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Key Concepts, Actors and Potential Entry Points
for German Development Cooperation

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FINAL REPORT

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Executive Summary

Information and communication technologies (ICT) have already revolutionized the way we live and work and have changed the way public infrastructures and social services operate. 'Smart' is the term currently used for referring to products or systems that rely on advanced ICT, which include, inter alia, embedded ICT, wireless technology applications and intelligent sensing technologies. The most advanced sectors with regard to smart technology adoption are transport, energy, infrastructure and the environment.

Emerging smart technology solutions

Examples of smart technologies that are already in existence or under trial deployment are the following:

- In the *building sector* we find smart meters for providing feedback on electricity use and buildings using ICT for reporting and benchmarking building data, also known as ecological buildings. Large rollout investment programmes for smart meters are underway around the world. Retrofitting of traditional buildings into ecological buildings is promoted through change in legislation and financial incentives.

- The *smart grid* represents the big hope in the energy sector. Smart grid components are already available and several pilot projects are underway to demonstrate their efficiency gains. The market of the smart grid is estimated at astronomic prices and is already driving industrial mergers and acquisitions.

- *Smart water management solutions* are applications using smart meters to monitor the hydrological cycle and accordingly adjust supply. Such solutions are already available for plants or mid-scale landscape management. Smaller scale solutions are under development for implementation in ecological buildings. Smart water management solutions include leakage detection sensors.

- *Intelligent transport systems* or ITS have been in operation for around a decade and include applications such as tracking congestion and feedback systems, smart ticketing, smart lighting and vehicle detection technologies. They are also widely used in *congestion charging* as well as in *car sharing* systems.

Role of cities

Cities are the ideal location for developing and piloting smart technologies. Cities making use of several smart products or technologies are often referred to as smart cities. However, at the programmatic level there is still some disagreement as to what sets smart cities apart.

The expert interviews carried out in the framework of the present study revealed two distinct narratives:

- One group of actors views smart solutions as an instrument for achieving the goals of sustainable development. Those actors who opt for this definition underline the importance of the 'green urban economy' agenda in response to resource depletion and climate change. They also stress that technological development is part of social development and not vice-versa. In this category we find officials working for city networks established in order to promote sustainability, such as CDIA, ICLEI and the Clean Air Initiative, as well as officials working for development agencies, such as UNEP, DANIDA or GIZ.

- The second narrative on smart cities emphasizes the power of new information and communication technologies to enhance connectivity of data and people, thus providing the basis for evidence-based policy and improving the coordination among different levels of government. This supports decentralisation, facilitates learning and exchange, and empowers citizens. Scientists working at ICT university laboratories or researching smart cities as well as corporate actors are often of this view.

The above definitions do not contradict each other. Rather they emphasize different dimensions in response to different policy specializations at institutional level. A convergence of the two narratives is likely to materialize in the future. Accordingly, we propose to define:

> *"Smart cities as those cities…*
>
> *… that deliberately engage in participatory learning and evidence-based policy-making in order to improve their services and infrastructure and, in this process, make use of advanced information and communication technologies. ICT are used to improve connectivity – at the infrastructure level (i.e. from machine to machine), at the level of services (i.e. from human to machines) as well as at the group or personal level (i.e. from human to human). Given the right conditions, this improved connectivity contributes to resource efficiency, hence also to environmental sustainability, as well as to the betterment of governmental services thus indirectly at the reduction of social inequalities and increased societal participation."*

Following from this programmatic definition, smart city projects or programmes should:

- integrate with the learning and exchange networks of a city;
- make use of ICT for the purpose of connectivity, data collection and processing;
- consider external conditions such as availability of infrastructure and institutional capacity; and
- explicitly target resource efficiency and/or the effectiveness and inclusiveness of public and social services.

Prospects for development policy

Development policy has only reluctantly come to recognize the usefulness of the smart city concept. Nonetheless, the gradual recognition that cities may no longer be ignored, in conjunction with the growing demand of development countries to be taken seriously as trade partners and as political actors, has brought about a shift of policy focus from development to international collaboration, from technology transfer to technology exchange and from institutional capacity building to learning, knowledge and reform. Against this background there is a slow enlargement of priorities to include ICT and, by default, smart cities.

The challenges regarding smart cities for development countries vary significantly, depending on the economic and institutional base of the country / city in question.

In **cities in developed countries or in emerging economies** with high or solid prosperity values, we find deployment of ITS, congestion charging and car sharing schemes. Regulatory issues and lack of awareness are the main barriers for the large-scale deployment of various smart technologies in the building sector, in the areas of water and waste management as well as with respect to smart meters. Emerging technologies include smart grids, electric vehicles, big data processing and cloud computing.

In **cities displaying unbalanced development** (mainly to be found in middle-income countries), smart city deployments are predominantly located in the areas of e-government and car sharing. The potentials for smart meters, ecological buildings, smart waste management, ITS and congestion charging are high. In these sectors much can be achieved through coordination actions, technical exchanges, market studies, regulatory harmonisation and the financing of pilot or trial projects. Deployment of smart grids, smart water management, electric vehicles, big data processing and cloud computing is lagging behind.

In **cities in least developed countries**, the most promising areas are e-government and projects targeting the health and education sectors which utilise wireless technologies. In the poorest urban areas, as well as in rural areas, pilot projects relying on wireless technologies, such as m-money, m-health, m-education and m-women, have a high potential to help individuals and communities escape the poverty trap.

Potential entry points

In line with the above, it is possible to specify a number of entry points for the future engagement of German development cooperation in the field of smart cities.

To begin with, it is recommended to mainstream ICT in all projects under the seven priorities of the cities focus of German development policy, i.e. green urban economy, climate change, safety, governance, urban development, poverty and human rights. This should go hand in hand with increasing awareness regarding ICT within agencies of German development cooperation whilst exploring options for enlarging the scope of financial cooperation with private industry. In addition, links with smart city networks should be strengthened.

In parallel to the above, it is recommended to launch projects that place smart technologies and smart cities at centre stage in connection with resource efficiency and the improvement of social services:

- In cities with solid prosperity factors and/or emerging economies, priority should be given to regulatory, standardisation and benchmarking actions in the areas of ecological buildings, smart meters, water and waste management; as well as to pilot projects in the field of energy (smart grids) and ICT (city clouds).

- In cities with moderate prosperity factors, unbalanced development or middle-income countries, several entry points are possible: technology transfer in the field of e-government and in the areas of water and waste management; disaster prevention and recovery systems; market and financial studies for transport, especially concerning ITS; civil society projects to support citizen participation and the collection of data at neighbourhood level, among else through crowd sourcing; and support of wireless technology-based projects to advance business, entrepreneurship and education.

- In cities with weak prosperity factors or least developed countries, priority should be given to exploratory actions in the field of e-government, social services, education and business; disaster prevention and recovery systems; civil society projects to support citizen participation and the collection of data at neighbourhood level, among else through crowd sourcing; as well as projects that utilise wireless technologies.

Finally, it is recommended to earmark some funds for supporting original project ideas developed in collaboration with private industry. This could be done by launching an open call on 'Smart Cities and Development' and/or through the establishment of a competence centre in collaboration with industry and the research sector.

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List of Abbreviations

ADB	Asian Development Bank
APW	Asia-Pacific Weeks
BMELV	Federal Ministry of Food, Agriculture and Consumer Protection
BMZ	Federal Ministry for Economic Cooperation and Development
C40	Climate Leadership Group
CDG	Global City Dialogue
CDIA	Cities Development Initiative for Asia
CEB	Central European Bank
CFL	Compact fluorescent lamps
CHDI	City Human Development Index
CMR	Cities and Metropolitan Regions
DANIDA	Danish International Development Agency
DAU	Development-as-usual
DC	Direct current
DED	Deutscher Entwicklungsdienst
DFID	Department for International Development
EBRD	European Bank for Reconstruction and Development
EIB	European Investment Bank
ELENA	European Local Energy Assistance
EPIC	The European Platform for Intelligent Cities
EU	European Union
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
HDI	Human Development Index
ICLEI	Local Governments for Sustainability

ICT	Information and Communication Technologies
IIED	International Institute for Environment and Development
IÖW	Institut für ökologische Wirtschaftsforschung
IT	Information Technology
ITS	Intelligent Transport Systems
IZT	Institut für Zukunftsstudien und Technologiebewertung
JDA	Joint Development Agreement
KfW	Kreditanstalt für Wiederaufbau (German Development Bank)
M2M	Machine-to-machine
MAMA	Mobile Alliance for Maternal Action
MDG	Millennium Development Goals
MoU	Memorandum of Understanding
PPP	Public-Private Partnership
PSI	Public Sector Information
SECO	State Secretariat for Economic Affairs
SIDA	Swedish International Development Cooperation Agency
SWH	Solar Water Heater
UCLG	The Global Network of Cities, Local and Regional Governments
UNEP	United Nations Environment Program
UNFPA	United Nations Population Fund
USAID	U.S. Agency for International Development
VOA	Voice of America

1 Introduction

This is the report of the scoping study 'Smart Cities' commissioned by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). The report's overall aim has been to shed light on the concept of smart cities and elaborate promising entry points for German development cooperation. The study was based on a state-of-the-art literature review; a mapping of initiatives by different stakeholders; and a series of expert interviews. The methodology is detailed in chapter two.

Chapter three looks at the social history of 'smart', examines the state-of-play of smart technologies and explores different narratives of smart cities.

The concept of 'smart' is the last of a series of terms that have emerged from the discourse on the information age. Earlier terms include information society, information age, network society, digital city, connectivity and intelligent city.

One core idea behind smart is that information and communication technologies (ICT) render communication faster and more efficient. More importantly, they allow the integration of information from different sources as well as across levels and units of analysis. Insofar as integrated information represents knowledge for action, ICT transform information societies into knowledge societies and produce a new pathway for economic and social development (cf. Bell 1976, Castells 1996, 1997, 1998, Stehr 2002).

Not all stakeholders and academics agree with this approach. The main lines of critique are similar to those found in the discourse on globalization. One central criticism is that the information society agenda is Eurocentric in drawing conclusions for the whole world based on developments in post-industrial societies. At the same time, or so critics argue, the information society agenda ignores the blaring inequalities between and within societies and how these continue to determine hegemonic centre-periphery relations. These inequalities are socio-economic in nature; and also concern infrastructure, organisational capacity and political culture. Before these structural problems are overcome, technologies such as ICT cannot be expected to play more than a marginal role for growth and development.

The above concerns have been aggravated by the corporate branding of information technologies (IT) as smart – as in smart phones or smart applications. Cities are especially susceptible to this trend. A casual reading of website descriptions, conference announcements or policy measures reveals a rather inflationary discourse with 'smartness' presented as a panacea solution that combines competitiveness and sustainability towards better living, better services, more resource efficiency, greater prosperity and, even, zero negatives. An equally unrealistic scientific theory that is often mentioned in tandem with smart cities is 'decoupling'. Decoupling envisages the separation of economic growth from environmental ills through the application of technology alone.

Undoubtedly, such an approach is too simplistic. However, it would be wrong, on these grounds, to dismiss smart cities as mere corporate branding or as science fiction.

The definition of smart cities adopted by this report is both closer to reality and grounded in the sociological theory and study of urban development:

> *"Smart cities are those cities…*
>
> *… that deliberately engage in participatory learning and evidence-based policy-making in order to improve their services and infrastructure and, in this process, make use of advanced information and communication technologies. ICT are used to improve connectivity – at the infrastructure level (i.e. from machine to machine), at the level of services (i.e. from human to machines) as well as at the group or personal level (i.e. from human to human). Given the right conditions, this improved*

connectivity contributes to resource efficiency, hence also to environmental sustainability, as well as to the betterment of governmental services thus, indirectly, to the reduction of social inequalities and increased societal participation."

Where does this definition leave the development agenda? This is the subject of chapters four and five of the report.

As is often the case with technologies and products developed to meet the needs of the developed world, the fear is that such technologies will never reach the developing world because of lack of interest or resources, thus widening the gap that already separates developed countries from those less developed.

Notwithstanding these legitimate concerns, the situation is somewhat different in the case of smart technologies. For one, several leading ICT companies are either based or have subsidiaries around the world and are aggressively pursuing their interests in emerging economies. Second, among ICT developers there are several who are genuinely committed to development. Bill Gates represents the most notable but not the sole example among them. Third, as a result of the growth of mobile and wireless communication, some smart solutions are turning out easier to implement in less developed parts of the world than originally anticipated. Indeed, the gap between developed and developing countries, especially with regard to the deployment and utilisation of voice and data services, has decreased considerably during the past 15 years (Castells 2011). Last but not least, the turn to 'smart' has fuelled interest in social innovations more generally. Even though such solutions are lower-tech, they are often based on similar principles like smart technologies in terms of integrated information, communication and efficiency.

Chapter four looks into how development theory and practice has responded to the challenge of smart cities. Chapter five focuses on the German case and proposes entry points for engagement in the field based on this report's findings.

2 Specific Objectives and Methodology

The specific objectives of the present study were to:

- provide an overview of the international debate on smart cities focusing on key concepts, trends, actors and practices; and to

- identify strategic options for German development cooperation by mapping 'smart cities' issues against the priorities of German development aid and cooperation strategies with emerging economies.

The study was conceptualized and implemented as an exploratory activity lasting two months. It relied on:

- a desk-based review of policy, scientific, technical and corporate documentation on smart cities;

- interviews with key stakeholders in Germany and abroad; as well as

- meetings with the client to brainstorm interim results followed by presentations of the study's results at the Asia-Pacific Weeks 2013 in Berlin and at GIZ in Bonn in July 2013.

The information on smart city initiatives is available in a database. A power point presentation summarises the main results and recommendations.

2.1 Desk-based review

The desk-based review covered:

- academic literature using JSTOR and Google Books;

- policy and concept reports published by public and private agencies as well as corporations working in related fields;

- progress reports on various cities which are implementing smart city components;

- information on research programmes and projects dealing with related topics;

- press articles on the market of smart technologies;

- summit and conference documents related to smart cities; as well as

- relevant newsletters.

The references section of this report refers to those sources that are explicitly mentioned in the main text. Further references, or initiatives related to them, can be found in the project's database.

2.2 Interviews with stakeholders

In line with the terms of reference for this study, the core group of interview partners for this study included representatives of:

- German development cooperation (that is to say of the German Federal Ministry for Co-operation and Development (BMZ), the GIZ, the KfW Development Bank and the German Federal Ministry of Food, Agriculture and Consumer Protection (BMELV));

- corporate actors;

- various smart or sustainable city networks;

- multilateral and Foreign Donor Organisations;

- research institutions;

- philanthropy; and

- city governments.

A total of 28 interviews were carried out face-to-face or by telephone. A full list of the interview partners is provided in Annex A.

