Annex 3 Smart Cities

1. Introduction

Increasing urbanisation is one of the great megatrends of our time. By 2050 there will be an additional 3 billion people on Earth, 70% of them will be living in cities[1], and these cities will be generating 80% of global emissions and accounting for 75% of the world's energy consumption. Today, the challenge is how to make cities and urban areas competitive, sustainable and habitable.

With their immense economic importance, cities and urban areas are the engines that drive today's growth, offering opportunities for development, employment and prosperity. At the same time, many urban infrastructures are reaching their limits, for example in relation to secure energy supply, transport, buildings, safety and security, water and waste management and healthcare. In addition, cities and urban areas must manage and analyse "big data" using appropriate software in order to provide the best lifestyles for their citizens. It is estimated that cities globally will have to invest trillions of Euros in infrastructure for the foreseeable future[2]. In addition, cities and urban areas are to a large extent responsible for global climate change, as mentioned previously. The battle against global warming will thus be decided in cities.

Given the fact that this increase of urbanisation will predominately (or almost exclusively) happen outside Europe with a focus on emerging countries in Asia, Africa and Latin America, the question that should be asked is how far such global development will impact the position of European industry and how the inevitable requirement to make cities smarter can create increasing opportunities for European industry.

In Europe, the ageing population represents one of the most extraordinary social transformations that currently characterizes and will continue to characterize European society. The number of people aged 65+ will increase significantly over the next 20 years. Technology can assist them in living in their own dwelling for longer.

The European electrical engineering industry is developing a wide range of solutions and systems to rapidly progress Europe's urban centres to smarter, sustainable, more efficient, effective and inclusive cities. Electrical energy is the most flexible and cost-effective energy vector used in cities for all applications. Since the European Union has decided to address societal challenges in its Europe 2020 strategy and flagship initiatives, the electrical engineering industry is committed to work with the European Commission to define the right strategies and to design the optimal tools to meet future challenges. Cities and urban areas will only be competitive, green and habitable when they are smart; this outcome will require new technologies and approaches as well as the upgrading of old or obsolete systems in the fields of Buildings, Homes, Lighting, Safety and Security, Infrastructures (Grids), Transportation, Ports and Harbours, Health and Living, Water and Wastewater and other largely public services. **Smart cities combine competitiveness, sustainability and quality of life, the three elements being intimately entwined.** A smart city will be a "**System of Smart Systems"** that addresses the different areas listed above.

The development of a smart city needs a collaborative approach involving:

- Governance: ownership by and commitment of local authorities. Industry must cooperate with local authorities to achieve common beneficial objectives.
- Technologies: to increase quality of life and sustainability, and foster productive growth, mayors and city leaders around the world are looking for solutions using the joint technologies provided by ICT and the electrical engineering industry. Many of these technologies are already available and can be used to begin upgrading the conventional and inefficient / dated installations currently in use.

The electrical engineering industry is investing in R&D to make products and systems flexible because the needs of each city will be unique, depending on the particular characteristics and needs of a city. The electrical engineering industry believes that cities are where there is the closest link between government, firms, universities and citizens, and this justifies the involvement of industry in supporting the development of the "Smart Cities" objective for Europe.

2. European Political Context

The Europe 2020 strategy is Europe's growth strategy towards 2020. Several Flagship initiatives contain provisions, ideas and initiatives in the field of Smart Cities:

- Flagship initiative:
  - The Digital Agenda
  - An industrial Policy for the Globalisation Era (see Focus on Sustainable mobility)
  - Resource Efficient in Europe
  - The Innovation Union (R&D)
- The European Cohesion Policy
- The EC Green paper on Solid State Lightning

1. Increased urbanisation is a fact that sets the world at a crossroads. As the graph below shows, the balance between urban and rural populations will tilt towards cities with a sharp increase of urban populations in the coming decades, leading to tremendous challenges such as energy security in cities, transportation, waste management, and access to water. It is self-evident that meeting these challenges will require cities to become "smarter" and to apply a new range of actions to accommodate such changes in an environmentally and socially sustainable way.
2. Investment in the further development and diffusion of technologies and solutions to meet the special needs of cities and urban areas is of vital importance. There are already countless technologies available to reduce the energy demand of major cities and these solutions can be aligned with the EU's objectives of energy efficiency, reduction of gas emissions into the atmosphere and the integration of renewable energies into the existing energy system. Solutions including smart grids, smart transport and traffic management, smart water and waste management and smart safety and security, which are all strongly dependent on ICT and the integration of information technology into the hardware of products and systems.

- The SET PLAN - Smart Cities Initiative.
- Recommendation of 21 October, 2011 on the research joint programming initiative "Urban European – Global urban challenges, joint European solutions."
- Recommendation of 27 October, 2011 on the research joint programming initiative "Water challenges for a changing world."
- Opinion of the European Economic and Social Committee on "EU crisis exit strategies and industrial change: more precarious or sustainable jobs? " (own initiative opinion) 2011/C 318/07.

3. Opportunities

- **Opportunities**
  - Inclusive, competitive and sustainable cities
  - Smart SMEs
  - Sustainable growth in smart cities, creating business opportunities for the European electrical and electronic industries in Europe and more globally: better places to live, better business etc.
- **Challenges:** The challenge is how to make cities and urban areas competitive, sustainable and habitable:
  - European cities are mature and largely require the renovation of existing infrastructures in all domains and appropriate funding;
  - The complexity of working around existing infrastructure is one of the main challenges;
  - Space in cities is constrained and noise and security are key issues;
  - Many urban infrastructures have reached their limits, for example in relation to secure energy supply, transport, buildings, safety and security, water and waste management and healthcare;
  - Large data management infrastructures and ICT are needed to provide real time control of cities;
  - ICT networks with high-speed broadband connections are needed to underpin information flows and boost city economies.

4. Recommendation – key messages

A) Built environment

Developing smart cities in Europe and more globally in the world requires interested parties to address the "built environment" and not only the buildings. The "built environment" can be divided into two sections that are addressed in the following chapters and for which concrete recommendations are made.

