GrowSmarter
Transforming cities for a smart, sustainable Europe

DELIVERABLE 7.3c: FOLLOWER CITY REPLICATION PLAN
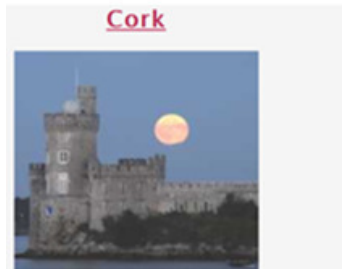
CITY OF PORTO

WP 7 – REPLICATION

Graz

Porto

Suceava

Cork

Valetta

Follower Cities of GrowSmarter

Prepared by: Paulo Calçada, City of Porto

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Email: paulo.calcada@portodigital.pt

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1 Objective

The GrowSmarter Follower Cities (FCs) are committed to preparing for the replication within their territories of the Smart Solutions demonstrated by the Lighthouse Cities (LCs). In order to ensure appropriate and effective transfer of knowledge, experiences and Smart Solutions, the FCs have developed a baseline assessment for replication and an implementation plan of selected measures in the medium and long term, reflected in this document.

The objectives of this Replication Assessment and Implementation Plan include:

- Identify and assess the full potential of replication and up-scaling of Smart Solutions on a city level and for specific districts
- Provide a matrix for FCs to develop their smart city projects through in-depth understanding of concept, approaches, applications, opportunities, challenges, needs, success factors of smart city applications in LCs
- Support related and necessary local smart-city stakeholder engagement
- Support the political and technical capacity development process through mapping the framework conditions for deploying Smart Solutions and identifying opportunities and needs for a knowledge transfer
- Identify and select key actions needed to implement and replicate the GS smart solutions on a city/district level.
- Define a replication plan for the selected GS smart solutions in accordance to city priorities and to address city sustainability challenges.

2 Engagement of parties for Assessment and Replication

The Assessment Report and Replication Plan has been prepared by all GS FC. The cities of Cork, Graz and Porto are supported through all activities by ICLEI while Suceava and Valetta are supported by ICLEI and REC.

The different stakeholders that are supporting the assessment and future implementation of smart solutions in the city of Porto include:

Lead author (Follower City of Porto): Paulo Calçada, Head of Innovation Unit (paulo.calcada@portodigital.pt)

Support: Margarida Campolargo, Innovation Unit

Members of Follower City Porto Liaison Group

- Fernando Rui Russell Cortez Barbosa Pinto, DMSI
- João Sendim, DMVP
- João Neves, DivDMVP

3 Timeline and replication roadmap

The Smart City Replication Assessment and Plan can be understood as a living document that which is continuously (and at least annually) updated and refined as needed to reflect the latest developments of the potential and framework conditions for the replication of Smart Solutions. Two public reports are foreseen; the first for month 6, the second for month 30. Subsequently, the Replication Assessment will lead to the development of a Replication Plan in month 48.

The Replication Assessment and Implementation Plan is part of the overall replication roadmap of the Follower Cities (FCs) of GrowSmarter and can be characterized by the following milestones:

Milestone 0	• FC made initial selection of LCs' Smart Solutions for
Milestone 1	• Establish a multi-stakeholder Smart City Liaison Group
Milestone 2	• 1st Replication Assessment for deployment of Smart
Milestone 3	• Establishment of capacity development programme and stakeholder process in FC
Milestone 4	• 2nd Replication Assessment for deployment of Smart
Milestone 5	• Development of Replication Plan in FCs
Milestone 6	• Up-scaling and replicability Report

4 Structure of the Replication Assessment and Implementation Plan

The Smart City Replication Assessment and Implementation Plan consists of the following main sections:

Smart City Replication Profile

- Mapping the overall framework conditions and potentials for replication within the city territory

Smart Solutions Selection

- Description of replication potential of selected Smart Solutions of LCs within FC

Smart District Replication Profile

- Per potential replication site/district: Mapping of district related framework conditions relevant for the replication of the selected solutions

Smart Measure Specifications

- Assessment and adaptation of measures towards the most effective deployment and integration at site/district level

Replication Plan for Smart Measures

- Definition of activities and actions required for the replication and future implementation of the specific smart solutions on a city and district level.

5 Replication Assessment of the Follower City Porto

5.1 Smart City Replication Profile

5.1.1 Mapping the overall framework conditions for replication within the city territory

5.1.1.1 Q1 What is the overall replication potential for Smart Solutions until 2020 and beyond?

The city of Porto is the second-largest city in Portugal and one of the major urban areas in Southern Europe. Porto has more than 250,000 inhabitants and it's the centre of a large metropolitan area with more than 1.8 million inhabitants.

In February 2010, the Porto Digital association founders, led by the City Council, launched a new strategic plan, which aimed to foster the development of Porto as a knowledge based city and in which the innovation area has a paramount importance. As the name of the strategy hints, such strategy leverages the investments done by the Municipality since 2005 on a large scale fibre optic backbone and in an advance ICT platform.

Porto has also designed and embraced a policy strategy aiming at implementing measures for the implementation of Smart City principles. Citizen's centred sustainability, energy efficiency, R&D and economic growth are the main areas of interest of the City who started different programmes and projects in those areas. The implementation of this innovative strategy adopted an interdisciplinary approach in which the city well-known strengths are aligned with the excellence of the work developed by the Academia. With the support of reference industry partners, the strategy developed was able to contribute to the creation of hundreds of qualified jobs and to transform the city centre into a place where people, especially young entrepreneurs, are inspired by a new risk culture and integrated in a new multicultural and international ecosystem. As a clear result of this strategy the city is now attracting more people for the city centre, creating new jobs, developing solutions required by citizens, reducing social exclusion, and increasing the city security.

As an example of the impact of the aforementioned strategies, the University of Porto was awarded a grant of 1.6M€ from the FP7 Capacities program, justified by the development of the Porto Living Lab and the expansion of the Centre of

Competence in Future Cities of the University of Porto. Also as another example of this strategy 'impact, UPTEC, the Science and Technology Park of University of Porto, won the RegioStar 2013 award in Smart Growth.

Another example is the Porto´s Sustainable Energy Action Plan (SEAP-P), which was created to respond to the commitments assumed under the Covenant of Mayors. The Municipality together with AdEPorto (Agência de Energia do Porto – Energy Agency of Porto) had previously foreseen an Action Plan following the energy diagnosis and CO_2 emissions inventory, the Energy Matrix, published in 2007 with data referred to 2004. The Porto Smart City strategy is fully aligned with the sustainable Energy action plan developed, and the actions in progress reflect this alignment of strategies. The rehabilitation of the different areas of the city take into consideration the energy efficiency of buildings, the reduction of CO_2 emissions and the behavioural transformation of citizens by involving them in the decision making process.

Within the strategy of the city, several initiatives have been undertaken with a special focus on the implementation of the projects in accordance to the Porto´s sustainable strategy. With the support of the designed strategies (essentially based in Porto's Sustainability Strategy of 2009), Porto has been implementing the several projects aiming at addressing sustainability and energy efficiency issues.

As presented in the figures bellow Porto's SEAP defines ambitious goals for greenhouse gas reduction in several areas, but foremost to highlight that the new smart City Strategy expands these targets to new areas. For instance, the public lighting infrastructure is already being replaced by LED technology and at the end of 2015 at least 10% of the total infrastructure was already replaced.
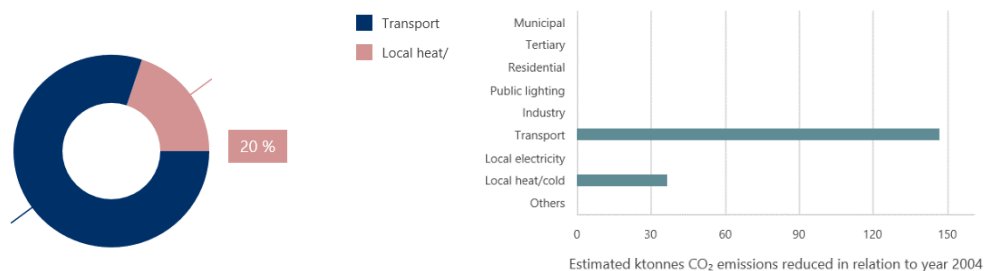
SEAP – Estimated greenhouse gas emissions reduction in 2020.

Other actions include the promotion of urban rehabilitation of the historic centre of Porto, World heritage, and contributing to the development and social and business

dynamics of this area of the city. Other priorities include reducing motorized individual transport by encouraging the use of mass transit, favouring unequivocally intermodality and creating infrastructure for less polluting forms of transportation, such as bicycles and more footpaths. Affirmation of the city of Porto as an "Educator", which values education and correct training of all its citizens as a necessary condition for citizenship. Development of attractive conditions for the reception of advanced services and intensive economic activities, based on the relation to research and development institutions. To boost Porto as a City of Innovation and Science through cooperation platforms between economic agents, business, and research and development entities. Promoting Porto as a sustainable city, in its relationship with the territory in historical aspect, its sustained centrality function, and "brand in the region". The measures directly related to the reduction of CO_2 emissions and energy efficient materialize in various interventions such as placing solar panels in social buildings, building refurbishment, creation for the Observatory of Energy and Environmental Sustainability of Buildings, and moving the fleet of STCP buses to natural gas.

The structuring of these measures took into account a set of methodological steps guided by energy efficiency criteria and assessed by their potential contribution to the reduction of CO_2 emissions, namely:

- Characterization of Porto´s quantitative and qualitative (electricity, heat, etc.) specific energy needs, in line with the Energy Matrix (2007);

- Integration of energy issues within an urban sustainability framework, as defined in the " Porto's Sustainability Strategy" (2009);

- Identification of the Porto energy carriers (final energy), needed for buildings and their activities; mobility and transport; and general productive activities (industry, commerce, etc.);

- Definition of the final energy options according to useful energy[1]: heat for cooking, domestic hot water and environmental comfort; electricity and fuel for transport; electricity for artificial lighting, appliances, etc. Example are solutions for domestic hot water, representing about 25% of the consumption for a Portuguese average household, with solar systems using natural gas as back up, or the promotion of district heating and cooling networks on natural gas, the cleanest fossil fuel for the paradigm change;

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[1] The portion of final energy which is actually available after final conversion to the consumer for the respective use. In final conversion, electricity becomes for instance light, mechanical energy or heat. (www.euronuclear.org).

- Assignment of high priority to the demand management and to the access to more efficient technologies. Demand management examples are the improvement gained from higher insulation of either rehabilitated or new buildings, better management of solar gains (e.g. shading) and public transportation promotion as the alternative that overcomes any individual using energy vehicle. Examples of access to more efficient technologies are the exploitation of the potential intelligent natural lighting; the spread of low consumption, public and interior, artificial lighting; the expansion of very efficient electrical appliances; but, also the perspectives for new urban mobility paradigms. Porto, as other cities in the Europe, is facing an intense change in the mobility sector. New and innovative forms of transportation are appearing every day. The most important new paradigms are related to the use of the electrical car, the implementation of a consistent programme for intramodality in collective transportation and new models such as car sharing or mechanisms such as Uber.

Equally a Local Action Plan was developed in the context of the CSI (City Sustainable Investment) programme (integrated in the URBACT initiative), conceived as to explore European Structural Funds to achieve a smarter city. Amongst the objectives of this Plan, it is important to emphasise the creation of a UDF (Urban Development Fund) specialised in sustainable and affordable projects, and the strengthening of technical training and information improvement.

The Local Action Plan comprises three main actions: Support Fund for the Renovation of Buildings of the Historic Centre of Porto; Technical Assistance; and Pilot Project.

In the constitution of the LAG (Local Action Group), a set of criteria was considered, including the need to include:

- different levels of government: national, local and metropolitan;

- different sectors of activity that were chosen from the diagnosis of the city (this diagnosis was made through a multi-stakeholders analysis with an important participation of the research and academic partners of the city) – the best activities to sustain a process of growth in the future (2014-2020). In the composition of the LAG, a set of principles was considered, namely the need to represent the different areas of activity and the main entities related to the management of the Urban Development Funds (UDFs), including those related to the Europe 2020 strategy. Thus, the LAG of Porto, includes 21 entities and about 50 active members.

- representatives of the private sector, public sector and of other forms of organisation;

- entities directly associated with the management of UDFs and the Holding Fund;

- Educational, R&D and training institutions;

- institutions in the Entrepreneurship and SME area;

- active institutions in the social area;

- institutions in the area of mobility.

The strategy for the city of Porto included, so far the use of different funding's to ensure the valorisation of the city ecosystem. As an example it is important to refer the creation in July 2009 of the JESSICA Holding Fund Portugal (JHFP), with a total amount of 130M€, from which Porto clearly benefitted. Its Investment Committee comprises the Managing Authorities of the five Operational Programmes as well as the Operational Programme for Territorial Enhancement (OPTE) and the Directorate General of Treasury and Finance. The tender process that took place between 2010 and 2011 resulted in the creation of three UDFs run by three separate entities (Caixa Geral de Depósitos, Banco Português de Investimento and Turismo de Portugal) in five regions of continental Portugal. In Porto, there are two operational UDFs, one managed by Banco Português de Investimento and the other by Caixa Geral de Depósitos. 54% of the 20 projects identified until today in the city are related to tourism. Tourism has an element with an important impact in the city transformation. Its significant influence in the cities growth and rejuvenation, given its cross-cutting impact on the society, leads to strong effects on the many aspects of the economic, social, cultural and territorial city life.

Tourism can work, if properly planned and efficiently managed, as a catalyst for a dynamic economic growth and social development in cities by re-building infrastructure, creating jobs, stimulating local business, developing partnerships, creating distinctive local attractions, and others. In these cases, innovation is commonly used as a vehicle for developing new products, addressing to existing and new market niches and upgrading the quality of the city services.

In the city, the multiplier effect of JESSICA is of 5 with one Euro of JESSICA investment leveraging five Euros of private investment.

5.1.1.2 Q2 How does the "Smart City" approach feed into/connect with your existing local planning processes?

As described above Porto has been implementing strategies and plans designed to ensure that it becomes a Smart City. The move towards a Smart City is not the result of a single initiative neither a question of an accumulation of initiatives. The main success factor is a change of mentalities at all levels of the Local Public Authorities and the ability to exploit the articulation of local and regional/national initiatives, mutually reinforcing and creating the relevant scale and impact.

The particular attention given by the Local Authorities to innovation favours and reinforces also the adoption of Smart City concepts as it links the advanced thinking of innovation clusters with the administrative practices.

As an example it could be mentioned is the important attached to the connection between the SEAP-P, the urban mobility plans and the territorial development.

Within the context of the Smart City Plan and organizational structure, several synergies have been articulated although some constrains regarding legislation can be identified. The City, as an energy system or a cluster of energy systems, is not isolated. It is interlinked and part of the North Region and of the Country system, aspect that may bring benefits, such as the contribution to the national renewable electricity program (focussed on the decarbonisation of the electricity mix) put in motion in the last decade. Regarding the electricity mix evolution, REN – Redes Energéticas Nacionais (National Energetic Grid Lines) – draws two expectable evolution scenarios of the national electricity production system in the period 2009–2013 and until 2020 : Reference Scenario2, which includes energy efficiency measures of PNAEE – National Energy Efficiency Action Plan; Efficiency Scenario3 – 20%, assuming a total CO_2 emissions reduction by 20% in 2020, compared to the ones verified in 2005 (in line with the European Union objectives Europe 2020). In the contrext of the city, the main goals of such initiatives and plans are to improve the quality of life of the citizens, contributing to the city´s actractiveness for social and economical purposes. The aim is to improve economic growth, attract new investements and implement an energy and sustainability framework integrated with the national and European ones. At the same time such plans call upon the Academia to exploit the benefits of ICT based systems such as smart grids. The implementation of pilots and the development and integration of technologies, possible on top of open services platforms, is a path being explored by the Municipality.

