Information Marketplaces

The New Economics of Cities

THE CLIMATE GROUP

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DIGITAL ECONOMY RESEARCH

This report is a research partnership between The Climate Group, Arup, Accenture and Horizon, University of Nottingham.

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Foreword

Mark Kenber | The Climate Group

A Clean Revolution is quietly underway around the world.

In city halls, boardrooms and cabinet offices, government and business leaders are embracing what humanity has been doing best throughout its history: Change. They are changing the way we produce and consume energy and natural resources. Their motives for embracing change vary: from ensuring corporate profitability to meeting the challenge of an expanding urban populace to ensuring energy security in an uncertain world. Whatever their reasons, they all realise the opportunities in the low carbon economy – and they are already benefiting from them.

But what precisely is the Clean Revolution?

In short, it is a swift and massive scaling-up of clean technologies and infrastructure, combined with a fundamental shift to sustainable production and consumption patterns. It is the only viable route to cut global emissions and avoid dangerous climate change. It can create jobs, strengthen economic growth and enhance energy security. It is a revolution based on leadership and the belief in a better, more prosperous future for the 9 billion people that will be on the planet by 2050.

And most of those 9 billion people are going to be living in cities. The 21st century is an urban century. Cities are going to be in the forefront of driving the Clean Revolution forward.

Our *SMART 2020* report found that deploying smart technologies in key areas of electricity grids, transport, logistics, buildings, and industrial motors could save 15% of global emissions in 2020, and around $900 billion a year by 2020 in energy savings to global industry.

The report you hold in your hands outlines how smart cities could pay off hugely in the coming decades if we act now. This isn't only a technical challenge, it is a leadership challenge. As the report shows, cities are already making investments in low carbon 'smart' services from cycle hire schemes to real time transportation apps, and are increasingly the site for smart grid and distributed electricity generation pilot projects. But the explosion in access to data – 400% growth since 2005 – means that more low carbon services could be developed today. To make this opportunity real, cities can set ambitious visions, measure track and manage their progress to sustainability goals enabled by the digital infrastructure, and test new business models to scale up solutions.

We hope this report inspires city leaders across the world in their efforts to take transformational action on the low carbon economy and bring on board in the process private sector partners who will benefit by providing "smart" solutions.

The Clean Revolution is underway. It is our best hope for the future. And cities all over the world are driving the effort for a smarter, cleaner better world. For all.

Foreword

ARUP

Volker Buscher | Arup

Time for change

Cities deliver opportunities; providing efficient access to essential services as well as a rich tapestry of culture and entertainment. But cities and their citizens face new challenges. Economic uncertainty, austerity, growth within a new ecological context and the demands of citizens for a great place to live and work is driving leaders to seek opportunities to innovate.

Over centuries, cities have developed sophisticated solutions for many of the physical aspects of urbanity: architecture, transport, utilities and the public realm to name a few. However the use of information and the role of technology in cities has barely progressed.

Some leaders in cities around the globe are starting to move beyond the physical city; they are conceiving Digital Infrastructures and Information Products as a platform for economic development. This is the missing link in the ecological age and in creating great urban centres for people to live and work in.

Politicians around the world are faced with new choices due to emerging technologies, how they respond to these has become a factor in how people will vote.

Technology as a driver of change

The technology has reached a critical point; cloud computing, the internet of things, hyper connectivity and modern analytics are providing opportunities at affordable cost that only a few years ago would have been described as science fiction. The success of Information and Communications Technologies (ICT) at home and at work has meant that citizens now have access to powerful smart devices wherever they go.

Time for leadership

Continuing with the status quo will not capture this opportunity. Our research has shown that the city that makes the change from fragmented use of technology projects to a systemic approach will improve local conditions and gain export opportunities for the solutions they develop.

Leaders in government, small to large businesses and academia need to redefine their roles in this emerging world. Civic leaders can determine priorities and set strategic frameworks. Industry is providing innovative combinations of capabilities, products and services in new partnerships. Academia is developing the human capital and demonstrator campuses for all to learn from.

We produced this report with our partners to help cities capture this opportunity. Our aim was to provide a coherent framework that government, academia and industry can use to move forward in this exciting new world of: “New Economics of Cities”.

Foreword

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Mark Spelman | Accenture

We are at a point of inflection.

The size and economic output of cities is becoming on par with small nations. Today only 600 urban centres generate about 60% of global GDP[1]. Tokyo, with 35 million people and nearly $1.2 trillion in economic output, ranks among the world's top 15 economies, larger than India and Mexico[2].

The pace and scale of the change is unprecedented.

Cities alone will have to spend a staggering $350 trillion or 7 times current global GDP in the next 30 years on urban infrastructure. With 180,000 new people moving into cities each day[3], the 21st Century will be a century of urbanisation.

The challenges posed to our national and municipal governments, to businesses and individual citizens are immense. The interconnectedness of our national economies, supply chains, talent and resource pools, means that this is a collective problem to solve. Fortunately, the opportunity of technology to help address these challenges has also never been greater.

As the processing power and storage capacity of computer chips double every 18 months[4] and the global sales of smart phones is set to rise to over 1 billion by 2016[5] – we have the ability to apply technological innovation. ICT can be applied to our built environment and will not only help address the problems that we see in our cities today – like congestion and wasted energy – but also offer exciting new consumer experiences and convenience, and help to stimulate the much needed economic growth and job creation, that is particularly required in the Western world.

Whilst technology is a core enabler, Smart Cities are not just a technological issue; they also require innovative business and operating models.

For any city, the first step is to understand the diverse value that smart technologies can deliver. City leaders need the tools and vocabulary to be able to translate the value of their technology investments in to terms that resonate with their voters and to the businesses that would like to invest in their city. City leaders will need to nurture their digital economies. Leaders will need to step outside of their traditional focus on the physical footprint of their cities and put in place the appropriate strategic direction, operating frameworks, and incentives that will enable the digital aspects to flourish.

1 http://www.mckinsey.com/mgi/publications/urban_world/index.asp
2 http://www.theatlanticcities.com/jobs-and-economy/2011/09/25-most-economically-powerful-cities-world/109/
3 http://youthink.worldbank.org/issues/urbanization
4 http://www.economist.com/node/15557443
5 http://imsresearch.com/press-release/Global_Smartphones_Sales_Will_Top_420_Million_Devices_in_2011_Taking_28_Percent_of_all_Handsets_According_to_IMS_Research

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Executive Summary

Now is the time for government and business leaders to recognise the value created by smart city thinking. The technology-enabled city is an untapped source of sustainable growth and represents a powerful approach for tackling unprecedented environmental and economic challenges. By unlocking technology, infrastructure and public data, cities can open up new value chains that spawn innovative applications and information products that make possible sustainable modes of city living and working. While smart initiatives are underway in urban centres around the world, most cities have yet to realise the enormous potential value from fully-integrated, strategically-designed smart city development programmes. We believe that through clear vision and, most of all, leadership, civic leaders and executives can help cities make the transition to initiatives that maximise the smart city value opportunity.

Home to more than half of the world's population, cities around the world must think 'smart' to deal with the growing pressures of urbanisation. Cities are economic drivers and places of opportunity; but they also face unprecedented environmental and social challenges as more and more people migrate to cities and demand ever higher standards of living.

Information and Communications Technologies (ICTs) are also transforming our lives. Social media, the internet, 'cloud' computing, sensors and mobile phones are creating a 'smart' or digital infrastructure that is more powerful every year, allowing us to do everything from communicating with one another to solve problems collectively, to making our electricity grids more efficient, to providing new options for services such as using video conference instead of driving to the office.

Cities that face choking congestion from traffic, rising CO_2 emissions, or brown-outs during times of peak energy demand now have new options to solve those challenges by building on this digital infrastructure. An 'intelligent' or 'smart' city is one that meets its challenges through the strategic application of ICTs to provide new services to citizens or to manage its existing infrastructure.

Cities are already 'smart' in tackling their challenges by implementing cycle and car hire schemes to get vehicles off the road, and building performance monitoring to drive down peak demand. While more of this should be encouraged, our findings show that cities may be missing some of the value that is at stake if they do not think strategically about how to manage technology innovation. Beyond the visible roads and building infrastructure of the city is a hidden set of complex interactions from resource use, to consumption and waste, where huge inefficiencies are occurring all the time.

Sources:

http://www.sustainable-innovations.org/GE/UNEP%20%5B2009%5D%20A%20global%20green%20new%20deal.pdf

http://www.itif.org/files/2010-1-27-ITS_Leadership.pdf

We call this the 'surplus' city where value is not being recognised or captured today. Tackling this complexity and delivering value is a leadership opportunity that brings vast rewards. Cities will be able to access economic, social and environmental benefits from economies of scale in combining resources across projects, stimulating their economies and international competitiveness, improving existing services, mitigating risk through better planning and prediction, and engaging citizens in the process.

Our findings show that there is an explosion of interest in 'smart' solutions and we are at the first stage of realising this opportunity today. Open Application Interfaces (APIs), (the interfaces between developers that enable new data-driven services) have grown at 400% since 2005 and government, retail, transportation and utility APIs have grown faster than any other area. In addition, existing literature shows the potential for smart grid investments to yield 50% more jobs than the typical infrastructure projects, and Integrated Transportation Systems to drive economic benefits 25 times the original investment.

The risk is that this potential for value creation does not come to pass, and benefits for citizens are not realised. A key first step to realising the potential is to set a vision and create common metrics for cities, allowing them to access new financing options and build new partnerships and business models that involve the private sector. As cities improve their ability to manage the digital infrastructure, they will be able to not only to build an ecosystem of service providers and value chain at home, but will be able to take the lead internationally, learn from what has been invented elsewhere, collaborate, and transfer knowledge to reap the most benefits.

It is time for cities to step in and create a market, or citizens will lose out.

A smart city can't be measured by internet connectivity alone, and it will be just as important to have a Chief Information Officer or policy for including small businesses (SMEs) in their procurement process as it is to have ubiquitous broadband. It is time for political and private executives to achieve a strategic view of innovation to meet its challenges, setting a high level vision and working iteratively to manage a process of organisational change to unlock benefits for citizens.

5 billion
people will be living in cities in **2020**

Buildings use
40%
of world's **energy savings** and up to 40% of energy savings are not captured today

Smarter logistics
could yield **27% fuel savings**

Access to public data is estimated to be worth
€27 billion
in the EU

15%
of emissions can be saved in 2020 through **ICT-enabled energy efficiency**

ICT-enabled energy efficiency could translate into over
€600 billion
worth of **cost savings** for the public and private sector

Smart grid creates
50%
more jobs than the average infrastructure project

South Korea's
Green New Deal
and low carbon strategy create over **500,000** jobs

Smart grid initiatives
have created over **12,000** jobs in Silicon Valley

5 billion
people have **mobile phones** today

More than
50%
of **web connections** will be mobile by 2013

[1] http://www.smartgridnews.com/artman/publish/Business_Strategy/Smart-grid-equals-jobs-at-least-for-Silicon-Valley-4128.html

The promise of a data-driven city is to measure and manage progress toward a city's sustainability goals

Interview with **Adam Freed**, Deputy Director of Long Term Planning and Sustainability, New York City, October 2011

Already, 3,000 government buildings in New York City benchmark and publicly disclose their energy use. Next year, under New York City's Greener Greater Buildings Plan, every building in the city over 50,000 square feet will be required to annually benchmark and disclose their energy use. This is one of 132 initiatives in PlaNYC, Mayor Michael Bloomberg's data-driven strategy to create a greener, greater New York.

Adam sees the benefits of this approach, but knows it will not be easy. Cities aren't built to collect the data to make that cost benefit analysis work: "There used to be one energy bill for the city of New York. Now, the major city departments are getting charged separately so that they can figure out how to save money." In addition, utilities are not set up to easily provide detailed data—often facing regulatory obstacles and legacy data systems. But measurement is a key part of knowing how to effectively reduce energy use and greenhouse gas emissions, two of the key goals of PlaNYC. That is why the City has adopted a data-driven approach to target investments and track progress toward its sustainability goals. The City uses its GHG inventory, benchmarking data, and energy audits to prioritize $100 million in annual energy efficiency investments to reduce municipal government GHG emissions. "We need the data, to show what could be saved, and then we can make it happen."

Adam's approach is to carefully sequence the interventions they can implement based on the data they have collected. "If you don't have a good understanding of your buildings, which begins with benchmarking, you shouldn't be investing in a 'bells and whistles' system to manage an entire network."

The carbon inventory is the city's roadmap, but they are starting with what they are able to tackle first. In transportation, the Midtown in Motion project uses algorithms to speed up traffic and GPS units were placed in cabs to better understand how drivers were using the streets and what caused congestion. With 90,000 miles of underground cables in the city today, the smart grid has to be done gradually. "We need an incremental system or retrofit, so that when we have a high impact area or challenge, we can tackle that first. This is also why when we get pitched a 'smart grid for the city' it doesn't work. The wholesale rebuilding of an enormous system like New York City's energy grid just isn't practical from a fiscal or regulatory standpoint."

Adam also sees the benefits to industry beyond a cost benefit analysis. He wants to create the energy efficiency industry in New York – where companies can be located near world class engineering schools, to drive the market. The case for the Greener, Greater Buildings Plan showed that 17,000 jobs could be maintained or created while saving New Yorkers $750 million a year in energy costs.

Technology and data are necessary enablers of solutions. And the benefits can be measured: On September 19, Mayor Bloomberg announced that city-wide Greenhouse Gas (GHG) Emissions are down 12% since 2005, and the government's own emissions fell 5% in the last year.

Chapter 1

Cities in Transition

Smart thinking holds great promise for urban centres; it's time city leaders recognise the opportunities

If you are a city leader looking for 'smart' solutions to meet sustainability challenges, you are not alone. The problems of mass urbanisation – from overburdened infrastructure and transport congestion to soaring energy consumption and inter-city competition for investment – are becoming so complex that those offering solutions are finding a receptive audience willing to listen and act. Indeed, the proliferation of smart grid, smart city and sustainable city initiatives announced by all levels of government is creating an audible 'smart' and 'sustainable' city buzz. In cities around the world, such as Lavasa in India, Songdo in Korea and Masdar in Abu Dhabi, ambitious attempts are being made to build new 'smart and sustainable' cities from the ground up. In Europe, 23 cities have signed up to the Green Digital Charter mission of developing 'green digital' pilot projects that meet the greenhouse gas (GHG) emissions reduction goal of 30%[6]. For the C40 global network of city mayors, measurement and monitoring tools are regarded as underpinning thriving, sustainable cities. 17 of the C40 cities have smart metering projects underway, 18 have made real-time traffic information available to citizens.

Smart thinking holds huge potential for cities, but the full value of smart cities is not being realised. While it is encouraging to see pilot initiatives and even some large-scale projects, few cities are maximising the full opportunities offered by **digital infrastructure** development. It is time for city leaders – working with other levels of government, universities and large and small companies – to recognise the opportunities and take the lead in creating strategies and policies for managing the wave of innovation that comes from citizens who have greater access to new technologies.

What is a smart city?