Smart Buildings

Buildings consume a staggering 40% of worldwide energy. Of these, buildings constructed before 1980 are responsible for about 80% of this energy demand. Thus there is a lot to gain by retrofitting existing buildings and ensuring that new ones are energy-efficient from the start. Today's technologies related to energy supply, intelligent automation and control, lighting, heating and water use are available. **Today, Europe is the leader in green and building technologies** and has a fair chance to **increase its presence in this respect on a global scale**. **New intelligent building management systems help reducing energy costs and CO_2 emissions by 20-30%.** Building automation systems (BAS), intelligent networks of electronic devices, monitoring and control of the energy supply, lighting systems, heating, air and water management as well as security systems (e.g. concerning fire safety or toxic substances) in an integrated network are reducing maintenance and energy costs significantly. For buildings **to be truly "smart"**, highly energy-efficient and intelligent building automation must be accompanied by the **integration of low carbon energy supply technologies** and the **possibility for connection with smart grids**. In the future, new buildings will have very low energy consumption for space heating. The electricity consumption (by appliances etc.) will be higher than that needed for heating. Ventilation and cooling will therefore become more and more important. Every (non-residential) building needs a specific and individual solution and well-regulated heating and lighting control systems will be essential. Comprehensive sustainability is only possible via holistic energetic building solutions, including constant energy services (such as monitoring and controlling), which are necessary to meet the demands in relation to quality and energy management[3].

Smart financing instruments such as **performance contracting models** allow the financing of relatively ambitious minimum requirements in terms of energy performance of buildings. It is critical to overcome the prevalent legal and regulatory barriers in this regard, such as e.g. tenant-owner dilemmas and public procurement.

Concrete recommendations:

- Europe must address the needs of existing buildings by setting a **clear roadmap of renovation targets** to be achieved by 2020, 2030, 2040, etc. **notably for public buildings**.
- Foster **convergence and harmonisation** of **calculation methodologies** and criteria (KPIs); this is the only way to permit comparisons and best practice sharing;
- To make use of the **full potential** of **performance contracting**, it requires an improvement of the **regulatory framework** in Member States, especially in relation to public procurement, as well as **administrative structures** proposed by the Commission (which then may be transposed nationally e.g. via national agencies) for improved capacity-building.
- Foster certification of minimum cost-effectiveness via life-cycle cost controlling, focusing notably on the management of the different energy usages.
- In the context of safety and security, harmonisation of building codes / codes of practice and the introduction of standardised application guidelines.

3. For instance, the intelligent linking-up of facilities for building services engineering and building safety via "Total Building Solutions" leads to more transparency and lower costs of operation.

Smart home

A smart home not only means being connected to the Internet, having remote access and control capability, or having a smart meter. What makes a home "smart" is the dwelling having devices that can elaborate input data, originating both inside and outside the home, and being transformed into useful information for use by various end users or by other products and systems that may also be in the home.

The electrical engineering industry can turn the challenges of climate change and changing demographics into opportunities. The key element is **to adapt dwellings** to improve their energy performance (by integrating energy-efficient applications and renewable energy) whilst meeting the current and future societal needs:

- Active energy management of the home.
- Technology-assisted living for the elderly.
- Flexible homes that can suit all ages and family compositions.
- Homes with well-equipped working spaces.

Smart Homes can thus provide benefits in **several areas** such as active energy management, technology-assisted living, flexible homes with a well-equipped home office, and support for electric vehicles:

1. Considering **active energy management** of the home, we consider that better informed consumers will exhibit more responsible behaviour towards their energy consumption, whilst simultaneously taking more interest in and making greater use of new technologies and renewable energy sources.
   A smart home equipped with products that can adjust consumption and provide feedback to end-users on their real-time energy consumption can reduce overall system costs, and potentially change the character of the energy consumed. Smart products that by default shift consumption outside of peak periods, or which, through information, encourage consumers to do so, will play an active role in "peak shaving" and "load shedding" thus minimizing the energy waste associated with a disproportionate amount of demand occurring during peak periods and insufficient demand occurring when renewable energy is available.
   Compared to actual base electric power generation, the peak required by electric power generation is more carbon-intensive. Within the smart grid process deployment, a smart home can bring a very positive contribution to this issue. Shifting energy consumption off peak or when renewable energy becomes available can greatly contribute to the reduction of primary energy consumption and of CO_2 emissions.
   As detailed in the European Commission's communication on smart grids, consumers tend to change behaviour and save energy if they are presented with their energy consumption figures. As we do not expect consumers to constantly monitor external input data and manually act on the information, a smart home with the right kind of devices, able to anticipate information on energy consumption, can play a key role in increasing the level of awareness of consumers and thereby in contributing to a reduction in energy consumption. It is also expected that load shifting and differentiated tariffs can lead to saving energy costs for the user. Smart homes require smart users, empowered by their ability to manage their energy usages (and costs) through monitoring, visibility and understanding of their energy consumption and carbon footprint, enabling energy savings and providing full (including remote) control of their comfort and safety. This is heavily dependent on the creation of an interoperability system, which will allow electronic systems located in the smart home to communicate with the external world. Information and communication technologies (ICT), and especially software, are the embedded link to ensure interoperability of the different solutions available to the end user. The Smart Grid technologies already available allow the management and the integration of the home/building performances. The electricity distribution systems management, both in Low Voltage and in Medium Voltage systems, will have to be adapted to be able, in a user-concentrated area to manage the load and flows of electrical energy in the system with sufficient supply and quality as well as enabling the integration of local generation of renewables (such as from photovoltaics, heat pumps, mini-eolics etc). Thus the end users, with the installation of local renewable generators, can also become producers of electrical energy – so called "ProSumers." The quality of supply of the electrical Distribution Management Systems (DMS) is regulated in several countries by law. Among the other tasks of managing diverse local system applications reliably, the DMS allows their integration into the existing network, *via* the bi-directional flow of the electrical energy locally produced which is not consumed. It is recommended that any investments in this area of applications be supported by proper feed-in tariff and de-taxation.

2. **Technology-Assisted living at home:**
   Europe's ageing population – with an increasing number of people 65+ – will increase significantly over the next 20 years. Technology can assist them in living in their own dwellings for a longer time. Such systems include electric buggies, electric stair-lifts, orientation lighting and many others. Older people also have an increased need for fire alarms and electronic security systems. Moreover, elderly people often live in older houses that may have not been recently renovated.

