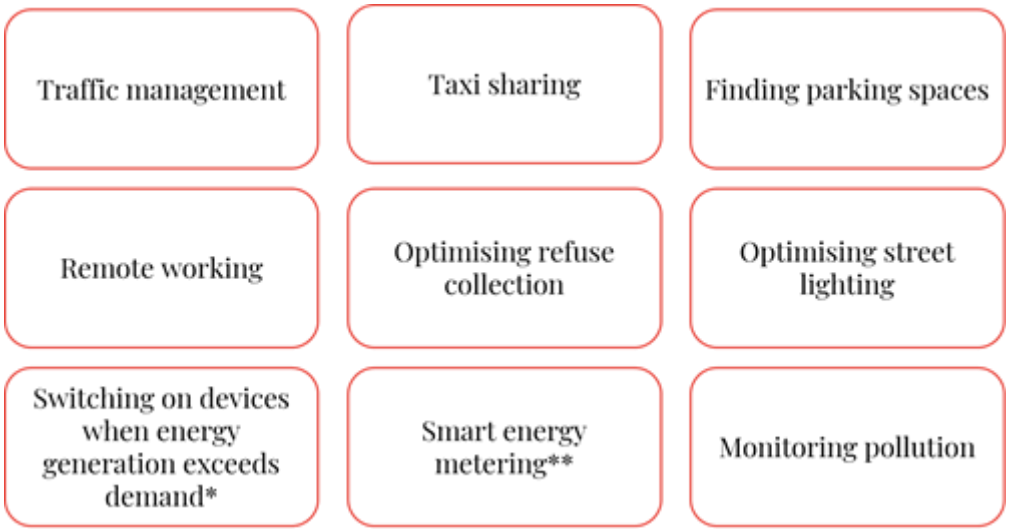
How Smart Cities can help tackle climate change

Countries around the world have set aggressive targets for cutting greenhouse gas emissions. If such goals are to be achieved, cities will need to use significantly less energy. In this article, we explain how smart cities can reduce greenhouse gas emissions and consider the role that telecoms networks could play in smart cities. Importantly, we also assess how policy makers can ensure that the appropriate telecoms infrastructure is in place to facilitate the development of smart cities.

Greenhouse gas cuts and the city

Today 55% of the world's population lives in urban areas, with this share expected to grow to 68% by 2050.[1] Cities are responsible for the majority of the world's economic activity, energy consumption and greenhouse gas emissions. Therefore, to significantly cut emissions, urban centres will need to both use less energy and take greater advantage of periods when intermittent renewable energy is available. "Smart cities" are expected to play a pivotal role in achieving these objectives. The term smart city can encompass a broad range of initiatives, but in this article we focus on those closely linked to the Internet of Things (IoT). These initiatives offer cities the potential to make step changes in efficiency by harnessing new technologies and automating processes in applications as diverse as those shown in the figure below.

Figure 1: Potential Smart Cities Applications



*Note: *Examples include charging electric cars and switching on washing machines. This will be useful because energy generation from renewable sources, such as wind and solar, are intermittent. **Users may reduce consumption if they are more aware of how much energy they are using.*

[1] UN Department of Economic and Social Affairs

While fully functioning smart cities may appear a distant dream, some urban centres are already starting to implement smart technologies. For example, in Singapore, which is often ranked as the best-performing global smart city, improvements in mobility are already coming through. First piloted in 2015, Beeline is an application for crowdsourced bus services. It works by the government sharing anonymised data with privately run bus operators to suggest new routes which are determined by community demand. This leads to more efficient public transport and helps to reduce private car usage.

The role of telecoms in smart cities

Many of the methods for reducing greenhouse gas emissions in smart cities rely on sensors either to record and relay real time consumption information or to detect the activities of residents. To be effective, many of these sensors need to be connected back to a central processing system to allow for data analysis and process automation. Fixed and mobile telecommunications networks are ideally suited for a lot of these tasks. For many of the possible use cases, relying on telecoms networks for connectivity will likely be cheaper than building bespoke networks from scratch[2].

In this article, we focus on the role of mobile networks in supporting the development of smart cities. Existing mobile networks can already support many IoT applications with minimal enhancements. For example, a modified version of 4G[3] can support many IoT applications using narrowband IoT (NB-IoT). However, at some point, smart cities will exhaust the capabilities of 4G networks. This is where the next generation mobile technology (5G) comes in, which will offer the following improvements over 4G networks (amongst others)[4]:

- Significant improvements in capacity and speeds
- An ability to support a greater number of connected devices (including IoT devices), which should help drive down the cost of sensors due to economies of scale
- An extension in the battery life of sensors, thanks to lower power requirements
- Greater reliability[5]
- Quicker response times (referred to as “lower latency”)[6]
- The ability to offer virtual “Network Slicing”, meaning that operators can offer different levels of quality of service to different users[7]
- Reduced energy consumption for the mobile network

Therefore, to maximise the reduction in greenhouse gas emissions that can be achieved by smart cities, policymakers will need to facilitate the timely roll-out of 5G.

2 It is possible that some of the possible use cases will rely on private networks.

3 Mobile technologies are split into different generations. 1G networks provided a basic voice service with low capacity and low security. 2G networks significantly increased voice capacity of mobile networks while introducing additional applications – packet data and SMS. 3G networks offered significantly more capacity for packet data services with increased performance in terms of user bandwidth. 4G networks offered increased capacity and performance for packet data services.

4 Source: ITU

5 The ITU defines reliability as “the probability that an item can perform a required function under stated conditions for a given time interval”.