As a conclusion, the example of sustainable energy is here provided to illustrate how the integration of the city dimension in national initiatives provides critical mass and the rigth dimension, making the city more attractive and economicaly viable, creating a push/pull mechanism in which technological innovation is triggered in a context of innovation ecosystems of startups that respond to the needs of the public authorities and the expectations of the citizens.

The Porto Municipality has implemented in June 2015 the new Integrated Management Center in the Town Hall. This center brings under one roof the services responsible for Mobility, Municipal Police, Fire department, Civil and Environmental Protection, and its main objective is to contribute to increased efficiency and effectiveness in areas such as street cleaning and waste collection, security and civil protection and traffic control, among others.

The Integrated Management Center is a key step in the creation of the first National City Operator, the municipality is developing, and where the use of collection tools and advanced data analysis, implemented within a "Smart City" concept, will promote an effective "smart" management of the municipal services.

Cities are generating an increasing amount of information from the traffic light systems that can adapt to the dynamic mobility standards, traffic cameras, which more or less automated identify a wide variety of situations in the public highway , environmental sensors, which are now able to give us information in real time and on a scale never before possible. The information generated by these platforms will require an agile management and multi-service, for only in this way can all this information be translated in efficiency gains with clear and objective improvements in services provided to citizens.

With this new management center, and the creation of the City Operator, the City Council intends to put the city of Porto in a new level of integrated management services following its own strategy of innovation and inspired by the best practices.

In addition to the initiatives presented above, the Municipality decided, in 2001, to implement a Monitoring system of Urban Life Quality (MSCQL). Running since then, this project has been capable to compile data on the living conditions and wellbeing of the city, monitoring the progress path in severel dimensions. This trend monitoring exercise, which includes the environmental, economic and social level (with crucial impact in the quality of life of the citizens), has been accompanied, over time by a performance comparaison of the Porto metroplotitan area with the reality observed at a national level and with the European Benchmarks. Another component of this project is the mesurement and data collection of the citizens

perception about the city quality of life. With these two areas coombined, the city aims at providing a solid support for decision making by deepening the kowledge about the challenges that the city and the citizens face in their dayli lifes. Thus this is a platform provided by the municipality for an easier access to relevant information, to stimulate the debate, to rise collective awareness on several matters and to stimulate collaboration between citizens and local governemnt.

5.1.1.3 Q3 Is there a (strategic) plan and organisational structure in place to become a "Smart City"?

Porto Municipality has been consolidating the local ecosystem for the creation of a multidisciplinary and cross-sectorial strategy for the implementation of the Smart City concepts.

Within this strategy, Porto Digital, a company owned by the Municipality of Porto, has emerged as one of the main organisation/infrastructure capable of supporting this intervention.

The aim of Porto Digital is to contribute decisively to a structural change in the operating mode of the city, to make it ready to improve and address the challenges. Recognizing the difficulty of this task, four key points were conceived as a goal to achieve measurable results:

- Education – make a qualitative leap in terms of infrastructure to support the use of ICTs in education covering all the way from primary school to university and R & D laboratories.

- Employment – to increase the competitiveness of the business fabric of the city of Porto and make it more attractive for investment.

- Bureaucracy – reduce inefficiency and bring citizens closer to the public administration.

- Quality of life – improving urban quality of life for residents, workers and visitors to the city of Porto.

Porto Digital will act at several levels, to ensure that citizens, academia, industry and Public Authorities can cooperate, benefit and be active partners in the process of creating a Smarter City. Porto Digital acts therefore at the level of:

- Infrastructure – to allow a generic access to the digital world (looking at digital as basic services, equivalent to energy, communications, water or sanitation)

- Promotion – enticing real communities to the digital world, looking to its articulation with the real world by producing contents in areas such as scientific, informative, tourist, recreational and cultural

- Accessibility – spreading access points to the Internet and services throughout the city

- e-Government – redesigning administrative processes, exploring the notion of e-citizens and adding transparency to local government

- Sub-sectorial projects – representing an intervention at the level of a sector area (such as employment, economy or culture) aiming at modernizing the economic fabric and increasing competitiveness through business cooperation activities, research and development, investment attraction, increased productivity and increased qualified employment.

5.1.1.4   Q4 Are there synergies and/or conflicts of the "Smart City" plan and organizational structure with existing initiatives and their structures within the city?

There are many synergies between Porto City, Porto Digital and other entities and initiatives in the field. Organizations such as UPTEC, INESC Porto and others create a multi-sector cluster which provides opportunities for collaboration and innovation to achieve economic growth, to address mobility issues and to improve energy efficiency.

5.1.1.5   Q5 Which and how are regional and local stakeholders involved in the Smart City strategy and planning process on a city level?

It becomes clear, from the stated above that the local ecosystem being induced by the City of Porto includes a significant number of partners which are representatives of the local and regional dimensions.

The stakeholders involved in this process include the structure described below.

The governing bodies of the Municipality of Porto are the City Council (the executive office) and the Municipal Assembly (deliberative body). Porto Digital will, as described above, act in different domains to ensure the cooperation between the stakeholders of the city.

As an example of other stakeholders involved from the City side, the urban regeneration plans in the city centre are managed by Porto Vivo, SRU – Sociedade de Reabilitação Urbana da Baixa Portuense, S.A. (Society of Urban Rehabilitation of the Centre of Porto); the Integrated Management Centre will play an important role in

the strategy; and APOR (Agência para a Modernização do Porto – Agency for Porto´s modernization) is a partner which creates synergies for better cooperation between public and private entities and promotes the upgrading and modernization of the urban, industrial and business fabric of the city.

The aim, and very much the reality, is to involve all the relevant stakeholders from the local ecosystem considered important for such developments. Those stakeholders are from the academia side, such as the University of Porto, the Polytechnic of Porto, from the research side, such as INESC Porto, and from the entrepreneurial side, such as UPTEC.

5.1.1.6 Q6 What are past (<5 years) and current projects that are closely related to the "Smart City" concept?

In the last 5 years Porto has been part of several projects that are very relevant in the Smart City domain and in coherence with the Political strategy to transform Porto into a Smart city.

- Enter.Hub – European Network exploiting Territorial Effects of Railway Hubs and *their Urban Benefits*

  The Enter Hub project aims at:

  - o Supporting and promoting a global vision of transport and territorial development, considering mobility, transport networks and in particular the TEN-T as a European backbone in terms of connections and interaction but also in terms of territorial development;

  - o Promoting sustainable, common and easily available transport systems all over Europe, to make cities and regions more accessible, more attractive and more competitive;

  - o Sharing practices and using an exchange and learn approach in order to enrich their common and strategic vision of future Europe at different territorial scales, also in view of the new financial programming period 2014-2020, concerning urban and infrastructures development.

- CIVITAS – ELAN – Mobilising Citizens for vital cities:

  The mayors of the cities of Ljubljana, Gent, Zagreb, Brno and Porto have agreed to a common mission statement "To 'mobilise' our citizens working with them to develop clean mobility solutions for vital cities, ensuring health and access for all."

As a policy-driven project, CIVITAS-ELAN will make significant contributions to major global, EU and national policy processes. In responding to citizens' needs, CIVITAS-ELAN has identified 18 common headline objectives for each CIVITAS policy field:

- o Increasing energy efficiency
- o Using alternative fuels
- o Cleaning up vehicle fleets (electric, hybrid, integrated strategies)
- o Implementing effective, high quality mobility solutions
- o Planning intermodal infrastructure with public participation
- o Charging for access
- o Managing public space and access
- o Improving mobility management
- o Making walking and cycling more attractive
- o Establishing a mobility dialogue with the citizens
- o Developing integrated & target-group specific safety/ security strategies
- o Increasing road safety
- o Improving security in PT
- o Implementing flexible mobility services
- o Rationalising freight distribution
- o Giving priority to clean modes
- o Enhancing traveller information & ticketing
- o Introducing telematics for clean modes.

- Future Cities: Porto Living Lab

The Future Cities Project aims to turn Porto into a smart city, a living lab, by providing it with a wide range of sensors and communication equipment, thus creating the conditions for future research and development using advanced technologies for data collection through mobile platforms, wireless communication and large-scale information processing. This living lab

enables the development of research in areas such as sustainability, mobility, urban planning and information and communication technology.

As in all Living Labs the main methodological approach is based on open and user centered innovation: the pilots and experiments already accomplished (e.g. with taxis, buses) show how important has been for the city to adopt such a methodology as potential future solutions benefit from an early validation and adoption by citizens.

- CSI Europe:

Porto Vivo, SRU participates in the project "CSI Europe: City Sustainable Investment in Europe - asking financial instruments work for cities", which aims at analysing the role of financial instruments in the planning of sustainable urban development. Some concrete results deserve a lot of credit, namely in the context of urban revitalisation.

- Scale up Porto:

The project ScaleUp Porto emerges as an initiative that aims to stimulate the Innovation ecosystem targeting existing high growth and high potential businesses and giving them access to opportunities in the area of financing, skills and customers.

The Municipality of Porto has already carried out several initiatives in the area of entrepreneurship and innovation with the objective of consolidating the city ecosystem of innovation, fostering employment, economic development, internationalisation and the well-being of citizens.

5.1.1.7 Q7 Which sites/districts are projected to be developed in the next five/ten years?

The district areas of intervention for the next 5 to 10 years are mainly identified by the ARU (Areas of urban Rehabilitation) defined by the Porto Municipality. There are 7 ARU created in the Porto City which aim at addressing different issues all around the urban area.

- ARU do Centro Histórico do Porto
  The ARU of the Historical City Centre is the first of seven ARU to be created in accordance to the provisions of RJRU (Regime Jurídico de Reabilitação Urbana – Legal System for Urban Rehabilitation) which provides that municipalities

must, within 5 years from the date of entry in effect of this law, implement a strategy for urban rehabilitation of the SRU areas (Sociedade de reabilitação urbana – Society of urban rehabilitation), converting them into one or more ARU (área de reabilitação urbana – area of urban rehabilitation).

- ARU dos Aliados

  The Aru of Aliados, consists of an urban fabric which suffered a profound transformation since the late nineteenth century. This transformation gave Aliados a prominent role at a city and regional level, as this location is considered the administrative, economic and civic center of the city. The concentration of services and activities on this site, translated into an emptying of their housing function. According to the last population census (2011) there were registered less than thousand and a half residents, which corresponds to a density lower than the average. However, in recent decades, due to the relocation of several activities, especially those related to the financial sector, public and private investments in transport infrastructure and urban regeneration, touristic activities and others, the area of the Aliados has been reversing this trend and is also the aim of the ARU contribute to this recovery.

- ARU do Bonfim

  This ARU is characterized by its morphologically homogenousness, due to the urbanizing process that began in the mid-nineteenth century. Traditionally this area included a wide variety of uses, ranging from the housing through the existence of small industrial units, commercial spaces and services. However, this area has suffered in recent decades a gradual abandonment process for its population, leaving the elderly.

- ARU da Cedofeita

  The ARU Cedofeita is a territory resulting of an urban structure designed in the late eighteenth and early nineteenth century and was gradually filled in during the following centuries. Traditionally it includes a mix area of housing, commerce, services and several higher education institutions.

- ARU de Miragaia

The area included in this ARU is a scenic drive and very characteristic and striking the city. The touristic potential of this area is evident by the presence some of the most emblematic gardens of Porto. There are also many public buildings and collective use equipment located in its ARU, such as the Customs building, the Santo António Hospital, the Library Almeida Garrett and even the Pavilion Rosa Mota. There are some narrow residential fringes and rehabilitation initiatives, thus, it is intended with this ARU give a new framework and encouragement to these initiatives, creating for such, tax benefits of Municipal levels, complementing already provided for in the Statute of Tax Benefits to support urban regeneration.

- ARU da Lapa

  The ARU da Lapa is characterized by a urban fabric formed from the nineteenth century, The urban fabric and its buildings, and the existence in this place of a diversified commercial offer, supported by some services and facilities, are more than enough reasons to make this highly attractive region in housing terms, and evidence of this is the fact that it has the highest population density of the city (102 res. / ha, Census 2011).

- ARU de Santos Pousada

  Along with the residential area, there are still, in this ARU, many old industrial buildings (now emptied of that function and in an advanced state of degradation), urban voids and old workers blocks. It is therefore an area with a discontinuous urban fabric, which fall within built-up areas of considerable size, as those remaining industrial units are now abandoned, and whose recovery and destination are factors to take into account when drawing up a strategy for rehabilitation and revitalization of this part of town.

- ARU de Campanhã

  This ARU covers part of the parishes of Bonfim and Campanhã, comprising an area of approximately 112ha. Despite the problems of physical degradation and socio-economic vulnerability that persist in this urban area of the city there is a set of urban transformation opportunities that, once implemented, may significantly contribute to the revitalization of the eastern part of the city, which is the specific goal of this ARU.

All these areas, due to their particularities aim at addressing different challenges and implementing several solutions that include mobility, energy, refurbishment, ICT and others.

According to the goals of the project, the needs of intervention and the evolution of each programme (ARU), the selected District for intervention is the Campanhã area. This area of intervention will be characterized more in detail bellow.

5.1.1.8 Q8 What are the main areas of interest of the FC in the Smart City concept?

As stated above, the urban strategies for smart city and sustainable development include projects and programmes which, in some cases are already being implemented. In this context it is important to highlight projects such as Porto Living Lab (Future Cities) in which the main areas of intervention are already identified. In this case, the creation and promotion of a local ecosystem, working as a Living Lab plays an essential role in the entire field. The Porto Living Lab is the result of a long term partnership between the Porto Municipality and University of Porto, with strong support of the Industry and relevant partners.

The Porto ecosystem, developed in the last years aims at turning Porto into a Smart City, by:

- Providing it with a wide range of sensors and communication equipment, thus creating the conditions for future research and development using advanced technologies for data collection;
- Implementing solutions for Smart governance and monitoring. Several initiatives are already in place and more are being programmed for administrative simplification and participatory governance;
- Increasing visibility and public awareness for different fields such as sustainability, mobility, urban planning and information and communication technology;
- Promoting energy efficiency through refurbishment, innovative technological solutions and community participation;
- Increasing the usage of alternative energies (solar , biomass , geothermal) in order to reduce the dependency for the classic energy sources (coal, petrol)
- Supporting companies at different stages, from start-ups to scale-ups and stimulating public and private investments;

- Implementing integrated solutions for mobility, through the creation of integrated infrastructure and mobility and urban planning. Implementing the electro mobility and sustainable urban transportation and traffic.
- Separating waste collection and recycling implementing measures for citizen behaviour transformation
- Innovative PPP financing schemes for Smart City Projects.

5.2   Smart Solutions Selection

The table below shows which solutions the Follower Cities plan to replicate.

		Follower Cities				
Area	Smart Solutions	Porto	Graz	Cork	Valetta	Suceava
Housing measures	1. Efficient and smart climate shell refurbishment		X	X		X
	2. Smart building logistics and alternative fueled vehicles					
	3. Smart, energy saving tenants through information	**X**	X			X
	4. Smart local electricity production and integration with buildings and grid			X		X
Integrated measures	5. Smart lightning, lampposts as hubs for communication	**X**	X	X		X
	6. Waste heat and local heat integration by new business models		X			
	7. Smart waste collecting, turning waste to electricity, heat and biogas for vehicles.	**X**				X
	8. Big data protocol for saving energy and improving the quality of life	**X**				

Mobility measures	9. Sustainable delivery				X	
	10. Smart traffic management					X
	11. Alternative fuel driven vehicles for decarbonizing and better air quality	X		X		X
	12. Smart mobility solutions		X	X	X	X

The solutions selected for Porto include:

Smart Solution 3. Smart, energy saving tenants

Almost 18% of the Porto's population leaves in social neighbourhoods, which makes it a top priority in the Municipality strategies. In order to increase the quality of life and the sustainability in social neighbourhoods, the City of Porto has invested more than 160M€ in the refurbishment of buildings in the last 10 years. The City Council will replicate, within its social neighbourhoods' infrastructure, a number of the measures identified in the Lighthouse cities. Namely, in the smart and energy savings, the city council is expecting to use the developed solutions to help more than 12000 tenants in the city' social neighbourhoods to reduce their energy consumption.