The expectation of living longer combined with the growing number of elderly citizens represents a challenge for Member States: they are facing radical social change with a clear need to redefine welfare policy objectives. The cost for pensions, health and long-term care is expected to increase, with total expenditure **tripling** in the next decades. Development of electronic-based services can help to achieve substantial progress combined with cost savings. For example, early patient discharge from hospital due to the introduction of mobile health monitoring would save a lot of money.
The home, seen as the place of reference for the life of retired senior citizens, where they carry out those fundamental daily routines, such as sleeping, taking care of personal hygiene, preparing and eating meals, and feeling safe and secure. The home must also satisfy various complementary needs that increase the quality of life and the psychological wellbeing of the individual.
To maintain elderly and/or disabled people at home, much of the same technology and equipment is used as for general home automation, security, entertainment and energy conservation but tailored to the needs of elderly and disabled individuals.

3. **Flexible homes, well equipped home office and electric vehicles:**
Ownership of dwellings is changing increasingly often these days. Families have different needs to singletons and younger people from older people. So homes need to be organised in flexible ways to be able to respond to all ages and family compositions. Working from home is increasingly popular and reduces demand for transport energy (and congestion). But it requires a well-equipped **home office**:
   - Sufficient power sockets and home IT infrastructure: computer, printer, external hard disk, smart phone loader, modem, etc.
   - Broadband internet connection and multimedia network.
   - Protection of equipment against lightning strikes and EMC problems.

   Moreover the expected development and growth of the **e-vehicle** in Europe will equally require appropriate support infrastructure at home and mean adaptations in the home for smart and safe charging.

Concrete recommendations:
- Set **minimum requirements for the energy performance** of new public and private dwellings.
- Favour **renovation of existing** dwellings.
- Foster the emergence of **open, interoperable and safe communication protocols** (including data model) to facilitate integration of electrical features in homes (European standards as foreseen by mandate 441 and 490).
- Favour the **deployment of Demand Response and Time-of-Use tariffs** to take full advantage of the benefits offered by Smart Grid and Smart Homes.
- The European housing stock is ageing. To realise capacity and peak power improvement, increased control of the energy flows, and electrical safety, **current electrical installations are largely insufficient.** Members States should encourage renovation and upgrading of the electrical installation in homes by all means as to integrate new electrical applications and functions offering better energy management, comfort and safety.
- Ensure that **smart financing tools** are available to support investments in smart technologies and products for the home.

B) Smart Lighting [4]

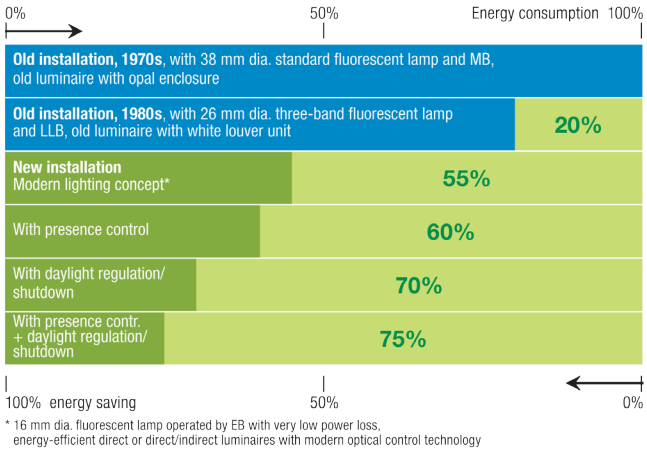
Lighting technologies have undergone major evolutions in the last decade, offering cities new perspective on, and possibilities for the development of their urban lighting strategies. Natural daylight is essential for life. In cities artificial light is needed to help citizens to fulfil their visual tasks, since daylight is not available everywhere and at any time. Light affects our mood; improves well-being and biological processes. Light stimulates productivity and accommodates the 24-hour lifestyle, ensuring safety and comfort, even for the ageing population.

The importance of good lighting in cities is unquestionable as lighting provides essential service to people in all places. Good lighting in cities will:
- enhance the quality of urban and city social and cultural life.
- beautify the visual appeal of urban architecture and city landscape.
- increase the visibility of every visual task and reduce fatigue in working environments.
- improve safety and usability of streets and roads for motorists, pedestrians and residents.
- motivate and stimulate learning and study in the educational world.
- improve productivity, promote safety and accuracy in the workplace.
- stimulate the amenity and experience of the retail and leisure environments.
- be an integral factor to cope with challenges arising from demographic change and having an ageing population in cities.

Society places significant importance on climate and energy protection. Lighting in cities can play a central role in saving energy, resources and costs. New lighting technologies and controls can deliver savings of at least 40%.

4. Note: European Lighting Industry in a nutshell:
   – Thousands of lighting companies in Europe, most of them small and medium-sized luminaries enterprises
   – 150,000 persons employed in Europe's lighting sector
   – 20 billion Euros annual turnover

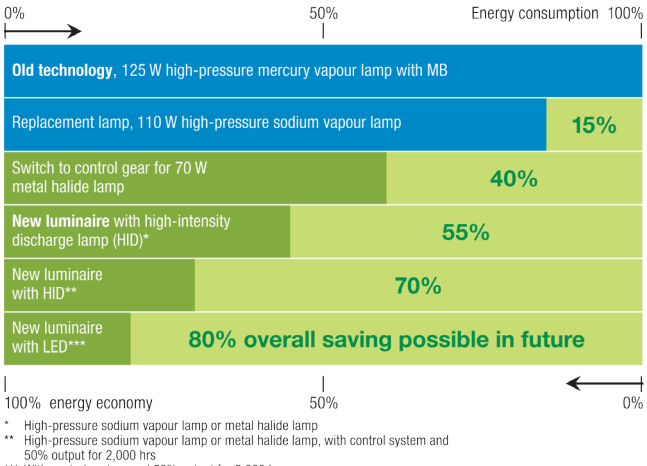
Savings potential of interior lighting



* 16 mm dia. fluorescent lamp operated by EB with very low power loss, energy-efficient direct or direct/indirect luminaires with modern optical control technology

