INTELLIGENT CITIES

Intelligent Cities – Routes to a Sustainable, Efficient and Livable City

Management Summary

A Report initiated by B.A.U.M. e.V. and Accenture GmbH
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B.A.U.M. Bundesdeutscher Arbeitskreis für Umweltbewusstes Management e.V.

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Developing an intelligent city
Statements of the initiators

Professor Dr. Maximilian Gege,
Chairman, B.A.U.M. e.V.

"The ever growing trend of urbanisation and the major challenges of our time such as issues concerning energy, climate change, mobility, demography, resource availability, land usage, etc. are increasingly pushing cities and regions towards focusing on sustainability and development of intelligent structures and systems in their future planning. What will a modern, intelligent, efficient and livable city look like? Which options are available and what kind of experiences by others would be advantageous when planning? What could be initial steps and what could be possible limitations? Politicians, city planners, decision makers and other groups interested in this subject must discuss these and other similar questions and look for common starting points. There is no need to reinvent the wheel every time if you can draw conclusions for the future from positive and negative experiences in the past.

The application-oriented report **"Intelligent Cities – Routes to a Sustainable, Efficient and Livable City"** will help you in the quest for an intelligent city. Together with the co-initiator Accenture and our other partners ECE, HP, Panasonic and the NATURpur Institut (HSE), B.A.U.M. e.V. has prepared this report using an integrated approach."

Alexander Holst,
Managing Director of Sustainability Services, Accenture GmbH

"Life in cities must become intelligent to achieve the climate targets. Activities, buildings and traffic in cities generate CO_2. Cities are also simultaneously competing in drawing the attention of companies, investments, ideas and bright minds. The economic power and the environment quality play an important role in attracting these. Cities are on the verge of a wave of modernisation: Traffic, supply, disposal and a large part of the building infrastructure need to be revamped. An intelligent city offers solutions, which include more than only using the IT systems. These include energy efficiency, renewable energy, intermodality and the improvement of public services for better quality of life and better conditions for companies. There is no dearth of ideas and technologies: Bottrop as InnovationCity Ruhr and Cologne with SmartCity Cologne have realised this.

Reducing CO_2 is reasonable, but individual benefits for citizens must be clearly formulated and substantiated with measurable objectives. Issues related to finances can also be resolved with more ease. The right partners must cooperate to ensure that a city becomes intelligent: For example, the municipal corporation of the city and local energy suppliers. Roles must be clearly defined along with the benefits, the organisational structure and the processes. A reliable participation concept must be drafted to take citizens on board. Determination, creativity and new, comprehensive and interdisciplinary thinking are required. Otherwise, concepts remain on a small scale and do not go beyond the pilot status."

Developing an intelligent city
Statements from policy makers

Dr. Johannes Hahn,
EU Commissioner for Regional Policy

“More than two third of the European population lives in urban areas. Cities are where problems arise and their solutions are found. They are the breeding ground for science and technology, culture and innovation, individual and collective creativity and for the measures to prevent the effects of climate change. However, cities are places where problems such as unemployment, segregation and poverty are more concentrated. The development of our cities will shape the future of Europe. Therefore, it is becoming increasingly important to plan ahead and develop a vision for the future European cities.

There are different ways to define and cultivate “intelligent cities”. I think an “intelligent city” is a city that makes the most of its potentials as far as population, business, culture, cultural heritage, environment and surrounding regions are concerned. An “intelligent city” is a livable city, a city that is diverse and dynamic, a city where people and businesses can thrive and a place for the young and the old.

Technology is important to implement an intelligent city concept, to create new business opportunities, to attract investments and to generate employment. However, technology alone would not bring about any miracles. Good governance and the active involvement of citizens in the development of new organisation models for a new generation of services and a greener and healthier lifestyle are also important.

We need experiments to implement innovations. Projects like the “Intelligent Cities” report are helpful for developing and testing new ideas of a sustainable and integrated city development. For the success of EU2020, we need municipally supported innovation that makes our cities more intelligent and greener, and incorporates all these factors more intensively.”

“The residential and living space in a city and its complex structures requires intelligent and sustainability oriented solutions. The Federal Government is working on this within the scope of its active city development policy and so are many other actors. This is what is essential.

Maximum possible people thinking – and even encouraging “cross thinking” intensively about routes towards a sustainable, efficient and livable city would be a welcome change.” Therefore, I appreciate explicitly contributions like this report by B.A.U.M. e.V.”

Dr. Peter Ramsauer,
CSU, Member of the German Bundestag, Federal Minister for Transport, Building and Urban Development

Introduction, objectives and target groups

The future of cities and regions

A city is a living space to many people. Cities and regions play a key role in the development of future living spaces as well as the environment and climate. The trend of urbanisation has continued since decades without any signs of decline. Since 2008, an increasing number is moving to the cities rather than living in rural areas, all across the world, as a result of which the urban centres are growing rapidly. Until 2030, out of approximately 9 billion people, approximately 70 percent will live in urban systems that are continuously growing and becoming more and more complex. While there is a rapid growth in the population in many parts of the earth such as Asia, Africa and South America, Western Europe is experiencing reduced population growth and its society is getting older. This development in Europe is slightly curbed only by the immigration processes and intranational migrations, which are characteristics of European cities. Owing to the massive urbanisation, cities across the world are influencing the developments on our planet – technologies, society, companies, social interaction, resource consumption, quality of life, etc.
While dynamically growing regions in the developing and developed countries primarily necessitate construction of new infrastructure and buildings in cities, many western urban regions only require changes to the existing structures and environment.

Why do we need an intelligent city?

Cities generate approximately 70 percent of the worldwide CO_2 emissions and are the primary cause of air, water and environmental pollution. At the same time, cities are exposed to specific risks due to climate changes that are exceptionally relevant for a large part of the global population that is still growing. For example, the frequency of severe weather extremes causes major damage to buildings, infrastructure and agriculture as well as it has negative effects on people's health (e.g. heat or cold related deaths). Adaptation and precaution strategies are sought-after in such a case.
Furthermore, consequences of growth in consumption and resource consumption that accompany the development of economy and society need to be tackled in

