of the city. Our work drew on analytical tools – we call them lenses – that Shell introduced in our most recent long-term energy scenarios, *New Lens Scenarios,* published in 2013.

The lenses considered two typical institutional development routes that evolve in response to emerging pressures and the leadership choices that are made: some are able to adapt and reform, giving them "room to manoeuvre"; while others delay action until it is forced by growing crisis, what we call a "trapped transition".

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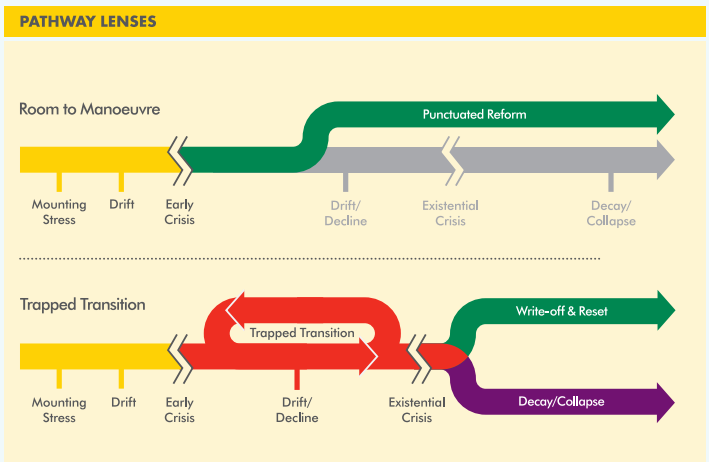

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Characteristics of "Room to Manoeuvre" in city development:

- Visionary leadership coalitions shape growth
- Authorities foresee stresses and implement integrated land, transport, energy, water and waste planning
- Structural energy-effective solutions, including compact city development and public transport
- Knowledge shared and valued

Characteristics of "Trapped Transition" in city development:

- Localised market forces dominate patterns of growth
- Authorities assume problems are too hard to tackle, and too unpopular to implement
- Stresses ignored until city liveability is threatened and infrastructure is difficult to re-engineer
- Ad-hoc, individual solutions

01 Compact Singapore has improved liveability despite population growth.

02 Pathway lenses – 'Room to Manoeuvre' and 'Trapped Transition'.

Our workshops with CLC identified five factors for well-managed growth:

01 Flexible long-term vision
Urban planning decisions need to build in sufficient capacity to adapt to reflect future technology trends and stresses, while allowing for micro-level changes too.

02 Invest in the future
Investments into education, capacity and innovation hubs should be made continuously, anticipating skills needed to drive future economic growth, and attracting and retaining skilled citizens and migrants.

03 Capacity to implement
Nurture highly effective implementation, reinforced by transparent measurement, by having the right parties involved and finding common goals between stakeholders. Professional project management is crucial.

04 Building trust
Provide a stable environment, consistency in rules and regulation, and a sense of fairness for all involved.

05 Collaboration
All sections of society recognise that working together is necessary. Incentives and sanctions for consumers and businesses should encourage smart growth, infrastructure, housing and transport solutions. Coordinating bodies can help overcome disagreements and avoid paralysis.

Nanchong: A Compact City Model for China

By 2030, an additional 350 million Chinese will inhabit cities. Hence, the way in which urbanisation occurs in China will have enormous impact on resource efficiency globally. In 2011, Shell collaborated with urban research and design group, the Dynamic City Foundation (DCF), to study how China might achieve sustainable urbanisation by 2030. The DCF developed a model, which progressively transforms existing low-density industrial zones into vibrant communities, merging living and working areas. According to the DCF, if the densities found today in China's urban centres – already dense by international standards – are extended uniformly to the edges of the less dense industrial development zones around their periphery, China could accommodate all 350 million new urbanites within existing urban zones by 2030.

To show how this would work in practice, the DCF developed a template and case study for Nanchong, a city in Sichuan

province between Chongqing and Chengdu, with 600,000 inhabitants in the urban core area. Nanchong was selected because the formation of the Chongqing-Chengdu Special Economic Zone (SEZ) in 2011 promises accelerated urban and economic growth in the region, creating ideal conditions to showcase an innovative and scalable model for sustainable development.

