OVERVIEW

Finance & Procurement for Smart Cities

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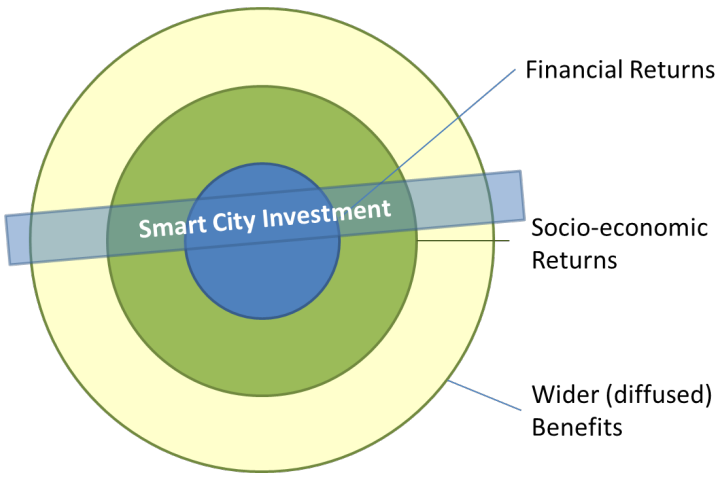
1. Creating Value through Smart City Solutions

Smart city technologies and connected solutions offer a significant opportunities to create sustainable environments which support efficient municipal services and whilst improving the quality of life forcitizens in our cities. Intelligent solutions that connect a range of technologies not only has the potential to **increase efficiency but** also produces a range of **additional benefits**. For example, an **electric car-sharing** solution reduces noise in cities, frees up urban space, reduces emissions and enhances personal mobility. Similarly, a **hybrid district energy grid** reduces fossil fuel consumption, maximizes clean energy use, offers cost effective production along with the use and storage of energy via intelligent balancing schemes. In doing so, it increases liveability for city dwellers reducing both demand and cost. These benefits can translate into **real financial returns on investments** and make smart city solutions attractive investments.

In most cases, the financial returns of smart solutions has **social, environmental and wider economic impact.** For example, a local SME or start-up providing components of a data-driven smart city solution - (e.g. a platform for an electric scooter sharing system. This has several positive effects at a local level (*jobs, environmental benefits, tax payments, a sustainable mobility system, commuter time saving, less GHG emissions, and better air quality*). These wider benefits can be translated into monetary benefit (*e.g. one job equals x EUR in taxes, y EUR in local consumption and z EUR saved in the social security system*). However they are challenging to include into a business and robust financing model.

Alongside thewider benefits, smart city solutions create additional and diffuse benefits on a personal level- quality of life, comfort, well-being, health, social integration, security and happiness can all be an outcome of good investment in smart urban solutions.

Figure 1: Creating Value through Smart City Solutions



Return on investment is the main driver for a private investor in smart city technologies. Providing a robust and convincing business case is often a challenge. The wider value for society of a smart solution or a smart process often exceeds the financial return. To harness the potential of smart solutions,we need to deploy existing instruments to finance urban development and procure innovation in a smart way. We need new "off the shelf" financial instruments that have the ability to capture the full value of smart urban solutions on both private and public levels.

2. Challenges to financing innovation and ICT-based urban infrastructures

Most smart city projects share a characteristic that challenge conventional approaches to finance, investment and procurement.

1. **Innovation means higher risk**

Most smart city solutions are based on either innovative technologies or have an innovative component. Often it is not the technology itself but rather the integration of several different technologies (e.g. sensors, smart phones, cars, charging stations, electricity grid, smart meters, lampposts etc.) in an interoperable system using connectivity and IoT.

Whether it is new technologies or new constellations of proven technologies (or both), smart urban solutions are from an investor perspective, are seen as innovations and therefore as a risk.

Higher risk is also associated with higher prices. These necessitate a higher return in order to secure investment. This means that private capital will be attracted to smart city investments only when there is a good chance to generate high return margins (e.g. 35% within 10 years' time or more) or when a smart city project comes with a credible or proven approach to de-risking and secure against losses.

2. **High complexity means high transaction costs**

A unique selling point (USP) of smart urban solutions is the **interlinked and connected nature of the systems.** It is not about a single technology, but rather a set of technologies that together offer functions and interactions with users / operators. Smart urban solutions are socio-technical systems that interact in an intelligent way to deliverbenefits to a network of beneficiaries.

The more actors there are in a transaction, the higher the costs of organizing and governing the transaction. The more interactions between objects (e.g. sensors, PV panels, street lights etc.), the higher the costs for calibration, testing, and operation / maintenance. Smart city projects require smart organisation and governance. Stakholders can include providers of different products, operators of IT networks, owners of infrastructure and buildings, municipal partners, customers and citizens, and investors. A smart city project will only be successful in the long term if each actor understands the benefits that the smart solution provides. For example, a smart waste management system will only be successful if the waste company, the staff, the municipal waste department, the investor, the supplier of sensors, smart bins and IT systems and the users (i.e. those disposing /recycling waste), feel that they can will benefit or profit from the new system. If benefit is not foreseen the investment is not likely to take place.

Negotiating stakeholder agreements that deliver a positive cost-benefit relationship for all stakeholders is an arduous task and consumes time and resources. It raises the transaction costs of smart city projects during development and also during operation. Business cases that are able to calculate the different types of return on invest for the different stakeholders involved are essential.

3. **Priority of local context means a fragmented market**

Smart city solutions and technologies need to adapt to local circumstances. These are multiple: geography, existing infrastructure, size of district, and amount ofusers, national or local regulations etc. This places higher costs on solution providers because standardization is only possible in a modular way – fully standardized smart city solutions that function like "off-the-shelf products" and can be sold to a diverse range of cities are virtually impossible to find.

In addition procurement and project development are subject to local political cycles, making it difficult to align the investments to solutions and products. Cities may also want to support their local innovation ecosystems, for example through procurement of innovation and involvement of local SMEs.

All these lead to a fragmented market where scale-effects are scarce and solutions remain expensive. They are the reason why the smart city market is strongly innovation driven but not yet very attractive to investors.

To counter these challenges new approaches and instruments to finance and procurement of smart solutions are needed:

- **Blended finance vehicles** for smart cities that help share risks and returns to leverage significant private funding by taking first-loss guarantees and creating a low-to medium-risk high-return investment.
- **Holistic cost-benefit models** help calculate and capture the complex and distributed returns on a smart city investment. Through this, public authorities can better calculate the wider social, economic and environmental benefits of their investments and are willing to give guarantees and become core-investors in public private partnerships.
- **Standardization of solutions** – the **interoperability** of connected products and IT-interfaces drastically reduces transaction costs for investments into smart solutions. Combined with new solution-based market-platforms like BABLE[1] a higher transparency of the EU smart city market can be achieved and fragmentation of the market will reduce.
- **Improved governance** of smart city investments is needed - new **contract models**, co-operation agreements and framework contracts that standardize consortium-based or ecosystem-based approaches to delivering and operating smart urban solutions. This has the potential to reduce complexity and increase security for investment for all stakeholders.
- New investment vehicles like **smart city bonds** or **smart city funds** can pool investments from different public and private sources. This can help ensure social, economic, financial and environmental return on invest corresponding to their monitoring schemes.
- **Procurement of innovation** and the application of alternative procurement instruments help cities invest into problem solving, rather than pre-described technologies that may not achieve best value for money.
- Lastly, **dynamic purchasing systems** allow cities to join forces for procurement of smart solutions, giving them a greater pull on the market..