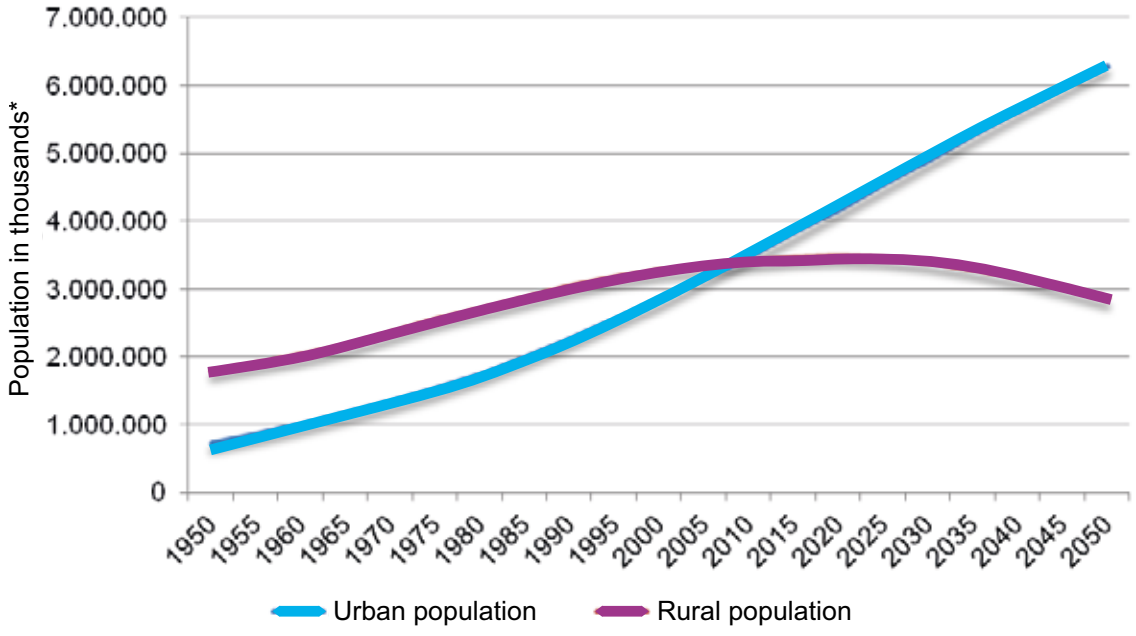


Figure 1: *Development of urban and rural population in terms of absolute numbers (source: United Nations – Department of Economic and Social Affairs (UN/DESA): World Urbanization Prospects: The 2009 Revision)*

* From 2010, based on average population development forecast of the UN/DESA

"… it requires more than new technologies to ensure that people feel at home even in "intelligent cities". The transition to a resource-conserving and low CO_2 lifestyle in cities is a challenge for the entire society. Inhabitants accept "intelligent cities" as their municipal living space if they are extensively involved in shaping their own future. Research for an "intelligent city" therefore involves citizens right from the beginning."

Prof. Dr. Annette Schavan
Federal Minister of Education and Research

cities: Shortage of resources, overloads and destruction of ecosystems, i.e. biodiversity, etc., since a major part of the resources is consumed in cities. Cities generate the largest part of emissions and waste. Intelligent disposal in combination with a suitable recycling system in congested urban areas is absolutely essential when handling the resources. Not only do new technologies need to be developed for reusing or refurbishing the used raw material, but the consumption of resources also needs to be avoided or reduced. A new way of thinking in cascades and circuits must be embodied in the citizens' behaviour. This new way of thinking as defined in the "Cradle to Cradle" approach (Braungart, McDonough, 2002) must be incorporated and supported in production and services as well.

Last but not least, not only do cities become bigger, but the composition of population also changes along with the change in demographics. This leads to new age structures, changed household sizes, divergent mobility patterns, migration movements, etc., which are also associated with other specific requirements for municipal systems.

The problem intensifies further due to effects of the financial and economic crisis, leading to restricted financial elbow rooms for many municipal corporations as well as due to the effects of diminishing trust of citizens in the political system (disillusionment with politics). Therefore, one must tread new paths in the process of developing the cities to take up new challenges and to retain or cultivate sustainability in the future. Innovative planning processes with new methods of involving citizens are absolutely essential. A more active involvement of citizens is vital to design open and transparent planning processes and to ensure that people show greater acceptance for the decisions taken. Citizens are important actors in the city planning process and should be involved right from an early stage. Credibility, participation and dialogue are the most important principles to be followed. Intelligent information and communication technologies (ICT), can help in complying with these principles. Transparent handling of public administrative data and information and effective communication can simplify many processes when used at the right place. Acceptable concepts for future are always originated from the dialogue with actors.

Owing to the age of buildings and infrastructure, many cities are on the verge of a wave of modernisation. This should comply with the requirements of an "intelligent city" unconditionally since the decisions are taken for a long term. There is no shortage of technologies, knowledge and different finance instruments that will allow even the municipal corporations with limited financial reserves to develop and implement suitable measures. However, the challenge is to utilise all of these with maximum possible advantages.

Methodology

An overall view is a decisive factor on the route towards a sustainable, efficient and livable city. Within the scope of this report, we have considered numerous national and international projects that have already been implemented, best and good practice examples as well as exemplary measures in the development of cities (you can find these in the detailed version (the main title) of the report as well as on the homepage www.intelligent-cities.net). From the large variety of topics related to an intelligent city development, this report focuses on the following four **action areas (core areas):**

- **Intelligent energy concepts:** Renewable energies, energy efficiency, storage, requirements for power grids and distribution structures, energy saving measures and reduced consumption

- **Intelligent mobility:** innovative, infrastructural and logistical transport and traffic concepts

- **Intelligent planning and governance:** intelligent city administration and structural measures in the redevelopment or new development of real estate, streets or entire sections of city, safety

- **Intelligent economy:** Production, waste management, consumption patterns, lifestyle

This report is special since apart from these action areas, the three **cross-cutting issues**

- ICT
- Civic participation
- Finance

are also included in it. The consideration of practical examples has shown that activities for developing an intelligent city – depending on the focus and characteristics – are normally associated with these clusters. This results in an integrative, comprehensive approach that often goes beyond a technologically oriented consideration since technology alone is not the solution. Although it offers enormous potential, it also causes a lot of problems. A holistic approach is therefore essential.

Objectives

The objective of this report is to present interesting solution approaches and successfully implemented examples with the help of the four core areas and the three cross-cutting issues, to recommend actions and ultimately simplify access to an "intelligent city".
It should be shown as to how the concept of an "intelligent city" not only helps cities in contributing towards reducing the environmental pollution and achieving the targets set by the energy and climate policy, but also in improving the quality of life of actors and offer a locational advantage against other cities. With the help of the dimension matrix (see Figure 5) generated from the action areas and cross-sectional topics, every city can determine its location on the route of intelligent development: In which areas have the core points already been identified and in which areas do gaps still need to be determined? What are the areas where actions need to be taken urgently for holistic intelligent urban development? The individual path for every city can be specified with the help of **three key success factors:**

(1) A clear **vision** (and strategies and measures derived from it)
(2) A fully functional **steering committee** to coordinate all interests and activities of different actors
(3) A suitable **monitoring system** for measuring the success and checking the progress

Target groups

This report is intended for the policy level, selected persons and committees, mayors and regional decision makers as well as for the administrative level and civil society. The focus is on existing cities and regions and not on so-called "megacities" or the development of new cities since they require a different approach owing to their structural conditions.