Smart Solution 5. Smart lightning, lampposts as hubs for communication

The city council is building an infrastructure using the public furniture such as traffic lights and lamppost, to install low energy communication equipment and a distributed sensing infrastructure. This infrastructure is developed using a "Zero site" concept in which all the spots could be shared by several companies and partners, such as Telcos or R&D institutions. In partnership with the University of Porto the city council has installed already 6 sites. The city council expects to use the project results to increase the number of sites with this concept to more than 60 new sites.

Smart Solution 7. Smart waste collecting, turning waste to electricity, heat and biogas for vehicles

Porto already produces 40GWh of energy by burning the non-recycled garbage, which represents two times the energy used in the lighting infrastructure. The City Council plans to use the solutions developed among the measures within this smart solution in the GrowSmarter to increase these results by developing new garbage management infrastructure.

Smart Solution 8. Big data protocol for saving energy and improving the quality of life

The Porto Living Lab is the result of a long term partnership between the Porto Municipality and University of Porto, with strong support of the Industry. Porto Living Lab aims to turn Porto into a smart city, a living lab, by providing it with a wide range of sensors and communication equipment, thus creating the conditions for future research and development using advanced technologies for data collection through mobile platforms, wireless communication and large-scale information processing. In this context the City Council plans to replicate the Big Data protocol developed in GrowSmarter as a reference protocol for the Porto Living Lab infrastructure.

Smart Solution 11. Alternative fuel driven cars for better air quality in cities

In the follow up of the ambitious target defined to reduce the CO_2 emissions the city council is defining a new mobility plan in each it will promote low CO_2 emission fuels, such as bio-gas. The city council will replicate the validated solutions developed in GrowSmarter in this context.

5.2.1 Smart Measures Selection

The table below specifies which smart (bundle of) measures within the 12 solutions each FC plans to replicate.

SC Measure	Measure title	Follower City Porto

Low Energy Districts

Solution 1 – Efficient and smart climate shell refurbishment

1.1 – Energy efficient refurbishment of the building	Energy efficient refurbishment of residential buildings – Stockholm	x
	Climate shell refurbishment – Cologne	
	Energy quality assurance – Stockholm	
	New adaptative control and regulation techniques for heating systems – Barcelona	
	Re-build an industrial site: Ca l'Alier – Barcelona	
	Efficient and smart climate shell and equipment refurbishment – Barcelona	
	Efficient and smart climate shell refurbishment of residential buildings – Barcelona	
	Efficient and smart climate shell and equipment refurbishment of tertiary buildings – Barcelona	
	Energy efficient swimming pools – Barcelona	

Solution 2 – Smart building logistics and alternative fuelled vehicles

| 2.1 Integrated multimodal transport for construction materials | Construction consolidation centre – Stockholm | |

Solution 3 – Smart, energy saving tenants
tbd

3.1 Active House/Home energy management system/Smart home system	Home Energy Management – Cologne	
	The Active House – Stockholm	
	An Open Home Net – Stockholm	

	Hubgrade – Energy Saving Centre – Stockholm	
	Adaptive Temperature Control System – Stockholm	
	Home Energy Management System (HEMS) – Barcelona	
	Virtual Energy Advisor – Barcelona	
	Dynamic Pricing Models – Barcelona (Stochastic Model of Appliances Energy Consumption)	

Solution 4 – Local renewable energy production and integration		
4.1 Virtual power plant	Residential Estate Management – Cologne	
4.2 Smart energy and self-sufficient block	Smart Energy & Self-Sufficient Block – Barcelona	
	Building Energy Management System (BEMS) to minimise consumption of fossil fuels and electricity – Barcelona	

Integrated infrastructures

Solution 5 – Smart lighting, lamposts and traffic posts as hubs for comm. tbd		
5.1 Smart streetlighting	Smart LED streetlighting – Stockholm	
5.2 Combined electrical charging and street lighting poles + wifi	Combined electrical charging and street lighting poles + Wifi-to-grid connection – Barcelona	x
	Combined electrical charging and street lighting poles + Wifi-to-grid connection – Stockholm	x
5.3 Smart meter information analysis and actuators	Smart Meter information analysis and actuators – Barcelona	

Solution 6 – New business models for district heating and cooling		
6.1 Open district heating with feed-in of waste heat	Open district heating – Stockholm	
6.2 District heating and cooling rings	District heating rings – Barcelona	
6.3 Smart local thermal districts	Smart local thermal districts – Barcelona	

Solution 7 – Smart waste collection , turning waste to energy tbd		
7.1 Optical sorting of waste	Smart waste management – Stockholm	x
7.2 Introduction of AWCS		
7.3 Waste collection statistics for individual households/businesses		
Solution 8 Big open data platforms tbd		
8.1 Big consolidated open data platform	Big consolidated open data platform – Stockholm	
	Big open data platform – Barcelona	
	Urban Cockpit – Cologne	x
8.2 Urban models		
8.3 Semi-automatic instance mapping		
8.4 Integration of sensor and heterogeneous data in standard data format	Integration of sensor data in a uniform in standard-driven data format – Barcelona	
8.5 Sustainable connected lighting to enhance safety and mobility		

Sustainable Urban Mobility

Solution 9 – Sustainable delivery		
9.1 Integrated multi-mode transport for light goods	Communal service boxes for sustainable deliveries – Stockholm	
9.2 Micro-distribution of freight	Micro distribution of freight – Barcelona	
Solution 10 – Smart traffic management		
10.1 Traffic management through MFD	Smart traffic signals – Stockholm and Barcelona	
10.3 Travel demand management		
10.4 Traffic control systems for passenger vehicles		
10.5 Traffic signals synchronised to prioritize movement of goods		

Solution 11 – Alternative fuel driven vehicles		
tbd		
11.1 Developing charging infrastructure	Normal charging infrastructure for electric vehicles – Stockholm	
	Fast charging infrastructure for electric vehicles – Stockholm and Barcelona	
	eTankE – Cologne	
	Vehicle to X (V2X) Charging for EVs – Barcelona	
11.2 E-mobility management system		
11.3 Charging infrastructure for electric tricycles for micro-distribution		
11.4 Refueling facilities for alternative heavy duty fuels	Alternative fuels for heavy duty vehicles – Stockholm	x
11.5 Smart guiding to alternative fuel stations and fast charging		
11.6 Small distributed CNG grid	Small distributed CNG grid – Barcelona	
Solution 12 Smart mobility solutions		
12.1 Green parking index	Green parking index – Stockholm	
12.2 Electrical and cargo bike pool		
12.3 Mobility hub	Mobility Hub – Cologne	
12.4 Electrical and conventional car sharing		
12.5 Conventional/PHEV/CNG vehicle sharing fleets		
12.6 Smart taxi stand system	Smart taxi stand system – Barcelona	

5.3 Smart City and District Replication

There are several sites and areas in the city centre that are programmed to be developed over the next years as described above. The aim is to focus the implementation of smart cities solutions on these previously identified areas. Within those areas the main focus goes to Campanhã and Bonfim which were the object of a new strategy, ARU Campanhã (Área de Reabilitação Urbana de Campanhã). In the areas identified the main goals are to create a sustainable development based in the opportunities that they present, namely in what concerns an integrated

infrastructure, smart refurbishment, mobility and energy, together with a special concern related to social innovation and the creation of a local identity.

5.3.1 Smart District Replication Profile

5.3.1.1 Q1 What are the main characteristics of the district and what is the replication potential?

In the case of Porto, and due to the characteristics of the identified Smart Solutions areas (see chapter (5.2 – Smart solution selection), the aim is to make the interventions as broad as possible. It is important, when considering the data collection that the area of intervention includes, as much as possible, different contexts within the city to make its analysis and consequent strategy implementation as efficient and replicable as possible. Having said that, and thus including a large area of the city as part of the district, Porto city has an elected area of priority intervention as described below.

Priority area of intervention:

The eastern part of the Porto City is a priority area of action of the current Municipal Executive, to create conditions for territorial and social cohesion of the City and its harmonious and sustainable development.

The Master Plan (Plano Director Municipal) of Porto, currently in effect, includes as one of its strategic objectives the reduction of existing urban disparities, underlining the need to develop efforts in fields such as equity on the location of public investments, social and territorial cohesion by the adding value to currently troubled territories. Although with a strong focus on social housing, the goal does not fail to equate several other dimensions of territorial social cohesion, in

particular those that refer to the existence of major imbalances of urban development at city level and the prevalence of both physical and social degradation in specific territories.

Urban area and Population:

The delimitation of the intervention zone covers an area of approximately 8.13 square kilometres, with a number of 32,659 inhabitants. This area is characterized by challenges related to water resources with high pollution issues, old industrial zone, important social challenges, but also very positive opportunities such as the fact that it is the largest mobility hub in the city and the fact that it contains important heritage sites.

Urban Context:

An Urban Rehabilitation Plan was developed for the area of Bonfim and Campanhã consisting of the restructuring of space for sustainable development of the intervention area.

The Campanhã railway station, the main external rail link to the city is in the centre of this area of intervention. The surrounding territory of this important transport infrastructure currently shows a combination of problems related to the sharp deterioration of many buildings, lack of quality of the public space, weak economic and cultural vitality and strong social vulnerability, which cannot be fought with measures of isolated sectorial policy.

The development of transport, including the construction of bridges over the Douro, contributed to the continuity of the great urban transformations over the 20th century, of this area marked by very strong industrial presence of which there are still some traces. In recent decades, and following the developments of the Portuguese cities, the eastern side of the city, experienced a strong deindustrialization process. This trend has become more evident from the 80s of last century, when many units were closed and transferred to municipalities in the periphery.

Employment:

In the past decade, there has been an intensification of this phenomenon, and employment in manufacturing industries located in the Porto area decreased by

more than 7,000 jobs between 2003 and 2012. A significant part of the hand labour still depended, until very recently, of this sector, is located in the east area of the City. Difficulties in finding new employment opportunities arise and were further aggravated by the global problems at national level which contributed to substantially worsen unemployment rate, which in the case of Campanhã already exceeded 24% of the active population 2011.

The parish of Campanhã concentrates almost half of social housing in the city of Porto. To register the large concentration of population at risk of poverty, with households affected by unemployment, large families without livelihoods and social problems.

In this territory a variety of advantages and opportunities can be recognize easily vis-a-vis those who are, today, desirable conditions for sustainable urban development, in particular: very favourable internal and external connectivity; local heritage values and symbolism able to design a new local identity; environmental and landscape features; large deactivated plants and urban voids with potential installation of new functions and activities; and significant number of buildings of interest to rehabilitate.

There is a clear need to design and implement an integrated intervention strategy for this area of the city. A strategy which promotes the local assets and capital gains, by successfully facing the challenges that the socio-economic development faces in order to improve the living conditions and citizen's well-being, leveraging one that is intended to be a process of transformation of the whole eastern part of Porto.

5.3.1.2 *Q2 Are there synergies and/or conflicts related to the Smart Solutions with the existing infrastructure, socio-economic profile and social acceptance?*

Asserting Porto as a place for the development and experimentation of technology solutions, products and value-added systems for smart cities at global level is one of the goals of this initiative. We intend to create synergies among different players enhancing the roll out of integrated and scalable creative solutions to solve urban problems. The solutions tested in Porto can be replicated in other urban spaces around the world, improving the internationalization potential of national companies. This action is an awareness, intelligence, advocacy and acceleration platform, which will also tackle demand side measures and contribute to eliminate market barriers, in the areas of public procurement, standardisation, business

models, financing mechanisms, stakeholder's involvement, etc. In fact, citizen participation in urban transformation process is a critical success factor for the implementation of smart cities strategies, in a perspective of co-creation and population involvement in the generation of new ideas for future cities.

5.3.1.3 Q3 How will local stakeholders be involved in the replication of Smart Solutions?

The local stakeholders of the district will be selected and responsibilities will be defined within the first period of this project. Nevertheless, the stakeholders involved in the city transformation and mentioned in Q5, will play an essential role, according to each area of expertise, in the development and application of the solution.

5.4 Smart Measures Specifications

5.4.1 Low Energy District - Smart Solution 3: Smart energy-saving tenants

In the city of Porto, the water supply system is managed by a municipal company called Águas do Porto[2] (AdP). AdP has been making a significant investment in order to assure a sustainable water use, which, among other initiatives, includes water leakage detection and the promotion of reasonable water consumption by its clients.

Both these two objectives (lower water leakage and lower water consumption) can be partially achieved by the real-time monitoring of the water consumption levels of each client. By comparing water supply levels (distribution) with water consumption levels, it also prevents fraud and detects water leaks.

The solution that is being deployed in the city of Porto comprises a telemetry system and a mobile app, which are complementary.

The telemetry system is made of wireless water meters that are installed at each client's home and data concentrators, which collect data from several meters on a single point. The water consumption data can be collected by walk-by (when

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[2] www.aguasdoporto.pt

necessary), by drive-by (around one measure per month) and on a real-time basis (data is sent to AdP by cellular communications).

Wireless water meters which are being deployed in the city of Porto.

The mobile app[3] is optional and provides general information about the water quality, and valuable information to its clients about its consumption profile (like alerts, consumption analysis, notifications and warnings, consumption comparison with other similar clients), and promotes a more sustainable water consumption.

AdP client's mobile app which is being used in the city of Porto.

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[3] app.aguasdoporto.pt

Presently, around 20.000 wireless water meters have already been deployed in the city, which covers around 13% of all the water meters installed in the city (more than 150.000).

An additional solution is also being piloted and tested in the city of Porto (in the Damião de Góis neighbourhood), which intends to reduce all the utilities (water, gas and electricity) consumption. This system is based on a mobile app and an online platform, and fosters competition between different client through gamification. The clients which have the best results (higher consumption reduction, for example) receive some kind of award, which in the end, promotes a sustainable utilities usage.
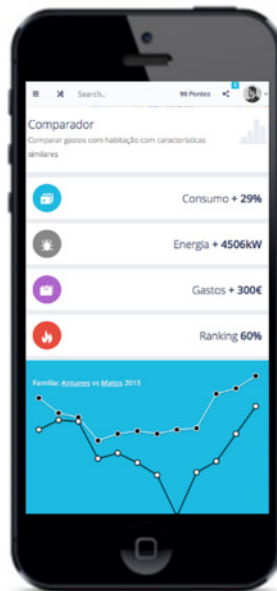
Utilities monitoring mobile app, which is being piloted and tested in a neighbourhood in the city of Porto.

5.4.1.1   Q1 What is the replication potential of the Smart Measure(s)?

The main motivations are to reduce water consumption, both downstream (by each client) and upstream (by detecting water leaks and water consumption fraud).

The solution is fully designed and tested, and has been implemented in the city over the past few years.

The deployment of wireless water meters is constrained by financial issues (significant investment at the start) and by operational issues (some old water meters are located inside each home, and not on the outside).

5.4.1.2 Q2 What is the business case and do financing opportunities already exist?

The system deployment in presently financed by Águas do Porto, which is also the owner of the wireless water meters.

The system design, test and the first deployments were co-financed by the Interreg IV SUDOE programme.