Face-to-face and telephone interviews proved to be an effective means for revealing smart city entry points and strategies for German development cooperation. An electronic version of the questionnaire was uploaded on a secure domain of adelphi's website. This online-survey was used in order to complement or facilitate face-to-face/telephone interviews.

Annex B includes the interview guide used for the expert interviews.

2.3   Brainstorming meeting and Asia-Pacific Weeks

The preliminary results of this study as well as a first list of potential and promising entry points for German Development Cooperation were discussed at a workshop organized by GIZ on 3 June 2013. The meeting was attended by the authors of this report and, on behalf of GIZ, the heads of the sectors projects 'urban development' (Politikberatung in der Kommunal- und Stadtentwicklung) and 'ICT' (Einsatz von IKT in der Entwicklungszusammenarbeit). The meeting was used to brainstorm on the preliminary findings and comment on the draft report.

Feedback to the study's results was also obtained at the workshop on 'Connective Cities' organized by GIZ in the framework of the Asia-Pacific Weeks (APW) 2013 in Berlin as well as during a meeting with GIZ officials in Bonn in July 2013.

3 Smart Cities: Fad or Innovation?

This chapter reviews the state-of-the-art literature on smart cities and the activities of relevant stakeholders in the public and private sphere. The discourse on smart cities has still to be consolidated and, therefore, the scholarship remains fragmented with definitions tending to one-sidedness.

The present review is, to our knowledge, the first comprehensive review of the smart cities concept. Its added value lies in the representative coverage of different perspectives; and the contextualization of these into broader policy and scientific debates regarding growth, development and sustainability. Based on this review a more realistic and evidence-based definition of smart cities is proposed at the end this chapter.

The interview data and the information gathered at the APW workshop provide a good introduction into the different definitions of 'smart cities'.

3.1 Stakeholder perspectives on smart cities

All experts and stakeholders interviewed for this study agree there is a heightened policy interest in cities around the globe. This is explained with reference to the size and economic significance of urban agglomerations; and the fact that cities concentrate both opportunities and risks for development, sustainability and social cohesion. Opinions differ as to what specifically defines smart cities.

The interview guide used by the study included an open definitional question on smart cities; and it also asked interviewees to respond to a battery of items on the main issues and main sectors they associate with the concept. In addition, we considered statements made by speakers and participants to the APW Workshop on 'Connective Cities'.

The analysis revealed two distinct narratives on smart cities.

- One group of actors defines 'smart' as one instrument for achieving the goals of sustainable development – and not necessarily the most important one. Those actors who opt for this definition underline the importance of the 'green urban economy' agenda; the significance of resource efficiency as well as of the goal to reduce environmental externalities; the role of resilience in relation to sustainability; the demand for an integrated urban planning incorporating the cities' hinterlands; and that technological development is a part of social development and not vice-versa. In this category we find officials working for city networks established in order to promote sustainability, such as the Cities Development Initiative for Asia (CDIA), ICLEI (Local Governments for Sustainability) and the Clean Air Initiative, as well as officials working for development agencies, such as the United Nations Environment Program (UNEP), the Asian Development Bank (ADB), the Danish International Development Agency (DANIDA) or the GIZ.

- The second narrative on smart cities emphasizes the power of new information and communication technologies to enhance connectivity of data and people, thus providing the basis for evidence-based policy and the efficient coordination among different levels of government. In turn, this supports decentralisation, facilitates learning and exchange and empowers citizens. Scientists working at ICT university laboratories or researching smart cities as well as corporate actors are often of this view.

In line with these findings we find the first group more likely to associate smart cities with issues such as 'green agenda', 'sustainability', 'efficiency' and 'innovation' whilst the second group associates smart cities with 'IT', 'technology', 'modernization', 'learning' and 'information'.

All of the actors interviewed agree that the most advanced sectors with regard to smart technologies are those of transport, energy, infrastructure and the environment. There is also agreement that mobile and wireless technologies entail a high market potential at the global level.

The majority are further of the opinion that smart technologies are primarily relevant for developed countries and, secondarily, for cities in emerging economies. Theoretically, poorer countries stand to benefit from smart technologies yet they often lack the necessary material infrastructure and governance structures. Nonetheless, among those actors who adopt the 'connectivity' perspective on smart cities, a few were of the opinion that smart technologies entail a potential to accelerate the modernization of poorer countries thus helping them 'leap-frog' the slower pathway of development.

We return to stakeholder perspectives when examining the specific challenges for development policy. In the following sections, we further discuss the issues raised by stakeholder interviews with reference to the literature on the subject.

3.2   Smart as the new green

According to Singh (2012) what distinguishes 'smart' from 'green' is the former's *emphasis of efficiency* without having to reduce consumption by changing personal habits. Significantly, the transition to smart is achieved through the deployment of technology and information "away from closed island solutions to cross-linked intelligent solutions". Thus, a city can be called smart if and when it achieves significant efficiency gains through the better use and linkage of information, especially in the fields of energy, transport and built infrastructure.

This understanding of 'smart' as the 'new green' is, in fact, nothing else than a more positive branding of what in the environmental policy literature is known as the 'weak sustainability discourse'.

In the area of sustainable development we find two competing paradigms. Proponents of the *strong sustainability discourse* argue that negative environmental externalities can only be tackled by changing energy consumption patterns so that the overall energy consumption is reduced. Under the *weak sustainability* or *ecological modernization discourse*, technology is expected to do the trick, alone or in conjunction with a turn to renewable sources of energy, for which new technologies are, again, needed for either extraction or transportation (Hajer 1992).

The middle ground is usually represented by those who favour the deployment of new technologies but continue to insist on behavioural and economic-structural changes in order to prevent irreversible changes such as climate change.

Currently, the focus of governments and large corporations is on efficiency. This is in line with the weak sustainability discourse, which is, however, no longer referred to as 'weak sustainability' but rather as the 'green economy', with 'smart' representing a useful affix.

This is illustrated, among else, by three high-level recent reports: one by the United Nations Foundation entitled *Realizing the Potential of Energy Efficiency* (Expert Group on Energy Efficiency 2007); the second by the World Economic Forum (2010) entitled *Towards a More Energy Efficient World*; the third by the Climate Group of the Global e-Sustainability Initiative (2008) entitled *Smart 2020: Enabling the Carbon Economy in the Information Age*. All three

reports call for decreasing the so-called efficiency gap,[1] and place the emphasis on buildings, transportation and industry since these are the three sectors which use most energy. Smart technologies have here a key role to play. For instance:

- They can be deployed in so-called new ecological buildings (or in older buildings in the framework of retrofits) for controlling lighting and temperature and for providing feedback on energy use. In San Francisco such technologies are part of the so-called 'Zero Net Energy Buildings' program.

- They are the core element of the so-called 'smart grid', also referred to as 'the internet of electricity'.[2] A smart grid delivers electricity only when needed and not round-the-clock like traditional grids. Moreover, advanced versions allow the balance of traditional and renewable energy sources.

- Finally, smart technologies have a role to play in transportation, specifically in relation to mobility plans that combine the introduction of transit (bus or metro) systems with congestion pricing and traffic management schemes.

Critics of the efficiency approach argue that the efficiency gains brought about by new technologies, including smart technologies, are offset by the so-called 'rebound effect', whereby energy savings achieved through efficiency gains are equalized by increases in consumption brought about by decreasing prices. Economists disagree as to the size and relevance of the rebound effect,[3] and it is beyond the scope of the present report to develop this argument any further. Suffice to note that while clearly representing an important constraint, it does not completely undo the efficiency gains from technology. However, it is a call for caution against the use of excessive branding as happens with 'Zero Net' outputs, such as used in Zero Net Buildings, Zero Net Energy, Zero Net World, Zero Waste or Net Zero Cities.[4]

3.3   Smart as connectivity

The invention and fast diffusion of new information and communication technologies, beginning with the Internet all the way to embedded technologies, has ushered new ways of thinking and living based on integrated information (cf. Bell 1976; Castells 1996, 1997, 1998; Stehr 2002).

Since at least the invention of the smart phone this vision has assumed concrete form and it is now possible to imagine the potential of smart products in terms of productivity. This is how Singh puts it in a recent book entitled *New Mega Trends; Implications for our Future Lives* (2012: 7):

> *"A Smart product is characterized by an intelligent sensing technology that is increasingly being integrated with Internet technologies, thereby allowing the product to react and communicate to the changing environment around it, thereby optimizing operations and improving efficiency."* (Singh 2012: 7)

In the future, Singh continues, being smart "will mean moving away from closed island solutions and solo Smart products towards cross-linked intelligent solutions. This would mean not just a Smart device but a Smart home, Smart building and also Smart cities" (ibid. 8).

It is no surprise that 'smart' is a fitting notion for cities. This branding builds on the earlier definition of the 'technopolis' urban scenario, described by Bog Hodgson in 1992 as follows: "technology-driven development concentrated in world cities linked by sophisticated communications and integrated into a network of similar global centres that control and service an increasingly integrated world economy."

The understanding of smart as 'connectivity' also matches the findings of another research stream, namely that concerning learning and innovation. Comparative research carried out in

the United States (Glaeser and Saiz 2003) suggests that cities with a high share of educated work force, or 'skilled cities', are more productive and display better amenities at the local level, including in less affluent neighbourhoods.

According to Campbell (2012), who compared learning modalities in more than 300 cities, "the most active of learning cities also develop mechanisms to store, spread and verify newly-acquired ideas and apply them to solve local problems".[5]

- In terms of content of learning, the number one topic was urban transport, followed by 'local economic development' and 'climate change'. Several city officials were also on the lookout for management knowledge, such as policy analysis, decision-support tools and financial management.

- In terms of style of learning, cities differed according to the ways in which they appropriated and used external expertise. So-called informal learners, like Turin, favour the bottom-up channelling of scientific expertise to policy. Technical learners, like Curitiba in Brazil, rely on think-tanks that work in a semi-autonomous fashion. Finally, corporate learners, like Bilbao and Singapore, place an emphasis on formal management structures that match those found in the private sector.

The main lesson from this research stream is that "urban learning is much more complicated than a straight technology transfer" (ibid.: 184). This also explains why some cities fail to learn. Cities with fast-changing administrations, weak institutional capacities (in conjunction with lack of political motivation and financial clout), and limited knowledge, as well as cities with limited cohesion such as Mumbai, are often unable to effect a sustainable urban growth or regeneration strategy through learning.

What drives contemporary urban development deviates significantly from the post-war mainstream approach, when cities were viewed as mere implementers of the reform agendas of national authorities. It is rather important to focus on "the horizontal dimension of exchange at the base, not the apex, of the policy and implementation pyramid" (ibid.: 203). This means removing institutional barriers by facilitating learning from other cities thus "embedding knowledge in the city culture" (ibid.: 204).

The above conclusions fit with the association of smart technologies in some of our interviews with the potential to 'disrupt centralized systems of control', besides providing an opportunity for the local empowerment of citizens.

3.4 E-government as precursor to smart cities

Electronic government represents one of the early applications of ICT and the internet in the public sector for the purpose of facilitating communication between government to government (G2G), government to citizens (G2C), government to business (G2B) and government to employees (G2E). E-government began to be introduced in the second half of the 1990s and was actively promoted during the first decade of the twenty-first century, among else by the United Nations.

At the outset, the idea and first programmes of e-government were met with scepticism, in similar fashion to what can be presently observed with regard to smart cities. The early proponents emphasised the expected efficiency gains of e-government through the anticipated discontinuation of telephone and counselling services at administrative agencies. Opponents drew attention to the slow, at first, uptake of e-government services especially among older citizens and lower socio-economic groups (ELOST Final Report 2007).

These cleavages have yet to disappear but they are not as accentuated as they used to be, not least because of the successful combination, in many countries and sectors, of personal-

ised and internet services. Besides, greater attention is today given to contextual and design factors (Heeks 2004).

In the meantime, e-government is promoted as an instrument of empowerment and citizen participation. This is the view taken, among others, by the United Nations which every year releases a world e-government survey to report on progress with respect to the closing of the digital divide, the implementation of e-government as well as the promotion of e-governance and e-participation (UN 2012).

The new trend in the field of e-government is that of 'multi-channel service delivery' to take advantage of ICT innovations, including wireless technology. For the United Nations and development agencies multichannel delivery represents an opportunity to provide "accessible services needed by the poor" thus increasing "the inclusion and participation of socially-disadvantaged groups in government policies and decisions." (UN 2012: 74).

In line with remarks in the previous section about smart as connectivity, the UN report notes the following:

> *"Multichannel public service delivery can be used to deliver sustainable services to socially excluded groups. Research shows that these groups require an intermediary person or organization to enable them to benefit from a combination of information and transactions to meet their highly specific and complex needs. In multichannel delivery, public services can be delivered by using a mix of channels, complemented by human interaction and networks. Their intermediaries can be from any sector—public, private or social enterprise or community support group. Multichannel service delivery is thus defined as involving the organizational interactions that make up the network, rather than just a collection of access routes for delivering the service." (ibid: 74)*

The above definition highlights the relevance of e-government projects for developing and least developed countries and as a possible transition pathway to more ambitious smart cities projects and programmes making use of advanced technologies.

3.5   Smart technologies

What are then the technologies that can be found in smart cities? In this section of the report we provide an overview of those smart technologies that are already under deployment or at the stage of development or demonstration. For each sector we list relevant technologies, describe their estimated phase of development and market demand, and provide examples.

The compilation of the list has been based on preliminary lists available in previous publications, most notably a report by The Climate Group of the Global e-Sustainability Initiative in collaboration with Arup, Accenture and Horizon and the University of Nottingham (2011); and a report by the German National Academy of Science and Engineering (ACATECH 2011). The information on each of the list items is based on findings from the present study. Examples are provided from both developed and developing countries.

3.5.1   Buildings

The following technologies or smart approaches are under development or already under deployment in the building sector. Here, as in the following sections, we begin with those technologies that are the most advanced.

* *Smart meters*: The technology is available and there are rollout investment programmes in the European Union (EU), Japan, South Korea, Singapore and Australia. In the EU the target is for 80 per cent of the households to be using smart meters by 2022.[6] The market demand is also growing in Asia and Latin America. In some countries (e.g. the UK) rollout

is being delayed due to interoperability problems and lack of standards. A leading developer in the private sector is Toshiba.[7]

- *Technologies for reporting and benchmarking building data*: Such technologies are already available in the developed world, whereby diffusion is slow due to retrofitting costs and lack of financial incentives and/or awareness (ECOBUILD project[8]). Within the EU, energy efficiency in buildings is promoted by the Energy Performance of Buildings Directive 2010/31 and the Delegated Regulation EU 244/2012 on the establishment of a comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements for buildings.[9] A company active in the field is Schneider Electric.[10]

- *Integrated building automation and control systems* are in operation or under implementation in large building agglomerations such as universities.[11] An example of this is Cornell University in the USA. Siemens is one company active in the area.[12] The technology is not yet available in residential areas.