Source: ELC CELMA

Savings potential of exterior lighting

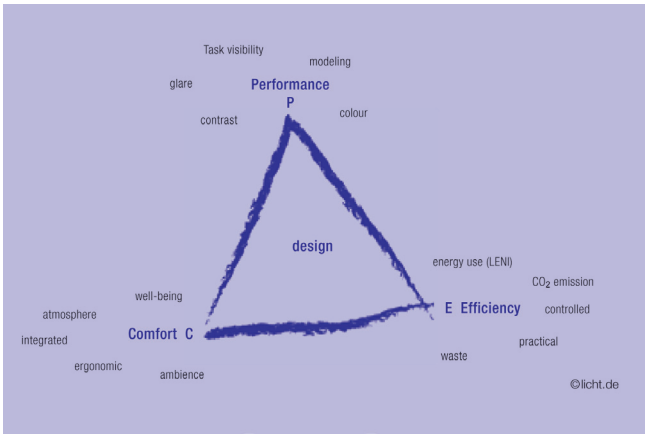


* High-pressure sodium vapour lamp or metal halide lamp
** High-pressure sodium vapour lamp or metal halide lamp, with control system and 50% output for 2,000 hrs
*** With control system and 50% output for 2,000 hrs

Innovations in the lighting sector are transforming the ways of energy consumption and offering entirely new lighting solutions for a comfortable and healthy lifestyle in cities. Application-focused illumination with efficient luminaries using energy-efficient light sources interacting with electronic lighting controls is the key for smart city lighting. The luminaries have to be installed referring to an appropriate lighting design to ensure maximum efficiency of the whole system, and to best fulfil citizens' requirements.

High-efficiency LEDs (Light Emitting Diodes) will in the near future play a dominant role in lighting since LED lighting offers cities previously unavailable lighting scenarios and applications. This "breakthrough" in lighting technology can help to drastically reduce the consumption of energy for lighting compared to existing, conventional lighting technologies, whilst improving light quality as well as people's lives and wellbeing.

Lighting triangle



Source: ELC CELMA

Concrete recommendations:

- One of the most effective measures for cities to reduce energy consumption is to **use lighting only when it is needed by the use of intelligent lighting systems.** Application-designed illumination with efficient luminaries using energy efficient light sources interacting with electronic lighting controls is the key to smart city lighting. Intelligent lighting systems measures, which can save more than 40% of energy, are optimally exploited when the lighting is properly designed, installed, operated and maintained in the best way. By providing the correct light in cities in the right place and at the right time, lighting can significantly improve the quality of life of EU citizens and will contribute substantially to the EU's efforts to achieve its energy efficiency and sustainability targets.
- **Increase the renovation rate of existing indoor and outdoor lighting in cities** with latest intelligent lighting technologies, systems and solutions as the annual refurbishment rate is slow at about 5% (7% for indoor lighting and 3% for outdoor lighting). Furthermore, existing schemes are often inefficient and very old (75% of existing lighting installations in buildings are older than 25 years and 33% of existing street lighting technology is older than 40 years).

In order to achieve the full potential of smart lighting in all its forms for smart cities within and outside Europe, and to help the EU achieve its low-carbon economy objectives, an **accelerated switch to LED lighting is essential.** The EU Green Paper "Lighting the Future, Accelerating the deployment of innovative lighting technologies" (COM (2011) 889 final) on Solid State Lighting (SSL) covering LED and OLED (Organic Light Emitting Diode) is expected to be the roadmap for accelerating the switch to these new technologies in Europe and to enhance the competitiveness of the European industry in this regard. In order to implement the conclusions of the EU SSL Green Paper, the launching of a European Solid State Lighting network including the whole value chain is recommended.

C) Safety and Security

Urban areas are faced with specific problems concerning safety and security, including crime and violence, fire, terrorism, forced eviction and insecurity of tenancy and natural disasters. These threats to urban safety pose a huge challenge to both national and city governments. In the event of an urban infrastructure emergency, the right measures need to be taken in order to minimise negative impacts on citizens, assets and the economy. There is a growing demand on public authorities to inform the population as early as possible via **public alert and mass notification systems** (examples include: street information posts, mobile services, internet-based systems) to observe a line of conduct. Moreover, detailed information on causes and the damage situation needs to be available as fast as possible. For example, buildings that are located in areas likely to suffer seismic activity can be provided with ICT systems that can communicate with the meteorological and geographical institutes to increase prevention and reaction time. These data, which can partially be derived from building information models and partially be simulated, need to be assessed and provided to interested parties in real time, for example inside a building or underground structure for self-evacuation. Furthermore first responders, such as fire-fighters, police, emergency personnel, and others can benefit from these data. It supports them in appraising the situation and finding the best way of dealing with the typical requirements in certain situations, e.g. establishing a safety perimeter around an urban infrastructure and enabling access to a building safely to provide rapid, efficient help. Finally, these data provide valuable "post-mortem" information to minimise the downtime of the building or urban infrastructure and ensure quick restoration of the infrastructure. Interactive information and simulation systems can display the latest safety and security status and provide relevant information in case of an emergency. In preparation, simulations of certain impacts help to analyse different scenarios and to derive the right responses. Simulations also show how to improve areas and procedures for evacuation.

Clear regulations to evaluate **how downtime** in urban and building infrastructure can be **minimised** through increased resilience or means of fast recovery are necessary. Again, for fire safety such regulations do exist, but for security there is often no common understanding of what should be done to establish a basic standard to protect people and assets.

The electrical and electronic industry and others have put **considerable effort** in establishing **pan-European standards** for **products, systems** and also **services** to allow pan-European **certification and conformity assessment**. Moreover, the quick adoption of a **single EU-wide testing and certification scheme** is necessary. Public-Private Partnerships with adapted liability terms for the protection of critical infrastructures should also be considered in this context. What is more, **training and practice** exercise regulations for safety and security system providers and operators are keys. Like a vehicle test certificate, safety and security installations and operations may be **audited and serviced regularly**.

Concrete recommendations:

- Further refinement of pan-European standards for products, systems and services and of the integration of all infrastructure information systems.
- Europe-wide testing and certification scheme.
- Industry should be given the responsibility for taking care of maintaining and adapting the installed systems.

D) Smart Grids

Smart Grids is a priority area for the future energy system in Europe. Grids need to able to handle and convey to the barycentre of consumption in the cities the green energy coming from large bulk renewable fluctuating energy, such as wind, solar and hydro while taking into account local, small renewable energy sources. The issue of smart grids must be tackled with a **holistic approach that** is not only focusing on individual components but on the **whole integrated system**. It is essential that we have an **overall strategic legislation** to ensure that **all grid components will communicate with each other** with the aim of reducing greenhouse gas (GHG) emissions and increasing efficiency and making a city truly smart.

