



SMART CITIES

Fair investment for sustainable growth

Michael Tavares and Joe Fyans

About Localis

Who we are

We are a leading, independent think tank that was established in 2001. Our work promotes neo-localist ideas through research, events and commentary, covering a range of local and national domestic policy issues.

Neo-localism

Our research and policy programme is guided by the concept of neo-localism. Neo-localism is about giving places and people more control over the effects of globalisation. It is positive about promoting economic prosperity, but also enhancing other aspects of people's lives such as family and culture. It is not anti-globalisation, but wants to bend the mainstream of social and economic policy so that place is put at the centre of political thinking.

In particular our work is focused on four areas:

- **Reshaping our economy.** How places can take control of their economies and drive local growth.
- **Culture, tradition and beauty.** Crafting policy to help our heritage, physical environment and cultural life continue to enrich our lives.
- **Reforming public services.** Ideas to help save the public services and institutions upon which many in society depend.
- **Improving family life.** Fresh thinking to ensure the UK remains one of the most family-friendly places in the world.

What we do

We publish research throughout the year, from extensive reports to shorter pamphlets, on a diverse range of policy areas. We run a broad events programme, including roundtable discussions, panel events and an extensive party conference programme. We also run a membership network of local authorities and corporate fellows.

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Any errors or omissions remain our own.

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Executive Summary

The smart city agenda, pushing cities to use modern technology to better integrate their communicative, physical and digital infrastructure, is advancing globally with the UK at its forefront. This report focuses on two risks associated with the smart city agenda: the provision of physical infrastructure to support the increase in demand on local energy distribution networks and the inclusivity of the necessary roll-out of improvements.

Much is made of the personal and political implications of the vastly improving *digital* infrastructure in modern cities. The rapid rise of the 'Internet of Things' – everyday items like watches and speakers embedded with smart, interconnected technology – looks set to characterise human development in the years and decades to come. Running parallel to this process is a move away from carbon technologies, with governments worldwide looking to a near-future of decarbonised transport and drastically reduced industrial emissions. It is in this context that the smart city exists: in urban areas, not only is the interconnectivity of modern society intensified, the ecological imperative is far greater. Our ability to monitor and manage our energy usage in urban areas is critical to improving their liveability and sustainability. Yet the ability of new, digital technologies to help improve the way we use resources, from time to fossil fuels, depends entirely on our ability to power them.

Challenges ahead

Debates around smart cities have often failed to consider the supply and management of *physical* infrastructure, particularly as it relates to energy efficiency and sustainable economic growth; two central goals of the smart city. Physical infrastructure, including energy distribution networks and local transport networks, should be successfully implemented before digital infrastructure can allow city officials and residents to manage their energy consumption toward efficiency and sustainability. While technologies such as smart meters can help manage electricity usage far more efficiently, there remains good reason to be concerned that take-up of new technologies will lead to a strain on the existing energy network capacity. In this report, we focus particularly on the energy issue as it relates to electric vehicles. Uptake of electric vehicles is accelerating month-on-month and the UK Government is committed to phasing out fuel-burning vehicles by 2040. In spite of this impressive uptake and clear *stated* direction from government, are we sending clear enough signals to the market that electric vehicles are the future? Furthermore, do we have the infrastructure capacity to match our ambitions?

The uptake of electric vehicles is key to the alleviation of another problem we focus on in this report: air quality in urban areas. High NO₂ concentrations predominate in cities, on major roads and at pinch-points of congestion, for instance ports and crossings like bridges and tunnels. While data coverage is poor and government's modelling has been criticised for being unreliable¹, it

¹ EHN (2016) – Defra air quality modelling based on 'fantasy data'

is clear the problem is most acute in urban areas. All but one UK 'air quality management zones' have illegal levels of NO₂², exceeding statutory European Union (EU) targets and often by significant amounts. The smart city agenda promises cleaner and more efficient transport, through better managed public transport flows and prevalence of electric vehicles. The mounting tenor of the public debate on air quality makes implementing the changes necessary to accelerate the smart city agenda a political, as well as environmental, imperative.

A policy programme for smart cities

The issue of fairness must be central here. Smart energy has huge implications for helping people out of fuel poverty, as households will be better able to predict their bills and manage their usage, yet these benefits can only be felt through a considered roll-out of the physical infrastructure needed to deliver the smart grid. There is a risk that the infrastructure needed to support the smart city agenda is rolled-out unevenly, with areas which are already deprived being left behind more affluent places.

Recommendation #1: Upgrades to networks to enable smart energy and the roll-out of EVs must be done fairly to ensure equitable opportunities for households across different socioeconomic backgrounds and to ensure existing disparities are not exacerbated.

New regulatory framework for the smart grid

In order to produce optimal and sustainable cities, the full potential of digital infrastructure must be unlocked through pre-emptive investment in energy infrastructure. The UK Government does not offer a cohesive strategy on transitioning to a smart city. What the UK Government can do, however, is provide a 'market making' approach to try and ensure that the right conditions are available to encourage energy network providers to invest in distribution networks, and consumers to take up new technologies. Businesses and cities cannot, on their own, solve the obstacles that hinder the growth of smart infrastructure and technologies. A key barrier to readying our cities for electric vehicles, recently acknowledged by the Department for Business, Energy and Industrial Strategy (BEIS) select committee, is the ability of energy network providers to invest ahead of demand. Currently, providers are restricted to investing only where there is proven need (investing after demand). Given the inevitable rise in electricity usage as a fuel source, not just in cars but also for central heating, and the increasing reliance on constant connectivity as the smart city agenda advances, we argue that this restriction should be lifted. In addition, we argue that charging points and associated grid upgrades should be provided ahead of demand, in order for private business and citizens to be fully confident of electric vehicles as the technology of future road transport in Britain.

Recommendation #2: Ofgem should loosen regulations to allow energy network providers to invest ahead of demand.

The success of the smart city agenda will ultimately rely on how cities, the private sector and other stakeholders support and use it. The market for 'smart' technologies is relatively new; the framework within which these technologies can be harnessed and integrated to best effect has only just begun to be developed. It falls upon city authorities – who know their place and people better than distant authorities – to work with the private sector and communities to make the most of 'the smart agenda' and serve distinct urban needs.

Cities will experience the transition in different ways but the current regulatory framework will limit their ability to initiate and respond to this change. The situation therefore calls for more localised regulation. As energy network providers preside over natural monopolies, it is of course crucial that they are

2 Defra (2017) – Air Pollution in the UK 2016

regulated by Ofgem. Locally-specific decisions on infrastructure upgrade, however, are better understood and managed at the local level. Local regulation should inevitably be nationally coordinated, while regulatory measures should be proposed locally on a city-by-city basis at the level of the energy distribution system. Central policy must not become disconnected from regional regulatory bodies, but should work with them to ensure regionally and locally specific outcomes. This is why we call for certain regulatory powers of Ofgem to be devolved so that cities have the freedom to upgrade their infrastructure in a way that is tactile and responsive to their energy needs.

Recommendation #3: Certain regulatory powers of Ofgem should be regionally devolved so that cities can develop their own energy policy.

Local authorities: the strategic role

Better physical infrastructure and smart technology could, potentially, result in less equitable outcomes. Those in higher income areas could have a higher concentration of residents willing to invest in smart technologies. This in turn could lower bills in areas of high income, while having little impact on energy bills in neighbouring lower income areas. In other words, the higher the income of an area, the greater the chances of reinvestment in energy infrastructure. If not implemented strategically and with knowledge of socioeconomic differences between areas, the location of upgrades to energy distribution networks and later use of smart technologies could perpetuate and deepen existing socioeconomic differences. Long term strategic thinking is required in cities and their wider city-regions to ensure that everyone can benefit from the upcoming change. This is especially important as, through their energy bills, the costs of the smart grid will be socialised. Neighbouring local authorities need to work together as consortia, with each other and with the private sector, to ensure that the various initiatives amounting to a smart city transformation are coordinated and work for everyone in the area.

Recommendation #4: Local authorities should be given a mandate to form consortia and develop smart city plans which integrate various initiatives across geographical boundaries.

Regulatory changes can only go so far, however. Adoption of the smart cities agenda presents a spectrum of required changes, with changes to physical infrastructure on one end and changes to cultural behaviour on the other. As one city councillor told us during research for this report, “decision-makers must take the electorate with them”. After years of telling the public to use less energy, the advent of the smart grid could lead to people using more electricity; for cars, heating and other applications. This means educating people as to the benefits of electric vehicles, as stated above, but also on the benefits of using public transport or ‘active transport’ such as cycling and walking.

Recommendation #5: Public awareness of the environmental and financial benefits of smart city growth and development should be increased.

Network providers and local authorities in partnership

The smart city agenda is based on integration of a city’s various functions across networks. As such, its success depends entirely on coordinated collaboration. Where the smart grid is concerned, collaboration must be primarily between local government and energy network providers. Maximising the benefits of the smart city through the successful implementation of all the recommendations outlined above depends on a close and collaborative relationship between energy network providers and local authorities.

Recommendation #6: Local government should work with private energy network providers to deliver physical infrastructure.

Part of this collaboration will involve the sharing of data. Ofgem is currently holding a funding competition for electricity network innovation, with network

providers putting forward several proposals for bringing energy distribution forward with the smart agenda. As part of the research for this report, we have seen examples of coordinated efforts by network companies which aim to investigate solutions for electric vehicles by engaging relevant stakeholders across the energy and transport networks and the planning system. Central to this is the sharing of information. This kind of joined-up solution is key to realising the full potential of the smart grid, information should be able to flow freely between city planners, transport officials and energy network providers in order for proper integration of city functions.

Recommendation #7: In developing smart city strategies, private providers should be given access to public data and vice versa.

