ERICSSON

NETWORKED SOCIETY CITY INDEX

2016 Edition

Networked Society Lab

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The Networked Society City Index compares cities' ICT maturity and their social, economic and environmental development (triple bottom line).

NETWORKED SOCIETY FOR SUSTAINABLE DEVELOPMENT

The world is entering a new era, where the economic and political importance of cities is growing rapidly. Today, the majority of the world's population lives in cities, and urban concentration is accelerating. Therefore, cities are vital for solving major social, environmental, and economic challenges.

The General Assembly of the United Nations recently adopted the 2030 Agenda for Sustainable Development. This is a plan of action for people, planet, and prosperity, and it includes 17 Sustainable Development Goals. Cities play a significant role in fulfilling the 11th goal of making cities and human settlements inclusive, safe, resilient, and sustainable – and also several of the other goals. Cities will be critical for the advancement of social conditions, poverty reduction, better health and education, and improved inclusion. Equally, cities will heavily impact the progress in encouraging economic inclusion and development toward more sustainable consumption and addressing climate change. Forthcoming joint research by Ericsson and Columbia University highlights how information and Information and Communication Technology (ICT) can accelerate the achievement of the Sustainable Development Goals.

Cities therefore need to take the lead in working toward the Networked Society, notably in terms of their social and environmental benefits and resource efficiency in a multidimensional perspective. Cities should be governed in a dynamic way in order to be resilient and be adaptive to future challenges. As such, strong and visionary leadership is necessary for cities to develop and reform institutions and systems that enable new ICT solutions to be fully implemented.

The 2016 edition of the Networked Society City Index has been developed by Ericsson in collaboration with Sweco, a leading consultancy firm specializing in sustainable development. In this edition of the Networked Society City Index, we seek to capture how cities perform in relation to sustainable operating limits and not just in relation to each other. In so doing, we have introduced the city boundaries concept. Our aim is to relate a city's environmental performance to globally recognized limits. We foresee that this tool can be

further developed in future versions of the index as more data becomes available and this Networked Society City Index approach is a basis for constructive discussion with cities on ICT and triple bottom line improvements.

The Networked Society City Index ranks cities based on ICT maturity and their performance in sustainable urban development. In this edition, we have added Riyadh in Saudi Arabia to the index, taking it to 41 cities in total.

Stockholm ranks highest in the Networked Society City Index, followed by London, Singapore, Paris, and Copenhagen. The top five cities are the same as in 2014, but Singapore has reclaimed the third position from Paris. Irrespective of the cities' current status, in all cases the index shows strong links between ICT maturity and sustainable urban development.

None of the cities in the Networked Society City Index is sustainable from an environmental perspective, not even any of the top performers. Less affluent cities may have low climate impact and low resource use, but conversely they have problems with high pollution levels and consequently lower health levels. All cities face great challenges to become more sustainable. However, ICT is proven as an enabler of change and has significant potential to further promote sustainable urban growth.

In our vision of the Networked Society, cities embrace the possibilities provided by ICT. The Networked Society is built on integrated systems and services, such as flexible and efficient energy and transport systems that can easily be adapted to consumer and societal needs. Individuals, organizations, and businesses share spaces, belongings, and services in an extensive way. Innovative ways to communicate and share information create new collaborations and organizations that are adapted to a
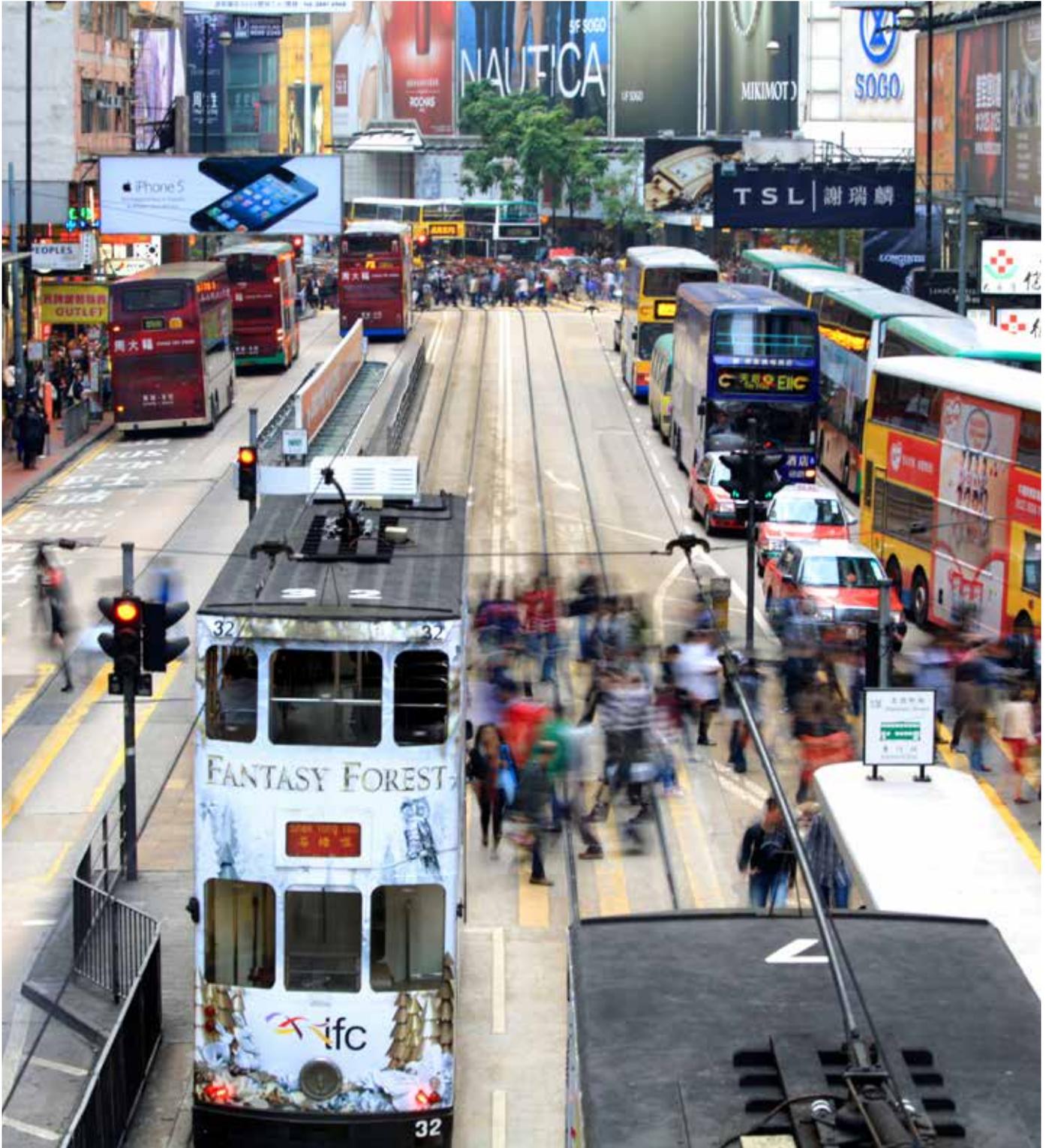
more connected and individualized society. The Networked Society is also a more responsive and transparent society that will be steered with greater access to information, respecting privacy and integrity, and powered by more effective communication.

Cities need to rethink how to change existing structures to fully grasp the benefits of the Networked Society, which go beyond the current concept of smart cities. This involves new urban planning and design combined with groundbreaking policy development and strategies. This transformation is of utmost importance for cities to become inclusive, safe, resilient, and environmentally sustainable. Technology, and ICT in particular, is essential to this development.[1]

NETWORKED SOCIETY FOR SUSTAINABLE DEVELOPMENT

Today's challenges for cities

Most cities fail to meet globally recognized limits for climate change, air pollution and fossil-free energy consumption.

Sustainable operating limit

CLIMATE CHANGE
FOSSIL-FREE ENERGY CONSUMPTION
AIR POLLUTION

Cities are facing increasing socioeconomic challenges excluding some from participating.

Vision

Cities need to rethink how to change existing structures in order to fully grasp the potential of ICT. This involves new urban planning and design together with groundbreaking policy development and strategies. This development is of utmost importance for cities to become attractive, sustainable and vibrant.

RESILIENCE   PARTICIPATION   MOBILITY   COLLABORATION

Characteristics of the future Networked Society

Networked Society of tomorrow

Cities are sustainable and resilient.

CLIMATE CHANGE
FOSSIL-FREE ENERGY CONSUMPTION
AIR POLLUTION

Cities are safe and inclusive.

A NETWORKED SOCIETY BEYOND SMART CITIES

ICT is an enabler of change and has great potential to further promote sustainable urban growth. The technologies are affecting individuals, businesses, industry sectors, communities, and governments in a far-reaching way. Information spreads around the world without delay, and one can instantly share knowledge, experiences, and emotions. ICT is an essential element of the latest innovations and a major contributor to globalization, woven into the fabric of people's daily lives. It changes the way daily activities are accomplished and how processes are executed. In so doing, it impacts the social, economic, and environmental development of cities and regions.

The 2001 OECD Ministerial report, The New Economy: Beyond the Hype, concluded that ICT was an important factor with the potential to contribute to more rapid growth and productivity gains in the years to come. Since 2001, ICT has become more powerful, accessible, and widespread. However, in 2016, the proponents of technology are still arguing that ICT can be an important enabler of sustainable growth. There are two main reasons why the argument remains the same after 15 years. First, the continuous development of ICT constantly moves the frontier forward, creating new possibilities and debates about ICT's potential. Second, the fast-paced and far-reaching impact of ICT has increased the importance of policy change and the political leadership of cities. Creating economic and social benefits, with a reduced environmental footprint, will first of all require forming an intention to achieve a sustainable future, setting goals and directions, and creating ICT-based follow-up systems to ensure that the road is followed. It will not only require large investments and commitment from different stakeholders, but also changes to regulatory frameworks, cooperation between governments and industries, and strong public engagement. It is imperative that regulatory authorities provide solid new regulatory frameworks that are updated for the digital future and allow cities to grasp the potential of ICT.

ICT HAS A KEY ROLE TO PLAY IN SUSTAINABLE DEVELOPMENT

There are many reasons why ICT is clearly one of the key enabling technologies with a major role to play in sustainable development.

First, there is the sheer scale of global participation. ICT is a technology offering practical benefits to billions of people every day.