Managing the consumer side feed-in from thousands of small decentralized and distributed renewable sources, such as photovoltaic, biomass generators and wind turbines can only be planned with a smart grid approach.

So, if cities are to continue to grow at a sustainable rate, an integrated approach with the smart grid technologies is a must and ICT systems like SCADA (Supervisory Control and Data Acquisition) totally dedicated to the smart grid are essential. It is necessary to create an ICT framework that is connected, scalable, compatible and integrated and has the power to improve a city's security, healthcare, transport, communications, businesses and public services thus enhancing its economic prosperity and the quality of life of its dwellers.

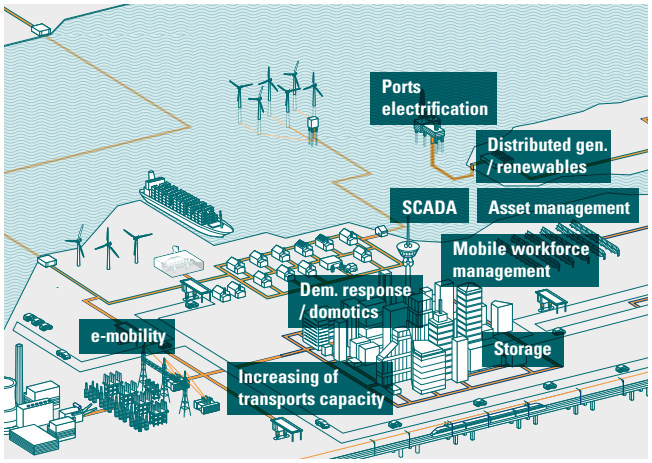
Today's generally passive consumers in the energy system will develop into interactive "**ProSumers**" – who both produce and consume electricity in a cost-optimised and environmentally responsible manner. Another priority is the balancing of the whole energy system (High, Medium and Low voltage streams), especially via energy storage capacities. Balancing all

of these distributed consumption/generation units will require a flexible, intelligent and optimally controlled grid connected to smart buildings, homes, lighting, and transport systems in a new bi-directional energy system.

Concrete recommendations:

- Foster visible pilot projects connecting smart grids with smart cities projects, supported by public financing identified in the EEGI (European Electricity Grid Initiative) and sponsored by DG R&D.
- Public acceptance of the necessary infrastructure changes: for a decisive change to renewables, it is imperative to have a **shared commitment for infrastructure** changes that includes politics, industry AND **citizens and civil society**.
- Major **education/training programmes, across the EU**, with a focus that includes education of institutions, social partners, business and national authorities.
- **Sponsor standardisation** for interoperability and allowing for economies of scale, also for industry to remain competitive internationally.
- A city cannot be smart without the smart grid process properly addressed. Many areas in the cities require technical and integrated solutions at the state-of-the-art level. The management and services as well as the competences of the stakeholders appointed to run the future smart system, need to be prepared (training) in advance. The figure below highlights the areas that need to be addressed. For all these areas the European industry has adequate solutions and details can be found in the other chapters and annexes of the current report.
- The electrical infrastructures in smart cities play a defining role for energy security and reliability of supply. The high-energy intensive demand in the metropolitan area, combined with possible energy-intensive industrial areas like ports and industrial zones, requires the local utilities / government to properly plan such developments with a systematic approach with the support of the smart system manufacturers. In this way, all assets available from the smart meter industry can be adopted to maximise advantages to raise citizens' quality of life, which in many areas is currently affected by climate change limitations and pollution.

Smart grids



Source: T&D Europe and ABB

E) Transportation

Urban mobility (including eCars)

Urban mobility is essential to productivity, health and general quality of life within a city. In Europe, traffic congestion costs the EU over 1 percent of GDP, or over 100 billion Euros per year. Moreover, about a quarter of the EU´s greenhouse gas emissions in 2008 were caused by transport, of which 71.3% can be attributed to road traffic. Cities therefore need an improved network of intelligent transport systems that are accessible, secure, reliable and sustainable, without curbing people's mobility.

Smart mobility contains safe, green, efficient and reliable public and private transport, logistics and traffic management. Modern rolling stock and rail automation must meet several demands: in addition to making the transport of people and goods reliable, speedy, on time, secure and convenient, they must be efficient in relation to energy consumption. The transport of people and goods is an important element in making a city more competitive, green and habitable. Europe already has many diverse solutions to meet these demands. There is however still a strong **need for public funding** and standardisation in transport, for instance in **relation to TEN-T** to create a truly integrated single market in transport. The full benefits of a common European rail system in terms of interoperability, safety and performance can only be realised if **national investments** are strongly coordinated **along international priority corridors**. Transport also needs to have a strong position in the EU's **forthcoming research projects** as set out in the framework "Horizon 2020." Europe is well placed in the worldwide ranking in terms of electrified mobility, but to retain this leading position, we must be able to launch major research programs, especially in the area of electrified transport, including rail and eMobility. An important element would be a **Joint Technology Initiative (JTI) in the field of rail transport.** R&D in rail technology is an important keystone not only for improving Europe's leading competitive position worldwide in rail, but also to achieve the goal of more sustainable transportation and the achievement of a single market in transport. Inventions that could be covered by such a JTI include, for example, improved rolling stock and eTicketing.

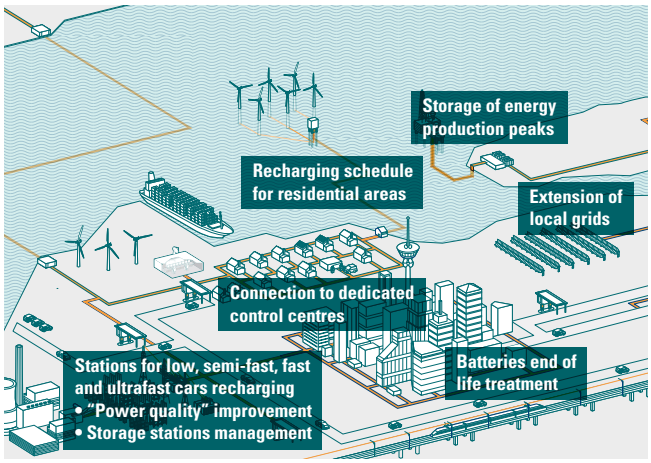
In the context of greater railway efficiency, trains perform much better and are **more reliable** when the **industry providing them** takes care of **maintenance**. The current situation in most EU Member States is that the supply industry cannot provide maintenance services that are the sole competence of operators and infrastructure managers. Suppliers therefore have no access to maintenance data.

