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RED PAPER

Urbanisation 2.0: emphasising quality of life

November 2018

There is an opportunity for our cities to do so much more than just 'keep pace' with population growth and urbanisation. We explore the possibilities that lie beyond providing the bare necessities that facilitate a productive economy, focusing on delivering infrastructure that improves the liveability, sustainability and social value of our cities. We highlight digital infrastructure, distributed healthcare, turning waste to value and better utilising public transport as key areas where the private sector can contribute meaningfully to improving the quality of life of urban residents.

It is opportunity which is driving the global movement of people from rural areas to towns and cities. This is transforming our cities and driving the need for better infrastructure to protect and enhance quality of life.

Employment opportunities in cities are one of the main attractions, together with the quality of healthcare, education and cultural assets. In developing countries, urbanisation often takes place with greater urgency due to broader factors such as poverty, poor living conditions and environmental changes.

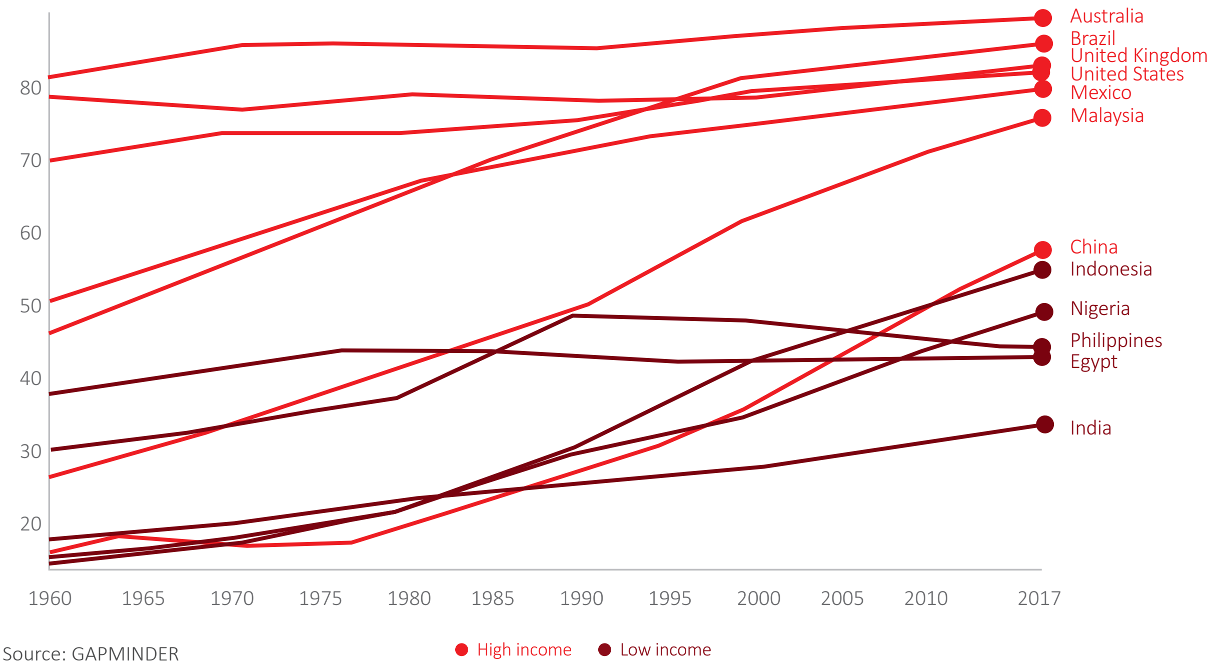
The momentum of urbanisation shows no signs of abating as the United Nations estimates that another 2.5 billion people will be added to urban areas by 2050, with close to 90 per cent of this increase taking place in Asia and Africa.[1] However, it is a mistake to think of urbanisation as being the preserve of the developing world.

In fact, it's the world's most affluent countries that are continuing to push the limits of urbanisation. **(Figure 1).**

The issues confronting citizens and policymakers in major developed cities such as New York, London, Paris, Los Angeles, Hong Kong, Sydney and Melbourne are of a profoundly different nature to those faced by their emerging countries' counterparts.

Figure 1: High-income countries are the most urbanised and are still becoming more urbanised

Urban Population (% of total)