The first step is to conduct a detailed inventory and analysis of the city, reviewing its ecological, geographical, industrial, economic, spatial usage, energy, climate and other characteristics, identifying areas requiring immediate remediation. Flexible rezoning is then applied to locate heavy industries near industrial transport hubs and free up areas for densification, residential and commercial development while completing existing transport and road network gaps. High standards for the efficiency of building construction and operation are enforced.

"Transit-oriented development" is introduced through a secondary grid between existing major roads to accommodate future public transit infrastructures. These "eco-promenades" provide flexibility for public transport to evolve over time, making the construction of future roads unnecessary. At first, regular buses are used as a flexible, cheap option that can adapt to the existing unfinished road system. As the grid is completed and density begins to accumulate,

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an upgrade to a Bus Rapid Transit system becomes feasible. Eventually, an elevated subway or light rail system can be introduced if necessary. The corners of the new urban blocks created by the eco-promenades are curved to facilitate use of track-based transport like trams and allow travel speed to be maintained throughout the journey – saving time and energy. Where rounded corners meet, star-shaped parks and squares naturally arise, ensuring a continuous flow of green space across the city and providing better water management capacity.

A "time-oriented development" approach could ensure flexible integration across both space and time. The city is divided into one-kilometre blocks and teams of city planners design in relay for different blocks for different time phases in their development. Each group of planners begins by designing their designated block for today's conditions. The groups then swap blocks and work on another team's block for a different time phase, e.g., 2020. They then swap again and create a plan for 2030, etc. This method encourages

developers to collaborate to create integrated plans that are adaptable and prepared for changes in future conditions.

Micro-zoning is used to promote mixed-use in neighbourhoods, recognising that, by 2030, many of China's cities will have moved towards a more service-oriented economy. Stacked factories ensure more efficient use of space and resources. Star-shaped parks create quiet areas particularly suitable for residential use. This is offset by concentrating high densities on top of transportation nodes, geared towards commercial use. Combined with a public transit system that is always within walking distance, parking requirements can be cut by half. In between the eco-promenades, a micro-grid can be introduced specifically designed for pedestrians and bicycles, paved with a soft, permeable surface to help manage storm water and prevent pollutants from entering the water table. The micro-grid ensures that even in the densest areas of the city, all buildings are easily accessible by foot.

The smallest scale intervention is at the level of individual micro-plot divisions. An extra fine system of plot divisions is introduced to encourage diversity in building size and ownership. Where larger buildings are needed, a limited number of adjacent plots can be developed as a single project. Moreover, in many instances, plots on either side of the road can be developed together. This promotes bridging and elevated structures, as in Hong Kong.

In order to create a truly sustainable urban landscape, China's new eco-city developments must also regenerate the urban core. In later stages, the eco-promenades and parks will penetrate the old city. Densities are maintained as old buildings are replaced by taller structures. In the final stages, the centre is fully integrated with a dense, modern and retrofitted downtown.

Collaborating for the Future

Today's successful cities will grow rapidly, bringing new opportunities and adding significant strains to existing infrastructures. Tomorrow's success will depend on how well these are managed and how quickly government, business and civil society improve their collaboration today and enhance the wellbeing of residents. The importance of the interplay between these sectors of society is a recurring lesson from our *New Lens Scenario* work, and details of this are once again emphasised when we place the scenario lenses on cities.

Jeremy Bentham leads Shell's Global Business Environment team, a core corporate strategy activity best known outside the company for developing the Shell Scenarios. He graduated from Oxford University, and joined Shell in 1980 following post-graduate experience at the California Institute of Technology. He also holds a Masters degree in management from the Massachusetts Institute of Technology, where he was a Sloan Fellow. During his time at Shell, Mr. Bentham has worked in research and technology development, managed refineries, delivered corporate strategy analysis, and joined the leadership team of Shell's global technology company. He subsequently served as chief executive of Shell Hydrogen before becoming head of Shell Scenarios.