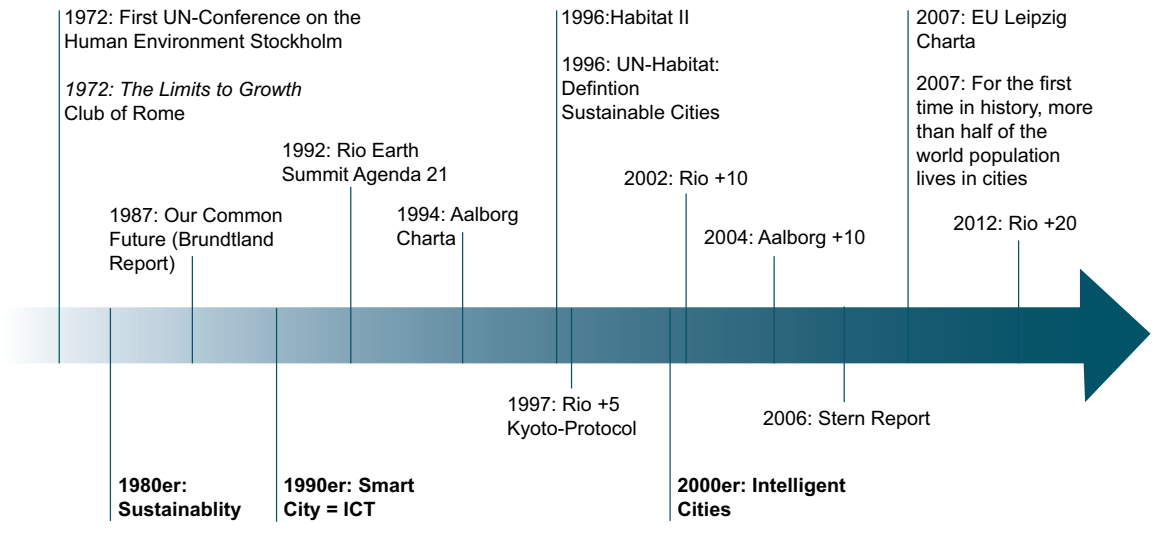


***Figure 2:** Historical development of the topic "intelligent cities" (author's own diagram)*

Definition and vision

"The term 'city' covers a huge field of developments from every physical and social aspect. For its definition, only general characteristics like the 'organisation form of short routes' can be served."

Prof. Dr. Guy Brasseur
Director of the Climate Service Centre Germany
Helmholtz-Zentrum Geesthacht

Definition

In the context of this report, a city is considered to be intelligent if it is sustainable, efficient and livable at the same time. However, an all-embracing and generally applicable definition does not exist. Terms like "intelligent city", "smart city", "green city" or "innovation city" can be extremely vague sometimes and allow a lot of room for individual interpretations and preferences. Thus, companies, persons or institutes can identify with the concept of an intelligent city more easily.
As per our basic understanding, an intelligent city is not only a sustainable, green or smart city, but much more than that. While these terms are textually restricted and often only focus on topics like environment and climate, an intelligent city also includes mobility, economy, resources, land usage, consumption patterns and quality of life. It also involves networking and interactions between isolated actors, creative forces, competencies, existing solutions, etc. The world and, by implication, decision-making processes too, are becoming more and more complex, are subject to short-term changes, and more efforts than ever before are required to counteract all this. The intelligent development of a city must ensure that a flexible adaptation is possible as per the changing requirements based on higher transparency and reliability.
Complex systems, i.e. even a city, often face events that lead to great stress and problems. For the future, it is essential to develop more resistance power (resilience) for better handling of such disturbances. The following components are derived from Figure 3 "Concept of an 'intelligent city'" and represent our detailed definition of an "intelligent city":
*The "**intelligent city**" focuses on key areas such as energy, mobility, city planning and governance as well as economy in the course of the essential municipal transformation process. The elementary characteristic of an "intelligent city" is the integration*

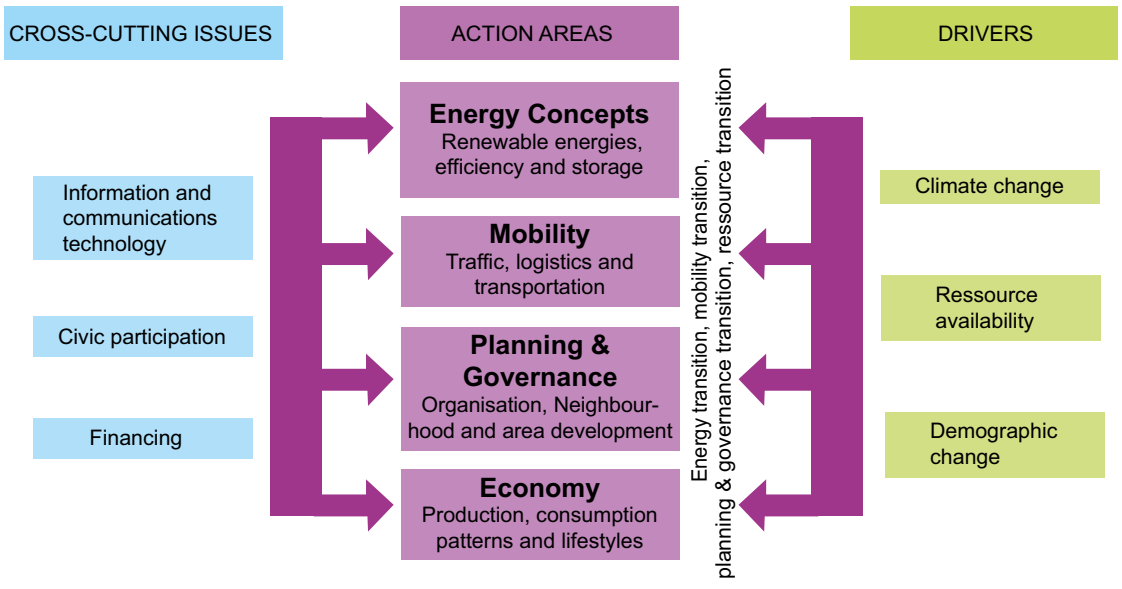


***Figure 3:** Concept of an "intelligent city" (author's own diagram)*

and linking of the mentioned core areas with each other as well as the inclusion of cross-cutting issues such as ICT, public participation and innovative finance instruments.

Vision

One of the initial steps towards an "intelligent city" is the development and communication of a widely embodied and individual vision, since an all-embracing prototype of an "intelligent city" is not available. Ideally, this vision is a commonly drafted image of the future of the respective city. It thus describes the objective determined along with the interest groups and the intention of the entire desired development process. Cities are nodal points for people, companies, services, cultures, infrastructures, etc. Therefore, it is important to pay attention to different actors when drafting the vision and to involve them actively. A common vision is the basis for master plans, concepts, strategic and measures plans, etc. to be derived from it.

Actors in an intelligent city

A sustainable, efficient and livable city is not defined by the interlinked infrastructure, but rather by the network of the actors involved. These actors collectively shape up the development of a city. An urban society is complex and individual. This variety of ideas, knowledge and experiences needs to be bundled and integrated into the process for developing an "intelligent city" in the best possible manner. This can be achieved using information and communication, e.g. within the scope of different event formats such as future conferences, etc. that involve citizens and allow them to contribute their interests, ideas and visions. In the context of generational equity and the long time horizon, different age groups must be taken into account.