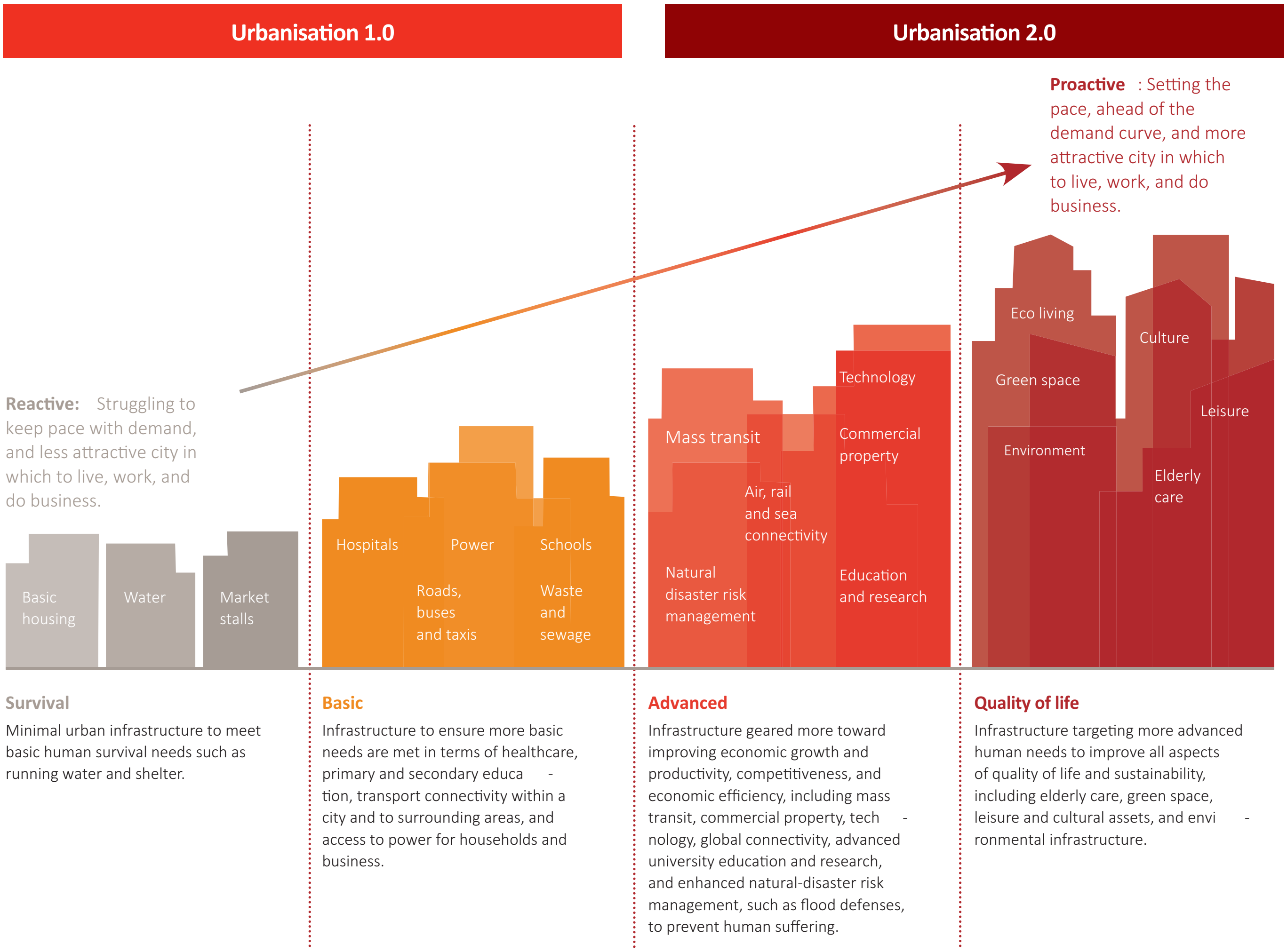
Source: GAPMINDER

The essentials of modern living ranging from housing, clean water, reliable energy provision, universal healthcare and education, and functioning transport systems have been in place in high-income countries and their cities for many decades. However, we operate in an environment of constant growth. For instance, in Australia alongside persistent urbanisation, the total population has doubled from 12.5 million in 1970 to approximately 25 million today. Countries and cities are increasingly feeling the pressure to provide these essentials both in an efficient and cost effective way, and also with an eye on what the future needs may be.

Approaching the issue in a Maslow's hierarchy of needs manner, policymakers in wealthy countries must first protect these basic tenets of socioeconomic development from degrading on a per capita basis as urban populations grow. It is only then that the quest for the next stage of improvements in quality of life ("Urbanisation 2.0") can begin **(Figure 2)**.

Figure 2: Urbanisation 2.0 is concerned with quality of life

Four-stage urban infrastructure evolution



Source: PwC Cities of Opportunity

To ensure citizens of developed nations continue to see improvements in quality of life within increasingly urbanised cities, urban infrastructure must sufficiently address and then move beyond the basic needs of society to focus explicitly on improving quality of life. Without this building block progression toward Urbanisation 2.0, the benefits of urbanisation relative to a decentralised model may never be fully realised.

Many major cities find themselves part way down the path of Urbanisation 2.0. New York, Sydney and Melbourne come to mind as cities that are increasingly focussed on developing their cultural assets and liveability. However, by increasing their attractiveness as destinations, the task of maintaining appropriate levels of basic infrastructure becomes increasingly challenging. It is a process that requires delicate balance.

Further, climate change and the drive to decarbonisation continue to influence peoples' views on how cities should be developed. Concerns regarding air quality in large Chinese cities have resulted in urgent changes to how regions are planned, supported by a 'Three-year Action Plan for Winning the Blue Sky War'.

When talking about managing urbanisation, infrastructure owners and asset operators need to be front and centre in these conversations and contribute actionable ideas.

That said, the topic is so vast that libraries of books are required to address them fully. Rather than going down that path, our aim is to make the topic more manageable by confining this paper to four specific areas; rolling out digital infrastructure, distributed healthcare, turning waste to value, and better utilising public transport.

We address each in turn below.

DIGITAL INFRASTRUCTURE — THE NEW HARD POWER

Outstanding digital infrastructure is essential, not a "nice to have" as we are in a stage of technological revolution where digital infrastructure is key to most interactions within the economy.

The advent of digital technology has been disrupting the established orders. Energy, urban mobility, health, financial institutions — digitalisation has made inroads into every corner of modern life and work, and shaken up traditional sectors **(Figure 3)**.

Connectivity is today a mandate for both cities and modern urban dwellers, and so the world's leading cities must constantly up their digital game.

These shifting undercurrents have greatly molded the terrain of a digitalized city. Running the gamut from artificial intelligence, to machine learning and big data, the relentless parade of new digital technologies and new possibilities unfolding on many fronts are calling for the right urban infrastructure. Data centres, fibre optic networks, 5G infrastructure and sensors to support the Internet of Things are a few key examples of the types of assets requiring investment.

Figure 3: Digital infrastructure adds intelligence to the urban world and uses it to solve problems and achieve a higher quality of life

Source: McKinsey & Company

Digitalisation reaches across sectors, resulting in a domino effect across the board. A major hub for Europe's data traffic as well as a port for traded goods, the Netherlands has been leveraging digital power to complement the development of its other industries. In Amsterdam, there are more than 100 Smart Work Centers, which offer high-end working facilities aiming to reduce travel and promote efficient and sustainable ways of working.[3]

Data and technology can help capital-intensive sectors, such as energy, utilities and transportation, digitalise their physical assets and maximise their utilisation rate. Take the case of the smart-parking pilot project in Los Angeles in 2012. With the installation of 6,000 high-tech meters, the system directs drivers to open parking spots through dynamic street signs and mobile-phone apps. Pricing for parking varies with demand, from 50 cents per hour to US$6 per hour.[4]

Data can also help service sectors with a long tail of small firms, such as retail trade, digitise their customer transactions. Labor-intensive sectors within manufacturing and mining have the potential to provide digital tools to their workforce, increasing safety and improving the efficiency of decision making.

Within the logistics industry, these trends are being exacerbated by the rise of e-commerce giants, who demand ever more efficient logistics networks, placing competitive pressure on every link in the supply chain to utilise technology to drive down cost and improve outcomes for customers.

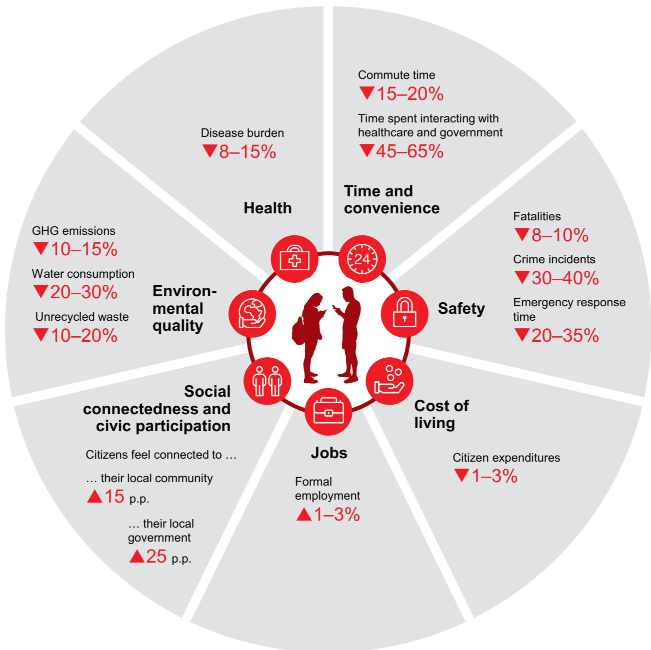
The world will gallop into the next decade with advances in cloud computing, big data, and open data. 50 billion devices will be connected through machine-to-machine communication, fostering the industrialisation of the Internet. Intel predicts that in a decade, the Internet of Things will be a US$1.5 trillion-a-year business—just from a technology point of view. But on top of that there will be another US$2 trillion annually in new services.[5]

