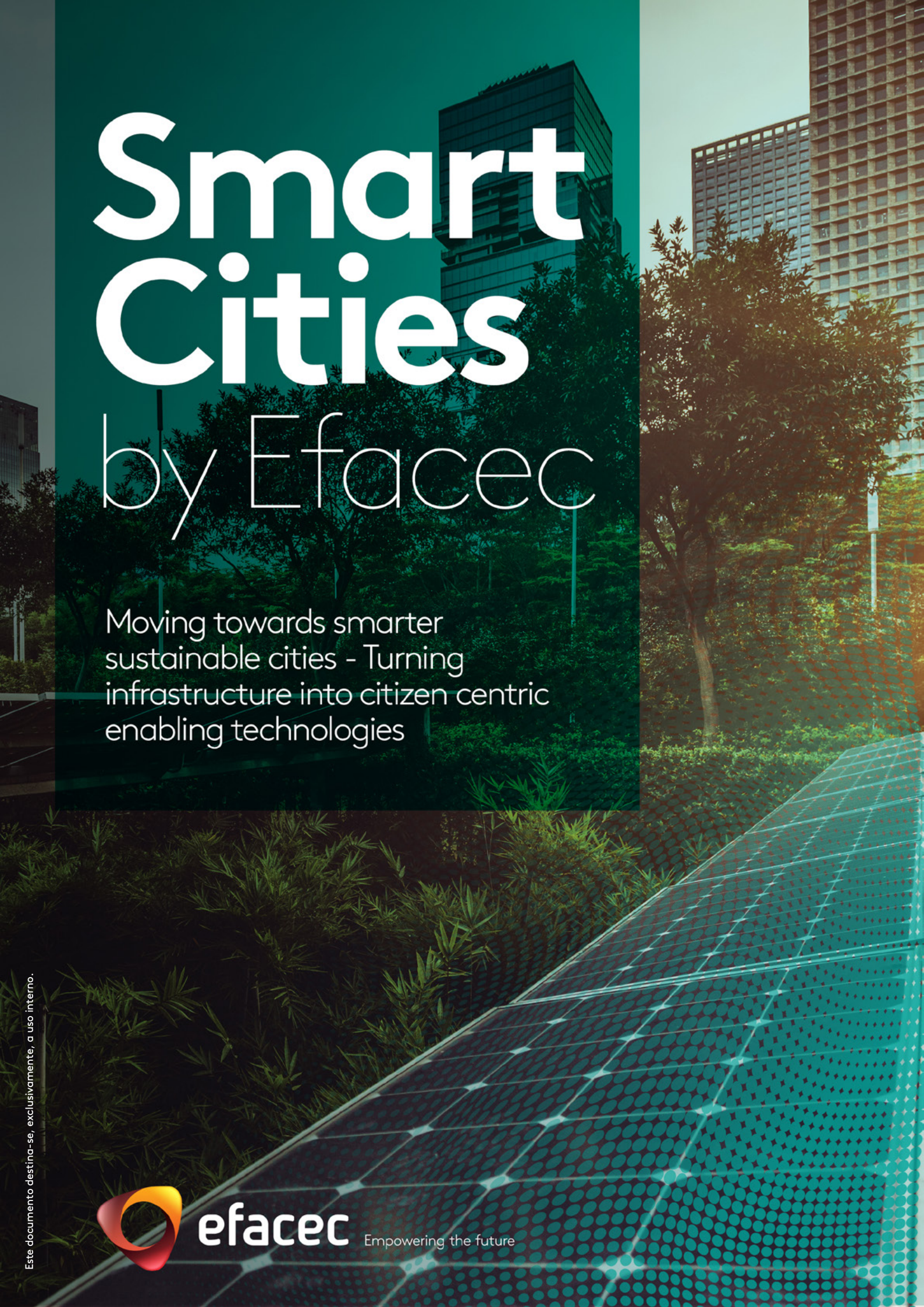


Smart Cities by Efacec

Moving towards smarter sustainable cities - Turning infrastructure into citizen centric enabling technologies

efacec Empowering the future

We anticipate and shape the future through greener efficient energy systems, environment friendly projects and smarter customized mobility solutions."