- *Home energy and consumer energy management technology*: This technology is the next step following smart meters and will be comparatively easy to both develop and deploy, albeit only following the full deployment of the smart grid.

- *Other smart appliances*: Under this rubric we find those technologies which promise to make smart homes out of our houses and apartments by relying on so-called embedded technologies. Examples include the 'virtual butler' producing shopping lists automatically by monitoring refrigerators and other home appliances. Such technologies are often used for branding smart technologies. Most appliances are, however, still at an early development stage.[13]

In summary, it can be stated that this is a sector of growing market potential, especially in the developed world and in emerging economies. By far the most advanced technologies are smart meters and ecological buildings. Integrated building automation and control systems are good examples for upcoming pilot projects.

A technological concept that entails potential for successful application in developing countries is that of solar water heaters (SWH). This was successfully piloted in the framework of the 'Climate Proofing Project' in Johannesburg.

3.5.2 Energy

In the energy sector, the thrust of research is concentrated on the *smart grid*. The smart grid uses ICT to gather information on energy supply and consumption and use this to improve the efficiency of both the production and distribution of electricity. The various components of the smart grid system are already available, but their integration is not fully developed. To this must be added the problems of transition or adaptation from traditional to smart grid systems and interoperability issues. Pilot projects using smart grids can be found in Italy, Germany, Portugal, Canada and the USA.[14] The market is estimated at astronomic prices and this is driving corporate investments. Key player in the private sector are Honeywell, Siemens, Schneider Electric and Accenture.[15]

The smart grid technology is especially relevant for developed countries and, in part, for emerging economies. In the developed world, the main problem remains that of upgrading the existing electricity systems and extending coverage to rural areas. There, it makes more sense to talk of *microgrid* solutions representing small-scale low voltage power systems with distributed energy sources and storage connected to the central grid or 'islanded'.[16] The programmes Grip IT by ACATECH[17] as well as ESMAP (Energy Sector Management Assistance Program) of the World Bank[18] address the question of adaptation of intelligent energy solutions such as smart grids, for deployment in the developing world.

In the short-term, projects focusing on raising awareness regarding energy consumption are more promising. An example of such a project is the Favela Project 'Morar Carioca Verde' in Rio de Janeiro, where customers who recycle waste receive discounts on their electricity bills.

3.5.3 Water

Smart water management solutions are applications using smart metes to monitor the hydrological cycle and accordingly adjust supply. Such solutions are already available for plants or mid-scale landscape management. Smaller scale solutions are under development for implementation in ecological buildings.

Smart water management solutions include leakage detection sensors. An example is the 'Stopping Water Leakage System' in Tokyo.

Various projects suggest that smart water metering entails a potential for deployment in the developing world and especially in those countries and regions facing problems with water supply. Thus, for instance, the Smart Link Network specializing on this was recently bought by the India subsidiary of Schneider Electric;[19] and in 2009, the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) implemented pilot projects on digital water monitoring in several regions, notably in Kenya and Zambia (GTZ 2009).

3.5.4 Transport

The convergence of the transport and ICT sectors goes back at least two decades. As a result, transport is also one of the leading sectors in relation to smart cities.

- *Intelligent transport systems (ITS)*: Research in this field began already in the 1990s and, as a result, several ITS have been in operation since around a decade. They are currently widely deployed in the developed world; represent a rapidly growing field in emerging economies; and entail potential also for select cities in the developing world. Some solutions might be easier to implement in the developing world because of less competition. Examples include tracking congestion and feedback systems, smart ticketing, smart lighting, sensing technologies, and vehicle detection technologies.[20]

- *Congestion charging* is already in operation in several cities. Examples are Stockholm and London. Evaluation results are positive and there are numerous technological solutions available. The main barrier for wider deployment is public and political acceptability.[21]

- *Car sharing schemes*: The first experimental car sharing schemes were introduced in the late 1990s and were, at first, frowned upon. Currently there are several schemes in various cities, all representing good businesses. Unlike original schemes that targeted commuters, current schemes concentrate on city residents. ICT is used for mobile apps and for tracking purposes. There is, in principle, nothing that speaks against such schemes in emerging economies or in developing countries.[22]

- *Electric vehicles and charging systems*: Electric vehicles are currently on trial deployment on a small scale. The main problem with wider deployment has to do with the development of charging systems and the construction of charging stations. The latter are currently being piloted. Conceptually there still remain disagreements as to the long-term economic and environmental sustainability of electric vehicles. In any case, this is one of the core priorities of the Transport Research Programme of the European Union and the infrastructure investment programme of the TEN-T Executive Agency.

In developing countries, best-practice examples for moving towards smart transport technology solutions include the 'Cairo Transport App Challenge' and the 'Skybus Lavasa' in India. The Cairo Transport App Challenge was an online competition that was used to gather ideas about dealing with traffic congestion in Cairo and improving the transportation system with

the help of ICT. Skybus Lavasa is a microbus service platform that manages web and mobile requests, allocates them to vehicles and adapts routes in real-time.

3.5.5 Health

The health sector is one of the future sectors for smart technologies. Applications are still in the research development phase.

There are already ICT solutions related to *health monitoring* and the linking of health data for hospitals. Home health monitoring systems are being developed under the rubric of active ageing and embedded technologies. This is one of the priority research areas of the Health Programme of the European Union.

Mobile health monitoring has been popularized by science fiction and action movies and is often used for branding ICT and convergence technologies. In reality it is still at an early development stage, but attracting public investments due to its relevance for the military.[23]

In developing countries projects in the field of health are beginning to make use of wireless technology for linking patients to services. An example is the Mobile Alliance for Maternal Action (MAMA), which is working to provide timely health messages to mothers. In Tanzania, Swedish International Development Cooperation Agency (SIDA) and the United Nations Population Fund (UNFPA) support a project that facilitates the transferring of money via SMS to women that cannot afford transportation to the hospital.

3.5.6 Disaster prevention emergency response and recovery

ICT is increasingly used in the field of disaster prevention, emergency response and recovery. Geographical information systems are used to warn populations of upcoming disasters in high-risk areas; and for updating databases on hazard areas thus improving the predictability of models. Specific SMS applications have been developed to link affected populations with emergency and health services. This technology was extensively used in the wake of Hurricane Katrina in the United States in 2005. A German application is KatWarn.[24]

An interesting example for integrated disaster management using ICT was recently deployed in Rio de Janeiro in Brazil. The city has been equipped with sensors in thirty locations feeding data to a control centre which, in turn, is in charge of coordinating the work of thirty agencies. The objective of the project is to react early to environmental disasters arising out of severe weather conditions, landslides and river floods. The system can also be fed by citizens using telephone, SMS or Twitter. The project was commissioned by the mayor's office and is being run by IBM in cooperation with CISCO.

A simpler yet almost equally effective platform was developed in Kenya after the post-election fall-out in 2008 for documenting violent incidents and warning journalists and citizens. The so-called Ushahidi platform has in the meantime been developed into a Web-based application that is being used by political activists around the world. Ushahidi stands for 'testimony'.[25]

In April 2008 the UN established a special unit to promote the development and diffusion of such systems. The Information and Communications Technology and Disaster Risk Reduction Division (IDD) is part of the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP).[26]

3.5.7 ICT as an enabler of integrated urban management

Within ICT proper, the current emphasis is on the further development of ICT infrastructures and ICT processes to enable the faster and more efficient processing of data and their linkage. Like the smart grid, these advanced forms of data management are considered one of the fastest developing markets in the mid-term.

- *Cloud computing* delineates the pooling of IT infrastructures abstracted for the purpose of efficiency. The idea behind cloud computing is integrating different information systems such as mail, traffic management as well as public and private services. Work on city clouds is already underway in both the EU and the United States. Examples are London,[27] Vienna[28] and Berlin[29] (Fraunhofer 2010). In the EU, regulatory and data privacy issues are high on the agenda.

- *Big data processing* was the breakthrough in synthetic biology; and is turning out useful in political campaigning.[30] It is what underlies the success of Google as a search engine; and it constitutes the core argument for Facebook's high market value. Its application to urban contexts and in sector policies is slower due to data protection issues and questions relating to the reuse of Public Sector Information (PSI). The direct PSI-related market has been estimated at 32 billion in 2010 (Vickery 2011); the aggregate direct and indirect economic impacts at 140 billion annually. The EU Directive 2003/98/EC on the Re-Use of Public Sector Information is currently under revision in the framework of the Digital Agenda for Europe.

- *Master data management* is similar to big data processing, albeit with the emphasis on the storage and management of data, hence also the link to cloud computing. Master data management builds on earlier *e-government* and *crowd sourcing* solutions which are already deployed and are getting increasingly sophisticated.

- *Sensor networks* are in deployment in the transport sector (vehicle detection) and in buildings (lighting). They are under development for health care. As with other health technologies, their development is in part driven by military interests (dual-use). The key issue conceptually and in terms of research is 'machine-to-machine' (M2M) communications. A potential problem is that of interoperability.

On a more basic level, in Rio de Janeiro, the 'Meu Rio+20 Project' identifies innovative green business ideas and helps to scale them through crowd-funding, micro-philanthropy and seed funding. Another example of how technology can be used to promote urban management is cloud-based surveys. Using freely available products, Google Ideas, in partnership with the Africa Division of Voice of America (VOA), has piloted a simple phone-based constitutional survey in Somalia surveying citizens on their opinions on key constitutional issues.

More generally, crowd sourcing concepts promote societal participation and transparency. For instance, the smart profiling project in Khayelitsha, one of Cape Town's largest informal settlements, has gathered basic socio-economic data on its inhabitants, thus enabling to hold city decision-makers accountable. In 2005, the 'HABITATJam', based on IBM's concept of Online Jams, provided a platform for the discussion of concerns, ideas and priorities of urban citizens.

Finally, in the field of education ICT render possible capacity building programmes such as a distant education programme for public servants in Sri Lanka, which trains public servants in 150 group-learning centres in order to enhance the communication between the central government and the provincial councils.

3.5.8 Wireless technology

Wireless technology has already revolutionized the way we live and work and it will likely continue to do so in the years to come. In the field of smart technologies and, especially, the context of smart cities, it is estimated to entail a high potential. It is also of relevance for the developing world, where it is already in use for facilitating exchanges and learning at communal level and for business. In this regard, one often talks of *m-solutions* such as *m-learning*, *m-women* and *m-health* or wireless public safety applications. *M-money* refers to a version of electronic banking relying on mobile technology. This is a growing market in less developed regions and is also used for monitoring the repayment of micro-credits.

In Kenya, for example, the project 'M-PESA' helped to provide access to basic financial services to nine million Kenyans within five years by using mobile technology. In India, the 'Andhra Pradesh Smart Card Project' has succeeded in increasing the outreach of financial services to the poorest and wireless technology is used to facilitate the efficient and timely transfer of government benefits. Lastly, 'Mobile Initiative Afghanistan' uses mobile technology for providing financial services to people with no bank accounts.

In Santa Cruz, Bahia (Brazil) fishermen were provided with wireless devices for getting updates on weather conditions and information on markets. A similar example is that of farmers in the hinterland of Indian cities receiving expert assistance as well as market information via simple G2 mobile technology.

3.6 Key actors and trends

The 'smart' agenda has captured the imagination of public and private actors alike. In this section of the report we summarise the main trends for each stakeholder group and provide examples.

3.6.1 Pioneer cities

The two cities that appear in most lists of smart cities soon-to-be are Copenhagen and Amsterdam.

Copenhagen[31] expects to be the first carbon-neutral capital by the year 2025 (see among else Ramboll and City of Copenhagen 2012). Besides major investments in the use of wind power and solar energy, fifty 'lighthouse projects' are already under implementation towards meeting this target. Examples include:

- the construction of new and better cycling lanes with bike counters and real-time data;

- the introduction of IT mobility solutions in transport such as text-ticketing, real-time information and the use of GPS technology to keep lights green for buses;

- the use of smart sewage systems enabling the utility provider to operate a reimbursement scheme for landowners who succeed in decoupling rainwater;

- the use of a smart system for regulating water pressure thus helping better water management and the introduction of individual meters for monitoring use of water in multi-residence buildings;

- the use of IT for coordinating and integrating the use of three different methods of cooling; and

- retrofitting buildings with equipment that measure and report on the use of water and energy and on ventilation.

The *Amsterdam*[32] 'smart city' plan focuses on five themes: living, working, mobility, public facilities and data:

- under the living theme, the city is planning the renovation of old canal-side buildings and the installation of smart meters for monitoring energy use;

- actions under the working theme include projects aiming to popularize the use of collective working places called 'smart work' spaces as well as tele-conference centres;

- mobility solutions include the piloting of smart grid loading stations for cars and an electrical battery system for electric cars, the installation of shore power stations to allow ships to connect to clean energy and the expansion of the WEGO car sharing system;

- under the public facilities theme, schools, sports parks, streets and others have been encouraged to submit energy saving projects using IT to a competition; and

- the Amsterdam Open Data Program experiments with crowd sourcing to encourage citizen participation in policy-making.

Other leading smart cities include *Vienna* (Smart Energy Vision 2050, Roadmap 2020), *Toronto*, an active member of the Clinton 40 (C40) megacities which seek to transition to the low-carbon economy; and *Barcelona* with several digitalisation projects and plans to launch a living lab for smart city innovations.

Examples of smart cities in emerging economies include *Singapore* (e-government programme REACH and m-government system), *São Paolo* (Heliopolis Smart Informal Territories Lab), *Mexico City* (school connectivity and other social inclusion and e-government programmes), *Tapei* (extensive e-education and e-government projects), and *Rio de Janeiro* (crowd sourcing green entrepreneurs, rapid transit bus system and bike sharing).