Ideally, this system can be installed on all the existing water meters in the city.

A possible financing scheme, which could increase the deployment speed of this solution, would make the clients order and pay the wireless meter, and be compensated during some years with a lower water fee.

5.4.1.3 Q3 What are the main challenges and barriers related to the measure(s)?

The solution was designed and developed with companies which manufacture the wireless meters, the data concentrators and the portable data meters, and also with companies which develop the software. New solutions on this field are being launched by many companies, so a close and permanent dialogue with companies is useful and mandatory.

5.4.1.4 Q4 How does the Smart Solution integrate with the existing and future infrastructure?

The wireless water meters can be installed on ordinary water meters, which are already deployed in the city as part of the water supply infrastructure.

The system functioning only requires cellular communications and the deployment of data concentrators.

5.4.1.5   Q5 What user / stakeholder involvement is foreseen?

Clients may be sceptical, because this solution brings several privacy issues and concerns, as it enables AdP to know in real-time when someone is or is not at home.

The clients which have in-house water meters may block (or remove) the wireless meter installation.

Environmental conscious or cost-sensitive clients will be the main supporters of this solution, as it will enable them to monitor their water consumption, and thus, reduce it.

5.4.1.6   Q6 What is the potential implementation timeframe?

More than a decade, unless an alternate and significant funding scheme is available.

5.4.1.7   Q7 What do you need to know for the successful deployment of the Smart Measure(s) beyond the GrowSmarter factsheets?

tbd

5.4.2 Integrated Infrastructure – Smart Solution 5: Smart street lighting

The Municipality of Porto is currently analysing and testing different smart street lighting solutions. The way we envision it, smart street lighting systems should (ideally) comprise the following features:

- Environmentally friendly
    - o Low electricity consumption (LED light)
    - o High energy autonomy, in the sense that it is capable of generating and storing the electricity required to power the system (wind or solar powered)
    - o Excess energy is supplied to the electric grid
- Remotely monitored and controlled
- Compatible with the existing lighting and electricity infrastructures
- Minimal on-site maintenance required

- Can incorporate additional equipment, such as, Wi-Fi hotspots, 4G small cell antennas, environmental sensors and weather stations, surveillance and monitoring cameras, power plugs for electric vehicles charging, etc.

Although we are aware that such a complete and adjustable solution is not easily found on the market as a turn-key solution, we are already working with some solutions that are complementary and can partially respond to the city's needs.

Presently, the Municipality of Porto is deploying two pilots with autonomous light poles. The system comprises 13 units of the OMNILED platform, which is developed by a local company (OMNIFLOW[4]). The LED light poles are fully autonomous and work off the grid (renewable energy is provided by a wind turbine and solar cells, and the energy is stored on batteries), they are remotely monitored and controlled by a dedicated web platform, and may incorporate some additional hardware equipment, such as cameras, and Wi-Fi and small cell antennas.

OMNILED solution from OMNIFLOW (image credits: OMNIFLOW).

The Municipality of Porto is presently analysing and assessing another smart street lighting, this one from Philips Lighting (Lightpole Site Slim[5]), both on a technical and business model point of view.

The LED light poles are connected to the grid, are remotely monitored (but not controlled), and can incorporate other equipment, such as, 4G/LTE antennas and communication hardware and Wi-Fi hotspots. Depending on the installed hardware, it requires connection to a wired or wireless communications network.

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[4] www.omniflow.pt

[5] www.lighting.philips.com/main/systems/connected-lighting/connected-lighting-for-smart-cities/smart-cities-initiative/smart-pole

This solution is clearly a very well designed one, in the sense that the used equipment is embedded on the light poles, and thus, has no visual impact (as is the case, when we need to use equipment boxes on light or traffic light poles).

Lightpole Site Slim solution from Philips Lighting (image credits: Philips Lighting).

The third solution is not a light pole, but suits some of the requirements of a smart street lighting solution described above. This solution (Vodafone Small Cells) is provided by Vodafone Portugal and is basically a pole with communications equipment. The system comprises cellular communications hardware (small cells) and/or Wi-Fi hotspots.

It benefits the telecom company (Vodafone Portugal) because it can easily expand the 4G/LTE coverage, in particular at touristic hotspots; and it benefits the city, because the poles can be equipped with Wi-Fi hotpots, and thus, they increase the public Wi-Fi coverage (Wi-Fi Porto Digital).

Vodafone Small Cells solution from Vodafone Portugal (image credits: Vodafone Portugal).

The Municipality of Porto is now planning to install these poles on four locations in the centre and the historic centre of the city, and is discussing with the company the technical and operational details of its deployment.

5.4.2.1   Q1 What is the replication potential of the Smart Measure(s)?

The main benefits of these smart street lighting solutions are to be environmentally friendly, in the sense that they use low-power light sources (LED) and they can generate and store their own energy by incorporating wind and/or solar generators. Accordingly, this reduces the energy bill of the city and lowers its CO_2 emissions.

Besides, the incorporation of communications and sensing equipment (embedded on the poles, instead of boxes on poles) has no visual impact; allows the telecom operators to expand their coverage without the need to use large and heavy equipment on top of the buildings (with an unpleasant visual impact); and enables the city to expand the sensing and the public Wi-Fi networks and coverage.

5.4.2.2   Q2 What is the business case and do financing opportunities already exist?

Although we should not make any 'public' statements about the proposed commercial conditions from the companies, we can make the following comments about their business models:

- OMNIFLOW is a regular equipment and software supplier of a turn-key solution. In this particular case, this solution is being deployed because

OMNIFLOW won an ideas contest promoted by the Municipality of Porto (Desafios Porto[6]).

- Philips Lighting

    o The company supplies these light poles to the city free of charge, and in exchange, they are free to negotiate with telecom operators the use of the small cell communications equipment, which are embedded on some light poles.

    o The light poles remain property of the company; accordingly, they are third-party owned city infrastructure.

    o Although the light poles are made available for free, they require a significant investment in terms of deployment and communication cabling costs.

    o The existence of a long-term contract, and the fact that the company is the one who chooses the places to deploy them in the city (where they identify better business oportunities for selling the communication cells), are two major handicaps of this solution.

- Vodafone Portugal

    o The company supplies these poles free of charge to the city, and in exchange, they use the embedded small cells for their telecom operations.

    o The poles remain property of the company; accordingly, they are third-party owned city infrastructure.

    o Although the poles are made available for free, they require a significant investment in terms of deployment and communication cabling costs.

    o The fact that the company is the one who chooses the places to deploy them in the city (where they need to expand the cellular communications' coverage), is a major handicap of this solution.

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[6] www.desafiosporto.pt/en

5.4.2.3   Q3 What are the main challenges and barriers related to the measure(s)?

Several companies have been contacted by the Municipality of Porto, and other companies have contacted the Municipality of Porto. The city plans to adopt different solutions, and not a 'one size fits all' solution, because different areas of the city have different and specific requirements and needs.

The city scale deployment of these solutions will take time, a significant investment, and will require finding the right business partners, with adequate and fair business models.

5.4.2.4   Q4 How does the Smart Solution integrate with the existing and future infrastructure?

The smart street lighting solutions require:

- Connection to the electric grid (in case they don't generate their own energy, or in case they can supply the excess energy to the grid, or just as a redundant option), which is already available in the city.

- Connection to the city's optical fibre network (in case it is equipped with Wi-Fi hotspots), which is already available in the city.

- Connection to a private communications network, in order to connect the small cells equipment to the telecom's network (which is the case of Philips Lighting and Vodafone Portugal).

5.4.2.5   Q5 What user / stakeholder involvement is foreseen?

The implementation of these solutions involve equipment manufacturers and suppliers (of the poles or light poles solutions); telecom operators interested in using the embedded communications equipment; electricity suppliers that may be interested in supplying energy to the vehicle chargers or to buy the excess energy created by the autonomous light poles; and the Municipality of Porto, which is interested in expanding the public Wi-Fi coverage and the sensing network with minimal visual impact.

### 5.4.2.6 Q6 What is the potential implementation timeframe?

The OMNIFLOW's solution was fully deployed and working since September 2017. The Vodafone Portugal's solution was fully deployed and working by the end of 2017. No decision has been made yet about the solution from Philips Lighting.

5.4.2.7 Q7 What do you need to know for the successful deployment of the Smart Measure(s) beyond the GrowSmarter factsheets?

We will need regular communication on each sub solution or projects including technical specification, lessons learned and issues raised by stakeholders.

5.4.3 Smart Solution 7: Smart waste collection

The Municipality of Porto has been studying the possibility of implementing a smart waste collection system in the city. It is well known that a smart waste collection system enables measuring and forecasting the fill-level of waste containers; accordingly, the waste collection routes can be properly designed, managed and programmed, and thus, optimized, by avoiding unnecessary journeys and stops (figure below).
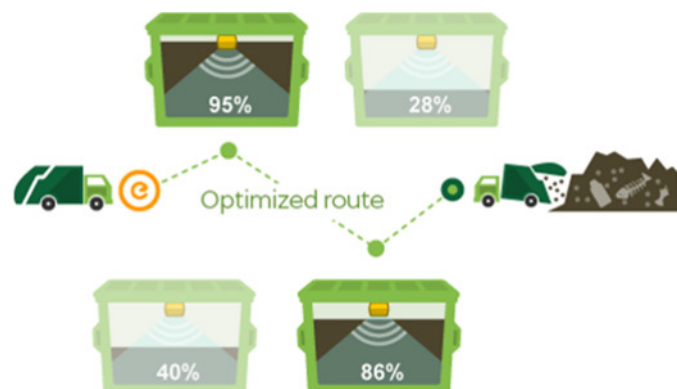
Waste collection optimization with bin sensors.

The study that the Municipality of Porto has been doing involves, at first, two different but complementary assessments: technology and efficiency.

The technology assessment intended to test a waste collection system on a pilot demonstrator. The system comprised waste bins equipped with fill-level sensors, data aggregator hub, processing units and communication devices. Data from each sensor was collected at the aggregator hub, and after being processed, it was sent to the final destination by using a given communication channel (Wi-Fi, cellular communications, or by a delay-tolerant network or opportunistic communication system).

These tests were particularly innovative, because they involved using the vehicular network available in the city (buses which communicate among themselves and with the city infrastructure) as 'data mules'. In this system, buses act as 'data mules' in the sense that they carry the bin sensor data until they reach a fixed communication unit or a city's Wi-Fi hotspot, which are connected to the city's optical fibre network, and finally routes the data to the destination. Accordingly, sensor data is transferred without any communication costs, which is not the case of cellular communications.

These tests proved that the system's technology was not only suitable for collecting data from waste bin sensors, but also from other sensors and meters, like the wireless water meters described at the "Smart Solution 3: Smart energy-saving tenants" section.

The efficiency assessment involved measuring the real collection efficiency of the different waste types (undifferentiated, selective and glass), based on historic data. The main collection efficiency results were the following:

- Undifferentiated: 96%
- Selective: 39%
- Glass: 14%

These results enable the Municipality of Porto to take informed decisions regarding the eventual installation of waste bin sensors for the different waste types, which results in the following main conclusions:

- The collection efficiency of the undifferentiated waste is already very close to 100%. Accordingly, the installation of bin sensors would not bring any significant efficiency gains, when considering a cost-benefit analysis.

- The collection efficiency of the selective and glass waste is very low, in particular for the glass. Accordingly, the installation of bin sensors will bring significant efficiency gains, and thus, significant cost reduction.

5.4.3.1 Q1 What is the replication potential of the Smart Measure(s)?

The main motivations are to reduce waste collection costs (fuel, human resources, vehicles, etc.), by optimizing waste collection routes.

The Municipality of Porto is still analysing and evaluating different technological solutions (from a cost-benefit point of view), and no decision has yet been made regarding the future deployment of waste bin sensors in the city.

Once implemented, this solution will benefit all the city.

The implementation of this solution requires a significant investment on the installation of the waste bin sensors and data aggregators.

The city has different types of waste bins, which are manufactured by different companies, and many bins can't be easily equipped with sensors.

5.4.3.2 Q2 What is the business case and do financing opportunities already exist?

The deployment of a smart waste collection system may be done in two ways: 1) installing sensors on the already existing bins in the city; 2) specify the requirements of the smart waste collection system and order future bins already equipped with sensors that comply with the requirements and specifications.

5.4.3.3 Q3 What are the main challenges and barriers related to the measure(s)?

The previously described tests have been made with the cooperation of local companies and the University of Porto.

Business dialogue with companies is mandatory, in order to identify proper technological solutions that fit the city's need, from a hardware and software point of view, and taking into consideration that the city can't be vendor locked-in (both to the waste bins and to the sensing technologies).

5.4.3.4   Q4 How does the Smart Solution integrate with the existing and future infrastructure?

The waste bin sensors communicate with data aggregators, which need to be deployed. As noted before, the wireless water meters also require data aggregators to operate (around 3.000 units are already deployed in the city). Accordingly, we could have significant economies of scale if both sensors (waste and water) can communicate with the same data aggregators, so there are important synergies with the "Smart Solution 3: Smart energy-saving tenants".

Besides, these data aggregators can send data to its final destination through the already available city networks, in particular, the Wi-Fi and fibre networks (which are owned by the Municipality of Porto through Porto Digital[7]) and the vehicular network (which is co-owned by STCP and is connected to the city's Wi-Fi and fibre networks).

5.4.3.5   Q5 What user / stakeholder involvement is foreseen?

The main motivations are to reduce waste collection costs (fuel, human resources, vehicles, etc.), by optimizing waste collection routes.

The main supporters will be the city inhabitants and local companies, because this will potentially provide a better waste collection service, and will reduce operating costs, which may, in the end, reduce collected taxes.

The waste bin manufacturers may not be supportive, because the eventual mandatory requirement of supplying waste bins with sensors (with some requirements and specifications) will increase their manufacturing costs, will require them to work and use unknown technologies (for many of them) and may require some customization for the city of Porto, instead of having a standard solution for any city (as is normally the case of an ordinary waste bin).

5.4.3.6   Q6 What is the potential implementation timeframe?

Not yet defined.

5.4.3.7   Q7 What do you need to know for the successful deployment of the Smart Measure(s) beyond the GrowSmarter factsheets?

We will need regular communication on each sub solution or projects including technical specification, lessons learned and issues raised by stakeholders

5.4.4 Smart Solution 8: Big data management

In terms of big and open data management, the Municipality of Porto (with the coordination and support of Porto Digital) has been working on several initiatives, in particular, the following:

- Urban Platform
- Hackacity
- Open Data Platform
- Integrated Management System (CGI)

The Municipality of Porto is presently designing, specifying and developing an Urban Platform, which will collect and analyse mobility, environment, energy, waste and civil protection data for the city management and service provision. The Urban Platform is a software infrastructure which will use open APIs from the FIWARE[8] platform as building blocks, and will be developed according to the following principles and guidelines:

1. City data flows
   The Urban Platform brings together data flows within and across city systems.

2. City level engagement
   The Urban Platform enables the city to shift from fragmented operations to predictive effective operations, and engages and serves city stakeholders in order to transform outcomes at local level.

3. Security and privacy
   The Urban Platform implements data privacy and security policies, assuming that it will be a valuable target for attackers.

4. Low integration effort

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[8] www.fiware.org

The Urban Platform integrates with existing or future systems with relatively little adaptation effort, and itself cannot represent an obstacle to the city's legacy or greenfield systems.

5. High scalability
   The Urban Platform is designed for performance and scalability, and is able to support extremely large quantities of data with almost no degradation of performance, and allows tackling scale problems by the simple addition of resources.

6. Data and executable code
   The Urban Platform consumes and produces data and supports executable code (analytics, bigdata, computing engine) to be able to process and transform that same data.