The following sections describe some of the new approaches to financing and procuring smart urban solutions. The examples from SmartImpact member cities help understand how they function in reality and what barriers are still to be overcome.

3. Financial Models, instruments and collaboration mechanisms

Blending - this is funding model that applies blended finance leverages, development finance and philanthropic resources to attract further private capital. Blended finance is used to diversify investment risks as well as decrease the investment dependency on one source of capital (mostly the city budget). Blending funds from various capital sources, e.g. grants, national funds, ERDF (European Regional Development Funds) as well as private capital can increase the impact of the city budget, as well as increase the risk-sharing. This model is extensively used in cities like Manchester and Eindhoven . There are various options of blending: grants, junior equity, flexible debt, guaranteesas shown in below.

Figure 2: Blended Finance for Smart Cities

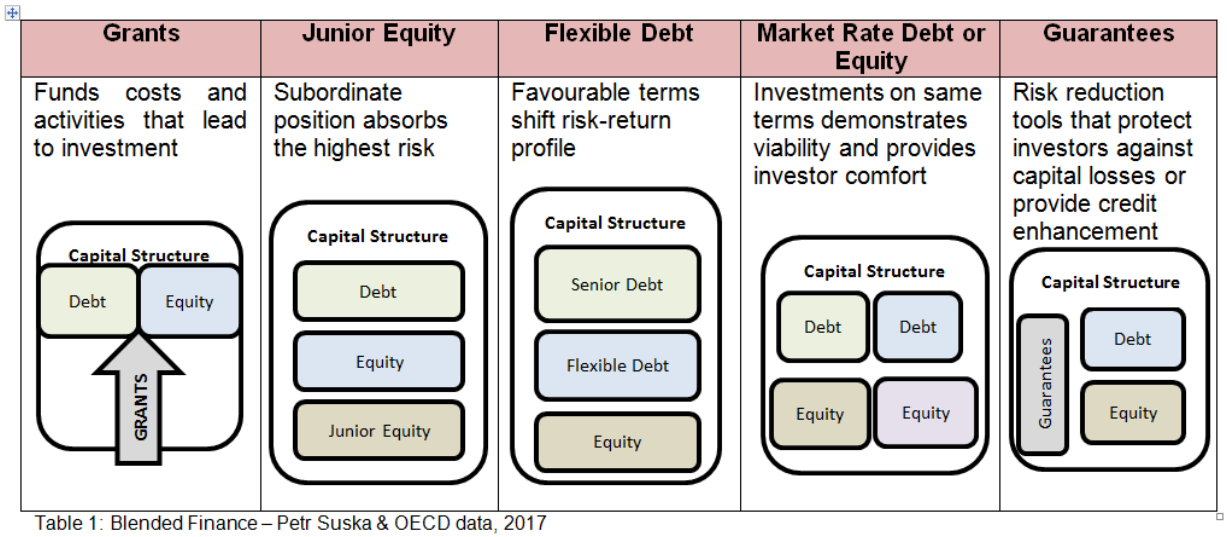


Table 1: Blended Finance – Petr Suska & OECD data, 2017

The principal reason for blend funding is to leverage and increase private investments. The benefits include:

1. Allocation of risks between public and private finance
2. Expansion of investor's risk appetite
3. Combination of projects to bring in international institutional money
4. Crowding in local finance, leveraging local savings
5. Simplification of project preparation – homogenisation

There is an evolving spectrum of 5 categories of financing options for smart city projects :

1. **Government-based Finance Options**
    - *Examples: Green Bonds, Social Impact Bonds, Energy Efficiency Loans*

Cities maintain capital funds separate funds from their operating funds. Capital funds are used to repay the financing of long-term investments with a lifespan over many years. Under the model of public finance, governments issue debt instruments with an agreement to pay back the debt, usually over the lifespan of the item being financed at an agreed-upon interest rate. The most common tools used to pay for these kinds of capital costs are **government-issued bonds**. There are many examples of these, such as green bonds issue in Gothenburg, Sweden to make earmarked investments into low-CO2 projects.

2. **Development Exactions**
    - *Example: Tap Fees, Linkage Fees, Impact Fees*

      Government-based financing tools are the most commonly used for the funding of unproven smart technologies with high risks. Another set of financing tools (Development Exactions) highlight the regulatory power of governments to **force developers to pay for the infrastructure services that their developments will access**. For example Philadelphia levies impact fees to fund a storm-water capture program (the city assesses property fees on the ratio of the property's impervious surface area that prevents water absorption). Likewise, the city of Freiburg requires investors to fund local social infrastructure like child-care and schools as well as to provide 1/3rd of the housing in the district as social housing, when purchasing public land.

3. **Public-Private Partnerships**
    - *Example: Traditional PPP, Pay for Performance, Securitization and Structured Finance.*

      The most common PPP in the area of smart cities are **Energy Service Contracts (ESCOs).** Here the public authority contracts a service company to invest, install and operate an efficient smart city solution–offering greater cost saving than the existing infrastructure. A long-term contract makes sure that the investors harnesses the return on investment (ROI) and offers the city long term savings.

      Pay for performance means that an investor into a particular technology starts generating return on that investment once the technology delivers the financial and operation performance results.

      Increasingly, public and private investors,are mitigating their risks by using financing instruments that secure their investments and reduce their risk. This can be done through a key instrument called **securitization through structured financing**. Structured finance is a complex financial transaction by entities with financing needs that do not match traditional loan structures. Securitization is the pooling of various revenue-generating assets and selling them off through shares to invests. This means that similar investments can be packaged together into a larger portfolio to generate immediate revenue from long-term revenue streams as well as diversifying risk. For

smart city investments this means that risks of innovative technologies can be mitigated (diluted) by packaging them with conventional investments.

4. **Mechanisms to Leverage the Private Sector**
    - *Example: Loan Loss Reserve Fund (LRF), Loan Guarantees, On-Bill Financing, Pool Bond Financing, Value Capture, Tax Increment Financing*
      A lLoan Loss reserve fund is a fund aimed at retrofitting of homes which provides below-market rate loans. This was used in New York in 2011 to support a programme to replace existing windows with better insulated ones. This is a method to get the 'buy to let'property landlords to invest in their buildings.
    - Loan guarantees use special Risk Sharing Instrument (RSI) to ease access to financing for SMEs and increase competitiveness. The European Investment Fund is governed by the EIB and BPCE Group in France) is a collaborative effort to provide funding to developing regions.
    - Pool Bond Financing suggests a creation of a legal entity, which is owned by a private and public actors (Development Banks, Association of Cities and Communities, Ministries, etc) This entity can borrow funds at a lower interest rate and lend to local banks to distribute funds to particular projects.
    - Value Capture –Betterment levies are a form of tax or a fee levied on **land that has gained in value because of public infrastructure investments.** Manchester has used previously *Betterment Levies*. These are considered the most direct form of value capture. Whilst impact fees and developer exactions work from the cost side of budgets, betterment levies try to capture part of the infrastructure investment already incurred by the government. At one point, the UK imposed a betterment tax equivalent to 40 percent of the land-value gains to be channelled in to public infrastructure investment.[2]

5. **New Alternatives of Funding**
    - *Example: Crowdsourcing, Micro Lending, Venture Capital, philantropic funding*
    - Large parts of the development and piloting of smart city solutions has been driven by start-ups and SME's in the past. Cloud-based approaches for funding start-ups and SMEs through crowd-sourcing platforms like "Kick-starter", venture capital investment, or equity finance have thus played a large role in pushing the smart city market in Europe throughout the last few years. This model is typical for an immature and fragmented market and – since it is a bet on the future – theimportance will reduce when market fragmentation is reduced.
    - Other alternative funding schemes e.g. citizen-investments, IT-based cooperative development funds etc. offer a more future-proof alternative for local investments. Citizens, philanthropists and local companies directly benefit from (local) smart city investments, not only financially but also in other ways, e.g…….. This makes them a perfect investment partner for a local smart city fund or a cooperative investment.