Cities experimenting with smart city solutions on a smaller scale include: *Paris* with its Velib and Autolib programmes; *London* with its congestion pricing system and its plans for launching a Smart Cities Research Centre at Imperial College; and *Tokyo*, which plans a small smart town in the suburbs in partnership with Panasonic, Accenture and Tokyo Gas.[33]

3.6.2 City networks

With more and more cities interested in learning from each other about sustainability and connectivity, recent years have seen a rise in the number of networks established in order to promote this type of exchanges. Examples include:

- UCLG – The Global Network of Cities, Local and Regional Governments is one of the most powerful networks world-wide with an agenda-setting role in the UN-HABITAT Programme. Its members are cities or other more specialized networks.[34]

- ICLEI (Local Governments for Sustainability) is another global network focusing on sustainability. It represents 12 megacities, 100 super-cities and 450 large cities. It provides assistance in the form of knowledge transfer in the areas of green growth, food, integrated urban water management and biodiversity. Its smart urban infrastructure programme focuses on energy efficiency.[35]

- C40 Climate Leadership Group is a network of megacities working together to reduce climate risks. It was created by the former Mayor of London Ken Livingstone in partnership with President Clinton's Climate Initiative. Its current president is the mayor of New York Michael Bloomberg.[36]

- Cities Alliance is a global partnership focusing on poverty reduction. It has launched an action plan for improving the lives of 100 million slum dwellers by 2020. The EU, UN-HABITAT and the World Bank are multilateral members and donors.[37]

- Global City Dialogue (CDG) is an international network of city mayors promoting initiatives relating to the information society. Fighting the digital divide, e-government and e-commerce are three of its main goals.[38]

- Clean Air Asia is an UN-recognized partnership of Asian organisations, including cities. It is channelling funds and know-how related to policy measures that target air quality and the reduction of greenhouse gases.[39]

- Metropolis – the World Association of Major Metropolises represents cities with more than one million inhabitants. It fosters learning in different areas such as governance, accessibility, growth, public-private partnerships (PPP), culture and education. It also manages the metropolitan section of UCLG.[40]

- EPIC – The European Platform for Intelligent Cities targets medium-sized cities (50.000 to 500.000 inhabitants) and provides advice on products and services related to smart cities. The network was established with funds from the Competitiveness and Innovation Programme of the European Union.[41]

The above networks are the most powerful of existing city networks with official representatives. Those with institutional backing carry the greatest leverage.

There are several others operating on a smaller scale. The majority of these are specialized either thematically and/or in terms of characteristics of their members (geography, size, etc.). Among these the most interesting are those representing regional grassroots community organisations such as Slum Dwellers International (SDI) or the Asian Coalition of Housing Rights (ACHR). These are using ICT to become better connected and to enlarge their outreach.

3.6.3 Private actors

The energy industry is one of the fastest growing sectors. According to Frost and Sullivan (cited by Singh 2012), the global market for the smart grid will be worth US $100 billion by 2015, and will double that by 2020. Two other growing industries are data management, including cloud computing, and ecological buildings.

As a result, recent years have witnessed the major repositioning of big corporations as well as numerous mergers and acquisitions. In the building sector this applies to Schneider, Johnson Controls and Honeywell; in the energy sector to Siemens, GE and ABB; in the ICT sector to Cisco, Oracle and IBM. The success of Accenture and ST Electronics in winning the Singapore tender for a smart grid pilot project in 2010[42] led to major re-structuring of the industry:

> *"This came as a shock to Siemens, and to all traditional players in this industry. Since then they have all been on an aggressive shopping spree making acquisitions to bolster their software and IT capabilities. Swiss grid giant ABB spent about 1 billion USD to buy Ventyx in 2010, while Schneider Electric made a suite of software purchases, notably its 2 billion purchase of Telvent, a European Smart grid software provider. … Siemens, who has been fairly quiet for a period of time, at the end of 2011 bought its Smart grid software partner eMeter. Combined the big four in this industry – GE, Siemens, ABB and Schneider – have made about 25 acquisitions worth about 8-10 billion. … Is this the end of the shopping trip? No. This is only the start and is expected to accelerate."*
> *(Singh 2012: 26)*

According to Kanellos writing for 'Greentech Media' in 2011, the overall strategy of many companies in this sector is "to build a comprehensive portfolio that can include nearly everything from demand response and home networking to pieces of industrial gear that cost millions".[43] In other words, the convergence of technologies is leading to a convergence of the telecommunication and IT industries with energy, infrastructure and automation.

The growing significance of the smart cities industry is, among else, shown by corporate investments in public relations and branding. Siemens leads in a big way. In 2009, it launched the Siemens Green City Index to monitor the environmental performance of 120 cities around the world (Economist Intelligence Unit 2012);[44] and completed construction of the Crystal landmark building at the Royal Victoria Docks in London.[45] The Crystal is home to the world's largest exhibition on urban sustainability. Exhibition zones focus on urban planning, smart buildings, clean energy, water, healthcare, mobility and future scenarios.

3.6.4 Civil society

Environmental campaigning and civil society organisations are beginning to include smart technologies on their agenda. A good example is provided by Greenpeace, which in 2009 launched the 'Cool IT Challenge'[46] to urge IT companies to come up with solutions that con-

tribute to reversing climate change, whilst reducing their own global warming emissions at the same time. The 2013 leaders were Google and Cisco, followed by Ericsson in third place, IBM in eighth and Microsoft in twelfth.

Civil society organisations are also playing a key role in the implementation of development projects involving IT solutions. Examples already listed in previous sections include the Ushahidi platform, members of the Slum Dwellers International as well as the Asian Coalition of Housing Rights. Several others are working on a project level or in specific countries. They stand to benefit from the enlargement of the membership base of city networks such as those listed in section 3.6.2 above.

3.6.5 Research sector

A lot of research on smart technologies is currently carried out by universities with funding from national and supra-national funds and in collaboration with industry. One example is the 'Digital City Exchange' five-year programme at Imperial College which is funded by the Research Council Digital Economy Programme with GBP 9.5 million. In 2011, Imperial together with University College London and Cisco entered into a three years agreement to create a Future Cities Centre.[47] In Santander, in Spain, a smart city research centre will be built with funds from Ferrovial.[48] In Germany, a smart city lab is run by Fraunhofer FOKUS, another one by RWTH Aachen.

One of the best examples of university research on smart cities is the 'City Science' MIT Media Lab Initiative. This is organized around six themes: (a) urban analytics and modelling, (b) incentives and governance, (c) mobility networks, (d) places of living and work, (e) electronic and social networks and (f) energy networks. For instance, research under the mobility theme includes projects on vehicle-pedestrian interfaces and interfaces for shared-use vehicle systems, while research under the energy theme is concerned, among others, with the development of microgrids for urban cells and DC (direct current) power networks for residential buildings. In its own words, City Science aims to develop a data-driven approach to urban design and planning, hence also the creation of a so-called 'urban analytics' research theme for advancing the tools and concepts for the collection and analysis of urban data.

At European level, smart technologies are a core element of the ICT Work Programme of the 7th Framework Programme as well as a cross-cutting component in various other sectorial programmes such as Energy and Transport. Under the ICT Work Programme (European Union 2012), research was funded for developing personalized services for health care, independent living and active ageing; personalized health status monitoring; ambient intelligent solutions as interfaces to smart environments; digital social innovation platforms; electricity distribution grids, data centres, cooperative mobility, smart energy grids as well as smart cities. These topics are expected to continue to be prioritized under the Horizon 2020 Programme.[49]

In addition, it is planned to launch a Smart Cities and Smart Communities Initiative (European Commission 2011). This will cover buildings, heating and cooling, electricity and transport and include ten demonstration cities for each theme.[50] Finally, under the European Local Energy Assistance Facility (or ELENA), the European Investment Bank (EIB) in collaboration with the KfW, Central European Bank (CEB) and European Bank for Reconstruction and Development (EBRD) are co-financing local and regional public authorities technical assistance for the development of bankable sustainable energy investments. Several smart-to-be cities have been receiving funding from ELENA, among else for smart technology projects. This includes Barcelona, London, Paris and Malmö.[51]

3.7 Conclusion: A holistic approach to smart cities

Some of the stakeholders consulted by this study advocated the adoption of a holistic approach to smart cities, i.e. one that takes into account its relevance for both the 'green economy' agenda and for 'connectivity'.

Empirically much speaks in favour of such an approach at the urban level. Existing definitions of smart cities consider all the areas and sectors considered in section 3.5; and there is no doubt that the challenges faced by cities concern both sustainability and connectivity.

The disadvantage of a holistic approach is that the majority of stakeholders, and especially those who manage public funds, think in one or the other way, that is to say they either place the emphasis on the 'green economy agenda' or on 'connectivity' issues. Another problem is the risk of thinning out as a result of scarcity of funds or aggressive branding. This is a danger that is always inherent in the introduction of new concepts. Each new paradigm is called to legitimate itself with reference to previous paradigms, and this often leads to competition over funds.

Notwithstanding these risks, we think it sensible to adopt a holistic approach to smart cities in order to do justice to the complexity on the ground and further strategic integrative thinking. However, in order to avoid the raising of unrealistic expectations, we propose to link the concept of smart cities more explicitly to learning and problem-solving in addition to proposing an explicit impact pathway that does equal justice to sustainable development and connectivity.

On this basis, it is proposed to define smart cities as follows:

Smart cities are those cities which:

- deliberately engage in learning and evidence-based policy-making in order to improve their services and infrastructure and, in this process,

- make use of advanced information and communication technologies.

- ICTs are used to improve connectivity – at the infrastructure level (i.e. from machine to machine), at the level of services (i.e. from human to machines) as well as at the group or personal level (i.e. from humans to humans).

- Given the right conditions, this improved connectivity contributes to resource efficiency (hence also to environmental sustainability) as well as

- to the betterment of governmental services, thus indirectly contributing to the reduction of social inequalities and the increase of societal participation.

One other advantage of this definition it that it allows a better assessment of actions (including funding programmes) implemented in order to realize smart cities. Accordingly, successful smart city projects are those that are integrated in the learning and exchange networks of a city, make use of ICT for the purpose of connectivity, data collection and processing, consider external conditions such as availability of infrastructure and institutional capacity, and explicitly target resource efficiency and/or the effectiveness and inclusiveness of public and social services.

In chapter five of this report we use this definition for defining entry points for German development cooperation in the area of smart cities. Prior to this we review the literature on smart cities and the development agenda.

4 Smart Cities and the Development Agenda

In the mainstream sociology of development, the trend has been to distinguish between two types of discourse: a modernization discourse that focuses on developed countries in Europe and North America as well as in Australia and Japan; and the development discourse that focuses on the rest of the world, i.e. Latin America, Asia and Africa (Liping 2009).

Modernization is the much more specialised discourse as it is oriented to economic development and is often associated with capitalism. By contrast, the development discourse is broader and draws from different theories, among which that of basic needs, structuralism, dependency theory and sustainable development. In addition, the development discourse is more critical of approaches that focus on modernisation and economic development as it is feared this may lead to the aggravation of inequalities within and between societies (Preston 1996).

The more methodical perspective of development theory and practice explains why development agencies tend to favour sustainable development and the fighting of poverty as overarching goals and are cautious about adopting the smart city paradigm (see section 3.1). Nonetheless, the gradual recognition that cities may no longer be ignored, in conjunction with the growing demand of development countries to be taken seriously as trade partners and political actors, has brought about a shift of policy focus from development to international collaboration, from technology transfer to technology exchange and from institutional capacity building to learning, knowledge and reform. Against this background we can also observe a slow enlargement of priorities to include ICT and, by default, smart technologies.

An unresolved problem remains that of tailoring programmes to fit the needs of different countries or cities. This is important in view of the differentiation between least developed countries and emerging countries as well as the exacerbation of centre-periphery gaps in both. This problem is not germane to smart cities but is there particularly acute.

There is no easy answer to this problem and, therefore, a 'one size fits all' type of an approach is unlikely to bear fruition. Each new initiative will have to be evaluated on its own merits and with reference to the context of implementation. The expansion of the mandates of several development agencies to include evaluation units that emphasize evidence-based policy-making and monitoring are steps in the right direction.

Recent work done by the United Nations Human Settlement Programme on the determinants of city prosperity provides additional points of reference. This research is summarised below. It is followed by a brief overview of the position of the World Bank and an outline of ICT programmes under implementation by development agencies. Thereafter we explore the challenges faced by the adoption of the smart city agenda in the developing world, as revealed by the stakeholder and expert interviews carried out in the framework of the present study.

4.1 Cities at centre stage: The UN-HABITAT report

That cities are important for growth and development is nothing new. What is new is the interest in them in the framework of the development agenda, which dates back to the beginning of the millennium. Different factors are driving this development. Two are of primary importance: first, the rapid growth of urban settlements both in emerging economies and, especially, in developing countries;[52] second, the gradual modernization of agriculture practices, which is expected to lead to the further decline of this sector's significance for the labour market.

As remarked by Uwe Ohls, Head of Department of the German Development Bank KfW for Europe and Asia: "If we need to reach poor people, we need to invest in cities." (cited in KfW and DEG 2010: 11)

This is also the position adopted by the United Nations Human Settlement Programme. The 2012/2013 report (UN-HABITAT 2012) highlights cities as 'the home of prosperity' and 'a remedy for global crises'. However, it warns against a narrow focus of prosperity on economics, as this is "a limiting view that shuts out other dimensions that are integral to human well-being and necessary for individual and collective fulfilment" (ibid.: 13). Accordingly, UN-HABITAT proposes a new approach to thinking about prosperity and cities that takes into account all relevant dimensions, namely, *economics, infrastructure, social services, poverty* and the *environment*.

The City Prosperity Index (CPI) compiles data on all five dimensions and provides indices and measurements that help assess each city's standing besides providing comparative statistics. Using this index,[53] the following six-fold classification has been constructed:

- *Cities with very solid prosperity factors* (0.900 and above) feature "high volumes of goods and services as well as strong economic fundamentals and high productivity. Their populations live long and are well educated. Infrastructures are available and the environment is well managed" (ibid.: 19). This top category includes mainly cities in Central, North and Western Europe as well as New York City from the United States, Tokyo from Japan, Melbourne from Australia and Auckland from New Zealand.

- *Cities with solid prosperity factors – first category* are those with a CPI between 0.800 and 0.899 such as Prague, Athens, Budapest, Lisbon, Ankara and Shanghai. These cities display "relatively strong institutions, responsive legal and regulatory frameworks and large availability of public goods" (pp.20-21). Mexico City, São Paolo and Seoul also form part of this group when the equity index is excluded from CPI. When it is included they fall into the next category.

- *Cities with solid prosperity factors – second category*: This is a heterogeneous group with combined CPI values between 0.700 and 0.799 but displaying variable or 'uncoordinated' development on individual dimensions. "This comes as the result of institutions, legal and regulatory frameworks and urban management practices that are being consolidated and because of this they cannot hold together all the elements." (ibid.: 21) Cities in this category include Cairo, Amman and Casablanca; Johannesburg and Cape Town; Manila, Jakarta, Bangkok, Beijing and Hanoi; as well as Yerevan and Kiev. Once again, some cities in this group, namely Johannesburg and Cape Town, slide into the next category when the equity index is included in the equation.

- Development is even less balanced in *cities with moderate prosperity factors*, i.e. with CPI values between 0.600 and 0.699. This category includes the Asian cities of New Delhi, Phnom Penh and Mumbai; the Latin American cities of Guatemala City and Tegucicalpa; the African cities of Nairobi and Yaoundé; as well as Ulaantaabar in Mongolia and Chishinau in Moldova.