The technology-enabled city is an untapped source of sustainable growth

Cities now represent the core hubs of the global economy, acting as hives of innovation in technical, financial and other services. Globalisation has led to the creation of a hierarchy of cities across the world[7] within which cities compete for access to natural resources and skilled workers. Cities must not only create traditional employment opportunities, but also help create and attract new industries to their areas. To maintain and secure global competitiveness, cities today must tackle their own challenges while also maintaining growth.

Technology has already had a profound impact on the way corporations do business, leading to the creation of global conglomerates that sit atop the 'apex' of massive value chains that span the world. This helps to make those companies more productive through more efficient use of resources.[8]

The value chains achieved in the world of business, however, have yet to be realised in cities. The connected, technology-enabled 'smart city' is today more vision than reality, and its features are as varied as the citizens who reside in them. For some, the smart city is about its infrastructure: how efficiently are its services delivered? For some it is about the knowledge and information that is available to citizens and what they do with it to create new services and become more sustainable.

[6] http://ec.europa.eu/information_society/activities/sustainable_growth/green_digital_charter/index_en.htm
[7] Egger, Determining a Sustainable City Model, 2006
[8] Nolan, Global Business Revolution, Cascade Effect and the Challenges for Catch-up for Large Indigenous Chinese Enterprises, 2006
[9] http://www.theclimategroup.org/_assets/files//BTCDJune08Report.Fin.pdf, p.20
[10] http://www.unfpa.org/swp/1996/ch3.htm
[11] http://www.brookings.edu/~/media/Files/rc/papers/2010/03_china_middle_class_kharas/03_china_middle_class_kharas.pdf
[12] http://m2m.vodafone.com/insight_news/2010_12_03_m2m_and_enterprise_innovation.jsp

In the context of this report, we use the following definition:

A city that uses data, information and communications technologies strategically to:

- provide more efficient, new or enhanced services to citizens,
- monitor and track government's progress toward policy outcomes, including meeting climate change mitigation and adaptation goals,
- manage and optimise the existing infrastructure, and plan for new more effectively,
- reduce organisational silos and employ new levels of cross-sector collaboration,
- enable innovative business models for public and private sector service provision.

By aligning the interests of stakeholders, employing new technologies and new market mechanisms, cities will be better able to obtain the full value of the smart city. This report explores specifically how cities and companies can begin to capture value by making infrastructure management more efficient and by supporting the market for an entirely new kind of digital infrastructure-based product: the **information product**.

Why do we need smart cities?

Cities today need the tools to tackle unprecedented environmental and economic challenges

Cities share a set of challenges related to climate change, globalisation and sustainability. They have the challenge of maintaining and raising living standards for a growing population with only 1/10th of the Greenhouse Gas (GHG) emissions we emit today[9]. As one million rural people resettle in cities every week, cities will be home to almost 5 billion people in 2020[10], with more than 3 billion people moving into the middle class[11]. Such explosive growth will escalate the need for upgrading aging infrastructure, tackling rising costs of service delivery, and meeting ambitious targets for innovation and sustainability agendas. Cities must do this all within a post-financial crisis, risk-averse funding environment.

At the same time, Information and Communications Technologies (ICTs) are rapidly changing our world. 5 billion people have access to mobile phones, and 2 billion of these are 'smart' phones with an internet connection. In India alone, there are 20 million new mobile subscribers each month. More than 50% of web connections will be mobile by 2013. Furthermore, ICT is becoming part of the citizens' expectations of a great place to live and work.

Computing in 'the cloud' means crunching data is cheaper and data services are more powerful than ever. Communications are increasingly possible not only between people but also between sensor-embedded digital devices, appliances and databases, a system known as the Internet of Things (IoT). Ubiquitous connectivity, super fast internet access, and falling costs of sensors and instrumentation mean that 'big data' will grow in size while better mining and management of that data will be possible. As many as 412 million 'machine to machine' applications are expected by 2014, enabled by 50 billion connections by 2025.[12]

Information Product:

A tangible asset to drive the economy forward.

Smart cities are driven by the need to tackle long term challenges such as climate change and aging infrastructure, and short term problems such as traffic congestion, peak energy demand and rising energy costs.

In 2050 cities will need to meet the needs of future citizens with 1/10th of the carbon we generate today

In economic terms, ICT enabled energy efficiency could transalte into over €600 billion worth of cost savings for the public and private sector

'Smart' holds the promise of finding new ways for citizens get the services they crave, without using exponentially more resources. The marriage of technology with the physical and built environment enables more efficient construction and management of infrastructure, and the potential to change behaviour for personal or public good.

The SMART 2020 Report[13], the definitive report on ICT and climate change, highlights the promise created by the convergence of the environment and digital infrastructure. The report found that globally, ICT-enabled solutions of smart grid, smart buildings, smart logistics and industrial processes can potentially reduce urban global greenhouse gas emissions by as much as 7.8 Gigatonnes in 2020 – a reduction larger than total emissions produced by China in 2010. In economic terms, ICT enabled energy efficiency could translate into over €600 billion worth of costs savings for the public and private sector. Some of this value is being captured today, but not all, as we will explore in Chapter 2.

Recent research conducted global by Booz & Co. finds that cities alone will have to spend a staggering $350 trillion, or 7 times current global gross domestic product over the next 30 years, on urban infrastructure, including energy systems, residential and commercial buildings, water and waste systems, roads and transportation, and supporting information and communications technology.[14] To do so without applying transformative solutions will be unsustainable. The same research shows that additional $22 trillion invested today in ICT to improve building and transportation efficiency would save cities $33 trillion and reduce future emissions by as much as 50%.

How is this value actually realised?

By unlocking information, ideas and energies, smart city applications and services create more sustainable modes of living and working

Through better use of information and communications, our cities have the potential to be 'mined' for surplus capacity, by using data and information to improve services for citizens at a low cost.

Opportunities arise from:

- **Measurement, automation and feedback to decision-makers, creating more efficient use of infrastructure, including buildings and roads, enabling both short term benefits from crisis management and long term benefits from better planning**. For instance, as we better understand energy use in buildings through benchmarking and monitoring, building operations can be better managed. The tools used plan and construct buildings can be fine-tuned to match intended use with operational realities, saving construction time and material costs along the way. Smart grid solutions enable utilities to have more transparency over the electricity distribution networks and manage supply and demand dynamically, a crucial tool for managing the growing peaks in demand from home appliances. In future, utilities will need to manage the growth in electric vehicles as a mobile energy storage option to help balance supply and demand for power.

- **Making both public and private datasets about the interaction between people, infrastructure and technology systems available to third-party service providers and developers**.
  For instance, city transportation departments, in a bid to reduce road congestion, are seeking to get people out of their cars and into public transportation and onto their bicycles. Already, developers are creating mobile phone apps that draw on city data that helps people use public transportation more easily[15]. We will explore this further in Chapter 3.

But cities can do more than manage the construction, automation and use of infrastructure in cities. They can build an industry around creating new services for their citizens. In 2010, Clay Shirky observed a phenomenon he called 'Cognitive Surplus'[16], in which new digital technologies allow people to aggregate their individual creativity with others online (sometimes called 'crowdsourcing'), creating valuable projects such as open source software.

Today we can link not only people, but also data and information to a city's challenges, to unlock a new untapped resource for solutions and economic growth, what we are calling the 'surplus city'. Cities are vast interactions between people, infrastructure and technology that can be accessed, shared and inter-connected thanks to new digital technology. Giving policymakers and citizens the opportunity to tap these resources, technology can ignite new applications and services, and, in turn, create better ways of living and working. In Amsterdam, for instance, a new application service helps city workers find a 'smart work centre' to avoid travelling during rush hour. "Amsterdam realised a year ago that if the city had a smart work network in place, it could build a city-wide, city-employee smart work strategy to allow people to work from home. This will allow the city's 20,000 workers to occupy 120 buildings instead of 200, a direct savings in energy and carbon, and save people time sitting in traffic," says Bas Boorsma, Cisco Systems, who has been working on smart working solutions for the last five years.

Digital access to energy information similarly is opening up service provision options to non-traditional suppliers[17], with the potential to create services and associated jobs and benefits beyond what the energy industry could predict today. Cities that have participated in the Living Labs Global Award process over the past 2 years have seen over 500 digital and IT service providers vie to solve their challenges. See Appendix 1 for a list of solutions and enabling technologies envisioned in the coming decade.

What are cities already doing?

The signs are encouraging: smart city initiatives are underway in many urban centres

Cities are already beginning to link solutions to policy goals and initiatives, assessing smart city value either based on individual technology analysis, such as smart meters, or grouping technologies as solution sets, such as smart grid systems. San Diego's benefits from a planned smart grid implementation were estimated to be US$2.7 billion over 20 years with an internal rate of return up to 75% and payback period of 3.5 years[18]. Some cities are also improving pricing policies, through initiatives such as mobile parking payment options, and infrastructure management, such as smart building management systems.

The 'Surplus City' is our opportunity to turn inefficiencies into value by understanding the city as a system, breaking down silos and reducing fragmentation

[13] The Climate Group and GeSI, SMART 2020: Enabling the low carbon economy in the information age, 2008
[14] WWF- Booz, Reinventing the City, 2011
[15] http://www.mta.info/apps/
[16] Shirky, Cognitive Surplus, 2010
[17] http://www.ey.com/GL/en/Newsroom/News-releases/Energy-companies-must-reinvent-themselves-to-compete
[18] San Diego School of Law, San Diego Smart Grid Study – Final Report Energy Policy Initiatives Centre, 2006

Sector	Actions	Description	Implemented	Authorised or awaiting authorisation
Energy	Smart grid	Sensors and instrumentation to improve distribution network efficiency, in conjunction with smart metering, helps match energy demand and supply	6	11
	Building energy management system	Occupants can automate the energy-consuming systems in buildings	13	3
	Smart building sensors and controls	Building sensors and controls allow for better use of buildings, or prediction of faults	12	9
	Smart energy metering	Automated meter reading enables utility and occupants to access information digitally	17	14
	Outdoor lighting smart controls	Dimming and other controls enable greater energy efficiency	3	3
Transport	Smart transport cards	Ideally smart cards link multiple forms of transport and make it more convenient to use, and for transport authorities to understand mobility patterns	18	10
	Car clubs	Users can hire or share vehicles easily, and will ideally not buy a car, but instead simply use one when it is convenient	6	1
	Cycle hire programs / sharing programs	Uses can hire bicycles instead of driving	10	7
	Electric buses	Buses that are more efficient and ideally run on renewable power	10	3
	Electric trains	Trains that are more efficient and ideally run on renewable power	8	3
	Electric vehicles	Vehicles that can become mobile storage for energy, helping to balance peak demand	14	14
	Real time information for logistics	Telematics and communications with drivers to optimse routes	7	0
	Real time transport information	Provides the basis for mobile applications for journey planning	18	10
	Real time transport displays	Provides visibility to users and encourages uptake of public transportation	12	7
Water	Smart water metering	Monitors and helps water managers reduce waste in the system, saving 10-15% per household	12	3
Total			**29**	**28**

Figure 1.1 Technology-enabled actions by C40 cities.

Digital infrastructure:

The hardware and software assets, including mobile networks, mobile phones, fixed broadband, sensors, databases, visual interfaces, data assets generated from the movement of people and things, and open APIs.

The pockets of success at the project level are encouraging. A survey of policies, initiatives and activities by the C40 cities to address climate change in 2011[19] clearly shows numbers of initiatives already underway that require ICT or are improved by a significant ICT component (see Figure 1.1).

Although the specific path to a 'smarter' city will depend on context of the local city challenges, such as congestion, rising costs of water or heat provision, or reliability of electricity, for all cities some common, core features will be part of the transition to a smarter city. One common feature is the development of 'digital infrastructure' which includes the physical ICT assets (data centre capacity, prevalence of smart grid, connectivity and bandwidth, software and visualizations, etc.) and 'soft infrastructure' that manages this technology and infrastructure. Although it is easiest to describe the common elements in levels or stages as shown in the framework described in Figure 1.2, in practice, implementation may not be necessarily a linear process. It may be, for example, that infrastructure development progresses before the management is in place. Alternatively, management and leadership capability may be more advanced than the technological infrastructure. We will discuss the steps that cities can take to manage this process in chapter 4.

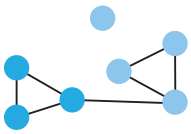
Smart City Project Implementation	 Level 1	 Level 2	 Level 3	 Level 4
Soft Infrastructure				
Value Assessment	Individual project business cases	Some non-financial value assessed	Holistic value assessment (social/ environmental/financial)	Holistic value assessment supporting diversification of funding sources
Governance	Departmental governance structures	Some cross-departmental collaboration	Cross-departmental 'Smart City' management positions in place	City-wide governance structures and shared performance targets combined with international collaboration
Strategic ICT Focus	Limited ICT capability	Some strategic focus on ICT	ICT vision for the city	ICT vision and strategy overseen by dedicated City CIO
Citizen Engagement with Service Design	Limited citizen engagement	Project-level, basic needs analysis, pilots	Citizen feedback loops established	Citizen participation in integrated service design
Hard Infrastructure				
IT project focus	Little or no ICT projects	Targeted ICT project investments (e.g. Smart Grid)	Integrated ICT investments (including embedded sensing, control and actuation)	Real-time city operations optimisation
Integration of Data Streams	No data integration	Small scale data integration	Creative data mash ups pulling data to a common platform	Open data and crowd-sourcing initiatives
Digital Service Provision	Little or no digital service provision	Handful of digital services	Integrated digital services around the city environment	Diversity of cloud-based citizen services

Figure 1.2 Framework for a Smarter City

Why is the value not being realised?

Several challenges are holding back the promise of smart city planning and development

While many smart city technologies – including smart electricity grids, smart meters and real-time transportation information – are already in pilot programmes and some cities are even implementing large-scale smart transportation and grid projects, there are no examples to date of cities launching fully-integrated, strategically-designed, smart city development programmes. Media hype and the political rhetoric aside, deployment of smart city initiatives that maximise integration opportunities is still limited.

Of the 36 cities interviewed for the C40 report[20], very few had made the connection between the initiatives listed in Figure 1.1 and ICT strategy. None had a strategic plan in place to set a vision or policy framework for putting major technology trends into their city planning. The vast majority of cities are not more than level 2 on our smart city framework sketched in Figure 1.2.

[19] http://www.arup.com/Publications/Climate_Action_in_Megacities.aspx
[20] http://www.arup.com/Publications/Climate_Action_in_Megacities.aspx

"We have so many service providers coming to us with a 'smart city' offer, but they don't seem to understand that it's not just a matter of finding the newest, most complex system available. They know they have the product to sell and cities know they would like to be smarter, but there are a number of competing factors that go into making a match."

Adam Freed, Director for Long Term Planning and Sustainability in New York

This is perhaps not surprising. Capturing the benefits of converging technology to solve social, economic and environmental challenges is not straightforward in practice, and will happen once those technologies make 'common sense'. However, given the urgency of the challenges cities are facing, it is worth accelerating the pace of innovation when the benefits are so vast.

The implementation gap stems from several challenges that we see within the smart cities context today, which arise from the interaction between citizens and consumers, cities, national government and companies.