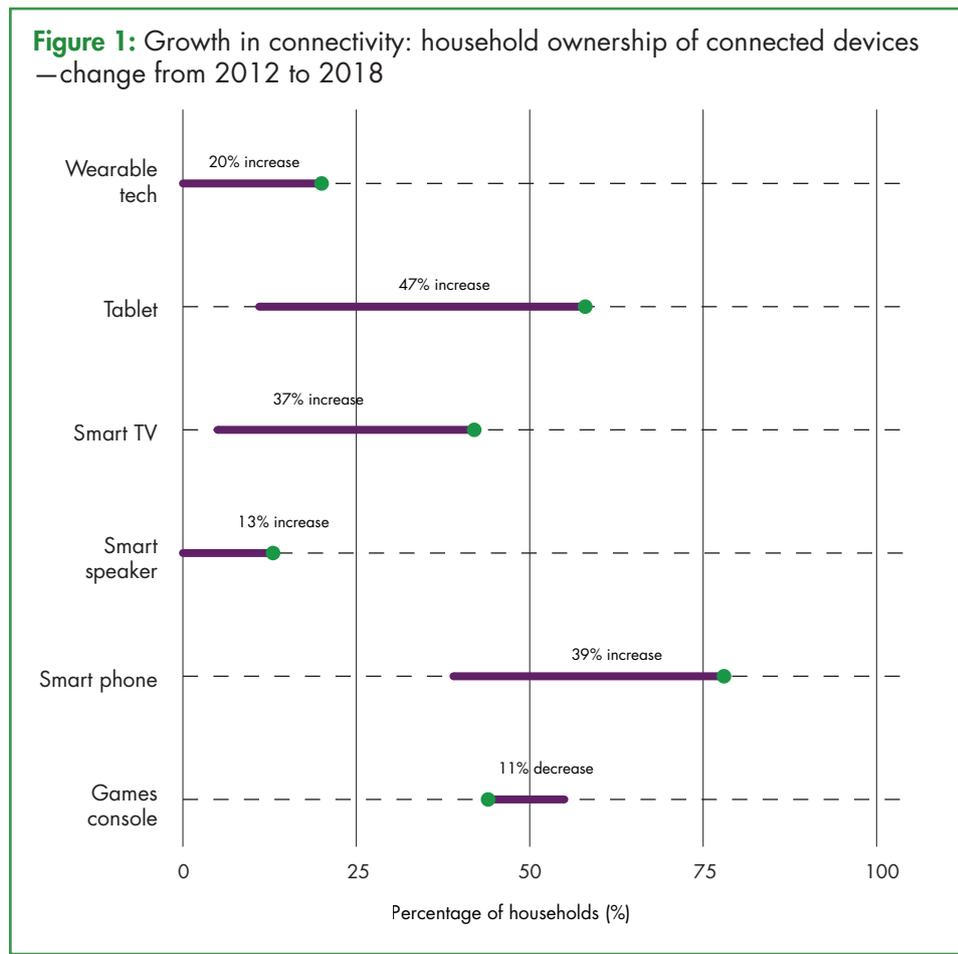
Central government: direction and funding

Without dedicated direction and funding from central government, fair and equivalent access to energy infrastructure upgrades cannot be achieved. To achieve the recommendations put forward in this report; energy providers, local authorities and manufacturers must be working within roughly the same technological parameters whilst adapting their individual solutions to their place. For this reason, echoing the BEIS select committee, we call for greater standardisation on what kind of charging points are desired for electric vehicles. Furthermore, the relationship between level of electric vehicle uptake and level of infrastructure upgrade required must be standardised and revealed in detail by central government.

Recommendation #8: Government must produce a standardised framework for electric vehicle charging equipment and associated infrastructure upgrade requirement.

1. Introduction

Technology is transforming the way we live our lives, the way we organise our work and the way we run our homes. The rapid rise of the internet of things – the connectedness of everything from our appliances to our vehicles – enables us to manage the complexity of modern life. These transformations in modern living have led us to pose some crucial questions: how can we leverage this technology to manage the increasing complexity of cities, making more efficient use of the congested resources we share? How can we build, use and maintain physical, smart and intelligent infrastructures to create sustainable and inclusive growth?



Source: Ofcom

This ambition is often described in terms of ‘smart cities’. Key cities like Glasgow³ have an important part to play and are already pioneering ‘smart city’ practice through pilots geared to mitigate fuel poverty, clean up their air, improve

3 Letaifa (2015) – How to strategize Smart Cities: Revealing the SMART model

health and reduce carbon emissions. Across the country there exist ambitious plans to use technology and data to forge new ways of governing urban Britain.

This report proceeds as follows: after offering a definition of the smart city and explaining the popularity of the concept, the challenges currently faced by smart cities are identified. The importance of energy infrastructure to smart cities is emphasised before existing central and local government policies and regulatory environments are discussed. Lessons from the UK and abroad are outlined before the report concludes with policy recommendations regarding the future roll-out, delivery and use of energy distribution networks in UK smart cities.

Figure 2: 'Lighthouse' smart city projects are in place in Bristol, Glasgow, London, Manchester and Nottingham



Source: EU Smart Cities Information System

2. Smart Cities: Understanding the New Dynamic

2.1 What exactly is a smart city and why is the concept so popular?

Globally, cities face increasingly complex challenges. Modern urban populations deal simultaneously with air pollution, the intensification of carbon emissions and a growing strain on infrastructure, typically exemplified by sometimes crippling transport congestion. With increasing urbanisation and inadequate legacy infrastructure, the depth of these challenges will only increase.

In response, the rapidly-improving technological capabilities available to city governments and their stakeholders have led some to explore the potential of the so-called 'smart city' through a series of demonstrator projects. There are over 150 large-scale smart city demonstrators globally⁴, testing the concept in a wide range of fields, with the aim of de-risking the development and scaling-up of solutions and services that are not yet ready for the mainstream market by providing safe environments for experimentation and innovation. The UK has emerged as a strong force in this space, with several prominent project examples, including Manchester CityVerv, MK:Smart and the Future City Glasgow initiative.⁵

Yet many of these smart city solutions remain in the pre-commercial phase of development with uncertainty about precisely what a smart city is, what a successful smart city would look like and how best to deliver the benefits: institutionally, technically and at scale. There is still no blueprint for what a smart city should look like, but a number of definitions have been offered within the UK and beyond.

For example:

- In 2014, the British Standards Institute offered a broad definition of the smart city as *'the effective integration of physical, digital and human systems in the built environment to deliver a sustainable, prosperous and inclusive future for its citizens'*. The aims are to make more efficient use of physical infrastructure (roads, built environment and other physical assets) through artificial intelligence and data analytics, so that the city is more agile, adaptable and able to respond more effectively and promptly to changing circumstances.
- Deloitte's 2018 definition of the smart city also emphasises the pivotal role played by digital infrastructure in the smart city. According to Deloitte's recently published report 'Forces of change: Smart Cities', the ultimate aim of the smart city is the integration of human intelligence, collective intelligence, and artificial intelligence, whereby city infrastructure is made smart through real-time data collection, with analysis and predictive modelling across city districts.

⁴ Smart City Consortium

⁵ Future Cities Catapult (2018) – Smart City Demonstrators

These various authoritative definitions of a smart city emphasise the adoption of 'scalable solutions that take advantage of information and communications technology to increase efficiencies, reduce costs and enhance quality of life'.⁶ What these definitions fail to consider is the supply and efficiency of physical infrastructure in the city, particularly as it relates to energy efficiency and sustainable economic growth; two central goals of the smart city. **Physical infrastructure, including local energy distribution networks, should be successfully implemented first, so that digital infrastructure can allow city officials and residents to manage their energy consumption toward efficiency and sustainability.**

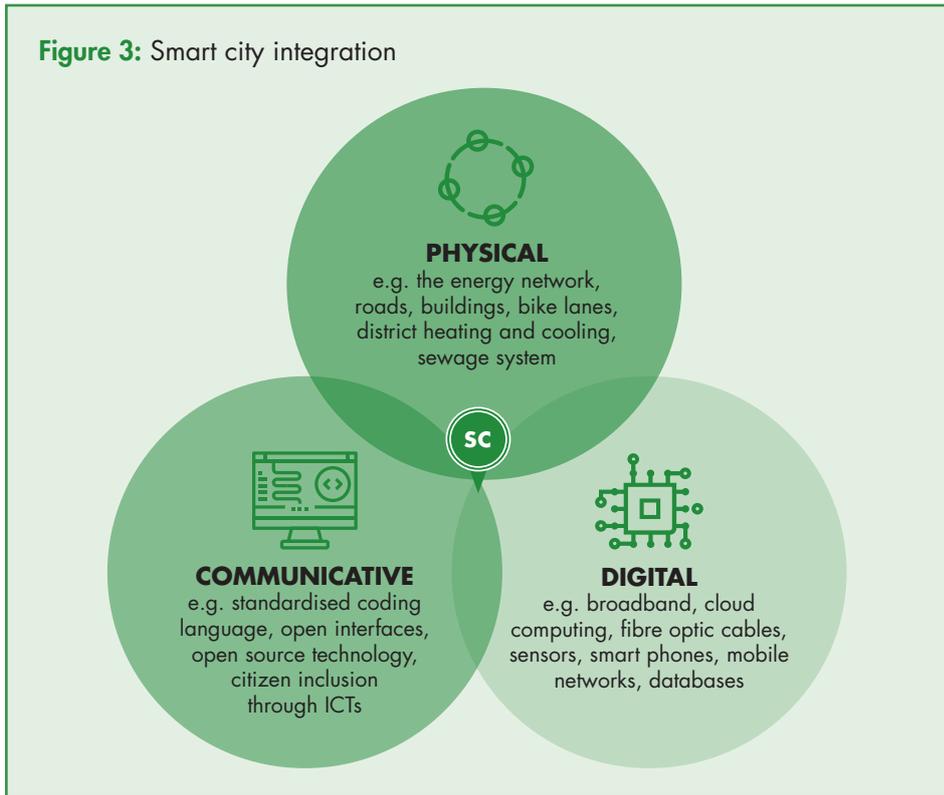
2.2 Policy challenges

Policy moving forward must have a specific focus on local distribution networks and local power networks; both are key to environmentally sustainable and cost-effective outcomes. The definitions noted above provide a helpful outline of the broad ambition of the smart city, but also highlight that the smart city is a journey, not a destination. The task now is to convert these definitions into a policy programme. This is well recognised and has been emphasised by the UK Government: "The concept is not static, there is no absolute definition of a smart city, no end point, but rather a process, or series of steps, by which cities become more 'liveable' and resilient and, hence, able to respond quicker to new challenges".⁷ While this allows for the fluidity and experimentation essential in a rapidly changing technological context, there is the danger that smart city initiatives become short-term and disconnected. Without sufficient long-term aims and coordination of various aims and initiatives, progress in the smart city will be piecemeal. **Without essential physical infrastructure and power networks, digital infrastructure and intelligent energy technology will fail to reap the social, economic and environmental benefits promised.**

⁶ Cisco (2012) – Smart City Framework

⁷ Department for Business, Innovation and Skills, 2013

Figure 3: Smart city integration



In a smart city, the physical and digital infrastructures are integrated. Energy distribution networks, sensors and smart meters deployed throughout the city can provide information about traffic flows, vacant parking spaces, energy demand, car crashes, weather conditions etc. This information can then be accessed by the city government and residents via smart devices to inform them about the most efficient options for moving around the city. This makes the physical infrastructure much more flexible and customised for citizens and allows local authorities to target improvements for maximum impact.

Tied to the question of integration is the question of delivery. Which level of government is best placed to coordinate and deliver public-private partnerships? In addition to arguing that the implementation of energy distribution networks is pivotal for the success of smart city initiatives, this report also argues that local government is best placed to coordinate smart initiatives. While it is often inferred that authorities do not have the capacity or skills to effectively participate in large-scale innovation programmes, research has shown⁸ that **local authorities often make valuable contributions to these initiatives, drawing on their strong stakeholder and project management, awareness of local conditions and their key role as local convenors.**

8 Future Cities Catapult (2018) – Smart City Demonstrators

3. The Challenges Facing Smart Cities

Cities becoming 'smarter' is a necessary response to a number of pressing challenges. The resources we use need to change and the way we use them needs to become much more efficient. In a city where household energy usage is known in real-time by network providers, informed decisions about levels of supply can be made – saving money and resources. Where transports systems are fully integrated into the smart city, real-time demand information can help officials provide a smoother and more tactile service, as our cities become more crowded the imperative for this change increases. This report examines some of these challenges below.