- *Cities with weak prosperity factors* (CPI: 0.500 to 0.599) are those where "much still needs to be done in terms of quality of life, infrastructure and environment" (ibid.: 23). Such is the situation of most African cities (e.g. Lusaka, Dar es Salaam, Harare, Dakar, Adis Ababa, Lagos, Accra, Kampala, Dhaka or Abidjan) as well as La Paz in Bolivia and Kathmandu in Nepal.

- *Cities with very weak prosperity factors* (CPI: below 0.500) display contrasted patterns on the various dimensions, like the second categories of cities with solid prosperity factors, albeit at a much lower level. This category includes Monrovia (Liberia), Conakry (Guinea), Antananarivo (Madagascar), Bamako (Mali) and Niamey (Niger).

Further to the above, UN-HABITAT recommends distinguishing cities according to where they are located in terms of regional connections. There are three new spatial configurations: 'mega regions', 'urban corridors' and 'city regions'.

- Mega regions are amalgamations of several cities such as the Tokyo, Nagoya, Osaka, Kyoto and Kobe region in Japan with 60 million inhabitants.

- Urban corridors are transport corridors connecting cities that can thus capitalize on fast growth. Several of the so-called trans-European transport corridors linking Western and Eastern Europe as well as the North African corridors foreseen by the Mediterranean Transport Plans were originally designed as urban corridors. An example from a non-European region is the Kuala-Lampur Klang urban corridor in Malaysia.

- City regions are large conurbations of big cities and their hinterlands. Bangkok in Thailand is such a region and likewise São Paolo in Brazil and Cape Town in South Africa.

Entry points for international collaboration and development aid are water, ICT, energy, waste and recycling, urban transport and renewable energies. The support of civil society and institutional capacity building remain priorities as before – on their own or in combination with technical assistance projects. In addition, the UN-HABITAT report calls for directing more attention to the process of transition from a state of backwardness or under-development to one of development. One reason why development aid often fails to deliver as expected is because it ignores or pays insufficient attention to the intermediary phase of development and to the related transaction costs, whether financial, institutional, social or human.

Specifically with respect to ICT, the UN-HABITAT report draws attention to the fact that developing countries account for 75 per cent of the growth of mobile telephony since 2001. Telecommunications infrastructure is among the highest developed across continents, and especially in cities. This applies to African cities as well.

4.2 The World Bank's search for a new strategy

Smart cities are by name not yet a priority of the World Bank. However, there is a gradual re-orientation of country strategies towards greater attention to both cities and digital technologies. This concerns especially middle-income countries. These are home to the majority of the world's poor but display uneven development. They are also generally creditworthy but lack access to finance markets.

In a policy paper entitled *Smart Cities as Engines of Sustainable Growth* commissioned by the World Bank and based on research carried out at MIT (Frenchman and Joroff 2011), it is stated that 'real measurable progress towards sustainable development' will only be possible through greater resource efficiency in cities and that this, in turn, is achievable through smart technologies.

> *"… unless new strategies are adopted, much of this growth [in terms of urban population] will be constructed using a pattern of city form invented in the 20th century – when fuel was cheap, land was open, the air was clean and global population was one fifth of what it is projected to be in 2050. … We understand from experience in developed countries that this kind of city, replicated on a mass scale, consumes vast quantities of resources and is highly inefficient. … New models of business, logistics, social interaction and planning are emerging in part because of the failure of obsolete systems, and in part because of opportunities provided by 21st century digital systems and advanced communication technologies that are vastly more potent. These technologies can and will increasingly be applied to the planning and organization of cities, offering a new paradigm of productive and more sustainable growth." (ibid.: 2)*

Besides greater investment in 'networked' cities, the term favoured by the World Bank to refer to smart cities, it will be important to remain flexible as there is no single ideal model of a 'sustainable city'.

> *"… In rush to urbanize, any model deemed to be 'the right' model stands to be repeated endlessly, to the detriment of cultural diversity, livability, and we will argue later, to sustainability itself. The concept that environmental policy should be based on model development forms or minimum design standards is in itself a modernist invention, the limitations of which are clear when we observe the uniform character of large scale, rapid growth. … In the case of sustainable development, the challenge is to devise more ways of achieving it – not fewer – that may vary from site to site, city to city, climate to climate." (ibid.: 5)*

The World Bank's ICT sector strategy that has been running since 2007 comprises three pillars: connect, innovate, transform. Under the first pillar the emphasis has been placed on expanding connectivity infrastructure and helping stabilise conditions for the telecommunication industry. Under the second, 'innovation' pillar, attention is focused on promoting entrepreneurship, especially of women and youth. Finally the third pillar targets government services in health, education, e-government and financial services.

Countries that have benefited from loans and grants from the World Bank in this sector include Ghana, Mexico, Rwanda, Iraq, Moldova, Nicaragua and Afghanistan. The Bank has committed US $1.3 billion in standalone ICT projects since 2003; and a further US $7.3 billion in some 1,700 projects with ICT components focusing on education, health and public sector management.[54]

4.3 New ICT agendas for development agencies

Partly in response to conceptual and empirical work carried out by the UN-HABITAT Programme, several development agencies have been enlarging their operational portfolio to cover ICT. A few examples are provided below. The positioning of German development cooperation agencies is addressed in the last chapter of this report.

USAID – In the field of ICT and communications, the U.S. Agency for International Development is prioritizing projects that make use of ICT or wireless technology to help people connect, do business, learn etc. (Shah and Radelet 2012). For instance, it recently signed a Memorandum of Understanding (MoU) with Qualcomm to support programmes for closing the mobile phone gender gap (m-women), promoting entrepreneurship and learning programmes as well as e-government solutions in the fields of health and public safety. Qualcomm is helping implement wireless connectivity to help fishermen in Brazil promote their business and also train in more sustainable fishing methods. It is working in El Salvador on behalf of USAID to use wireless technology to help municipal governments implement public safety programmes; and in the Philippines to help hospitals compile and share patient records.[55] In another project, USAID is supporting the use of mobile technology for tracking neglected tropical diseases, as was earlier done with HIV.[56] In Kenya, support is given to schools to improve technology access and, especially, the use of the web for teaching maths and science.[57] Seven elite American universities are being supported by USAID to create distance learning and other web-based education programmes for African cities. Mobile money (m-money) projects are underway in Haiti, Afghanistan, Indonesia, the Philippines, Malawi and Mozambique. These projects are being implemented in partnership with banks, private foundations and mobile network operators (USAID 2013).[58] USAID also plans to make greater use of smart technologies in the implementation of its First Water and Development Strategy, which was launched in May 2013.[59] Finally, in its *Forward Report for 2013* (USAID 2013), USAID elaborates how it plans to make greater use of data processing in evaluations and monitoring.[60]

SIDA – The Swedish Development Agency is supporting the use of internet and mobile technology to reach various goals. An example is the 'Huduma' project in Kenya, a web platform for reporting citizen complaints regarding public services.[61] The Financial Sector Deepening Trust programme is providing funds or securities to local banks for supporting small commercial enterprises, ICT being one of the priority sectors. Finally, SIDA supports agencies that are developing mobile technology solutions for health projects.[62]

DANIDA – In the field of smart technologies, the Danish Development Agency is providing support to the Energy Sector Management Assistance Program of the World Bank which, among else, has set up a training portal on smart grids targeting developing countries[63] besides launching a five-year Energy Efficient Cities Initiative (EECI) for promoting knowledge exchange on energy efficient programmes in developing countries.[64]

4.4 Challenges for smart cities in developing countries

The stakeholders and experts interviewed for this study identified a series of challenges faced by contemporary development – in general and, especially, in relation to smart cities. These can be clustered in two categories: there are those that relate to the potential target countries and those that relate to development agencies.

4.4.1 The perspective of target countries

In least developed countries the main problem remains that of *lack of basic services* and infrastructure. This includes the *digital divide*. *Poverty* is number one priority, hence also the concentration of funds on rural development.

Other problems, which are also present in some or parts of emerging economies, are:

- *Institutional capacity and resources*: In several cities there is lack of leadership, a weak learning culture and, therefore, little coordination among relevant stakeholders including within city governments and administrative entities. Policy initiatives tend to be fragmented and often turn out untenable in the medium-term.

- *Tax-base*: In the developed world, financing is a problem for cities as a result of the concentration of the tax base at the national level. This problem is especially acute in the developing world and implies that all actions require approval at the national level and preparedness on behalf of the state government to continue supplying funds after international donors have left (cf. Chattobadyay 2006).

- *Decentralisation*: Again this is a problem we know from the developed world but which is perhaps even more acute in the developing world. As cities expand in size, they often undergo decentralisation and segregation, which is evidenced in segregated communities or slums in town centres. At the national level, the emergence of capital or megacities is accompanied by the decline of second-tier cities and rural regions (cf. Katz 2000; O'Conner 2009; Ryder and Brown 2000).

- *Lack of data*: Whereas in developed countries the problem appears to be that of data security and abuse, in less developed countries there is often not enough data to support policy-making or the monitoring of policy reforms. The problem is multifarious and relates to both lack of institutional capacities and the absence of a culture of evidence-based policy.

4.4.2 The perspective of development agencies

Development agencies no longer understand themselves as donors in the classical sense. Even the term development tends today to be shunned and is gradually giving way to the more modern concept of international cooperation. From the strategic perspective, and also in accordance with the wishes of beneficiary countries, development agencies want to operate in a more corporate manner in terms of procedures and management style.

Despite this, several agencies continue to operate in a traditional manner, that is to say their mode of work does not yet match their changing agendas and priorities. In this connection the following problems were highlighted as particularly relevant:

- *Funding programmes tend to be specialized* by sector and are very bureaucratic. Changing this will necessitate internal organisational reforms. These are difficult to implement due to established hierarchies and inertia. Programmes will often continue to be funded as always, despite near-consensus that they are not appropriate in their original format. A lot speaks for this piecemeal approach under conditions of stability. It is less useful at times of change when circumstances call for more risk-taking and for pilot projects.

- *Lack of awareness* about technological developments and the potential benefits of ICT – this is a problem that can be found at all levels, also within development agencies, and which denotes a lack of innovation and unwillingness to learn. There is a missing link between the discourse on technology on the one hand, and the debate on development cooperation and its goals, on the other hand.

- *Conventional understanding of public-private partnerships*: several officials working for development agencies mentioned problems with getting the private sector interested in their programmes. This statement was met with surprise by private industry representatives. The reason for this mismatch of conceptions has probably something to do with the fact that development agencies are used to collaborate with non-governmental organisations under the assumption that the private sector is not interested in collaboration with them, despite evidence to the opposite. To this must be added the fear of risks which has been accentuated by the recent global financial crisis. There is concern that IT projects will not deliver what they promise in addition to incurring cost overruns and delays.

- *Lack of recognition of cities in international politics*: Benefactor governments and development agencies continue to mainly negotiate with national governments, not cities. This is sometimes counterproductive.

4.5 Conclusion: A forward-looking perspective on deployment and adoption potentials

According to a recent White Paper released by the ICT European Technology Platform Net!Works (2011)[65], several smart technology applications in the areas of health, energy and transport have already entered the exploitation phase. Assuming open regulatory questions and interoperability issues are clarified, wide-scale deployment within the European Union should take off by 2020, or even earlier. The same is true for other developed countries like the United States or Japan.

By contrast, the situation is quite different in the rest of the world and in both the emerging economies and developing countries. As discussed in the previous section, this is because of lack of infrastructure and weak institutional capacities, often in combination with sheer size and decentralisation. This does not render smart technologies irrelevant. But it does require a different approach that does justice to the context and the specific problems faced by these societies.

According to the same report, since every city is different in terms of geography, socio-economic background as well as ecological conditions, "there are also different needs for action that cannot solely be determined by the characterization of 'growth' or 'shrinking'. Smartness should therefore also mean aligning smart, integrated, and interconnected solutions to the need for action of every individual city" (ibid.: 12). This position is similar to that of the World Bank reviewed in section 4.2.

Along similar lines, a report by the German National Academy of Science and Engineering (ACATECH 2011) recommends the use of ICT "as secondary solutions" for improving the efficiency of service provision but also for the purpose of "making data available in the first place". Thus, in the very least or minimum 'development-as-usual' (DAU) scenario, ICT should be used for collecting information about policy implementation and targeted areas or users for future deployments.

This is not to say that there is no room for the broader deployment of smart technologies in cities in the developing world. As the discussions in the previous sections and chapters have demonstrated, there are already several cities with a high innovation potential in developing countries and, especially, in the so-called emerging economies. In cities like São Paolo, Bangkok, Jakarta, Cape Town, Guatemala City, New Delhi or Mumbai, and in their surrounding conurbations, infrastructure investments are booming, industries are fast growing and a young educated middle-class is in the process of consolidation. As highlighted by the UN-HABITAT report, the main problem of these cities is their uneven development in different sectors. Coordination and better use of information using ICT is therefore a possible entry point for smart development in these cities, besides already-existing cooperation in the fields of energy efficiency, water, waste and the construction or retrofitting of buildings.

By contrast, in poorer cities with weaker institutional structures, infrastructure continues to represent the most appropriate entry point for development, whether in the telecommunication sector, in water, waste or urban transport. Finally, an important form of assistance towards better connectivity is the promotion and expansion of city networks at different levels of government as well as with regard to scientific expertise.

The sections below map the prospects for the deployment of smart technologies in different types of cities classified according to socio-economic development and institutional capacity. Clearly, deployment depends on the technology sector in question and the availability, where relevant, of related infrastructure. For some technologies, like smart grids, it is still too early to talk about deployment since the infrastructures are not yet fully in place. This applies to developed countries as much as to developing countries. The situation is different for applications such as car-sharing schemes that make use of existing infrastructure and where, as a result, it is possible to talk about competitive deployment on the supply side. Less prosperous cities as well as cities with inadequate institutional capacity are less likely to be equipped with the appropriate infrastructure for all technologies. In turn, this will impact on their prospects with regard to the deployment of smart technologies in the near and mid-term future but not necessarily in the long-term future.

Cities are classified according to the UN-HABITAT classification following the city prosperity index. Technologies are classified according to the categorisation presented in section 3.5.

4.5.1 Cities of high or solid prosperity (CPI ≧ 0.800)

In cities in developed countries or in emerging economies with high or solid prosperity values, the prospects for deployment are comparatively high with respect to ITS, congestion charging and car sharing schemes.

Regulatory issues and lack of awareness are the main barriers for the large-scale deployment of various smart technologies in the building sector, in the areas of water and waste management as well as with respect to smart meters.

Emerging technologies include smart grids, electric vehicles, big data processing and cloud computing. Many of these technologies are still under development or at the demonstration stage. Their deployment, whether at the city or national level, requires significant financial investments. Cities will most likely be used to showcase pilot projects.