Empowering the future

Contents

Macro Trends

The 19th century has been dominated by empires, the 20th century has been dominated by nations while the 21st century will be dominated by the increasing powerful ecosystems of smart sustainable cities. The scale of these ecosystems will promote considerable economic advantages, well-being, quality of life and resource efficiencies.

Denser cities are seed-beds of innovation and productivity improvement that keep attracting people worldwide.

According to the UN, by 2050 68% of the world population will live in cities as currently about 1.3 million people move to cities every week

Automation and digitalization of the urban ecosystems will continue to increase, being expected that by 2025 the number of IoT devices in smart cities might overcome 75 billion.

These IoT devices range from smart domestic appliances, smart air conditioning or smart thermostats up to sensors to monitor the traffic, the street illuminance or the air quality.

Nowadays, urban mobility accounts for 40% of all CO2 emissions of road transportation and it is estimated that urban GHG emissions will grow by 63% between 2013 and 2050. With COP commitments to decarbonize transports and the economy, low and zero emission mobility systems are gaining momentum. Vehicles are becoming more and more electric and soon will be progressively autonomous and shared. According to the International Energy Agency (IEA) the number of Electric Vehicles (EV) will balloon to about 125 million by 2030, spurred by the decarbonization policies and citizen's awareness about climate changes.

Cities represent about 67% of world's primary energy demand, which will increase by 70% between 2013 and 2050. Meanwhile, cities are evolving from consumers to net generators of energy and advanced smart grid solutions and building automation are improving energy efficiency. Distributed renewable energy systems and energy storage capabilities implemented in multiple urban infrastructures are contributing decisively to net zero or plus energy neighbourhoods, being them connected or disconnected from the conventional energy grid. This technological revolution will boost resilience and energy efficiency and reduce emissions.

These trends will lead to the proliferation of smart devices that connect seamlessly and transmit data regularly. Therefore, there is a demand for digital higher capacity communication networks with better coverage, lower latency and lower power consumption. That is the mote for the future 5G networks.

Together, these and other technologies are enabling the cities to embark on a journey to become digitally smarter, more innovative and sustainable. Efacec has a long experience in the automation of several subsystems and has been developing innovative technological solutions to make cities smarter, more sustainable and more user-friendly.

Concept Definition

The increasing confluence of persons into urban areas, the changing climate and the aging of the population are pressing the quality of life and the well-being of the cities' inhabitants. All this is pushing for the use of new technologies to create cooperative integrated systems that manage resources more efficiently while considering citizens needs and expectations – this whole ecosystem contributes to the herein named Smart Sustainable Cities.

There are many different, however similar, definitions for a Smart Sustainable City. Efacec vision is aligned with the ITU-T Focus Group for whom: "A Smart Sustainable City is an innovative city that uses information, communication technologies and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects".

The implementation of this vision implies addressing challenges as:

- Listening the communities of the cities;
- Installing sensors in quantity and quality throughout the diversified city infrastructure;
- Building an end-to--end Information and Communications Technology (ICT) network able to collect, process and correlate massive amounts of data;
- Imbedding such ICT within the city government systems and processes;
- Making available to citizens real--time information and guidance advice, as well as adequate indicators about city services and the working environment;
- Developing and implementing perceived practices that bring the people and ICT together to foster innovation and enhance community knowledge and its quality of life;
- Acting every day in a symbiotic and enlarged cooperative way to improve the overall ecosystem efficiency and assuring sustainability in the long run.