Data use globally is growing exponentially. In Australia, some 2.5 Exabyte of data were generated in any given day in 2015 – more data than was generated in total by humanity up until 2014.[6] Globally, data creation is forecast to reach 160 Zettabytes by 2025, up from around 30 Zettabytes today. In 2025, more than 25% of data created will be real-time in nature, and real-time Internet of Things data will make up more than 95% of this.[7]

The potential global annual GDP value of the Internet of Things is estimated to be around A$11 trillion: some A$120b per annum for the Australian economy by 2025.[8]

Digital infrastructure that serves these digital needs is in the vanguard to help cities capture and materialise these opportunities **(Figure 4)**. In an era when innovation and technology have been hailed as a nation's new soft power to exploit for economic gains and extend global influence, high performing digital infrastructure can serve to reinforce the nation from inside out. It does so by providing the platform to shore up competitive and comparative advantages, protecting potential data leakage and fending off external security threats.

Figure 4: Digital infrastructure can improve key quality of life indicators



Source: McKinsey Global Institute

Under Urbanisation 2.0, digital infrastructure is the new hard power. But its limits have been constantly challenged and tested.

Some statistics are worth contemplating. Worldwide spending on infrastructure and construction is about US$2.5 trillion a year, and Information and Communications Technology (ICT) spending is less than 1.5 percent of that.[9] Estimates suggest that the US economy as a whole is reaching only 18 per cent of its digital potential due to an uneven degree of digitalisation across the sectors.[10] That's a remarkable finding given the US' status as the world's pre-eminent technologically advanced nation.

The development of ICT infrastructure is also disproportionate across countries. Based on McKinsey analysis, while most countries are participating in the global flows of goods, services, finance, people, and data, the flows are still concentrated among a relatively small group of leading countries,[11] whereby 8 out of the 10 top ranked countries also boast a top 10 ranking in their data connectivity. The two outliers within the top 10, China and Saudi Arabia, are known to be investing to improve data connectivity.

Cities have been scrambling to keep up with the digital movement. Today many leading cities have a ten-year plan that includes a master ICT plan. A city without an ICT master plan risks becoming an also-ran.[12]

Globally, the infrastructure investment needs are significant and expected to grow, especially in relation to data centres, fibre optic networks, 5G infrastructure and sensors to support the Internet of Things.

NOTHING SOFT ABOUT SOCIAL INFRASTRUCTURE

In urban planners' terminology, there are two types of infrastructure: economic infrastructure and social infrastructure. The infrastructure that underpins the existence of communities, from transportation to water, energy and digital facilities, is categorized as economic infrastructure as opposed to the infrastructure that supports the building blocks of a liveable city, like health, housing, education, art, recreation, and cultural heritage, known as social infrastructure.

A nation's quality of life is enriched by investments and excellence in both. In most high-income countries, health and pension-related expenditures represent the two largest items of government spending. This gives some insight into community priorities and expectations.

Increased demand for services is leading to rising expenditures and funding pressures in key areas such as education, but nowhere is this trend more prevalent than in the healthcare space. This is being driven by the external pressures of the ageing population, ongoing investment in technology, growing rates of chronic disease and increasing demand for mental health and disability services.

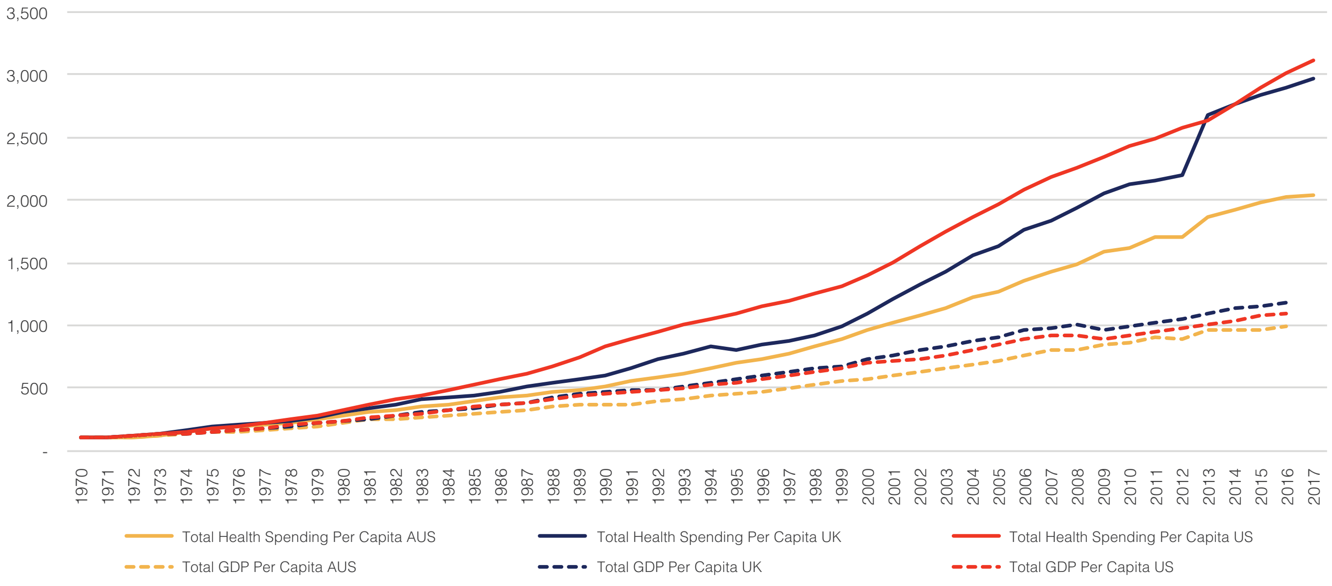
Re-engineering clinical processes within hospitals and enhanced IT infrastructure have a major role to play in healthcare, supporting both treatment and administration.

Decentralised models of healthcare delivery also have a significant role to play in improving patient outcomes, driven by improvements in mobile technology, data sharing and analytics, new modalities (e.g. augmented reality and virtual reality) and better communication across users and healthcare providers.

Still, operational and management innovation, and even technology can only do so much. Demographics are difficult to outrun.

In OECD countries, the average life expectancy now exceeds 79 years, a jump of about six years between 1983 and 2008.[13] The senior population aged 65 and over in the OECD will reach 53% by 2050, almost double the level of 28% from 2015.[14]

Figure 5: Longer lifespans are to be celebrated, but will also require greater financial resources [14]



Source: Population ageing and rising inequality will hit younger generations hard. OECD. 2017.

The health-related demand implications are immense. An estimate, several years ago concluded that by 2050, if current bed use trends and as the numbers of frail and older patients rise markedly, a 62 percent increase in hospital beds will be required to meet expected demand, at a cost almost equal to the size of the current Australian healthcare budget.[16]

Sometimes the ageing of the population and growing lifespans are portrayed as if they are cause for regret. On the contrary, they are cause for celebration that medical science is progressing at such a rate that people can enjoy bountiful lives longer. That celebration of life and human achievement, though, needs to be properly financed if it is to be sustained **(Figure 5)**.