4.5.2 Cities of unbalanced or moderate prosperity (0.600 ≦ CPI ≧ 0.799)

In cities displaying unbalanced development or scoring moderately on the city prosperity index, the deployment and adoption of smart technologies is underway in the areas of e-government, disaster prevention and recovery systems as well as car sharing.

Upcoming sectors, i.e. sectors with high prospects for deployment and adoption are the fields of smart meters, ecological buildings, smart waste management, ITS as well as congestion charging. In these sectors much can be achieved through coordination actions, technical exchanges, market studies, regulatory harmonisation and the financing of pilot or trial projects.

The prospects for the deployment of smart grids, smart water management, electric vehicles, big data processing and cloud computing are lagging behind due to under-developed infrastructures.

4.5.3 Cities with weak prosperity factors (0.500 ≦ CPI ≧ 0.599)

Cities falling under this category require financial assistance for practically all types of smart technologies with the exception of m-money and car sharing schemes.

The areas with the higher short-term potential are projects relying on wireless technology and targeting the health and education sectors. Such projects are often not financed and managed by cities but rather by provincial and federal authorities alone or in collaboration with the private sector. In other words, the implementation of projects entailing smart technology components in these cities must still be mediated by higher levels of government.

4.5.4 Cities with very weak prosperity factors (CPI < 0.500)

In cities with very weak prosperity factors, development assistance should continue to concentrate on fighting poverty in cities and in rural areas. Pilot projects relying on wireless technology such as m-money, m-health, m-education and m-women entail a high potential for helping individuals and communities to escape the poverty trap. Given the weak urban governance structures in these countries, the implementation of such projects will continue to have to be done through the regional or national levels of government or alone in collaboration with civil society organisations.

5 Smart Cities and the German Development Agenda

In this chapter we take a closer look at German development cooperation and define potential and promising entry points relating to smart cities. These take into account the new priorities of German development policy defined in 2011-2012 as well as the findings of this report regarding trends and market potentials.

5.1 Revised priorities of German development policy

The last years have witnessed the transformation of German development policy in line with the United Nations Millennium Development Goals (MDG). In a programmatic report from 2011, the Federal Ministry for Cooperation and Development BMZ states the new approach to development policy as follows:

> "Development policy is more than charity. It represents an investment in the future and serves comprehensive interests. Insofar as it is future-oriented, it is called upon to enable innovative and cooperative solutions around the globe. Collaboration stands for cooperation and not for confrontation; it stands for values and interests; it does not lead to dependent relations with partners; it offers opportunities; and it empowers peoples to live in freedom, peace and self-reliance."
> (BMZ 2011: 8, own translation).[66]

In this context, the goals of the new German development policy are: good governance, dignified life, ecological and responsible activities and growth that is oriented to job-creation as well as fair structure for economic and political cooperation (ibid.: 10). The criteria according to which activities are to be judged are (ibid.: 10-12):

- the strengthening of innovation capacity;
- education and training;
- self-reliance;
- human rights, rule of law and democracy;
- good governance;
- market orientation and entrepreneurship; as well as
- climate protection, resource efficiency and renewable energies.

An important principle is for development policy to follow a differentiated approach. What development policy means today is not what it meant twenty, thirty or fifty years ago:

> "The development landscape has changed dramatically. This justifies the reform of development policy. Former development countries have grown into important political and economic actors. The number of wars has decreased and democracy is on the rise. Economic growth has increased the pressure on resources and on the climate. Nonetheless, there are still one billion of people who have to make ends meet with less than 1.25 USD per day. Unlike what was the case twenty years ago, these poor people are no longer to be found in poor countries. 600 million people living in absolute poverty are residing in middle-income countries like China, India and Vietnam. Another 300 million are living in failed- or conflict-ridden states. Of the 30 countries which will not be meeting the millennium goals by 2014, 20 are characterized by state-failure or violent conflicts."
> (ibid.: 12, own translation)[67]

The new emphasis of German development policy on innovation, market orientation and entrepreneurship is also shown by the creation of GIZ and the expectation that it follows a problem-oriented evidence-based approach whilst seeking 'value for money' (ibid.: 14-15). Its name, which emphasizes international rather than technical cooperation, reflects the new priorities.[68]

In summary, these priorities are summarised under ten headings: *more innovation, more education, more self-reliance, more impact, more engagement, more entrepreneurship, more dialogue, more investment, more climate protection and more prevention*.

It is against this background that German development policy is currently seeking to define its approach to cities, in general, and smart cities in particular.

5.2 Role of cities in new German development policy

A recent information brochure published by the Federal Ministry for Economic Cooperation and Development (BMZ 2012) outlines the reasons for placing cities at centre stage of development policy. Urbanisation is a mega trend and raises both opportunities and challenges.

Already more than half of the world's population lives in cities and metropolitan regions (CMR). Forecasts by the United Nations predict this number to increase to over 75 per cent by 2050. According to the computed value of the United Nations Population Fund (UNFPA), over the coming decades a city of 180.000 inhabitants would have to be built *every day*. Cities are major polluters as well as herds for poverty and socio-economic inequalities, hence also of crime and violence.

At the same time cities are engines for development and hubs for innovation. Within least developed countries they can serve as draft centres of innovation and development. This is manifested especially in the areas of sustainability, e.g. energy efficiency, biodiversity and climate change, as well as the area of transport, e.g. traffic congestion. In their role as emerging international actors, cities hold great potential for implementing international agreements such as the Millennium Development Goals.

The information brochure published by the Federal Ministry for Economic Cooperation and Development lists seven thematic areas as priorities:

- *Green urban economy*: This includes innovative strategies and projects in the field of transport, waste management and resource management as well as technical assistance in terms of policy design, implementation and management. Examples of ongoing projects are the Eco-City Da Nang in Vietnam and a solid waste management programme in Indonesia.

- *Cities and climate change* targets institutional capacity building through network formation and learning exchanges towards enlarging knowledge base for preparing urban development projects. An example of a project funded under this theme is the City Development Initiative for Asia (also supported by the Asian Development Bank and the Swedish International Cooperation Development Agency). Additionally, the German Federal Ministry is assisting the government of Ukraine to develop a strategy on eco-buildings.

- *Cities and Safety* includes urban infrastructure investments such as lighting and pavements in combination with soft measures such as the strengthening of civil society institutions to engage in neighbourhood regeneration and conflict resolution. Cities targeted by this theme include Cape Town in South Africa and various cities in Colombia.

- *Cities and good governance* provides support to local and national governments with re-spect to self-government, fiscal responsibility and decentralisation. The sub-programme targets both the capital city and several medium-sized cities in Bangladesh.

- *Municipal financing and urban development* is similar to above, albeit focusing on munici-palities and financial management. Nepal is an example of a partner country.

- *Cities and poverty*: Reducing poverty in cities requires a multi-sector approach that in-cludes investment in the improvement of infrastructure services (transport, waste, water, sanitation), the construction of social housing and the support of social services such as those targeting youth employment and conflict resolution. Ethiopia is an example of a partner country.

- *Cities and human rights* focuses on housing rights and housing policy as a means of gradually improving the living conditions in slums or 'informal neighbourhoods', thus em-powering their citizens to a better life.

Since 2009 and by way of the 'green economy' agenda shift of development aid and interna-tional cooperation, more attention is given to cities and their role for promoting sustainable economic development. The nine goals of the 'green urban economy', identified by GIZ and ICLEI (2012) on the basis of a review of international policy literature, overlap with those of development aid as presented above, but also interface well with the 'smart cities' agenda. The nine goals are the following:

- an eco-effective and eco-efficient economic structure;

- the creation of green jobs;

- poverty eradication and inclusiveness;

- urban form and design for eco-effective infrastructures;

- energy and resource efficiency in the physical infrastructure;

- renewable energy production and sourcing;

- a valued urban ecosystem;

- innovation, research and development; as well as

- stakeholder involvement.

The potential overlap is exemplified even clearer by the three proposed approaches to the green urban economy. These are (a) technology innovation, (b) business/governance inno-vation and (c) new green business opportunities. Several of the city and/or pilot initiatives used to exemplify approaches have already been showcased in this report with reference to smart cities – for instance, Singapore, Portland and Tokyo or green buildings, water and resource management.

5.3 Entry points for smart cities

How can Information and communication technologies contribute to broader goals of devel-opment cooperation? To begin with, it is important to underline that ICT are not the magic bullet or panacea in developing cooperation. While there can be no smart city without ICT, the application of smart technologies is not a sufficient condition for a smart city. ICT can only be a subordinated or downstream part of broader and super-ordinate development goals. ICT are not an end but must serve broader goals of development cooperation.

At the same time, ICT have the potential to contribute to the achievement of goals of development cooperation. ICT promote the connectivity of data and people and contribute to more efficient communication and coordination, as well as exchange and learning. Therefore, they have the potential to reduce information asymmetries, enable evidence-based policy-making and empower citizens. Concrete practical examples with an urban focus and high relevance for development cooperation were already outlined in the section on smart technologies. A list of selected past and ongoing initiatives can be found in Annex C of this report. They form part of a larger database that has been set up by adelphi and currently contains approximately 450 initiatives and projects related to the concept of smart cities.

It is beyond doubt that smart cities will come to constitute part of the agenda of German development cooperation over the next few years. Given the extensive corporate branding of 'smart cities' it could well be that this focus is called differently, i.e. 'connective cities', as at the APW, or 'networked cities' as with the World Bank. The naming issue is, however, of secondary importance. The key finding of this report is that smart technologies, on their own, and in relation to cities, are transforming the way public and communal policy is being done, both at home and abroad. The question is, therefore, **not whether smart cities are topical; but rather how the concept should be used by German development policy**.

This follows from the re-orientation of development policy as documented in this report, paired with the potential benefits ICT can bring to the achievement of broader development goals. International organisations such as UN-HABITAT, the World Bank and various national development agencies consider cities an important focus for development. This is not only because cities are attracting the largest share of populations around the world; but also because they are growing in middle-income countries which are home to the majority of the poor populations around the world. Consequently they pose serious challenges for environmental sustainability and resource efficiency. At the same time they represent hubs for economic growth, thus providing opportunities for entrepreneurship and innovation. Therefore, the question is not if, but rather how.

Flexibility is of key relevance in this context. All reports reviewed and all experts interviewed are of the opinion that modern development cooperation must build on flexibility. The economic, social and environmental trends that can be observed around the world speak in favour of such an approach. Countries and cities are today more differentiated than what used to be the case, which is also why it is no longer possible to talk about the developed vs. the developing world, but rather about high, middle- and low-income countries, advanced, emerging and least developed economies or cities of high, solid, moderate, low and very low prosperity factors. These differentiations according to economy or quality of life must then be matched against considerations regarding size, geographical location, political stability and the like.

Luckily, the call for flexiblity does not automatically need to lead to the abandonment of sector or country strategies – only to their appropriate adjustment. As discussed in sections 4.4 and 4.5, in cities with weak to very weak prosperity factors – and more generally in the least developed countries – the emphasis of development policy must remain that of fighting poverty and strengthening social infrastructures through education, human rights, good governance and the promotion of self-reliance. By contrast in cities of unbalanced or moderate disparities – and more generally the middle-income developing countries – there should be additional room for projects dealing with entrepreneurship, the environment and resource efficiency. Here, smart technologies have a potential role to play, at least in the framework of pilot actions.

Against the above background, **the following entry points** can be defined.

Considering that ICT is already applied in various development projects supported by German development cooperation, it is recommended to reinforce this trend by making it a requirement to mainstream ICT in all projects, and, especially, those supported under the sev-

en priorities of the cities focus of German development policy, i.e. *green urban economy, climate change, safety, governance, urban development, poverty* and *human rights* (see section 5.2).

From this follow a number of **horizontal actions**:

5.3.1.1　Addressing the lack of awareness about technological development

It is important to build awareness and knowledge of the portfolio of smart technology solutions and their benefits in (1) institutions engaged in development cooperation as well as (2) among representatives and decision-makers of targeted city governments and administrations. This is especially important because smart city concepts tend to be supply-, not demand-driven. In this connection it might be useful to establish an own ICT Competence Centre within GIZ.

In addition, it might be useful to actively seek collaboration with international organisations such as UN-HABITAT, the World Bank and other bilateral development organisations on demonstration projects. Besides promoting the transfer of know-how, such actions would benefit recipient countries by capitalising on synergies and connectivity.

5.3.1.2　Continue to support networks on smart cities in developing countries

The rapid growth of urban settlements in emerging and developing countries, paired with the limited awareness of benefits of smart technologies, calls for the scaling-up of smart solutions via city networks.

City networks have important functions:

- they communicate and share knowledge and experience creating learning effects, e.g. by presenting best practice cases (or worst practice cases);
- they solve information asymmetries linking interested cities to funding and implementing institutions as well as existing programmes (both nationally and internationally);
- they enable a permanent exchange and distribution of information, which is important in the rapidly developing field of modern technology; and
- they provide platforms for learning and exchanging information on international standards.

It is important for German Development Cooperation to continue collaboration with networks on smart cities in developing countries and, especially, with those that provide the highest leverage for its type of work.

5.3.1.3　Explore options for financial cooperation

Mainstreaming ICT, connectivity and networking aspects in all projects of German development cooperation includes adding smart technologies solutions to the portfolio of financial cooperation, in particular regarding infrastructural development. Exploring the development of financing concepts for the maintenance of smart technology solutions is equally important. Financing instruments could include financing for operator models, PPPs, trust funds or incentives for investors through independent verification.

Further potential entry points for financial cooperation are:

- Exploring financing models tailored to cities that face financial restrictions due to the specific national budget allocation. In this regard, KfW Development Bank could initiate a specialised fund—or alternatively allocate a portion of existing funds—for smart solutions in cities.
- Many smart cities projects are too small for international development banks but too big for community-based financing. This could be a potential entry point for financial German

financial cooperation. In addition, it is worth exploring the option of strategic cooperations with regional development banks, in particular in Asia.

- Megacities generally face little difficulty in attracting investment. This is not the case of second-tier cities. The latter represent a potential entry point for German financial cooperation.

5.3.1.4   Specific actions: project funding

In parallel with the above, it is recommended to earmark funds for projects that place smart technologies and smart cities at centre point in connection with resource efficiency and the improvement of social services. Such projects should build on the holistic definition of smart technologies proposed by this report (see section 3.7).

The most promising fields of engagement in emerging economies and/or cities with solid prosperity factors, as defined by the UN-HABITAT report, are:

- regulatory harmonization, standardisation and best-practice benchmarking projects in areas of ecological buildings, smart meters, water and waste management; and
- pilot cooperation projects in the field of energy (city smart grids) and ICT (city clouds).