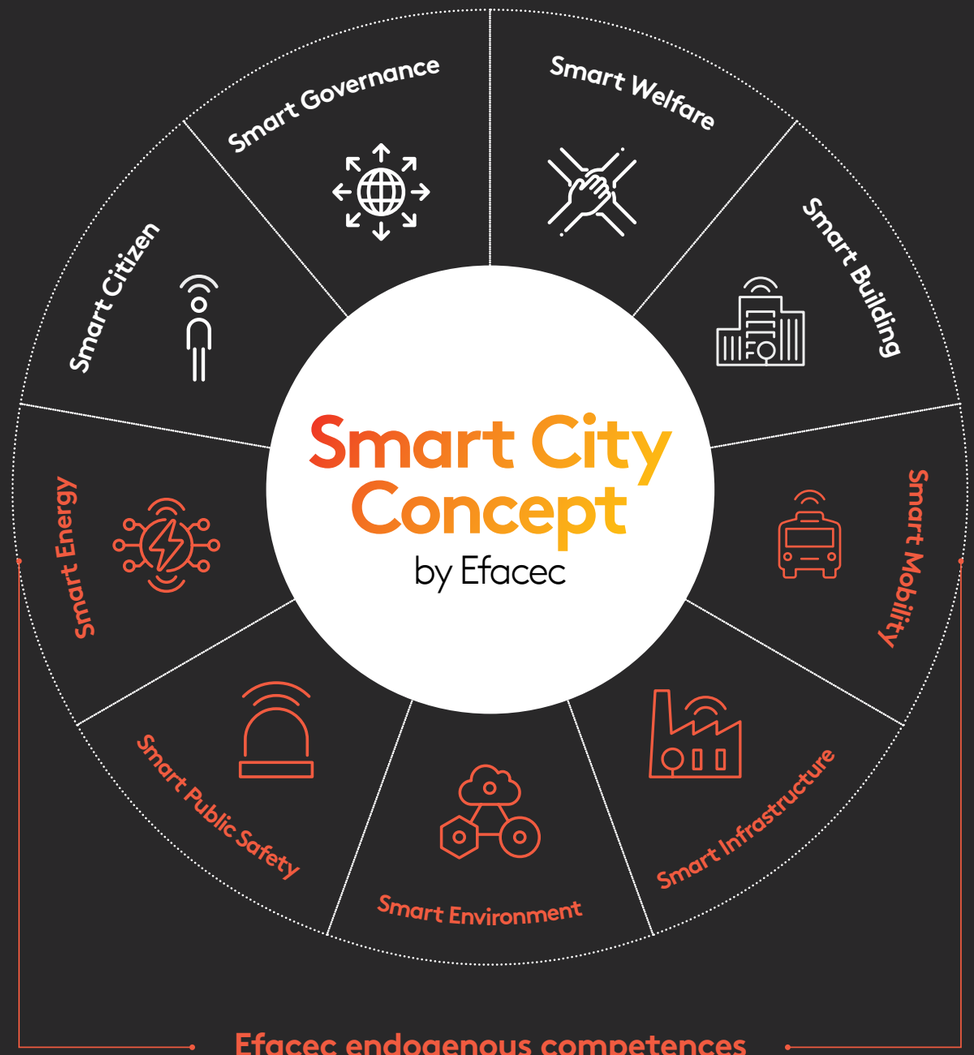
Smart sustainable cities make life easier, accommodate needs and increase the well-being and welfare of its citizens though the enabling power of new technologies based on connectivity, communicability and massive data processing. Moreover, smart cities are "living" ecosystems that evolve continuously driven by local specificities and using a holistic and systematic approach and are characterised by the integration of digital technology into a strategic approach to sustainability, citizen well-being, and economic development.

Efacec Positioning and Focus Areas

The development of smart sustainable cities is the answer to the macro trends above referred, namely the growing urban population, the traffic congestion and the increasing limitations on primary needs such as water, energy, and land occupation and use.

In its conceptual model, Efacec understands a smart city as comprising focus areas of competences and solutions for smart: Governance, Welfare, Buildings, Mobility, Infrastructure, Environment, Public Safety, Energy and Citizens.

This smart city concept summarizes those focus areas and identifies the areas where Efacec has been creating distinctive solutions, leveraged by the endogenous skills of its people: Energy, Environment, Mobility and Digital Connectivity. These areas are the main vertical subsystems of a smart city where Efacec can add more value. Efacec offer in its focus areas is quite holistic and comprises an inter-operable solution combined in a common platform.



These distinctive solutions comprise electric vehicle chargers (for cars and buses), water and sewage treatment stations, solar stations, energy storage systems, full automation of light rail networks or intelligent platforms for electrical grids. All these solutions are Efacec native and are being customized to the evolving needs and expectations of the smart cities and citizens.

Although focused in their main areas of competences, Efacec will keep mindful about the evolving needs of the smart cities with the aim of being a privileged partner of any city and/or any city stakeholder who targets to lead the transformation of its city or neighbourhood.

We understand smart cities technologies as enablers regardless of the business model for the operation, whether under the direct management of the municipality itself, under a Public-Private Partnership or under a temporary concession to third parties.