Figure 4: *Actors in an "intelligent city" – the local network (author's own diagram)*

Barriers to action

"The ageing process, the change in ways of life and lifestyles, adaptation to the climate change and globally irrefutable energy policy are the challenges for this century. Cities must 'reinvent' and ensure their future readiness to cope with these challenges."

Klaus J. Beckmann
Managing Director of the Deutsches Institut für Urbanistik (German Institute for Urban Studies)

Why are not all cities intelligent, i.e. sustainable, efficient and livable already? Why were innovative approaches not developed further, good ideas not implemented or pilot projects not repeated? What were and are the barriers?
This report mentions important barriers from our point of view.

Lack of participation of citizens

Many ecological, economical and social aspects of an "intelligent city" require more than just the approval of citizens. They require active involvement. A city can actually be considered "intelligent" only when behaviour is adapted to the changed availability of resources.

Change in consumption patterns and lifestyle

However, such a lifestyle can not only be prescribed "top down" by the policy, but should also be developed "bottom up", i.e. in a self-organised manner. This process is normally very slow and requires a lot of time. Modern-day consumption patterns and lifestyle that, among other things, are characterised by the technological development of sales-promoting marketing and product strategies by many companies are associated with enormous resource consumption and correspondingly high waste and emission levels. They exacerbate consideration of the significance of retaining the vital ecological systems. We are living at the cost of future generations. An intense change in consumption patterns and lifestyles is essential at this point.
However, barriers for changes primarily lie in the fact that the reduction of resource consumption requires a change in consumption patterns and lifestyle of every individual. This is often considered as unnecessary or even directly abandoned and therefore has a negative connotation.

Different interest levels and time horizons

Different actors are involved in the restructuring process of a city and these are characterised by varied interests and sometimes by different time horizons. Differentiated objectives, possible solutions and implementation methods must therefore be intensively weighed against each other to form a basis to define a holistic and intelligent solution path for maximum collective benefit. This process is not easy since global objectives (maximum global warning by 2 °C, only two tons CO_2 discharge per head instead of ten, only two hectares of land usage instead of ten, and many more until 2050) are still 40 years away from a present-day perspective. This is because most actors think in much shorter cycles: Companies focus on quarterly or year-end balances, political parties work in four or five-year legislature periods – and many consumers are constrained to decide overnight. However, society must "think about their grandchildren" and think, plan and act with the future in mind. Thus, the time horizon is an important barrier.

Shortage of finance

Owing to the persistent economic crisis and the high debt burden of governments and municipalities in some cases, many municipal corporations find it difficult to initiate and finance desired developments in existing systems. However, innovative financing concepts are available and mentioned in the report. Shortage of capital is actually not the main problem considering approximately 5000 billion euro of private assets in Germany. Rather, a part of these assets needs to be mobilised for financing intelligent and sustainable measures (e.g. the energy transition). Information stating that interesting profits can be linked with a contribution towards climate protection and social improvements and private investors can thus be integrated into the development

of an “intelligent city” and this is important in this case. New, innovative financing models such as the B.A.U.M.-Zukunftsfonds (future funds) described in detail in the report can mobilise capital from the region to support measures in that area and strengthen regional economic cycles.

Lack of monitoring systems

A central challenge is to develop adequate and practical monitoring systems that can be used effectively to check whether or not targets have been achieved. Only reliable quantitative and qualitative indicators that cover all essential aspects of an efficient project execution and the degree of achieving targets can help in determining the progress and the result of such holistic concepts and controlling and adapting projects, processes and systems better.

Excessively strong focus on technology

Unilateral technological focus in many projects is often another barrier. “Smart” cities are often perceived as technology-oriented cities – but an “intelligent city” offers much more than that. As described above, intelligent regional development also includes technological innovations and pilot projects. Since one needs to focus on holistic concepts as defined by the sustainability triad (environment, economy, social needs), representatives of these concepts must predominantly look for the technological aspects, initiate conceptual alignment and include other aspects along with technology.

“It is evident that investments in energy-efficient and smart cities will result in ecological and economic profits. However, numerous hindrances such as technical risks, uncertain investment returns or supervisory hurdles are currently making it difficult to tap this huge potential of innovative and intelligent technologies.“

Günther H. Oettinger
EU Commissioner for Energy

“Bottom-up” instead of “top-down“: Many ecological and social aspects need civic participation: Citizens have to actively choose a change in their lifestyle.

Intelligent energy concepts Renewable energies, energy efficiency and storage

"The energy transition is one of the biggest challenges of our time: Approximately three fourth of the population lives in cities. The potential to reduce CO_2 is correspondingly high. Intelligent approaches in the sections of a city are essential to reduce this. These approaches must not contain isolating measures, but take into account different actors and mutual effects of energy consumption."

Dr. Ulrich Schröder
Chief Executive Officer of the KfW Bankengruppe (Banking Group)

As a response to challenges of climate change and primarily the disaster of Fukushima, Germany has adopted the energy transition, which includes backing out of the nuclear energy programme by 2022, CO_2 reduction by 80 percent and increasing the percentage of renewable energies in the power mix to 80 percent by 2050. Huge technological and economic potential is involved in the implementation of this energy transition. In spite of that, the energy transition is proceeding slowly since it is a complex process that must be implemented on multiple levels and includes numerous instances. Policy makers, economy and citizens must become equally active to accelerate this process.
The energy transition requires quick development and implementation of intelligent energy concepts. These must provide more benefits to consumers rather than saving power by making sacrifice. We live in a technology-oriented environment that will have a certain minimum requirement of current, heat and mobility even in the future. An intelligent energy concept must take this into account along with all aspects and components (of energy generation, distribution, storage and energy efficiency) and focus on using regenerative sources of energy.
Two different cases are considered when implementing intelligent energy concepts: on the one hand, upgrading the existing systems as is the case within the scope of structures in Western Europe that exist over a long period ("energy transition"); on the other hand, new systems must be set up, e.g. similar to the agenda of planning and building a new city or a new city section (e.g. Fujisawa, Japan, see the main title of the report, section 13.2 "Fujisawa Sustainable Smart Town").

Weaknesses offer development potential

The answer to the question 'what does an intelligent municipal energy system actually constitute' is evident from the inherent weaknesses of our traditional energy systems. These originate from the time wherein an excess of energy was apparently available. We have gotten used to consuming a lot more energy than that would be required for respective applications. In addition, technological advancements always introduce new products with appropriate energy consumptions on the markets.
Weaknesses of existing energy systems can be summarised in three central points:

- **Inefficiency**

The largest source of energy at present is saving the energy by implementing energy efficiency measures and changing the behaviour and consumption patterns of citizens, public institutions, companies and other institutions. Saving potentials of up to 80 percent (depending on the consumption sector and area of application) can be realised.