Electrification of transport has also the greatest improvement potential in the short-distance environment of a city: in an **electric car** the energy stored in the battery is converted into kinetic energy with 95% efficiency compared to a combustion engine driven car which has an energy efficiency of only 20 to 30%. In addition, provided that the energy used is from renewables, eCars are emission-free. **A significant advance in battery technology is essential to lower the cost and increase the performance of eCars in the next few years**, as is the **building up of electrical energy infrastructures and recharging systems**. An electric car can simultaneously serve as **both a means of transport and as a mobile energy-storage device** that serves to balance out energy fluctuations in the smart grid, helping to stabilise the whole grid system. To this end, the energy and communications interfaces with the power grid should be standardised, so that rapid charging processes can be coordinated with minimal effort across the whole grid.

Concrete recommendations:

- Clear and overall **emission reduction targets** should be the primary goal for transport policy.
- To fulfil the requirements of operators regarding product liability, it is necessary **to open up the maintenance market** to reinforce the competitiveness of the rail industry.
- A **Rail JTI** should be an integral part of "Horizon 2020" in order for Europe to remain competitive worldwide in rail and to achieve a more sustainable and interconnected transport system.
- Governments can accelerate the transition towards e-cars by creating **economic incentives for consumers** (e.g. tax breaks, exemption from congestion charges) and **supporting research capabilities** – including for SMEs.
- The Connecting Europe Facility (CEF) is the right tool to push for the further development of eCars. It is very important that the future eCar can connect with Smart Grids.
- The expected increasing quantity of e-cars in cities requires the planning and implementation of dedicated energy infrastructures and service systems. The interconnection of the current installed system with new investment areas required (see figure below) will require investment in smart solutions for future infrastructure, to assure energy efficiency and proper quality standards. To achieve this, it is envisaged that there be smart cooperation between the industry sector investing in the dedicated areas and the support of dedicated projects for demonstration. This will be necessary for citizens to gain suitable confidence in the emerging e-car technologies.

eVehicles



Source: T&D Europe and ABB

Smart ports and harbours

Ports and harbours are the main economic assets for many cities, irrespective of their dimensions. More than 90% of the world's goods are transported by sea, and the efficiency of the European ports has become a definitive positive asset for the current and future European integrated economic system. Considering the energy efficiency performance of the electrical installations associated with ports, many areas are today still quite dated, not only in the support efficiency of the system itself, but also in quality of life of from the citizen's point of view. In fact, ships' emissions being typically very intense and polluting, the surrounding societies are facing adverse consequences related to societal costs and health issues of the citizens. European industry can provide solutions in this field, and so can deliver a significant contribution to improving the technical aspects and indirectly to reduce the health and societal costs.

Overall, shipping is a highly efficient means of transporting cargo with lower CO_2 emissions per ton-kilometre than trucking and far lower emissions than air transport. However, the industry is – according to the latest report by the International Maritime Organisation (IMO) – estimated to account for more than a gigatonne of global CO_2 emissions, that is around 4% of all CO_2 emissions globally (compared to 2% for aviation)[5].

5. Shipping also accounts for 10 to 15% of all emissions of nitrogen oxides (NOx) and 4 to 6 percent of sulfur oxides (SOx), which are linked to smog and acid rain, respectively.

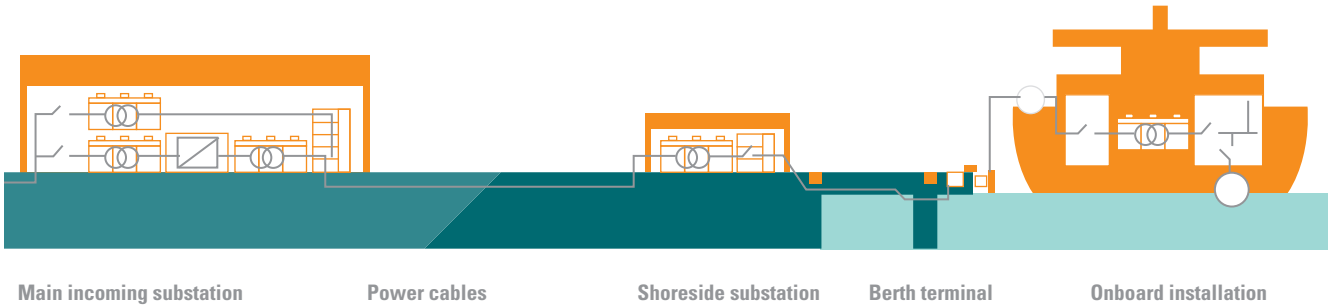
Emission scenarios show that by 2050, without adequate policies, CO_2 emissions from international shipping may grow by a factor of 2 to 3 (when compared to 2007) as a result of the growth in shipping. Besides the energy efficiency improvement of the electrical installations in ports required by the EU 20/20/20 targets, it is worthwhile considering that there are also significant health impacts associated with ship emissions, mostly due to air quality issues in the communities surrounding large ports.

Ships while docked can drastically reduce their emissions.

As arresting as these figures may be, there is now a solution to the challenge of mitigating ship emissions while in port. Instead of running diesel generators onboard, ships draw power from a connection right at the quay. For ferries and other roll-on roll-off vessels, this might amount to one or two megawatts, but large container ships can use as much as 6 MW while in port and cruise ships up to 15 MW and more. When considering that several ships are docked simultaneously, then the total power needed may reach up to 100MW. That's enough power to serve more than 150,000 average homes in Europe.