3.1 Air quality

Air quality pertains to the presence of particular chemicals, physical agents and biological agents that modify the natural characteristics of the atmosphere. From nitrogen dioxide (NO₂) to sulphur dioxide to particulates, a range of pollutants impact air quality. For the purposes of this report, we focus on rates of NO₂ and provisions that can be made to reduce its levels in places worst affected. This is because NO₂ concentrations exceed legal limits in a number of highly-populous places in the UK.⁹ Reducing those concentrations is a direct aim of government, as outlined in its 2017 plan for tackling roadside nitrogen dioxide concentrations. And it is a pollutant for which road transport is responsible for 80 percent of emissions, a feature which the central and local state has significant control and influence over.

High NO₂ concentrations predominate in cities, on major roads and at pinch-points of congestion, for instance ports and crossings like bridges and tunnels. While data coverage is poor and government's modelling has been criticised for being unreliable, it is clear the problem is most acute in urban areas. All major British cities have levels of NO₂ exceeding statutory European Union (EU) targets and often by significant amounts.

For government, the private sector and consumers, there is an imperative to reduce air pollution levels for human, economic and national-interest reasons. On the human level, air pollution has a significant impact on health and mortality. Toxic air results in hundreds of thousands of early deaths across Europe each year. In the UK, air pollution is a risk factor in 8% of deaths annually – amounting to 50,000 people per year.¹⁰ Perceived inaction on the part of the government has led to accusations of idleness, with Green Party MEP Keith Taylor describing the state's attitude as "steadfastly apathetic".

Furthermore, the economic costs of air pollution are most likely to incentivise the private sector to act. In 2015, WHO and OECD estimated that the economic

⁹ Defra (2017) – Air Pollution in the UK 2016

¹⁰ The Guardian (2018) – Renewed calls for UK to tackle toxic air ahead of high court hearing

cost of premature death and disability from air pollution in Europe is close to US\$1.6 trillion. Air pollution takes its toll on the economy in several ways: it costs human lives, it reduces people's ability to work, it affects vital products like food, it damages cultural and historical monuments, it reduces the ability of ecosystems to perform functions societies need and it costs money in remediation or restoration.¹¹ Air pollution is said to cost the UK economy £54 billion a year. Indoor and outdoor air pollution costs European economies as much as US\$1.6 trillion (£1.05 trillion) each year.¹²

While central and local government will inevitably be concerned about the impact of poor air quality on economic productivity, an additional concern for policymakers and industry leaders alike, is the sometimes disproportionate impact of poor air quality on the most vulnerable.¹³ In addition to discriminating by age and sex (older people and women are reported to be more susceptible to the adverse health effects of air pollution), air pollution has proved more harmful to the most economically vulnerable. There are well-documented inequalities in the distribution of pollutants in the UK, although the relationship with deprivation is not straightforward.¹⁴ Deprived communities live in poorer-quality environments that experience higher levels of air pollution, a relationship reported in other developed nations and in the former communist states of Eastern Europe.¹⁵

Moreover, existing policy instruments have proved punitive for the most vulnerable. The impact of congestion charging in central London on reducing levels of NO₂ and Particulate Matter (PM) has been greatest on residents living in the most deprived areas.¹⁶ This is why, as will be argued in section five, **local government, with its awareness and knowledge of place-based social-economic indicators, is best placed to oversee the implementation of both smart physical infrastructure and smart digital technology.**

3.2 Decarbonisation

Despite the occasionally differing aims of consumers, local and central government, and the private sector, it is essential to acknowledge that all stakeholders share a growing concern around sustainability issues and the increased threat of global warming. Acting now becomes crucial not only for the reasons outlined above, but for the obligations we owe to future generations to protect the planet we currently inhabit. The recent report from the Intergovernmental Panel on Climate Change stressed this imperative, urging much greater cuts in carbon emissions to avoid genuinely catastrophic consequences for future generations. The UK has its own 'carbon budget', set by the Committee on Climate Change, displayed in the table below. Technology to assist in achieving these targets, in the form of smart meters, intelligent traffic networks and various other innovations are currently being piloted and purchased across the world. **However, before these various new technologies can be successfully piloted and later implemented, it is crucial that the essential energy distribution networks are in place to ensure that such transformative change is both sustainable and efficient.**

11 UNECE – Air pollution and economic development

12 This accounts for 3.7% the GDP in Britain, where 29,000 people each year are currently estimated to die prematurely from air pollution.

13 The concept of vulnerability indicates that increases in exposure to pollution may have substantial effects on a vulnerable person. Conversely, reductions in pollution levels may lead to pronounced health benefits in population groups with the highest vulnerability portion of the population, even if the change in risk for the whole population is small.

14 Royal College of Physicians (2016) – Every breath we take: the lifelong impact of air pollution

15 Ibid.

16 Brunt et al (2018) – Air pollution, deprivation and health: understanding relationships to add value to local air quality management policy and practice in Wales, UK.

Source: Committee on Climate Change

Budget	Carbon budget level	Reduction below 1990 levels
1st carbon budget (2008 to 2012)	3,018 MtCO ₂ e	25%
2nd carbon budget (2013 to 2017)	2,782 MtCO ₂ e	31%
3rd carbon budget (2018 to 2022)	2,544 MtCO ₂ e	37% by 2020
4th carbon budget (2023 to 2027)	1,950 MtCO ₂ e	51% by 2025

Carbon targets in the UK

Electric vehicles (EVs) provide us with a reminder of why physical infrastructure, in the form of charging points, proves just as integral to the smart city as digital infrastructure does.

3.3 Transport/Electric Vehicles

EVs are a key technology for the reduction of air pollution and the eventual improvement of urban life. EVs produce fewer emissions that contribute to climate change and smog than conventional vehicles.¹⁷

Making sense of vehicle emissions

There are two categories of vehicle emissions: direct and life cycle. Direct emissions are emitted through the tailpipe, through evaporation from the fuel system, and during the fuelling process. It is important to note that **EVs have vastly lower running emissions than fuel burning vehicles.**

- Direct emissions include smog-forming pollutants (such as nitrogen oxides), other pollutants harmful to human health, and greenhouse gases (GHGs), primarily carbon dioxide. All-electric vehicles produce zero direct emissions, which specifically helps improve air quality in urban areas. Since most PHEVs (plug-in hybrid electric vehicle) are more efficient than comparable conventional vehicles, they still produce fewer tailpipe emissions even when relying on gasoline.
- Life cycle emissions include all emissions related to fuel and vehicle production, processing, distribution, use, and recycling/disposal.¹⁸ All vehicles produce substantial life cycle emissions, and calculating them is complex. However, EVs typically produce fewer life cycle emissions than conventional vehicles because most emissions are lower for electricity generation than burning gasoline or diesel.

In mid-September 2018, the UK held the world's first Zero Emission Vehicle Summit, bringing governments from across the world together to collaborate towards a shared vision of a zero emissions future. In showing its commitment, the UK guaranteed £106 million for research into zero emission related technology. Additionally, the government expects 1,000 jobs to be created and a further half a billion pounds of investment in the area. The Summit saw new plans for a Degree Apprenticeship Centre, which will be backed by the University of

¹⁷ EERE – Reducing Pollution with Electric Vehicles ¹⁸ Ibid.

Warwick. And the UK is not alone in this, shown through 13 other governments across the world committing to a future where transport has zero emissions.¹⁹ Certain countries and cities within the UK are going for their own zero-carbon targets, including the 'UK100'; a highly ambitious network of local government leaders seeking to devise and implement plans for the transition to clean energy. It supports decision-makers in UK towns, cities and rural areas in their transition to 100% clean energy by 2050. It is the only network for UK local authorities focused solely on climate and clean energy policy.

There is still some way to go, however, in aligning policy with investment and intention. In 2018, the government released the Road to Zero strategy, a plan which is intended to culminate in the year 2040, with 100% of all new cars and vans sold being zero emission. Whilst a positive step, the strategy misses a number of key opportunities to decarbonise and clean up road transport.²⁰ It does not include measures or policies sufficient to reduce the demand for travel, nor does it propose ways to shift existing travel to more sustainable modes of transport.²¹ The Road to Zero strategy takes a technology-neutral approach to meeting the UK's climate and air quality ambitions. While the strategy restates the intention to end the sale of new conventional petrol and diesel cars and vans by 2040, it implies that petrol and diesel hybrid electric vehicles (HEV) will be available for sale beyond 2040. Since the announcement, alternative-fuel vehicles sales have increased even as the automotive market saw its biggest drop in overall sales since the financial crisis²², but stronger market signals are needed from government.

Analysis of international trends has recently led to projections of up to 35% of global car sales being EVs by 2040.²³ In October 2018, the select committee for the department of Business, Energy and Industrial Strategy released a report on the electric vehicle market. The committee used the aforementioned trends along with data from the National Grid²⁴, which provided various models for the future of energy with a top-end prediction of 36 million EVs in the UK by 2040. This analysis led to the committee anticipating electricity as a fuel source overtaking internal combustion engines by the mid-2030s and subsequently recommending the Road to Zero target be brought forward to 2032. They also encourage the government to seek 'more creative' options than tax incentives to encourage EV purchase, in an effort to send the kind of market signalling described in the box below.

19 Department for Transport (2018) – Zero Emission Vehicle Summit

20 Department for Transport (2018) – Road to Zero

21 Ibid.

22 SMMT (2018) – October 2018 Review

23 BNEF (2018) – Electric Vehicle Outlook 2018

24 National Grid – Future Energy Scenarios

The importance of market signals: the diesel example

Throughout this report, there are multiple references to the ability of energy network providers to invest ahead of demand. Currently, providers are restricted to investing only where there is proven need (investing after demand). One reason this regulation should be lifted is so EV infrastructure can be rolled-out ahead of need as a market signal to fleet-owning private businesses and consumers. The very recent example of diesel illustrates why government should be expected to lead from the front, rather than encourage from the side.

Diesel was initially lauded as one of the biggest factors in the shift to an eco-future and fight against climate change. In the UK, successive governments continued to promote it for its 20% lower CO₂ emissions rate and 20% better fuel efficiency than cars running on petrol.²⁵ However, public opinion on the 'greenness' of diesel turned, to the point where now multiple global cities and governments around the world are considering banning diesel cars, to varying degrees, altogether. There are multiple reasons for the initial infatuation with diesel. The economic benefits regarding fuel efficiency being the most obvious for everyday consumers. At the same time, the rising concern of governments across the globe, especially in the UK, of the need to tackle increasing carbon emissions turned their attention to diesel as a solution. The fact that diesel produces 20% less CO₂ was a clear incentive. Moreover, this premature faith in diesel as an 'eco-friendly' alternative was promoted by car manufacturers themselves²⁶, and switching to it was incentivised by government with lower road tax for diesel cars.²⁷

Yet, it started to emerge that this faith was misplaced, especially as more and more damning reports started to emerge of the environmental and health effects that diesel was having. The European Environmental Agency's 2016 report on air quality in Europe has stated that 71,000 premature deaths occurred across Europe in 2013 as a result of dangerous levels of nitrogen dioxide in the air²⁸, and so far in 2018 there have been a reported 9,600 premature deaths as a result of it.²⁹ According to subsequent research, children across the entirety of the UK are "being exposed to illegal levels of damaging air pollution from diesel vehicles at schools and nurseries across England and Wales" in addition to 'towns as far afield as Plymouth, Poole and Hull all having nurseries and schools in areas above legal NO₂ limits'.³⁰

People and businesses who remember buying diesel based on previous assurances have a right to be sceptical about spending on clean technology. For electric vehicles then, the government must incentivise manufacturers to change or ramp up production of the range of makes and models of cars and vans needed to suit most tastes and preferences, including those who could potentially invest in an EV. Similarly, it remains unclear as to where and how the physical infrastructure (i.e. energy distribution networks) is going to be delivered. In order to get ahead in adopting this crucial technology, the government needs to send the clear signal to consumers and businesses that EVs really are the future. Part of this can be achieved through procurement, by making sure government at all levels is using electricity as a vehicle fuel source.³¹ At a more fundamental level however, market signaling can be achieved simply by allowing grid network providers to invest ahead of demand and improve the infrastructure for electric vehicles, letting the market know that the UK is truly committed to traversing the Road to Zero. The BEIS select committee have taken this position, albeit cautiously, advising that the "Government and Ofgem work with charge point providers and electricity network companies to assess, by June 2019, the potential for investments ahead of need which could hasten the growth of charging infrastructure and reduce the cost of its implementation".