- **Using fossil resources**

The use of fossil resources such as coal, oil, gas and nuclear fuel like uranium is future-compatible only to a limited extent since these raw materials are of finite nature and their stock will not end with the current generation, but probably with the next one. Furthermore, enormous environmental, disposal and climate related problems are associated with them and there is a huge dependency on supplier countries which are often politically unstable.

- **Lack of networking**

New energy systems, i.e. the shift from fossil to renewable energy forms, emphasise the third weakness: The existing grid structures are "one-way streets". They have been desired to feed energy from the central generator system to consumers, but not to feed the power from a consumer and several decentralised locations into the network. Within the scope of futuristic and intelligent energy concepts, power grids that allow decentralised generation and "two-

way traffic" and that also simultaneously provide information about the statuses of all connected units throughout the grid will be required. In addition, new and efficient storage technologies are needed. Furthermore, it must be ensured that even mobile storage units (electromobility) can be seamlessly integrated at any desired location.

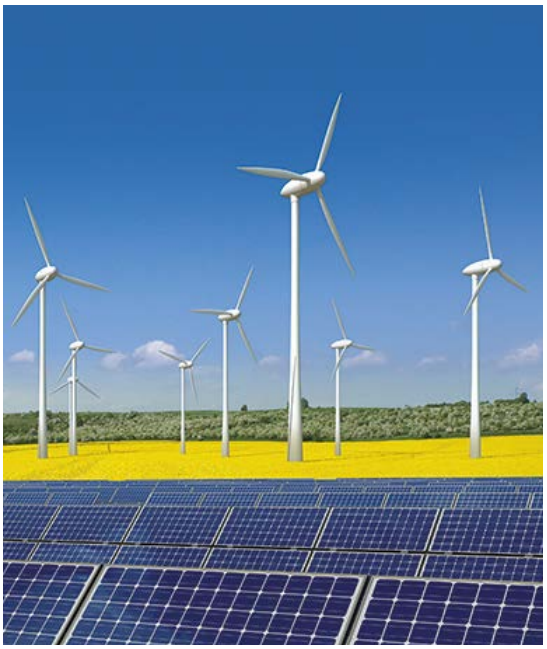
The core focus of networking of energy systems is to upgrade passive infrastructures to intelligent, information-rich and dialogue-capable solutions. Smart grids, smart meters and smart storages can be optimised for energy efficiency and CO_2 emission as interlined components via electromobility and intelligent traffic control. They also enable a better control of consumption, e.g. reducing the peak load by shifting the power consumption to more cost-effective low load periods (real time pricing).

Thanks to the state-of-the-art smart grid electronic unit, municipal public utility works departments become intelligent city management units that use virtual power plants to control the decentralised energy supply power of their city precisely. These systems, whose technology is increasingly becoming complex, must however be provided with increased safety measures to be able to handle faults in the system.

In addition to the specified adaptation and precautionary measures, an intelligent energy system essentially contains measures to avoid energy misuse and integrates the three cross-cutting issues ICT, public participation and intelligent financing concepts.

Future-oriented technology enables controlling the balance between the demand and supply of energy intelligently. In addition, intelligent forms of public participation and financing are required when restructuring at the municipal level. These can be implemented through frequently used measures such as citizen-owned solar or wind power plants which are often organised cooperatively and implemented as combined. Such a solution ensures transparency, higher acceptance and better level of information to people. It also helps in overcoming the financial bottleneck by mobilising the private capital. In addition to these citizen-funded models, different types of contracting or even the innovative B.A.U.M.-Zukunftsfonds (future fund) model (Gege, 2008) can be used to ensure intelligent financing to achieve the prescribed objectives within the scope of energy concepts.

Practical recommendations for actions and tested best and good practice examples for the energy domain of an intelligent city are listed in the main title of the report.



The energy transition offers great technological and economical potential. Still, progress is only slowly as it is a complex process which has to be realized on various levels and includes different instances.

Intelligent mobility Traffic, logistics and transportation

In 2010 alone, Europeans have covered a total distance of approximately 5.6 billion passenger-kilometres (European Commission, 2011). In addition, 31.7 percent of the final energy consumption of EU-27 in the same year was attributed to the transport sector (Eurostat, 2012). This sector is therefore one of the largest polluters across the world. Many cities are on their way to becoming sustainable, efficient and livable cities and want to transform the transport sector in the sense of a sustainable development in order to counter air pollution, climate change and the finiteness and rising prices of resources using a "post-fossil mobility concept" (Würdemann, Held, 2006).
The challenge for cities is not only securing a livable environment for all inhabitants, but also complying with increasingly changing mobility requirements in various cities. Cities among each other, (virtual) companies and all urban actors wish to and must be linked with each other. The major challenge lies solely in the increasing traffic volume and the fact that traffic (in the form of transporting people and goods) is an important driver of economy and prosperity. Unfortunately, the mobility sector has neither been decoupled from fossil, environment-polluting energy carriers nor from the capacity of roads until now. In order to guarantee a socio-economical development, cities should ensure adaptability and individual mobility in a sustainable, low-emission and affordable manner. Changes in individual behaviour, better traffic management and technological innovation are required for this purpose. Cities must support the implementation of intelligent and technology-aided mobility and, despite the investment in technologies with ever increasing complexity, manage the difficult split between achieving objectives (among others, reduction of CO_2 emissions and air pollutants, increasing transport capacities and their utilisation, linking the public transport systems with private transport with passenger cars, bikes and on foot) and cost management.

Until now, public authorities were responsible to assure mobility to a large extent. Public participation is rare unlike the energy generation sector where the decentralisation of production allows even small and privately organised investor groups and associations to have a share in the energy supply. The question arises how the participation model for the mobility domain should look like, who should initiate it and which prerequisites must be met. Behavioural changes and finance concepts thus become the focus of attention.

ICT spurs urban mobility

It is not just recently that cities have started working on developing mobility in urban regions in a social and environment-friendly manner. Information and communication technology has been playing an important role for a long time and has grown thanks to the use of repeatedly proven traffic congestion sensors. Varied data and information help in reducing waiting and idle times, optimising the availability of means of transportation, controlling the prices and capacities depending on the demand and thereby reducing the emissions and noise levels as well as improving the capacity and comfort of infrastructure and services offered. The significance of ICT for the traffic system will further increase considerably.
An important prerequisite for developing these applications is the easy access to relevant data and systems of respective modes of transport. Cities play a decisive role here since they can depend on the transparent provision of relevant information to make the most of innovative capacities of people and private companies.

Participation means behavioural change

However, ICT is only an instrument for more efficient development of transport with lower emissions. Participation and behavioural change of users are also important since

these can actively support cities. Opportunities in this case go beyond the promotion of buses and trains. Common use, electromobility, switching to non-motorised means of transports and avoiding unnecessary travel are the key factors to anchor the mobility domain on an ecologically sustainable basis and simultaneously transporting it to a "lifestyle product".
For example, the "sharing" concept was reintroduced a few years ago. "Using instead of owning" is the trend. The new eCar, bike and eBike sharing facilities offered by city authorities, transport companies and private service providers should help in reducing and optimising city traffic. This also includes the idea of switching a part of the regional commuter traffic to rails by providing additional cost-effective and eco-friendly means of transport for local point-to-point connections. ICT can be used here to simplify the usage options, e.g. bookings via a mobile telephone.
Connecting the sharing concepts with electromobility is another factor for success. For the success of electromobility in urban areas, the constant combination with regenerative energies, and good facilities with charging stations and simple charging and settlement systems are more decisive than the reach.