- Smart city dialogue and plans that are technology-led, rather than needs and values-led, run the risk of compromising development plans. Smart metering is a case in point. In US markets, a technology-driven approach has led to a backlash amongst consumers who do not see the benefits of energy savings that were promised[21].
- The value of digital investments is not being clearly articulated for all stakeholders. Cities may be unsure of the payback or may not possess mechanisms to pay for up-front costs even if payback is certain in the long term.
- Value objectives for one stakeholder may not be aligned with social, economic, environmental value for the city. European utilities, for instance, are estimated to gain between €22 and €29.3 billion annually from smart grid investments. However, the same smart grid projects could produce energy for European consumers worth €3.6 - €18.2 billion, potentially cutting into utility sales. The gap between utilities' and cities' societal value goals could slow development plans[22].
- Cities are complex organisations and decisions that involve multiple departments can take time and can often be at odds with the sales cycles of companies. Procurement cycles for cities can take up to three years from initiation to sale, which can prevent innovative under-resourced companies from participating in smart city development opportunities.

We point to possible ways through these challenges in later chapters.

Given the size of the challenge ahead, we need to proactively nurture smart city initiatives that are already underway and support city leaders who are driving change, especially those who are looking across departmental silos in an effort to make connections and achieve greater innovation.

The vast majority of cities are not yet developing fully integrated physical, economic and digital master planning

Making the Smart City Transition

Making the move towards smart city development requires a full understanding of its strategic value

The smart city offers a holistic, strategic vision for bringing together innovative digital infrastructure solutions that address a multitude of issues facing modern urban centres and communities. But if the smart city is to evolve from an infrastructure concern to a strategic part of the urban development, then city leaders will need to recognise its full value opportunities.

This report intends to help address some of the open questions within the industry today and help expedite the transition to a smart, more sustainable future. Within each chapter we will work to uncover:

1. What value is derived from a 'smart' city and how can it be better captured?
2. What is the "product" of a smart city and how can we maximise its value?
3. What leadership and softer infrastructure is required to realise the opportunity?

Meeting cities' challenges will only possible if the role of Information and Communications Technologies are made explicit. ICTs or 'smart' solutions are no silver bullet, and must be seen within the context of what they can achieve.

Real transformation in cities will require us to look at the 'surplus city' hidden within the city. Beyond the public transport systems, micro-wind turbines, and parks there is an underlying system, connecting resources to waste to consumption in a set of complex interactions. ICT can begin to help us manage this complexity – and redefine how we operate our energy networks, our transport infrastructure, and the buildings in which we work and live.

[21] http://gigaom.com/cleantech/why-the-smart-meter-backlash-story-isnt-going-away/

[22] Geert-Jan van der Zanden, The Smart Grid in Europe: The impact of consumer engagement on the value of the European smart grid, IIIEE Theses, 2011:33

3 *billion people will move to cities by 2050*

Transparency helps departments in Rio de Janeiro work together for better city services and outcomes

Interview with **Rodrigo Rosa**, Special Advisor to the Mayor on Sustainability, Rio, Brazil, May 2011

As Rio prepares to host one of the most anticipated climate change events in 2012, Rio+20, marking the 20th anniversary of the 1992 Earth Summit, the city is also gearing up to launch its own new sustainability initiatives. One of these is the sustainable *favela* project, "Morar Carioca Verde", a policy of urbanising, retrofitting and improving the city's *favela* slum areas. "We would love solutions to be brought to us, and we can see how we could incorporate them," says Rodrigo. He hopes to find innovative ideas that will involve both public and private sector. Rio's power utility Light, which now provides service to Rio's *favela* neighbourhoods, offers discounted electricity bills to customers who recycle – a low-tech solution to the problem of too much trash in the neighborhood.

For a city whose mayor was awarded a national prize for his innovative use of IT to solve the city's challenges last year, technology is also part of that sustainability agenda. Indeed, one of the most advanced operations centres has recently opened in Rio. Built with the help of IBM and Oracle, it is a high tech 'situation room' designed to support the city in managing its services.

Another promise of an operations centre is in delivering support crisis management, increasingly important following the devastating mud slides that have hit Rio state in recent years. "Our biggest challenge is flooding and landslides. We are learning a lot about crisis management and coordination. 25 people were killed last year in the city, and 800 in the state. Better weather prediction will help avoid this. And we can better collaborate with state officials."

The operations centre is a powerful decision-support tool. "Sometimes we don't even know what it can do for us." Rodrigo is considering the necessary training for municipal government employees who are not used to the high tech tools they now have access to. "We have people out there on the ground working on their issue, such as transport or security, but aren't used to looking at the data to do something different."

Rodrigo is sure that the city is better off just by having transparency between the different departments that may not have worked together before. "Information is more clear - you can see it on screen. You have the concept of geo-referencing everything that makes it easier to understand. If traffic is bad in a particular part of the city and you know a waste management truck can help quickly to clean something up, that truck can be routed to the location to avoid traffic."

Rodrigo looks forward to seeing how the project develops and to measuring its impact. He hopes that it will support knowledge-sharing between city officials and sub-national government that will ultimately lead to better services for Rio's citizens through more efficient use of resources.

Chapter 2

Connecting Smart Cities to Value

The time has come to clearly understand and articulate the smart city value proposition

Use of a single set of metrics sheds light on a smart technology's rate of return on investment and enable comparison against other technologies

The previous chapter introduced the Smart City and its environmental, economic and social drivers, and explored reasons why the value of the smart city is not fully exploited today. In this chapter we look at how cities can better recognise, capture, communicate and commercialise the value of their smart city initiatives.

We introduce several limitations to current approaches for valuing smart city investments and highlight opportunities to provide a more holistic methodology for assessing value. The value of smart city projects is often assessed on an individual, case-by-case basis, rather than as part of the greater jigsaw of the city. As a result, the benefits of economies of scope and scale created by smart projects are often not measured and consequently, not communicated. Value assessments tend to overlook core benefits of smart city initiatives, such as cleaner air, new jobs, and entrepreneurship. City leaders need to be able to better crystallise the benefits of a smarter, faster, more environmental-friendly city and then, by applying business model innovation, translate these desirable outcomes into city revenues that support new financing mechanisms.

Measuring within a Common Framework

Setting common metrics will enable cities to evaluate different projects on a like-for-like basis

Smart city initiatives are typically evaluated using metrics that are specific to a sector or department. For instance, smart grid projects are measured by a reduction in energy losses and efficiency gains, and Variable Road Pricing is measured by reduced traffic congestion. While the value of each project can be readily assessed at the departmental level, it is less easy to understand the contribution of the project to the city's overarching objectives. For example, how would a city compare the relative value contributions of a Smart Grid and Variable Road Pricing towards its city-wide aims of economic development, livability, and environmental sustainability? Such questions present a challenge to city leaders who need to make capital allocation decisions across a portfolio of smart city initiatives. Cities do not yet have the necessary tools to deploy their finite resources in the most capital efficient way.

For the value of smart city projects to be effectively compared, a common suite of metrics needs to be developed that tie the performance of individual initiatives to the city's long-term strategic aims. The aims of a city will be unique to the challenges it faces. Mexico City, for example, may aim for greater public security, job creation and reliability of electricity networks, while Copenhagen may have its sights set on being CO_2 neutral capital by 2025. A single city scorecard, based on specific objectives, enables the city to understand the relative

value of different smart technology initiatives based on how well each delivers on the city's overall strategy. It helps city leaders decipher whether a smart buildings scheme, for example, is more or less valuable than an electric vehicles pilot to their city's needs. As the value of smart city initiatives change over time, using a single set of metrics sheds light on a smart technology's rate of return on investment and enable comparison against other technologies.

As well as helping to select initiatives, a common set of metrics enables the city to monitor its overall performance over time and compare this against other cities. Historical analysis of a city's performance can reveal useful results that generate understanding and provide evidence for how well the city is meeting its targets. Around the world, cities are increasingly participating in benchmarking activities to better understand their performance and to share lessons with other cities, from the Global City Indicators Program[24], which now has over 180 city members, to the environmentally-focused disclosure platforms, including the Carbon Disclosure Project for Cities[25] and the United Nations Global Compact Cities Programme[26]. The proliferation of methodologies and reporting frameworks in the marketplace can, however, make the decision on where and how to disclose potentially confusing for cities. It is important that city leaders choose the disclosure platform that best suits their city's needs. Once selected, city leaders can then create customised methodologies to gather local data against the chosen set of standardised metrics. This approach would enable a city to effectively benchmark itself against a global audience whilst still incorporating the city's unique context. While selecting and implementing benchmarking metrics is no easy task, the benefits of greater understanding and international credibility will only increase over time as historical data is accumulated to drive new insights about the city.

In the corporate world it is becoming common practice for companies to measure their performance against a set of sustainability measures; the number of companies producing sustainability reports has increased by 600% between 1999 and 2010[28]. To support this process, companies have developed automated sustainability measurement tools, such as Enterprise Resource Planning (ERP) of reporting modules. Cities such as Singapore[29] and Abu Dhabi[30] are starting to partner with software vendors to create web-based management solutions. While cities may not be willing to invest in developing their own measurement tools, options are available for cities to purchase similar software as a service. As more and more companies and cities recognise the value of having a single set of sustainability metrics, the barriers to adopting measurement tool are decreasing. Soon all cities will be able to measure and benchmark the performance of their smart initiatives, giving them a greater, connected understanding of their operations.

It is important for city leaders to understand which disclosure platforms best suits the city's needs

[24] http://www.cityindicators.org
[25] http://www.cdproject.net/en-US/Respond/Pages/CDP-Cities.aspx
[26] http://www.citiesprogramme.org/index.php/about/#ungc
[28] http://fm.sap.com/data/UPLOAD/files/EIU_-_Sustainability_Performance_Management[1].pdf
[29] http://www.carbonneutral.com/about-us/media-centre/press-releases/singapore-to-lead-the-way-with-carbon-management-tool-pilot/
[30] http://www.thenational.ae/news/uae-news/environment/abu-dhabi-to-monitor-greenhouse-gas-emissions#

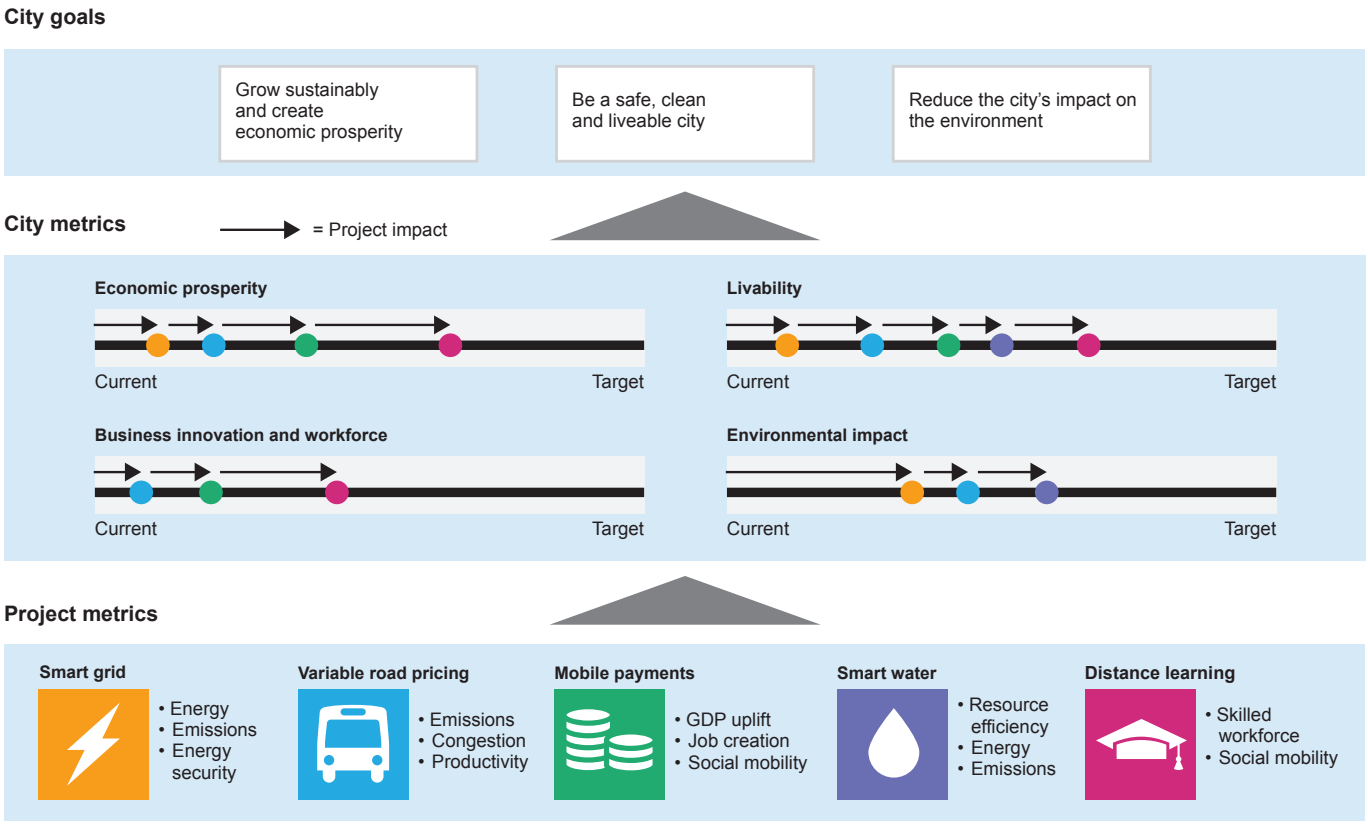


Figure 2.1 Measuring city projects against a common set of metrics

Capturing the value of a city-wide approach

Identifying and capturing the incremental value from connecting infrastructure projects across the city

Smart city initiatives tend to be assessed, planned and implemented at the department-level of city administrations and relatively small pilots are often used to estimate the benefits of each project. However, new technology is changing the dynamics of how and where value is created. Smart grids are bringing together our energy and telecommunication grids, electric vehicles are bridging our transport systems with our energy networks, datastores making energy and transport data more accessible. A single departmental assessment of a smart initiative's value doesn't capture these broader benefits and, as a result, opportunities to realise economies of scope and scale across departments get missed. For example, the telecommunications backbone deployed for a smarter energy grid may also serve as the communications backbone for a smarter water grid. Without a broader, more lateral understanding of the systemic value of smart projects, the city can miss such valuable opportunities.

The potential for smart technologies to enable economies of scope and scale is great. Sensing and control capabilities embedded in smart technologies produce a vast quantity of data, and the collation and analysis of this data from different infrastructure layers can generate powerful insights about a city's operations. Imagine a real-time view of the city that simultaneously shows the flow of transport, electricity, communication networks and retail transactions. Such an integrated picture, magnified at the city level, reveals new social, economic and mobility patterns and drive efficiency gains and resource savings. The power of this smart city view is beginning to be recognised; the European Union is offering funding for cities in Europe to develop comprehensive urban planning tools and "models for strategic sustainability planning"[31]. Smart cities will harness the value generated by more informed planning and use of resources. The value of a smart city is greater than the sum of its parts.