7. Open sourced, no vendor lock-in
   The Urban Platform adheres to open solutions to speed adoption and to prevent vendor lock-in.
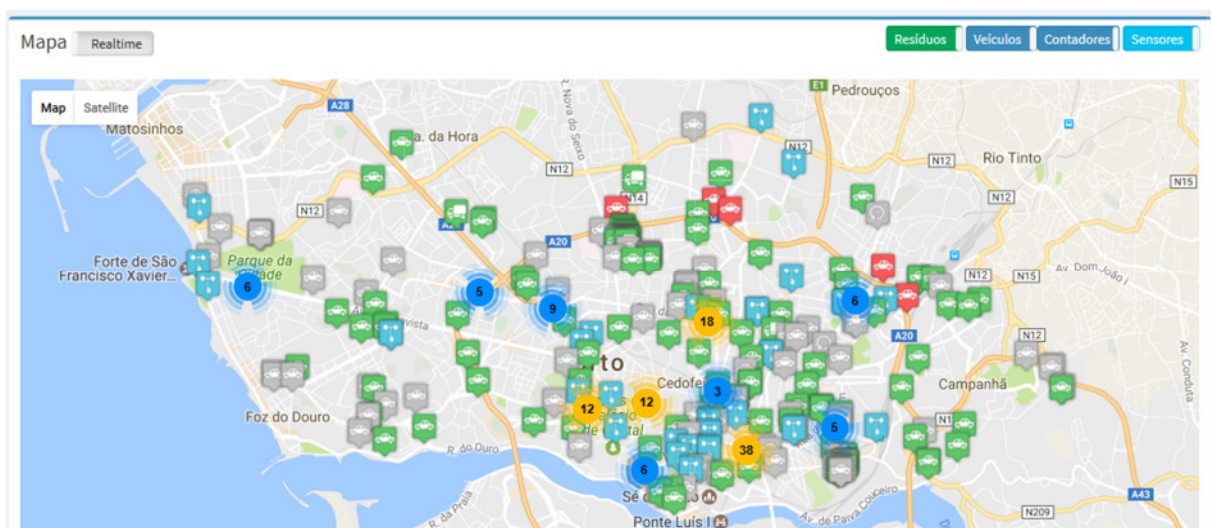
Prototype version of the dashboard of the Urban Platform.

Hackacity[9] is a hackathon that aims to test big data and promotes its use to develop solutions that will have an impact in the city, but also fosters collaboration amongst stakeholders. For 24 hours, participants get together to develop solutions based in
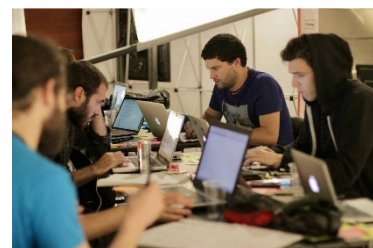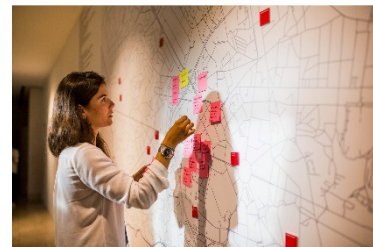
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[9] www.hackacity.eu

open source platforms as FIWARE to address challenges faced by the citizens, using data provided by the city. The FIWARE platform provides a rather simple yet powerful set of APIs that ease the development of smart applications in multiple vertical sectors, whose specifications are public and royalty-free.

It started in 2015 in the city of Porto. In 2016, the city of Porto challenged the cities of Amersfoort/Utrecht in Netherlands, Olinda/Recife in Brazil and Santander in Spain – with the support of the Open and Agile Smart Cities (OASC) initiative – to work together, as a first attempt to implement an integrated approach of the use of data for the creation of innovative city solutions.

The 2017 edition took place in June and brought together the cities of Porto[10] in Portugal, Garanhuns[11] and Cuiabá[12] in Brazil and Utrecht[13] in Netherlands on four local Hackacity events. The Utrecht event took place within the 2nd FIWARE Summit. The cities of Zagreb in Croatia, Santander in Spain and Paterborn in Germany did not organize an event, but they contributed to the Hackacity events by providing data to the participants.

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[10] https://hackacity.eu/porto
[11] https://hackacity.eu/garanhuns
[12] https://hackacity.eu/cuiaba
[13] https://hackacity.eu/utrecht

Photos of the 2017 edition of the Hackacity Porto (2–3 June 2017).

The Open Data Platform of the Municipality of Porto[14] is already developed and available online. The first development phase represents an investment of around 300.000 Euros, and also included making available 800 datasets (so far, closed). The second development phase is expected to last until 2019, involves an additional investment of around 300.000 Euros, and will make 400 datasets open and available at the Open Data Platform.

Webpage of the Open Data Platform of the Municipality of Porto.

Finally, the Municipality of Porto also created the Integrated Management Centre (CGI), which provides real time information and promotes an integrated action amongst different public stakeholders and services, such as, security (Police and local Police), emergency (civil protection, medical emergency and firefighting), public transportation, and services of the Municipality of Porto (such as, environment and waste, mobility and traffic, and fleet management).

It was launched in 2015, and was significantly upgraded in 2016. It now comprises an operation room with 82 m^2 and a crisis room with 48 m^2, it monitors the city

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[14] http://dadosabertos.cm-porto.pt

through the lens of 130 cameras and is connected to the city's fibre network with a 10 Gbit/s connection (owned and operated by Porto Digital).

Integrated Management Center (CGI) of the Municipality of Porto in 2015 (left) and 2016 (right).

5.4.4.1   Q1 What is the replication potential of the Smart Measure(s)?

The main objectives are to use data to bring value added to the city. Data can provide valuable information for informed decision making by the Municipality of Porto and the city's services; besides, the availability of city's open data enables companies to add value and to offer new services and solutions that increase the quality of life of the inhabitants, visitors and tourists.

By aggregating, processing and delivering rich data, the city's services can work more effectively and in a predictive way, instead of working on a reactive, fragmented and isolated way. Besides, data processing creates new data, which would not be available in a raw analysis.

The Urban Platform is presently being designed, specified and developed, and should be fully operational at the beginning of 2019. The Hackacity events take place every year at the city of Porto since 2015. The Open Data Platform is deployed and working, and 400 open datasets will be made available at the Open Data Platform until 2018. The CGI is fully working since 2016, but will be improved when the Urban Platform is operational.

5.4.4.2   Q2 What is the business case and do financing opportunities already exist?

All these initiatives are funded by the Municipality of Porto. Possible complementary sources of funding include the H2020 EU programme and the Urban Innovative Actions programme.

Since the Urban Platform will gather data from different sources (sensors, cameras, other equipment), and since we want to develop it based on open APIs, we may need customized developments in order to adapt the available APIs to the existing hardware standards and protocols.

5.4.4.3 Q3 What are the main challenges and barriers related to the measure(s)?

Each of the 'vertical' solutions of the Urban Platform (such as, mobility and environment) will be developed by companies. The Municipality of Porto will launch a public procurement procedure for this development. The preliminary developments of the Urban Platform, in particular, the integration with the FIWARE node, are presently being made with the cooperation of a Portuguese company.

Hardware supply and software development will be made by companies.

The Municipality of Porto and Porto Digital are working on the design, specification and implementation management of the different solutions, and its integration with the city's sensing and communications infrastructure.

5.4.4.4 Q4 How does the Smart Solution integrate with the existing and future infrastructure?

The Urban Platform will gather data from sources already deployed in the city and from others sensors that will be deployed in the near future.

Data is transmitted from its sources to the Urban Platform and to the CGI by broadband communications, which include the city's Wi-Fi and fibre networks already available in the city.

Data from wireless energy and water meters (SS3), smart street lighting and additional equipment (SS5), waste bin sensors (SS7) and electric vehicles (SS11) can be gathered and processed by the Urban Platform, and can be used by the CGI for predictive or reactive operations.

5.4.4.5 Q5 What user / stakeholder involvement is foreseen?

Real-time or historic data, and open or closed data, is 'owned' and provided by several sources within the municipality, services and companies. Although the

principles behind the Urban Platform and the CGI are supported at the top level of the City Council, each stakeholder may be sceptical and block data release.

5.4.4.6 Q6 What is the potential implementation timeframe?

Described above and at Q1.

5.4.4.7 Q7 What do you need to know for the successful deployment of the Smart Measure(s) beyond the GrowSmarter factsheets?

We need regular communication on each sub solution or projects including technical specification, lessons learned and issues raised by stakeholders

5.4.5 Sustainable Urban Mobility – Smart Solution 11: Alternative fuel driven vehicles

The Municipality of Porto has been making a significant investment in the electric mobility, by replacing the current diesel fleet by electric and hybrid vehicles, which are used by the municipality services, the police and the municipal companies.

In 2016, the Municipality of Porto acquired and received four 100% electric vehicles and one hybrid (electric and fuel engines) vehicle for urban cleaning and garden maintenance operations. The electric units have an autonomy of around 100 km and are used for public space cleaning, waste collection at the city centre and garden maintenance. The hybrid units have an autonomy of around 400 km (80 km electric) and are used for high pressure water cleaning. In 2016, the Municipality of Porto also received 12 new electric vehicles for passengers.

More recently, in 2017, the Municipality of Porto ordered 390 new electric vehicles, which represents a global investment of 10 million Euros. The replacement of the current diesel vehicles by these new electric units will have a significant impact on fossil fuel consumption (less 450.000 litres until 2022), on CO_2 emissions (less 2.300 tons until 2022) and on operational costs (less 600.000 € per year on fuel consumption).

Electric vehicles on urban cleaning, waste collection and garden maintenance operations in the city of Porto.

Besides, the public bus company (STCP) – which operates in the cities of Porto, Gondomar, Maia, Matosinhos, Valongo and Vila Nova de Gaia, and is managed by several municipalities under the leadership of the Municipality of Porto – has also been making a significant investment in alternative fuel driven vehicles, in particular, by replacing the diesel buses by gas ones.

In 2017, STCP launched an international public procurement procedure in order to buy 188 new gas and electric bus units (173 gas, 15 electric), which represents an investment of 46,7 million Euros and will renew around 45% of the entire bus fleet. The first 35 units were delivered in 2018.

At the beginning of the year, STCP also tested a 100% electric bus, which is made by a Portuguese manufacturer (CaetanoBus[15]). The tests were made on a real route (904), which connects the centre of Porto to the centre of Vila Nova de Gaia, and provided valuable information to STCP regarding the specifications and operational conditions of this type of vehicles, and enabled STCP to evaluate the feasibility of using electric vehicles on a regular operation. This bus has an autonomy of 80 km

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[15] http://caetanobus.pt/en/

(the batteries are fully charged in 30 minutes) and can reach a maximum speed of 70 km/h, and was the first electric bus used in the city of Porto on public bus operations.

Electric bus (eBUS) being tested in a real route in the city of Porto.

Presently, 38% of the STCP's bus fleet is powered by diesel and 62% is powered by gas. The ambition is to have a fleet made of more than 90% gas or electric vehicles by 2019.

In September 2017, the car-sharing company Citydrive[16] started operating in the city of Porto with a fleet of 200 units of 100% electric vehicles (Nissan Leaf). Later, the company expects to provide a similar service of 100% electric shared scouters. Both kinds of vehicles can be charged at the public chargers already available throughout the city.

5.4.5.1   Q1 What is the replication potential of the Smart Measure(s)?

The main motivations are to reduce CO_2 emissions and fossil fuel consumption (thus reducing pollution levels in the city associated with mobility) and to reduce fuel costs.

The replacement of diesel vehicles by alternative fuel driven vehicles (electric, hybrid and gas) is already taking place, and the acquisition of new vehicles has already been formalized (both by the Municipality of Porto and STCP).

The implementation of the solutions are only dependent on legal and mandatory measures associated with public procurement procedures and time.

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[16] www.citydrive.pt

5.4.5.2 Q2 What is the business case and do financing opportunities already exist?

The acquisition of these new vehicles is funded by the Municipality of Porto and STCP, and is co-funded by national and European funds.

The acquisition of the electric and hybrid vehicles by the Municipality of Porto will be made by a renting contract, which includes vehicle's maintenance and insurance along the 4 years' duration of the contract (until 2022).

The main technological barriers include vehicle's autonomy and battery charging time.

5.4.5.3 Q3 What are the main challenges and barriers related to the measure(s)?

Availability of proper financing (because fleet renovation is expensive), long-term vision (because it takes times to have results) and proper support infrastructure (because the operation of these new vehicles require adequate energy supply infrastructures).

Dialogues with companies are important in order to have adequate solutions that properly fit the city's needs.

We also expect that the use of alternative fuel driven vehicles in public services (municipality, police, public bus company) will motivate inhabitants to change their own cars for alternative energy sources, and thus positively contributing to the city's environmental sustainability.

5.4.5.4 Q4 How does the Smart Solution integrate with the existing and future infrastructure?

The operation requires electrical (public and private) and gas (private) supply infrastructures, which are already available in the city.

In the case of electric vehicles, they will be mainly charged at the municipality's and STCP's own premises, with the exception of the car-sharing services, which will use the public network of electric chargers.

The STCP's gas buses will be refilled at their own premises, at a gas station which is already available (because STCP has been using gas buses for several years).

5.4.5.5 Q5 What user / stakeholder involvement is foreseen?

The main motivations are to reduce CO_2 emissions and fossil fuel consumption (thus reducing pollution levels in the city associated with mobility) and to reduce fuel costs.

Both leading institutions (the Municipality of Porto and STCP) have these objectives on their environmental and sustainability policies and strategies.

5.4.5.6 Q6 What is the potential implementation timeframe?

Described above.

5.4.5.7 Q7 What do you need to know for the successful deployment of the Smart Measure(s) beyond the GrowSmarter factsheets?

We will need regular communication on each sub solution or projects including technical specification, lessons learned and issues raised by stakeholders

6 GrowSmarter Replication Plan

6.1 Replication plan of Smart Solution 3: Smart energy-saving tenants

6.1.1 Summary of implementation activity

- What does the measure consist of/key components?
The measure consists in refurbishing older buildings using new construction techniques in order to reduce the amount of energy use. Just like most old buildings there are problems with thermal bridges and the fact that the climate shell is not airtight. Porto City Council will replicate smart and energy savings measures, profiting more than 12000 tenants in the city' social neighbourhoods by reducing their energy consumption.

- Specify area and scope of implementation (e.g. deep refurbishment of m2)
The district areas of intervention for the next 5 to 10 years are mainly identified by the ARU (Areas of urban Rehabilitation) defined by the Porto Municipality. The social neighbourhoods that will be intervened belong to ARU Campanhã (8.334 tenantes) and Paranhos (6.214 tenants)

- Name key steps and activities required for the project implementation
The first step is to make a survey of the buildings within the identified area that will need **a climate shell refurbishment** with an external insulation added to the whole buildings envelope, new windows and balcony doors and **a system for geothermal heating**. After that, a detailed implementation plan will be outlined for the next 5 years.

- Status quo of deployment / implementation step (if) already achieved (see below)
The solution currently is between the survey and implementation analysis phases.

6.1.2 Phase 1: Preparation of the implementation framework

Objective: Set the basis for a successfully implementation of the measure.

Indicative timeframe	Description of key activities	City departments/ offices involved
Jun 19 – Dec 19	- **Policy and regulatory screening** All current Portuguese regulations have already been analysed and no adaptations are need for the solution to be implemented. - **Stakeholder´s roles definition:** Porto Vivo, SRU – Sociedade de Reabilitação Urbana da Baixa Portuense, S.A. (Society of Urban Rehabilitation of the Centre of Porto) and APOR (Agência para a Modernização do Porto – Agency for Porto´s modernization) are partners which create synergies for better cooperation between public and private entities and promote the upgrading and modernization of the urban, industrial and business fabric of the city.	**Direção Municipal de Urbanismo** (Municipal direction of Urbanism) **CMPH – Domus Social – Empresa de Habitação e Manutenção do Município do Porto, EM** (Company of housing and maintenance of the municipality of Porto)

6.1.3 Phase 2: Project inception planning, performance and finance

Objective: Outline key structural aspects for the measure's implementation.