Holistic architecture by Efacec

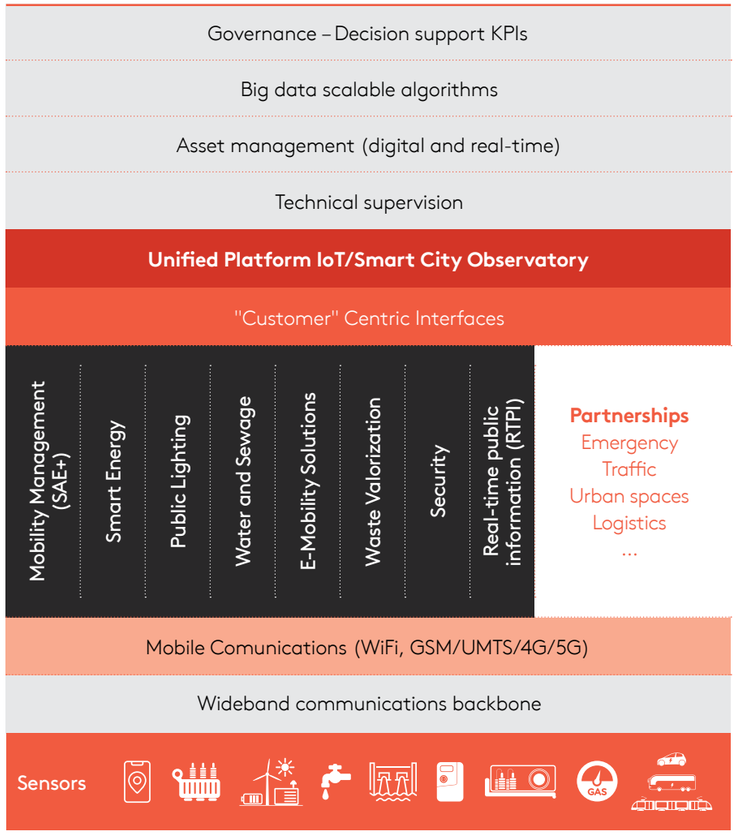
According to Efacec's perspective, all infrastructures and physical assets of a city should be supervised and operated by a control centre. The enablers are the comprehensive deployment of sensors, a cybersecure communication network and the IoT platform that will feed in the system with the needed data.

Being agnostic in terms of the communication technology allows us to be quite flexible in the ways to reach sensors and vehiculate all information to the adequate sub-system, at the required latency and with quality and accuracy (architecture depicted below).

Each infrastructure has its own specificities and therefore the architecture is structured in different vertical subsystems which are interoperable although also having the appropriate autonomy for an optimal operation.

The Smart City solution is however working symbiotically, as an integrated ecosystem, interchanging relevant data for a global city management using a platform who presents detailed views over the subsystems, an integration of other stakeholders and partner's systems and a decision support dashboard which is based on Big Data and Artificial Intelligence.

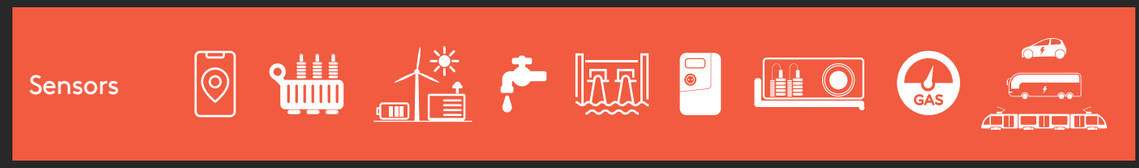
This integrated platform is developed around the needs of the city's citizens and their quality of life standards. The whole solution evolves and adapts to the city as a scalable complex system which must focus on the evolving needs of each community over time.



→ Efacec´s vision on general model of implementation and functioning of a smart city.

Enablers

IoT and sensors



Smart sustainable cities depend on real time data collected from its infrastructures and inputs from its citizens for further processing and correlation to promptly act and better plan future services offer.