Many cities however encourage a different type of behavioural change: They reply on increased usage of non-motorised means of transport and focus on developing the bicycle and footpath infrastructure to reduce the environmental and transport loads. This not only includes a well-built route network but also adequate and safe parking facilities as well as suitable interfaces on crossings for the public passenger transport system.

Intelligent mobility requires innovative financing models

In order to accelerate the development of eco-friendly technologies in Europe, investments of approximately 2.9 billion euro will be required until 2020 (Accenture, 2011). Municipal corporations require intelligent financing concepts especially during the economic crisis and high debts. Public authorities alone cannot cover the capital requirement for cultivating intelligent mobility. Therefore, additional actors must support the financing required for sustainable mobility projects.
Practical recommendations for actions and tested best and good practice examples for the mobility domain of an intelligent city are listed in the main title of the report.

The transport sector is globally seen one of the largest generator of pollution. To guarantee a socio-economic development, cities are stipulated to ensure flexibility and individual mobility in a sustainable, low-emission and affordable way.

Intelligent planning and governance Organisation, neighbourhood and area development

"Intelligent city development uses the options for development in a holistic approach: The city of tomorrow is ecological, interconnected and livable."

Dr. Gerd Landsberg
Executive member of the Executive Committee of Deutscher Städte- und Gemeindebund

In the context of this report, intelligent planning and governance of a city includes new forms of public participation, using innovative technologies (e.g. E-Government solutions for participatory budgets and other forms of web-supported participation and management) and sustainable financial solutions for transforming the existing urban structures. Urban renewal, urban redevelopment or urban reconstruction, are challenges for cities in industrial countries. These are triggered by a structural change (as in the Ruhr region in Germany or in British industrial cities) or by the targeted ecological and/or sustainability oriented redevelopment of urban areas.

Solution approaches for intelligent town planning and governance

In addition to a funded public participation concept, solutions for intelligent town planning and governance are primarily the energy, mobility and resource transitions. Modern ICTs are increasingly penetrating all areas and allow implementation intelligent strategies and measures in many cases.
The **energy transition** means redeveloping the existing buildings and building technologies with an eye on energy efficiency. In Germany alone, approximately 75 percent of buildings are not yet renovated as long as energy technology is concerned and approximately 15 out of 19 million heating systems are outdated. In EU-15, more than half of the buildings have been built before 1975 (Ecofys, 2006) and are in dire need of renovation since these buildings contribute approximately 40 percent of energy consumption and corresponding CO_2 emissions (BMWi, 2012). Such facts put city administration authorities under enormous pressure to plan and push city renovation and redevelopment activities involving a major transformation. They can be benefited from changes in building technology and a fully new energy infrastructure that is built from the collective growth of energy grids and data networks.

The **mobility transition** in cities is characterised by the development of a climate-neutral local public transport and the promotion of individual electromobility and non-motorised traffic (bicycles, pedestrian traffic). This requires developing a new traffic, charging and fuelling infrastructure which is not only a solution approach for town planning measures and investments, but also forms the basis for rethinking in the commercial area and in private households.
The **resource transition** is associated with a reorganisation of production and consumption structures including buildings and infrastructure facilities. This reorganisation is driven by the desired reduction in consumption and increase in efficiency as well as by the circulation of new disposal, recycling and recirculation concepts and become a cornerstone of sustainable city planning and development.
Last but not least, intelligent solutions in town planning and governance are characterised by **modern ICT** that enables or calls for new planning concepts in energy, mobility and land usage domains and also allows a completely new type of citizen-friendly city administration (e.g. E-Government). In combination with intelligent infrastructure systems, ICT is also an important instrument for safety. For example, it offers a clear separation of the private and public life adheres to social and cultural limits, criminal preventive measures and the implementation of planning and administration standards.

Two central challenges:

- **Sustainable land usage**

Land is one of the most limited natural resources in cities and urban regions. Therefore, considerations for the maximum possible efficient use of this resource in an intelligent settlement and city development have great significance.
Public involvement is essential for the logical implementation of measures to reduce usage of land. Cities can achieve this by form-

ing a public land usage counter system. The number of hectares of "green areas" (i.e. the city area) used daily or monthly for settlement and traffic is counted and presented in this system. The reused fallow areas in a city can be presented quantitatively.
In addition, cities can provide economic incentives to make fallow areas and previously used areas reusable or to reallocate them. They can develop programmes for "sustainable soil and land usage for development and infrastructure" and submit them such that they encourage exceptionally efficient or effective usage of the area as far as the all-embracing vision is concerned.

- **Building technology and strengthening the existing buildings**

Intelligent urban development is significantly associated with the structure of existing buildings. Passive and zero-energy or even the plus-energy houses are the latest technological advancements in the new construction. This is also applicable for multi-story residential buildings and public buildings that should serve as a role model. Architecture and urban development can form important basis for their energy efficiency through the layout, cubage, roof shape and the direction of slopes of buildings. The energy-relevant redevelopment of existing buildings has the maximum saving effect since the energy consumption of buildings is approximately 30 percent of the total CO_2 emissions, according to the information provided by the Federal Ministry of Transport, Building and Urban Development. An intelligent municipal redevelopment programme therefore distinguishes itself by the "low hanging fruits" that are implemented first. However, the construction culture, form and quality of living must not be sacrificed for efficiency. In addition, acceptance by occupants and user behaviour must be taken into account. New financing models should be used here as well in order to implement absolutely essential measures.
Practical recommendations for actions and tested best and good practice examples for the planning and governance domain of an intelligent city are listed in the main title of the report.

Neighbourhood and area development should satisfy the needs of the actors living in a city. "Shared-space" is a European wide philosophy for the development of public space.