People over the age of 75 incur per capita health expenditures that are five times higher than people aged 25 to 34.

Starting from around 6% of GDP currently, the combined public health and long-term care expenditure for OECD countries is projected to reach 14% in 2060 under current policy settings.[15]

At a time when governments are facing overall fiscal constraints, healthcare costs will continue to rise. Further, there are expectations from the community that governments will ensure everyone has access to affordable, high-quality healthcare.

These factors are combining to challenge the fiscal sustainability of healthcare arrangements.

The public sector is dominant in healthcare in the developed world, with the state covering 70 percent of health spending in OECD countries, but there is also a relatively high degree of openness to private-sector involvement.[17] Even France, historically typecast as a country with very high government service delivery, funds around 20 percent of health expenditure from the private sector.[18]

However, the importance of 'how' healthcare services are delivered cannot be overstated, due to the direct impact the quality of service delivery has on the lives of the most vulnerable members of society. As such, in partnering for healthcare investments, it is critical that governments develop trusted partner relationships with like-minded organisations who are heavily focussed on social impact, quality of care and governance as long-term pillars of their investment process.

We address the different potential models of private sector investment at the end of this paper, including a range of case studies from the healthcare space.

WASTE TO VALUE: ONE PERSON'S JUNK IS ANOTHER'S GOLD

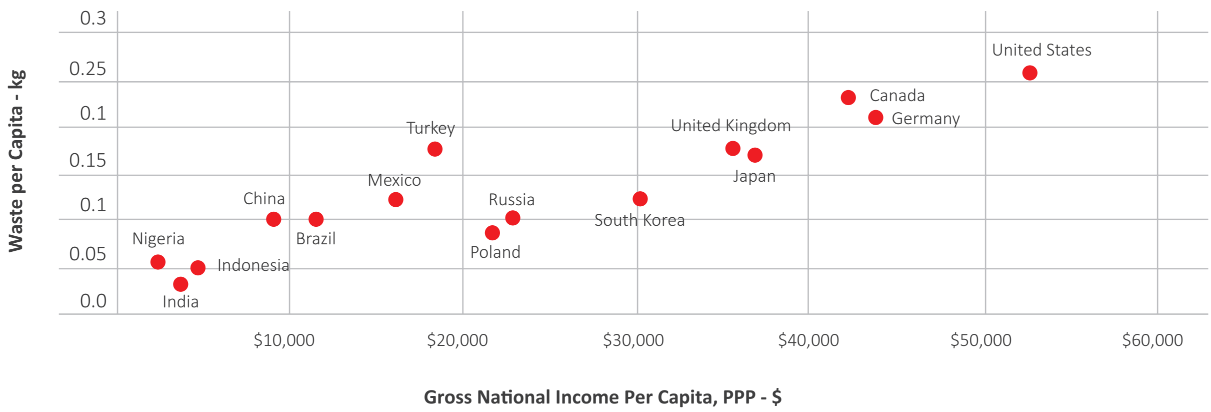
Being born in a wealthy country is a wonderful stroke of luck, akin to a lottery win. There aren't too many downsides to growing up in a high-income country. One of the few negatives is the amount of waste generated.

Studies have revealed the magnitude of the relationship between waste generation per capita and countries' living standards **(Figure 6 and 7)**.

Regions where living standards are high (such as OECD countries) produce greater amounts of waste in kg/capita-day, while less-developed countries such as those in the South Asian Region (SAR) present lower waste generation levels per capita. Furthermore, within each single region, there can be large variations of waste production depending on local conditions and specific dynamics.[19]

Figure 6: Wealthy countries generate more waste per capita

Waste generation per capita (kg/day) to gross national income (GNI) ratio in 2014 in selected countries



Source: Navigant Research, World Bank (2014)

Figure 7: Waste generation data in 2012, by region

Region	Total urban population (millions)	Total urban MSW* Generation (tonnes/day)	Urban MSW* generation per capita (kg/day)
Africa	261	169 120	0.65
East Asia & Pacific	777	738 959	0.95
Eastern & Central Asia	227	254 389	1.12
Latin America & Caribbean	400	437 545	1.09
Middle East & North Africa	162	173 545	1.07
OECD	729	1 566 286	2.15
South Asia	426	192 411	0.45
Total	**2 982**	**3 532 255**	**1.19**

*MSW is "Municipal solid waste," and broadly defined as wastes consisting of everyday items such as product packaging, grass clippings, furniture, clothing, bottles and cans, food scraps, newspapers, appliances, consumer electronics, and batteries.

Source: Hoornweg & Bhada-Tata (2012) from Waste to energy, World Energy Council, World Energy Resources 2016 https://www.worldenergy.org/wp-content/uploads/2017/03/WEResources_Waste_to_Energy_2016.pdf

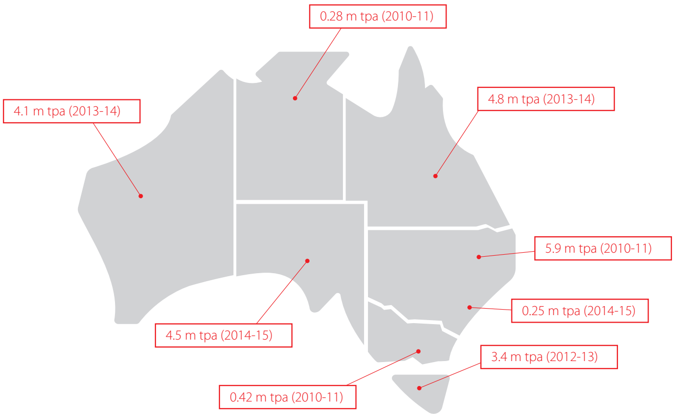
OECD countries today produce around half of the world's urban waste, which will nearly double by 2025 to over 6 million tonnes of waste per day. Disconcertingly, global waste generation rates are not expected to peak even by the end of the 21st century, while OECD countries will reach 'peak waste' by 2050.[21]

Until January of this year, many developed countries had shifted part of this burden onto China. For years, China had accepted container ships from the developed world carrying scrap paper, plastics and metals for recycling and reuse. Under their 'National Sword' policy, implemented in early 2018, China stopped accepting waste imports, placing pressure on many developed countries to invest in appropriate levels of waste processing infrastructure.

For the time being, much of the waste previously destined for China has been delivered to other parts of Asia, to countries without proper waste facilities, resulting in damage to the environment. It is likely that these countries will soon follow the example set by China, increasing pressure on developed nations to develop the capability to process their own waste.

In Australia, even with increasing recycling, landfilling remains by far the most utilised solution for waste disposal, despite being the least desirable waste management practice. Australia currently sends around 23 million tonnes of urban waste to landfill: the breakdown state by state is shown in **Figure 8**.[22]

Figure 8: Waste to landfill in Australia



Source: Energy from Waste in Australia — is there a future? By Dr Ron Wainberg, Technical Director, MRA Consulting Group, 14 March, 2016

Rather than scouring the country for evermore landfill sites, turning waste to value in ways that go beyond traditional recycling methods represents a largely untapped opportunity for many developed countries.