The use of IoT and sensors in smart cities is powerful and has the potential to be one of the most significant catalysts for change in decades. But, to be innovative, more competitive and sustainable, the cities of tomorrow need to roll-out a set of complementary subsystems, namely a digital infrastructure connecting distributed sensors to a data centre, distributed renewable energy systems, smart buildings, smart grids, diversified smart mobility solutions, as well as government digital services. This digitally enabled smart infrastructure will upload data to the operational centre to be analysed and correlated, driving efficiencies in public services through optimization of operations and equipment, changing operational patterns based on demand, and managing and maintaining systems remotely.

Cybersecurity

At the core of any smart sustainable city there is a fully digital communications network that supports data and information exchange.

Therefore, an end-to-end digital security solution must be put in place to assure a holistic secure approach – cybersecurity is a key issue. That is a big challenge as cities will have billions of connected devices through digital communication networks.

Moreover, personal data is also being uploaded into the data centre or to the cloud, and it is often shared with digital devices, which, in turn, might share the information among multiple users. Consequently, it is vital to safeguard that kind of information from unappropriated use.

Each smart city digital ecosystem must implement a complete set of cybersecurity measures to safeguard personal and proprietary information of citizens, companies, government entities, as well as of the enlarged digital infrastructure that is a critical part of the ecosystem.

Holistic Platform

By connecting equipment and infrastructures to data analytic platforms, smart cities will unlock new insights, driving greater efficiency and creating new solutions tailored to user needs.

The command centre platform supports city council operations to break down the traditional information silos existing between water, energy, waste, and mobility systems. This new enlarged way of exploiting data information is the base to foster collaboration across different departments, results in cost savings and generates insights and synergies for new future services.

Smart Streams

The smart city concept unfolds through a multi-layered approach with several focus stream areas. These smart streams target specific needs of specific infrastructures or systems and create the suitable context for an optimization of the sectorial operation, while being able to create synergies between verticals for cross-fertilization.

In practice, data streams coming from every subsystem are the essence that feeds the smart city responsiveness to address present challenges and needs of every community and supports the development of future user centric advanced services.

The mains smart streams are described as follows:

Mobility

Mobility in urban areas is becoming a growing challenge, due to congestion and service quality degradation that citizens experience every day as well as due to its negative strong effects over air quality and emissions.

The existence of modern public transport systems and its use by habitants are only a first step to improve urban mobility and minimize environmental impact.

It is necessary to have a much more enlarged digitally accessible mobility offer.

Technological initiatives to improve urban mobility and transports systems are the most common in smart sustainable cities. Better transport infrastructures and services have a major impact on social inclusion, economic development, quality of life of local communities, air quality, and emissions reduction.

To improve mobility, smart cities are investing in different technological solutions including intelligent traffic and parking management, mobility applications, sensing transportation networks, electric vehicles charging infrastructures, soft-mode solutions, and reducing the impact of traffic on air quality. However, decarbonization of urban areas will also be very much correlated with electrification of the transportation sector.

Smart sustainable cities are developing a digitally supported enlarged mobility ecosystem, that embraces public and private actors as well as local communities to explore new complementarities in transport modes and realize the full potential of the ecosystem. User centric public mobility systems must be complemented with parking solutions at the entrance of urban areas, effective easy-to-use soft mode systems, and that needs to be combined with a powerful user-centric engagement strategy to foster the use of digital mobile applications to explore all mobility offer, namely to reserve A-to-B mobility services, to found parking and EV charging stations, to book specific trips or to explore the full potential of mobility-as-a-service.

This requires strong cooperation between public authorities and private transport players, ICT infrastructures, public safety, local communities, and government offices taking care of customer service. Efacec has more than 2 decades of experience in developing technology for mobility automation and has a broad technological offer in turn-key integrated solutions for efficient public transport systems, namely light railway trams, metros and railway systems.

Smart Energy

Electrical grid is a core part of the city ecosystem. The access to quality, sustainable and efficient electricity supply is an essential component of citizens' quality of life.