4. EIB approaches to Smart City Finance

About the EIB

The EIB is the bank of the European Union, owned by the member states, with a mission to support through sustainable investment, EU policy. It was created by treaty in 1958 and is the world's largest multilateral borrower and investor.

The bank has a credit rating of AAA which allows it to raise finance at advantageous rates which is then used to support sustainable investment projects that meet the EU policy objectives. In 2016 the EIB committed €83.8 billion into 376 projects across the EU and outside, with approximately 10% of investments being made outside the EU in support of wider policy objectives.

In addition to its lending operations, the EIB also supports EU Policy objectives through its wider technical assistance, advisory and capacity building activities. Through its role in initiatives including ELENA, fi-compass and epec the EIB provides support and expertise to project promoters across a range of different sectors.

Since its origination, the EIB is also supporting the Investment Plan for Europe (the Juncker Plan) both through the European Fund for Strategic Investments (EFSI), which utilises a guarantee from the Commission to support investment into higher risk projects; and the European Investment Advisory Hub which provides advisory and technical support to project promoters seeking to implement mature or maturing projects.

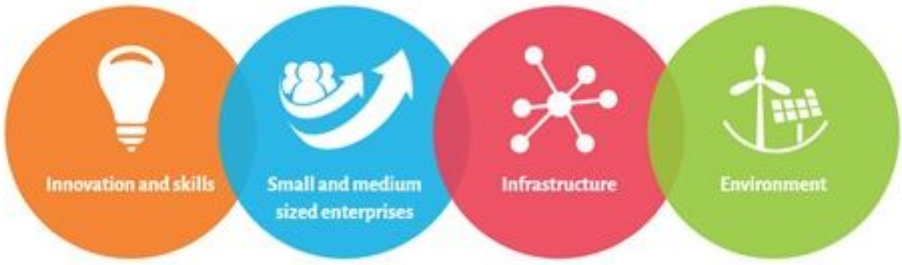
EIB Operations

The EIB's operations fall into four key categories: Innovation and skills, SMEs and midcap finance, Infrastructure and Environment.

The EIB supports these priorities through its three core activities:

- **Lending:** financing projects through loans, guarantees, microfinance and equity investments.
- **Blending:** Providing support to unlock financing from other sources, particularly from the EU budget. This is blended with loans to form a full financing package.
- **Advising:** As the lack of finance is often only one barrier to investment, we help with administrative and project management capacity to facilitate investment.

Projects are supported directly and indirectly through a range of different types of products. EIB support can cover up to 50% of the total cost for both public and private sector promoters, although on average this share is about one-third. Typically, larger projects with an investment need from the EIB of over €25m can be funded directly by the bank. The EIB can also fund an investment programme through framework loans to pubic authorities which allows the recipient to fund several eligible projects.



As well as direct support to cities and their project promoters, in order to reach smaller projects EIB makes loans to local banks and other financial intermediaries who then "on-lend" the resources to individual projects. The EIB and the European Investment Fund (EIF), support SMEs by financing venture capital and private equity fund managers to provide risk capital to growth SMEs. EIB also supports investment in funds that target early stage companies developing or using advanced technologies; support microcredit operations; and stimulate and catalyse private capital through investment in equity and funds.

EIB and Smart City Finance

Investment in Urban infrastructure, in sectors such as mobility, energy and development has always been important areas of operation for EIB lending. The EIB has actively supported the implementation of urban development funds investing ERDF, through the JESSICA initiative and has developed blending and advisory models which have enabled EIB lending to complement and enhance other EU funds.

The EIB is supporting the Urban Agenda for the EU, which brings together the Commission, member countries, city governments and other stakeholders to promote better laws, easier access to funding and more knowledge sharing on issues relevant for cities. The EIB is extending its lending to urban projects with higher risk under the Investment Plan for Europe allowing for further opportunities to finance smart city projects. Some examples of projects currently being supported by the EIB are:

- Grand Paris Express – an automated metro network to serve 22 municipalities in the South of Paris
- Belgium Climate Action Facility – a €200m intermediated loan through the Belfius Bank to support investment in climate action and the circular economy
- City of Rzeszów Framework Loan – a €76m loan supporting schemes in the area of transport, education, health, social care, culture, ICT and energy efficiency measures.

5. Examples from SmartImpact

The North West Evergreen Loan Fund

The North West Evergreen Loan Fund was established in response to the market failure to provide loan finance. Following the major financial crisis, lenders includingbanks became risk averse. Whilst the demand for finance remained, the supply was significantly reduced and a lack of finance was impacting businesses in the city region, particularly small and medium enterprises (SMEs). To mitigate this, the North West Evergreen Fund was established.

The Evergreen Fund is a public/private partnership using money borrowed from financial institutions together with public money like the UK Regional Growth Fund along with ERDF funding. It provides debt and equity funding to SMEs. It supports the delivery of commercial property, regeneration and infrastructure projects at competitive commercial rates and in line with state aid regulations.

The objectives of the fund are to

- create business growth, creating and safeguarding jobs;
- provide flexible finance solutions, at market rates, for businesses unable to leverage support from commercial banks and investors;
- create a sustainable and independent fund for GM;
- integrate closely with businesses in order to maximise income and minimise cost;
- generate private sector finance and leverage.