Ofgem should loosen regulations to allow energy network providers to invest ahead of demand.

25 What Car (2018) – Should I buy a diesel car?

26 Audi's 2010 Green Police advert comes to mind

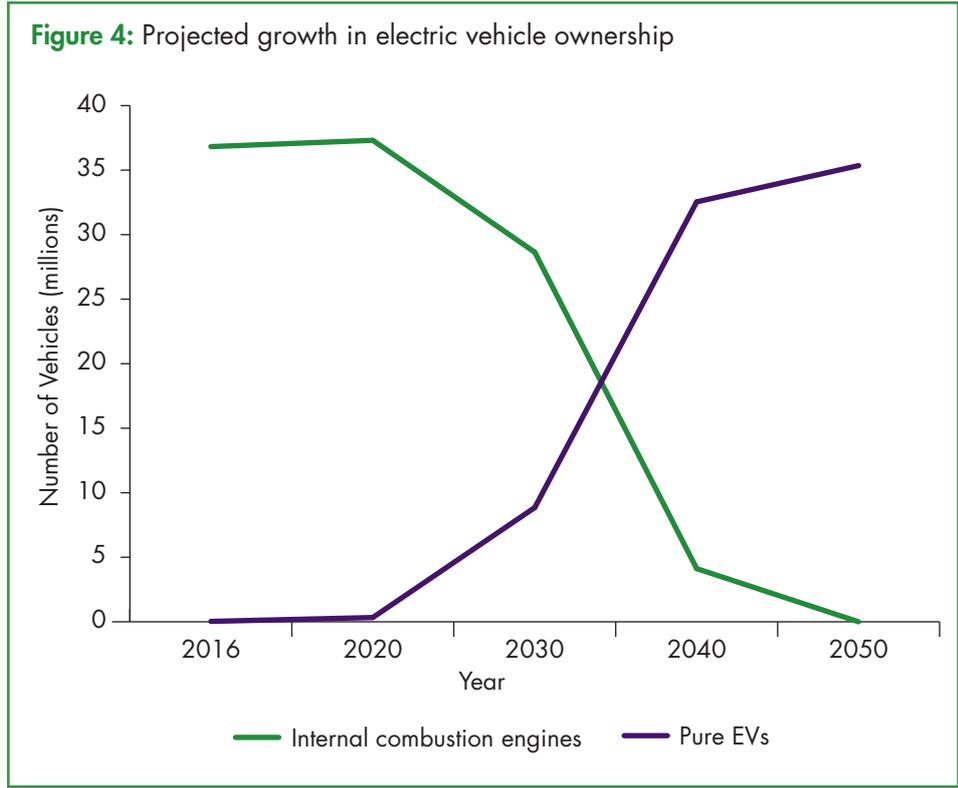
27 The Telegraph (2015) – Labour made 'wrong decision' over diesel car tax, admits shadow minister

28 EEA (2016) – Air Quality in Europe

29 EEA (2018) – United Kingdom – Air Pollution Country Fact Sheet

30 The Guardian (2017) – Thousands of British children exposed to illegal levels of air pollution

31 Green Alliance (2018) – How the UK can lead the electric vehicle revolution



While enthusiasts have taken to EVs, the current policy environment and mixed messaging on conventional fuels (especially diesel) could fail to convince those beyond the ‘early adopters’ to switch to zero emission vehicles. In a recent AA poll, 80% of people surveyed who did not own electric vehicles said they were concerned about the lack of charging points.³² Localis agrees with and echoes UKERC’s call for a clearer and longer-term strategy on how to avoid the ‘valley of death’ for emerging technologies. This is largely missing from the Road to Zero Strategy. As the BEIS select committee note in their report, “statements made to us and in the Road to Zero Strategy indicate that the government simply expects new cars and vans to have “significant zero emission capability” by 2040”. **Central government’s role in the transition to electric vehicles should be one of leadership. Allowing the roll-out of charging points and associated infrastructure upgrades ahead of demand is fundamental to achieving this. Government should produce a framework for local authorities and private providers to work within when delivering electric vehicle charging equipment and associated infrastructure upgrades.**

Cities that have evolved organically over centuries or even millennia can be challenging to retrofit with technology. Urban planning mistakes of the past, such as sprawl, may be deeply rooted, and creaky legacy infrastructure is hard to overhaul. Moreover, without the correct and sustainable implementation of physical infrastructure, the potential benefits of digital infrastructure will inevitably come up short. While urban legacy infrastructure disables UK cities from building ‘smart from the start’, we can translate this approach into one which is procedural and ensures the successful implementation of physical infrastructure (energy networks) before that of digital smart technology.

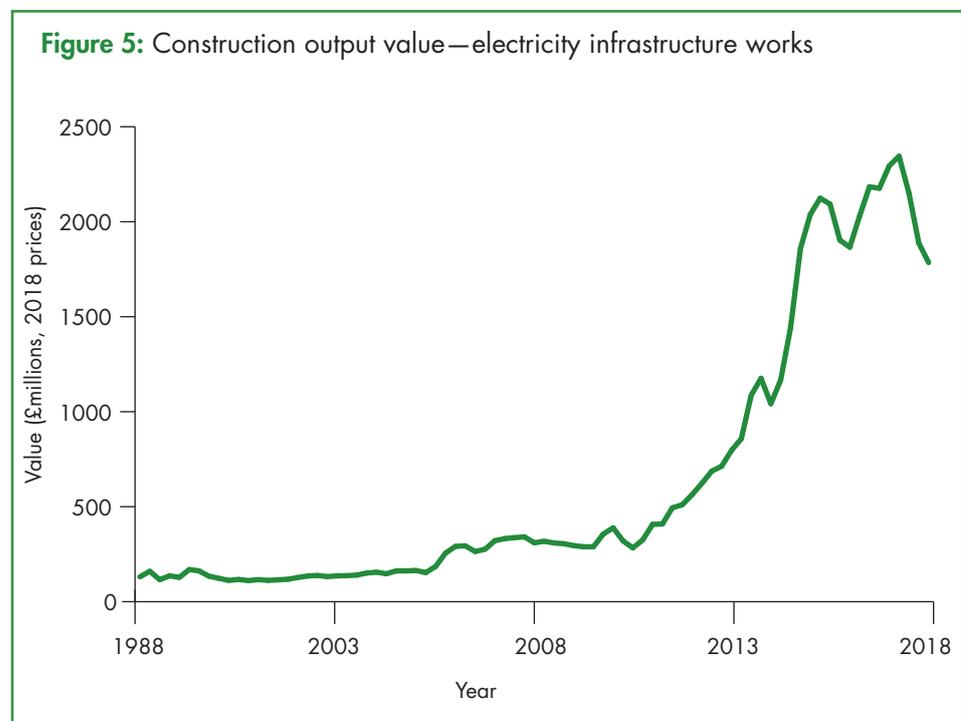
Given these obstacles to the uptake of EVs and the limitations of the Road to Zero Strategy, this report makes the following recommendation, each of which will be elaborated upon in additional sections:

Local government should work with private energy network providers to deliver physical infrastructure. This recommendation specifically refers to the roll-out of distribution networks/local power networks.

32 AA (2018) – Highlights from our Driver Poll Surveys

Economic costs and benefits

This approach to building EV capability on a local level will inevitably carry risk. The EV revolution depends on the consumer enjoying the benefit of financial savings. **However, without sufficient supply of public charging points for EVs and low demand, the financial savings associated with any major uptake remain elusive.** Interviews with various industry experts and engineers indicated that proactive investment is required if EV targets are going to be met across the UK. Updated infrastructure can potentially reduce the need for additional supply as the capacity to generate electricity through the grid network is better managed. The graph below shows the value of construction works to economic output. Allowing investment ahead of demand would serve to increase this already sizeable contribution. As the graph below shows, energy infrastructure works can add significant value to the construction sector, which in turn has knock-on effects on associated services. Furthermore, the kind of work required to ready the smart grid is inherently decentralised and carries fewer risks than headline-grabbing 'grand project' infrastructural improvements. This is because, as the Institute for Government have noted, "Delivering multiple small, homogenous projects can lead to more accurate prediction of costs and benefit".³³



Source: ONS Estimates

Individual costs and benefits

Underneath the national risks and rewards of the switch to EV are the savings made by individual owners. Cost-saving is often one of the main benefits that electric car drivers discover once they've made the switch.³⁴ Cost-saving is achieved in a variety of ways:

- Opportunities to save cash range from lower road tax (now called Vehicle Excise Duty) on many electric and plug-in hybrid cars, to cheaper servicing, running costs.
- Operating costs per mile are significantly cheaper with EVs – a 2017 study

³³ IFG (2017) – Big vs small infrastructure projects: does size matter?

³⁴ Go Ultra Low (2018) – How much could you actually save with an electric car? EV owners have their say

on two similar cars found the electricity powered car cost just under five pounds to fully refuel, compared to £53 for the petrol car.³⁵

- Various local schemes: For example, EV drivers are exempt from London's congestion charge and many towns and cities offer EV drivers free parking.

Given political life-cycles, it is unsurprising that government would publicise the immediate financial benefits provided by smart meters over the longer term financial return achieved by EV cars. **This makes it all the more imperative for the private sector, including energy network providers, to supply the physical infrastructure ahead of demand. Only then can the significant environmentally sustainable outcomes associated with the uptake of EVs and the intelligent smart city become a reality.**

35 Green Age (2017) – The running costs of electric cars

4. Energy Infrastructure & Consumer Behaviour

4.1 Framing the smart city

Understanding the roles of energy infrastructure and consumer behaviour are crucial to realising the smart city. The development of the smart city and the transformation of the energy industry are born from the same aims. There are shared drivers relating to the advancement of the clean energy agenda, including: responding to climate change and the transition to a low carbon economy; the possibilities offered by distributed energy resources; and the digitisation of energy products and services. Living in this new urban environment, where public transport is more efficient and combustion engines are no longer the norm will also require citizens to change their behaviour and expectations. The relationship is symbiotic: the roll-out of infrastructure upgrades allow the city to become cleaner and smarter. As the city becomes cleaner and smarter, the options for using energy and travelling in more efficient ways expand, and as people take these options up the city becomes cleaner and smarter still.