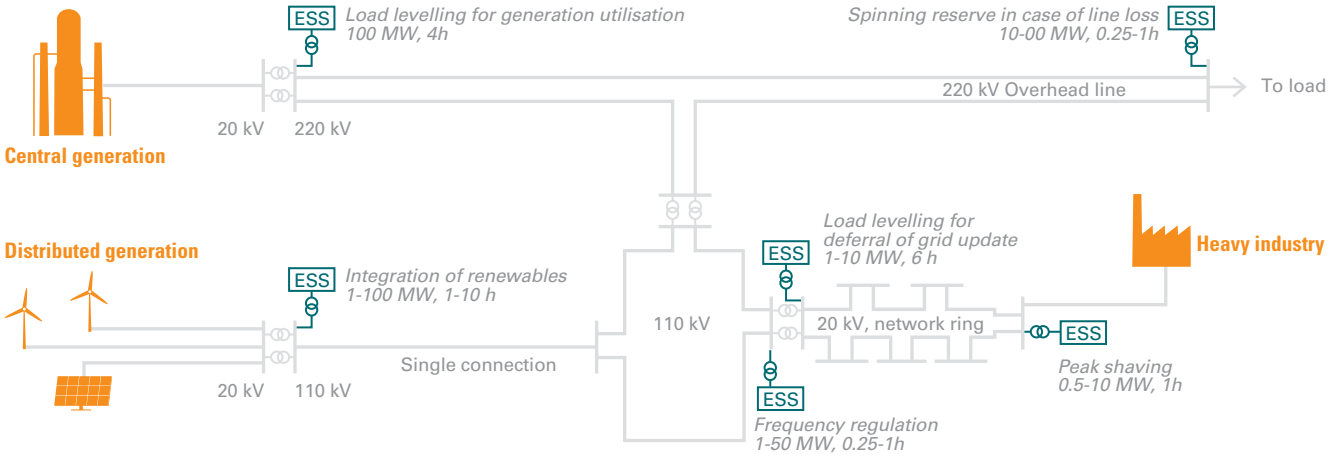
Power supply to ports is typically equivalent to that of a small factory, with electricity needed to power shore-side loading and unloading infrastructure such as cranes, belts and gantries, cooling, heating and incidentals. Most ports have access to enough power to supply these consumers, with an additional 2 to 3 MW for secondary needs. Given that a vessel's power needs while in port may be as much as up to 10 MW (for big cruise liners up to 20 MW). Depending on the type of vessel, the electrical infrastructure at many ports will be insufficient to handle significant operations without a major improvement to their grid.

Smart ports and harbours



Source: ABB

Battery energy storage systems, applications in transmission and distribution grids



Sources: ABB

The fact that the European industry has these competences means that it can also take the lead in the borderland countries. Port electricity loads are typically of such a size that they can be fed by stable, renewable energies like offshore wind farms. The port load itself can further help to stabilise the grid system in Europe in case of a dedicated Integrated Transmission System for renewable energies[6].

Battery Energy Storage Systems

Today's energy requirements in a smart city impose on the design of a future electrical system the need for it to fulfil, at any energy demand conditions, the following conditions: capacity, reliability, efficiency and sustainability.

Battery Energy Storage Systems (BESS) provide such a capability to balance power demand and supply, contributing to the stability of network parameters such as reduction of electric peaks and troughs, maintain power frequency and ensure power remains available for critical loads when power cuts occur. In addition, certain applications can also provide enough power to maintain operations until systems can be systematically shutdown or provide enough power until backup/ alternative generation comes on-line. Energy storage solutions[7] additionally provide several strategic benefits such as improved flexibility for grid operators, increased national energy security, and reduced environmental impact.

Electrical Energy Storage technology, in the smart grid contest, enables the effective integration of Distributed Renewable Energies with consequential dispatch of distributed resources and therefore allowing "true" demand response, satisfying both the peak demand and the end user needs.

One Megawatt battery storage system provides on-demand power, 250 MWh for peak loads and power support.

F) Water and Waste management

Water is increasingly a mega-topic. According to the UN, worldwide, at least 1.2 billion people live in areas of water scarcity. This problem is now recognised as the greatest resource risk of the 21st century. It is essential that cities tackle the low value perception of water [in Europe] towards a cultural change that will better respect and preserve this crucial commodity. In addition, using waste materials as a source of renewable energy is crucial to the long-term health of our cities.

When considering the electrical energy used by urban water distribution pumping systems, this represents about 20% of electrical energy used in a city. Considering that many such systems are dated and obsolete, there is a potential energy saving of 30-50% when using the latest technologies available, based on motors and drives delivering higher efficiency at lower operational cost. Life factor as well as efficiency in operation of a water system is very important in a city. In fact any cost reduction in the energy used does not only impact on the quality of service, but also directly on cost to citizens.

Solutions are already available from European manufacturers that allow better management of water pumping stations. Solutions for process automation and optimisation such as pressure and leakage management are also available. (See following figure showing energy in water applications with relevant average cost estimates.)

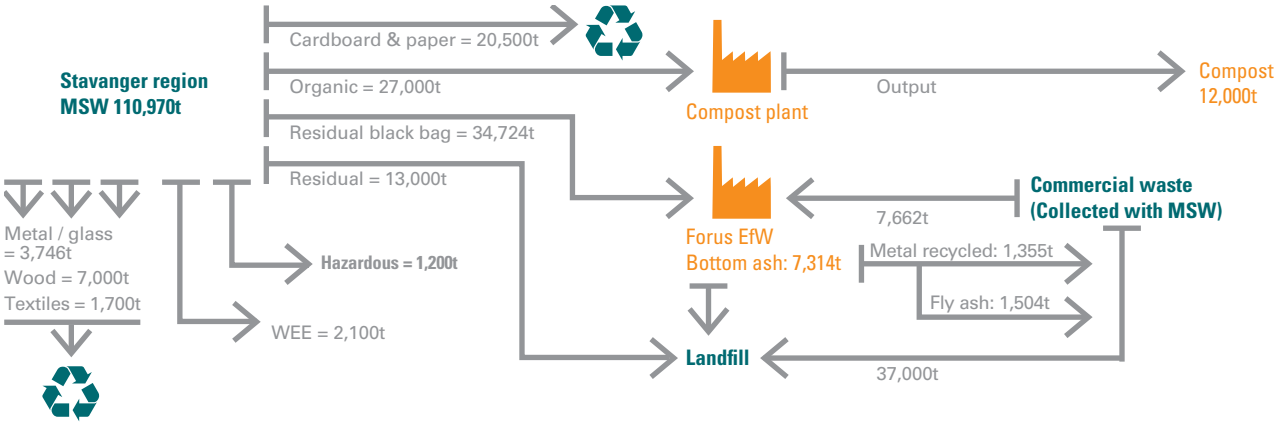
So water management as well as wastewater treatments require further attention by the relevant authorities. Moreover, the energy aspect directly impacts on service continuity and operational costs.