Intelligent economy Production, consumption patterns and lifestyles

The type of economy and living will considerably differentiate future "intelligent cities" from the traditional cities in the past. A "green and fair economy" is defined as a production and consumption cycle that leads to increased well-being of humans and social justice while reducing the ecological shortages considerably. A green and fair economy thus has a low carbon footprint, is resource-efficient and can function only if social aspects are also integrated (UNEP, 2011; Germanwatch, 2012). Greenhouse gas emissions and environmental pollution will be reduced, the energy and resource efficiency will be increased and the loss of biodiversity and ecological systems will be prevented. The objective is to decouple growth from the use of resources. Absolute – and not just relative – reductions of consumption are essential for this.
Distinctive features and objectives of such a green urban economy are:

- A maximum possible percentage of companies and employees in future-compatible economic areas such as environment and health
- Maximum possible companies following environmentally-oriented and sustainable business policies in traditional economic areas
- The maximum number of citizens who align their consumption patterns as per the environmental and sustainability criteria, i.e. who lead a sustainable lifestyle
- A city administration that sets a good example, i.e. procures products and services by logically applying criteria like "sustainable" and "fair" and thereby drives change in the behaviours of consumers and manufacturers
- An intelligent supply and disposal system
- Intelligent recycling and closed-loop recycling systems

However, an intelligent economy is more than just a "green and fair" economy. As already mentioned several times, the term "intelligent" is characterised by the use of modern ICT, public participation and innovative financing models. The city government or administration cultivates a green economy with the help of information, company-related ecological programmes and cooperation with local economy and science fraternity, e.g. in the form of environmental alliances. Similarly, they cultivate intelligent consumption by their citizens with the help of information and consultation, municipal support programmes that simplify or even enable intelligent consumption. An intelligent consumption pattern and lifestyle is indicated by a lower ecological footprint of individual citizens or individual households. A globally compliant CO_2 emission per capita is the correct indicator for the same. Thus, a city can also implement a climate protection concept, thus reducing its ecological footprint considerably.

Sustainable lifestyle

An intelligent economy in a city is also characterised by the companies following sustainable business policies, a city administration that procures sustainable products and sustainable consumer behaviour and lifestyle of private households and more importantly by the mutual effects and interlinking of these three aspects. This will be reflected in the energy and mobility transition as well as the investments in the renovation of buildings and infrastructure.
What does sustainable consumption and living actually mean for individuals? It means that the consumption patterns and lifestyle of a citizen or a private household (or a company or public authorities) do not exert more environmental stress than the prescribed ecological system compatible value per head with the specified global population, i.e. approximately 7.1 billion people at present. For the CO_2 emission,

this means that values greater than 2.5 tons per capita in a year are not compatible with the climate. The average emission per head in Germany is approximately 10 tons and is not much higher than the EU average of 7.5 tons. With international comparison, it however shows that Germany, with its percentage of 2.59 in the global energy-related CO_2 emissions, is relatively well positioned. In 2011, China caused approximately 24 percent of CO_2 emissions closely followed by the USA with approximately 18 percent (Germanwatch, 2011). The USA heads the negative record with a balance of approximately 20 tons CO_2 emissions per head (IEA, 2011). It is possible to lead a climate-compatible lifestyle even today, i.e. to push the per head CO_2 value to the climate-compatible value of 2.5 tons per year or to establish 100 percent climate neutral status. For developing countries like India, whose current CO_2 emission value is only approximately one ton per head, this would mean that the emissions should drop or at least remain constant during the development process. Practical recommendations for actions and tested best and good practice examples for the economy domain of an intelligent city are listed in the main title of the report.

A green urban economy needs sustainable consumption, intelligent supply and disposal systems as well as considered recycling and circular economy systems.

Energy and climate protection potentials of a metropolis with the example of Hamburg

The Hanseatic City of Hamburg aims at climate-neutrality.

Effects of climate change are varied and range from extreme weather events, increased sea water level, displacement of vegetation zones to social changes such as migration movements. These developments have changed Hamburg from multiple aspects: The location exposed to water, a high number of citizens with migration background (approximately 30 percent of citizens registered in Hamburg have a migration background; Statistical Office of Hamburg and Schleswig-Holstein, 2011) and logistics as a significant factor of the urban economy make the city exceptionally sensitive to changes and economic developments associated with them.

Climate-neutral energy supply until 2050

The Hanseatic city of Hamburg has set the goal of covering its energy requirement using climate-neutral sources until 2050 and become a pioneer in the field of climate protection and usage of efficient energy services. According to a new study conducted on behalf of the Hamburg Future Council, with a 5.17 hector of natural area, a citizen of Hamburg leaves a higher ecological footprint that the German average (5.08 hectare; Hamburg Future Council, 2012). In addition, every citizen of Hamburg generates approximately 10 tons CO_2 per year. Last but not least, this number should be a motivation for Hamburg to not reduce the activities in the second year after the Green Capital year (2011), but to utilise all the resources and opportunities for strengthening the usage for climate-neutral Hamburg.
In Hamburg, it is evident that especially the small and medium sized companies are rarely aware about their specific saving options. In addition, there are numerous obstacles, like before, for economically viable investments to optimise the energy supply despite rising energy costs. In addition to financial restrictions, which, as described before, can be handled by using intelligent and new financing models such as the B.A.U.M.-Zukunftsfonds (future fund) or the Federal Support Programme that was newly launched at the end of 2012 and that focuses on highly efficient cross-sectional technologies, these obstacles primarily include lack of information and too little personnel capacities.

“Masterplan for the climate protection of Hamburg”

In order to face these challenges, which we have also summarised in section “Barriers to action” of the main title, and to respond appropriately depending on the situation and urban conditions and achieve the challenging goals, the city of Hamburg has already formulated, analysed and implemented different measures and concepts: e.g. the “climate protection concept” by the climate protection office of the Urban Development and Environment Authorities (BSU) or even the “Master plan for the climate protection of Hamburg”.
This example is illustrated in detail in the main title of the “Intelligent Cities” report: The importance of discussing the subject of intelligent development of a city has been explained within the scope of a detailed analysis of energy efficiency and climate protection potentials of the urban system and the metropolitan area. Huge potential that can be tapped and the complexity of the transition from theory to practice have been presented. Different actors in the city, especially companies, public institutions, private households with suitable structures and the local traffic have been especially taken into consideration. Varied numeric and calculation examples show the enormous saving potentials for energy, costs and CO_2 emissions. Finally, a list of concrete (investment and non-investment) recommendations for actions and solutions for a city like Hamburg is given; it provides concrete suggestions for successful implementation.

Starting points on the route to an “intelligent city”

Formulating the strategies and measures, depending on the individual, city-specific and other situations, for a route towards an “intelligent city” are a huge challenge for all mayors, regional decision makers and even the citizens. The richness of the content of subjects in combination with the presented cross-cutting issues explains the complexity of this task. This will become increasingly massive due to the drivers of urban development and trends of continuously growing population and depleting natural resources. With these growing challenges the actors of urban development need to find integrative solutions today to maintain environmental quality and do so at minimal or no costs. Many cities have already started developing a futuristic vision for their city, deriving measures from it and implementing the concepts. Numerous best and good practice examples in the main title of the report show how these sustainable and successful management systems can be designed.

From vision to implementation

In order to simplify the introduction to an “intelligent city” development, a short and practical guide was compiled. It is supposed to open doors to a sustainable, efficient and livable city to the target group of the report and accompany them along the route. Based on the four action areas and the three cross-cutting issues, it contains practical suggestions, food for thought and short questions that should help in progressing. In addition, the results matrix shows the dimensions of an “intelligent city” (5), how the exiting projects in a city can be positioned quickly and easily to be able to determine the current status depending on the situation. However, the short guide of the main title does not replace the commonly developed vision of urban actors and the corresponding decision and implementation instances in the region and the detailed master plan.