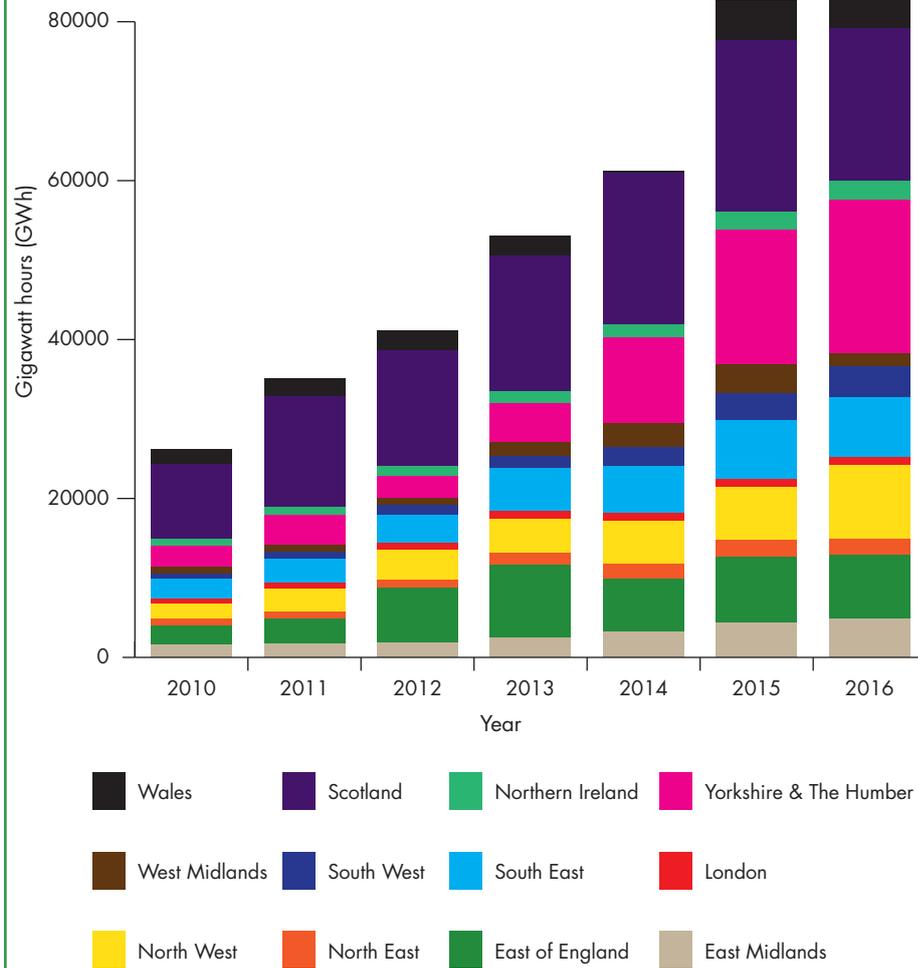
This symbiotic relationship has been taken for granted in the literature on smart cities. All three elements – physical, digital, behavioural – must be in place. There is an implicit assumption that digitisation will emerge without **explicit reference to the necessary and prior implementation of physical energy infrastructure, along with a concerted effort to inform the public of the economic and environmental benefits of change.**

4.2 The role of energy infrastructure in a fair transition to smart cities

In a city aimed at sustainable outcomes, local power networks are reconfigured as intelligent energy information networks that not only transport energy, but also generate data about consumption and capacity. In facing up to the challenges of meeting increased demand and environmental targets, the most common applications piloted in demonstrators reviewed by the UK Future Cities Catapult were smart meters, smart grids and dynamic energy marketplaces.³⁶ These tools allow households and energy suppliers to exchange data transparently. Smart meters allow consumers to arrange their power consumption according to the most efficient– and cheapest – patterns of use. Moreover, increasing sources of renewable energy (see graph above) will cause larger fluctuations of supply and demand for power generation, which will inevitably influence the price of household energy. Smart metering allows consumers to see when supply is high and price is low, so that they can adjust their personal energy consumption. **Energy efficiency and demand-side management strategies represent a core part of rebalancing the energy mix in the smart city.**

³⁶ Future Cities Catapult (2018) – Smart City Demonstrators

Figure 6: Renewable energy generation in the UK by region, since 2010



Source: BEIS renewable energy generation data

Ultimately, smart cities aim to make power more local. Microgrids serve as enablers for locally driven energy schemes, allowing communities to sell their own renewable energy back to the grid or, as is being trialled in Brooklyn, to each other.³⁷

The Brooklyn microgrid project is a collaboration between LO3 Energy and Siemens, which aims to introduce a microgrid-supported local energy market that allows residents with rooftop solar to sell their excess capacity to their neighbours. The selling of renewable energy between individuals and communities may increase levels of 'social capital' - a potential by-product of smart technologies and defined as "the collective value of all social networks (who people know), and the inclinations that arise from these networks to do things for each other (norms of reciprocity)."³⁸

The success of smart sustainable technologies, therefore, rests on the behaviour of consumers. Adjusting personal consumption of energy according to supply level and price, and the self-generation of renewable energy are their responsibilities. However, we should not expect the automatic take up of smart technology. Consumers need to be informed that benefits will not accrue overnight, but will lead to a greater financial return and sustainable outcomes over the long-term. On the other hand, there is no guarantee that social capital will increase as individuals come to trade or sell renewable

37 Power Technology (2018) – Smart Cities: redefining urban energy

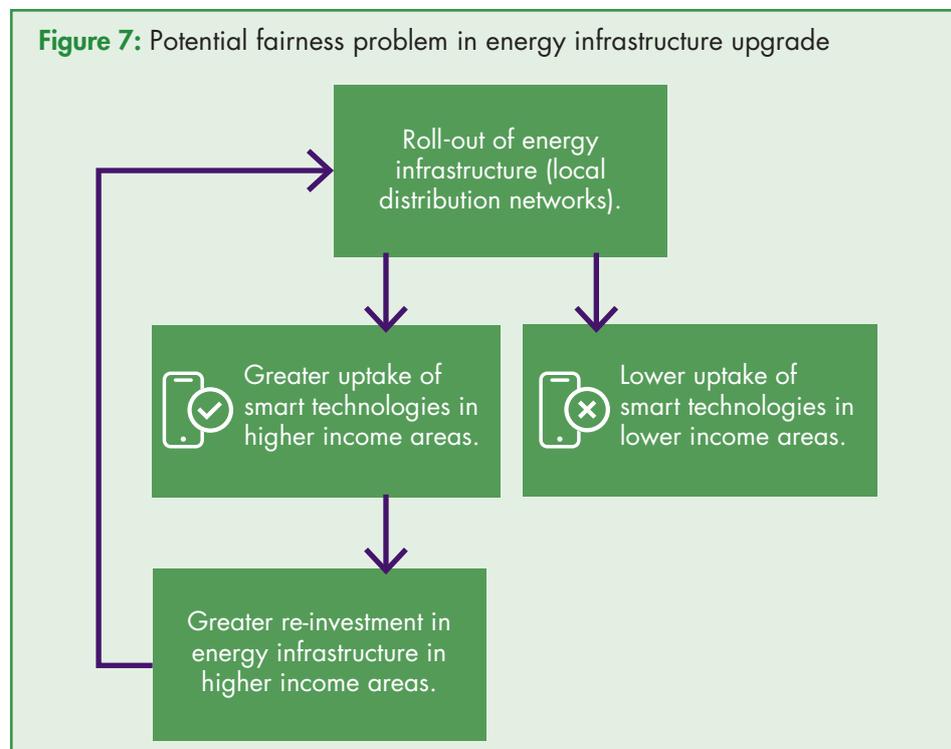
38 Harvard Kennedy Centre – Sagauo Seminar: Civic Engagement in America

energy back to the local grid. Smart cities also raise questions of equity.³⁹

The needs of all demographics and neighbourhoods should be on the agenda when cities choose which programmes to pursue.

The rising prevalence of smart technologies in the home, combined with the integrated infrastructure of the smart city, presents a huge opportunity for alleviating the pressures on household finances felt by many in the UK. This pressure is evident in the rise of personal debt across the country caused by people turning to credit cards to pay monthly bills.⁴⁰ Improved predictability of charges can help prevent unexpectedly high bills. Where energy usage is concerned, the smart grid and the next generation of smart meters can be a vital tool to help households manage their expenditure by providing detailed signals about the pricing of energy usage at different times, allowing potential savings and more predictable bills. Electric vehicles, combined with the provision of and education about the benefits of alternative transport, can also reduce fuel bills – a 2018 study found EVs to be around half as expensive to operate as internal combustion engine cars⁴¹ – and improve public health. Achieving these outcomes requires a well thought-out strategy of rolling out the physical infrastructure for smart cities, to avoid the benefits going only to those who need them least.

Unless strategically managed, key factors of geographical location and a lack of market choice in smart technology could cause an inverse relationship to arise. More physical infrastructure and smart technology could, potentially, result in less equitable outcomes. Those in higher income areas could have a higher concentration of residents willing to invest in smart technologies. This in turn could lower cost in areas of high income, while having little impact on energy cost in neighbouring lower income areas. In other words, the higher the income of an area, the greater the chances of reinvestment in energy infrastructure. If not implemented strategically and with knowledge of socioeconomic differences between various geographical areas, the location of energy distribution network upgrades and later use of smart technologies could perpetuate and deepen existing socioeconomic differences (see below).



39 McKinsey (2018) – Smart Cities need smart governments: 5 places to start

40 The Guardian (2018) – UK consumers trapped in credit card debt for longer than thought

41 Electric Vehicles Cost Less Than Half As Much To Drive

Avoiding this outcome is especially important with regards to energy, because network costs (national transmission and local distribution) account for 26% of a household energy bill⁴². It is vital that information about smart technologies and their associated benefits is spread to all sectors of society, because all sectors of society will be contributing financially to the transformation via their energy bills. **As the costs of upgrading to the smart grid are socialised to a certain extent, the gains must be felt equally across society.**

Fuel Poverty

The depth of fuel poverty blighting Britain's poorest households is expected to worsen because of energy price rises this year. A key measure known as the average fuel poverty gap – the gap between households' energy bills and what they can afford to pay – is set to widen in 2018. The Department for Business, Energy and Industrial Strategy forecasts that the gap will expand by 9%, up from £326 in 2016 to £357 in 2018. For fuel-poor households, this is a sizeable increase and is evidence of the ineffectiveness of existing government measures intended to curb fuel poverty. The prospect of deepening fuel poverty comes despite a price cap for millions of vulnerable households, which started in April 2017.

Given the slow uptake of smart meters and additional smart technology, fuel poverty provides UK Government and energy network providers with an additional incentive to act ahead of demand and implement the necessary physical infrastructure and energy distribution networks. Only then will consumers be able to actively use smart technology and attain net savings in energy bills and potentially lower vehicle running costs.