The ability to collate data from different infrastructure layers and to plan and operate the city as a united 'system of systems' brings unexpected and broad-ranging benefits beyond economies of

The value of a smart city is greater than the sum of its parts

scale. Not currently captured by traditional value cases, the environmental, social and economic benefits are known as **positive externalities**:

- **Economic stimulation** – Technology is quickly becoming an indispensable enabler of innovation. Digital and internet technologies provide cities with opportunities for service innovation and business models. City open data initiatives, such as the 'apps competitions' or 'hackathons', are examples of efforts to promote technology-driven innovation within cities. These initiatives bring together citizens, businesses, organisations and technology developers to build new mobile and web applications using public data provided by the government. Many cities around the world have run events to encourage entrepreneurialism as well as collective problem-solving. The resulting apps often solve citizen problems that have not yet been addressed by the market. The winner of the first New York City BigApps contest is now a venture capitalist-funded startup, MyCityWay, which offers a digital city guide to help citizens and visitors to better navigate and experience the city[32]. Even if all of the apps do not succeed commercially, the competitions often guide industry development and allow the testing of new ideas and systems.
- **Service innovation** – As well as improving the efficiency of city services, smart technologies enable the creation of new services for citizens and businesses. Just one example is a project being carried out in Singapore by the Massachusetts Institute of Technology. Because Singapore rainfall often comes in intense, localised downpours, the demand for taxis can often outstrip supply in storm areas. To help warn taxis of upcoming rainstorms and demand surges in specific parts of the city areas, the MIT team combined short-term (ten minutes in advance) weather forecasts with GPS taxi location data. By using existing technologies in an integrated fashion, the city was able to provide a useful, new service to citizens[33]. At the same time, high quality services of this kind help to increase tourism and attract new businesses, supporting the city's overall economic growth.
- **Citizen engagement** – By relying on ad hoc opinion surveys or relatively small scale focus groups to gauge citizens' opinions, governments can often be 'out of touch' with people's needs. ICT can provide city leaders with tools for widespread citizen engagement and new ways of interacting and collaborating. New York City's 311 Customer Service Centre is an example of how ICT can enable a two-way conversation between governments and citizens. The 311 centre provides citizens with 24 hour access to government information and non-emergency services through various portals (e.g. telephone line, website, blog). In addition to 311, a growing number of online forums are collecting citizen feedback on city services and planning. The real-time and widespread feedback collected through these forums can be invaluable for city administrations and companies. In this way ICT can both empower citizens by providing them with transparency and accountability while also enhancing the reflexivity of city services.
- **Greenhouse gas reduction** – Climate change impacts cities all over the world, regardless of where greenhouse gas emissions are emitted. As more cities feel the effects of climate change, transparent management of a city's services and

[31] http://ec.europa.eu/research/participants/portal/page/cooperation?callIdentifier=FP7-ENERGY-SMARTCITIES-2012
[32] http://ideas.nycbigapps.com/
[33] http://senseable.mit.edu/livesingapore/

adaptation become increasingly valuable, as we are already seeing in Rio de Janeiro (see interview with Rodrigo Rosa). A smart city approach gives cities the tools to track their emissions and manage them over time. While the value of cutting CO_2 emissions is today underestimated, in some states and countries legislation is increasing the price of carbon. The monitoring and reduction of emissions through a smart city approach will drive immediate cost-savings as well as the long-term benefits of monitoring the impact of the city's operations on greenhouse gas emissions. Accounting for carbon at the city-level today will pave the way to realising value from carbon savings.

- **Risk mitigation** – Greater information about a city's operations and infrastructure facilitates the identification and management of risks to the city. For example, real-time information about the flow of citizens around the city from combined smart transport and mobile data can help cities to deploy security services during emergencies. Climate change risks can also be managed more efficiently using smart technologies. Information on the local climate and urban fabric has helped communities in Chicago mitigate the "heat island" effect through urban landscape modifications such as planting trees or shrubs on parkways, replacing asphalt surfaces, and creating rooftop gardens[34]. In addition to mitigating physical risks, the measuring and reporting capabilities of smart technologies can offer assurances to bond issuers, insurance companies and corporate investors, which would, in turn, reduce premiums and increase investor confidence.
- **Health benefits** – As the pace of life increases and the nutritional value of our food decreases, good health is increasingly valued in today's world. By driving resource-efficiency gains, smart initiatives contribute to the creation of a cleaner environment. Smart traffic management together with smarter buildings, transport and waste management reduces air pollution. Copenhagen's main seaport used to be permanently closed for bathing as the high levels of water pollution posed a health risk. In a long-term effort, the Copenhagen municipality used smart systems to control wastewater management and control and forecast the water quality. Today, public outdoor swimming at the port has become one of the most popular recreational activities in the city. Realising the health and quality of life benefits associated with clean water surrounding the city, Copenhagen continues to explore the use of smart technologies, including the electric charging of cargo ships at port in order to reduce the release of pollution into the water[35]. Smart city technologies provide great potential to increase the health of residents.

This is not a comprehensive list, for example some cities must prioritise resource efficiency or education. The positive externalities described above drive economic, political, social and environmental benefits that city leaders consider when making ICT investment decisions. The costs of inaction when a city does not invest in ICT should also be taken into account. For example, a lack of ICT investment can put a brake on the transition to a low carbon economy and hamper a city's ability to attract talented individuals and companies.

To realise the full value of a smart city and reap all of the benefits, cities need to adopt a more holistic approach that captures the **positive externalities**, **economies of scope and scale**, and value of **individual smart projects**:

[34] http:// www.chicagoclimateaction.org/pages/adaptation/49.php
[35] http://www.ecoinnovation.dk/NR/rdonlyres/9FEEE910-27A4-4BE7-8A01-DD17BE0C072E/0/KBH_havn_baggrundsartikel_1.pdf
[36] http://www.oecd.org/document/56/0,3746, en_2649_37465_48033720_1_1_1_37465.00.html
[37] http://www.globalreporting.org/ReportingFramework/ReportingFrameworkDownloads/

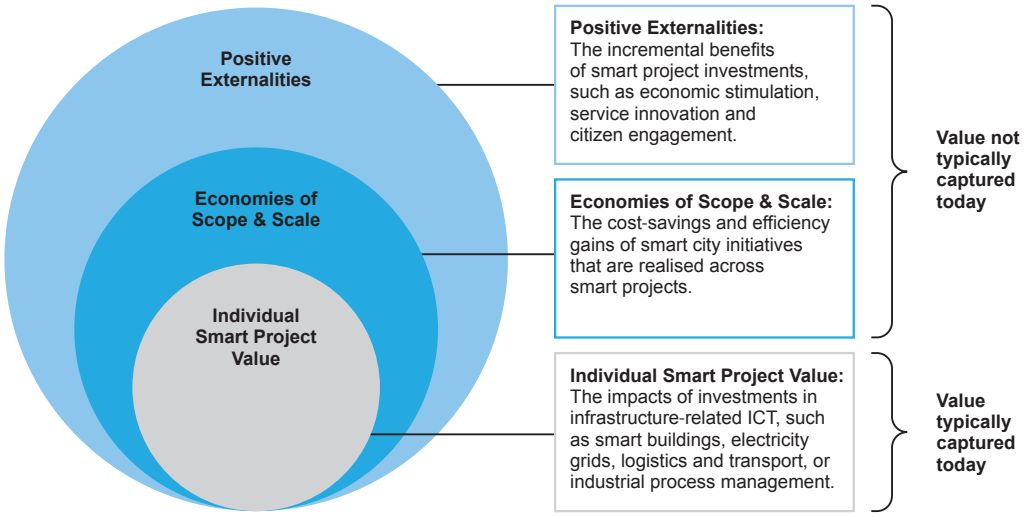


Figure 2.2 Layers of Smart City Value

Challenges must be overcome when adopting this holistic approach. The outcomes of the positive externalities and economies of scope and scale can be difficult to ascribe value to, largely because they:

- are distributed across multiple stakeholders,
- arise from confluence of factors, making it difficult distinguish cause and effect,
- may have a long time delay before realisation.

This is not to say a holistic approach shouldn't be attempted. Some forward-thinking agencies are already helping to capture some of this value. They have developed auditing and indicator systems that capture economic, social, and environmental outcomes to help organisations gain a broader view of their own activities. The Organisation for Economic Co-operation and Development (OECD), for instance, is developing Green Growth indicators to measure the holistic value of environmental initiatives[36]. In addition, the United Nations' GRI Sustainability Reporting G3 Guidelines are designed specifically for use by public agencies to assess and monitor their policies and practices in relation to sustainable development on an external, standardised, inclusive platform[37]. Measuring and understanding value are just the first steps. To fully realise this value, smart city initiatives need to be quantified to address the needs of potential investors and stakeholders.

Tailoring value cases to different audiences

Using quantitative measures and vocabulary that resonates across different actors

Smart city stakeholders assess value in very different ways:

- Businesses focus on driving shareholder returns and maximising profits,
- City municipalities, politicians and regulators are motivated to deliver societal benefits and high quality services whilst driving operational efficiencies,
- Citizens are looking for improvements in services, greater choice, and opportunities to save money.

While smart city initiatives often deliver benefits to meet the needs of these different groups, current techniques for measuring and communicating value are often not sufficiently tailored for each audience. For a smart city to be successful, it will require collaboration and participation from all these stakeholder groups. Each participant needs to understand "what's in it for them".

Currently the public sector tends to communicate smart city investment opportunities in terms that do not always resonate with the private sector. This makes it difficult for the private sector to identify opportunities that will prompt its participation and shared value creation.

A truly smart city will involve unprecedented levels of citizen engagement and behavioural change

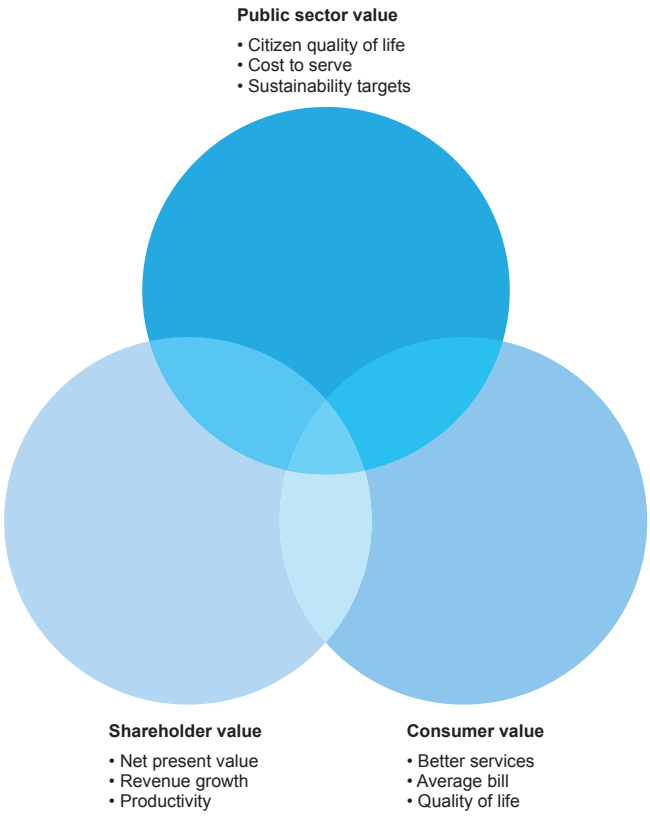


Figure 2.3 Multi-dimensional Value Case

€2.9

trillion is required to finance the development and roll-out of new low carbon technologies in Europe

The disconnect is weakening the flow of private sector investment and the transition towards a smarter, more sustainable future. Given that many of the world's economies are capital constrained, now, more than ever, the public sector needs to translate outcomes into a language that the private sector can recognise. Value cases that cross the public-private sector divide demonstrate value in terms that both parties can connect with, such as access to information, new consumer segments, the impact of operational efficiency to their bottom line, and new revenue opportunities such as the development of new services or intellectual property. The New Economics Foundation and the Scottish Government have designed a progressive framework, called the Social Return on Investment (SROI), to help organisations capture social and environmental value and translate it into financeable, private sector terms. "SROI is about value, rather than money. Money is simply a common unit and as such is a useful and widely accepted way of conveying value."[38] For the private sector, tools like this will generate understanding of the adequate investment returns that can be generated from smart initiatives; only when this understanding is gained will the private sector commit capital.

Another key source of funding for cities comes from the developmental sector. Multilateral financial institutions and development banks, such as the United Nations, European Bank for Reconstruction and Development, Global Environment Facility, and Green Climate Fund, provide funding to cities and organisations whose projects demonstrate a positive societal impact. To access this funding, value needs to be communicated in the terms of the philanthropic organisations' desired investment returns, which are likely to overlap with the societal and environmental returns sought by cities. In addition, value should also be articulated for the development sector in terms of long-term outcomes to provide certainty for the funding, and should include clear, quantifiable targets to encourage investment.

Citizens' hopes and goals are distinct from those of both the private and public sector. Around the world, citizen's expectations are rising for customised, high quality services. Increasingly tech savvy, citizens are demanding increased transparency from companies and governments. A truly smart city will involve unprecedented levels of citizen engagement and behavioural change. When cities fail to articulate the value-add of investments to their citizens they risk not realising the full potential of their technology investments and disillusioning their voters. Cities therefore need to communicate to their citizens in a language that has direct relevance to citizens' lifestyle and that they can connect with. A smart transport initiative, for example, should be articulated in terms of the time saved in a citizen's daily commute or in terms of decreased levels of air pollution and road accidents.

[38] http://www.neweconomics.org/publications/guide-social-return-investment
[39] http://ukpolicymatters.thelancet.com/?p=1323
[40] http://www.adlittle.com/uploads/tx_extthoughtleadership/ADL_E-Mobility_02.pdf
[41] http://www.rwe.com/web/cms/en/113648/rwe/press-news/press-release/?pmid=4002466

Translating value into financeable solutions

Innovating around business models to monetise positive externalities and increase access to a diversity of capital sources

Communicating in the right language is only the first step in unleashing the potential of private sector capital. Appropriate business models also need to be in place. Today, significant investment is required to finance the low carbon technologies that cities desperately need. A recent report by Accenture and Barclays Capital demonstrated that from now until 2020, €2.9 trillion is required to finance the development and roll-out of new low carbon technologies in Europe. City leaders need to focus on what gives the private and developmental sector sufficient assurances and clarity of revenue streams so that they are comfortable co-investing.

A new approach is required to help city leaders deliver and monetise smart city investments. Innovative business models are needed that translate the broad range of smart city value into something financeable and are aligned with the interests of stakeholders – in terms of fees, the structure of funds and the investment horizon. City leaders can stimulate the creation of new business models in the following ways:

1. Employing new technologies to create new revenue streams for information and convenience-based services. For example, a service whereby citizens can make micro-payments through their mobile phones to know when the next bus will arrive.
2. Encouraging market mechanisms that help to monetise societal outcomes. Social Impact Bonds[39], for example, create an outcome-driven system for solving societal issues that aligns public sector funding with private sector incentives so that there is a mutual benefit from the improved outcomes.
3. Leveraging the procurement power of the public sector. Long term concession-based contracts can provide attractive propositions for both the private and public sectors. For example, a street lighting concession, based upon a 20% energy efficiency improvement as part of the service provision, could prove a draw for private investors.
4. Providing greater opportunities for social enterprise. An enormous opportunity exists for social enterprise to have a bigger role in supporting cities' efforts to achieve improvements in their social and environmental outcomes.