Second, ICT is evolving rapidly, giving rise to new capabilities. Increased digitalization brings opportunities to radically improve efficiency as well as to transform consumption and production across all sectors of society. Equally, ICT presents opportunities for developing societies by introducing sustainable solutions that supersede traditional industrialization trajectories.

Third, ICT provides an innovative environment open to everyone. The collaborative dimension of ICT is already proven to be an extremely powerful force in influencing and democratizing the societal discourse. With powerful platforms and low entry barriers, ICT is also making a strong shift in terms of innovation. With access to tools, data, resources, and not least a market, innovation has turned into a matter of ideas and creativity rather than a matter of financial power. The effect is a democratizing of innovation with new, richer means of realizing the social benefits ahead.

ICT is an enabler of change and has great potential to continue to promote sustainable growth

Fourth, ICT enables perceptive decision-making and insightful follow-up to goals and directions through analytics and the collection of data while respecting privacy.

Collaboration, digitalization, automation, the Internet of Things, and virtualization are some key concepts that come with the continued development of ICT. None of these concepts is, by design, guaranteed to bring improved sustainability performance. It will, as always, be a matter of how people and societies at large take advantage of the opportunities provided. It requires leadership and global commitment to these and other capabilities for the benefit of coming generations and the health of our planet. An outline of the potential includes the following opportunities:

> Intensified **collaboration** brings possibilities to shape a future agenda together. People can significantly contribute with ideas and collaborate more effectively with resources and skills to enhance current ways of living. Increased sharing of things and collaborative consumption are examples of such opportunities.
> **Digitalization** creates new "big data" assets and layers of information. All kinds of activities, interactions, and data captured from usage and operational conditions of things, transactions, and social attitudes provide insights and optimization opportunities that simply were not possible in the past. This can lead to new and radically improved efficiencies across business and society.
> Advanced algorithms, supported by big data and analytics, bring **automation** with closed-loop systems to carry out increasingly complex tasks.

This could result in automated and highly dynamic management of large systems with more useful services provided with radically reduced resources and effort. Naturally, automation will reshape employment and, as in the course of history, we will see a shift in job-related skills requirements.
> An **Internet of Things** that can deliver more relevant functions such as smart buildings and homes, connected agricultural systems, and more become a reality, allowing different systems to optimize productivity while sharing resources.
> Significant functions, complete practices, and qualified resources and capabilities can be acquired as **virtualized** versions. This holds opportunities to change the way organizations are set up: with a simpler structure, slimmer and more decentralized, with reduced redundancy.

Even if there is early evidence of all of the above developments, we are – with the exception of collaboration – at the very early stages of developing and using these tools. To some extent, "smart cities," "smart grids," "intelligent transportation," and other industry concepts all build on ICT. However, it is clear that very few, if any, have harnessed their full potential.

Today, ICT maturity correlates better with socioeconomic progress than it does with environmental sustainability. This hinges on the general trend of an increasing environmental footprint that typically comes with socioeconomic progress. However, research and case studies indicate that ICT is not only critical to socioeconomic progress; equally importantly, it enables the decoupling of this progress from an increasing environmental footprint. As cities

invest in ICT and more data becomes available, it is both appropriate and reasonable to make a long-term prediction of the relationship between cities' environmental performance and ICT maturity. Our prediction is that the current scattered correlation will evolve into a picture where ICT is increasingly intertwined with environmental performance. We therefore envisage the emergence of the following patterns:
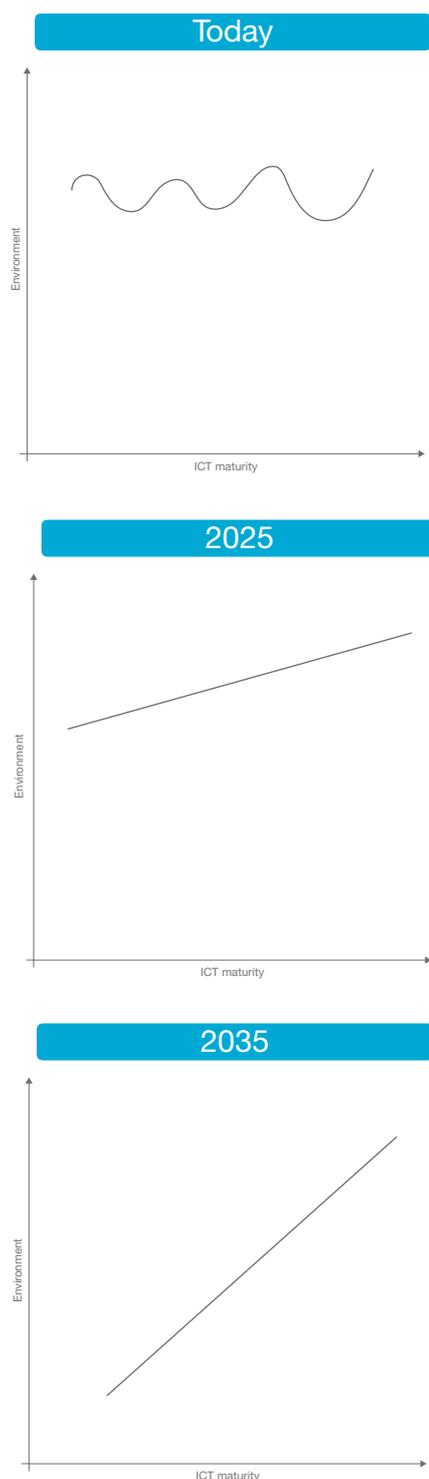

Figure 1 – Prediction of the relationship between cities' environmental performance and ICT maturity

In support of this prediction, Ericsson has recently researched the effect that ICT could have on global greenhouse gas (GHG) emissions and concluded that ICT solutions could help to reduce these by up to 15 percent by 2030. This equals around 10 gigatonnes of CO_2 equivalents: more than the current carbon footprint of the EU and US combined. This includes ICT solutions within agriculture, energy, buildings, travel and transportation, work, and services.[2]

GRASPING DIGITAL OPPORTUNITIES

To grasp the potential of ICT, we need to go beyond smart cities. Today, concepts like "smart cities," "smart grids," and "intelligent transportation" are mainly used to optimize existing systems and behaviors in cities. This approach leads to more sustainable cities, but has its limitations. Cities need to rethink how to change existing structures to fully grasp the potential provided by ICT. This involves new urban planning and design in combination with groundbreaking policy development and strategies. This development is of utmost importance for cities to become attractive, sustainable, and vibrant.

The future Networked Society city, which goes beyond the smart cities of today, has the following characteristics:

> **Resilience** – Cities and communities are robust yet adaptable. Neighborhoods are places for living, working, shopping, and seeking entertainment. Citizens have, at short distances, access to important services and daily necessities. The neighborhoods are characterized by their efficient use of resources. Individuals, organizations, and businesses share spaces, belongings, and services in an extensive way. Green areas create a coherent sense of nature in the urban environment. They provide ecosystem services, as they clean the air, take care of water, and increase biodiversity. Advanced urban agriculture and aquaculture have a natural place in the city. The energy system is efficient and adaptable, and is largely composed of locally produced renewables. Living spaces, facilities, and public spaces are multifunctional and flexible. Facilities can be shared and used for different purposes. Living space can easily be transformed to meet different needs. Public spaces can be used for different activities, and at the same time be designed to store water during heavy rainfall. All of these systems and services are integrated to facilitate collaboration and mutual exchanges between individuals and actors.
> **Collaboration** – Organizations and businesses are more dynamic, flexible, and efficient. Innovative ways to communicate and share information will usher in new collaborations, such as crowdsourcing

and crowdfunding. These networking organizations have adapted to a more connected and individualized society. They use new cloud-based services, automation, and other developments. Networked groups of self-employed people or companies work toward a common goal, then transform or dissolve. They therefore have more access to human capital and less need for financial capital, and are better able to optimize resources.

> Participation – A more responsive and transparent society, respecting privacy and integrity, will be steered by people with greater access to information, and powered by more effective communication. Individuals are engaged in city development in everyday life. This includes decision-making, urban planning, and the sharing of information on a daily basis to simplify and improve how cities function and evolve. This creates a dynamic coproduction process, resulting in more inclusive, higher quality, and more efficient public services. People are self-organizing to establish cooperative initiatives that tackle social problems, improve living conditions, increase collaboration, or – in countless other ways – make their cities better places to live.

> Mobility – Services and communities are accessible, regardless of who you are and wherever you live in the city. Everybody and almost everything is connected. The transport system is fossil-free and electric, and there are many shared alternatives. It is also flexible and can easily be adapted to changing travel patterns as the city develops. With shared resources and data, the transport system can react and adjust immediately to sudden events and new conditions, and people can easily choose the most convenient way of traveling. Thanks to global ecosystems with public transport and shared alternatives, people can easily move, regardless of the city or country they are in.

In a Networked Society, extensive data resources are used to simplify and improve city life, and to optimize and improve urban systems. Technology, and ICT in particular, is a prerequisite in this context. In the Networked Society, solutions are also of great importance to guarantee privacy. The path to more sustainable cities requires leadership, strategies, and groundbreaking efforts.

From insight to action

We are already living in the Networked Society. But cities face great challenges to become more sustainable, especially when it comes to climate mitigation and adaptation. The future Networked Society, beyond smart cities, will address these challenges to become sustainable. Based on this study and previous city reports, the following actions have been identified as essential to reach this state of development:

> **Strong and visionary leadership** on multiple layers is necessary for cities to develop and reform institutions and systems to empower participation and knowledge sharing, and enable new ICT solutions to be implemented. Furthermore, investments are needed to fulfill the United Nations' Sustainable Development Goals.

> **New regulatory frameworks** must be provided that are updated to the digital future and that allow cities to adapt to new collaboration patterns and to grasp the potential of ICT.

> **A holistic approach** is necessary to promote more resilient cities, and ICT needs to become an integral part of a city's overall development plan for the future. As cities implement new solutions, leaders should think multidimensionally and consider their social and environmental benefits and resource efficiency together. An understanding of the resource flow between countryside and city is important to make correct suitability assessments.