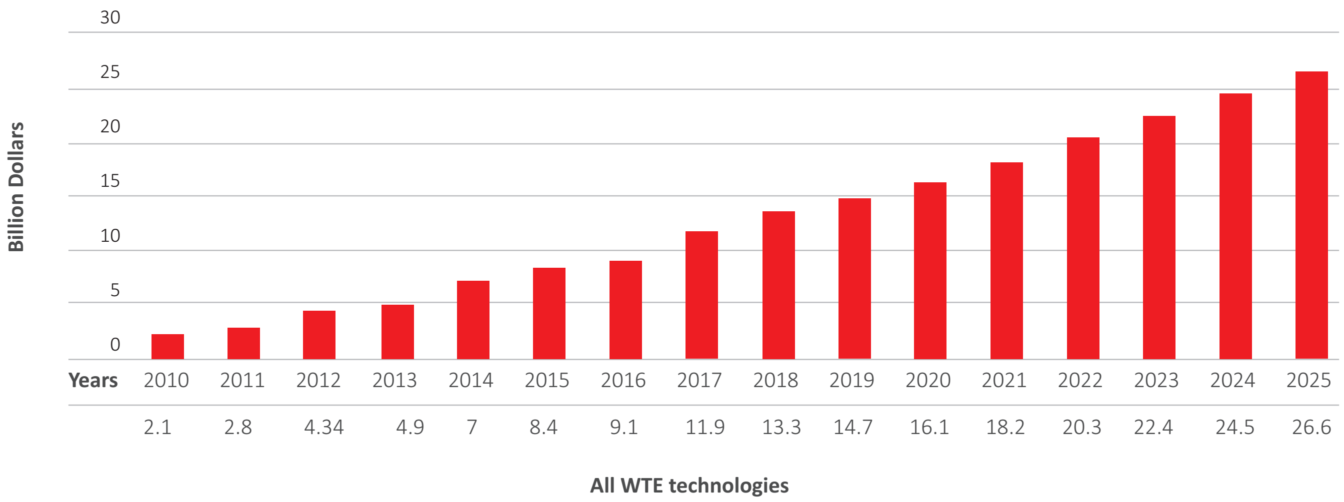
Waste to energy (WtE) by thermally treating waste recovers the valuable energy stored within these materials. Using waste to produce energy can offset the community's use of other, non-renewable energy sources.

WtE plants reduce the volume of processed waste up to 90 percent, effectively preventing the expansion of landfills.[23] The decline in available space for landfilling is an increasing issue in many countries around the world, making WtE technologies a solution to this pressing concern of increasing waste streams and reduced space for disposal. The land saved could successfully be used for housing and other economically productive activities or just left unutilised for nature conservation.

Restraining greenhouse gas output and local energy solutions

The global WtE market is expected to maintain its steady growth to 2023, when it is estimated it would be worth US$40 billion, growing at a CAGR of over 5.5 percent from 2016 to 2023.[24] **Figure 9** shows that globally, all WtE technologies will grow significantly even with conservative forecasts up to 2025.[25]

Figure 9: Growth of all WTE technologies with a conservative forecast up to 2025



Source: Ouda & Raza (2014) in *Waste to energy*, World Energy Council, World Energy Resources 2016

Waste-to-energy is an important part of the European waste industry. Significant demand for heat means efficient and tightly controlled waste incinerators are common.

Australia, by comparison, lacks an established market, community knowledge and understanding remains low with policymakers being slower than their European counterparts in developing frameworks to encourage the industry's development.

Signs of change, though, are emerging at both the Federal and State levels signalling perhaps a growing interest in waste-to-energy and waste-to-fuels. The NSW Government, for instance, announced the extension of the Waste Less, Recycle More initiative with a further A$337 million over four years from 2017-21.[26]

In Western Australia, a project at Kwinana will convert household, commercial and industrial waste into enough energy to power up to 50,000 homes through a A$668 million renewable energy project.[27]

Up to 400,000 tonnes of household, commercial and industrial waste — one quarter of Perth's post recycling rubbish — will be diverted from landfill to be thermally treated and converted into steam to produce electricity.[28]

This example illustrates how WtE also provides a way of connecting the waste sector to the energy sector. Waste materials, which originally have been used as specific products for societal needs, can be used for a second purpose: as a useful energy resource.

WtE can also contribute to reducing Australia's greenhouse gas impact.

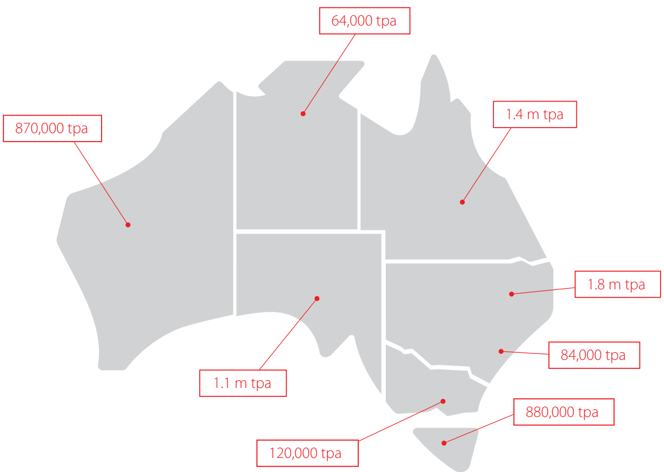
Emissions from landfill facilities produces around 15 million tonnes of carbon pollution every year, equivalent to three per cent of the country's emissions. Without action to reduce emissions, a tonne of standard municipal solid waste will continue to release about 1.2 tonnes of carbon pollution in landfill.[29]

This is especially important as decomposition in landfill creates methane, a greenhouse gas with a warming potential 25 times that of carbon dioxide. Technology already exists for capturing and converting landfill gases to energy, but waste-to-fuel is a complementary measure that limits landfill in the first instance.

To be clear, not all landfill waste is suitable as a fuel. An estimate from a few years ago suggested suitable waste as fuels (plastics, paper and cardboard, wood and textiles) was around 6.3 million tonnes per annum.[30] The nationwide distribution of these 'fuels' is shown in **Figure 10**. While additional materials in the waste could be used as a fuel, it would be at the expense of established resource recovery and recycling.

The calorific value of the fuel currently being landfilled is estimated to be 63 million GJ per annum. If the material is used for electricity production it would generate around 13 million GJ per annum of power (assuming 20 percent efficiency).[31] The short term investment needed to realise Australia's WtE opportunity set is estimated to be between A$3.5-5.5 billion over the period to 2020, generating 800MW of new capacity. A$2.2-3.3 billion of this would be focussed on electricity production from urban waste.[32]

Figure 10: Potential fuels in urban solid waste



Source: Energy from Waste in Australia — is there a future? By Dr Ron Wainberg, Technical Director, MRA Consulting Group, 14 March, 2016

Addressing community concerns

The overlap between the waste management and energy sectors touches several points linked to human society. The environmental implications of choosing specific WtE technologies can lead to social concerns and doubts on this type of solution.