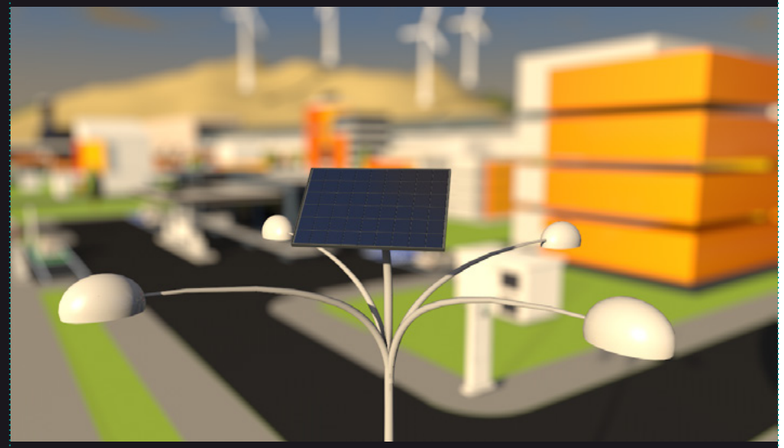
Furthermore, it is integrated in an overall system, many times at a national scale.

The energy sector is facing a significant change in its operation paradigm. The underway shift in this sector is originating innovative business processes with strong impact on the market organization. The municipalities and utilities face the need to manage the network infrastructures in a more automated way and in real time, improving the correspondent technological resources utilization.

A higher automation and remote management capacity are needed for all the network components as well as a more dynamic and adaptive management system. Information Systems need improved adaptation capacity to face the future needs resulting from the new business processes.

The deployment of solutions for smart grids, ranging from smart metering and data concentrators, distributed generation, self-healing grids with increased levels of automation and data intelligence, are key to increase observability and controllability of the system. Also, community storage systems are also considered as a game changer to increase flexibility and fully enable a sustainable energy transition.

Real-time supervision and control using advanced SCADA/DMS solutions blended with platforms that support decision making with a confluence of difference sources of information will help the optimal management of the electricity distribution grid. These are well established solutions that Efacec has been supplying to its customers for decades and which have been specifically customized for smart city contexts, allowing for multiple stakeholders to be part of the system.



Public Lighting

Platforms to manage the Public Lighting system within the city are now available for the municipalities to use.

The configuration options are endless when segmenting the city in different areas, aggregating various circuits, creating user profiles with easily applicable pre-settings and looking at the calendar and setting the behaviour according to the lighting conditions in an automatic way.

This serves only as an example of the potential functionalities this platform allows. Given the permanent observability of the system and the intelligent processing and correlation of events and alarms received from the public lighting infrastructure, it is also possible to automatically detect if some of the luminaries may be not operational and its location. When conjugated with advanced luminaries already incorporating sensors and LED lights, the level of functionalities extends even further.

Controllable lights enable an active participation on Demand Response schemes which means that the municipality can use the flexibility of this infrastructure and capitalize that for extra revenues without compromising the comfort of safety of the citizens. This can be done by using management and control systems of Public Lighting systems which have been part of the Smart Grids solution portfolio since the beginning, with controllers to be commissioned at the secondary substations and a flexible and customizable platform for observability, configuration and management.

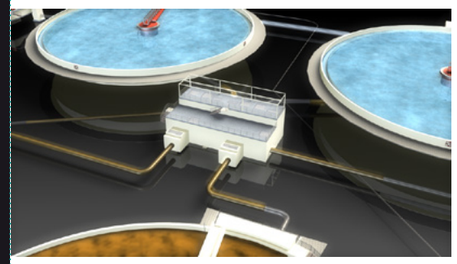
Water and sewage

Clean and safe drinking water and effective wastewater treatment are basic elements for a high quality of life everywhere and cities are not an exception.

Drinking water is typically supplied by taking water for treatment from a river. Then the water is used, and it is collected again as wastewater or sewage for treatment before being returned to the river. The water cycle is reinitiated when the evaporation of the water produces clouds from which the water falls again as rain.

In cities, the growing urbanization and concentration of persons difficult the water cycle and can promote water shortages. So, it is anticipated that new technologies to produce clean water will be needed.

The water systems of the smart cities will be made up of technologies to promote a more effective use of the water resources while maximizing the number of pathways for water circulation. This also includes monitoring devices to detect leaks as well as changes in water pressure to determine whether water infrastructure is working properly. Efacec has been deploying water and sewage stations for cities worldwide over decades.