> **Collaboration between cities** is needed to achieve compatible solutions for a globalized world. Cities must reconsider which of their challenges need to be addressed through "custom-built" solutions, and which could be more efficiently addressed through greater knowledge sharing, collaboration, and solutions created for usage across all cities.
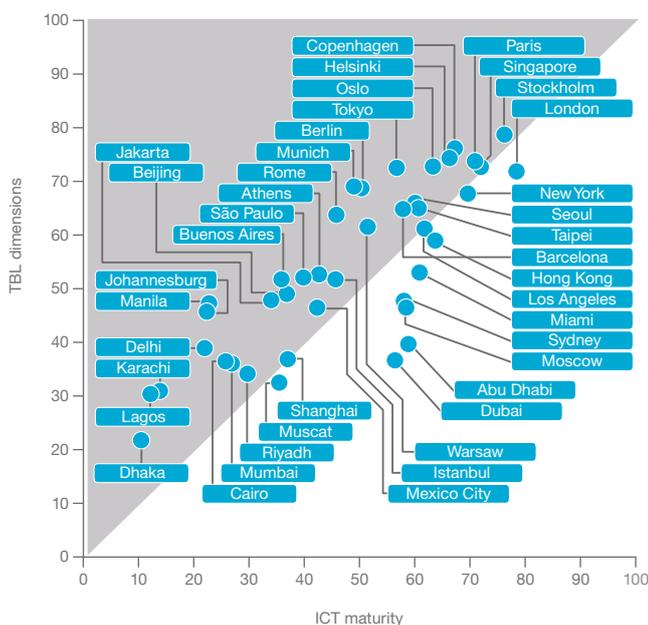
CITIES IN THE NETWORKED SOCIETY

The Networked Society City Index ranks cities based on their performance in sustainable urban development and ICT maturity. The triple bottom line (TBL) dimensions – social, economic, and environmental – reflect the three dimensions of sustainable development in the cities. Stockholm ranks top in the 2016 Networked Society City Index, followed by London, Singapore, and Paris. The race for third position is close, with Paris and Singapore again swapping positions. Stockholm and London perform well in all dimensions of the index and distinguish themselves particularly with their high ICT usage. London ranks top in the ICT part of the index, followed by Stockholm and Singapore.

Stockholm is ranked No. 1 in the TBL part of the index, closely followed by Copenhagen, Helsinki, and Paris. Stockholm keeps its No. 1 ranking in the Networked Society City Index, which is explained by high performance in all TBL dimensions, and by the city's well-developed ICT infrastructure and usage. London has had better ICT development compared with Stockholm, and therefore took over the No. 1 spot in the ICT maturity part of the index this year.

The correlation between ICT maturity and TBL shows that cities' ICT maturity largely mirrors their position on the development ladder. A high level of sustainable urban development is typically correlated to high ICT maturity. Affluent cities have reaped the benefits of early industrialization and are indeed able to invest more in ICT and are, partly due to preconditions, better at utilizing ICT investments than developing economies.

As previously mentioned, of the three sustainability dimensions measured in the index, the **social** and **economic** indicators correlate more closely with increasing ICT maturity than the **environmental** indicators, as socioeconomic progress typically increases the environmental footprint. Research and case studies indicate, however, that ICT is important to socioeconomic progress and that it can lead to a greater level of sustainability rather than increasing the environmental footprint. In this year's report, the relationship between the environmental dimension, ICT

Figure 2 – 2016 Networked Society City Index ranking and the relation between TBL and ICT

RANK	CITY
1	STOCKHOLM
2	LONDON
3	SINGAPORE
4	PARIS
5	COPENHAGEN
6	HELSINKI
7	NEW YORK
8	OSLO
9	TOKYO
10	SEOUL
11	TAIPEI
12	LOS ANGELES
13	BARCELONA
14	HONG KONG
15	BERLIN
16	MUNICH
17	MIAMI
18	WARSAW
19	ROME
20	SYDNEY

RANK	CITY
21	MOSCOW
22	ISTANBUL
23	ABU DHABI
24	ATHENS
25	SÃO PAULO
26	DUBAI
27	MEXICO CITY
28	BUENOS AIRES
29	BEIJING
30	JAKARTA
31	SHANGHAI
32	RIYADH
33	MUSCAT
34	MANILA
35	JOHANNESBURG
36	MUMBAI
37	CAIRO
38	DELHI
39	KARACHI
40	LAGOS
41	DHAKA

NORTHERN EUROPE
Stockholm, Copenhagen,
Helsinki, Oslo, Moscow

68

WESTERN AND
CENTRAL EUROPE
London, Paris, Berlin,
Barcelona, Munich,
Warsaw, Rome, Athens

60

62

NORTH AMERICA
New York, Los Angeles,
Miami

CHINA AND
NORTH EAST ASIA
Beijing, Hong Kong, Seoul,
Shanghai, Taipei, Tokyo

55

38

THE MIDDLE EAST
Dubai, Muscat, Abu Dhabi,
Cairo, Istanbul, Karachi, Riyadh

30

INDIA
Delhi, Mumbai

SOUTH EAST ASIA
AND OCEANIA
Sydney, Singapore, Dhaka,
Manila, Jakarta

43

LATIN AMERICA
São Paulo, Mexico City,
Buenos Aires

44

26

SUB-SAHARAN AFRICA
Lagos, Johannesburg

Figure 3:
Index average per region
Global average = 50

maturity, and future opportunities is analyzed in greater depth. The environmental dimension of the TBL has also been redefined to better reflect the cities' performance and development.

Performance also differs between regions. For example, the Northern European cities perform more than twice as highly, compared with cities in Sub-Saharan Africa and India. Some regions are relatively homogenous, while others have large intra-regional disparities. South East Asia and Oceania has the largest disparities among its cities, ranging from Singapore (72) to Dhaka (15).

NETWORKED CITIES ARE MAKING PROGRESS
The 2016 Networked Society City Index reveals rapid changes in technology and its uptake by people in urban centers worldwide, as cities shift toward an even more Networked Society.

The current data shows a clear improvement in ICT infrastructure in cities around the world. At the same time, ICT has become significantly more affordable, with a decrease in tariffs and IP transit prices worldwide. These developments in infrastructure and price levels have in turn generated an increase in the number of people using ICT, and changed the way new technology is used. The internet is now a truly personal experience, consumed on mobile devices and used in more and more aspects of everyday life. New patterns of relationships influence collaboration, working life, and

how business and governments interact and deliver services to customers and citizens. Today, cities with low ICT maturity tend to mature at a faster rate than cities with higher ICT maturity, which indicates that there is a catch-up effect. This can be interpreted as evidence of how new technology provides solutions to many of the challenges and problems that limit development in highly demanding environments. Lagos, Karachi, Delhi, Jakarta and Manila are cities that experience low ICT maturity levels and also face several social, economic, and environmental challenges, but in which there are many examples of social enterprises built on the foundation of ICT.

Signs of improvement in the Networked Society City Index are evident with Lagos, Karachi, Delhi, Jakarta, Manila, and Johannesburg. Although starting at a low level, they are progressing in all ICT dimensions of the index: infrastructure, affordability, and usage. European cities such as Barcelona, Berlin, Munich, and Rome are also experiencing substantial improvements in their ICT maturity. Cities that have noticeably moved up in the 2016 Networked Society City Index ranking are Barcelona, Istanbul, and Jakarta. On the other hand, Hong Kong, Moscow and Dubai have dropped in the ranking. The reasons for the change in rankings vary.

Both Istanbul and Jakarta have improved their ICT maturity and TBL performance. The quality and speed of mobile broadband networks have improved in both cities, especially in Jakarta. We can also see improvements in affordability, internet usage,
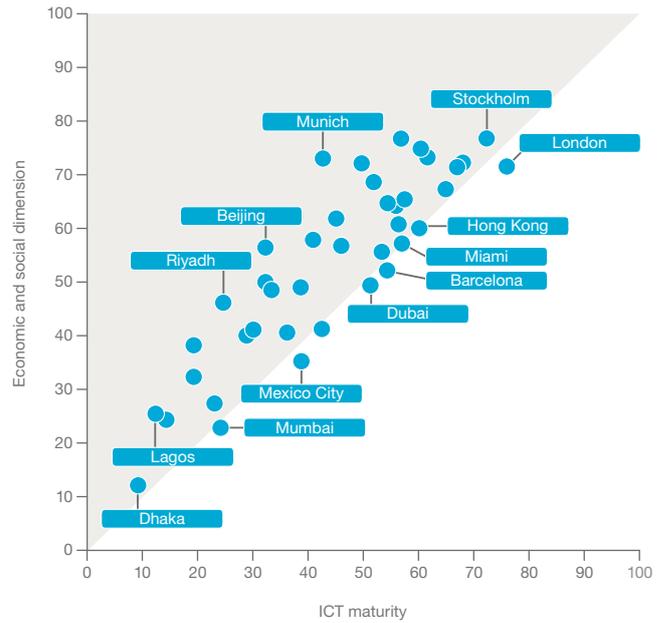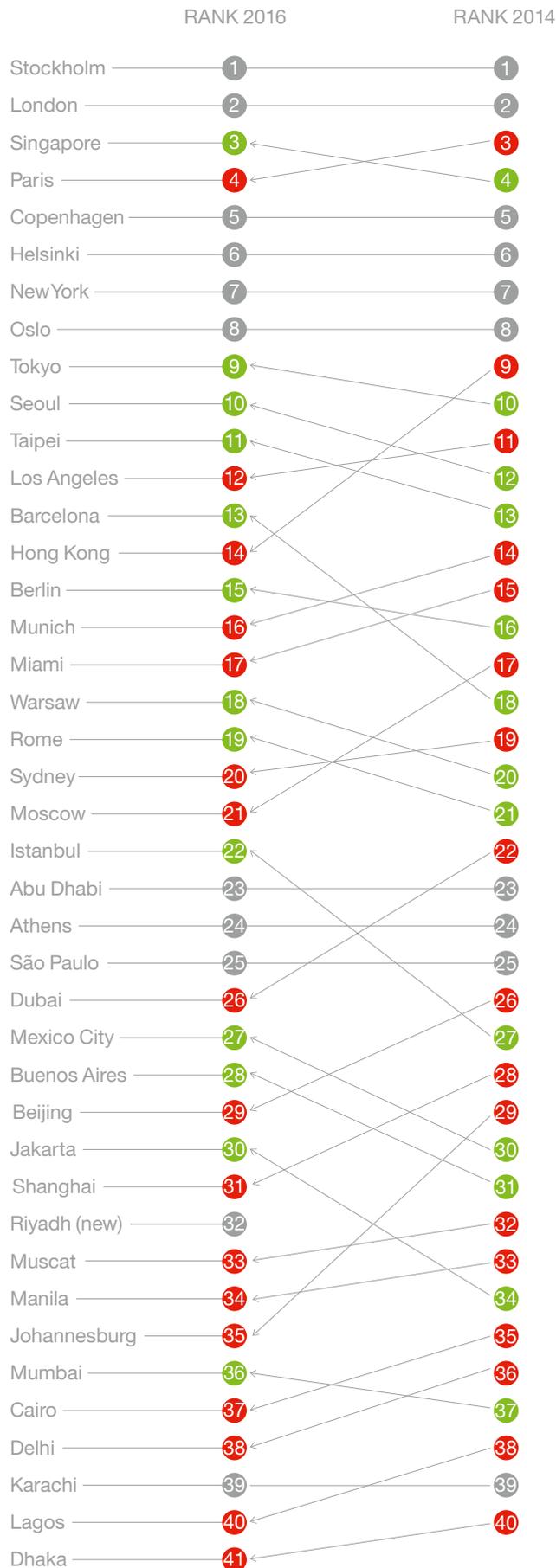
City	Rank 2016	Rank 2014
Stockholm	1	1
London	2	2
Singapore	3	3
Paris	4	4
Copenhagen	5	5
Helsinki	6	6
New York	7	7
Oslo	8	8
Tokyo	9	9
Seoul	10	10
Taipei	11	11
Los Angeles	12	12
Barcelona	13	13
Hong Kong	14	14
Berlin	15	15
Munich	16	16
Miami	17	17
Warsaw	18	18
Rome	19	19
Sydney	20	20
Moscow	21	21
Istanbul	22	22
Abu Dhabi	23	23
Athens	24	24
São Paulo	25	25
Dubai	26	26
Mexico City	27	27
Buenos Aires	28	28
Beijing	29	29
Jakarta	30	30
Shanghai	31	31
Riyadh (new)	32	32
Muscat	33	33
Manila	34	34
Johannesburg	35	35
Mumbai	36	36
Cairo	37	37
Delhi	38	38
Karachi	39	39
Lagos	40	40
Dhaka	41	