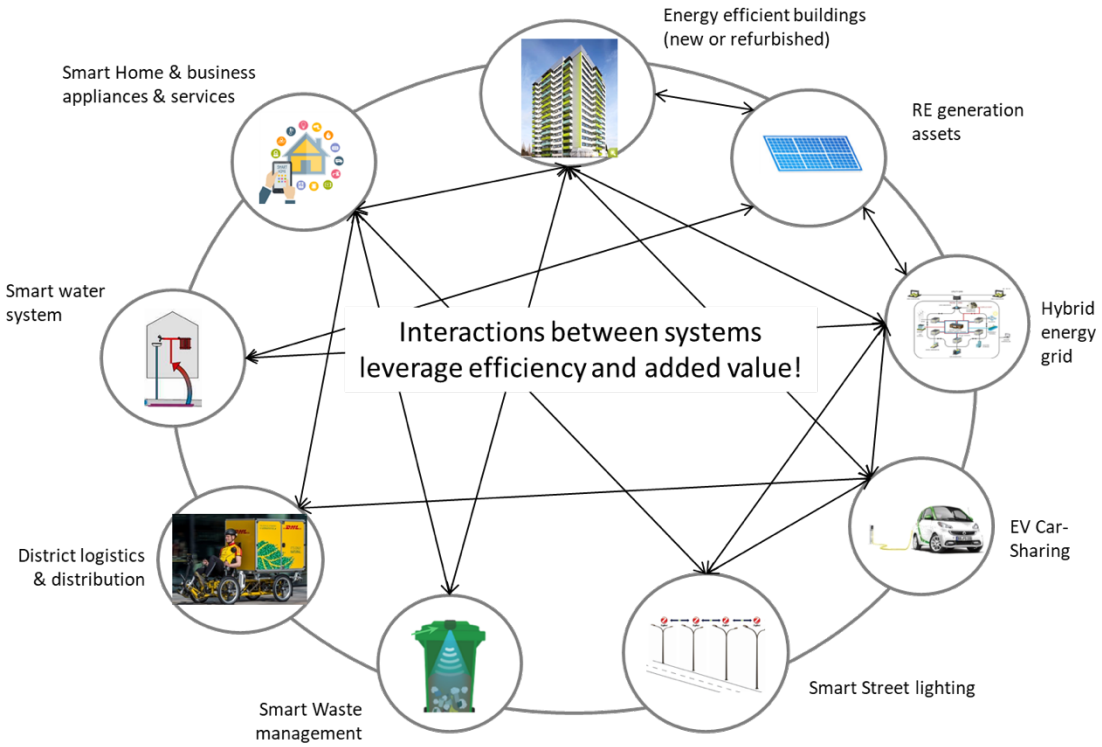
A pipeline of projects was developed and fund manager appointment via a procurement process. Examples of projects financed from the Evergreen Fund include the Citylabs . Opened in 2014, this is a dedicated space providing wet laboratories, specialised research facilities for clinical trials and evaluations, hub space to encourage interaction, break out areas and meeting rooms, and teaching facilities for vocational training. Outputs include job creation, contribution to GVA, increased productivity, regeneration of brownfield sites, new and upgraded floor space.

The main benefit of the Evergreen Fund is that as a recyclable fund rather than a grant and therefore limited resources go further.

Financing Smart Districts

”Smart Districts“ are urban areas where infrastructures, buildings and technologies are connected through the Internet of Things (IoTs) to leverage efficiency gains, reduce operation costs and provide value added services to citizens and businesses. For example, a smart district links energy generation through PV; solar thermal panels or co-generation to a district heating and smart grid system. It connects building energy management systems with EV charging infrastructure,LED street-lights to a fibre-optic broadband infrastructure providing first-class connectivity and a backbone for digital services.

Figure 3: Connected technologies that create Smart Districts



There are four types of business models associated with the development of smart districts. These are the basis for different types of potential financing approaches:

Table 1: Business Models for smart districts

1. Save costs during operation	• Integrated energy systems • Sewage & biomass 2 energy • Energy efficient buildings • Smart water grids • RE generation on-site
2. Save investments through efficient use of resources	• Car- and bike sharing • Smart lighting • Higher density
3. Provide value added digital services to businesses and citizens	• Fibre optic infrastructure • Smart home services • Smart business services
4. Increase real estate value through 1 – 3 + great design.	• Well designed urban plans • Green spaces & recreational areas • Intermodal public transportation • Good architecture

To develop a smart district, ideally these business models are combined to harness a larger benefit for the local community and to provide maximum efficiency and return on capital. In a conventional district development project, the **operational costs** of the buildings and infrastructures usually make-up for >80% of the lifecycle costs of the district (Figure 4). A key learning from is **that most of the value is created during the operation of the district** and where most of the costs are saved (e.g. lower energy costs due to highly efficient buildings and local production energy, or availability of local e-car-sharing and removing the need to aown car).

This operational value, however, can only be accessed when **higher investments are made during the planning and development process**. The integration of infrastructures is complex and needs detailed planning and calibration. cConnected and efficient technologies and district infrastructures are more expensive than conventional infrastructures (e.g. smart energy grids, smart water grids, smart waste systems, fibre-optic infrastructure etc.). Figure 5 shows, how by shifting 4% of the total costs for a smart district to the planning and design phase can reduce the operational costs by as much as 50% and generate a total reduction of ca. 30% in life cycle costs.

Figure 4: Cost Breakdown for conventional district development

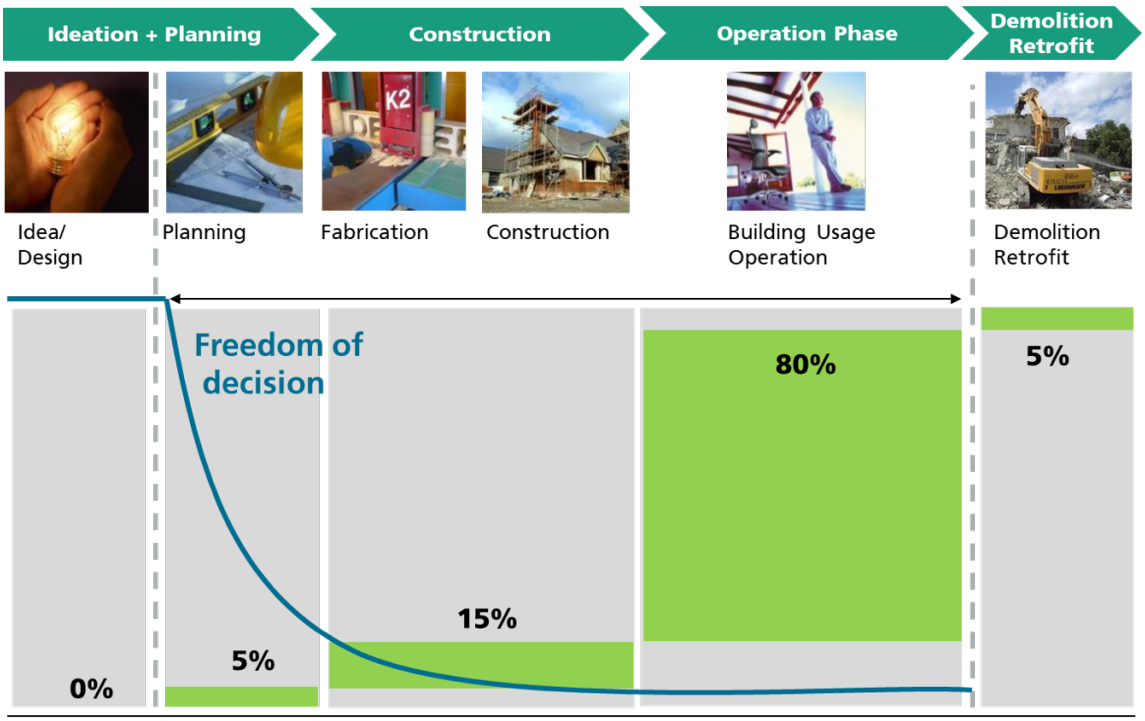
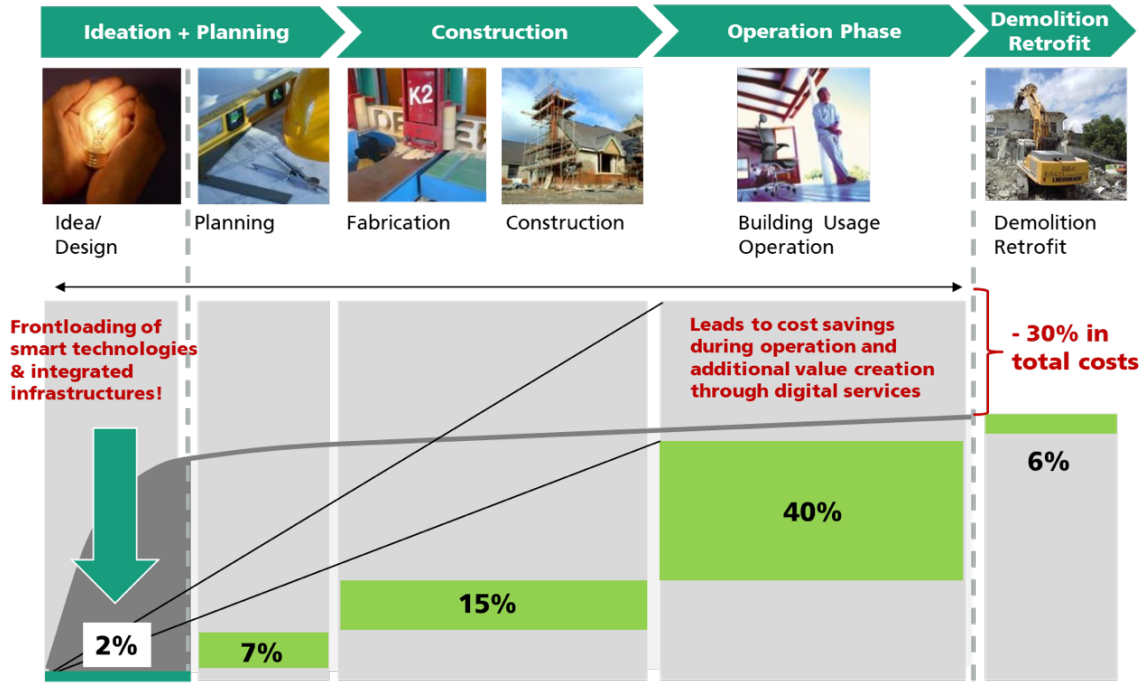