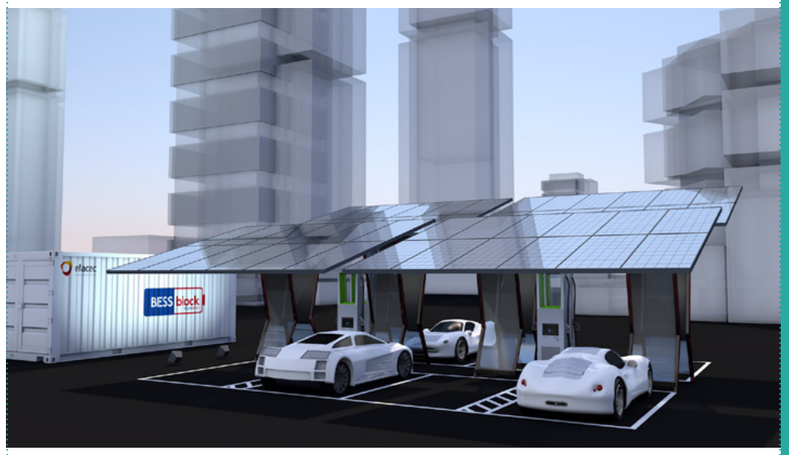
Electrical Vehicles management

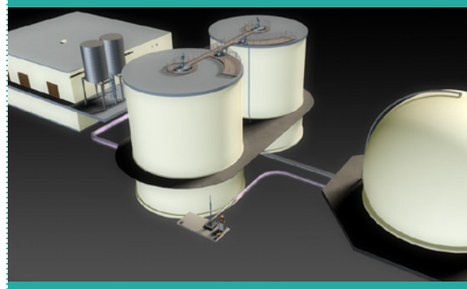
EV integration in the city's mobility ecosystem is essential to meet the sustainability goals of the city and make it cleaner, safer, quitter and inclusive.

The decarbonization of transport is linking mobility with the electricity infrastructure and this means a careful and adequate management needs to be ensured when planning and operating the whole system.

When planning the deployment of the infrastructure for electric vehicles, the municipality needs to consider the multiple stakeholders that will be part of this vertical. From local operators to retailers with special tariff systems, including those who service the infrastructure and, of course, the final user. This means charging stations need to be flexible in what regards the way to interact, the payment options and the multiple standards different car makers are using (Europe and US vs Japan vs China).

Within its portfolio, Efacec has been developing a comprehensive set of solutions for public and private charging, with different rates available from 3kW up to fast charging of 50kW, wireless and even ultra-fast charging solutions of 175 kW and 350kW. Also, the brains for the implementation of smart charging strategies are available with a mobility management platform to assure there are no constraints from the infrastructure perspective so that the citizen can use it and contribute for the use of clean electric vehicles.





Waste

In smart cities, the waste is no longer seen as merely garbage but as a valuable resource.

Some examples are being reported worldwide about optimized collections of waste with direct impacts in the environment and in the society. Besides that, waste-to-energy and waste-to-gas are set to increase as they represent the most evident paths of valorisation of the daily waste produced in a city.

The decentralized generation of electrical energy or heat from the waste and the generation of natural gas to be injected in the existent gas grid are examples of valorisation that are becoming more efficient and are set to increase. Similarly, to the wastewater, the number of pathways for the recirculation of the waste generated in a city (and its surroundings) will tendentially increase. As these solutions increase the management of the gas and electrical grids become more similar and interconnected.

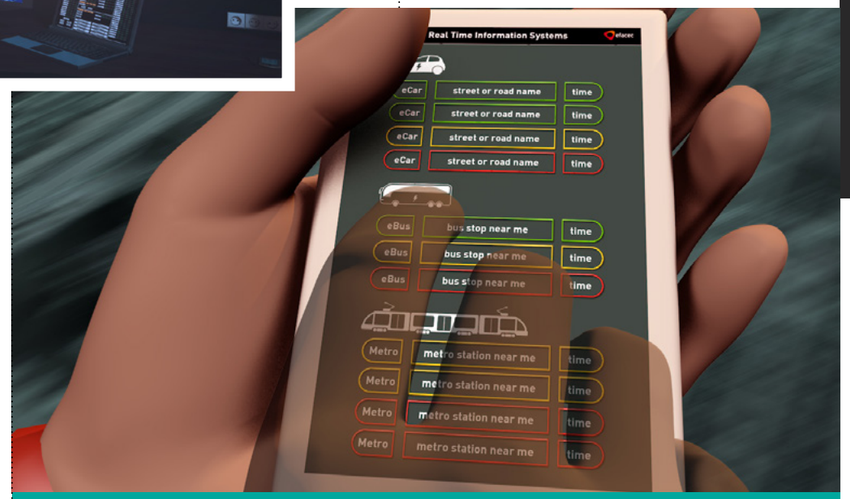
Efacec has been deploying solutions of waste-to-energy and waste-to-gas in several geographies in the most demanding contexts and markets.