Figure 4 – Relation between TBL economic and social dimension and ICT maturity

technology use, and public and market use. Jakarta and, in particular, Istanbul perform relatively well in the new environmental variable that measures trends in mitigation and adaptation, which is one explanation for their better performance in the TBL part of the index. Positive productivity development is another reason for their improved TBL performance, particularly Jakarta.

Barcelona has made clear progress in the TBL part of the index, improving its ranking in all TBL dimensions. One reason behind the higher ranking is a better performance for trends in mitigation and adaption compared with other cities that were previously ranked higher than Barcelona in the index. Overall, the higher ranking is explained by small positive changes in many of the indicators that together give Barcelona an improved performance on last year's index.

Hong Kong, Moscow, and Dubai have either the same or a slightly better ICT maturity ranking compared with the previous index. Their drop in the 2016 Networked Society City Index ranking is explained by a lower TBL ranking. This is mostly because of low performance in the new environmental variable that measures trends in mitigation and adaptation. For instance, Hong Kong performs well when it comes to sustainable modes for transportation, but its energy consumption has long been highly dependent on fossil fuels. The index has also been developed with new proxies that measure gender balance in employment and R&D expenditure. In particular, Dubai, and also Hong Kong, have a relatively low gender equality performance. All three cities also have a relatively low R&D performance compared with other cities in the index. Finally, Moscow and Dubai

have not had an equally positive improvement in productivity compared with other cities in the index.

Over the past two years, London has had better ICT development than Stockholm. As a consequence, London now ranks No. 1 in ICT maturity. Stockholm has to look out for continued progress from London, Paris, Singapore, and Copenhagen, particularly in both fixed and mobile broadband quality. These are important areas where Stockholm, despite its No. 1 position today, is not progressing as quickly. Interestingly, the race for third position is closely contested, with Paris and Singapore again swapping positions. The results are particularly close in many ICT maturity areas. While Paris is superior to Singapore in terms of international bandwidth capacity and use of electronic payments, Singapore performs consistently better than Paris for mobile broadband access and quality.

INVESTMENT IN ICT DRIVES SOCIAL AND ECONOMIC DEVELOPMENT

Networked cities are making progress, and research shows that investing in ICT is a key driver of social and economic development, both in emerging and developed economies. Cities often invest in ICT partly because of the sector's potential to have a positive impact on social and economic sustainability. Cities with high ICT maturity present the highest levels of social and economic development, suggesting that a city facilitated by ICT improves its overall performance in the long run. Equally, in cities with high ICT maturity, investment and spending on ICT services are prioritized on individual, business, and institutional levels throughout the different stages of development. A richer social life and new experiences, a more efficient daily life, and better ways to run organizations and businesses, as well as more groundbreaking innovations with radically new ways to tackle urban life and start new businesses, are some of the qualities of ICT that spur socioeconomic development.

ICT changes the rationale of value creation and wealth in cities

ICT affects economic growth in several ways. For instance, the presence of an ICT-producing industry can support growth in itself and plays an important role in some cities, but not all. However, the most important benefits arise from the possibilities provided by ICT to
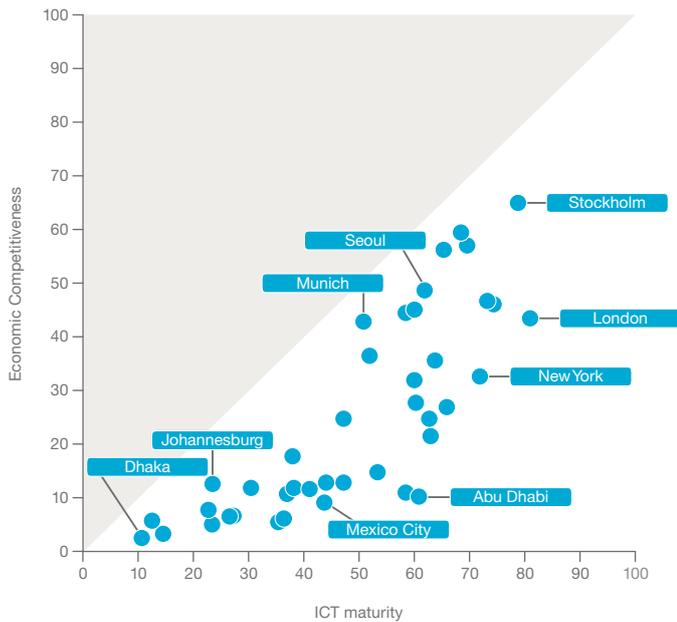
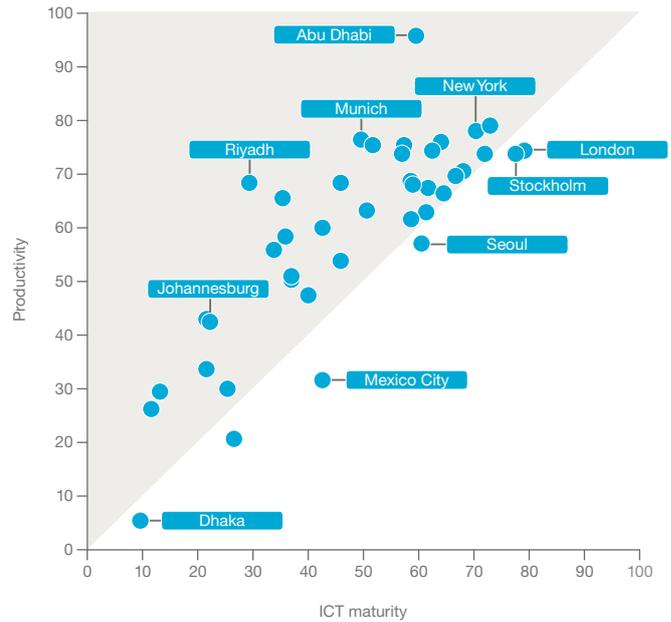Figure 5 – Relation between economic competiveness and ICT maturity

Figure 6 – Relation between productivity and ICT maturity

enhance productivity and enable transformation in other industries. Investment in ICT helps raise labor productivity across all sectors. At the same time, the use of ICT helps individuals, businesses, and governments to enhance efficiency and increase innovation.

> ## In the same way that ICT enables the shift in consumption from ownership to access, it is also a driver for new, innovative ways to collaborate and share information

The 2016 Networked Society City Index shows that ICT maturity strongly correlates to both productivity[3] and economic competitiveness.[4] Stockholm has the highest performance in economic competitiveness, followed by the other Northern European cities, which is explained by a high performance in all indicators. However, there are many cities that perform better than Stockholm when it comes to productivity. In this aspect, the top-performing cities are Singapore, New York, and Abu Dhabi.

The cities' combined economic performance, productivity, and economic competitiveness are particularly linked to their performance in public and

market use of ICT. Cities with well-developed open data resources and e-governance, as well as high use of electronic payments, often perform well in the economic part of the TBL index. The top-performing cities perform very well in open data and web presence. However, Singapore and Paris perform less well in their use of electronic payments such as e-commerce and mobile payments.

The curve illustrating the relationship between ICT maturity and productivity decreases at higher ICT maturity and productivity levels. At the opposite end, the relationship between economic competitiveness and ICT maturity indicates that a city needs to reach a certain level of ICT maturity before it can capitalize on its economic competitiveness. A strong economy provides better preconditions for investing in ICT. At the same time, ICT investments are a key driver for economic development in both emerging and developed economies. However, at a certain level of ICT maturity, the effect on the overall productivity in the economy seems to decrease and, simultaneously, the effect on economic competitiveness increases. This is probably connected to the overall development of the city and the need to reach a certain stage of development before the knowledge-intensive sector starts to grow, innovations are developed, and higher education becomes more widespread – and thus the possibility to gain from ICT increases.