The success of smart technology in reducing fuel poverty in the UK is becoming more and more evident. Liverpool's experience is particularly instructive. From the Merseyside collective switching scheme, which helped over 16,000 households save around £220 a year on their energy bills, to the 'Health through Warmth' award-winning programme and Energy Projects Plus, Liverpool has done much to assist some of the poorest residents with energy affordability issues.

One of the multiple reasons Glasgow wants to become a smart city may regard the problems many of its residents face in keeping up with energy payments. According to the Scottish Government's Scottish House Condition Survey,⁴³ 34% of households in Glasgow were in fuel poverty between 2012 and 2014, with 8% estimated to be in extreme fuel poverty. This equates to approximately 102,000 households in fuel poverty in Glasgow. This compares with the national averages of 35% and 10% respectively.

In order to implement energy infrastructure successfully, this report provides the following recommendations:

1. Energy network providers need to ensure that distribution networks and local power network upgrades are rolled out in a way that maximises fairness. Before implementing local power network upgrades, providers should work with local authorities to identify socioeconomic differences

⁴² Energy UK (2018) – Energy bill breakdown

⁴³ Scottish Government (2017) – Scottish house condition survey 2016

within certain areas. This should enable network providers to consider how the roll-out of physical infrastructure can cut across socioeconomic differences - allowing for more affordable energy costs for all.

2. Energy network providers should not only be responsible for the roll-out of physical infrastructure. It also falls upon them to educate consumers in the financial benefits and sustainable outcomes associated with smart technology.

4.3 Engaging the public and changing behaviour

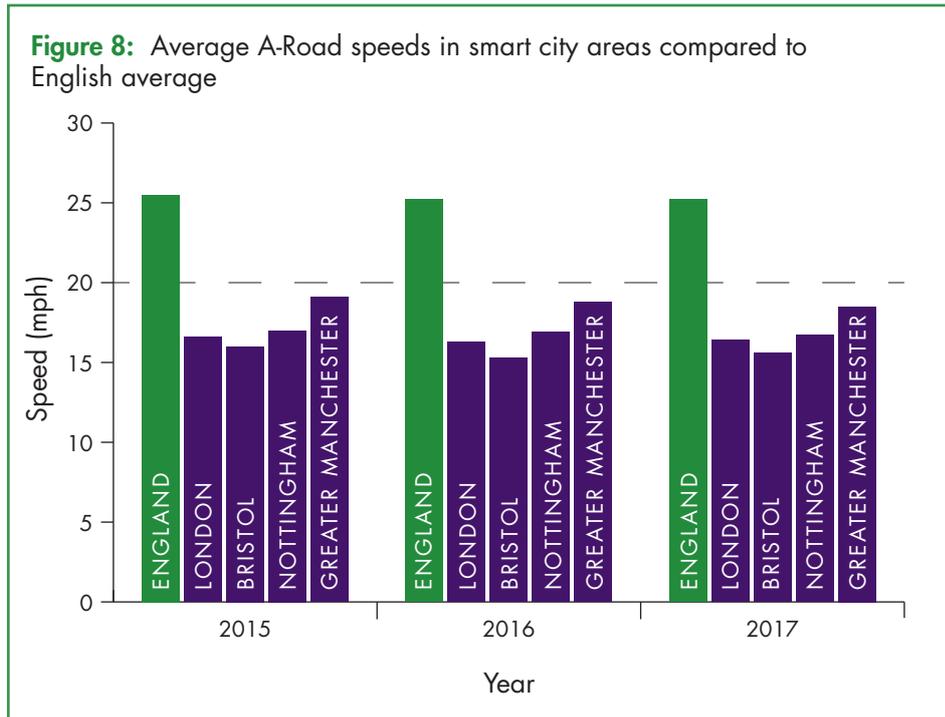
To quote directly from a recent report from the BEIS select committee:

“Now that EVs are becoming mainstream, an alternative approach is needed to promote deployment more evenly across regions.”

As with any decentralised function, it is important that the right level of government is engaged. To deploy on too small a scale risks uneven and confused implementation but too large a scale will risk losing the opportunity to consult accurately on the fairness of upgrade locations. We argue that local authorities should be mandated to collaborate in consortia at the sub-regional level on deploying infrastructure, as is done by metropolitan boroughs to achieve smart city transformations. **Beyond the role of promoting the roll-out of infrastructure however, it is important to promote the kind of behavioural changes needed to live in a smart city.** The potential benefits of changing our approach to energy and transport – in terms of improving air quality and the general city environment, as well as for cost reasons – must be promoted to the public as effectively as deploying the infrastructure is promoted to authorities.

Adoption of the smart city agenda presents a spectrum of required changes, with changes to physical infrastructure on one end and changes to cultural behaviour on the other. As one city councillor told us during research for this report, “decision-makers must take the electorate with them”. After years of telling the public to use less energy, the advent of the smart grid will lead to people being told that electricity is once again the most efficient power source. This means educating people as to the benefits of electric vehicles, as stated above, but also on the benefits of using public transport or ‘active transport’ such as cycling and walking. The graph below shows average A-Road speed in London, Manchester, Bristol and Nottingham⁴⁴ and illustrates the congestion problems in these pilot smart cities. While policies such as congestion charging are one way of reducing the problem, they must be accompanied by improvements in transport infrastructure via the smart cities agenda *and* educational programmes to inform residents from a young age of the benefits of a decongested city.

⁴⁴ Data unavailable for Glasgow

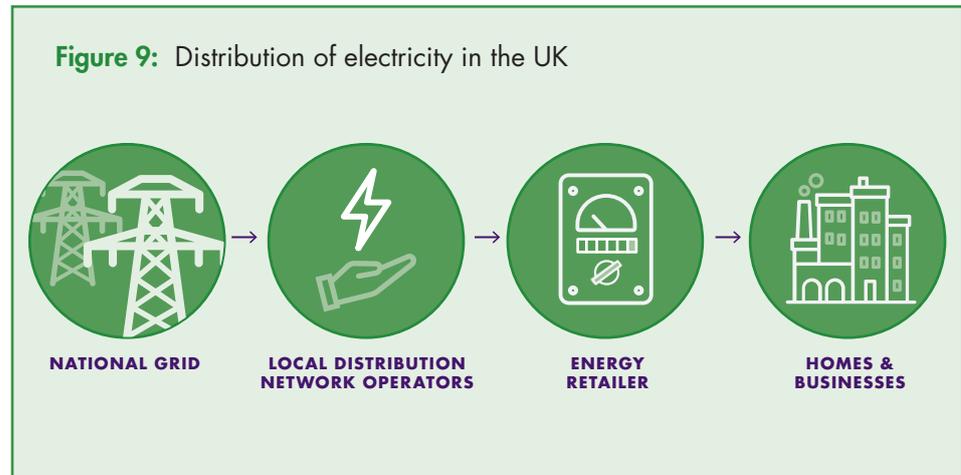


Source: Department for Transport

The convening power of local government could be pivotal in bringing about this behavioural change. **Local government has direct connections to energy network providers, educational institutions and citizens. These links can be used to better conceptualise existing consumer behaviour, identify changes which need to be made and drive this change through education and incentives.** There are already pilot initiatives using similar collaboration in this spirit in cities in the UK – in Edinburgh, the Business Process Change Pilot uses data to test the efficiency of customer service in terms of the amount of journeys citizens need to make in resolving problems with their council. Extending such pilot programmes, which make use of smart city infrastructure, to include the private sector and educational institutions, can help lead the way for broader collaboration on the smart cities agenda.

Testing and implementing such partnerships is key as city dwellers must be actively consulted with to determine the lines upon which the smart city agenda should proceed where they live. As EV ownership increases, the methods for charging cars will come up for greater scrutiny and discussion. Would residents prefer to ‘supercharge’ their electric vehicles in a more energy-intensive way or charge them overnight in the manner one might charge a mobile phone? The answer to this question will impact the way in which energy infrastructure develops in a given city. Furthermore, what kind of public transport should be the priority for investment for businesses and residents within a city? In a smart city, where we can better understand how people are travelling around, the question is more pressing and its benefits are clear: people are more likely to engage with a transport system they feel reflects local lifestyles. As with other points raised in this report, the ability to do so requires a certain amount of currently-prohibited investment ahead of demand. Beyond this consideration, however, there is little stopping a city council engaging its population in this way – particularly if businesses are convinced of the efficacy of the strategy and invest accordingly.

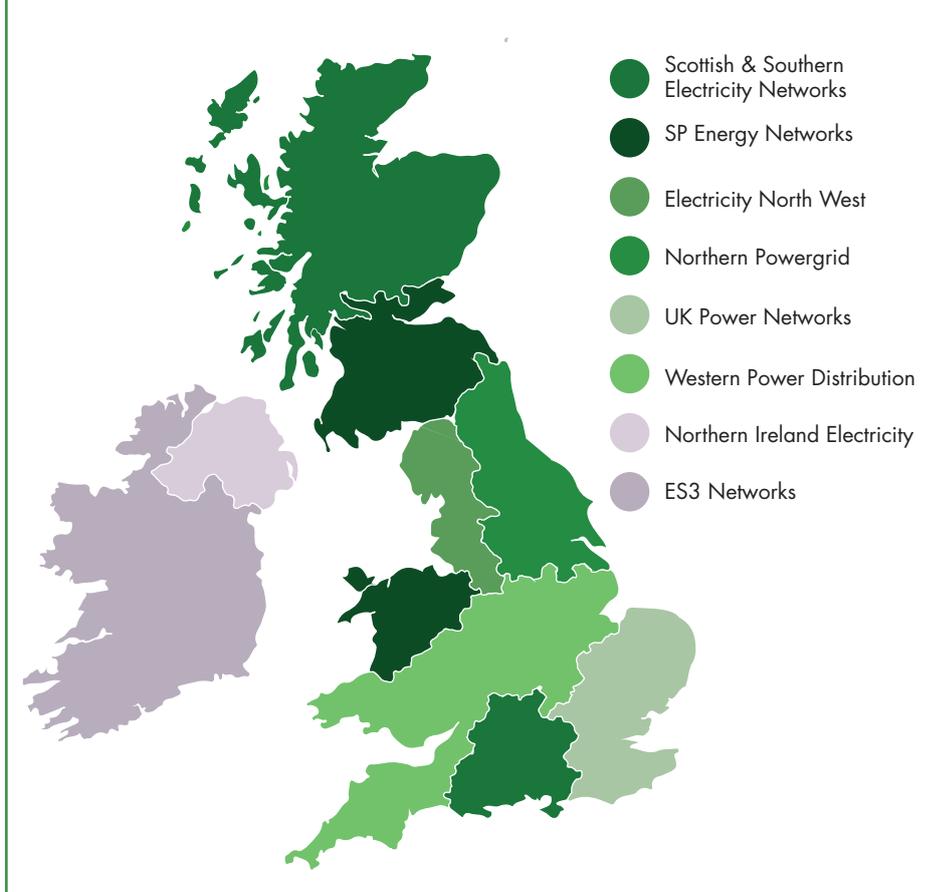
4.4 Forecasting and data-sharing



Distribution of electricity in the UK has three main parts: the National Grid, which acts as the overall service operator; the eight energy network providers who are in charge of distributing energy in different parts of the country and retailers who sell the energy at the household level via bills. In order to upgrade to a smart grid and operate it to its full potential as a source of information for providers and policymakers alike, information must flow freely between these bodies.