The need of waste treatment facilities close to urbanised areas is often in contrast with the public opinion to keep (incineration) WtE plants far away from cities because of health-related issues.

There are also concerns that adoption of WtE treatment encourages production of waste, discourages recycling and is not compatible with the policies that promote a 'zero-waste' economy. In contrast, the countries that recover energy from waste also have high recycling rates, so there is no real basis for this claim.

Moreover, there is no substantial evidence behind the fear that more WtE facilities translate into more wasteful management of resources. Developed countries focus on reducing waste generation, but the problem still persists due to population growth, urbanisation and higher rates of consumption.

WtE plants that operate in areas where the waste hierarchy is applied are more likely to have a stronger set of 'zero waste' policies, where residual waste is treated according to the energy value and environmental impact.

For all of these reasons, and for many more, it is important to consider the social and political orientation of a specific location in terms of waste management before implementing and operating WtE facilities.

Criticisms of waste combustion focus on the actual effective-ness of modern emissions abatement procedures and the inconsistency of monitoring plant operation to the highest standards. Modern plants are equipped with air emissions control technologies that can effectively remove substances that present any safety concerns.

The technologies available to control emissions range from fabric filters to electrostatic precipitators to scrubbers. The best air pollution control system includes dry scrubbing that neu-tralises acids followed by a baghouse that filters emissions of metals and organic compounds.

These technologies are useful as long as the combustion plants are properly operated and emissions controlled, and in many modern facilities computer control systems are utilised to achieve this.

Advanced thermal technologies are considered to be much safer in terms of emissions control and toxicity of dry residue. Gasification processes do not produce ash and the substanc-es contained in the residue are environmentally benign, while the resulting syngas is a useful fuel that substitutes fossil fuels and reduces greenhouse gas emissions.

Looking ahead

Governments around the world will increasingly adopt better MSW management practices, which include treating residual waste with various WtE technologies as it is a viable option for disposal of MSW and energy generation.

WtE markets will continue to develop globally as governments will impose supportive regulation with subsidies and tax benefits. The need to increase the share of renewable energy and reduce greenhouse gas emissions, along with raising environmental consciousness to protect the environment from polluting and unsustainable practices such as landfilling, will have a positive impact on WtE market development.

In addition, as waste generation grows, there will be enough space in the market for new entrants. There are many factors that will influence the choice of technology and every country and sub-national jurisdiction will have to properly assess its specific context to implement the most reasonable solution. While the narrower definition of urban waste to energy (WtE) has been the focus of this paper due to its relevance to urbanisation, mature technologies also exist to convert a broad range of municipal, agricultural and industrial waste streams into valuable end products such as plastics, fuels and fertilisers – a further opportunity for infrastructure investors.

The WtE sector is very complex, but the opportunity set is large for infrastructure investors with the right capabilities, if supported by appropriate policy and regulation to encourage development.

Following in "Methods of Converting Waste" is a discussion of three broad waste converting technologies.

METHODS OF CONVERTING WASTE[33]

There are three major waste to energy conversion routes – thermochemical, biochemical and physico-chemical **(Figure 11).**

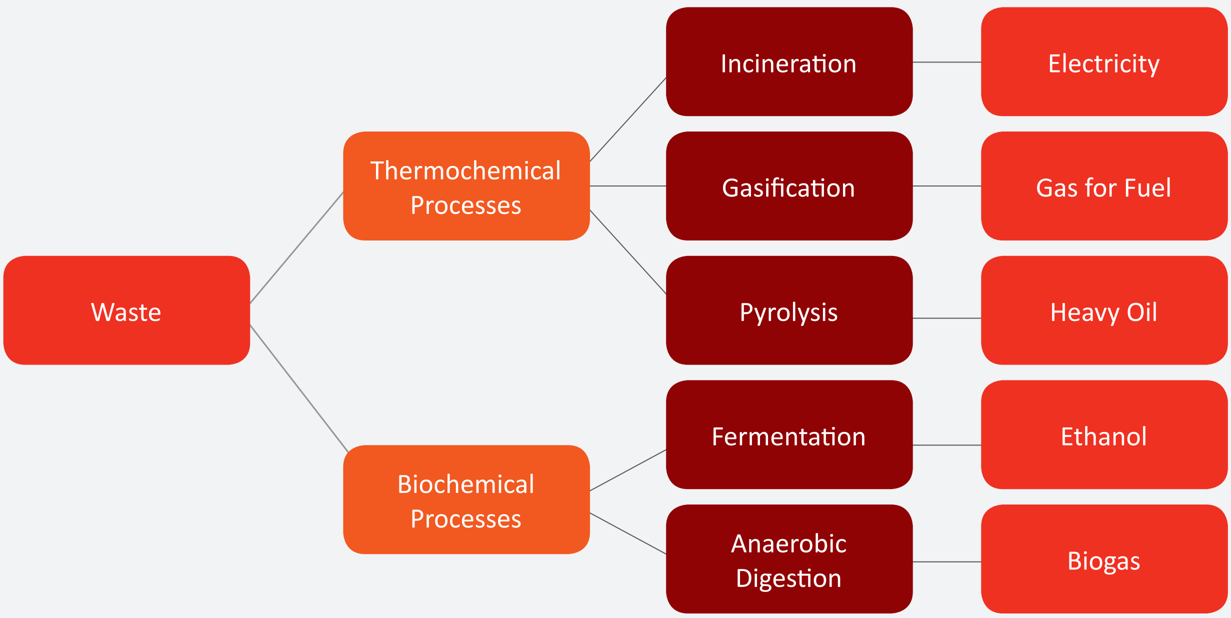
Thermochemical conversion, characterised by higher temperature and conversion rates, is best suited for lower moisture feedstock and is generally less selective for products. On the other hand, biochemical technologies are more suitable for wet wastes which are rich in organic matter.

Thermochemical Conversion

The three principal methods of thermochemical conversion are combustion in excess air, gasification in reduced air, and pyrolysis — the process of chemical decomposition at high temperatures in the absence of oxygen.

The most common technique for producing both heat and electrical energy from household wastes is direct combustion. Combined heat and power (CHP) or cogeneration systems, ranging from small-scale technology to large grid-connected facilities, provide significantly higher efficiencies than systems that only generate electricity.

Figure 11: Three broad waste to energy conversation routes



Combustion technology is the controlled combustion of waste with the recovery of heat to produce steam which in turn produces power through steam turbines.

Pyrolysis and gasification represent refined thermal treatment methods as alternatives to incineration and are characterised by the transformation of the waste into product gas as energy carrier for later combustion in, for example, a boiler or a gas engine. Plasma gasification, which takes place at extremely high temperature, is also getting attention these days.

Biochemical Conversion

Biochemical processes, like anaerobic digestion (a series of biological processes in which microorganisms break down biodegradable material in the absence of oxygen), can also produce clean energy in the form of biogas which can be converted to power and heat using a gas engine.