Indicative timeframe	Description of key activities	City departments/ offices involved
Jan 20– Mar 20	- **Governance designation:** **CMPH – Domus Social – Empresa de Habitação e Manutenção do Município do Porto, EM** (Company of housing and maintenance of the municipality of Porto) that ensures the maintenance and conservation of all buildings, equipment, facilities and infrastructures integrated in the public and private domain whose management is from the municipality of Porto. Presidente: Dr. Fernando Paulo - **Targets and goals setting (short– to long–term):** It is expected that these measures will (i) provide	**Direção Municipal de Urbanismo** (Municipal direction of Urbanism) **CMPH – Domus Social – Empresa de Habitação e Manutenção do Município do Porto, EM**

energy renovation of apartment buildings, (ii) reduce the environmental impact and (iii) promote sustainable economic development.
 	
Porto Smart City strategy, along with Porto´s Sustainable Energy Action Plan (SEAP-P), conceived as a long-term goal to achieve measurable results **the improvement of urban quality of life for residents, workers and visitors to the city of Porto.**
 	
- **Technology and infrastructure planning:**
Climate shell refurbishment will involve insulation to the roof, façade and basement walls and glass windows with U-value of 0,7 W/(m2K).
There will be installed geothermal heating with separate heat exchanger in selected buildings, a set of heat pumps and a heat exchange system to produce heat and hot water and water-saving tap water fixtures to reduce water consumption. Low energy lighting fixtures and PV cells to produce electricity will be added to common spaces for electricity saving measures.
CMPH, the Company of housing and maintenance of the municipality of Porto, will involve all the relevant stakeholders from the local ecosystem considered important for such developments.
 	
- **Definition of key performance indicators (KPIs):**
  - Reduction in annual final energy consumption (by buildings)
  - Reduction in life cycle energy use
  - Reduction of embodied energy of products and services used in the project
  - Financial benefit for the end-user
  - Payback period
 	
- **Cost-benefit analysis:**
Energy efficient renovation could potentially affect various socioeconomic variables. Positive externalities that will be achieved include reduced environmental impact measured by a reduction in CO_2 emissions, improvement in the quality of life, energy security
	(Company of housing and maintenance of the municipality of Porto)

and power usage reduction from tenants.

- **Business and financial model definition**:
Since the municipality owns and manages an important share of housing through its affiliated companies, in the first stage the implementation plan will be financed by public funding and by the GrowSmarter Replication budget. Trough the project "CSI Europe: City Sustainable Investment in Europe – asking financial instruments work for cities", financial instruments in the planning of sustainable urban development will be identified, particularly in the context of urban revitalisation.

6.1.4 Phase 3: Political approval and stakeholder engagement

Objective: Obtain and maintain political and stakeholder commitment for the implementation.

Indicative timeframe	Description of key activities	City departments/ offices involved
Jan 20 – Jun 20	- **Political commitment:** Promoting Porto as sustainable city, in its relationship with the territory in historical aspect, its sustained centrality function, and "brand in the region". The measures directly related to the reduction of CO_2 emissions and energy efficient materialize in various interventions such as building refurbishment. - **Strategic intermediaries:** Porto Vivo, SRU (Society of Urban Rehabilitation of the Centre of Porto), APOR (Agency for Porto´s modernisation) and Porto Digital Association are fully committed supporting the implementation of the Smart City concept. - **Public participation and citizen engagement:** Taking advantage of the knowledge and success of the initiatives promoted by Porto Digital to increasing	**Direção Municipal de Urbanismo** (Municipal direction of Urbanism) **CMPH – Domus Social – Empresa de Habitação e Manutenção do Município do Porto, EM** (Company of housing and maintenance of the municipality of Porto)

visibility and public awareness for different fields such as sustainability, mobility, urban planning and information and communication technology, Public participation and citizen engagement. This will be achieved by leveraging programs such as ScaleUp Porto and ScaleUp Europe initiatives.

- **Capacity building of city staff**:
The CMPH – Domus Social – Housing and Maintenance Company of the Municipality of Porto, MS, has almost 20 years of experience in municipal public housing management and in the maintenance and conservation of all real estate. In addition there will be planed benchmarking actions in Stockholm, seminars and training actions for the staff and the involvement of all public and private stakeholders.

6.1.5 Phase 4: Project implementation

Objective: **Plan the effective implementation of the defined measure.**

Indicative timeframe	Description of key activities	City departments/ offices involved
Jun 20 – Jun 21	- **Implementation plan:** 1. Definition plan considering the pilot area to intervene, procurement plan definition (what to buy, when and from what source) and definition of terms for contracts negotiation and management 2. Energy efficient refurbishment of residential social building from Campanhã and Paranhos (Pilot action) • External insulation added to the buildings envelope • Installation of new windows and balcony doors to the buildings • Improvement of the plumbing system of the buildings • Insulation of new pipes • Installation of a "Pipe in pipe" wastewater heat	**Direção Municipal de Urbanismo** (Municipal direction of Urbanism) **CMPH – Domus Social – Empresa de Habitação e Manutenção do Município do Porto, EM** (Company of housing and maintenance of the municipality of Porto)

	exchange system	
	• Installation of new substations and heat exchangers for district–/geothermal heating	
	• Installation of lighting fixtures ones with motion control.	
	• Installation of PV-cells on the roof for renewable local energy	
	3. Analyse KPI and document recommendation of actions for improve action quality on further buildings to be interventioned.	
	4. Benchmark session in Stockholm and seminar event in Porto to present the results and identify further chances for cooperation.	
	- Procurement model: To be defined at the fist step of Implementation plan	
	- Contract negotiation and management: To be defined at the fist step of Implementation plan	

6.1.6 Phase 5: Monitoring and progress evaluation

Objective: Plan the monitoring, evaluation and reporting of the implementation of the measure.

Indicative timeframe	Description of key activities	City departments/ offices involved
Jun 21– Dec 21	- **Project monitoring:** The monitoring and evaluation of the solution will be adapted from the one used by Stockholm. Additionally, the decrease energy consumption, the Lower energy costs and reduced CO_2 emissions will be evaluated using the previously defined KPIs. - **Project evaluation:** The impact will be measured by the increase in the quality of life of tenants – improved urban quality of	**Direção Municipal de Urbanismo** (Municipal direction of Urbanism) **CMPH – Domus Social – Empresa de Habitação e**

life for residents, workers and visitors to the city of Porto. - **Internal and external reporting:** Report and communication of the implementation results will be performed actively using the Municipality channels as institutional general newsletters and audio-visual tools. Other public events should be organizing to communicate the results to stakeholders in a detailed form.	Manutenção do Município do Porto, EM (Company of housing and maintenance of the municipality of Porto)

6.2 Replication plan of Smart Solution 5. Smart lightning, lampposts as hubs for communication

6.2.1 Summary of implementation activity

– What does the measure consist of/key components?

The Smart Towers solution transforms traditional urban furniture, like street lighting poles, into new small multi-functional urban sites, to resolve the connectivity trends in the city. A wide network of sensors and actuators should be deployed around the city to monitor and control the city. In addition, small micro-sites must be deployed in the city to support hyper-connected spaces and massive mobile connectivity. This solution opens a new paradigm for business models in the city, related to neutral host operators and the use of shared infrastructures.

– Specify area and scope of implementation (e.g. deep refurbishment of m2)
The Municipality of Porto is planning to install The Smart Towers on four locations in the centre and the historic centre of the city.

– Name key steps and activities required for the project implementation
Key steps are:

1. Define users and their needs for data collection and adaptive steering in City environments
2. Analyse the existence of optical fibre and electricity
3. Procure sensors and Internet of Things (IOT) platform to be able to both collect data, but also for applications and adaptive steering of street environments

4. Install and connect the sensors to an IOT platform

5. Analyse data and develop applications/solutions in the platform

6. Test and evaluate applications in the connected street environment to get instant feedback on their performance

– Status quo of deployment / implementation step (if) already achieved (see below)

In partnership with the University of Porto the city council has installed already 6 "Zero site" spots, in which all the spots could be shared by several neutral host operators (companies and partners). The city council expects to use the project results to increase the number of sites with this concept to more than 60 new sites with new specifications, according with the smart solution ideas.

6.2.2 Phase 1: Preparation of the implementation framework

Objective: Set the basis for a successfully implementation of the measure.

Indicative timeframe	Description of key activities	City departments/ offices involved
Jun 19 – Dec 19	- **Policy and regulatory screening** All current Portuguese regulations have already been analysed and no adaptations are need for the solution to be implemented. - **Stakeholder´s roles definition:** Porto Digital Association – Porto Digital will act at several levels, to ensure that citizens, academia, industry and Public Authorities can cooperate, benefit and be active partners in the process of creating a Smarter City. Porto Vivo, SRU – Sociedade de Reabilitação Urbana da Baixa Portuense, S.A. (Society of Urban Rehabilitation of the Centre of Porto), APOR (Agência para a Modernização do Porto – Agency for Porto´s modernization) is a partner which creates synergies for better cooperation between public and private entities and promotes the upgrading and modernization of the urban, industrial and business fabric of the city.	**Direção Municipal de Urbanismo** (Municipal direction of Urbanism) **Departamento Municipal de Mobilidade e Gestão da Via Pública** (Municipal Department of Mobility and Public road management)

6.2.3 Phase 2: Project inception planning, performance and finance

Objective: Outline key structural aspects for the measure's implementation.

Indicative timeframe	Description of key activities	City departments/ offices involved
Jan 20– Mar 20	**Governance designation**: Direção Municipal de Proteção Civil, Ambiente e Serviços Urbanos (Municipal Directorate of Civil Protection, environment and urban services) Project Manager: João Sendim Departamento Municipal de Mobilidade e Gestão na Via Pública (Municipal Department of Mobility and Public road management) Project Manager: João Neves - **Targets and goals setting (short- to long-term):** It is expected that these measures will (i) Improve quality of life by resolve the wireless connectivity demand and by helping city managers to take the most suitable decisions on traffic issues; (ii) reduce the environmental impact by promoting an adaptive steering of pedestrian, bicycle and vehicle traffic to reduce emissions and enhance the flow of traffic; (iii) promote sustainable economic development since neutral host operators will contract "Connectivity as a Service" and on the other hand, the marketplace of IoT services allows collaboration and co-creation of new services for the city and its citizens. Porto Smart City strategy, along with Porto´s Sustainable Energy Action Plan (SEAP-P), conceived as a long-term goal to achieve measurable results **the improvement of urban quality of life for residents, workers and visitors to the city of Porto.** - **Technology and infrastructure planning:** We plan to install two types of sensors to collect data on people and vehicle flow. The sensors will be connected to the existing optical fibre network. When pedestrians and bicyclists pass a sensor a time and	**Direção Municipal de Urbanismo** (Municipal direction of Urbanism) **Departamento Municipal de Mobilidade e Gestão da Via Pública** (Municipal Department of Mobility and Public road management)

ID-tag is collected from their mobile phone devices. When the same ID passes another sensor it is possible to, for instance, define the average speed and direction of the person. The other sensor is identifying vehicles' registration plates and checks it against the vehicle register. When there is a match the vehicle information such as type of vehicle, CO_2 emission can be defined.

This gives very exact information of the transport emissions in the area over a given time. The real-time data in the city is then transferred to a big data platform, where it can be analysed and used for developing applications for users.

Municipal Department of Mobility and Public Road management of the municipality of Porto will iinvolve all the relevant stakeholders from the local ecosystem considered important for such developments.

- **Definition of key performance indicators (KPIs)**:
    - Reduction of traffic accidents
    - Decreased delay by traffic congestion
    - Reduction in annual final energy consumption (by transport)
    - Reduction in life cycle energy use
    - Carbon dioxide emission reduction
    - Reduction in lifecycle CO_2 emissions
    - Decreased emissions of Nitrogen dioxides

- **Cost-benefit analysis**:
    Traffic reduction could potentially affect various socioeconomic variables, by improving citizens quality of life and by reducing the environmental impact due to traffic congestion. Other socioeconomic benefits are the increased quality of life by improving the wireless connectivity demand and by helping city managers to take the most suitable decisions on traffic issues. Positive externalities are the benefits achieved by the creation of more services related to IoT, wireless connectivity, and real time digital information and with the acess

to big data by external developers, which can develop new services for the public and it will also create economical growth.

- **Business and financial model definition**:
Since the municipality owns and manages an important share of street lighting equipment, in the first stage the implementation plan will be financed by Public Funding. Meanwhile, the deployment of dense access networks becomes feasible for mobile operators if they can contract "Connectivity as a Service", becoming a revenue source for the municipality.

6.2.4 Phase 3: Political approval and stakeholder engagement

Objective: Obtain and maintain political and stakeholder commitment for the implementation.

Indicative timeframe	Description of key activities	City departments/ offices involved
Jan 20– Jun 20	- **Political commitment:** Promoting Porto as sustainable city, in its relationship with the territory in historical aspect, its sustained centrality function, and "brand in the region". Through Porto Digital, Porto Municipality stake in a structural change in the operating mode of the city and its infrastructure by paving the way to allow a generic access to the digital world, - **Strategic intermediaries:** Porto Vivo, SRU (Society of Urban Rehabilitation of the Centre of Porto), APOR (Agency for Porto´s modernization) and Porto Digital Association are fully committed supporting the implementation of the Smart City concept and PORTO DIGITAL association. Several companies have been contacted by the Municipality of Porto, and other companies have contacted the Municipality of Porto. The city plans to adopt different solutions, and not a 'one size fits all'	**Direção Municipal de Urbanismo** (Municipal direction of Urbanism) **Departamento Municipal de Mobilidade e Gestão da Via Pública** (Municipal Department of Mobility and Public road management)

	solution, because different areas of the city have different and specific requirements and needs. - **Public participation and citizen engagement:** Taking advantage of the knowledge and success of the initiatives promoted by Porto Digital to increasing visibility and public awareness for different fields such as sustainability, mobility, urban planning and information and communication technology, Public participation and citizen engagement. This will be achieved by leveraging programs such as ScaleUp Porto and ScaleUp Europe initiatives. - **Capacity building of city staff**: In the last 5 years Porto has been part of several projects that are very relevant in the Smart City domain and in coherence with the Political strategy to transform Porto into a Smart city. Besides, there will be planed benchmarking actions in Stockholm, seminars and training actions for the staff and the involvement of all public and private stakeholders.	

6.2.5 Phase 4: Project implementation

Objective: Plan the effective implementation of the defined measure.

Indicative timeframe	Description of key activities	City departments/ offices involved
Jun 20 – Jun 21	- **Implementation plan:** 1. Definition plan considering the pilot area to intervene, procurement plan definition (what to buy, when and from what source) and definition of terms for contracts, negotiation and management 2. Smart lightning, lamp-posts as hubs for communication installation • Define users and their needs for data collection and adaptive steering in City environments • Analyse the existence of optical fibre and electricity	**Direção Municipal de Urbanismo** (Municipal direction of Urbanism) **Departamento Municipal de Mobilidade e Gestão da Via Pública** (Municipal

	• Procure sensors and Internet of Things (IOT) platform to be able to both collect data, but also for applications and adaptive steering of street environments • Install and connect the sensors to an IOT platform • Analyse data and develop applications/solutions in the platform • Test and evaluate applications in the connected street environment to get instant feedback on their performance 3. Analyse KPI and document recommendation of actions for improve action quality on further buildings to be interventioned. 4. Benchmark session in Stockholm and Barcelona and seminar event in Porto to present the results and identify further chances for cooperation. - **Procurement model**: To be defined at the start of the Implementation plan - **Contract negotiation and management**: To be defined at the start of the Implementation plan	Department of Mobility and Public road management)

6.2.6 Phase 5: Monitoring and progress evaluation

Objective: Plan the monitoring, evaluation and reporting of the implementation of the measure.