This interesting diverse pattern in the relationship between ICT maturity, productivity, and economic competitiveness also reflects how the economy
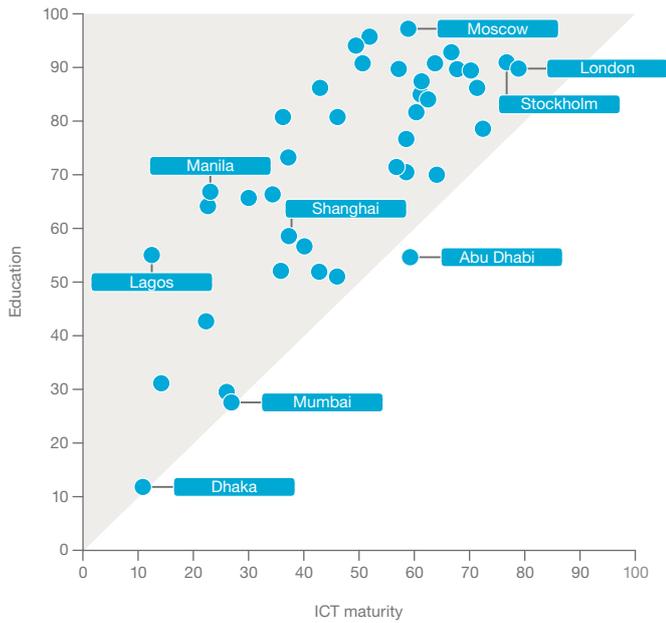
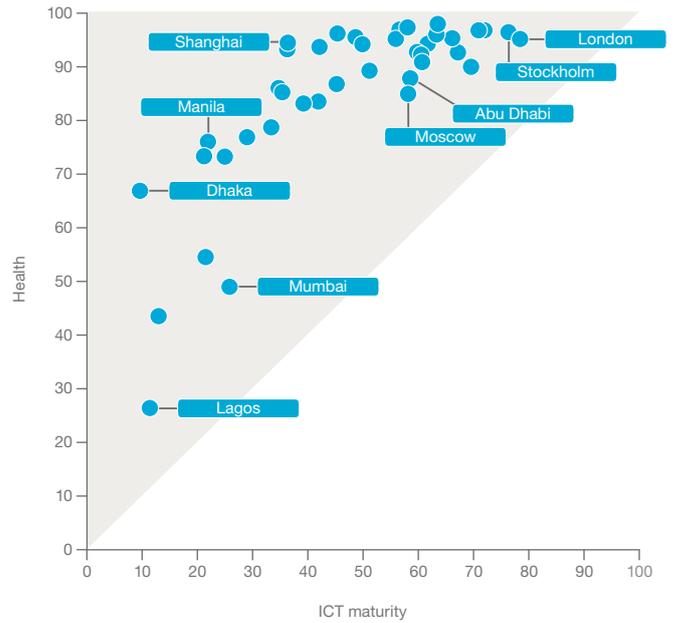Figure 7 – Relation between education and ICT maturity

Figure 8 – Relation between health and ICT maturity

functions in more advanced networked societies. The previous edition of the Networked Society City Index discussed how GDP, as a measurement of growth and productivity, needs to be redefined to capture a new understanding of sustainable value creation and wealth in cities. ICT is changing the rationale for value creation and, with it, the wealth of cities. Collaborative consumption – or sharing economies – signals a shift in consumption from ownership to access. High-density cities can use network technologies to do more with less by renting, lending, swapping, gifting, and sharing products, instead of increasing consumption and production. GDP does not capture this kind of value creation, and it is probably one explanation behind the pattern we already see today, with decreasing growth in GDP per capita at higher ICT maturity levels. How we measure growth and progress will be vital to achieving a higher level of sustainable development.

As the existing GDP measurements do not capture these new and increasingly important aspects of the economy, human well-being, and sustainable resource management, city leaders risk making poor assumptions regarding growth. The Networked Society, therefore, requires a new perspective on value creation and a new definition of growth.

ICT has the potential to help aid entrepreneurial activity by, for example, spurring an increase in the sharing of technology and knowledge. In the same way that ICT enables a shift in consumption from ownership to access, it is also a driver for new innovative ways to collaborate and share information.

Tesla Motors is a good example. The company shares its technology on the internet for anyone to take part in its innovation. Even though the purpose is multifaceted, it is an example of how a company can take advantage of opportunities in the Networked Society. Another example is a 3D printing house in Amsterdam, which uses the internet to spread ideas in order for people around the world to test the technology and provide input. The project is collectively funded, and the partners contribute with knowledge and finance. In this way, small companies benefit from an alternative to expensive R&D activities. These examples show how ICT can alter the economic system in profound ways. This change is current, but is in many ways still in its initial stages.

ICT can enable a more socially sustainable society

Beyond economic benefits, ICT is in a unique position to enable a more socially sustainable society. When considering the ICT industry's reach, with almost 5 billion people having a mobile phone and 3.6 billion mobile broadband subscriptions globally at the end of 2015[5], the importance of ICT in cities' social life cannot be understated.

The 2016 Networked Society City Index shows that ICT maturity is strongly connected to economic development, health and educational level. However, the potential of ICT in terms of raising the social quality of life in cities is still substantial. ICT enables a democratization of knowledge by enabling everyone with access to the internet to partake in knowledge in new ways. This can, for example, be seen in educational

institutions, with several Ivy League universities now providing access to seminars and courses for free, and other actors, such as the Khan Academy, being solely internet based and free for everyone.

This evolution is already significantly reducing barriers to knowledge, and there are no reasons to expect that this development should not accelerate and continue to play a significant role in educational systems. Equally, access to, and dispersion of, knowledge can also have positive effects on health through new and digital ways to provide professional care and treatment, as well as increased general knowledge for better self-care and proactive wellness for billions of citizens.

Gender equality and ICT

The United Nations Development Programme's Gender Inequality Index shows that no part of the world has achieved substantial gender equality. Women earn less, hold fewer positions of power, and make fewer decisions in businesses, as well as in political and public life. These inequalities also affect the ability of women to benefit equally from the opportunities linked to ICT.

The 2016 Networked Society City Index measures gender equality in three important aspects of human development: 1) "gender equality in governance," measured as the proportion of women to men on the city council; 2) "gender equality in employment," measured as labor market participation; and 3) "gender equality in education," measured as participation in secondary and higher education. The relationship
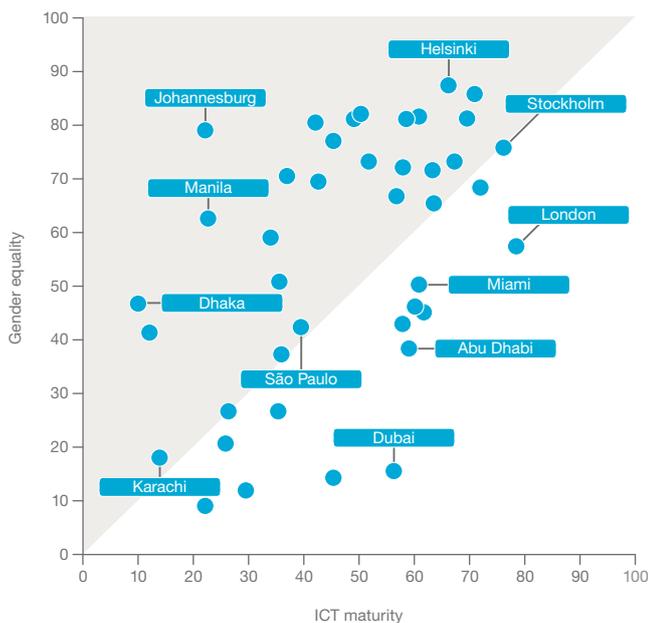
between ICT maturity and gender equality in education is scattered, while there is a positive relationship between ICT maturity and gender equality in employment and governance. This indicates that women in cities all around the world are well-educated relative to men and that female participation in higher education is not an effect of urban development but more to do with cultural factors. The scattered relationship between ICT and gender equality in education is also explained by lower enrollment among young men compared with women in some more affluent cities.

However, women in cities with lower ICT maturity, and therefore a lower stage of development, don't participate in the labor market to the same extent as women in more developed economies. The more developed an economy is, the greater the proportion of women in education who also participate in the labor market and benefit from the opportunities offered by ICT.

ICT can contribute to the empowerment of women around the world. While there is recognition of the potential of ICT as a tool for promoting gender equality and empowering women, a "gender divide" has also been identified, reflected in the lower number of women accessing and using ICT compared with men. Technologies are socially constructed and typically have a different impact on women and men. Women's capacity to exploit the potential of ICT as a tool for empowerment is constrained in different ways. These constraints, including technical infrastructure, computer literacy, and language skills, affect both women and men but concern women to a greater extent. Unless this gender divide is addressed, there is a risk that ICT may create new forms of inequalities between women and men and slow down the desired progress in terms of gender equality. For example, research shows that patterns of gender segregation are being reproduced in the information economy, with women concentrated in end-user, lower-skilled ICT jobs related to word-processing and data entry and men in more senior positions – managerial, administration, and design of networks, operating systems, and software.

However, ICT could contribute to the empowerment of girls and women around the world. Access to ICT can enable women to gain a stronger voice in their communities and in politics at the local, national, and global level. ICT also offers women flexibility in time and space and can be of great value to women who face social isolation. However, the gender aspects of ICT in terms of access and use, knowledge building, employment, and empowerment, must be addressed for ICT to be a powerful tool for the political and social empowerment of women and the overall promotion of gender equality.

Figure 9 – Relation between gender equality and ICT maturity

STRIVING CITIES – JAKARTA

Jakarta ranks 30th in the 2016 Networked Society City Index. Jakarta has improved both its ICT maturity and TBL performance and therefore its ranking. This is no coincidence; it has required strong leadership and initiatives at both national and city level.

In October 2014, the Indonesian government introduced a broadband connectivity plan to boost economic growth. The Indonesia Broadband Plan, which was later included in the National Medium Term Development Plan 2015-2019, defines broadband development and sets a strategy and major milestones for the coming five years. At the end of 2015, all programs had completed their first stage.

In December 2014, the Jakarta administration launched the Jakarta Smart City program in an effort to establish a new, technology-based service for its residents. During the launch, the city introduced the Jakarta Smart City website, smartcity.jakarta.go.id, as well as the smartphone applications Qlue for residents and CROP Jakarta (Cepat Respon Opini Publik) for civil servants and officials.

The website is integrated with the Qlue and CROP Jakarta applications. It displays road traffic information from Waze and various information from Qlue and CROP Jakarta using the Google Maps platform. Qlue is a crowdsourcing smartphone application in which users can report various incidents such as floods, crime, fire, or waste issues, and city officials respond through the CROP Jakarta smartphone application. Information on both Qlue and CROP is displayed and updated in real time in smartcity.jakarta.go.id. The website also has information about the location of schools, community health centers, fuel stations, hospitals, and restaurants.

Using these programs, the administration hopes to optimize services for residents with the support of technology. The app allows anybody to report problems they encounter throughout the city, such as potholes in the road, by taking a photo and filling out a short online form that is then relayed to the appropriate public official. With the program, the city officials and civil servants can see complaints in real time. Related civil servants and officials nearest to the reported incidents are detected through their smartphones and respond to the report. The government can monitor the performance of each official by seeing how long it takes them to respond to public complaints. The programs will also be integrated with the Jakarta Police's Kring Reserse, a program aimed at enhancing police response to crimes.