Security

Security and safety are becoming more and more critical components for the well-being of citizens living in urban areas.

The intelligent integration of video cameras with appropriated sensors complemented by video-analytic platforms are powerful tools to turn vast amount of video data into valuable information and knowledge about security of people and valuable assets. In complement infrastructure automation and data analytic platforms must also contribute actively to make urban areas and utility systems and services more resilient and safer for the users.

Efacec has more than 2 decades of experience in implementing customized security solutions and developing critical fail-safe technologies and systems for urban mobility, transportation systems and utilities.



Public Information

Operational efficiency and proactive decisions in smart sustainable cities result from timely information in its broadest sense, from real-time data coming from all smart infrastructures and inputs from citizens. Those inputs must be correlated by digital automated analytic tools to generate and share in context useful information to each community and specific service customers.

This digital "nervous" system is a key-driver for urban mobility efficiency and passenger adherence and satisfaction. In that context, urban mobility ecosystems need to develop geographic wide customized real time public information (RTPI) platforms that aggregate, correlate and share up-to-date information about all mobility options available for a certain trip, as well as eventual constraints the system may experience.

The RTPI platform must provide user access over multiple and diversified type of devices, namely at stations, via web, via mobile devices and through on demand SMS systems.

Efacec has been providing customized public information systems for more than 2 decades and has up-to-dated solutions for present and future urban mobility services.

Technological Initiatives

The Energy and infrastructure capacity availability is a key enabler on a smart city setting. The decarbonization of transport is being driven by climate change concerns, unfolded in reduction of emissions and pollution, a more efficient use of energy and a higher independence and endogenization of local resources.

In 2017 over 2 million EV were driving worldwide. By 2020 over 103 new EV models will be available on the market from all major car producers. Prices continue to drop while range increases.

Bloomberg New Energy Finance predicts that before 2040 sales of EV will overtake those of combustion engine vehicles. By 2030, 200 million of electric vehicles will be driven worldwide.

The electrification of public and private transportation creates a direct coupling between the electrical distribution grid and the EV charging infrastructure. Efacec is playing an active role on this transition by developing sustainable mobility solutions coupled with local electricity renewable production turning explicit the conjugation of the Energy and EV infrastructure verticals.

Taking into consideration the latest technological trends in digitalization and the interaction between the triangle user–EV-infrastructure, Efacec created a solution based on the concept of "Digitally Enabled Energy Hub". This system integrates symbiotically electric mobility users' needs (regarding parking layout, services available), EV chargers with various charging rates (for multiple tariff systems, agnostic and secure payment processes, ICT platform for interaction with the charger), renewable local production (solar and wind) and storage systems for an optimal integration and response to charging requirements. This means a truly sustainable concept is achieved, minimizing and even deferring the investments otherwise required to increase connection capacity on the electricity grid.

The solution can be customized considering each municipality's context, with architecturally integrated design and adapting to multiple possible business models for its operation. It basically presents an ecosystem where each user can charge their EV, having the possibility to chose from different charging rates (there are different fast charging station capacities from 50kW up to 350kW), where local energy production from renewable photovoltaics is used to power the electric charging needs making this a sustainable solution.

Furthermore, being complemented by a storage system which acts as a buffer to power higher charging demands while minimizing the needs to withdraw energy from the electric grid. Most of the times, this translates in deferring the investment required to upgrade the capacity at the connection point to the electrical infrastructure. The solution is bounded together by an Energy Management Platform that optimizes the performance of all assets as well as the charging profile of the EV. This is done so that the customer gets its vehicle charged with renewable energy and also efficiently integrated with the grid.

The overall system optimization is done by the algorithms running on this platform which is either running locally or cloud based.

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Credits:

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