Figure 5: Total cost reduction in Smart Districts through investments in connected infrastructures and clean tech



The key questions to be asked regarding financing a smart district are:

a) the definition of the process model,
b) the governance and ownership structure of the district
c) the integrated technical and spatial planning of the district.

Examples like StrijpS in Eindhoven, the Corridor in Manchester, or the Royal Seaport in Stockholm demonstratedifferent approaches can create successful financing structures for smart districtsThey offer examples of three different approaches:

1. **DBFO approach** (Design, Build, Finance, Operate through one company or joint-venture)
2. **Regulatory approach** (Increase regulation for private investors to meet smart district demands and invest in better design and planning)
3. **Living Lab approach** (offer district infrastructure as a testbed for innovations)

SmartImpact Example - the Royal Seaport- Stockholm

In 2008, the Department of Industrial Ecology at KTH conducted an evaluation of the sustainable lighthouse district of Stockholm.

The conclusion was that the following approach should be taken for urban development projects:

- A holistic perspective of the vision and the overall objectives

- The need for a clear goal-making process
- The need for instruments and incentives
- Follow-up of goals
- Marketing of environmentally-oriented neighborhoods

This experience is being realized in the ongoing work with the Royal Seaport. To emphasize the high ambition of the area, the city has formulated a world class agreement and invites local stakeholders to sign. The agreement is a letter of intent to develop the Royal Seaport into a world-class environmental development area.

The environmental program

The environmental program has been developed by the Stockholm City Building Office in cooperation with an administrative working group made up of representatives from planning, health and environmental administration, the traffic office and the local district administration, ,in dialogue with Stockholm's port. The program is based on the outcomes between stakholders (infrastructure companies, technology companies and universities) via workshops and meetings which took place 2009/10.

The purpose is to lead environmental and sustainable urban development in the area. The program contains a vision, operational goals and actions for the different sectors. The operational objectives are based on the environmental and sustainability requirements linked to various development programs and activities for the area. The program consists of action plans andevaluation model . Specification of the operational goals continuous in line with increased knowledge, technology developments and changing environmental requirements. The program is dynamic.

The City of Stockholm is the land owner in Royal Seaport. It, either sells the land (for a cost of approx. 2 500 € per sqm), or rents the land (if the project consists of rental apartments. The buyer of the land (I.e. building company) is aware they will need to develop in accordance with the sustainability standards./Whilst this s cost is carried by the end consumer through high prices or rent levels, they benefit via reduced energy costs and by contributing to a lower level of emissions generated locally and city wide through the high level of sustainable transport modes. Other beneficiaries are clean tech SME's, asthe sustainability demands of the project creates a market for new technologies and offers to showcase for their products.

SmartImpact Example - Dark Fibre in the Dublin Docklands

Connectivity is a key prerequisite for digital services and data-based value creation within smart districts. Yet, investors and developers are unlikely to invest into broadband infrastructure because they cannot generate a direct return on Invest from this.

In 2016 Dublin City Council used a **competitive dialogue tendering procedure** to source a company to manage a fibre optic network in the Docklands.

Due of the ever changing nature in the area of wi-fi, broadband, and fibre optics, Dublin City Council (DCC) was not in a position to judge what was the direction for the development of the Docklands network as a future proofed, diverse, and secure network.

Through a dialogue process with suppliers it emerged that the best option was an open access fibre network, where DCC remained the owners of the asset and offeedr access by operators on an equal basis.. This would provide fair competition amongst the telecoms operators and create choice to the end users.

Through the process of a competitive dialogue process,

DCC also determined the initial investment by the city would be paid back in three years from revenue generated, and the operation would continue to yield an annual profit from then on.

DCC has agreed a payment structure with the Fiber Management Co. A project team was set up within the DCC Docklands to manage the day to day activities. The steering group is made up of senior members of DCC from thelegal, planning, and engineering departments h to ensure proper governance and control.

Financing Smart Lighting

Street lighting is an important service, but can consume as much as **40 percent of a city's energy budget**. Sodium street lights are failure prone and costly to manage, adding to costs. The development of LEDs has meant street lighting has emerged as a leading smart city application.

By replacing existing street lights with LEDs, utilities and street light operators can **cut energy and operations costs by at least 50 percent**. Networking those LEDs delivers an greater return on investment (ROI), taking the payback period down to from 8 to 6 years, with features such as remote management and faster outage response.

In addition a network-based lighting solution provides an ideal **platform for multiple smart city services**, including smart parking meters, traffic lights and traffic management systems. Municipal utilities also have the opportunity to leverage smart city infrastructure for smart grid applications e.g. advanced metering infrastructure (AMI), demand response (DR) and distribution automation (DA). Understanding the operational details of networked LEDs and comparing those benefits and costs to traditional lighting lays the foundation for building a business case to upgrade lighting.