Later in 2015, a new suite of transportation features was released in Qlue. On top of a Google Maps layer, app users can see the city's public bus transportation system, TransJakarta, operating in real time. All stops are marked, and labeled buses can be seen traversing their routes. There are also layers for gas stations, train stations, and meeting points for "mudik bareng" – organized trips to travel home along particular routes as a group. Traffic reports created on the Waze application are also integrated into Qlue's transportation map on a separate layer. It is planned to integrate the city's commuter train system, so that passengers can see when trains will arrive at a particular station, or if there are significant delays.

There are many other good examples of how Jakarta has used ICT solutions for sustainable urban development. One is by providing better access to electricity, which is not evenly distributed throughout Jakarta today. Sustainable, plentiful, and affordable energy is a global issue, but it reaches even greater importance in the developing world, where the question of affordability is critical. The state electricity company in Jakarta, PLN, has started a new program where street vendors can buy small, affordable amounts of electricity through a coin-operated device. When they run out, they can top up with another coin, like using a pay phone. By adding M2M (machine-to-machine) features to the device, PLN will be able to operate its smart wireless device remotely and collect usability information in real time.

Another ICT example from Jakarta, and Indonesia, is the use of e-procurement to prevent corruption. Since the Indonesian government created an e-procurement unit (LPSE) to oversee the implementation of e-procurement systems across national and local-level governments, the country has seen slow, albeit generally steady, improvement in perceived corruption.

ICT'S ROLE IN DECOUPLING CITIES' SOCIOECONOMIC PROGRESS FROM INCREASED RESOURCE INTENSITY

The rapid development of ICT over the past two decades is driving digitalization and transforming our societies, creating radically different conditions for the future – one in which people are better informed and equipped with new and far more effective means by which to collaborate, share, and participate in society. Moreover, ICT is laying a new foundation for massive, cross-sector innovation, fueling radical change in how different industries and societal sectors operate. Some of the key characteristics of this new innovation paradigm are digital value creation, sharing and collaborative consumption service models, and large-scale efficiency gains by exploiting, for example, the value from data, analytics, and artificial intelligence.

Looking ahead, it is expected that technology will be a critical enabler in securing the necessary decoupling of continued socioeconomic progress with environmental degradation. Different technology in transportation and buildings, as well as carbon-neutral energy production, are examples of how innovations in new technology are increasingly pushing development in this direction. Moreover, on an industrial level, intelligent transportation, smart electricity grids, interactive e-health, and individualized e-learning are some of the ICT solutions that bring much-needed socioeconomic progress under the new condition of diminishing society's environmental impact. Equally, ICT can bring new innovative opportunities for social entrepreneurship by enabling the inclusion of groups previously left

outside banking, insurance systems, health care systems, and the labor market.

These and many more areas illustrate the power of ICT to enable attractive paths to prosperity and inclusion, with far better utilization of resources and reduced environmental impact compared with traditional approaches. Precisely how this development will unfold is hard to predict. But it is widely accepted that ICT has an important role to play in transitioning societies to a more sustainable future, as already seen in ICT's potential to accelerate achievement of the UN's Sustainable Development Goals. This is why we believe that the relationship between the complete TBL (economic, social, and environmental) development and increasing ICT maturity in cities should be continually analyzed, thus improving our ability to set more relevant targets and achieve better follow-up progress.

ICT's correlation to cities' environmental performance in the index

The social and economic dimensions of the 2016 Networked Society City Index demonstrate a strong and positive correlation with increasing ICT maturity. However, in the environmental dimension, the picture is more complex. The positive correlation in the former is the result of several multifaceted dependencies rather than a clear input-output relationship. In short, socioeconomic progress drives technological development for example, increasing the performance, availability, and usage of ICT. Equally, using ICT improves socioeconomic conditions. This intertwined causality is continuously repeated as innovation and
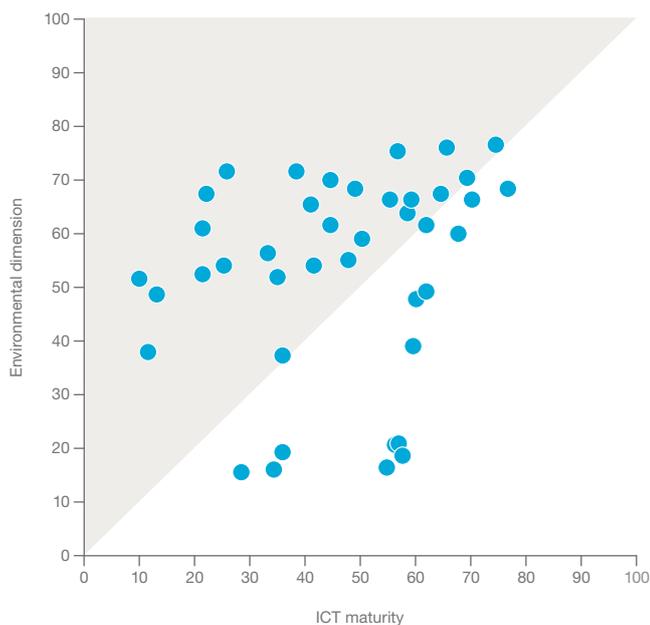

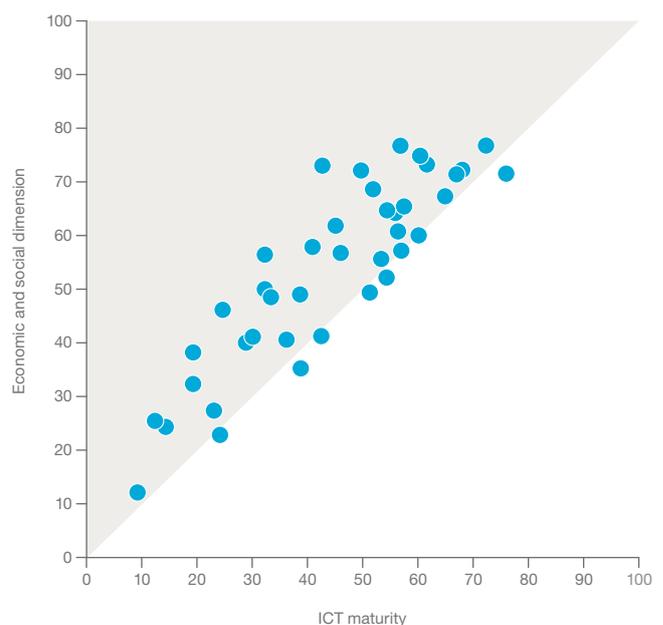Figure 10 – Relation between environment and ICT maturity

Figure 11 – Relation between economic/social factors and ICT maturity

new developments emerge, both in highly developed and developing urban and rural conditions.

In contrast, the environmental indicators mapped to respective cities' ICT maturity (Figure 10) present a scattered picture with a weak positive correlation. Looking at some of the specifics of the different data sets in the environmental dimension of the Networked Society City Index, it is clear that patterns of correlation between subsets of environmental variables and ICT maturity vary depending on a city's socioeconomic development. Specifically, cities' environmental performance regarding carbon dioxide emissions deteriorates as cities become more affluent, even while pollution levels tend to decrease, leading to an overall increase in emissions per capita.

This scattered picture is very similar to a mapping of the environmental dimension of socioeconomic progress. This supports the view that the relationship of technological progress – in this case ICT – to environmental performance mimics the relationship between the overall progress of civilization and the environment. In other words, socioeconomic development generally comes at the price of an increased environmental footprint. A reasonable explanation is that, until very recently, technology has

mainly evolved in response to socioeconomic needs. However, current developments give grounds to believe that this relationship between technology and socioeconomic development will increasingly incorporate, and focus on, addressing environmental challenges.

Looking ahead, it is expected that technology will be a critical enabler in securing the necessary decoupling of continued socioeconomic progress with environmental degradation

Mitigation and adaptation efforts are needed

In the economic dimension of the Networked Society City Index, two variables are used to capture the economic performance. The first is productivity, which is captured by the city's GDP per capita. The second is competitiveness, which aims to capture economic potential. Competitiveness is aggregated from a set of data points capturing innovation, intellectual activities,

and education status. In this year's index, we have applied a similar way of thinking to capture the existing potential for progress within the environmental dimension of the index. In particular, we are using trend data in the areas of energy and transportation to capture the direction of cities' progress in mitigation and adaptation efforts, thereby providing indicators for how well cities are prepared for future challenges.

Future readiness can, for example, be improved by cities reducing their CO_2 emissions through incentivizing energy efficiency measures and increasing the share of renewable energy in their energy supply. Fossil energy represents a significant share of the total energy mix for most cities. More specifically, South and East Asian cities tend to rely largely on coal, while Middle Eastern cities use natural gas to a great extent. Finally, Scandinavian cities' energy supply is largely based on hydro and nuclear power. Moreover, the share of modern renewables in the energy system is increasing substantially. This illustrates how contextual factors such as proximity to natural resources and local climate shape cities' energy use and supply. In addition, national plans and strategies, which the cities cannot influence, heavily affect supply.

With regard to energy intensity, most cities have experienced faster GDP growth than energy consumption growth. The results also show that cities with similar characteristics have followed different trajectories of energy intensity. For example, London's energy intensity has decreased substantially more than Paris' over the past few years.

More affluent cities, with high ICT maturity, generally enjoy a positive development with more rapid GDP growth than energy consumption growth, and are at the same time increasing the share of renewable energy in their energy supply. Some less affluent cities also show a positive trend, which indicates that it is possible to have sustainable economic growth at all development stages.

When analyzing cities' carbon emissions and resource use (including both energy consumption and waste per capita) relative to their economic development, three distinct categories of cities can be identified in the index: 1) affluent cities with medium to low resource use; 2) affluent cities with high resource use; and 3) better performing cities from an environmental standpoint (Figure 13). Several index cities do not fit into these categories, some of which are found in middle-income countries and have undergone a period of rapid development. Other cities are more affluent but have a large manufacturing base, which reduces their performance.

STRIVING CITIES – SEOUL

Seoul ranks 10th in the 2016 Networked Society City Index. Seoul has improved its ranking compared with 2014 (12) and 2013 (13). This is mostly explained by a better performance in the TBL part of the index.

Since the 1997 Asian financial crisis, ICT has emerged as an important growth engine in South Korea. Uptake of ICT solutions in the country is extremely high, supported by national strategies such as Cyber Korea 21 and financial initiatives. However, the country's rapid industrialization has resulted in carbon emissions more than doubling between 1990 and 2012. Moreover, environmental and natural resources are under pressure, and the country is vulnerable to energy price fluctuations because of its high dependence on imported energy.