Gaining stakeholder support for smart cities requires measuring and communicating value

The value of smarter, more livable, more sustainable cities is complex. The ability to measure and communicate the value of smart city ICT investments is important on two levels. Firstly it helps city leaders to make more sound choices for their citizens in tough economic times. It also generates the up-swell in citizen engagement and private sector participation that is required to move smart cities from pilots to the main stream.

This chapter has put forward several recommendations for improving upon current approaches. Understanding the value of smart cities is heavily connected to understanding the value of the information that is generated in a digitally-enabled built environment. In the next chapter we explore this concept in more detail.

E-Mobility Berlin: An innovative city private-public sector business model

With the average European household spending €500 on transportation each month, mobility is a more attractive market than ever[40]. Recent developments in e-mobility are changing the structure of the industry with new business models that go beyond the traditional automotive value chain. The "e-mobility Berlin" initiative is a joint project between Daimler, the car manufacturer, and RWE, an energy utility, and the German federal government, to provide electric cars for the city. Daimler will provide more than 100 electric smart cars, and services for the vehicles. RWE is handling the development, installation and operation of the charging infrastructure by providing 500 charging points and supplying the electricity and maintain central control of the system. The German federal government is also a key player in the initiative, encouraging investments from the private sector, gathering stakeholders to explore issues and solutions, and setting up a supportive policy framework. The E-Mobility Berlin joint project is a good example of how different sectors can work together towards the same goal and realise sustainable and financial benefits.[41]

Cities need a digital infrastructure to drive innovation in services and the economy

Interview with **Emer Coleman**, Director of Digital Projects, London, October 2011

Londoners checking the iTunes App Store will find a plethora of mobile applications that bring transport information to their mobile phones, letting them navigate the city easily and saving time, money and CO_2 emissions along the way. One of them, Tube Deluxe, an iPhone guide to the London Underground transport system, has 50,000 active daily users and 350,000 downloads. The best apps are in fact not necessarily built by Transport for London, but instead by a growing group of digital service providers, like Tube Deluxe, that mine London's datasets to provide new options for citizens.

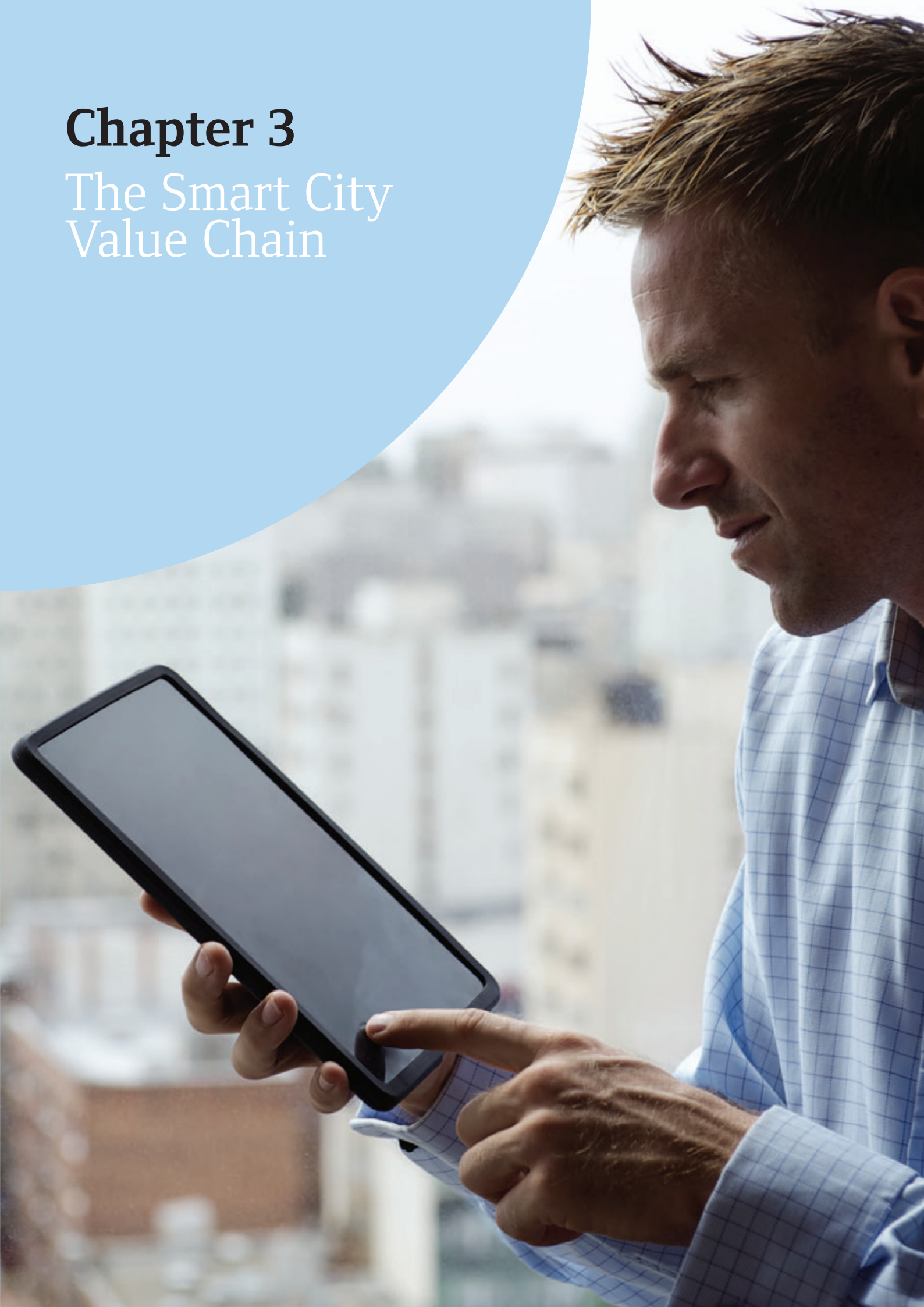
It is Emer Coleman's job to see that London's digital infrastructure is growing, driven by the city's desire to be transparent, accountable and open to new opportunities for economic growth. She started by opening up a London Datastore. For under £15,000, she set up a web interface that allowed developers to access ready-to-use datasets that have been cleaned up and meta tagged by the data management asset group. While she acknowledges there are more costs for more dynamic data that gets updated every few seconds, releasing the static data was an important first step. "Don't let the perfect be the enemy of the good" she says, "It is better to get the data out there, ugly and early".

To develop and test a methodology for encouraging early interaction between technologists and policy makers, London, together with Barcelona, Genoa and Bologna, will be part of the European iCity programme. London will look at stimulating the ecosystem around city data.

Emer is also looking at how best to partner with mobile operators and other private sector data holders, how to engage with developers early in policy strategy, and how to encourage the involvement of small -and medium-sized enterprises (SMEs) in contracting, all with the aim of helping London's citizens. She recognises that she's part of a global trend. "To a certain extent, it is a global business," Emer said. "Developers could come from Japan or Singapore." But, she says, it will be in London where citizens will benefit most.

Chapter 3

The Smart City Value Chain



Smart cities create digital value chains for the creation and marketing of information products

Value chain

The links between economic actors that are generating value, including developers, businesses, and people who use applications in the city. For a smart city, this includes understanding the role that the city government itself will take in helping foster an efficient value chain through its interactions with these economic actors.

Information products

The outputs of the value chain, where digital infrastructure assets, exposed through APIs, are the inputs, and economic actors work to create value from the assets for a range of audiences (citizens, consumers and also as improved decision making for enterprises and the city itself).

Cities wishing to understand how to obtain full value from their ICT investments need to address smart city technology from a total value chain perspective rather than treating each ICT project as an individual technology problem. As we have shown in chapter 2, aligning the interests of stakeholders and employing new technologies and new market mechanisms can capture the value of what are referred to as positive externalities. This chapter explores ways that cities and companies can begin to capture those positive externalities by understanding and supporting the market for an entirely new kind of good that citizens, cities, and digital infrastructure are creating: the **information product**.

Methodology

This chapter makes use of a combination of Global Value Chain research (which investigates how the network of labour and production processes combine to form a finished commodity) and System Dynamics in order to understand the industrial structure of the information economy. The work is based on four years investigation of value chains from semiconductors, equipment manufacturers, through to mobile handsets and developers. It is based on both quantitative data analysis and in-depth interviews with a few hundred people in different parts of industry.

Understanding the Smart City Value Chain

Information flows are the source of value-added applications and services for cities and their citizens

The data and information contained in ICT systems is a unique commodity. Unlike a raw material such as coal or titanium, data is not used up in the processes of production. Information that flows between systems may be used to develop and deliver real added-value to cities and citizens the development and sale of information products.

The information that flows between systems implemented as part of a 'smart' city development can develop and deliver added value to cities and customers. One early example, Real Time Rome, used existing infrastructure from Telecom Italia[42] to capture information from the mobile operator's network to create real time visualisations that exposed the dynamics of the contemporary city. The city of Rome used these visualisations to better understand building occupancy and its relevance to energy consumption and to modify public transportation to better match mobility patterns. In addition, the information made possible detailed mapping of mobile networks during high load situations, allowing Telecom Italia to streamline its operations, reduce overall energy consumption and provide a better service to its subscribers.

Collecting this kind of data has only recently become possible through the advent of mobile internet devices such as smart phones and sensor-devices that connect as well as buses, park benches or buildings. Combined with visual interfaces, data collected through the interaction of people, mobile technology and the environment can be used for policy decisions. Information products allow for feedback loops to be created within and between systems. Real Time Rome creates maps that help measure the real-time usage of neighbourhoods, the distribution of buses and taxis in correlation with population densities, and the ways that goods and services are distributed or how different social groupings use or inhabit the city.

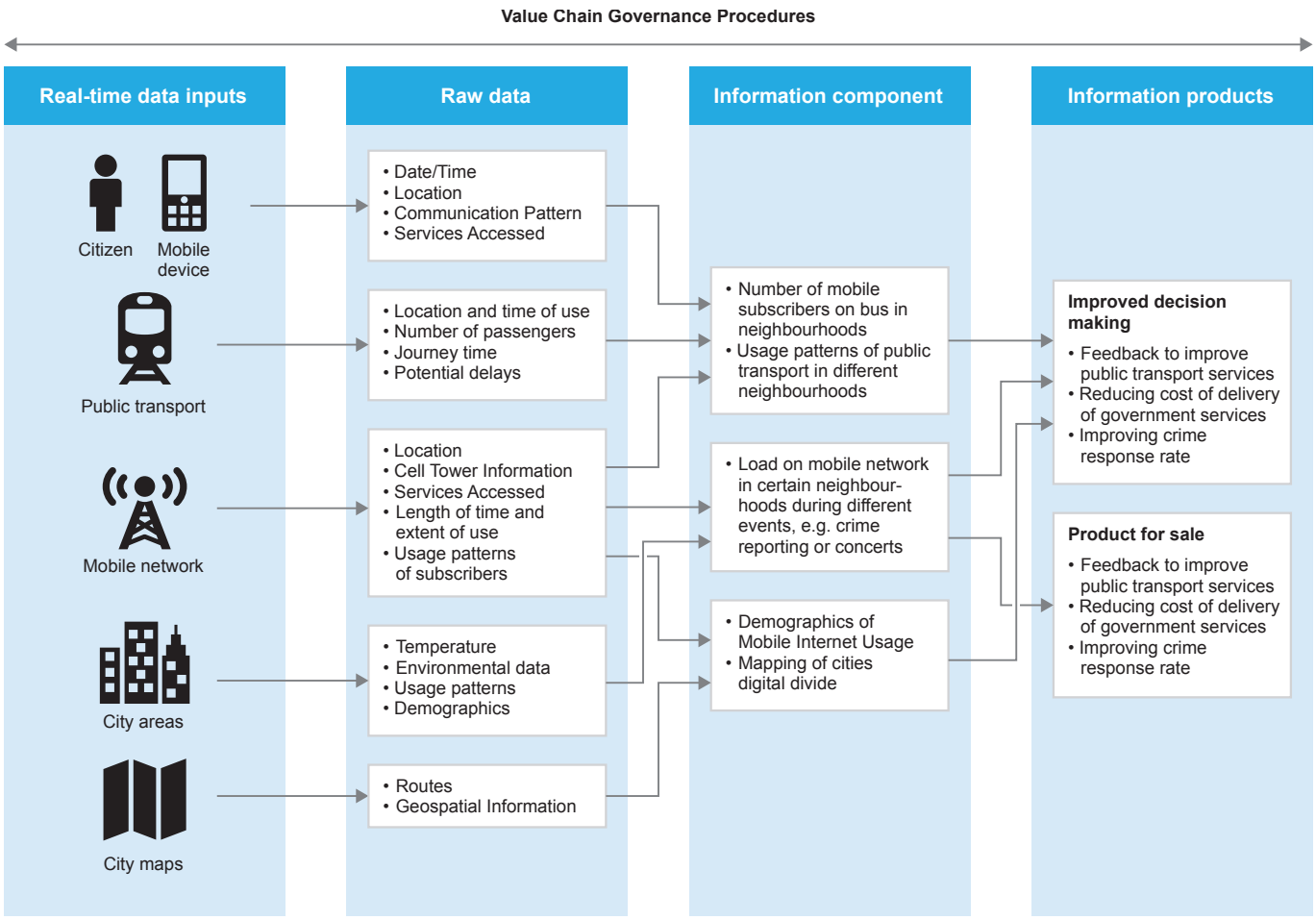


Figure 3.1 Value chain for Real-Time Rome example[43]

Cities now have a unique opportunity to build on these new capabilities unlocked by technology. To benefit, however, cities must understand how to create digital supply chains based on the information contained in their ICT systems. Figure 3.1 illustrates a high level view of how such a value chain might work.

Within a digital value chain, several underlying digital assets exist such as sensors on roads and in public transport, electronic maps, mobile networks and mobile devices. Real-time data streams-off these devices and provides terabytes of *raw data*. These raw data streams may be used to identify some of the following:

- Citizens and their activities, e.g. catching a bus or making a phone call to a taxi company,
- Purchases made by citizens within the city,
- Mobile network activity.

Application developers can take aggregated data streams and combine them in any number of ways to create information components, small components of analysis representing one input into a decision-making process. The final output of the value chain, however, is an information product: a product that provides either significant value for private enterprise or social benefit for city leadership or their citizens. From the simplest perspective, digital assets allow cities to not only implement cost reductions but to unleash the innovative capacity of citizens and private enterprises.

Cities can now treat their digital infrastructure and the "big data"[44] it contains as a market creation asset that can create new jobs, drive costs down, generate significant benefits for their citizens and promote digital industries within their regions.