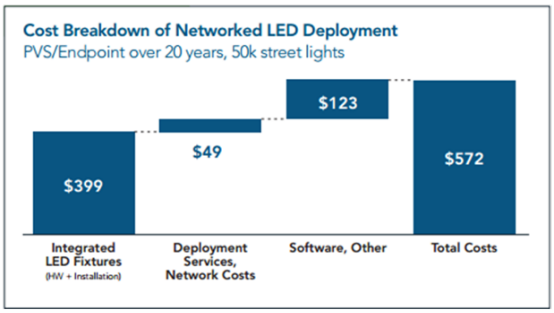
Figure 6: Costs and Benefits for Smart Street lights

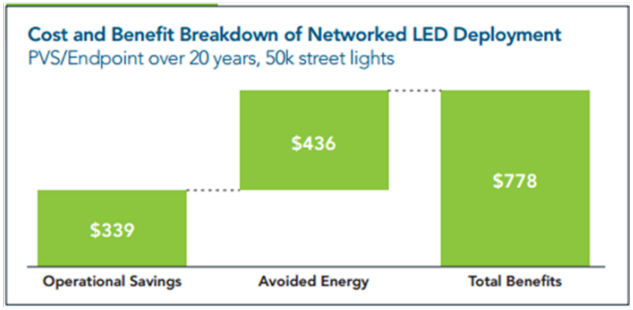
- **Energy savings:** Low wattage, Dimming, Reduced burn time

  60% – 74% less energy consumption

- **Operational savings**: Long lifetimes; » Remote monitoring and management, Automatic outage detection, Proactive maintenance:

  Ca. 60% less operational costs





https://www.silverspringnet.com/wp-content/uploads/SilverSpring-Whitepaper-Smart-Street-Light-Bizcase.pdf

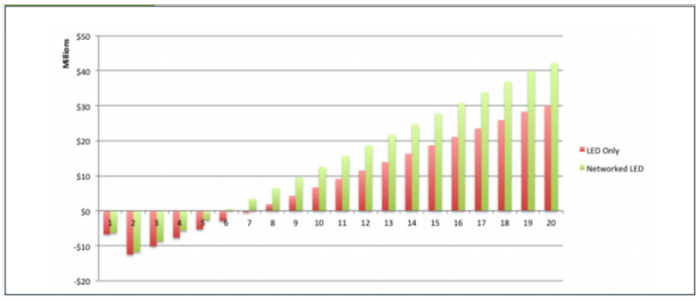
"Deploying networked LEDs has a faster ROI than LEDs alone and yields greater benefits."

Figure 7: Total return on invest for Smart Street lights

20-year analysis of networked LEDs
Costs: $572 per light
Benefits: $778 per light
Benefit/cost ratio: 1.36
Payback: 6 Years

	Costs (Year 1)	Costs (Year 2)	Benefits (Years 3 -20)
LED	$9M	$9M	$3.1M
Networked LED	$9.2M	$9.5M	$4.0M

financial advantages of networking street lights with the return on investment occurring two years earlier than the LED only approach.



Example from SmartImpact – Streetlights in Eindhoven

In 2011 the City of Eindhoven asked the Intelligent Lighting Institute (ILI) of the Technical University of Eindhoven (TU/e) to design a roadmap for development of the city's public lighting infrastructure for 2015 - 2030. In 2012 this roadmap was completed, depicting a future of "*continuous development of smart applications to enhance and improve the quality of the life of citizens, based on growing possibilities of collection, storage and processing of data, communication and lighting technologies*". This was summarized in the vision of the city council to improve the 'quality of life' of citizens, by means of newly developed services, enabled by a 'smart public lighting grid'.

The procurement process was preceded by a

The tender design was based on the competitive dialog procedure. Criteria for selection of candidates for the dialog was based ib:

1. demonstrated innovation potential ,
2. demonstrated capability in cooperation on a PPP-basis,
3. capabilities in design and maintenance of public lighting infrastructure and
4. management and achievements in the field of sustainability.

The second was split into two criteria, one focussing to capabilities in business development in a PPP-setting and the second,experience with client-oriented product development.

The final tender was based on the principles of best value, using the associated award criteria.: 1) substantiation of performance, 2) risk assessment, 3) offers that bring added value (at extra cost) and 4) the quality of key staff.

Financial setup

The contract value was limited to the total budget available for operation, maintenance and (foreseeable) investments. This value did not include additional funding of the innovations to be developed. I It was proven in the dialog that the service provider could r making savings on their costs via energy savings and achieving a higher efficiency (via an ESCO). This additional funding is primarily used for the investment in led-lighting and isnot enough to finance innovations. However successful innovations will result in additional earnings and the winning consortium offered to pre-finance the first innovation(s) . However this source of income is uncertain and had yet to be proven in reality. Therefore emphasis was put open innovation, allowing new entrants to make use of the smart lighting grid and the collected open dataon basis of terms of use set out in the contract with the winning consortium. This openness contributes to the attractiveness of the smart lighting grid as an innovation platform and helps in minimizing the risk of failure.

Financing Smart Traffic Management

Intelligent traffic management systems offer ways to improve traffic flows, reduce journey length, enable the public transportation system to be more efficient and facilate modal shilft towards bike, public transportation and walking. Traffic management generally falls into the realm of the municipality and cities need to be creative when looking for ways to finance (traffic management systems.

The table below shows smart traffic management use cases including signal control, public transport priority or congestion charging.

Table 2: Use cases and benefits of smart traffic management systems

Use case	Benefits
Signal control: Signal control processes traffic at junctions in the most efficient and safe manner. The objective is to allow a smooth flow of all traffic. Applications for	• **Transportation:** Decrease in travel times (up to 10% in peak hours), Reduced congestion (smoother flows), Improvement of 5-20% in the travel mean speed. more efficient engine use,

traffic signals (communication systems, adaptive control systems, real-time data collection and analysis, and traffic lights coordination) enable signal control systems to anticipate expected traffic flow and operate with increased efficiency.	smoother driving (minimization of stop and go) • **Environment:** Reduction in CO2 emissions (2-10%) and reduction in other emissions, Small decrease in fuel consumption • **Economy**: Improved operational efficiency of the network, reduction of the need to construct additional road capacity.
Public transport priority: Public transport priority means that the traffic control settings are programmed so that stops for buses or trams are minimized. The complexity of this increases when the complexity of the design of the junction increases. For example, when traffic lights also need to consider other road users (pedestrians, cyclists) and impacts on upstream/downstream flows. Signal priority must be carefully implemented so that it does not create relatively negative impacts on other traffic flows.	• **Transportation:** Reduction of travel times for public transport users (3-16%), Increase in public transport travel speed, Reduction of average public transport waiting times at traffic lights, Improvement in punctuality of public transport. • **Environment:** Reduced bus fuel consumption Reduced emissions. • **Economy:** Revenues increased in the number of passengers of public transport (long-term), Possible reduction of public transport rolling stock. • **Society:** High acceptance by users (>70%)
Congestion charge A means of s mitigating traffic and eliminating the negative impacts of traffic A prominent case of congestion charging is the inner City of London (the statisics on the right are derived from this).	• 2014–15 revenues were £257m, representing 8.5% of Transportation for London's annual revenues. • Operating costs to run the toll system were £80m. • Annual net operating income was £172m. • Some income from the congestion charge are used to securitise a London bond-issue that could then finance other transport projects in London. The first bond the Transportation for London issued was in 2005 and for £200m, it will be repaid at 5% interest over 30 years.

Example from SmartImpact - the Stockholm Congestion Charging

The Stockholm charges went from "the most expensive way ever devised to commit political suicide" (to quote the then- secret feelings expressed by the Head of the Congestion Charging Office) to something that the initially hostile media eventually declared to be a "success story".