Potential entry points for engagement in cities with unbalanced or moderate prosperity are:

- the transfer, development and application of technology in the field of e-government across sectors and in areas of waste and water management;
- disaster prevention and recovery systems
- coordination actions as well as market and financial studies in the transport sector, especially regarding ITS, congestion charging and transit systems;
- civil society projects to support citizen participation and the collection of socio-economic data at neighbourhood level through crowd sourcing; and
- the support of projects using wireless technology to support business and education activities at communal or community levels as well as activities that help improve social services (m-money, m-education, m-health etc.).

Promising fields of engagement in developing and least developed countries and/or cities with weak or very weak prosperity factors are:

- exploratory actions in the field of e-government;
- disaster prevention and recovery systems
- civil society projects to support citizen participation and the collection of socio-economic data at neighbourhood level through crowd sourcing; and
- the support of projects using wireless technology to support business and education activities at communal or community levels as well as activities that help improve social services (m-money, m-education, m-health etc.).

Finally, some funds should be allocated to original project ideas developed by cities in collaboration with private industry and involving pilot demonstrations or trial deployment components.

This can be done by way of existing partnerships (e.g. with Siemens or SAP) or through an open call on 'Smart Cities and Development'. The advantage of the latter approach is that it would raise interest in the topic of smart cities and signal the interest of German development cooperation to collaborate with corporate actors. The call could target corporate actors working in cooperation with civil society organisations, research organisations and local partners.

An alternative to the above would be to establish, within the GIZ or in collaboration with a university and/or corporate actor, a competence centre on 'Smart Cities and Development' in order to work on the tailoring of existing smart products or solutions to the needs of emerging economies and middle-income countries.

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Notes

[1] This is "the difference between the actual investment in energy efficiency and the higher level that would be economically beneficial from the consumer's point of view ... generally caused by market failures and barriers". (Expert Group on Energy Efficiency 2007: 3)

[2] See World Economic Forum (2010), p. 45, contribution by Peter Corsell, Chief Executive Officer of GridPoint, USA.

[3] A review of the debate is provided by Owen (2010). This echoes the debate on decoupling. See also the special issue of *Energy Policy*, Volume 28, Special Issues 6-7, 2000; Stan Cox's (2010) book on refrigerators; and the Second Science and Technology Report of the House of Lords (2005). There, the UK Government is called upon to further investigate the rebound effect and, on this basis, improve its definition of energy efficiency: "The Government's proposition that improvements in energy efficiency can lead to significant reductions in energy demand and hence in greenhouse gas emissions remains the subject of debate among economists. The 'Khazzoom-Brookes postulate', while not proven, offers at least a plausible explanation of why in recent years improvements in energy intensity at the macroeconomic level have stubbornly refused to be translated into reductions in overall energy demand. The Government have so far failed to engage with this fundamental issue, appearing to rely instead on an analogy between micro- and macroeconomic effects. We welcome the UKERC project to investigate the 'rebound effect' and the empirical basis for the 'Khazzoom-Brookes postulate', and recommend that the Government in parallel with the establishment of a more robust measure for energy efficiency, take full account of the project's progress and results in developing future policies in this area." (Paragraphs 12.9 and 12.10). The UKERC project on the rebound effect was completed in 2007. Its findings suggest that the size of the rebound effect varies according to sector and technology but must in any case be considered in energy intensive sectors, for instance, through caps on price decreases.

[4] See also chapter 4 in Singh (2012).

[5] In order to tap on modalities of learning among cities and throw light on "whether city size, wealth or some other characteristics, particularly innovation and reform, might be associated with pace and mode of learning", Campbell (2012: 76) distributed a questionnaire to 300 cities members of associations such as UCLG, Metropolis, CITYNET and the Administrative Staff College of India. The response rate was 16 per cent, which is low, nonetheless high enough to produce a reasonable sample for drawing preliminary findings.

[6] On the status of rollout in Austria, one of the more advanced countries, see: http://www.e-control.at/de/market_players/electricity/smart-metering.

[7] See http://www.landisgyr.com/ (bought by Toshiba).

[8] See http://www.iccr-foundation.org/projects/eco-build.

[9] See http://ec.europa.eu/energy/efficiency/buildings/buildings_en.htm.

[10] See http://www.schneider-electric.com/solutions/ww/en/edi/4871808-ecostruxure.

[11] See http://bacsi.fs.cornell.edu/.

[12] See http://www.buildingtechnologies.siemens.com/bt/global/en/buildingautomation-hvac/building-automation/pages/building-automation-system.aspx.

[13] See visionary article on home robotics by Bill Gates in *Scientific American*: http://www.scientificamerican.com/article.cfm?id=a-robot-in-every-home.

[14] For an overview of smart grid projects in Europe see the activities of the Smart Grid European Technology Platform at http://www.smartgrids.eu/. Standardisation issues relating to smart grids are being addressed by the ACATECH project 'Future Energy Grid', http://www.acatech.de/?id=1389.

[15] See, among others, Enel at http://www.enel.com/en-GB/innovation/smart_grids/; Siemens at http://w3.siemens.com/smartgrid/global/en/pages/default.aspx; Honewell at https://buildingsolutions.honeywell.com/hbscdms/smartgrid/; as well as http://www.smartgridnews.com/artman/publish/.

[16] For an example of a research project on migrogrids, see http://certs.lbl.gov/certs-der-micro.html; an example of an application in India can be found at http://www.renewableenergyworld.com/rea/news/article/2013/04/microgrids-in-india-bringing-light-to-those-in-need.

[17] See http://www.acatech.de/?id=1073.

[18] See https://www.esmap.org/node/2804.

[19] See http://www.smartlinknetwork.com/.

[20] For Europe, see also the European Directive 2010/40 on the deployment of ITS: http://ec.europa.eu/transport/themes/its/index_en.htm.

[21] On the UK experience with congestion charging see http://www.tfl.gov.uk/roadusers/congestioncharging/; on the Stockholm experience see Börjesson et al. (2012).

Notes continued …

[22] A good example is the Car2Go scheme in various European cities, Canada and the USA. See, for instance, www.car2go.com/en/wien.

[23] See, for instance, the Institute for Soldier Nanotechnology at MIT: http://web.mit.edu/isn/.

[24] See http://www.voev.de/web/html/start/verband/engagement/schadenverhuetung/katwarn/index.html

[25] See http://ushahidi.com/

[26] See http://www.unescap.org/idd/

[27] See http://data.gov.uk/.

[28] See http://gov.opendata.at/site/.

[29] On efforts nationwide in Germany see http://opendata-network.org/.

[30] See, for instance, an article in *Technology Review* on how the Obama campaign used big data to win the 2012 presidential elections: http://www.technologyreview.com/featuredstory/509026/how-obamas-team-used-big-data-to-rally-voters/.

[31] See http://subsite.kk.dk/sitecore/content/Subsites/CityOfCopenhagen/SubsiteFrontpage/Business/Growth_and_partnerships/Strategy/GlobalChallenges.aspx.

[32] See http://amsterdamsmartcity.com/.

[33] Source: http://www.fastcoexist.com/1679127/the-top-10-smart-cities-on-the-planet.

[34] See http://www.uclg.org/.

[35] See http://www.iclei.org/our-activities/our-agendas/smart-urban-infrastructure.html.

[36] See http://www.c40cities.org/.

[37] See http://www.citiesalliance.org/.

[38] See http://www.globalcitiesdialogue.com/.

[39] See http://cleanairinitiative.org/portal/index.php.

[40] See http://www.metropolis.org/.

[41] See http://www.epic-cities.eu/; other smart city networks funded with EU funds include the 'Smart Cities Innovation Network' (http://www.smartcities.info/) which focuses on the North Sea Region, the 'Strategic Energy Technologies Innovation System' SETIS (http://setis.ec.europa.eu/), and the 'Smart Cities Stakeholder Platform' (http://eu-smartcities.eu/).

[42] See http://www.smartmeters.com/the-news/1332-accenture-and-st-electronics-get-singapores-intelligent-energy-system-pilot-project.html.

[43] See http://www.greentechmedia.com/articles/read/schneider-electric-buys-another-one-smartlink-newtork-systems.

[44] See http://www.siemens.com/entry/cc/en/greencityindex.htm.

[45] See www.thecrystal.org.

[46] See http://www.greenpeace.org/international/en/campaigns/climate-change/cool-it/Cool-IT-factsheet/.

[47] See http://www3.imperial.ac.uk/newsandeventspggrp/imperialcollege/newssummary/news_10-11-2011-11-59-54.

[48] See http://www.spiegel.de/international/world/santander-a-digital-smart-city-prototype-in-spain-a-888480.html.

[49] The Horizon 2020 Programme is the follow-up of the Seventh Framework Programme and will be launched in 2014.

[50] See http://setis.ec.europa.eu/implementation/technology-roadmap/european-initiative-on-smart-cities.

[51] See http://www.eib.org/products/elena/index.htm?lang=en.

[52] What is telling in this connection is not only that one century ago eight out of ten people lived in rural areas but also that today, out of every ten urban residents in the world, seven are in developing countries. Of course, this additionally reflects the rapid population growth in developing countries as compared to developed countries.

[53] Analytically, the index has been constructed as follows: UN-HABITAT has adopted an incremental approach to the development of this index. Two of the dimensions – productivity and quality of life – correspond to components of the Human Development Index (HDI), and have been used to compute the City Human Development Index (CHDI). The three other dimensions – infrastructure, environmental sustainability and equity – are made of

Notes continued …

various key indicators (UN-HABITAT 2012). Thus, productivity is composed of variables such as capital investment, formal/informal employment, inflation, trade, savings, consumption and household income. Quality of life considers education, health and public space. Infrastructure combines measurements on infrastructure proper and housing. Environmental sustainability is made up of air quality, CO_2 emissions and indoor pollution. Finally, equity combines statistical measures of income and consumption inequality (Gini coefficient) and inequality of access to services and infrastructures.

[54] See http://www.worldbank.org/en/results/2013/04/13/ict-results-profile.

[55] See http://www.qualcomm.com/media/blog/2013/05/22/qualcomm-and-usaid-working-expand-access-mobile-technology-public-good.

[56] See http://blog.usaid.gov/2013/05/using-technology-for-sth-control/.

[57] See http://kenya.usaid.gov/programs/education-and-youth/1019.

[58] In recognition of this USAID was awarded the 'Best Government Policy for Mobile Development' Award, see http://www.usaid.gov/news-information/press-releases/usaid-wins-best-government-policy-mobile-development-award-mobile.

[59] See http://www.usaid.gov/news-information/press-releases/usaid-releases-its-first-water-and-development-strategy-0.

[60] The data from various evaluations have also been made publicly available at the USAID Development Experience Clearing House, see https://dec.usaid.gov/dec/home/Default.aspx.

[61] See http://www.sida.se/English/Countries-and-regions/Africa/Kenya/Programmes-and-projects1/New-technologies-promote-democracy-participation-and-accountability/.

[62] See, for instance: http://www.sida.se/English/Countries-and-regions/Africa/Tanzania/Programmes-and-projects1/When-new-technology-saves-lives/.

[63] See https://www.esmap.org/node/2804.

[64] See http://www.esmap.org/node/20.

[65] See http://www.networks-etp.eu/home.html.

[66] In original: "Entwicklungspolitik ist mehr als nur karitative Hilfe, sie ist eine Zukunftsinvestition im Interesse aller. Als Zukunftspolitik muss sie innovative und partnerschaftliche Lösungen weltweit möglich machen. Unsere Zusammenarbeit steht für Kooperation statt Konfrontation, sie steht für Werte und Interesse, sie macht Partner nicht abhängig, sondern selbständig, sie eröffnet Chancen und will Menschen ein Leben in Freiheit, Frieden und Eigenverantwortung ermöglichen."

[67] In original: "Die Entwicklungslandschaft hat sich verändert. Schon darum kann Entwicklungspolitik nicht bleiben, was sie war. Frühere Entwicklungsländer sind zu entscheidenden Akteuren in Politik und Wirtschaft geworden. Die Zahl der Kriege hat ab-, die der Demokratien hat zugenommen. Steigendes Wachstum erhöht den Druck auf Ressourcen und auf das weltweite Klima. Zugleich leben heute noch 1 Milliarde Menschen mit weniger als 1,25 US-Dollar pro Tag. Anders als vor 20 Jahren leben diese Menschen nicht hauptsächlich in armen Ländern. 600 Millionen Menschen in absoluter Armut leben in Mitteleinkommensländern wie China, Indien und Vietnam. 300 Millionen Arme leben in scheiternden Staaten und Konfliktländern. Von etwa 30 Ländern, die die Millenniumsziele bis 2014 verfehlen werden, sind über 20 durch Staatenzerfall und Gewaltkonflikte charakterisiert."

[68] The GIZ was established in 2011. The new institution combined the agendas of the Deutsche Gesellschaft für Technische Zusammenarbeit / German Technical Cooperation (GTZ), the Deutscher Entwicklungsdienst / German Development Service (DED) and the training institute InWEnt.

7 Annex

7.1 Annex A: List of interview partners

Institution	Name
German development cooperation	
Federal Ministry for Economic Cooperation and Development (BMZ)	Franz-Birger Marré
KfW Development Bank	Arne Gooss
KfW Development Bank	Horst Schwörer
GIZ	Stefan Opitz
GIZ	Manfred Breithaupt
GIZ	Philip Madelung
Federal Ministry of Food, Agriculture and Consumer Protection (BMELV)	Astrid Jakobs de Pádua
City networks	
ICLEI	Santhosh Kodukula*
ICLEI	Maryke van Staden*
ICLEI	Ashish Rao Ghorpade
Corporate actors	
SAP	Thomas Pfohl, Paul Schindler, Iris Rieth
Deutsche Telekom	Luis Neves
IBM	David Post
Academia	
London School of Economics	Philipp Rode
University College London	Sarah Bell
Urban Age Institute / Institute of Urban and Regional Development (Berkeley)	Tim Campbell
United Nations University	Saleem Zoughbi
Fraunhofer FOKUS	Ina Schieferdecker
Institut für Zukunftsstudien und Technologiebewertung (IZT)	Siegfried Behrendt
Ecological Sequestration Trust	Peter Head
Institut für ökologische Wirtschaftsforschung (IÖW)	Sascha Dickel
Philanthropy	
The Climate Group	Molly Web
International Institute for Environment and Development (IIED)	David Dodman*
ACATECH	Christian Kobsda

International agencies	
DFID	Stephen Young
USAID	Nancy Leahy
DANIDA	Hans Christian Aaskov
Cities Development Initiative for Asia (CDIA)	Bernhard Dohle
State Secretariat for Economic Affairs (SECO)	David Kramer
UNEP	Soraya Smaoun
Asian Development Bank (ADB)	Michael Lindfield

* Online-survey

7.2 Annex B: Interview guide used for the expert interviews

Name of interviewee and position:

Institution:

Date of interview:

PART A: THE CONCEPT OF SMART CITIES

1. **What is the nature of your interest/involvement with smart technologies and/or smart cities?**

2. **What is your own definition of a smart city?**
   (Please describe)

3. **What are the main issues and which the main sectors you associate with the smart city concept?** (Please only tick three in each category)

Issues		**Sectors**	
IT	☐	Energy	☐
Sustainability	☐	Environment	☐
Green agenda	☐	Mobility & transport	☐
Efficiency	☐	Public service delivery: infrastructure (Water, waste, communication & postal services)	☐
Modernization	☐	Public service delivery: people (Education, health & social services, public safety)	☐
Technology	☐	Public management & governance (e-governance, m-governance, citizenship)	☐
Information	☐	Economy & creative industries	☐
Innovation	☐	Living (Housing, urban planning, recreation & culture)	☐
Learning	☐	Other (Please specify)	☐
Local-Global	☐		
Development	☐		
Other (Please specify)	☐		

4. Which cities do you associate with the smart city concept?

Cities in developed countries (examples):

Cities in emerging economies (examples):

Cities in developing countries (examples):

5. In your opinion, which sectors are the most advanced concerning the realization of the smart city concept? (multiple answers possible)

Energy	☐
Environment	☐
Mobility & transport	☐
Public service delivery: infrastructure (Water, waste, communication & postal services)	☐
Public service delivery: people (Education, health & social services, public safety)	☐
Public management & governance (e-governance, m-governance, citizenship)	☐
Economy & creative industries	☐
Living (Housing, urban planning, recreation & culture)	☐
Other (Please specify)	☐

6. In your opinion, who are the leading actors in the field? ('Leading' here refers to promotion, production, diffusion, policy development etc.)