6 Latency refers to the time interval (delay) between transmission and receipt of data. Latency is very important for use cases that require quick response sites. As an example, autonomous cars will require very low latency. Autonomous cars may be able to reduce greenhouse gas emissions by driving in a way that minimises traffic.

7 This will be important as different use cases will have quite different needs for quality of service. For example, only some use cases will be require very low latency and high reliability.

The future of Fibre and 5G

Mobile operators are used to having to continuously invest in upgrading their networks, because they are keen to get ahead of their competitors. Operators are likely to have a strong commercial incentive to provide extensive outdoor coverage for 5G in cities due to the high density of connections. However, in order to do so, they will need access to additional spectrum and the use of fixed telecommunications infrastructure.

These are both areas where policymakers have a role to play. They will need to ensure the timely provision of appropriate spectrum, either by auctioning new spectrum for mobile services or allowing mobile operators to re-farm existing spectrum.

Access to fibre will be fundamental to 5G. Mobile operators will need sufficient bandwidth to connect all their various sites to their networks, so policymakers will have to put in place a regulatory framework that provides operators with the necessary access to fibre. This is likely to entail effective access to ducts, poles, dark fibre and/or active fibre leased lines.

Not so smart – potential gaps in coverage

The full potential of smart cities is likely to be achieved only if there is widespread indoor and outdoor coverage of 5G in those cities. While operators may have sound incentives to provide extensive outdoor 5G coverage in cities, three potential gaps in their services stand out, absent further policy intervention.

- *Coverage along transport routes:* To date, mobile coverage has often been poor along transport routes. This may be because of significant physical constraints on the equipment that can be installed and restrictions on site access for safety reasons. Smart cities rely heavily on the efficient use of transport. Therefore, unless coverage along transport routes is improved, use cases that could reduce greenhouse gas emissions, such as optimising traffic flows may not be feasible. To reduce greenhouse gas emissions in cities, improvements in coverage on transport routes outside of urban areas will also be needed, so that people can control IoT devices in their home regardless of where they are.
- *Extensive indoor coverage:* Mobile operators have typically provided indoor coverage by relying on outdoor signals to penetrate buildings. This “outside-in” approach is possible for lower frequency spectrum. But high capacity, high performance networks will require the use of higher frequency spectrum. An “outside-in” model may not be fit for this purpose in the case of large buildings and those made of certain materials. This may limit certain IoT applications, such as switching heating elements on and off, as these are typically installed in the centre of buildings, which may not have coverage. As a result, network equipment will have to be installed inside buildings to ensure mobile coverage. But, as with major transport routes, there might not be enough space to accommodate all the equipment of multiple operators. In addition, operators need to reach agreements with landlords, so they can access property to deploy their networks.
- *New use cases:* 5G has the potential to support a number of new use cases. However, even where there is likely to be strong demand from a particular vertical use case, such as industrial automation or autonomous vehicles, operators may not have a strong incentive to invest because of asymmetric information. This is likely to be an issue where significant upfront investment is required and the operator will recoup their costs only if there is sufficient demand. In this instance, the vertical user has an incentive to exaggerate the particular business case knowing that the network operator, once they have invested in the necessary infrastructure, will share a significant part of the downside risk. Realising this, the operator will discount the business cases presented to them unless it is supported by independent analysis.

The following table shows the extent to which different gaps in coverage may affect possible smart city applications.

Figure 2: Impact of possible coverage gaps on smart city applications

Application	Will possible coverage gaps be an issue?
Traffic management	Gaps in coverage along transport routes would be a problem. Autonomous vehicles will require very high quality of service (in terms of coverage, reliability and reaction times[8]), so there could an issue with operators being reluctant to invest in a new use case. Consistent standards will be needed to ensure that autonomous vehicles function across different regions and countries.
Finding parking spaces	Gaps in coverage along transport routes would be a problem
Optimising refuse collection	
Optimising street lighting	
Pollution monitoring	
Taxi sharing	
Remote working	Gaps in coverage inside buildings would be an issue. Fixed broadband networks may represent an alternative in some instances, especially in more developed countries where fixed broadband networks are more ubiquitous.
Switching on devices when energy demand exceeds demand	
Smart energy metering	

Source: Frontier[8]

What policymakers need to do

In general, competing networks should support the delivery of the 5G infrastructure necessary to underpin a wide range of applications and use cases, including those related to the development of smart cities.

However, to help fill potential gaps in 5G provision needed for smart cities to fully develop, some policy intervention is likely to be required. In cities, where operators are most likely to densify their networks, sites suitable for hosting 5G infrastructure – probably small cells - will be at a premium. This raises access issues. It could also be a costly exercise to deploy multiple networks. A so called 'neutral host' type model could be deployed to help fill gaps in 5G coverage without undermining the overall dynamics of competing national network operators. This could call for some policy intervention.

Policymakers can also play a role in ensuring that the public sector is an early adopter of 5G. This will spur the proliferation of use cases and generate economies of scope in the use of 5G.

[8] To achieve very quick reaction times, autonomous cars may have to rely on edge computing, which means that data will not have to travel as far before being processed. In contrast, having to transmit data to and from a cloud may take too long.

Conclusion

Smart cities can help to reduce greenhouse gas emissions in the transport sector and by reducing electricity and heat production. The transport sector makes up 14% of global greenhouse gas emissions, whilst electricity and heat production contribute 25%[9] (although these percentages don't solely relate to cities). By throwing their weight behind 5G, policymakers can not only promote a range of new use cases and apps that will improve consumer experiences and business productivity, but they can also support the effort to develop smart cities and ultimately contribute to the battle against global warming.

[9] https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data

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