It is a common misconception amongst the public and sometimes among decision makers, that drivers "have to" drive, and do not react to changes in the driving costs. This has been refuted numerous times

in many kinds of contexts. Increasing the cost to drive in particular places at certain times will decrease the number of drivers choosing to drive there. How large the decrease becomes depends on the ease of adaptation– in other words, how good the alternatives are, e.g. other time periods, modes, routes, destinations etc. It is imperative to keep as many options open as possible to achieve good traffic reduction impacts, but ultimately it is up to the drivers themselves to choose how to adapt.

A Cost Benefit Analysis (CBA) of the Stockholm congestion charging system provides the following results:

Table 3: Cost Benefit Analysis of the Stockholm Congestion Charging System

million SEK per year	Loss/gain
Shorter travel times	496
More reliable travel times	78
Loss for evicted car drivers, gain for new car drivers	-68
Paid congestion charges	-763
Consumer surplus, total	***-257***
Less greenhouse gas emissions	64
Health and environmental effects	22
Increased traffic safety	125
Other effects, total	***211***
Paid congestion charges	763
Operational costs for charging system (incl. reinvestment and maintenance)	-220
Increased public transit revenues	184
Necessary increase in public transport capacity[1]	-64
Decreased revenues from fuel taxes	-53
Decreased road maintenance costs	1
Public costs and revenues, total	***611***
Marginal cost of public funds, shadow price of public funds	***118***
Total socioeconomic surplus, excl. investment costs	***683***

The table shows that the congestion charges produce a **net social benefit of a little less than 700 mSEK/year** (approx. 80 mEuro/year).

- **Consumer surplus is negative**, as expected, but the **value of the time gains is high** in comparison to the paid charges at around 70% of the paid charges. This is high compared to most theoretical or model-based studies.

  This is mainly due to "network effects", i.e. significant amounts of traffic that do not cross the cordon and hence do not pay any charge but still gain from the congestion reduction.

- "Other" effects – environmental effects and improved traffic safety – is valued to **211 mSEK/year**.

- The **total public financial surplus is 611MSEK/year**, of which **542 mSEK is net revenues** from the charges and **184 mSEK is increased revenues from public transport fares**.

- The **yearly cost of the system (220MSEK)** includes reinvestments and maintenance such as replacement of cameras and other hardware, and additional costs such as moving charging portals when the building of a northern bypass began in 2007.

- The **annual socio-economic surplus of 683MSEK** be compared to the investment cost. To clarify the investment cost it is assumed that this is the entire start-up cost i.e. not only the

costs prior to the start of the system, but also the operating costs during 2006 plus other additional minor costs e.g. traffic signals, the services of the Swedish Enforcement Agency and the Swedish Tax Agency. This includes, system development in a widest sense, educating and training staff, testing, public information and the Swedish Road Administration's costs for closing down the system and evaluating the results during the second half of 2006. This is budgeted at approximately SEK 1.9 billion. A significant part of the costs prior to the start in early 2006 was extensive testing, it was absolutely necessary that everything worked from the start.

- Not all costs incurred during 2006 were"running" costs: the system was improved in several ways during the spring of 2006. **Actual running costs decreased significantly by each month.** it was quickly evident that progress was good : the number of complaints and legal actions were lower than anticipated, reducing costs for legal and tax administration. The number of calls to the call centre (the single biggest item in running costs) were down to 1500 calls instead of 30 000 per day.
- This meant that the call centre was ownsized, a reduction of running costs. This point may be especially important to note for other cities considering similar schemes.
- ming an investment cost of 1900 M SEK, that **the investment could be recovered in financial terms in around 3.5 years,** (the net financial surplus is around 540 mSEK/year). This excludes the increased net revenue of the transit operator**. In socioeconomic terms, the investment is "recovered" in a little more than 4 years**

A lifespan is assumed tTo calculate the net present value of the investment.Asreinvestment and maintenance costs are included in the running costs of 220 M SEK/year, a possible lifespan of 20 years is a cautious estimate. The Norwegian systems, for example, have been running for around 15-20 years, and there seems to be no technical reasons that they should not continue. This would give a net present value of around 8 billion SEK (assuming the Swedish recommended discount rate of 4% per year, and assuming that all benefits and costs remain constant) and a net present value ratio of 4.3. Present as a calculation+

6. Innovation Procurement as key to Smart City Finance

Technologies, Infrastructures and Service operations in cities are generally subject to public procurement processes. Traditional procurement is often not l suited to the purchase and deployment of innovative technologies and services within a constantly changing market. However as illustrated by the smart lighting in Eindhoven, cities can use the tool of innovation procurement to overcome the challenges of the smart city market.

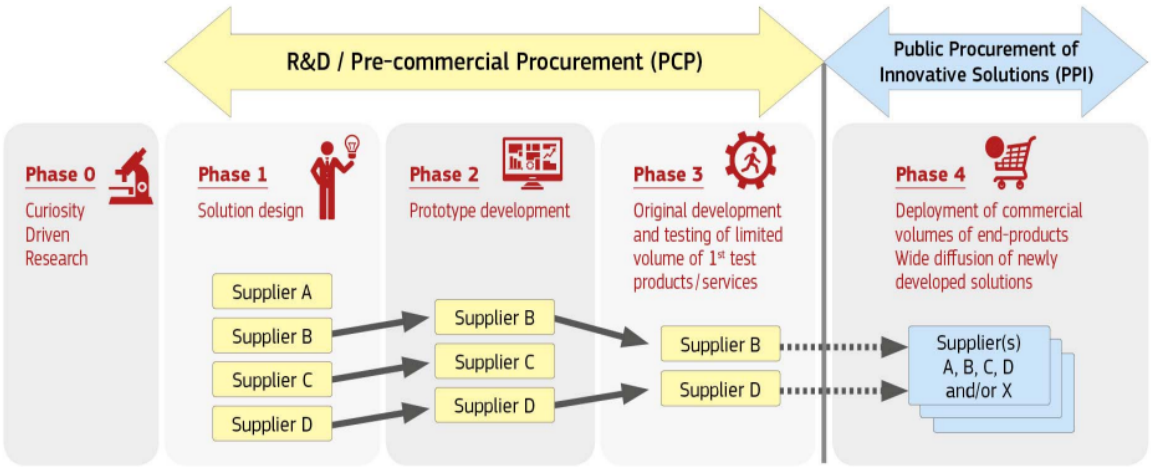
Innovation procurement is a new approach in Europe but the topic is increasingly on the priority agenda. Despite of the wide range of public sector challenges that require development of new solutions, research and development (R&D) procurement happens less frequently in Europe than in other parts of the world. Although public expenditure represents almost half of the European economy (47% of EU-25 GDP), 20 times less is spent on R&D procurement in Europe (approx. €2,5Bn/Y) compared to for example the US (over $50Bn/Y).

Since 2014, however, the European Commission has broadened the possiblity of public procurers to purchase innovation. Public procurers can continue to carry out procurements based on exemption for R&D services in the new Articles 14 in directive 2014/24/EC and Article 32 in directive 2014/25/EC. By 2017 almost all member states will have transferred the directive into national law.

Innovation procurement can be either pre-commercial procurement activities (PCP) or public procurement of innovation (PPI).

- **Pre-Commercial Procurement(PCP)** is used to steer the development of solutions towards concrete public sector needs, whilst comparing/validating alternative solution approaches from various vendors
- **Public Procurement of Innovative Solutions (PPI)** helps a public procurer to act as launching customer/ early adopter / first buyer of innovative commercial end-solutions newly arriving on the market.