This led South Korea to act on its environmental performance by developing ICT solutions. Priority areas include smart grids, waste management using ICT, public transportation equipped with a smart transportation system, and advanced industries. Ahead of COP21 in Paris, the country pledged to reduce its GHG emissions by 37 percent by 2030.

Seoul is considered to be one of the most technologically advanced cities in the world and is utilizing this advantage in its environmental strategies. The city has outlined targets to increase its self-reliance on electricity to 20 percent, cut GHG emissions by 10 million tonnes, and reduce energy use by 4 million tonnes by 2020. To integrate ICT solutions into its strategies, the city launched Smart Seoul 2015 with the purpose of upholding its reputation as a global leader in ICT and to boost sustainability and competitiveness through smart technologies. Of particular interest, Smart Seoul tries to create a collaborative relationship between the city and its citizens.

1. Affluent cities with medium to low resource use

Many Northern European, other Western, and several East Asian cities are found in the category of affluent cities with medium to low resource use. They are characterized by relatively low CO_2 emissions per capita, low energy usage, a relatively high use of non-fossil fuel energy sources, and relatively low pollution levels. Moreover, they enjoy a service-based economy that produces high-value goods and services.

The cities' urban planning policies and geographical context have led to high urban density and well-developed public transportation. Nonetheless, they are still environmentally unsustainable, not least from a consumption-based perspective. Consequently, these cities face a large, but manageable, challenge in reducing their CO_2 emissions and resource use.

By 2030, affluent cities with high urban density and low energy intensity could see their environmental performance increase substantially. ICT is a key enabler that needs to be an integrated part of the cities' implemented plans. Importantly, ICT solutions can be used to incrementally improve the performance of existing low carbon-intensity infrastructure. Moreover, ICT solutions could help to increase the environmental performance of new infrastructure, while simultaneously improving citizens' behavioral patterns, such as consumption levels and the introduction of sharing concepts for cars, housing, and office space. There are already many examples of how these new sharing concepts are being implemented in cities.

2. Affluent cities with high resource use

Affluent cities with high resource use include Muscat, Riyadh, Shanghai, Dubai, and Abu Dhabi. They are characterized by having very high levels of CO_2 per capita, combined with high energy usage and low use of non-fossil fuel energy sources. Often, these cities' economies are most often dependent upon national energy plans. They have generally promoted urban planning policies that have incentivized urban sprawl, along with a high reliance on automobile transportation. Unsurprisingly, their infrastructure and buildings are poorly adapted to environmental concerns. For example, a high reliance on air-conditioning, as opposed to traditional building methods, increases energy consumption. ICT solutions can be implemented to improve their environmental performance. For example, existing infrastructure with high carbon intensity could be incrementally improved using ICT solutions.

3. Better performing cities from an environmental standpoint

Finally, cities such as Dhaka, Lagos, and Karachi belong to the category of better performing cities from an environmental standpoint. Cities in this category perform well with regard to CO_2 emissions and energy usage per capita but experience high levels of pollution. Their private sector produces relatively low-value products and services, and many are undergoing a period of rapid industrialization and urbanization. Their infrastructure is often underdeveloped with regard to the needs of their citizens and the private sector.
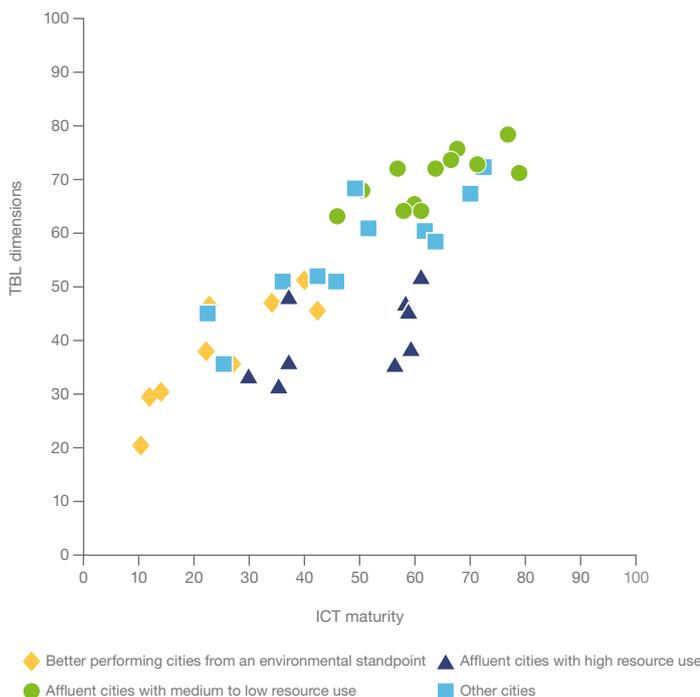

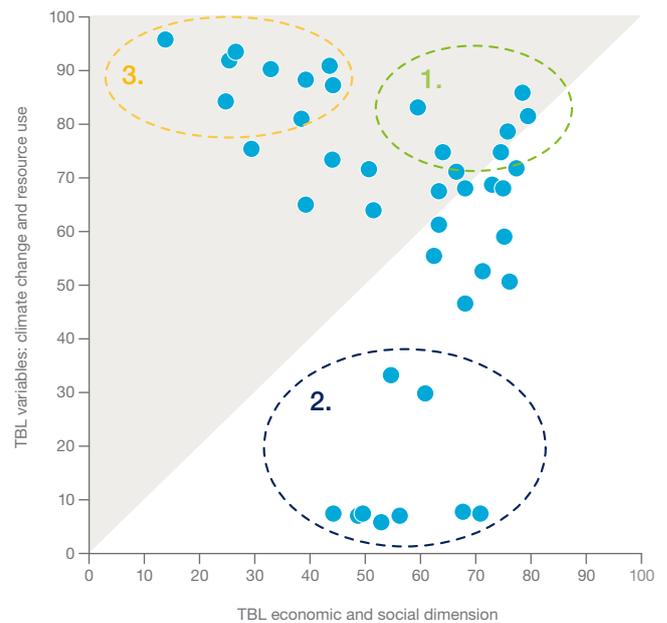Figure 12 – Relation between TBL and ICT maturity by city clusters

Figure 13 – Relation between socioeconomic performance and cities' performance in climate change and resource use

Many of these cities are at a crossroads in their development and should seek to avoid following the same path as the more affluent cities described above. Instead, they should grasp the opportunity to avoid carbon-intensive development by using ICT, thus enjoying low carbon development. Although cities in this category face multiple challenges, they also have the potential to gain a competitive advantage by creating a new form of development.

City boundaries: a concept for developing the Networked Society City Index

As the cities in the Networked Society City Index span a wide range of socioeconomic development, it can be reasonably assumed that they reflect the global situation; however, the environmental dimension is more challenging. To better understand and represent the cities' environmental performance, we therefore consider a "city boundaries concept" in this 2016 Networked Society City Index. The city boundaries concept is inspired by the planetary boundaries framework developed by a group of scientists led by Johan Rockström from the Stockholm Resilience Centre and Will Steffen from the Australian National University.

First published in 2009, the planetary boundaries framework has become recognized internationally as a method to highlight humanity's consumption of natural resources. According to its foundational research, humanity is exceeding its safe operating space regarding several planetary boundaries. For example, the planet's biosphere integrity is severely impaired, and the safe operating spaces of land-use change and climate change have been overstepped.

By introducing the city boundaries concept, we seek to capture how cities perform in relation to absolute targets and not just in relation to each other

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In a similar way, the city boundaries concept illustrates cities' environmental performance in relation to absolute targets[6] rather than according to their relative performance. As an example, three areas are included in the city boundaries environmental framework concept: climate change, air pollution, and fossil-free energy consumption. The climate change target is based on findings from the United Nations Environment Programme (Intergovernmental Panel on Climate Change) regarding the amount of CO_2 that can be

sustainably consumed per global inhabitant (in this report the city boundary is illustrated at around 1.8 tonnes per capita). The air quality target follows WHO's 2005 air quality guidelines for annual PM2.5 (10 μg/m3), and the goal for fossil-free energy is to have 100 percent decarbonized energy consumption. There will likely be other relevant indicators, however these three areas and indicators provide us with a reference to start the discussion.

By adopting the planetary approach for the city boundaries concept, we seek to capture how cities perform in relation to sustainable operating limits and not just in relation to each other. In other words, the city boundaries concept aims to illustrate if a city is environmentally sustainable. Our goal is to relate a city's environmental performance to globally recognized limits.

No cities in the Networked Society City Index are sustainable, not even the top performers. Less affluent cities may have low climate impact and low resource use, but they have problems with high pollution levels and consequently also lower health levels.
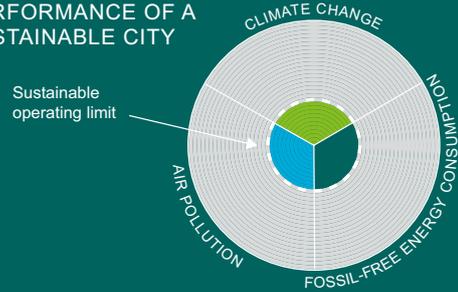
Some examples of city boundaries are shown overleaf for London, Helsinki, Moscow, Beijing, São Paulo, and Delhi. London is ranked second in the Networked Society City Index. However, when applying city boundaries to London, it is clear that the city needs to improve its performance. London fails to meet any of the city boundary targets, and is especially unsustainable when it comes to climate change. Helsinki's air pollution levels are substantially below the city boundary target, although the city needs to increase its share of consumed fossil-free energy. Moreover, CO_2 emissions need to be decreased substantially. Moscow and Beijing perform substantially worse than both London and Helsinki. The cities need to decrease their share of consumed fossil energy to lower carbon emissions and improve air quality. So, for example, both Delhi and São Paulo's carbon emissions per capita are below the city boundaries, but Delhi, in particular, needs to improve its air quality.