Waste management in cities is the other key element, which if not properly addressed, impacts directly on the quality of life of the citizens.

Cities already accommodate a majority of the population [of Europe] and they produce a corresponding majority of the waste materials. According to Eurostat figures[8], the "EU 27" generated 256 mt of municipal waste in 2009; 95 mt of this went to landfill and 51 mt was

6. Additional comments: The benefits and costs of the solution vary significantly depending on the existing configuration and location of the port, berth and ship. This means that its cost-effectiveness needs to be studied on a case-by-case basis, and that direct reduction of marine engine emissions should continue to be pursued.
In environmental terms, the solution achieves emission reductions well beyond those achieved from switching to 0.1 % ["low"] sulphur fuel at berth (as Directive 2005/33/EC requires from 2010), particularly for NOx and PM (particulate masses). It therefore merits particular consideration in ports where ship NOx and PM emissions are contributing to local air quality problems, such as exceeding the ambient air quality limit values for ozone and particles.
In general the figures suggest that for ships with larger engines regularly visiting the same port, switching to shore-side electricity should be both environmentally and economically preferable to using 0.1 % sulphur fuel. In economic terms, the solution should generate savings compared to low sulphur fuel for new-build ships regularly visiting the same ports, especially, but not only, if electricity tax reductions are offered as allowed under Directive 2003/96/EC. Member States and local authorities might wish to consider other means to encourage ports to invest in shore-side electricity infrastructure and to ensure its use.
7. Hydrogen fuel cells may be considered as battery energy storage systems. See: The written declaration on establishing a green hydrogen economy and a third industrial revolution in Europe, through a partnership with committed regions and cities, SMEs and Civil Society Organisations, 12/02/2007, European Parliament.
8. Eurostat, Environmental Data Centre on Waste, Waste Streams, data for 2009 reported in 2011. http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_wasmun&lang=en

Waste flows



Source: ENER-G Holdings plc

incinerated, 41 mt of the latter with energy recovery. Increasingly, this waste stream is today seen to be a resource, rather than a problem (See Zero Waste Edinburgh and Midlothian[9] and Zero Waste York[10] for examples). There are a number of other initiatives promoting this approach, such as the National Industrial Symbiosis Programme (NISP), an initiative supported by the European Union's Life+ Programme[11]. NISP seeks to "*brings together traditionally separate industries and organisations from all business sectors with the aim of improving cross-industry resource efficiency and sustainability; involving the physical exchange of materials, energy, water and/or by-products together with the shared use of assets, logistics and expertise.*" More generally, cities can collect waste and sift out what can be recovered or recycled and burn the remainder to provide heat and power. The objective of these schemes is to maximise the re-use of what were waste streams so that they minimise flows to landfills[12]. Such a policy would reduce our dependence on imported raw materials whilst adding value to waste streams. This has been recognised in the Commission's Raw Materials Initiative, which looks to increased levels of urban mining[13]. The figure shown above illustrates how the waste stream can be processed at all stages to draw out valuable resources and minimise those amounts combusted and sent to landfill.

This figure shows that waste streams from cities can be highly utilised and be a source of raw materials, heat and power. One feature of this diagram is the large number of interfaces into and out of this process. Indeed, the purpose of initiatives such as NISP is to create such links. Such schemes involve waste collection, waste recycling, raw material sales, compost and aggregate sales and the production and sale of heat and power. Many of these links introduce both commercial and regulatory risk if there are changes in material and energy prices or supporting regulations. To flourish, such schemes will depend on a stable commercial and environmental environment. Businesses do not expect governments to control the prices of raw materials and must accept and deal with those risks. However, it is vital that, as cities become increasingly interconnected and depend on complex interactions between business streams, then city authorities regulate waste resources in a holistic manner and consider the effect of their regulations on all aspects of the city infrastructure.

For water there are similar issues. Cities are major users of water and, as pressure on water resources increases around the world, there is a growing need to reduce water usage and increase water re-use. The production costs of drinking water and the water usage of technologies (low-carbon and normal-carbon) will be other key questions. Urban waste water is governed by the Waste Water Treatment directive[14]. In response to the directive, there are increased levels of secondary- and tertiary-level waste water treatment, although much remains to be done. Water supply and treatment are major users of energy. Approximately 30%-35% of pumps globally are sold to the water industry and

9. Zero Waste: Edinburgh and Midlothian (http://www.zerowastefuture.com/)
10. Zero Waste York (http://zerowasteyork.wordpress.com/)
11. http://www.nisp.org.uk/
12. This approach has been recognised by the European Parliament, which called for the Commission "to have a consistent policy of urban mining that aims to recover and to make available such a resource of valuable raw materials and to promote the new skills and jobs related."
13. "Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions; Tackling the Challenges in Commodity Markets and on Raw Materials." Brussels, 2.2.2011, COM(2011) 25 final
14. COUNCIL DIRECTIVE of 21 May 1991 concerning urban waste water treatment (91/271/EEC)

there are large potential energy savings to be in water pumping systems. Energy represents 60% of the cost of operating water pumping stations, 45% of water treatment plants and 50% of waste water treatment plant[15]. It will be important to minimise the energy use of new and existing water plant by the use of the most efficient plant and systems.

Concrete recommendations:

- The water system in a city is of vital importance and needs to be addressed with a proper, considered management policy and attention paid to its efficiency in a broader sense.
- City authorities should actively promote zero waste schemes and engage positively with the companies developing them. This would include support for planning consents and placing contracts granting access to waste streams.
- The Commission, governments, local authorities and regulators must consider changes to regulations in a coordinated fashion and ensure that changes to policies do not have unintended consequences.
- The effectiveness and value of such waste projects is increased if waste is collected via kerb-side, dry recycling techniques. This requires local authorities to organise waste collection appropriately and promote these to the public.
- The requirements of the Urban Waste Water Treatment directive should be fully met across all EU27 countries and energy costs should be minimised by requiring a life cycle approach to the resign and refurbishment of this plant.

15. Figures from ABB