London has already discovered the benefit of digital infrastructure for citizens through the development of its London Datastore, an official site providing free access to a number of data-sets from the Greater

Data Collected for Real Time Rome included

- Traces of information and communication networks formed across a city
- Movement patterns of citizens
- Movement of transport systems
- Spatial and social usage of streets and neighbourhoods

[42] http://c5.telecomitalia.com/default.aspx?idPage=458
[43] Mulligan, The Communications Industries in the Era of Convergence, 2011
[44] http://www.mckinsey.com/mgi/publications/big_data/pdfs/MGI_big_data_full_report.pdf

There has been an explosion of API developer interfaces since 2005, rising from approximately 235 publically available Open APIs in 2005 to just under 6700 in 2011

[45] http://rufuspollock.org/economics/papers/economics_of_psi.pdf
[46] Gartner, Innovative use of public data, report to the National IT and Telecom Agency, and the Danish Agency for Science, Technology and Innovation (Danish), 2009
[47] http://rufuspollock.org/economics/papers/economics_of_psi.pdf
[48] http://placr.co.uk/blog/2011/10/an-open-letter-to-andrew-tyrie-mp-about-the-proposed-public-data-corporation/
[49] Also known as Open APIs – i.e. APIs designed for use by parties external to the company that developed the platform in order to take advantage of network effects.
[50] Author's own database

London Authority. By providing access to valuable city data, the site has enabled the creation of a number of new application service development companies. London's experiences, however, show that such digital assets cannot be built by the public sector alone. Emer Coleman, Director of Digital Technologies for London's Datastore notes that this is a cultural challenge for public sector employees who may not be used to taking risks. "It's not actually about data, it is about organisational change," she says, "this requires new leadership from the public sector. Data surfaces political decisions."

The cost of closing the data only to those who can pay for it could be disastrous for this nascent industry. As a 2008 report on the Economics of Public Sector Information found, "Digital public sector information is best funded out of a combination of 'updater' fees and direct government contributions with users permitted free and open access. Appropriately managed and regulated this model offers major societal benefits from increased provision and access to information-based services while imposing a very limited funding burden upon government."[45]

The Austrian national government originally sold access to its datasets for profit. But, not surprisingly, after the government switched to a marginal cost pricing policy, which reduced the price charged to developers for Open API access, the number of datasets used in commercial applications rose by 7000%.

Private sector use of public data can generate substantial value. Denmark, for example estimated the business re-use of public data could amount to more than €80 million per year, while the social benefits would amount to about €14 million. 70% of this benefit was estimated to come from the private sector. The EU Commission, meanwhile, estimates an EU-wide potential from access to public data of €27 billion[46]. Cities and governments should not be attempting to generate revenue from digital infrastructure assets, but rather creating governance structures and a regulatory environment for the digital value chain that encourages appropriate use of these technologies for the benefit of their citizens[47].

London itself has seen a plethora of new applications built upon government data that "improves social equity, makes people's lives better, and ideally enables better responses from government at potentially lower cost," says Coleman, who also says that "data can help us re-think services". The London Datastore also created competition in the information product market, with several different applications competing for similar space. Citizens receive greater choice and the private sector grew as a result. For instance, UK-based public transport data aggregatation firm, Placr, achieved a £120,000 turnover within 18 months and several other companies are now following suit[48].

Cities therefore have much to gain through creating market instruments for digital assets. The next section investigates the market potential.

Market Potential for Smart City Assets

Open API interfaces link cities' digital assets to the creators of information products

The best-known markets for digital assets today are the application stores for Android, iPhone and iPad mobile computing devices. These app stores provide sales channels for developers to reach a critical mass of end-users. While iPhone component technologies, such as touch screens, data connectivity, Internet access from a mobile device have been available for many years, Apple was the first company to combine them in a form that

'Big data' has only recently become possible through the advent of mobile internet devices such as smart phones

consumers responded to favourably. Critically, the app stores provide a governance structure for the digital value chain. Moreover, they provide revenue stability for those involved in creating the application marketplace.

Many different Internet services have started to provide access to their data through interfaces designed for external third party developers[49] called "Open APIs". These interfaces are critical components that connect digital assets to developers, and, without them, the creation of information products would not be possible.

Specifically, such interfaces help to:

- Reduce transaction costs in market creation by removing the need for detailed legal contracts between the entity providing the data and those using it.
- Establish a digital value chain by allowing many developers to create products from the same raw data inputs. These interfaces create a market for innovative capacity in cities and other markets.

There has been an explosion of Open API developer interfaces since 2005, rising from approximately 235 publically available Open APIs in 2005 to just under 6700 in 2011[50].

The Open311 API illustrates these points quite well. The original 311 phone service was implemented on well-established telephony standards and protocols. As a result, multiple cities were able to rapidly implement the service once it was developed simply by re-using existing phone networks. Because the Open311 API connects directly to Web technologies, many developers can create web-based services on the Open311 API, for instance by combining graffiti reports with maps. In addition, apps developed in one city can be re-used in other cities and developers benefit from economies of scale by gaining access to a much wider market for their products. Citizens, meanwhile, benefit from having access to a wider range of applications. Cities, in turn, gain extra returns on their investments. For gains of this nature to be achieved, however, cities must take a local digital technology perspective and a national one.

While developer interfaces have proved useful for the communications industry over the past years, they are no longer only related to the ICT sector itself. The greatest increase in interfaces between 2009 and 2011 has been in city-based technologies with retail (550%), utilities (185%), transportation (2300%) and the government sector applications (278%). There is now a distinct opportunity for developing markets around smart technologies in cities. For this to be realised, however, it is crucial that cities understand and implement a strategic vision for their digital assets, select the correct Open APIs, and provide a governance structure for the digital value chain.

An explosion in interest, however, is by no means a sure path to success. While there may be many similarities between the market creation possibilities of the mobile device channels and those for smart cities, there are also some unique aspects of the smart city environment that need to be acknowledged.

Within the urban environment, applications need to evolve that run on mobile and fixed ICT platforms rather than just the existing mobile channels. This leads to a role for cities, or an intermediary on their behalf, to support the development and creation of a technical platform that delivers city services and applications to end-users. Such a platform would need to be robust enough to deliver citizen services, have a simple user interface, and ensure that developers or service providers are able to monetise their investments or deliver free community services. In addition, due to the sheer

Open Application Programming Interface API:

An interface between developers and the digital infrastructure that essentially allows software to speak to software, helping unlock the value of large datasets and lower transaction costs for developers, cities and private enterprise alike. Open APIs function to connect the digital infrastructure of cities with the developers who can create innovation.

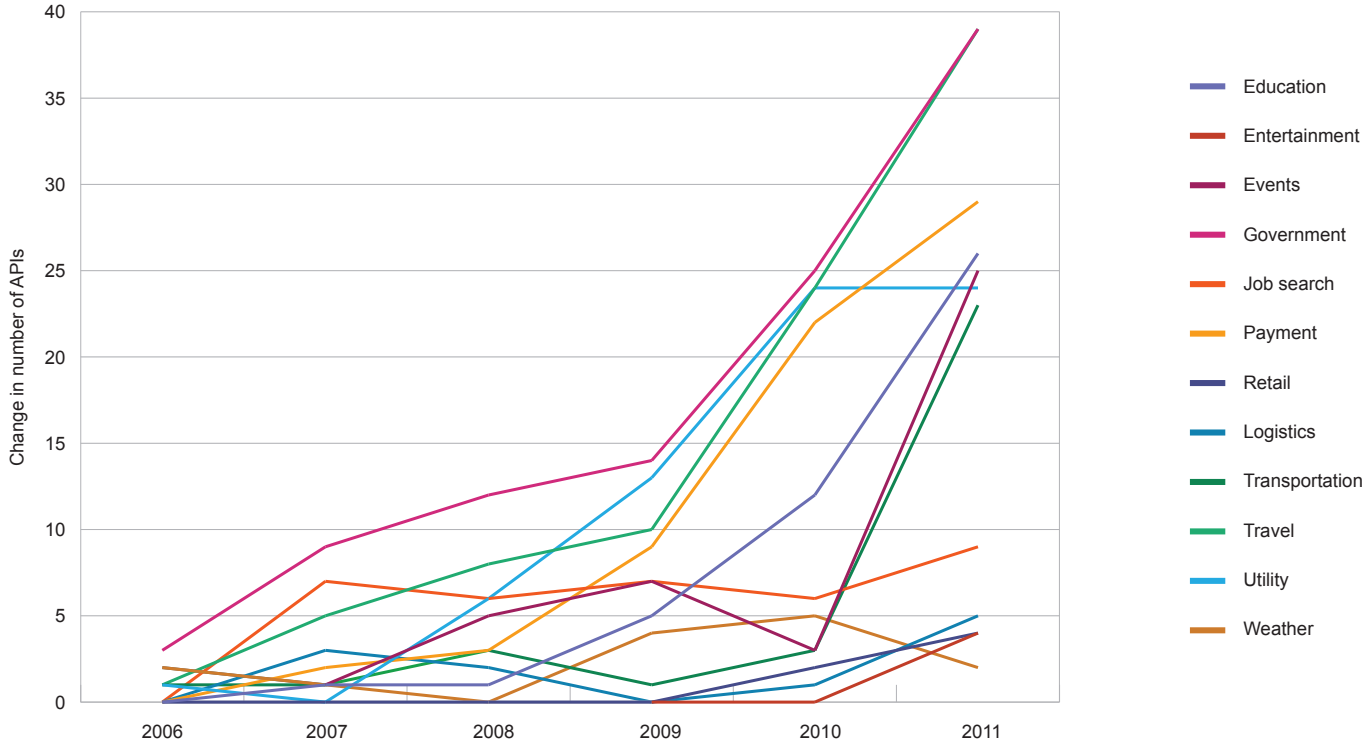


Figure 3.2 Rates of change in Open APIs associated with city infrastructure

Cities can now treat their digital infrastructure and the 'big data' it contains as a market creation asset

number of different types of businesses that could be built on these technologies, both the platform and channel strategy need to be flexible enough to handle multiple business models and multiple financing strategies in much the same way that a shopping centre handles multiple business models for the stores that use its physical platform.

Smart Cities and Market Creation

Smart cities provide the open market, the creation and use of cities' digital assets

While new technologies may pose new problems for cities, the development of markets is not a new one. Market development may be viewed as the raison d'être of many cities in the first place: they are convenient locations for traders to meet and exchange goods. London, for example, was the location of a market from the earliest period in its history[51].

It is perhaps useful to think the role of the public sector in digital technology infrastructure as similar to its role in the development of a shopping centre. Public authorities provide the basic underlying physical infrastructure for the shopping centre, including utilities, waste removal, water, etc, as well as the governance structure, including planning regime and zoning regulations that determine the sort of stores that can be located within a particular area. The city does not, however, attempt to run the shopping centre itself to generate profit. Instead, operations are left to a private developer that generally establishes a project for building the shopping centre and rents space to businesses. A shopping centre may be viewed as a physical platform[52] that connects consumers with physical goods and services.

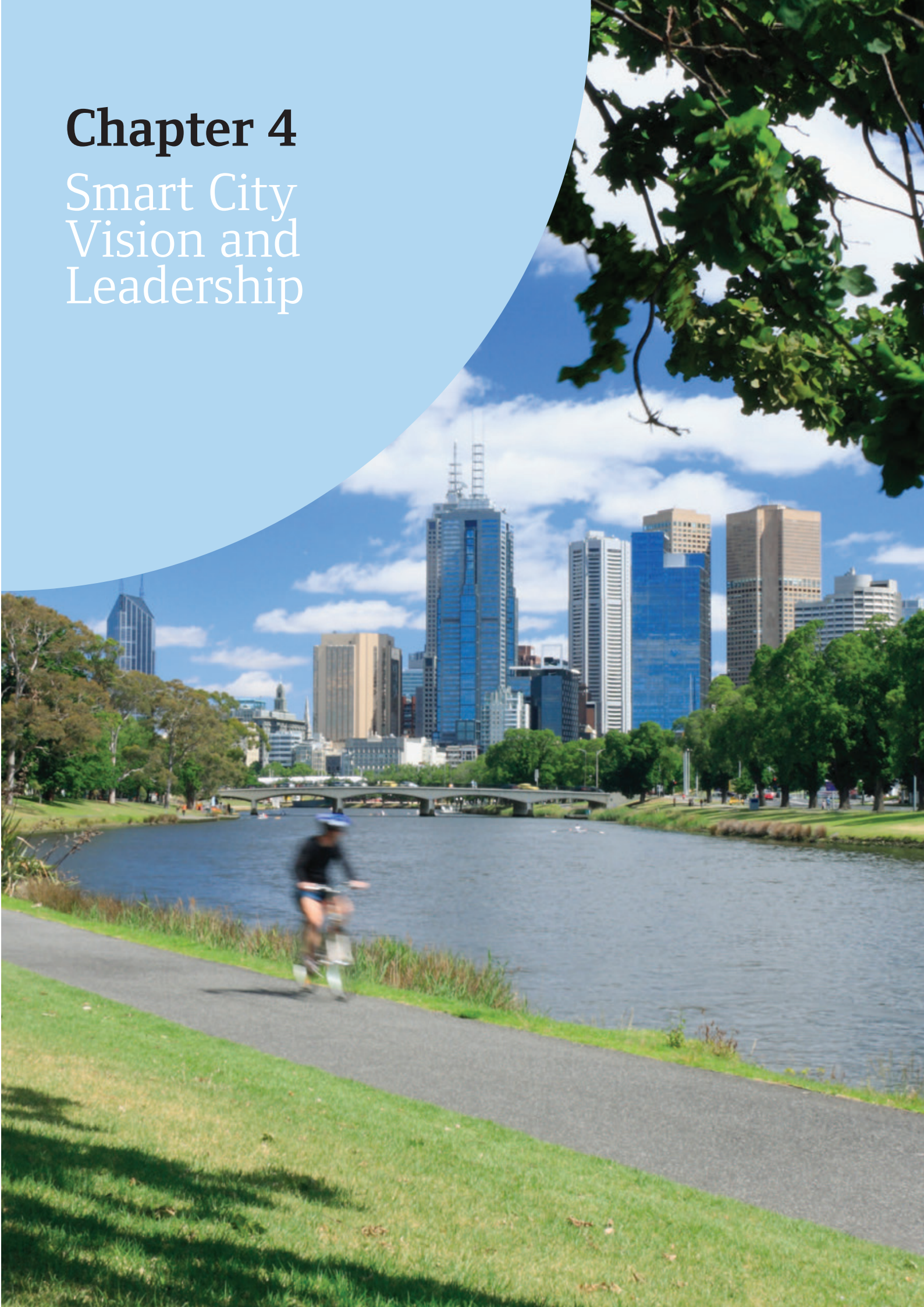
A similar approach is necessary to help develop the market for digital assets to be re-used and combined in the most efficient manner possible and ensures the broadest possible participation from the private sector in as open a marketplace as possible.

Market creation for smart cities is about much more than data and requires a structured approach to be taken by city leadership[53]. The rewards are great for cities that choose to take on the innovation challenge. Experience to date, backed up in the literature, shows that opening up access to data yields greater returns than keeping it closed. We turn to the governance choices for cities, nations and companies in chapter 4.