Figure 8: Innovation Procurement.

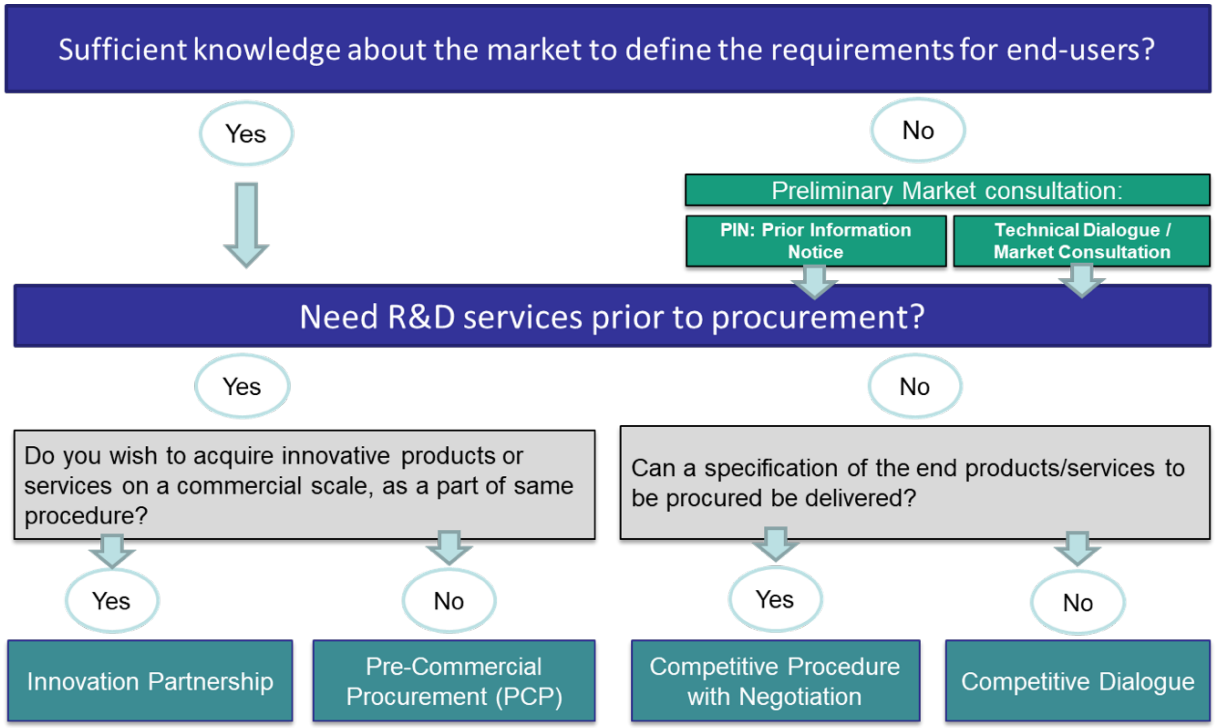


An assessment of early projects has presented successful results. For example, in Detmold (Germany), to reduce air pollution in the area of a central bus station, the innovative method chosen as a soution promises to achieve 40% of reduction of annual emissions of nitrogen oxides. The costs for the photocatalytic concrete soluation was not exceptionally high (90 000 Euro in total project cost of 2.8 million Euro).

Cost efficiency was a benefit in other examples: Hamburg (Germany) used innovation procurement to fund recycled asphalt for road resurfacing. The city saved 30% compared to the costs for conventional road resurfacing, (20K Euros).

Figure 9 gives an overview over the different types of innovationp and when to use them.

Figure 9: Innovation Procurement process in European Cities



European Union Participation in Innovation Procurement Processp

The EU contribution to promoting innovation Procurement across Europe is significant. This includes the creation of an innovation policy framework, providing assistance, as well as funding projects under different EU research and innovation programs (FP7, CIP and Horizon 2020).

Horizon 2020 has dfunding instruments for PCP and PPI that can be used across all areas of research and innovation. Horizon 2020 provides EU co-financing for PCP and PPI procurements undertaken jointly by public procurers from member states and/or associated countries. EU funding bodies can also participate themselves in PCP and PPI procurements together with European public procurers. New synergies between Horizon 2020 and the Structural Funds (ESIF) was envisioned from 2014 onwards for co-financing PCP and PPI projects.

Under Horizon 2020, the European Commission has listed three types of support to the public procurement of innovative solutions:

1. For networks of public procurers (including preparation of joint PPIs), management and follow-up, networking, training, evaluation, dissemination of results;
2. For co-financing the price of a joint or coordinated procurement of innovative solutions (include the price of the purchase as well as related coordination and networking costs to prepare, manage and follow-up the call for tender);
3. For a third channel, Horizon 2020 supporting PPI carried out by the EU (or relevant funding body) on it's own behalf or jointly with contracting authorities..

Additionally, the European Assistance for Innovation Procurement (EAFIP) has been created as a 3 year long initiative to promote the benefits and best practices from the first experiences across Europe. It aims to encouraging other public procurers to start new PCP and PPI procurements. DG Connect has appointed experts to provide training, promotion and local assistance on PCP and PPI (including legal

assistance) to public procurers that intend to start concrete PCP and PPI procurements for ICT based solutions across EU member states between 2015-2018.

All EU policy initiatives on Innovation Procurement are listed and tracked under the Digital Single Market Initiative: https://ec.europa.eu/digital-single-market/en/news/eu-policy-initiatives-pcp-and-ppi

Example from SmartImpact – Dublin Procurement of Innovation

Dublin has previously organized challenge based procurements for innovative small and medium sized companies under the Small Business Innovation Research (SBIR).

The SBIR falls under the category of **pre-commercial procurement (PCP).** PCP, as defined by the European Union, involves the purchase of research by a government body undertaken with the objective of stimulating innovation that the contractoror other party may benefit from at a later stage..

SBIR operates as an open competition to stimulate the creation of innovative new products and services. Competitions are demand driven and result in a fully funded development contract between the company and the government department - it is not a government grant.

SBIR competitions are open to all organisations that can demonstrate a route to market for their solution. The programme is particularly suited to small and medium-sized business, as the contracts are of relatively low value and over short timescales. Developments are 100% funded and focused on identified needs, increasing the chance of exploitation. Suppliers for each project are selected by an open competition process and retain the intellectual property, with certain rights of use retained by the contracting department.

It generally has a two-phased development approach that starts with initial feasibility followed by more detailed product development.

- Phase one, **feasibility studies** typically last up to three months and are worth anything up to €25k (project dependent).
- Phase two, **demonstrator or prototype** projects can last between 6 to 18 months with funding again anywhere up to €100k (project dependent). It should result in a commercial product or service.

Smart Dublin partnered with Enterprise Ireland to launch the cycling SBIR in March 2016 coinciding with the Launch of Smart Dublin. 100K EUR seed funding was available to pilot data driven solutions. Dublin received 96 expressions of interest and23 proposals from which 14 companies where selected to pitch their ideas. 5 were given Phase 1 funding. Four companies received Phase 2 funding in January 2017.

Smart Dublin has also won funding for two additional SBIRs on illegal waste and the monitoring of storm gullies in high risk flooding areas.

Figure 10: Smart Dublin SBIR Process