Indicative timeframe	Description of key activities	City departments/ offices involved
Jun 21– Dec 21	- **Project monitoring:** The monitoring and evaluation of the solution will be adapted from the used by Stockholm and Barcelona. Additionally, the reduction of traffic accidents, decreased delay by traffic congestion, reduction in annual final energy consumption (by transport), reduction in life cycle energy use, carbon dioxide emission reduction,	**Direção Municipal de Urbanismo** (Municipal direction of Urbanism)

reduction in lifecycle CO_2 emissions and decreased emissions of Nitrogen dioxides, will be evaluated by the previous defined KPI. - **Project evaluation:** the impact will be measure in the quality of life of citizens (improving urban quality of life for residents, workers and visitors to the city of Porto) and by the economic impact (the increase in competitiveness of the business fabric of the city of Porto and make it more attractive for investment). - **Internal and external reporting:** report and communication of the implementation results will be performed actively using the Municipality channels as institutional general newsletters and audio-visual tools. Other public events should be organizing to communicate the results to stakeholders in a detailed form.	**Departamento Municipal de Mobilidade e Gestão da Via Pública** (Municipal Department of Mobility and Public road management)

6.3   Replication plan of Smart Solution 7. Smart waste collecting, turning waste to electricity, heat and biogas for vehicles

6.3.1 Summary of implementation activity

– What does the measure consist of/key components?

The smart waste collection system combines Envac's underground waste transportation and optical sorting technologies, integrating smart metering, identification sensors and software.

– Specify area and scope of implementation (e.g. deep refurbishment of m2)

The technology assessment intended to test a waste collection system on a pilot demonstrator in the area of Campanhã.

– Name key steps and activities required for the project implementation

Key steps are:

- Analyse ENVAC comprehensive service packages and the integration cost and capacity with other smart functionalities (sensors and software)
- Procure sensors and Internet of Things (IOT) platform to be able to both collect data, but also for applications and adaptive steering of waste collection

- Install and connect the sensors to an IOT platform
- Analyse data and develop applications/solutions in the platform
- Test and evaluate applications in the connected waste bins to get instant feedback on their performance

– *Status quo of deployment / implementation step (if) already achieved (see below)*

The Municipality of Porto has been studying the possibility of implementing a smart waste collection system in the city and some pilot test were already been done.

6.3.2 Phase 1: Preparation of the implementation framework

Objective: Set the basis for a successfully implementation of the measure.

Indicative timeframe	Description of key activities	City departments/ offices involved
Jun 19– Dec 19	- **Policy and regulatory screening**: All current Portuguese regulations have already been analysed and no adaptations are need for the solution to be implemented. - **Stakeholder´s roles definition:** Porto Digital Association – Porto Digital will act at several levels, to ensure that citizens, academia, industry and Public Authorities can cooperate, benefit and be active partners in the process of creating a Smarter City. Porto Vivo, SRU – Sociedade de Reabilitação Urbana da Baixa Portuense, S.A. (Society of Urban Rehabilitation of the Centre of Porto). APOR (Agência para a Modernização do Porto – Agency for Porto´s modernization) is a partner which creates synergies for better cooperation between public and private entities and promotes the upgrading and modernization of the urban, industrial and business fabric of the city.	**Direção Municipal de Urbanismo** (Municipal direction of Urbanism) **Departamento Municipal de Mobilidade e Gestão da Via Pública** (Municipal Department of Mobility and Public road management)

6.3.3 Phase 2: Project inception planning, performance and finance

Objective: Outline key structural aspects for the measure's implementation.

Indicative timeframe	Description of key activities	City departments/ offices involved
Jan 20 – Mar 20	- **Governance designation**: Direção Municipal de Proteção Civil, Ambiente e Serviços Urbanos (Municipal Directorate of Civil Protection, environment and urban services) Project Manager: João Sendim Departamento Municipal de Mobilidade e Gestão na Via Pública (Municipal Department of Mobility and Public road management) Project Manager: João Neves - **Targets and goals setting (short- to long-term):** It is expected that these measures will reduce waste collection costs (fuel, human resources, vehicles, etc.). This new system will provide easy access to the waste disposal system, limit the use of inner and/or outer surfaces for waste bins and containers, improving citizens quality of life. It will contribute also for reduce environmental impact since waste collection traffic will be reduced by 90% with an accompanying reduction in CO_2 emissions, noise and pollution. Additionally, processing collected food waste as biogas will greatly reduce GHG emissions from the waste. Finally, the solution will showcase smart infrastructure and will entail a strong interaction with users by providing data in order to improve environmental behaviour, promoting sustainable economic development. - **Technology and infrastructure planning:** Resident puts his/her waste into the Envac waste inlet, the user is identified alongside the type (by colour of bag) and weight of waste being deposited. The different waste streams are then transported using suction through an underground pipe network to a collection station located outside the central city area. The system will be able to identify the amount and type of waste thrown away by individual users.	**Direção Municipal de Urbanismo** (Municipal direction of Urbanism) **Departamento Municipal de Mobilidade e Gestão da Via Pública** (Municipal Department of Mobility and Public road management)

This information could be used to provide feedback to the user, for instance, on individual recycling patterns. Any food waste collected will be processed as biogas, which in turn will be used to fuel public transportation.

Municipal Department of Mobility and Public Road management of the municipality of Porto, will involve all the relevant stakeholders from the local ecosystem considered important for such developments.

- **Definition of key performance indicators (KPIs)**:
The main indicator will be the (i) reduction in the amount of solid waste collected, (ii) the increased recycling rates and (iii) the increased conversion of food waste to biogas.

- **Cost-benefit analysis**:
Smart waste management solutions create higher efficiency in terms of resources and costs associated with keeping cities clean. Smart bins communicate information on fill levels and ensures collection only when the bin is full, leading to fewer collection visits, with reduced congestion and traffic interruption, resulting also in cleaner and safer streets. Besides, traffic reduction due to fewer collection visits helps reduce carbon dioxide and other emissions.

- **Business and financial model definition**:
Since the municipality owns and manages an important share of housing through its daughter companies, in the first stage, the implementation plan will be financed by Public Funding and by the GrowSmarter Replication budget. Trough the project "CSI Europe: City Sustainable Investment in Europe – asking financial instruments work for cities", it will be identified financial instruments in the planning of sustainable urban development, particularly in the context of urban revitalisation. The main supporters will be the city inhabitants and local companies, because this will potentially provide a better waste

	collection service, and will reduce operating costs, which may, in the end, reduce collected taxes.	

6.3.4 Phase 3: Political approval and stakeholder engagement

Objective: Obtain and maintain political and stakeholder commitment for the implementation.

Indicative timeframe	Description of key activities	City departments/ offices involved
Jan 20 – Jun 20	- **Political commitment**: Promoting Porto as sustainable city, in its relationship with the territory in historical aspect, its sustained centrality function, and "brand in the region". The Municipality of Porto has been studying the possibility of implementing a smart waste collection system in the city, thereby demoting its commitment to this measure. - **Strategic intermediaries:** Porto Vivo, SRU (Society of Urban Rehabilitation of the Centre of Porto), APOR (Agency for Porto´s modernization) and Porto Digital Association are fully committed supporting the implementation of the Smart City concept. **Public participation and citizen engagement:** Taking advantage of the knowledge and success of the initiatives promoted by Porto Digital to increasing visibility and public awareness for different fields such as sustainability, mobility, urban planning and information and communication technology, Public participation and citizen engagement. This will be achieved by leveraging programs such as ScaleUp Porto and ScaleUp Europe initiatives. - **Capacity building of city staff**: In the last 5 years Porto has been part of several projects that are very relevant in the Smart City domain and in coherence with the Political strategy to	**Direção Municipal de Urbanismo** (Municipal direction of Urbanism) **Departamento Municipal de Mobilidade e Gestão da Via Pública** (Municipal Department of Mobility and Public road management)

transform Porto into a Smart city. Besides, there will be planed benchmarking actions in Stockholm, seminars and training actions for the staff and the involvement of all public and private stakeholders.

6.3.5 Phase 4: Project implementation

Objective: Plan the effective implementation of the defined measure.

Indicative timeframe	Description of key activities	City departments/ offices involved
Jun 20 – Jun 21	- Implementation plan: 1. Definition plan considering the pilot area to intervene, procurement plan definition (what to buy, when and from what source) and definition of terms for contracts, negotiation and management 2. Test Envac's underground waste transportation and optical sorting technologies, integrating smart metering, identification sensors and software. 　- Analyse ENVAC comprehensive service packages and the integration cost and capacity with other smart functionalities (sensors and software) 　- Procure sensors and Internet of Things (IOT) platform to be able to both collect data, but also for applications and adaptive steering of waste collection 　- Install and connect the sensors to an IOT platform 　- Analyse data and develop applications/solutions in the platform 　- Test and evaluate applications in the connected waste bins to get instant feedback on their performance 3. Analyse KPI and document recommendation of actions to improve work quality on further areas.	**Direção Municipal de Urbanismo** (Municipal direction of Urbanism) **Departamento Municipal de Mobilidade e Gestão da Via Pública** (Municipal Department of Mobility and Public road management)

	4. Benchmark session in Stockholm and seminar event in Porto to present the results and identify further chances for cooperation.	
	- **Procurement model**: To be defined at the start of the Implementation plan	
	- **Contract negotiation and management**: To be defined at the start of the Implementation plan	

6.3.6 Phase 5: Monitoring and progress evaluation

Objective: Plan the monitoring, evaluation and reporting of the implementation of the measure.

Indicative timeframe	Description of key activities	City departments/ offices involved
Jun 21– Dec 21	- **Project monitoring:** The monitoring and evaluation of the solution will be adapted from the used by Stockholm. Additionally, the reduction in the amount of solid waste collected, the increased recycling rates and the increased conversion of food waste to biogas will be evaluated by the previous defined KPI. - **Project evaluation:** The impact will be measure in the quality of life of citizens– improving urban quality of life for residents, workers and visitors to the city of Porto and by the economic impact trough new business models and partnerships – to increase the competitiveness of the business fabric of the city of Porto and make it more attractive for investment. - **Internal and external reporting:** Report and communication of the implementation results will be performed actively using the Municipality channels as institutional general newsletters and audio-visual tools. Other public	**Direção Municipal de Urbanismo** (Municipal direction of Urbanism) **Departamento Municipal de Mobilidade e Gestão da Via Pública** (Municipal Department of Mobility and Public road management)

	events should be organizing to communicate the results to stakeholders in a detailed form.	

6.4 Replication plan of 8. Big data protocol for saving energy and improving the quality of life

6.4.1 Summary of implementation activity

– What does the measure consist of/key components?

The measure consists on a fast and easy overview of the situation in the identified city concerning traffic, energy and environment through a visualization tool (VT) analogues to the Urban COCKPIT. There is a group of many indicators that is updated every few seconds. What the indictors show can be adapted for every city and for every user group like citizens or control centre staff. On the other side of the Open Urben Platform (OUP) and the Visualization Tool (VT), there is more detailed information about various different aspects of the city's current condition. This may include the number of free parking spaces, number of cars shared, current use of public transport and so on. OUP module in the middle is a multisided big open data platform where all integrated traffic and energy measures can be supported as well as measures to reduce waste or to save energy by for example the use of smart humble lampposts.

– Specify area and scope of implementation (e.g. deep refurbishment of m2)

The technology assessment intended to test the System of an OUP and a VT on a pilot demonstrator in the area of Campanhã.

– Name key steps and activities required for the project implementation
1. Define users and their needs for data collection and adaptive steering in city environments
2. Analyse the existence of optical fibre and electricity
3. Procure sensors to be able to both collect data, but also for applications and adaptive steering of city environments (OUP does not use proprietary standards and therefore connectors can be developed from any data source and for every sensor/service interface.)
4. Install and connect the sensors to OUP module
5. Analyse data and develop applications/solutions in the platform
6. Test and evaluate applications in the connected street environment to get instant feedback on their performance.

-Status quo of deployment / implementation step (if) already achieved (see below)
The Municipality of Porto is presently designing, specifying and developing an OUP analogues to the Urban Pulse , which will collect and analyse mobility, environment, energy, waste and civil protection data for the city management and service provision. The VT will be developed in parallel with the Integrated Management Center (CGI) at the Municipality of Porto.

6.4.2 Phase 1: Preparation of the implementation framework

Objective: Set the basis for a successfully implementation of the measure.

Indicative timeframe	Description of key activities	City departments/ offices involved
Jun19 – Dec 19	- **Policy and regulatory screening**: All current Portuguese regulations have already been analysed and no adaptations are need for the solution to be implemented. - **Stakeholder´s roles definition:** Porto Digital Association – Porto Digital will act at several levels, to ensure that citizens, academia, industry and Public Authorities can cooperate, benefit and be active partners in the process of creating a Smarter City. Porto Vivo, SRU – Sociedade de Reabilitação Urbana da Baixa Portuense, S.A. (Society of Urban Rehabilitation of the Centre of Porto) APOR (Agência para a Modernização do Porto – Agency for Porto´s modernization) is a partner which creates synergies for better cooperation between public and private entities and promotes the upgrading and modernization of the urban, industrial and business fabric of the city.	**Departamento Municipal de Sistemas de Informação/Divisão Municipal de Gestão de Aplicações e Informação** (Municipal Department of Information Systems/Municipal Division of application and information management)

6.4.3 Phase 2: Project inception planning, performance and finance

Objective: Outline key structural aspects for the measure's implementation.

Indicative timeframe	Description of key activities	City departments/ offices involved
Jan 20 – Mar 20	- **Governance designation**: Departamento Municipal de Sistemas de Informação/Divisão Municipal de Gestão de Aplicações e Informação (Municipal Department of Information Systems/Municipal Division of application and information management) Project Manager: Fernando Rui Russell Cortez Barbosa Pinto - **Targets and goals setting (short- to long-term):** The information achieved with this action can be used to support cities in managing and optimising their traffic flows, energy consumption and production, and pollution outputs for future city planning as well as to determine which measures have the largest impact on the improvement of urban quality of life for residents, workers and visitors to the city of Porto. Digital interfaces to access information channels will be provided as Data Services on the open data platform of Porto. In this way service and app developers will be supported in developing new ideas for using this information to create new value-added solutions for users of e.g. the mobility hub measure of the City of Porto. - **Technology and infrastructure planning:** OUP is a high-level architecture solution system. The OUP is a multisided large open data platform. It is open to any kind of urban data on the urban data source side and can provide data and information via open standards to different data consumers. Urban data is provided from traffic management systems or from project partners or urban companies such as energy providers. Additionally, environment data from sensors can be used. All data will be processed in real time to generate value added data (information). This data will be stored to provide a	**Departamento Municipal de Sistemas de Informação/Divisão Municipal de Gestão de Aplicações e Informação** (Municipal Department of Information Systems/Municipal Division of application and information management)

historical prospective for the data analytics.

Data and information are provided to apps or as Data Services to consumers. In this case, the VT is the data consumer.