[51] Besant, The History of London, 1894
[52] Evans et al, The Industrial Organisation of Markets with Two-Sided Platforms, 2005
[53] Emer Coleman interview

Chapter 4

Smart City Vision and Leadership



Creating smart cities of the future will require collaboration, clear vision and, most of all, leadership

This report has shown that information products are the tools with which cities can mine the surplus capacity in the city's infrastructure and unlock citizens' creativity to make cities more livable. The new digital infrastructure – whether that is broadband networks, sensors on electricity grids or public transportation data – helps cities deliver a great place to live and work.

The debate until now has focused on technology – which solutions are 'smart', how much value do they provide, and which should cities do first? Are smart grid, electric vehicles and other infrastructure to be invested in today, or should the city focus on technologies like mobile phones to deliver some enhanced value from services in the short term? Both short term digitisation of services and long term investments in infrastructure upgrades that make those systems transparent will begin to deliver carbon and cost savings for citizens.

However, each city will plot a unique path, and must define their priorities based on city metrics and planning for the impacts they would like to achieve. In a city like Hong Kong, where 89% of emissions come from buildings[54], and which boasts one of the most efficient electricity grids in the world with less than 5% losses in transmission and distribution, leaders may choose to focus first on tackling building emissions. A city like Toronto however, where 40% of emissions are attributed to transport and over 95% of its power is renewable will focus first on mobility solutions.

Cities are now poised to take a leadership role in defining what they want to achieve and when, and drive innovation through partnerships with citizens, national government, and the private sector. Our recommendations focus on the three primary areas in which city leaders should act if they are to capture the surplus value in their city, and points towards the key messages for national governments and organisations. Our recommendations for cities are:

- Set a vision and metrics, so all departments can work effectively toward the same goals,
- Manage for success, to make the most of digital infrastructure,
- Create the foundation – and partnerships – for a new information marketplace.

Set a vision

Cities that hope to capture long term benefits from commitment to smart city development will need to create and effectively communicate an intuitive and compelling vision. The focus should be on measurable and auditable outcomes and prioritised investments that make life in the city more attractive for living and working.

Devise a shared vision

Cities may already have shared high level policy goals, such as climate change targets, or specific drivers of policy they have prioritised (such as saving citizens time on their commutes or bringing more jobs to the city). Cities that wish to capture the value highlighted in this report should create a vision that articulates the top level policy goals and outcomes the city would like to achieve and the role of ICT in achieving them.

In creating this vision, "urban policy-makers should begin from an awareness of local development aspirations and preferences, local knowledge of needs and options, local realities that shape choices and local potential for innovation"[55]. As this is continually explored, city leaders will become more able to interpret the opportunities of 'smart' within the context of their own economy, culture, drivers and values. As such, every city will have a unique vision and interpretation of the role of ICT in their city, and should embrace this as an opportunity for innovation and differentiation.

The vision created should be supported by a set of core principles and guidelines. These principles (e.g. opening up data, engaging citizens)[56] should be shared across city departments and underpin all investments made by those departments. They should be directly related to a city's vision and policy goals, and clearly articulated through a well designed and collaborative dissemination process. For instance, if a city has a 30% CO_2 emissions savings goal, its transport department will need to measure projects by their benefits to emissions reduction as well as increased mobility.

Develop and track performance metrics

This shared vision, supported by core principles, will support cities in setting the metrics that will chart their progress towards 'smart', as we explored in Chapter 2. An understanding of progress is important both for delivering a political message and lunderstanding the policy implications for certain smart city projects. This understanding can be used to inform future projects and ensure that progress towards policy goals is continually made.

The metrics should directly relate to the vision and core principles. This is particularly important in the complex system of the city where cause and effect relationships are difficult to assess and positive and negative externalities are difficult to capture and measure.

A good example of a vision aligned with metrics is New York City's PlaNYC, explicitly designed to tackle climate change, aging infrastructure, growing population and economic challenges. Its 132 initiatives are being measured so the city's planning office knows if they are on track and how to better achieve their goals.

In the corporate sector, companies that have been implementing sustainability metrics since 1993 are outperforming their peers over the long term[57]. Experience in cities is beginning to back this up. "On average, cities that have a climate action plan have taken twice as many actions as those that don't," says Mark Watts, Cities Director at Arup.

Audit and benchmark current investment in ICT

If cities are to set a relevant and effective smart city vision, they must start from a firm grasp of their current ICT investment. All municipalities across the world currently have some form of ICT expenditure, whether it is for organisational support such as an email server or complicated digital infrastructure project such as an Intelligent Transport System. However very few cities are aware of their current overall ICT investment across the city. This problem stems from the siloed organisational structure of city administrations and from the fact that, to date, ICT investment has not

[54] http://theclimategroup.org/_assets/files/A-Low-Carbon-Vision-for-Hong-Kong.pdf
[55] UN Habitat, Cities and Climate Change - Global Report on Human Settlements, 2011
[56] Climate Smart Precincts, The Climate Group, 2011
[57] Eccles et al. The Impact of a Corporate Culture of Sustainability on Corporate Behaviour and Performance, 2011

Cities may choose to appoint a Chief Information Officer (CIO), who understands the strategic implications of ICT for the city as well as the city's core goals.

been seen as a strategic priority but rather a technical support function. In order to ensure that the correct vision is in place at the outset, leaders need to investigate the city's current investment in ICT, which should be achieved through engagement with all city departments as well as ICT departments where they exist.

Prioritise investments
Once a city's vision has been articulated, city or departmental leaders will need a robust mechanism to support investment decisions. They need to be able to evaluate where best to invest in order to maximise value in accordance with their vision and principles. Decision makers will need to understand how to compare the value of seemingly unrelated technology projects and decide which ones bring them closest to achieving their vision using their agreed metrics.

City leaders also need to understand the long term view of their smart city investments, as well as the immediate implications. They need to take a view on how their smart city investments will create value over time and be able to explore the systemic implications of their investments. For example, the roll-out of a smart grid infrastructure should not only consider direct energy efficiency savings but also implications for the delivery of an electric vehicle scheme. This could spur economic growth in the automotive industry as well as in the information services for booking and charging systems. It could have implications for car sharing companies and dramatically reduce the carbon intensity of the transport sector of the city. Where a city chooses to invest or seek investment depends on the core values and principles set out in its strategic vision.

Manage for Success

Align organisational structures with vision
It is clear that 'technology projects' alone will not deliver the benefits of the smart city. We need to learn lessons from previous public sector attempts at incorporating new, transformative technology into their operations. Currently, only a third of government ICT projects are successful[58], which not only results in significant capital wastage, but also in inefficiently run city services. City administrators often fail to acknowledge projects as being complex or strategic and neglect many 'softer' issues that are essential for a project to succeed. In reality most government ICT projects are not ICT projects at all but complex organisational change projects that arise from the potential of a transformative technology.

Many cities have "developed a range of departments and agencies that have become isolated from one another, operating in their own silos with less coordination of information than desirable for integrated planning and goal achievement."[59] Within this kind of organisational structure, ICT is utilised on a project-by-project basis and opportunities for synergy are rarely sought or realised. Here, the approach to value creation through ICT is insular and remains solely within the bounds and scope of the specific project being undertaken, as we have noted in Chapter 2. Such projects might include the deployment of sensors to measure car park availability in the transport sector or the deployment of smart energy meters. This organisational structure does not allow a city to take a strategic approach to ICT investment, and cannot capitalise on the benefits of cross-departmental collaboration.

Cities will be balancing 'inside out' and 'outside in' development

Lack of integration between city departments (each with varying reliance on ICT), makes creating a unified vision challenging. City leaders must take direct action to counter discord, as it is a significant barrier to the success of a smart city programme. Firstly, cities must ensure that there is strong expertise at the strategic level of the city. This might take the form of a Chief Information Officer (CIO), who understands the strategic implications of ICT for the city as well as the city's core goals, or a team of expert strategic advisors that can support long term decision making.

The CIO capability must take responsibility for ensuring that the vision and supporting principles are aligned with political priorities and adopted consistently across city departments in a way that will achieve the overarching vision. For most cities this will require an organisational change programme that puts sufficient structures and investment in place for transitioning to this new, more integrated way of working.

For instance, Chris Vein, former CIO of San Francisco, was responsible for the city's first five year ICT plan. His role was to manage all IT and telecommunications projects for 28,000 employees over 50 departments. He acknowledged that when each department has its own procurement process, coordination is a challenge. However, he was able to begin a process of opening up data, and raising it higher on the political agenda. He then was able to work with colleagues across government, such as Kelly Pretzer, the New Media, Clean Tech and IT advisor in the Mayor's office to look at how to attract talent to the city.

Choose an operating model appropriate for desired services

Smart city actions are already underway, and are either within the city's control or are happening within the private sector and society. The actions could be characterised as 'bottom-up' or 'top-down' activities, but it may be more useful to think of them as activities that happen from the inside-out (i.e. from within government, out to wider ecosystem), or from the outside-in.

As the citizens are the central reason for the existence of city policy, outside-in engagement can support cities in defining and achieving their goals. This is particularly relevant in a world where citizens have become 'prosumers' (producers and consumers) rather than passive consumers of services. The idea that the city vision should be co-designed by government and citizens is particularly pertinent to the smart-city ideology, which holds transparency and inclusivity as its central tenets.

Cities may not choose to transform from the "inside out", but instead to juggle the benefits of "outside in" development. Cities will take different approaches, either to actively coordinate or provide basic access to infrastructure. As we've seen in chapter 3, a city has a role in creating a marketplace by providing the planning that specifies space the building can occupy and rules by which trade can occur.

[58] http://www.parliament.uk/documents/post/pr200.pdf
[59] Kanter and Litow, Informed and Interconnected: a Manifesto for Smarter cities, 2009

	No control over citizen or customer relationship	Control over citizen or customer relationship
Control over digital infrastructure assets	**Enabler**	**Integrator**
	Facilitating city services: can be open data initiatives or outsourcing of service creation based on provided datasets. Stimulating development is key Examples: SF Data, Apps for Amsterdam, NYC Data Mine, London datastore	Governmental city services: somewhat more closed approach, can be high cost depending on implementation Examples: 311, London cycle hire
No control over digital infrastructure assets	**Neutral**	**Broker**
	Unsupported City Services: City government does not take initiative and relies on privately funded projects Examples: Trip Advisors, Some EV schemes	City-branded services: An unlikelier scenario that would be targeted at city-branding and city-marketing, more than service provision Examples: Ljubljana Tourist Card

Figure 4.1[59]

As part of the market creation process, a city must choose the role it will play role in relation to new services. It should decide the extent to which it wishes to have control over digital infrastructure and whether it should be in greater or lesser control over the relationship with citizens. Specifically for mobile services, the city could be an integrator or enabler, with differing levels of control over 'assets' or the data that is used by developers (see Figure 4.1).

This operating model will require a city to think about how it manages its own data and what policies it might want to adopt in relation to private sector data. For instance, utilities will soon be accessing much more information from smart meters. Mobile operators will have access to valuable data on how we move through the city, and even what mode of transport we might be using, as we saw in the Real Time Rome example in chapter 3. This is an issue of increasing interest and research attention, but has not been within the scope of this report. Cities need to be able to think ahead to when issues of privacy and security of data become more mainstream.

Use digital assets to unlock economic growth

Once the city has articulated the role that it wishes to play in the creation and nurturing of the new market, it will need to support the production of digital products and services as described in chapter 3. It must also look at coordinating a wider set of digital infrastructure investments in cities such as buildings, energy and transport, and link this to economic growth.

To manage open data, we have found that the city will benefit if it:

- makes data available at no or marginal cost,
- collaborates with other cities and organisations on Open APIs for key city services, e.g. Open 311,
- creates a reference architecture for services to allow for integration with backend systems, e.g. problems that are reported via a FixMyStreet app go directly into the municipal maintenance systems for scheduling.

Cities have a two main options for infrastructure investments. One is to work with sub-national governments to find low-interest investments. For instance, Milton Keynes in the UK is accessing a recycling fund option via Salix[61] Finance Ltd up by set up by national government via the Carbon Trust. The council is given match funding by Salix for energy efficient investments and the savings are recycled into the funds for further upgrades. The council additionally funds energy efficiency measures in older homes through a carbon offset tariff on newly built homes. In Colorado, the city of Boulder has saved 3% of grid electricity for 50,000 homes taking part in the Xcel Smart Grid City project[62] and has attracted start-ups like energy management company, Tendril. Over 50 energy related bills passed since 2007 at state level have helped drive these benefits, and have created over 3,000 jobs in the state[63].

Cities can also work with the private sector, or a combination of national government and private sector partners. One example is in Manchester, one of the UK's awarded 'Plugged in Places' (PIP) projects, part of the UK government's initiative to create a national charging network for EVs. The Manchester Electric Car Company is a private

[60] Adapted from, Walravens and Pieter, The city as a Platform Exploring the Potential Role(s) of the City in Mobile Service Provision through a Mobile Service Platform Typology, 2011
[61] http://www.salixfinance.co.uk/
[62] http://smartgridcity.xcelenergy.com/
[63] Tom Plant, former energy advisor to Governor Ritter, Interviewed on July 7, 2010
[64] http://www.energystar.gov/ia/business/challenge/learn_more/HigherEducation.pdf
[65] http://www.epa.gov/reg3wcmd/solidwasterecyclingprograms.htm

Becoming a smart city is a process rather than a destination

sector company formed by The Association of Greater Manchester Authorities (AGMA) which has brought together a consortium of private sector companies to privately fund the PIP bid. In January 2011, AGMA received matched grant funding from central government roll out the first public electric vehicle (EV) infrastructure across Greater Manchester. The scheme will provide charging points and 5 'Pod centres' (multi-purpose charge stations similar to a traditional petrol station) which showcase different types of EV's from cars, scooters and vans. The Pods also lets consumers 'try before you buy' by hosting car club and rental facilities, and informing customers on home charging requirements. The membership scheme will be launched in early in 2012, and will be aligned with the Greater Manchester smart-ticketing architecture currently being developed, so customers can move hassle-free from public to private sector transport.

Create the foundation – and partnerships – for a new information marketplace

Becoming a smart city is a process rather than an end state. Cities will continually learn from projects, discover new opportunities for investment, develop relationships with stakeholders and have to respond to evolving priorities. Furthermore, it is not a linear process: cities will achieve different levels of maturity in different areas at different times. Therefore, an emphasis must be placed on seeking to adapt and learn from early deployments.

Look for opportunities to pilot business models
Too many pilots test technology but not business models. These pilots then fail to become mainstream services because cities are unable to pay for them or manage their deployment. Cities should use pilots to test and develop business models so that they can access the capital they need to roll-out these services more widely. Cities should work with the private sector to understand where value is created, who benefits, and how to communicate value to different stakeholders. In particular cities and the private sector need to identify value that can be translated into financeable projects.

Universities can be test beds
Modern universities act as a source of scientific and social innovations. Many universities also have complex municipal infrastructure systems including physical plants for power generation, oversight of lighting and environmental systems for hundreds of buildings, independent transportation fleets, and often operate their own police departments and hospitals. These "campus cities" consume substantial resources, spending over $14 billion a year on energy[64] in the US and they consume resources and generate waste streams equivalent to a small city[65]. Universities also have many of the technical and organisational skills to run effective pilots. Cities should consider partnering with their universities to implement certain pilots.