As a senior network engineer noted during interviews conducted as part of this research, energy network providers have a good track record of sharing information and capacity during extreme conditions. The summer heatwave of 2018 is a good recent example, as are the multiple instances of cooperation across the grid network each year due to bad winter weather. To deliver customers energy in exceptional conditions, networks will pool their resources where available. Another example of data sharing amongst network providers are the 'innovation frameworks' funded by Ofgem. All projects that are funded under these mechanisms must share the outputs publicly as part of the funding criteria. In a nation of smart cities, this data-sharing approach must be expanded to data-sharing between providers and authorities.

Figure 10: Electricity distribution in the British Isles



The massive amounts of data gathered and analysed within a smart city must be shared freely between the private and public sector for maximum public benefit. Knowledge of peak transport flows can inform greater efficiency among energy network providers, retailers and deliverers of public improvement works. Furthermore, sharing this information with the public increases transparency and, subsequently, trust in both public and private sector organisations.

5. Understanding the Policy Framework

In the UK it is largely cities themselves that are taking the lead, with city governments proposing and piloting various smart initiatives. On the other hand, central government offers a range of mechanisms that help to facilitate city-level action, including foresight, standard-setting, regulatory and research services. While the individual functions performed by central and local government need to be clearly stated and understood, their relationship also requires clarification. Moreover, their shared and distinct relationships with energy network providers needs to be clearly defined if the roll-out of energy and digital infrastructure is to be effectively targeted and marketed in and across UK cities.

5.1 Existing UK Government policy

The UK central government has taken an enabling role. This approach is focused on encouraging city governments to develop the vision and leadership to provide solutions to their own problems. The UK central government's largely supervisory role is guided by the following areas of responsibility:

- Encourage and empower city authorities to develop the vision and leadership to provide solutions to their own problems;
- Promote open data and the capacity of organisations to improve access to open data, to share and to use it, including the development of open standards;
- Promote programmes to develop underpinning technologies and to demonstrate their efficacy;
- Develop departmental programmes to encourage the adoption of new approaches and technologies, to transform both the service systems and consumer behaviour.⁴⁵

In these terms, the UK Government does not offer a cohesive strategy on becoming a smart city. What the UK Government can do, however, is provide a 'market making' approach to try and ensure that the right conditions are available to encourage energy network providers to invest in distribution networks, and consumers to take up new technologies. Businesses and cities cannot, on their own, solve the obstacles that hinder the growth of smart infrastructure and technologies. This is because the market constantly needs new standards, new infrastructure and regulation: all of which are beyond the individual scope of businesses and other stakeholders.

⁴⁵ UK Government (2013) – Background Paper on Smart Cities

To a large extent, the UK central government has already assumed this 'market making' approach – one which involves the assumption of three key roles:



1. CO-ORDINATOR

This refers to the bringing together of different interests and stakeholders to establish new platforms for collaboration. The Smart Cities Forum is aimed at doing just this; the Forum brings together cities, academics, businesses and Whitehall departments to improve cooperation on product development and to build the business models needed for co-investment. This can be achieved at local level – we learned in our research for this report of senior engineers seconded from the private sector into city councils to help steer development – but the convening power of central government is by nature the widest-reaching.



2. FUNDER

The government has acted as part-funder for infrastructure and demonstrator projects. This includes the Technology Strategy Board's (TSB) Future Cities Demonstrator project which awarded Glasgow £24 million to develop a city management system and £3 million each to London, Bristol and Peterborough to take smart projects forward.



3. REGULATOR

The government aims to ensure that common standards and regulations are in place. For example, the British Standards Institute (BSI) is working on a set of papers to help guide UK cities to engage in this agenda. In addition to the *Smart Cities Framework* already published, it intends to publish a *Smart Cities Concept Model* which will help cities combine data from different cities, and a *Smart Cities – Guide to Development* which will look closely at the infrastructure needed for cities to become smart. Other support includes related regulation – such as the Open Data Standards – which the government is gradually issuing in order to solve individual barriers in the market.

5.2 Ensuring efficiency

This 'market-making approach' can be improved in many ways. However, three areas of improvement should be prioritised:



1. INTEGRATION OF FUNCTIONS

It is essential that the UK Government's various functions are joined up. It is crucial that the government adopts a holistic approach whereby its funding, coordination and regulatory efforts are performed simultaneously and in tandem. This is also important at city level, as a senior transport official in Edinburgh outlined to us during the research for this report, the smart agenda cannot be placed in a silo, separate from the city's key functions.



2. INTEGRATION OF RESPONSIBILITIES

Given the lack of strategic direction provided by central government, the coordination of action and policies stemming from various departments needs to be managed. This includes coordinating and integrating the responsibilities of the Department for Transport (DfT), Department for Environment, Food and Rural Affairs (DEFRA), Department for Business, Energy and Industrial Strategy (BEIS), the Treasury and Ofgem (Office of Gas and Electricity Markets).

Recent reforms proposed by Ofgem (July 2018) allowing flexibility for charging on the EV grid offer an example of why government policy needs to be integrated and coordinated across departments. According to Ofgem analysis, if owners use 'flexible' charging – where they only top-up outside peak demand times on the grid – at least 60% more EVs could be charged up compared with 'inflexible' charging where electric vehicles are only charged at peak times.⁴⁶ However, the definition of 'peak time' will inevitably vary by existing localised conditions and future business planning in local areas. On these terms, Ofgem will have to coordinate and integrate plans with local authorities, private energy network providers, and most notably, DfT, Defra and BEIS. Only then can sustainable and economically productive outcomes be produced on a local scale.



3. MAINTAINING REGULATORY STANDARDS

A 'market making' approach needs to ensure that regulatory oversight does not become deregulation by default. It is essential that cities such as Glasgow and Liverpool do not engage in 'a race to the bottom', whereby deregulation becomes the norm. This is particularly important for the implementation phase (implementation of smart technologies, infrastructure etc.) which will set the foundations for inclusive and sustainable consumer behaviour over the long term.

⁴⁶ Ofgem (2018) – Ofgem proposes system reforms to support electric vehicle revolution

5.3 Local government policy

The UK Government-backed initiatives and functions outlined above represent good steps towards helping cities benefit from new technologies. Yet ultimately, their success will rely on how cities, the private sector and other stakeholders support and use them. The market for 'smart' technologies is relatively new; the framework within which these technologies can be harnessed and integrated to best effect has only just begun to be developed. It falls upon cities to work with the private sector and communities to make the most of 'the smart agenda' and serve distinct urban needs.

Why are cities and local authorities better placed than central government to design and implement smart initiatives? Many large-scale interventions can only happen with the cooperation and participation of city governments, due to the powers they hold and the assets they own. A small number of authorities are actively putting themselves forward as leaders in the field, in order to attract inward investment. While it is often inferred that authorities do not have the capacity or skills to effectively participate in large-scale innovation programmes, research has shown⁴⁷ that authorities often make valuable contributions to these initiatives, drawing on their strong stakeholder and project management skills, and their key role as local convenors. They are best placed to assess locally-sourced demographic data and advise energy network providers of the different energy distribution needs of various communities.

Nevertheless, local government consultations with residents will inevitably differ from place to place; not only because of the obvious social, economic and political differences between places but because each city will have a different definition of what 'smart' means. Each distinct and place-based definition of the smart city will rely upon:

- The integration of energy infrastructure and smart technologies with a city's own economic development and public services plans. Local government will wish to consider how technology or the use of data might help councils achieve broader social and economic objectives more effectively.
- Pragmatic approaches that can be adopted.
- The different participatory needs of city residents in setting and delivering smart strategies and initiatives.

These various criteria will prove pivotal for energy network providers as their roll-out of city-based physical infrastructure will inevitably have to consider the role of legacy infrastructure, future economic plans, changing demographics, current opportunities and the different needs of various groups of residents within the future smart city. **In order to understand the purpose and potential outcomes of smart initiatives within cities, energy network providers must work with, rather than for, local government.**

In addition to collaborating with the private sector to test products, deliver infrastructure and identify new business models to take projects forward, cities can start joining up efforts across departments, release more of their data, learn from international case studies on what works and what doesn't, and join new networks.

47 Future Cities Catapult (2018) – Smart City Demonstrators

Smart collaboration: the GMDSP

The Greater Manchester Data Synchronisation Programme (GMDSP) is an open data programme aimed to allow the free flow of data within public sector organisations of the Greater Manchester area, while creating a mechanism for the release of open data. Accordingly, the programme aims to:

- Create a mechanism through which Greater Manchester's open data can be linked and queried.
- Allow for skills transfers into the public sector with toolkits and resources for participants.
- Increase scope by putting civic minded developers into local authorities.
- Creating support mechanism throughout the project.
- Attract different sectors including business to create digital services.

The partner of the GMDSP include 5 councils within the Greater Manchester area and the Fire & Rescue division.

The project is run collaboratively with three innovative partners including Future Everything, Catapult: Connected Digital Economy, and Catapult: Future Cities.

This collaborative approach has proven successful for Manchester and is instructive for other UK cities. The Greater Manchester Data Synchronisation Project, which brings together the 10 councils of the Greater Manchester Combined Authority, is working with the Future Cities Catapult and other partners on a new framework that will coordinate data gathering and sharing across departments and boundaries. This experience can be translated into an approach which effectively implements energy distribution networks. Manchester's experience is particularly instructive because the city formed a central agency which could co-ordinate and implement a range of complementary 'smart' initiatives, to improve data-collection and access across policy areas and city boundaries. This collaborative and joined-up approach will prove essential as energy network providers look to implement local distribution networks in ways that would not perpetuate existing socioeconomic fault lines.

As the lessons from Amsterdam, Copenhagen and cities within the UK addressed in the next section suggest, city governments are best placed to evaluate existing conditions on the ground before implementing various infrastructural plans and smart initiatives with the help of the private sector.

5.4 Providing an amenable regulatory environment

One of the key obstacles to accelerating the uptake of smart cities is this inability of energy networks to invest ahead of demand and provide supply-side incentives. As natural monopolies, the companies controlling distribution of energy via the National Grid are tightly regulated by the UK-wide body Ofgem. Work on the network, as well as its general maintenance, is paid for by customers through their energy bill (mediated by an energy retailer, which may or may not be related in some way to the network provider). When people wish to generate energy themselves (and potentially sell this energy back into the grid) or increase capacity in their business or home to facilitate EV usage or electrical heat, that connection can require some reinforcement of the local electricity network. Currently this cost will fall on the first customer who requires that extra capacity which makes many projects unaffordable. Lifting the restriction

on investing ahead of demand would allow the cost to be shared more widely across those who will benefit in the future as well as those who require to connect now. In parallel, it removes the bottlenecks that would exist with the inevitable swift acceleration of EV/smart network take up and avoid a 'first come first serve' approach for available network capacity.

As recent controversies regarding the take up of smart meters have revealed, the government-managed roll-out of smart meters is not the most efficient way of delivering smart outcomes. The current roll-out has been entrusted by government to retailers of energy, rather than the distribution network – this has not been attempted anywhere else in the world. It should fall upon energy network providers to use their technical expertise and vast financial resources to roll out the local distribution networks necessary for EV charging points and other related smart technologies, as they are already engaged in installation and distribution in every street in the UK. Network providers are far less numerous than retailers with much greater brand recognition, as well as having an established means of carrying out works in domestic areas through network improvements. Therefore, new smart technologies should be rolled out by the network providers, rather than the retailers of energy.