All cities face great challenges to become sustainable. For more affluent cities, these challenges mostly concern their environmental impact. For less affluent cities, socioeconomic progress is a priority. However, decoupling continued socioeconomic progress from a negative impact on the environment is of utmost importance. And cities hold the key to solving our global challenges.
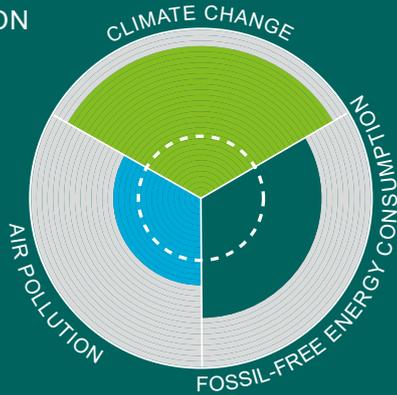
CITY BOUNDARIES CONCEPT

The city boundaries framework aims to illustrate if a city is environmentally sustainable. It shows how the city relates to globally recognized limits for climate change, air pollution and fossil-free energy consumption.
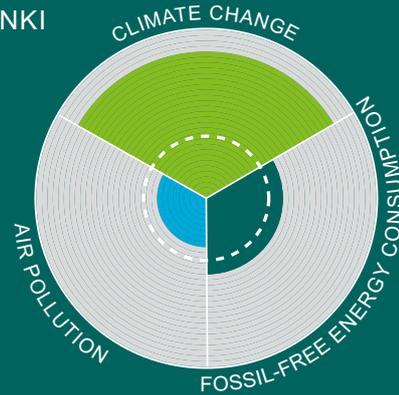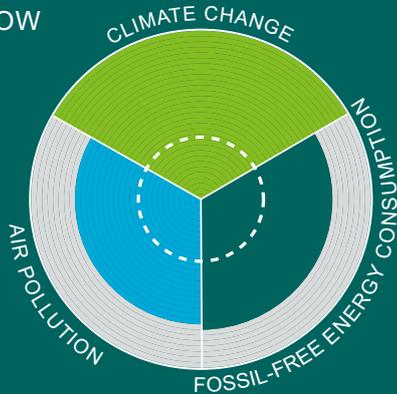

PERFORMANCE OF A SUSTAINABLE CITY

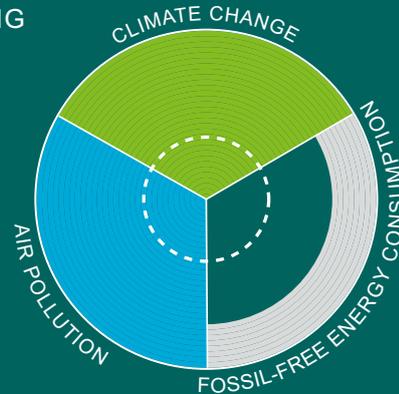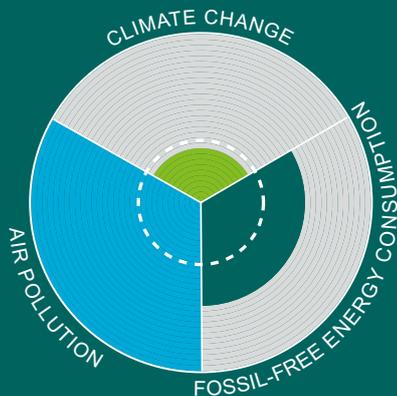Sustainable operating limit

CLIMATE CHANGE
FOSSIL-FREE ENERGY CONSUMPTION
AIR POLLUTION

LONDON

CLIMATE CHANGE
FOSSIL-FREE ENERGY CONSUMPTION
AIR POLLUTION

HELSINKI

CLIMATE CHANGE
FOSSIL-FREE ENERGY CONSUMPTION
AIR POLLUTION

MOSCOW

CLIMATE CHANGE
FOSSIL-FREE ENERGY CONSUMPTION
AIR POLLUTION

BEIJING

CLIMATE CHANGE
FOSSIL-FREE ENERGY CONSUMPTION
AIR POLLUTION

DELHI

CLIMATE CHANGE
FOSSIL-FREE ENERGY CONSUMPTION
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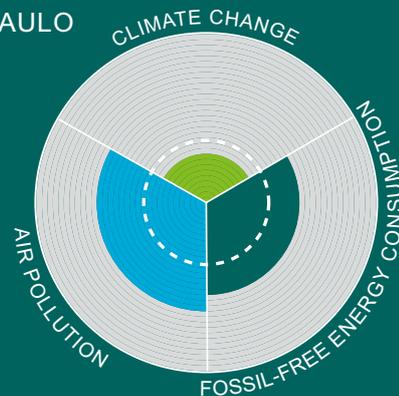
COMPOSITION OF THE INDEX

The 2016 Networked Society City Index measures the performance of 41 cities from two perspectives: their maturity in ICT and TBL, with particular regard to sustainable urban development in a connected society. The 2016 Networked Society City Index has been supplemented with indicators of equality, R&D expenditure, and transportation and energy trends; additionally, the indicators of energy consumption and mobile broadband tariffs have been improved. Finally, the standardization of proxies has been developed to better manage extreme values.

ICT maturity and TBL development are both divided into three dimensions. The TBL dimensions – social, economic, and environmental – reflect the three dimensions of sustainable development. ICT maturity is broken down into ICT infrastructure, ICT affordability, and ICT usage. These three dimensions capture the complexity of the connected society: a well-developed infrastructure, a competitive market that offers affordable prices to citizens and businesses, and sufficient know-how to invent, adopt, and adapt new ICT solutions.

Each dimension is described by a set of variables. The variables are created by aggregating a set of indicators and proxies that are meaningful in terms of describing a city's performance in the variable. Methodological changes have been made in the 2016 index to better manage the effects of index cities whose performance deviates significantly from other index cities. The indicator that measures cities' energy consumption has been improved by taking into account climatic impacts of different energy sources. Furthermore, new indicators have been added that measure mitigation and adaptation efforts. For further information about the composition of the index, refer to the appendix on methodology.

Figure 14 – The composition of the Networked Society City Index

NETWORKED SOCIETY CITY INDEX

TBL — Social · Economy · Environment — Infrastructure · Affordability · Usage — ICT

TBL: 8 Variables and 31 proxies

> Social
>> Health
>> Education
>> Social inclusion
> Economy
>> Productivity
>> Competitiveness
> Environment
>> Resources
>> Pollution
>> Climate change
>> Mitigation and adaptation efforts

ICT maturity: 7 Variables and 18 proxies

> Infrastructure
>> Broadband quality
>> Availability
> Affordability
>> Tariffs
>> IP transit prices
> Usage
>> Technology use
>> Individual use
>> Public and market use

ERICSSON IN THE CITY

Ericsson's engagement in urban development goes back to our founding in 1876. We have pioneered the communication industry since the 19th century and built some of the very first telecommunication networks in cities all around the world. Since then, we have driven the evolution of communication by developing technology and providing communication networks and services.

Forty percent of the world's mobile traffic is carried over Ericsson networks. Now we're making sure these networks are capable of serving the current explosive growth in smartphones and app usage, seen particularly in urban environments.

In Ericsson's vision of the Networked Society, many powerful forces converge, such as near-ubiquitous connectivity, mobility, big data, 3D printing, robotics, and cloud technologies. Globally, there are now as many mobile subscriptions as there are people, and the proportion of subscriptions associated with smartphones is now around 45 percent and growing rapidly, vastly increasing the amount of data created and consumed. Meanwhile, it is predicted that there will be 28 billion connected devices by 2021, more than half of which will be M2M and Internet of Things connections. Many of these devices will be connected through mobile networks, and 4G and 5G technology will increasingly be available, enabling more capacity for the vast number of connections and applications being used simultaneously.

As drivers of change, cities now have more and better technological tools at their disposal than ever before. Creating a smart, sustainable city is a continuous process, requiring vision, ongoing measurements, and constant rebalancing of complex, often competing needs. Such developments require a broad dialogue between stakeholders from all sectors of business and society. Ericsson is closely involved across a broad range of sectors, including power utilities and the emergency services.

Ericsson is also advising cities on generic ICT benefits and implementation solutions, as well as expanding its solutions for transportation and municipal government, including innovative electric car charging, municipal administration, and e-government solutions.

Examples of our involvement in urban development projects include:

Stockholm Royal Seaport, located in the northeastern part of the Swedish capital, is planned to include 12,000 homes and 30,000 workspaces, with a wide diversity of architecture and lifestyles. The development is a leading example of long-term planning, with a far-reaching vision that has been secured and agreed to by the various public and private stakeholders. Stockholm Royal Seaport aims to limit climate impact, be free from fossil fuels by 2030, and be adaptable to present and future climate change challenges. Ericsson is one of the lead ICT partners and advisors in this development.

São José dos Campos, a city with over 650,000 inhabitants, located 80km from São Paulo, is considered a national benchmark for technology and quality of life in Brazil, with an established technology park that attracts ICT investment and innovation. In response to concerns over rising crime rates, a long-term partnership was formed between the municipality and Ericsson to develop an emergency response system based on an integrated operations center, fiber-optic network infrastructure, a video platform, and managed services. In areas monitored by camera-based surveillance systems, the overall crime rate has decreased by 70 percent, with an almost 20 percent drop in the homicide rate in 2014.

Ericsson is a partner of the Centre for Sustainable Communications (CESC) at the KTH Royal Institute of Technology in Stockholm. CESC conducts innovative research into how ICT can help make societies more sustainable. Smart Sustainable Cities is a major research area, where CESC is studying how ICT can be used to support environmental and social sustainability in urban areas.

NOTES

1. Ericsson white paper: Laying the foundations for a smart, sustainable city
   http://www.ericsson.com/cn/res/docs/whitepapers/wp-smart-cities.pdf
2. Ericsson Mobility Report, November 2015 http://www.ericsson.com/res/
   docs/2015/mobility-report/ericsson-mobility-report-nov-2015.pdf
3. measured by GDP per capita in international dollars (logarithm)
4. measured by R&D expenditure, patents, business startups,
   knowledge-intensive employment, and higher education attainment
5. Ericsson Mobility Report, November 2015 http://www.ericsson.com/res/
   docs/2015/mobility-report/ericsson-mobility-report-nov-2015.pdf

APPENDIX

METHODOLOGY

Ericsson is the driving force behind the Networked Society – a world leader in communications technology and services. Our long-term relationships with every major telecom operator in the world allow people, business and society to fulfill their potential and create a more sustainable future.

Our services, software and infrastructure – especially in mobility, broadband and the cloud – are enabling the telecom industry and other sectors to do better business, increase efficiency, improve the user experience and capture new opportunities.

With approximately 115,000 professionals and customers in 180 countries, we combine global scale with technology and services leadership. We support networks that connect more than 2.5 billion subscribers. Forty percent of the world's mobile traffic is carried over Ericsson networks. And our investments in research and development ensure that our solutions – and our customers – stay in front.