Recognise the need for new partnerships to achieve growth
As part of the evolution towards a smart city, cities will be building relationships with new and existing players in order to deliver the digital platform for services. Firstly, cities need to work with various actors in the private sector, from individual developers to large corporations, as well as develop new business models (as highlighted in the Manchester 'Plugged in Places example above). New procurement models may be required to ensure participation from small innovative organisations. As more citizens start to depend on services offered on

the city platform (e.g. realtime transport apps), cities will need to offer service level agreements guaranteeing certain levels of reliability to companies using their data to provide services. This will also place different demands on city ICT infrastructure and back end systems, which could lead to different ways of working for the ICT department. Cities will also need to build new relationships with other cities to collaborate on Open APIs and other standards that may be required. Such partnerships enable cities to take full advantage of the economies of scale which a widely adopted standard could bring.

Engage early and actively with citizens
Finally, cities have an opportunity to build new relationships with citizens, by providing tools and applications for them to collaborate with city government to solve problems and identify opportunities for improving the city.

An example of a city driving collaboration and innovation through a concerted investment programme is the Singapore, where a Living Labs initiative is being implemented by its Economic Development Board. Looking to attract the world's best talent, companies and solutions, Singapore plans to spend $1 billion on clean tech solutions with an urban focus, aiming for 35 percent energy efficiency by 2014, including in smart grid and urban solutions[66].

Capturing the surplus value in cities through embedding 'smart' is beneficial for the city and for national and subnational governments and the private sector, which play a significant role in successful smart city development. As such, each of these stakeholders should participate in driving the smart city, work together to align their goals and activities, and collaborate on projects and pilots. In order to achieve these positive collaboration outcomes, these stakeholders should identify the role in the smart city ecosystem.

Recommendations for National/ Subnational Governments

National governments have overarching visions and strategies in which urban municipalities play an important part. They will be setting their own high level policy goals and targets, such as the UK's 80% GHG emissions reduction target by 2050. They own core infrastructure and set policies that directly affect the operational and strategic direction of cities. As a result, national and sub-national governments have a responsibility to ensure that they support and nurture cities to achieve locally set targets. National governments should:

1. **Encourage cities to use common, international metrics**. This will help decision-makers assess how smart city initiatives are performing, and can be used to inform investment priorities, policies, infrastructure and procurement etc.
2. **Lead by example**. Governments can focus on the infrastructure they already control at national or subnational level to get the ball rolling. The Climate Smart Precincts work in Australia is led by sub-national governments who would like these precincts to be exemplars of sustainable development[67]. Governments can provide zero interest loans or revolving funds for hospitals, schools or other municipal buildings to become more energy efficient.
3. **Identify regulatory barriers to cities' success**. National governments should identify areas of national policy that are hampering cities' efforts to implement smart city visions. Consider the utilities sector, which plays such an important role in integrated smart city strategies. The sector regulated at the national or state-level with its activities outside the bounds of city influence or control.

[66] http://www.upi.com/Business_News/Energy-Resources/2011/10/20/Singapore-poised-as-lab-for-green-energy/UPI-66961319134810/
[67] http://www.theclimategroup.org/publications/2011/6/14/climate-smart-precincts--adelaide-workshop-report/
[68] http://www.aceee.org/blog/2011/10/state-progress-energy-efficiency-crea
[69] Adam Freed interview, September 2011
[70] http://www.whitehouse.gov/sites/default/files/microsites/ostp/nstc-smart-grid-june2011.pdf
[71] http://www.ibm.com/smarterplanet/us/en/

With leadership, we can tap into the surplus city to provide more opportunity for all citizens

Incentives for power companies to sell more power or build new generation capacity instead of upgrading existing infrastructure can become step with city's ambitious energy efficiency plans. It is critical, therefore, that sub-national and national governments take a lead role in changing these incentives so that they are aligned with cities' needs[68]. In addition, where national government procurement processes will impact on city innovation, leaders could encourage reform in the procurement process, including taking steps to open up options for consortia or small, innovative companies to join the process.

4. **Create platforms/opportunities for collaboration and knowledge-sharing between cities**. This is imperative if cities are to capitalise on the opportunities offered by smart city services, especially when the concepts, technologies and emerging market structures are still largely unknowns.
5. **Engage cities in the process of developing the smart utilities, smart buildings and smart transport**. Building codes or technical standards are often set at national level, and will have a huge impact on a cities' environmental performance. Though some of these standards can take many years to change, and voluntary standards such as LEED play a role in the transition, government action today can help make projects easier to deliver. For example, New York City has worked with the US Environmental Protection Agency to develop standards for building performance data and support training for implementing the Greener Greater Buildings Initiative[69].
6. **Initiate goals for access to data and information**. We explored data access and its importance to the new information product industry in chapter 3. National governments can support this nascent industry by encouraging clear goals for access to information. For instance, in June 2011, the US White House released a report entitled "A Policy framework for the 21st Century grid: Enabling Our Secure Energy Future"[70] and it calls on states and their regulators to design policies that provide consumers with timely, predictable digitally-available information in a standard format, thereby enabling consumers to save energy and use it more efficiently. Consumers will then in turn be able to allow this information to be used by third parties to provide energy services on their behalf.

Recommendations for Companies

Large scale multinational organisations as well as local SMEs and entrepreneurial start-ups all have a role to play in the emerging ecosystem of information services within the city. This has been made explicit through both the large investment from companies such as IBM with its 'smarter planet' campaign[71] and as demonstrated by the wealth of small scale app creators that provide services integral to city life (such as travel information services, tourist apps etc).

If these companies are to continue thriving in the information economy and genuinely contribute to the delivery of better urban quality of life, they must engage cities with the following principles:

Both short term digitisation of services and long term investments in infrastructure upgrades that make those systems transparent will begin to deliver carbon and cost savings for citizens, and livable cities for the future

1. **Understand the decision-making process of cities**. Companies may have done their homework on technical solutions, but need to also be aware of the procurement processes, timescales and legal process cities need to follow when engaging with the private sector. Companies should also research the mayoral powers and specific policy goals. Understanding city control structures will help companies identify opportunities for innovation and development of novel services.
2. **Proactively engage with the public sector**. This will ensure that private sector service provision aligns to city goals, encourage public sector investment, and help city leaderships align their plans with private sector needs. For example, proactive engagement between developers and city datastore owners could encourage the release of datasets that foster the development of new private-sector products. Here we see that active collaboration can be mutually beneficial.
3. **Encourage pre-procurement task forces**. Industry leaders often have technical knowledge and skills that public sector investors lack. If the private sector wishes to create and participate in a sustainable industry that can support their activities in the long term, they must encourage and participate in pre-procurement task-forces. This will increase the success of public sector ICT projects and encourage the development of the market.
4. **Structure learning from trials that are appropriate for scaling up**. Consider scaling trials and pilots in a way that is appropriate for the city administration's process of implementation. Regis Hourdouillie, Smart Grid Director, Innovation & Demonstration Projects at Alstom Grid called this a 'Russian Doll Approach'. First he trialed their solution in a few buildings, then at Versailles University they tested how their system could support developing new electric vehicle business models and services. Finally they are part of a consortia delivering the NiceGrid project, a smart city project located near Paris[72].

We have shown that the sustainability and urban challenges cities face will require trillions of dollars of investment, new partnerships and the ability to manage a new digital infrastructure that is not just broadband and mobile phones, but the 'big data' that will allow decision-makers to do more with less, and provide enhanced services for billions of new urbanites.

We are just at the beginning of managing that process of deriving more value from our interactions with technology to meet society's needs. We have seen in chapter 3 that public data is growing in importance, but this is just part of the story. As more buildings are measured and monitored, and as our energy, waste and water networks are instrumented, we will also be able to derive public value from private data, with the caveat that it be managed properly to protect citizens' privacy.

Cities can only do this in partnership with others – their sub-national or national governments, universities and the private sector. With leadership, we can tap into the 'surplus city' to provide more opportunities for all citizens.

[72] http:// www.publispeak.com/alstom/sustainable-development-report-2010-11/18.html

Appendix 1

Technologies and Solutions that enable or deliver environmental, economic and social value

Sector	Technologies and solutions	Years to mainstream adoption	Description	Benefits?
Buildings	Reporting and benchmarking building data	2 to 5 years	Requiring basic reporting on building performance	Public data is available for a range of uses by developers, building owners save energy and carbon
	Continuous commissioning	2 to 5 years	Frequent optimisation of building use, fit out and retrofit	Building owners save on energy and carbon continuously
	Integrated building automation and control systems	5 to 10 years	Integration and optimization of the management of heterogeneous building infra equipment using IP and open standards	Building owners see 40% improvements or more, paybacks within 3 years or less
	Home energy management, consumer-energy management	5 to 10 years	Help consumers optimise energy use (passively, peer pressure, optimise generation and consumption based on pricing sgnals, weather conditions and consumption patters)	Homes avoid grid electricity when the price is right, retail metering and demand response providers benefit
	Smart appliances	5-10 years	Appliances that become part of the home area network and can be optimised within demand response	Retailers benefit, and homeowners save on energy costs
Energy	Mobile and web 2.0 for utilities	5 to 10 years	Social, business and technology evolutions for collaboration and participation	Citizens can switch providers, provide far more information on products
	Microgrids	5 to 10 years	Small-scale low voltage power systems with distributed energy sources, storage, controllable loads, connected to grid or 'islanded'	Utilities reduce T&D losses, improve reliability, opeational benefits, cost-effective asset management
	Distributed generation	5 to 10 years	Supply solution that can be at or near retail load, 99.999% reliability	Benefits non-traditional energy suppliers and saves energy and emissions
	Thermal or concentrated solar power	more than 10 years	Solar thermal storage	Benefits utilities with increased low carbon demand, decarbonisation of electricity
	Demand side management	2 - 5 years	Manage peak load through peak shaving, better matching supply and demand	Society benefits in the form of lower energy prices, and saves energy for customers
	Distribution network management, control	2-5 years	Reduce distribution losses	Utilities can save average of 3-7% grid electricity
Energy, Water	Advanced metering infrastructure	2 to 5 years	2-way data comms to manage meter data life cycle	Utilities benefit from billing revenue management, time of use pricing, DR, prepayment, distribution network analysis, outage reporting; customers can switch easily, save money and carbon
Health	Mobile health monitoring	5 to 10 years	Remote monitoring of health care	Citizens avoid travel and have regular contact with doctors
	Home health monitoring	5 to 10 years	Home monitoring of health care	Citizens avoid travel and have regular contact with doctors

Lighting	Intelligent lamppost	more than 10 years	Outdoor lighting intelligence	Streetlamp vendors and manufacturers benefit; cities could sell data to recover costs
	Remote dimming and control	5-10 years	Remote control of lighting systems to match conditions and occupancy	Savings of up to 20% of electricity is possible
Transport	Intelligent transport systems (ITS)	2-5 years	A collection of solutions for transportation management	Citizens benefit from lower congestion and pollutants
	Congestion charging	2-5 years	Pricing of inner city travel to reduce congestion	Citizens benefit from lower congestion and pollutants
	Cycle hire schemes	2-5 years	Public access bicycles to encourage modal shift	Citizens benefit from convenience and lower emissions
	Location-based services in automotive	2 to 5 years	Enable vehicle tracking, services etc	Automotive and navigation industries benefit; cities can offer public transportation options
	Vehicle information hub	2 to 5 years	Link between vehicles and portable devices	Owner benefits from revenue increase from information
	Plug-in hybrid electric vehicles	5 to 10 years	Vehicles and batteries	Utilities defer investment in peak geneartion; operational technology sales, billing, settlement and pre-sales
	Wireless electric vehicle charging	more than 10 years	Inductive charging (road to vehicle)	Citizens and utilities benefit from peak demand-reduction
	Electric vehicle charging infrastructure	more than 10 years	'Wired' charging infrastructure, with smart grid capability for scheduling charging	Distribution and retail reduce peak demand
	Car-to-infrastructure	more than 10 years	Autonomous ad hoc information networks between vehciles and road infrastructure	Citizens benefit from lower congestion and pollutants
	Electric vehicles	more than 10 years	More effcient motors that run on electricity for passenger, buses and other vehicles	Electric vehicles can be up to 80% more efficient than internal combustion engines with green electricity supply
	Mobile and Web 2.0 for transport	2-5 years	Websites that find alternative routes, support location-based services	Citizens have new service options, and lower congestion and associated emissions
Water	Smart water management	2 to 5 years	Analyse and manage quantity and quality of water throughout all portions of the hydroplogical cycle	City benefits from saving on water costs
Waste	Smart waste management	2-5 years	Waste process optimisation and pickup	City benefits from more efficient use of vehicles for waste pickup, resource savings
	Mobile and Web 2.0 for waste	2-5 years	Social networking tools to allow sharing of goods and more optimal recycling and re-use	Citizens and cities benefit with options for citizens to recycle
ICT	Cloud computing	2 to 5 years	Scalable computing using internet technologies	Changing user/vendor relationships and enable further services
	Smart governance operating framework	2 to 5 years	An administration that aplies and integrates infomration, comms and operational techs to planning, management and operations to generate sustainable public value	Integration of operations, new services, faster response to citizen

	'Big data' and extreme information processing & management	2 to 5 years	Management of extremely large datasets	Those who can better use information to outperform competitors
	Augmented reality	5 to 10 years	Voice, audio, visual integration	Enhanced user interfaces, complete solutions for schools, hospitals etc
	Master data management	5 to 10 years	MDM - business and IT work together to ensure the uniformity, accuracy, stewardship and semantic consistency of the enterprises shared datasets	Cities, citizens and businesses benefit
	Machine-to-machine communications services	5 to 10 years	Automated data transmission and measurement between mechanical or electrical devices	Opens up new applications for service providers
	Customer gateways	5 to 10 years	Allow consumers to become part of the smart grid by enabling CEM, smart appliances etc	Consumers benefit from new services
	Near field communication	5 to 10 years	Short range wireless tech that interacts with consumer electronics	Consumers benefit from new services, including mobile payments
	Consumer telematics	5 to 10 years	End-user-targeted vehcile-centric ICT systems and services, enabling GPS, traffic information, local search etc	Consumers benefit from new services
	Public telematics	more than 10 years	Government sponsored IT services to improve traffic flow and congestion	Citizens and city benefit from new service options
	Sensor networks	more than 10 years	Sensor networks that communicate data from around a city to a decision-maker	Citizens and city benefit from new service options
	Metrics and performance management	5 to 10 years	Link reporting to accounting practices to enhance operational efficiency and performance	Cities benefit by creating jobs, growth, and enhanced environmental and health benefits
	Internet of things	5 to 10 years	1st phase, value from data from sensors, 2nd phase, combining with people, processes and systems - the true 'smart city' as buildings, lamps, parking spots and infra become connected	Cities benefit by creating jobs, growth, and enhanced environmental and health benefits
	Information semantic services	5 to 10 years	Rule engine for application rights, information management hierarchy, in what order do you manage applications, data warehouses, readings from ERP, event processing etc	Enabler of the information economy
	Datastore or data stewardship applications	5 to 10 years	Structured approach to enterprise information management	City and citizens benefit from new service options

Sources: Team Analysis, Gartner Smart City Hype Cycle, 2011

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