Step by step towards an “intelligent city”

A clear policy with unambiguous and concrete objectives must be prepared for practical development activities in a city. This policy should deliver immediate results of short-term decisions, and forms the basis for long-term and profound programmes. These objectives can be aligned as per the different parameters of the actors in the city: For example, environmental parameters such as the extent of energy and water consumption, reduction of urban waste volumes or community-based issues such as the magnitude of diseases caused due to environmental damage. This is also part of social parameters that are directly linked with the quality of life in the city. Economic parameters in the objective formulation can include additional investments and newly initiated projects or newly forged cooperation that makes the objectives more specific. Oriented as per the five stages of the ‘policy cycle’ (Jann, Wegrich, 2003), the development of a suitable benchmark and a realistic overview for the whole thing, the requirements of people can be considered and the dynamics of the “intelligent city” can be maintained. Such an iterative introduction process can ensure that the objectives and the common vision become part of the daily routine and thereby lead to an intelligent urban system.

The main title of the report offers an extensive overview of the main topics of an “intelligent city”

Result: dimensions of an intelligent city

When working on this “Intelligent Cities” report, we have compiled numerous national and international best and good practice examples. We could determine that the activities can usually be clustered in the four represented action areas, namely energy concepts, mobility, planning and governance and economy as well as with the help of the three cross-sectional topics, namely ICT, public participation and finance. In addition, three success factors for designing the route towards an intelligent city can especially be defined:

(1) To begin with, **a clearly formulated vision** that should be commonly decided with all actors and interests groups in a city and that should communicate sustainable benefits. Strategies and measures can then be derived from it.

(2) In addition, even an “intelligent city” should convene a **steering committee** that ensures and coordinates the interests and activities of actors involved throughout the entire process. These include aspects such as coordinating a suitable participation system, developing a stakeholder and programme management system and ensuring adequate governance.
(3) The third success factor is to use a **monitoring system** for measuring success and checking progress.

Continuous verification of strategies and measures by the entrusted steering committees and the monitoring systems ensure a feedback within the urban concept, short routes and a higher degree of flexibility.
In our view, this integrative approach of dimensions and success factors will lead to the routes towards an “intelligent city”. By means of the prepared dimension matrix, cities can classify their existing projects in a grid and determine the status quo. They will identify the core points and gaps that need to be plugged as per their vision. The dimension matrix thus offers an instrument for siting as well as an approach and basis for further discussions, vision and strategy developments and programme optimisations. Based on this overview as well as numerous best and good practice examples, mayors, regional decision makers and city developers can identify a common route along with the actors and bring and steer their city on to a route that leads to an “intelligent city”.

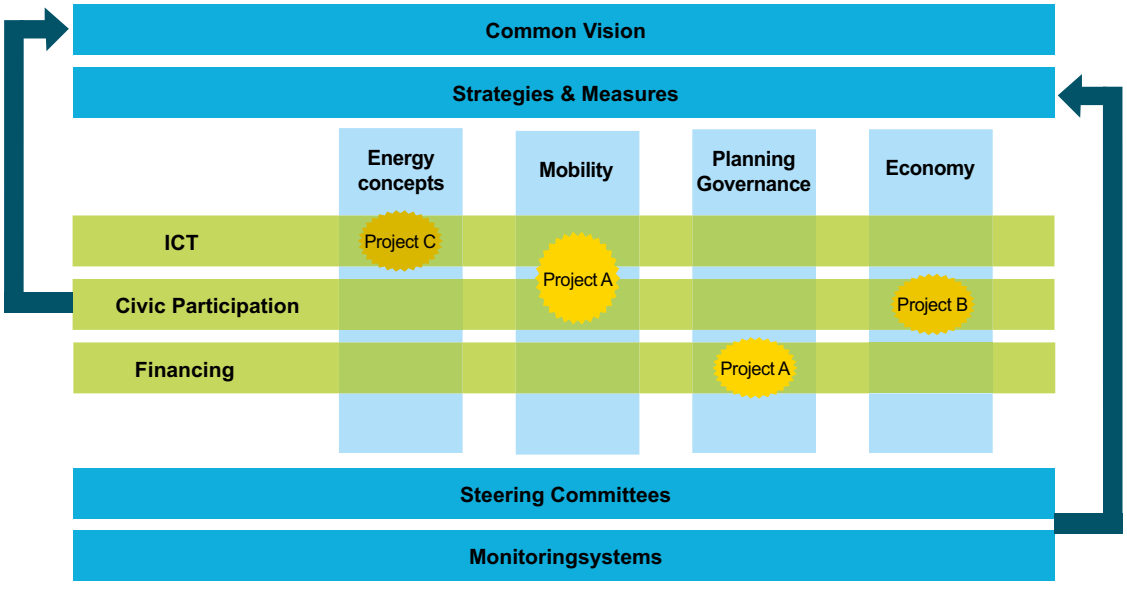


Figure 5: *Dimension matrix of an “intelligent city” (author’s own diagram)*

Networks, studies and further information

Accenture *The Intelligent Cities Simulator – Bringing the Vision to Life*	www.accenture.com/SiteCollectionDocuments/PDF/Accenture%20Intelligent-Cities-Simulator-Bringing-the-Vision-to-Life.pdf
Amsterdam Smart City	www.amsterdamsmartcity.com
C40 Cities	www.c40cities.org
Climate Alliance	www.klimabuendnis.org
Covenant of Mayors	www.covenantofmayors.eu
Deutsche Post DHL *Delivering Tomorrow – Zukunftstrend Nachhaltige Logistik*	www.dp-dhl.com/content/dam/logistik_populaer/trends/Studie-SustainableLogistics/dpdhl_delivering_tomorrow_studie.pdf
Deutscher Städte- und Gemeindebund *Innovators Club*	www.innovatorsclub.de/innovatorsclub/
Eco Ideas	www.panasonic.de
Eurocities	www.eurocities.eu
European Smart Cities	www.smart-cities.eu
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)	www.giz.de/de/mit_der_giz_arbeiten/8634.html
Green Region	www.hse.ag/engagement/green-region.html
HP Labs	www.hpl.hp.com
ICLEI - Local Governments for Sustainability	www.iclei.org
Intelligent Cities Expo	www.intelligentcitiesexpo.com
Intelligent Quarters	www.ece.de/de/geschaeftsfelder/projektuebersicht/objekt/oiqh
Siemens *Sustainable Urban Infrastructure Intelligente Energieversorgung für Berlin 2037*	www.siemens.de/nachhaltige-stadtentwicklung/pdf/sustainable-urban-infrastructure-berlin.pdf
Smart 2020	www.smart2020.org

Additional sources can be accessed on the project website via www.intelligent-cities.net

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Project website

In addition to the general information about the report, the project website also provides detailed statements of selected persons, several best and good practice examples in our sample case compilation, detailed descriptions of implemented projects, concise information in the short examples section and other sources.

This compilation and additional information is available in German as well as in English. It can be accessed and downloaded free of charge from the following link:

www.intelligent-cities.net