Leading actors among national & international agencies (examples):

Leading countries (examples):

Leading corporations (examples):

Leading non-governmental organisations (examples):

Leading networks (examples):

PART B: THE FUTURE DEMAND FOR SMART TECHNOLOGIES

7. Where do you see future demand for the following technologies in developed countries, emerging economies and developing countries, respectively?

	Developed	Emerging	Developing
Smart grid	☐	☐	☐
Smart waste management	☐	☐	☐
Int. transport systems	☐	☐	☐
Car sharing schemes	☐	☐	☐
Smart cars	☐	☐	☐
Smart water meters	☐	☐	☐
Smart health monitoring	☐	☐	☐
Cloud computing	☐	☐	☐
Big data processing	☐	☐	☐
Intelligent sensors	☐	☐	☐
Biometric monitoring	☐	☐	☐
Mobile computing	☐	☐	☐
M-money	☐	☐	☐
Smart integrated building control systems	☐	☐	☐
Eco-buildings	☐	☐	☐
Other (Please specify)	☐	☐	☐

PART C: YOUR OWN ACTIVITIES

8. With respect to smart technologies and/or smart cities in which areas is your company/organisation active?

9. With whom do you regularly cooperate in the field?

PART D: THE DEVELOPMENT AGENDA

10. **Based on your experience: what are the main challenges for the implementation of smart technologies and/or smart city solutions in**

    a) Emerging economies?

    b) The developing world?

11. **Which smart city applications entail the highest potential for the developing world?**

12. **Is a distinction necessary between first- and second-tier cities and/or between urban and rural areas?**

13. **Has your organisation worked with developing countries in the past?**

    Yes   ☐   Go to question 14

    No   ☐   THANK YOU FOR YOUR TIME!

14. **Did smart technologies figure in this work?**

    Yes   ☐   Go to question 15

    No   ☐   Go to question 20

15. **How has your organisation engaged with smart technologies and/or smart city solutions in the developing world in the past?**

16. **What lessons did you draw from this past engagement?**

17. What are your priorities for the future?

18. Which partnerships have proved useful, which less so?

19. Are there any specific partnerships you are looking for in the future?

THANK YOU FOR YOUR TIME!

CONTINUE HERE IF YOU HAVE ANSWERED QUESTION 14 WITH NO:

20. Are you considering expanding your portfolio to include smart technologies?

21. What are your priorities?

22. Are there any specific partnerships you are looking for?

23. Is there anything else you would like to add?

THANK YOU FOR YOUR TIME!

7.3 Annex C: Strategic information database (selected projects)

The projects and initiatives presented here form part of a larger database that has been set up by adelphi and currently contains approximately 450 relevant projects, initiatives, networks and actors related to the concept of smart cities. This small assortment summarises only the most relevant examples that were given in this report.

Initiative	Main carrier	Description	Website
Buildings			
Climate Proofing project, Johannesburg, South Africa	The City of Johannesburg / C40 / DANIDA	The Climate Proofing project involves the roll out of low-pressure Solar Water Heater (SWH) units, as well as the installation of insulated isoboard ceilings and distribution of compact fluorescent lamps (CFL) to 700 low-income households in Cosmo City. The project was funded by DANIDA under the auspices of the Embassy as part of a Rand 15 million climate change mini-programme for Johannesburg.	http://www.c40cities.org/c40cities/johannesburg/city_case_studies/city-of-joburg-launches-its-%E2%80%98climate-proofing-of-urban-communities%E2%80%99-project
Energy			
Favela project Morar Carioca Verde, Rio de Janeiro, Brazil	City of Rio de Janeiro	Rio de Janeiro's power utility Light, which provides service to the favela neighbourhoods of the city, offers discounted electricity bills to customers who recycle – a low-tech solution to the problem of too much trash in the neighborhood.	http://www.theclimategroup.org/_assets/files/information_marketplaces_05_12_11.pdf
Water			
Stopping water leakage system, Tokyo, Japan	City of Tokyo / C40	Tokyo's method of detecting and repairing leaks has halved the amount of water wasted by the city in the past ten years from 150 million m3 water to	http://www.c40cities.org/c40cities/tokyo/case_studies

		68 million m3 water. Concerning underground leakage, the potential leakage quantity is estimated by using minimum night flow measurement; leaks are then detected by using electronic leak detectors. A computerised system calculates and gathers comprehensive information on leakage such as the causes, details of each repair work or the cost for repairs.	
Digital water monitoring systems, Kenya and Zambia	GTZ	The GTZ has successfully supported the implementation of digital monitoring systems for water regulation authorities in Kenya and Zambia, among other countries. In Zambia, after the software developed with GTZ was installed, the regulator NWASCO revealed that coverage rates for water in urban areas had to be revised downwards from 90 per cent to 47 per cent compared to MDG monitoring.	http://www.giz.de/Themen/de/dokument e/en-factsheet-ict-water.pdf
Transport			
The Transport App Challenge, Cairo, Egypt	City of Cairo	The Cairo Transport App Challenge is an online competition that asks the technology community to propose ideas how technology can be used to improve the transportation system and address the issues of traffic congestion in Cairo.	http://cairo.hackathome.com/
Skybus, Lavasa, India	City of Lavasa	Lavasa in India is benefitting from a smart transport solution called Skybus, a microbus service which offers a personalised, convenient, low-cost and sustainable alternative to commuting. Skybus uses a platform that manages web and mobile requests, allocates them to vehicles and adapts routes in real-time, taking passengers to	http://www.theclimategroup.org/_assets /files/Agile-Cities-Report-Full-FINAL%281%29.pdf

		destinations in the fastest possible way and by sharing similar trips.	
Health			
Mobile Alliance for Maternal Action (MA-MA)	USAID	Through its Mobile Alliance for Maternal Action (MAMA), USAID is working to provide timely health messages to expectant and new mothers.	http://www.usaid.gov/news-information/press-releases/usaid-wins-best-government-policy-mobile-development-award-mobile
M-money to cover travel expenses to a clinic, Tanzania	SIDA / UNFPA	In Tanzania, maternal health care is free of charge but many women, particularly in rural areas, cannot even afford transportation to a hospital. Mobile phones are offering a solution. The United Nations Population Fund (UNFPA) supports a project that facilitates access to fistula treatment by transferring money through SMS to cover travel expenses to a clinic.	http://www.sida.se/English/Countries-and-regions/Africa/Tanzania/Programmes-and-projects1/When-new-technology-saves-lives/
Wireless access for health (m-health), Philippines	USAID / Qualcomm	Wireless Access for Health is an USAID m-health project which helps hospitals in the Philippines to compile patient records and streamline the reporting process at hospitals using 3G technologies by improving access to accurate and timely patient information.	http://www.qualcomm.com/media/blog/2013/05/22/qualcomm-and-usaid-working-expand-access-mobile-technology-public-good
M-health monitoring for HIV patients	USAID	In various projects USAID uses simple mobile technology to check on people living with HIV. Mobile phones are used to send reminders to patients and caretakers to improve adherence to antiretroviral treatment regimens. As a substitute for home visits, which are expensive, time-	http://blog.usaid.gov/2013/05/using-technology-for-sth-control/

		intensive, and far from discreet, mobile technology became a key factor in dealing with the stigma of HIV.	
Integrated urban management and Good Governance			
Cloud-based survey, Somalia	Google Ideas / Voice of America (VOA)	In partnership with the Africa Division of Voice of America (VOA), Google Ideas has worked with existing, freely available Google products, to pilot a simple, cloud-based surveying tool that would allow VOA to organize the first phone-based constitutional survey in the nation, surveying Somalis on their opinions on key constitutional issues.	http://www.google.com/ideas/projects/
Meu Rio+20 project, Rio de Janeiro, Brazil	City of Rio de Janeiro / C40	The Meu Rio+20 project is a crowd sourcing initiative aiming at promoting green entrepreneurs in Rio de Janeiro. From recycling communities to rooftop farmers to bike sharing businesses, Rio de Janeiro has many examples of the potential of innovative, locally owned, sustainable ideas, however, these ideas often remain largely unknown, and few are given an opportunity to scale. Meu Rio+20 will catalyse the development of green innovation projects and help democratise the City's culture of giving and community investment through participatory community decision-making. The project combines three types of funding: crowd-funding, micro-philanthropy and seed funding. Through community outreach and online crowd-sourcing, innovative green business will be	http://www.meurio.org.br

		identified and placed in competition for funding.	
Smart profiling, Khayelitsha, Cape Town, South Africa	Slum Dwellers International (SDI) / Santa Fe Institute (SFI)	Smart profiling Khayelitsha is a profiling exercise in Khayelitsha, one of Cape Town's largest informal settlements. One of the core objectives is the collection of basic socio-economic data.	http://www.sdinet.org/blog/2013/06/11/sdi-sfi-partnership-action/
IBM Online Jam: HABITATJam	IBM / World Urban Forum / UN-HABITAT	HABITATJam was a global online event organised by the UN-HABITAT, the Government of Canada, and IBM. Carried out from 1 to 4 December 2005, it aimed at providing a platform for discussion how urgent problems of the world's cities could be solved and set the stage for the World Urban Forum 3 conference (Vancouver, June 2006). Recognising that a limited number of individuals could participate in the physical conference in Vancouver, IBM provided the internet-based Jam, a solution which IBM had used previously within the company to determine its corporate values. This way even people in remote villages could be engaged in the discussion and bring forward concerns and ideas (usually gathering around a single PC that was provided in the villages). Ideas collected through the Jam later defined themes and shaped discussion topics for delegates attending the conference. Participation in HABITATJam was open to public and private organisations as well as individuals around the world.	http://www.unhabitat.org/cdrom/networking/habitat_jam_networking.html
Huduma online platform, Kenya	Sodnet / SIDA	Huduma (which means service in Swahili) is a digital platform for Kibera – the largest slum in Nairobi – that makes it possible for citizens to report on failed service delivery using a simple	http://www.sida.se/English/Countries-and-regions/Africa/Kenya/Programmes-and-projects1/New-technologies-promote-democracy-participation-and-

		text message, and then get help to hold the authorities and politicians accountable. It was developed by Sodnet (Social Development Network) with the support of the UN and the Swedish Development Agency SIDA. All complaints and reports coming in to Huduma are published online, in order to encourage service providers and other duty bearers to address the problems faster. Huduma also opens up for a dialogue between the state and its citizens, aiming at a strengthened democracy while at the same time providing increased accountability and reducing the risk of corruption.	accountability/
Wireless technology			
M-PESA, Kenya	Safaricom	Five years ago, only 6 million Kenyans had access to basic financial services. Today, nearly 15 million Kenyans, or about 70 per cent of the country's adult population, use Safaricom's m-money product, M-PESA, to manage their money.	http://www.safaricom.co.ke/
Smart Card Project, Andhra Pradesh, India	Andhra Pradesh City Government	The Andhra Pradesh Smart Card Project is a m-banking project. It aims at increasing the outreach of main stream banking and financial services to the poorest, ensure efficient and timely transfer of government benefits to the poor and achieve total financial inclusion via mobile technology solutions.	http://de.slideshare.net/avvprasad1/apsmart-card-project-april-2012

Mobile-initiative, Afghanistan	USAID	Ten years after the introduction of mobile-phone technology to the country, more than half of all Afghans have mobile phones. But only 7 per cent of Afghans have a bank account. By leveraging the mobile-phone network to provide financial services to the unbanked, key public- and private-sector services can be improved to serve hundreds of thousands of women and men across the country.	http://www.usaid.gov/frontiers/publication
Seguridad Inalambrica, El Salvador	USAID / Qualcomm	Seguridad Inalambrica in El Salvador uses 3G technology to enable law enforcement and municipal government personnel to increase public safety through mapping and sharing information about crimes as they occur.	http://www.qualcomm.com/media/blog/2013/05/22/qualcomm-and-usaid-working-expand-access-mobile-technology-public-good
Economic development & poverty reduction			
Fishing with 3G nets, Santa Cruz, Bahia, Brazil	USAID / Qualcomm	This programme works to promote economic development and increase public safety for isolated fishermen who live in Santa Cruz, Bahia. It helps them to promote their business and trains them in more sustainable fishing methods. Participating fishermen have been given wireless devices equipped with software that provides information on safety and weather, data-tracking and access to an online market.	http://www.qualcomm.com/media/blog/2013/05/22/qualcomm-and-usaid-working-expand-access-mobile-technology-public-good

Education			
Distant education and training for public servants, Indonesia	NORAD	The project consists of 150 group-learning centres at both ministry and divisional level. The goal is to offer adequate re-training of public servants, so that the communication between the central government and the provincial councils is enhanced.	http://www.pubad.gov.lk/web/eservices/ circulars/2001/E/30-200128e%29.pdf
Tafakari Mindset KIE Project, Kenya	USAID	The Tafakari Mindset KIE Project is a capacity building project that equips Kenyan teachers with skills to develop and utilize digital content curriculum for math and science. The Technology access activity involves the installation of Information Communications Technology (ICT) equipment, for instance, at the 19 Teacher Training Colleges.	http://kenya.usaid.gov/programs/education-and-youth/1019