Part of the problem with the regulatory landscape is the physical geography of the regulator itself. Locating the body responsible for all networks regulation from the Highlands to Land's End in a corner of central London has practical problems. It makes it difficult for the regulator to fully monitor and engage in the energy plans of various cities, particularly in the North and Scotland. Furthermore, cities will benefit from smart technologies in different ways. Discussions with local government make it obvious that instead of the traditional approach of energy regulation which is national and top-down there is a strong case given the diverse city agendas that a bottom-up approach is much more appropriate. This is why we feel Ofgem's regulatory powers should be devolved on issues related to the uptake of energy distribution and smart technology. Locally-managed regulation should, of course, be nationally coordinated. But regulatory measures should be proposed regionally at the level of the energy distribution system. Much like the A-road network, the grid is already devolved to a regional and sometimes sub-regional level (see figure 7), making devolved regulation simpler than it would be for a wholly centralised network.

6. Case Studies and Best Practice

6.1 Amsterdam: a city of partnerships

While systematic analyses of individual smart city strategies are few and far between, the case of Amsterdam's smart city strategy has enabled the construction of a step-by-step roadmap from which lessons can be learned by UK cities like Liverpool and Glasgow. The Amsterdam Smart City Programme was initiated in 2007, thanks to a collaboration between the Amsterdam Innovation Motor, the energy-network operator Liander, and the city government. Starting from the idea that information and communications technology can improve the way a city functions, these three organisations came together to embark on a programme of activities and to ensure its progressive implementation.

The programme operates across a number of categories, including mobility, infrastructure economy, and open data. Many of the projects involve stakeholders outside of government. For example, the city has begun using GPS data from an Amsterdam-based navigation software and technology provider to help manage traffic flow in real time. Data and analytics have from the outset been recognised as critical to the initiative: Amsterdam appointed its first Chief Technology Officer to coordinate its data work in 2004. The integration of data and analytics proved crucial from the initial targeting of energy infrastructure and distribution networks to the eventual uptake of EVs and smart meters by consumers.

Several lessons have been learnt which could prove telling for UK cities:

CASE STUDY: AMSTERDAM



Shore up political support.
Widespread political support and commitment has proved crucial for the city's smart strategy. Despite the change in the administration that occurred in 2010, the municipality's commitment to the roll-out of energy infrastructure and use of information technologies for promoting environmental sustainability has remained stable over time and clearly emerges in crucial policy documents.⁴⁸



Public-private partnerships are not enough.
Develop and integrate expertise from across public-private partnerships. Amsterdam's experience demonstrates that co-ordination between public bodies and private network providers, as well as that between key stakeholders located within different partners, is crucial. Planning activities started in 2008 and have been implemented by a specific team composed of various working groups belonging to each founding organisation.



Manage expectations.
Rhetoric around the internet of things and big data has created high expectations for rapid change. However, in reality Amsterdam has not seen this. Yet, expectations have been managed by the city government. It also falls upon energy network providers to manage expectations. This will involve warning consumers of the long-term gains achieved by the roll-out of local distribution networks.



Start where you are.
The fundamental first step for Amsterdam was to undertake a thorough stocktake of what turned out to be 12,000 datasets across 32 city departments, each with its own idiosyncrasies.⁴⁹ While this inventory had little short-term payoff, a successful analytics project has proved crucial for solid infrastructures and thorough data. Designing and creating this inventory has also allowed Amsterdam to keep up with a relentlessly growing data supply. Energy network providers who are planning the roll-out of local distribution centres should ensure that infrastructure planning is tied to the current and future capture and use of smart data. This will inevitably mean working with local government and those private groups responsible for analytics.



Build iteratively.
Amsterdam's smart city initiative has created more than 80 projects citywide. Many of these projects have been pilot schemes. This has allowed for spontaneous experimentation and, if required, reassessment of existing initiatives. Progress has been faster and impact greater than if the programme had been rigidly and comprehensively planned.⁵⁰

Above all, Amsterdam's experience confirms that building a smart city is an agile process rather than simply delivery against a rigid plan. The various stages (Starting, Planning, Development of Projects, Monitoring and Evaluation, Communication) are never definitively closed but are subjected to a continuous process of review and adjustment aimed at improving the structure and functioning of the strategy.

48 Luca Moura (2017) – How to Become a Smart City: Learning from Amsterdam

49 Brokaw (2016) – Six Lessons From Amsterdam's Smart City Initiative

50 Ibid.

CASE STUDY: COPENHAGEN



1.

Partnerships with a host of external stakeholders are of crucial importance when developing smart solutions.

In this regard, companies wishing to be part of the smart city market should consider engaging in new partnerships, even with other private companies which previously might have been considered competitors.

2.

Private sector use of public data can generate substantial value.

In fact, the business reuse of public data in Denmark alone has been estimated to amount to around €80 million per year.⁵¹

3.

Facilitate more public-private partnerships. Despite the successful cooperation of the public and private sectors in Copenhagen, there is still room for improvement.

As was pointed out by Claus Billehoj from the municipality of Copenhagen: "If we look at Singapore for instance, the border between the public and private sector – and the universities as well – is not as sharply drawn as it is in Denmark. There, it is a lot more integrated." According to him, both the private and the public sector need to move away from a traditional customer-supplier relationship in order to develop common solutions.⁵² This lesson is particularly instructive for energy suppliers who anticipate rolling out distribution networks. Energy suppliers need to work with local government to ensure that local distribution networks are best placed to incentivise a range of communities to adopt and use smart technologies such as meters and EVs.

4.

Capturing the positive externalities of smart solutions.

Besides having an intrinsic value, every smart city project transcends its own individual value and contributes to something greater. It can be difficult to grasp the value which lies beyond the individual smart project – as this value cannot be ascribed to a single stakeholder, but is brought about by the system in which the smart project is integrated and to which it contributes.

6.2 Copenhagen: a living lab

The road to a smarter Copenhagen is based on a dual strategy:

1. Firstly, Copenhagen aims to be the world's leading test-bed for smart and sustainable solutions. By turning itself into a living lab for new green solutions, the city is able to attract innovative companies. A very good example of this is seen in the creation of the new sustainable neighbourhood of Nordhavn, which is to house 40,000 residents and create a similar number of jobs. In order to facilitate new development, the city is focusing on collaboration (co-creation) between public authorities and private companies.⁵³
2. Secondly, Copenhagen is very much a believer in 'sharing is caring', as the successes and knowledge gained in the city are to be shared with other

⁵¹ Ibid.

⁵² Copenhagen Cleantech Cluster – Danish Smart Cities

⁵³ Copenhagen Cleantech Cluster – Danish Smart Cities: sustainable living in an urban world

cities around the world, and vice versa. This has branded Copenhagen an interesting city to invest in, and through the strong brand of Copenhagen, companies are offered co-branding if they create a solution in collaboration with the public authorities.⁵⁴

3. There are several lessons which have been learnt which could prove instructive for the roll-out of energy infrastructure and smart technologies in UK cities:

Furthermore, the added value of a smart project is often not realised right away, but takes some time to develop. This means that it can be hard to separate the cause and effect of the value created by smart city solutions.⁵⁵ This lesson could prove particularly telling for energy network providers in the UK. The benefits of essential local distribution networks will only be realised long after the fact. Ultimately, consumers will have to be informed of the initial risk undertaken by energy network providers to provide potentially long-term economic value and sustainable outcomes.

⁵⁴ Ibid.

⁵⁵ The Climate Group et al. (2011) – Information Marketplaces. The New Economics.

CASE STUDY: LESSONS FROM GLASGOW



Glasgow is a city with unique challenges and opportunities. It is a place where changing habits and culture will be essential to realising the full potential of the smart city. It is also a place that stands to benefit a great deal from more efficient and better monitored infrastructure. Setting the stage for the transformation to a smart city is a business culture and active city council who tend to recognise the imperative of getting ahead in making necessary changes.



The density of housing within the Glasgow city boundary reflects the density of population, with roughly 172 residents per square kilometre.

For Glasgow, as one city councillor told us, the switch to EVs represents the start of a necessary move away from a culture of car ownership. Smart transport infrastructure can be used to improve the transport network – the use of single-purpose travelcards ‘touched’ in on all forms of transport for example – which in turn encourages its use. Alongside educational programmes on the benefits of active transport, this can improve the health of residents and reduce traffic congestion.



There are also huge benefits to business and society from a better integrated transport network.

Areas such as the East End of Glasgow are blighted by social exclusion, something business representatives we spoke to in the city were acutely aware of. Some 47.3% of Glasgow’s residents live in areas that are among the 20% most deprived in Scotland.⁵⁶ One representative explained the problems for people in the East End looking for work or training who had to take two or more buses, charged individually, over an hour, just to access the locus of the labour market. There is, therefore, a major incentive for government local and national, along with business, to invest in the smart cities project to alleviate social problems and increase the size and dynamism of the labour market in one fell swoop.



The lack of localised regulatory oversight regarding energy became evident during Localis’ interviews with various stakeholders based in Glasgow. Some interviewees felt that the regulatory system (1) is not currently equipped for city targets and (2) prevents government, the private sector, and various stakeholders from recognising Glasgow’s targets. Glasgow’s experience of poor regulation could prove instructive for other UK cities who want to implement smart initiatives in the absence of rigid and sustainable regulatory standards.



Glasgow’s experience offers evidence of the potential success of a holistic approach and the pitfalls of an uncoordinated approach.

One of the many reasons the £24 million of funding from Innovate UK delivered a £144 million return for local people and businesses involved the growth in open data. Funding incentivised private partners to benefit from involvement in the Innovate UK programme. Funding enabled different interests and stakeholders to come together to establish new platforms for collaboration. Funding led to the coordination of public and private interests. On the other hand, there is little indication in the government’s evaluation of this Innovate UK project of the regulatory framework required to manage the growth of open data.

56 Understanding Glasgow (2017) – Deprivation in Glasgow

7. Recommendations

In order to build environmentally sustainable, economically productive and inclusive smart cities, Localis calls for the following policy recommendations:

Recommendation #1

Upgrades to networks to enable smart energy and the roll-out of EVs must be done fairly to ensure equitable opportunities for households across different socioeconomic backgrounds and to ensure existing disparities are not exacerbated.

Recommendation #2

Ofgem should loosen regulations to allow energy network providers to invest ahead of demand.

Recommendation #3

Certain regulatory powers of Ofgem should be regionally devolved so that cities can develop their own energy policy.

Recommendation #4

Local authorities should be given a mandate to form consortia and develop smart city plans which integrate various initiatives across geographical boundaries.

Recommendation #5

Public awareness of the environmental and financial benefits of smart city growth and development should be increased.

Recommendation #6

Local government should work with private energy network providers to deliver physical infrastructure.

Recommendation #7

In developing smart city strategies, private providers should be given access to public data and vice versa.

Recommendation #8

Government must produce a standardised framework for electric vehicle charging equipment and associated infrastructure upgrade requirement.

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