The Municipal Department of Information Systems of the municipality of Porto will involve all the relevant stakeholders from the local ecosystem considered important for such developments

- **Definition of key performance indicators (KPIs)**:
    - Reduction in annual final energy consumption
    - Reduction in life cycle energy use
    - Reduction of embodied energy of products and services
    - Reduction of traffic accidents
    - Decreased delay by traffic congestion
    - Reduction in annual final energy consumption (by transport)
    - Reduction in life cycle energy use
    - Carbon dioxide emission reduction
    - Reduction in lifecycle CO_2 emissions
    - Decreased emissions of Nitrogen dioxides

- **Cost-benefit analysis**:

    The main advantages of this measure are: (i) fast and easy overview of the current situation in the city concerning traffic, energy and environment, (ii) data and information obtained can be used for city planning, traffic and energy management, and environmental monitoring; (iii) data can also be provided on open data platforms of cities.

    The shift from fragmented operations to predictive effective operations, and the engagement to city stakeholders in order to transform outcomes at local level could potentially affect various socioeconomic aspects.

- **Business and financial model definition**:

    The first stage of the implementation plan will be financed by public funding. In addition, it is expected that the data obtained from the city environment

	monitoring can become a revenue source of for the municipality.	

6.4.4 Phase 3: Political approval and stakeholder engagement

Objective: Obtain and maintain political and stakeholder commitment for the implementation.

Indicative timeframe	Description of key activities	City departments/ offices involved
Jan 20– Jun 20	- **Political commitment:** Promoting Porto as sustainable city, in its relationship with the territory in historical aspect, its sustained centrality function, and "brand in the region". Through Porto Digital, Porto Municipality goal is to achieve a structural change in the operating mode of the city and its infrastructure by paving the way for greater representation in the digital world. - **Strategic intermediaries:** Porto Vivo, SRU (Society of Urban Rehabilitation of the Centre of Porto), APOR (Agency for Porto´s modernization) and Porto Digital Association are fully comited supporting the implementation of the Smart City concept and PORTO DIGITAL association. Several companies must be contacted by the Municipality of Porto. The city plans can adopt different solutions, and not a 'one size fits all' solution, because different areas of the city have different and specific requirements and needs. - **Public participation and citizen engagement:** Taking advantage of the knowledge and success of initiatives promoted by Porto Digital to increase visibility and public awareness for different fields such as sustainability, mobility, urban planning and information and communication technology, Public participation and citizen engagement. This will be	**Departamento Municipal de Sistemas de Informação/Divisão Municipal de Gestão de Aplicações e Informação** (Municipal Department of Information Systems/Municipal Division of application and information management)

achieved by leveraging programs such as ScaleUp Porto and ScaleUp Europe initiatives.

- **Capacity building of city staff**:
  In terms of big and open data management, the Municipality of Porto (with the coordination and support of Porto Digital) has been working on several initiatives: (i) Urban Platform, (ii) Hackacity, (iii) Open Data Platform, (iv) Integrated Management System (CGI)
  Besides, there will be planed benchmarking actions in Stockholm, seminars and training actions for the staff and the involvement of all public and private stakeholders.

6.4.5 Phase 4: Project implementation

Objective: **Plan the effective implementation of the defined measure.**

Indicative timeframe	Description of key activities	City departments/ offices involved
Jun 20 – Jun 21	- **Implementation plan**: 1. Definition plan considering the pilot area to focus on, procurement plan definition (what to buy, when and from what source) and definition of terms for contracts, negotiation and management 2. Action plan for data collection and adaptive steering in city environments – Traffic management systems – Project Partners – OUP 3. Test and evaluate applications in the connected street environment to get instant feedback on their performance. 4. Analyse KPI and document recommendation of actions to improve work quality on further interventions	**Departamento Municipal de Sistemas de Informação/Divisão Municipal de Gestão de Aplicações e Informação** (Municipal Department of Information Systems/Municipal Division of application and information management)

	5. Benchmark session in Cologne and seminar event in Porto to present the results and identify further chances for cooperation.	
	- **Procurement model:** To be defined at the beginning of the implementation plan	
	- **Contract negotiation and management**: To be defined at the beginning of the implementation plan	

6.4.6 Phase 5: Monitoring and progress evaluation

Objective: **Plan the monitoring, evaluation and reporting of the implementation of the measure.**

Indicative timeframe	Description of key activities	City departments/ offices involved
Jun 21 – Dec 21	- **Project monitoring:** The monitoring and evaluation of the solution will be adapted from the one used in Cologne. Additionally, the reduction in annual final energy consumption, the reduction in life cycle energy use, the reduction of embodied energy of products and services, the reduction of traffic accidents, decreased delay by traffic congestion, reduction in annual final energy consumption (by transport), reduction in life cycle energy use, carbon dioxide emission reduction , reduction in lifecycle CO_2 emissions and decreased emissions of Nitrogen dioxides, will be evaluated accordingly to the previously defined KPI. - **Project evaluation:** The impact will be measured in the quality of life of citizens (improving urban quality of life for residents, workers and visitors to the city of Porto), and by the economic impact (increasing the competitiveness of the business fabric of the city of Porto and make it	**Departamento Municipal de Sistemas de Informação/Divisão Municipal de Gestão de Aplicações e Informação** (Municipal Department of Information Systems/Municipal Division of application and information management)

	more attractive for investment).	
	- **Internal and external reporting:** Report and communication of the implementation results will be performed by actively using the Municipality channels, such as institutional general newsletters and audio-visual tools. Other public events will be organised to communicate the results to stakeholders in a detailed manner.	

6.5 Replication plan of Solution 11. Alternative fuel driven cars for better air quality in cities Summary of implementation activity

6.5.1 Summary of implementation activity

- What does the measure consist of/key components?

In order to replace fossil fuelled vehicles, both electric and sustainable biofuels are necessary. To push the market for alternative-fuel cars and heavy vehicles, barriers to the adoption of AFVs need to be removed and incentives introduced. A renewable fuelling station for cars and heavy vehicles is an important step in this process. Each such new station will be required to provide at least two of the following alternative fuels: Biogas (Methane gas), ED95 (ethanol fuel mix with 95 percent ethanol and 5 percent additive), HVO (Hydrogenated vegetable oil), and RME (Rapeseed Methyl Ester).

- Specify area and scope of implementation (e.g. deep refurbishment of m2)

The technology assessment team intends to test a pilot new station in the area of Campanhã.

- Name key steps and activities required for the project implementation

In order to get more vehicles operating on biofuels, a larger number of filling stations that provide biofuels are needed. The City of Porto will find suitable locations for these new stations, with the land being leased to filling station operators at a standard price, on the condition that at least two different biofuels must be supplied at each station. In addition to the new stations some existing diesel ones will add alternative fuels to their complement.

− Status quo of deployment / implementation step (if) already achieved (see below). Presently, 38% of the STCP's bus fleet is powered by diesel and 62% by gas. The ambition is to have a fleet made of more than 90% gas or electric vehicles by 2019.

6.5.2 Phase 1: Preparation of the implementation framework

Objective: Set the basis for a successfully implementation of the measure.

Indicative timeframe	Description of key activities	City departments/ offices involved
Jun 19 – Dec 19	- **Policy and regulatory screening**: All current Portuguese regulations have already been analysed and no changes will need to be done in order to implement the solution. - **Stakeholder´s roles definition:** Porto Digital Association – Porto Digital will act at several levels, to ensure that citizens, academia, industry and Public Authorities can cooperate, benefit and be active partners in the process of creating a Smarter City. APOR – Agência para a Modernização do Porto (Agency for Porto´s modernization) is a partner which creates synergies for better cooperation between public and private entities and promotes the upgrading and modernization of the urban, industrial and business fabric of the city. STCP – Sociedade de Transportes Colectivos do Porto, SA (Porto Collective Transport Society, SA)	**Departamento Municipal de Mobilidade e Gestão da Via Pública** (Municipal Department of Mobility and Public road management)

6.5.3 Phase 2: Project inception planning, performance and finance

Objective: Outline key structural aspects for the measure's implementation.

Indicative timeframe	Description of key activities	City departments/ offices involved
Jan 20 – Mar 20	- **Governance designation**: Departamento Municipal de Mobilidade e Gestão da Via Pública (Municipal Department of Mobility and Public road management) Project Manager: João Neves - **Targets and goals setting (short- to long-term):** The main motivations are to reduce CO_2 emissions and fossil fuel consumption (thus reducing pollution levels associated with mobility) and to reduce fuel costs. The new filling stations will make it possible for an increase in the number of vehicles operating on biofuels in Porto, which will reduce carbon dioxide emissions from fossil fuels. In some cases, noise levels will also decrease. Sustainable economic development will hence be promoted. By actively working with interested fuel companies and the automotive industry, GrowSmarter can create a win-win situation where the city is responsible for finding and renting the land and private stakensholderes handle the other investments. The Sustainable Energy Action Plan (SEAP-P), was conceived as a long-term goal to achieve measurable results in **the improvement of urban quality of life for residents, workers and visitors to the city of Porto.** - **Technology and infrastructure planning:** First suitable locations must be found for these new stations. The land may be leased to filling station operators at a standard price, on the condition that at least two different biofuels are supplied at each station. Some of the stations will be completely new, and some will be diesel stations to which alternative	**Departamento Municipal de Mobilidade e Gestão da Via Pública** (Municipal Department of Mobility and Public road management)

fuels are added.

Municipal Department of Mobility and Public Road Management of the municipality of Porto will involve all the relevant stakeholders from the local ecosystem considered important for such developments

- **Definition of key performance indicators (KPIs)**:
    - Carbon dioxide emission reduction
    - Reduction in lifecycle CO_2 emissions
    - Decreased emissions of Nitrogen dioxides

- **Cost-benefit analysis:**
    By actively working with interested fuel companies and the automotive industry, GrowSmarter can create a win-win situation where the city is responsible for finding and renting the land and private stakeholderes handle the other investments.
    In the context of the city, the main goals of such initiatives and plans are to improve the quality of life of the citizens, contributing to the city´s actractiveness for social and economical purposes. The aim is to improve economic growth, attract new investements and implement an energy and sustainability framework integrated with the national and European ones.

- **Business and financial model definition**:
    Both institutions (the Municipality of Porto and STCP) have common objectives on their environmental and sustainability policies and strategies. The acquisition of new vehicles and stations will be funded by the Municipality of Porto and STCP, and is co-funded by national and European funds.

6.5.4 Phase 3: Political approval and stakeholder engagement

Objective: Obtain and maintain political and stakeholder commitment for the implementation.

Indicative timeframe	Description of key activities	City departments/ offices involved
Jan 20 – Jun 20	- **Political commitment:** Promoting Porto as a sustainable city, in its relationship with the territory in historical aspects, its sustained centrality function, and "brand in the region". The Municipality of Porto has been making a significant investment in electric mobility by replacing its current fleet of diesel vehicles by electric and hybrid models, which are used by the municipality services, police and municipal companies. - **Strategic intermediaries:** Departamento Municipal de Mobilidade e Gestão da Via Pública (Municipal Department of Mobility and Public road management) and STCP – Sociedade de Transportes Colectivos do Porto (Transport Company Collective of Porto), are fully comited to supporting the implementation of environmental and sustainability policies and strategies. - **Public participation and citizen engagement:** Taking advantage of the knowledge and success of the initiatives promoted by Porto Digital to increase visibility and public awareness for various fields (such as sustainability, mobility, urban planning and information and communication technology), public participation and citizen engagement. This will be achieved by leveraging programs such as ScaleUp Porto and ScaleUp Europe initiatives.. - **Capacity building of city staff:** The Transport Company Collective of Porto (STCP) ensures passenger transport in the Porto Metropolitan Area, both by bus and metropolitan,	**Departamento Municipal de Mobilidade e Gestão da Via Pública** (Municipal Department of Mobility and Public road management)

having almost 80 years of experience. In addition, there will be planed benchmarking actions in Stockholm, seminars and training actions for the staff and the involvement of all public and private stakeholders.

6.5.5 Phase 4: Project implementation

Objective: **Plan the effective implementation of the defined measure.**

Indicative timeframe	Description of key activities	City departments/ offices involved
Jan 20 – Jun 20	**Implementation plan:** 1. Definition plan considering the pilot area to focus on, procurement plan definition (what to buy, when, and from what source) and definition of the terms for contracts, negotiation and management 2. Installation of new stations and addition of alternative fuels to existing fuel stations. 3. Analysis of KPIs and document recommendation of actions to improve action quality on further interventions 4. Benchmark session in Stockholm and seminar event in Porto to present the results and identify further chances for cooperation. - **Procurement model:** To be defined at the start of the implementation plan - **Contract negotiation and management:** To be defined at the start of the implementation plan	**Departamento Municipal de Mobilidade e Gestão da Via Pública** (Municipal Department of Mobility and Public road management)

6.5.6 Phase 5: Monitoring and progress evaluation

Objective: Plan the monitoring, evaluation and reporting of the implementation of the measure.

Indicative timeframe	Description of key activities	City departments/ offices involved
Jun 21– Dec 21	- **Project monitoring:** The monitoring and evaluation of the solution will be adapted from the one used in Stockholm. Additionally, the carbon dioxide emission reduction, the reduction in lifecycle CO_2 emissions and the decreased emissions of Nitrogen dioxides will be evaluated by the previous defined KPI. - **Project evaluation:** Impact will be measure in the quality of life of citizens (improving urban quality of life for residents, workers and visitors to the city of Porto), and by the economic impact (increasing the competitiveness of the business fabric of the city, and making it more attractive for investment). - **Internal and external reporting:** Reporting and communication of the implementation results will be performed actively using the Municipality channels, such as institutional general newsletters and audio-visual tools. Public events should be organized to communicate the results to stakeholders in a more detailed manner.	**Departamento Municipal de Mobilidade e Gestão da Via Pública** (Municipal Department of Mobility and Public road management)

7   Conclusions

The smart and digital Porto city strategy and policies date back to 2004, when the Municipality of Porto (MP) created the Porto Digital Association (PD), a private non-profit association, seeking the designing and promotion of ICT projects within the context of the city.

Since 2014, the municipality has been proposed a broader new strategy that aims the development of citizen driven services with high impact in increasing the city attractiveness for entrepreneurs, reducing social exclusion and increasing the city sustainability. The municipality strong commits in this new strategy and the results already achieved are being fundamental to attract new players from the ecosystem. Porto aims at turning out to be a true living lab, a catalyst of innovation, which works in a close cooperation with the academia, along with character reference entrepreneurs from Porto's bright innovative businesses ecosystem.

Testing and acquiring new innovations to transform the energy and transport environment of cities is certainly complex, highlighted by the challenging experiences of the numerous projects of the GrowSmarter experience. Once the arduous path of identify a successful new innovative solution is completed, the challenges is far from over. Innovations in general face the moment where the costs of entering the market and upscaling simply cannot be ignored. Lack of venture capital, market flops and other obstacles can bring the process to an end. This is not only a reality for smart city solutions, but because of their nature, but the number of obstacles is often greater than in many other areas of innovation.

Aligned with this innovation strategy, at the GrowSmarter application phase, the Follower City of Porto had selected a total of five disruptive GrowSmarter solutions that it would be benefit to replicate. An in-depth study will be performed as a starting point of each implementation action plan, even that some of the GrowSmarter solutions will go from more favourable conditions to achieve the success of the proposed measures. Some of the GrowSmarter solution will be harder to replicate at Porto, particularly the ones that leave from very different local context at the lighthouse city model. To overcome that obstacle, Municipal Department implicated in the project is fully committed in involve all the relevant stakeholders from the local ecosystem considered critical for achieve the proposed goals.

To ensure that successful innovative technologies tested in Lighthouse cities are replicated in Porto follower projects, best practices must be learned and implemented. Bringing together project developers, cities, institutions, industry and experts from across Europe, we must encourage the exchange of data, experience and know-how to collaborate on the creation of smart cities and sustainable urban environment.