Anaerobic digestion is the natural biological process which stabilizes organic waste in the absence of air and transforms it into biofertiliser and biogas. Anaerobic digestion is a reliable technology for the treatment of wet, organic waste. Organic waste from various sources is biochemically degraded in highly controlled, oxygen-free conditions resulting in the production of biogas which can be used to produce both electricity and heat.

Additionally, a variety of fuels can be produced from waste resources including liquid fuels, such as ethanol, methanol, biodiesel, and gaseous fuels, such as hydrogen and methane. The resource base for biofuel production is composed of a wide variety of forestry and agricultural resources, industrial processing residues, and municipal solid and urban wood residues. Globally, biofuels are most commonly used to power vehicles, heat homes, and for cooking.

Physico-chemical Conversion

The physico-chemical technology involves various processes to improve physical and chemical properties of solid waste. The combustible fraction of the waste is converted into high-energy fuel pellets which may be used in steam generation. The waste is first dried to bring down the high moisture levels. Sand, grit, and other incombustible matter are then mechanically separated before the waste is compacted and converted into fuel pellets or Refuse Derived Fuel (RDF).

Fuel pellets have several distinct advantages over coal and wood because it is cleaner and free from incombustibles, has lower ash and moisture contents, is of uniform size, cost-effective and eco-friendly.

GREAT PUBLIC TRANSPORT A CONGESTION-BUSTER

The Australian Automobile Association's recently released paper *Road congestion in Australia*[34] is uncomfortable reading.

Average driving speeds across Australia's capital cities have slowed by up to 8 percent since 2013 and road infrastructure is "no longer coping" with increasing urbanisation and population growth.[35] Every city except Darwin reported slower travel times and lower average speeds, according to the data, which was collected between January 2013 and June this year.[36] This is a common theme, with similar issues being experienced across many global cities.

This matters as driving remains by far the preferred means of transport within capital cities accounting for 80 per cent of travel.[37] The car's dominance has resulted in a situation where congestion is estimated to cost the country as much as A$53 billion by 2031 if further action isn't taken.[38]

The congestion blight is a widespread issue. In the United States, bumper-to-bumper traffic costs the economy US$305 billion each year in lost time and wasted fuel. In Los Angeles alone, drivers are spending 102 hours a year stuck in traffic jams.[39]

Despite technological advancements producing cars that emit less pollutants, the sheer number of automobiles on roads also means that smog remains a health and economic hazard.

The number of premature deaths due to outdoor air pollution is projected to increase from 3 million people globally in 2010 to a global total of 6 to 9 million people in 2060 (considering a nonlinear and a linear concentration-response function respectively).[40] This large increase is not only due to higher concentrations of particulate matter (PM2.5) and ground level ozone, but also to an increasing and aging population and to urbanisation, which leads to higher exposure.[41]

A smaller increase is projected in OECD countries, with the number of premature deaths increasing from around 430,000 people in 2010 to around 570-580 thousand in 2060, with the most significant increases projected in Japan and Korea.[42] Welfare costs from premature deaths stemming from air pollution are projected to more than double in OECD countries by 2060, going from USD 1.4 trillion in 2015 to USD 3.4- 3.5 trillion in 2060.[43] While the adoption of electric vehicles will provide some relief, forecast adoption rates suggest electric vehicles will still only represent around 10% of the global fleet by 2030.

The great irony of all this is that the car — long a symbol of freedom and mobility — has become a victim of its own success as traffic congestion limits and undermines mobility, and diminishes air quality across the world's metropolitan areas, imposing huge costs on individuals, economies and society. Moreover, building more roads, and doing little else, won't make things better.

The basic problem confronting transportation planners is that adding new infrastructure to relieve congestion is a notoriously slow and costly process. It's what legendary road builder Robert Moses learned in New York City in the 1930s; every time the city opened a new parkway, it was overrun with traffic jams.

To be absolutely clear, none of what we have said should be interpreted as being anti-car or anti-roads. Far from it. Successfully tackling congestion, and making it possible for people to move easily and comfortably from place-to-place is not about pitting cars (and roads) against mass transport such as trains (and railway lines). On this issue, in our previous Red Paper titled *Mobility-as-a-Service: The Coming Transport Revolution* we wrote:

"Changes happening in the world's cities are setting the scene for MaaS. Rapid urbanisation is both a fact and a megatrend… MaaS, by integrating public and private transport options on centralised digital platforms, enables users to register, plan, book, pay for, be ticketed and remain updated on their trips… MaaS would provide seamless, on-demand journeys that offer transport solutions tailored to specific customer preferences (be it journey time, cost and/or service levels), rather than requiring people to fit their lives and plans around the availability of dislocated transport options. Zero-sum thinking will entrench current stresses, not transcend them. MaaS represents a transformative vision, a step-change that would integrate public and private infrastructure."

In this context, public transport infrastructure should be viewed as a key form of capacity within the MaaS system, increasing the overall supply of mobility services available to be utilised and optimised by MaaS applications.

Notwithstanding the efficiency gains to be realised by MaaS, as well as the potential advances in autonomous and electric vehicles, public transport is irreplaceable and is expected to remain centre stage thanks to its existing scale, compatibility with a sustainable growth model, and potential benefits for cost and time saving if properly managed.

An automobile can only carry a finite number of passengers, which for the roomiest SUVs sits at around eight. A typical subway car can carry 100 passengers. Assuming a train has ten cars, that's 1,000 passengers per train. At a frequency of one train arriving every two minutes, capacity would be around 30,000 passengers per hour.[44]

In other words, trains, within the public transport context, will still represent the best way of moving large numbers of people relatively swiftly from place-to-place. It's difficult, at this stage, to conceive of any superior alternative for doing so.

One in eight people in Australia's capital cities use public transport for daily commuting, and after a lengthy decline, public transport patronage has been increasing over the past two decades.[45]

The largest increases in mode share over this period were in Perth, Melbourne and Sydney. The increase in public transport patronage has occurred mainly on rail systems. In Australian capital cities, 65 percent of kilometres travelled on public transport occur on heavy rail and 30 per cent on buses. Light rail and ferries make up the remaining five per cent.[46] Globally, as density increases we typically see higher mode share for rail, such as in New York where 81 percent of public transport commutes take place via rail.

Based on passenger kilometres travelled, public transport usage is projected to grow by 32 per cent across all Australian capital cities between 2011 and 2030.[47] Clearly, even greater investment in public transport infrastructure is required as well as more road-building if cities are to alleviate the impacts of congestion, such as lost productivity, social exclusion, emissions and health consequences.

For densely populated cities with a poly-centric model and larger budget capacity, electric railway systems are pivotal. Both intercity high-speed rail and urban metro fall under this category.

The relative speed of transit to traffic measures how effective public transport is in competing with the car. The best European and Asian cities for transit have the highest ratio of transit to traffic speeds, which are achieved through fast rail systems. Rail is also important as it has a density-inducing effect around stations which can help to provide the focused centres so critical to overcoming car dependence and they are electric which reduces oil vulnerability.[48]

Sydney has been investing heavily in expanding transit corridors to link up its multiple urban centres and is building its first metro line, known as Sydney Metro Northwest. Light rail is making a comeback in some parts of the United States with more than two dozen light-rail projects under way in the United States just a few years ago.[49]

If thoughtfully planned and closely monitored, public transit can adjust flexibly to peak and off-peak hours and help control congestion, which is costing Europe about 1 percent of GDP every year[50] and Sydney $5 billion per annum.[51]

By extending its tube service to 24 hours Friday through Sunday, London has successfully stimulated its night time economy, creating 1,965 permanent jobs and reaping an equivalent of £360 million as a Present Value over 30 years.[52]

On top of the concrete economic benefits, the city can profit socially from the deployment and spread usage of public transit as well. The tram network in Melbourne, the largest operating network in the world, is estimated to have an overall social value of US$730-$830 million per year.[53]

Additionally, around US$75-$97 million of environmental value is generated each year through reduced greenhouse gas emissions and air pollution by significantly reducing the number of cars on the road. The tram network has been valued by Melbournians for many reasons including increased connectivity, accessibility, increased independence, and improved well-being **(Figure 12)**.[54]

Figure 12: Highlights of social value results from Melbourne's tram network

IMPROVED WELL-BEING

50% of the total social value identified by tram users came through improved physical well-being as their journey was more comfortable, easier and quicker than the alternative.

INCREASED INDEPENDENCE

A significant number of tram users (12%) identified that the tram network gave them more independence and enabled them to be more active in the community.

INCREASING EMPLOYMENT

For some disadvantaged users the tram network is crucial in enabling them to be employed, generating social value of as much as $11,000 per user per year.

YOUNG PEOPLE

Young people benefited the most from the tram network, receiving on average 7% higher value than the average.

SAFETY AND SECURITY

The safety of the tram network was very important to older users, with 20% more value generated from the sense of security than the average tram user.

+20%

VISITORS

Visitors to Melbourne love the trams, with 24% more value generated from their journey being more comfortable, cheaper and quicker than the alternative.

REDUCED GHG EMISSIONS

The tram network saves Australia between $5m and $27m per annum through reduced greenhouse gas emissions depending on the valuation method.

REDUCED AIR POLLUTION

Through reducing air pollution by as much as 10%, the tram network saves Melbourne $70m per annum.

-10%

FEMALES

Female passengers gained independence from the tram network through access to shopes, services and cultural events, with 75% more value generated than the average user.

At times alterations in the existing transportation infrastructure can go a long way toward fostering urban mobility. As put by an urban planner from the Queensland Government, "80 percent of the infrastructure needed by 2050 already exists in Australia." The formula to achieving further mobility excellence is in operation and maintenance of the existing assets and regeneration.

Finally, public transport use is partly influenced by the level of accessibility to public transport for the population. Good accessibility to public transport also promotes walking for active transport. The RESIDE project, conducted by the University of Western Australia's Centre for the Built Environment and Health,[55] found that:

- having a train station within a 15-minute walk meant that residents were 50 per cent more likely to walk for active transport
- participants with better access to more bus stops were 88 per cent more likely to walk for active transport
- residents with public transport stops close to both home and work were 16 times more likely to use public transport than those with neither.

It is essential that policymakers, infrastructure asset owners and investors seek to make public transport better utilised as part of integrated systems meeting the challenges of increasing urbanisation.

DELIVERING NEW INFRASTRUCTURE WITH PRIVATE INVESTMENT

Infrastructure as a private asset class has matured significantly over the past decade, with increasing amounts of capital allocated to it by institutional investors.

There are a multitude of ways for private investors to partner with the public sector to deliver the infrastructure required to ensure quality of life continues to improve in the face of urbanisation.

Private infrastructure investment, fundamentally, is simply an alternative procurement model whereby better outcomes and risk transfer can potentially be achieved. Independent research in Australia has found that Public Private Partnerships (PPPs) offer substantial construction cost and time savings, compared to both traditional and alliance contracting.[56]

Key to a successful PPP is to approach it not as a way of taking capital expenditure off a nation's or state's balance sheet, but rather to optimise a value-for-money solution.

In the case of digital infrastructure and waste to energy, these are often commercial projects that may only require government to play the role of facilitator or strategic partner. However, PPPs can be one way of addressing the funding need for future healthcare and public transport infrastructure.

There are many global examples of PPPs for rail transport, including instances where demand-risk is transferred to the private sector, such as HS1 in the United Kingdom. The Cross River Rail project in Queensland, which has an estimated cost of delivery of $5.4 billion, is another recent example of a major rail project being procured by PPP. The project will double the rail capacity in the Brisbane CBD, while also benefiting long-distance commuters from growing population centres throughout South East Queensland.

In the healthcare sector, early health PPPs were based on full service model projects, which were employed as state governments moved to reduce costs in public healthcare. Unsurprisingly, there were teething problems initially, with hospital operators having trouble agreeing on budgets, calculating price increases and assessing how much risk the private sector partner would need to accept.[57]

The Latrobe Hospital in Victoria, and Port Macquarie Base Hospital in New South Wales, later reverted back to the governments. On the heels of such experiences, governments retreated to a model where a PPP is used for the asset, and the public sector delivers core services.

However, more recent examples have proven that the full-service model can be successful where an appropriate value-for-money solution is found. Joondalup Health Campus in Perth's northern suburbs is a full-service PPP, and is widely considered to be one of Australia's best examples of a successful healthcare PPP. The Western Australian Government pays the private operator to maintain and run the facility, which is administered under a 'build, own, operate and transfer' model.

Such successful examples should encourage opportunities to expand the scope of infrastructure PPPs to include a broader range of healthcare and public transport services, as they offer the possibility of increasing the efficiency and quality of public service delivery, while also driving efficiency into the operating expenses of governments.

Developing a mixed market of providers also opens up more possibilities for innovation in service delivery and allows public and private provision to be benchmarked against one another.

TIME TO GET ON WITH IT

French scientist Alexis Carrel once remarked that, "the quality of life is more important than life itself." Some might take issue with such dramatic sentiments, but in the world's affluent nations where most enjoy high living standards, the quest for quality of life represents a new frontier.

While we must continually invest in core infrastructure to service our most basic needs, there is a desire to move beyond the necessities to unlock lives marked by greater ease and leisure, and lower stress.

Technology can play a big role, allowing cities to optimise their existing infrastructure and to better understand, through data, how best to improve the quality of life of their residents.

Cities ranging from London to New York to Sydney and Melbourne are at a crossroads between succumbing to the pressures of population growth or journeying towards enhanced liveability.

The issues are well-known. Infrastructure investors and owners need to be proactive in contributing to the conversation with governments and communities, and in partnering to deliver the solutions.

This Red Paper is the result of a collaboration of the following people: Ross Israel, Matina Papathanasiou, Kirsten Whitehead, Wade MacRae, Albert Daniels, Caroline Nowacki, Hong Fan, Turab Bajwa.

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