
	<p>Project no. 314277</p> <p>STEEP PROJECT</p> <p>Systems Thinking for Comprehensive City Efficient Energy Planning</p>	
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Project no. 314277

STEEP PROJECT

Systems Thinking for Comprehensive City Efficient Energy Planning

Seventh Framework Programme
Theme Energy

**D4.2 Open–source Smart City methodology,
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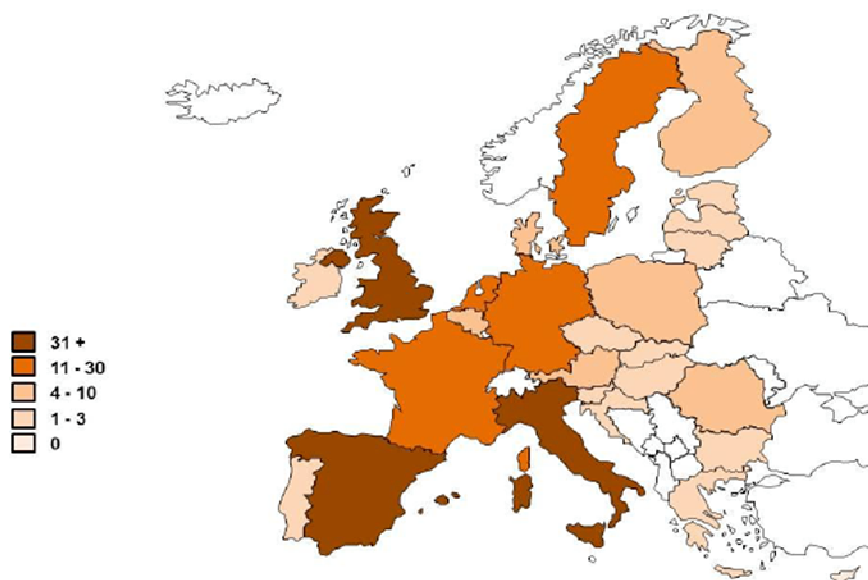
1. THE SMART CITY CONCEPT

In the EU 3/4 of the population live in cities and consume 70% of the energy. This is the reason why many EU policies target the urban sector. The Smart Cities and Communities initiative brings the cities involved to the forefront of the development of the low-carbon economy.

The Smart City concept is recent and it's quickly evolving with very broad implications: the definition is not clear but it's generally linked to the technology embedded in urban areas. Now cities are facing wider issues beyond smartness – there are issues of resilience and flexibility which are fundamental to enabling rapid adaptation to changes (e.g. economic, environmental, geo-political, social,...).

Smart cities should be able to adapt themselves as quickly as possible to the upcoming needs of their citizens: the “smart” idea involves ICT and innovation to achieve efficiency and sustainability and this is extending to resilience, including economic and social wellbeing.




From recent studies the countries with the largest number of Smart Cities are the UK, Spain and Italy – the three countries involved in the STEEP project.



The number of Smart Cities per country in Europe

(Policy Department A: Economic and Scientific Policy European Parliament – 2014)

The main common features which characterise the three Steep partner cities since the beginning of the project are that they all are strongly committed to EU targets with

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clear objectives covering a wide range of policies and that they have all already started a mix of supporting initiatives with concrete impacts and wide consensus.

For the three STEEP cities the SMART concept is linked to a bottom up approach from the data collection to the decisionmaking processes: any stakeholder is informed and linked and could participate in making the difference.

The study “mapping smart cities in the EU” of the Directorate general for Internal Policies defines ‘Smart City’ initiatives as multi-stakeholder municipally based partnerships aimed at addressing problems of common interest with the aid of ICTs, which underpin ‘Smart’ classification.

A smart city will put effort into driving innovation, predominantly enhancing synergies and relationships among different social levels and policy sectors. There is no unique solution for everyone, only a suggested path – to be adapted to each city, respecting different priorities and local institutions, based on cooperation at any level – which is the key to our methodology.

2. WHAT IS A SMART CITY MASTER PLAN

First of all we have to clarify what is meant here: smart cities are revolutionizing their functions trying to adapt themselves to a new broader idea of urban management. The need for a new tool which could play the lighthouse role for the existing plans and regulations belongs directly to the previous definition of a “smart city” which is based on integration and synergies exploitation at any level.

The Smart City Master Plan should coordinate every sector of influence, driving the city to innovation, achieving best results in less time and with less effort and cost.

A local strategic sustainable smart city plan should address the efficiency of energy flows across all the key sectors on the energy value chain in an integrated manner.

By taking an integrated approach to strategic city planning where all systems and their interlinkages are considered would actually result in greater efficiency in terms of both carbon and cost and also provide other benefits such as greater stakeholder engagement and ownership of actions. The instrument for this endeavour should be a comprehensive Smart City Plan which includes the whole set of necessary actions following a **holistic approach**.

Nevertheless, developing a Smart City Plan is a difficult task. The three STEEP cities detected the following key factors for its definition:

8 It is necessary to have the **collaboration of all the stakeholders** across the valuechain: public administrations, technology experts, companies, end users, etc.

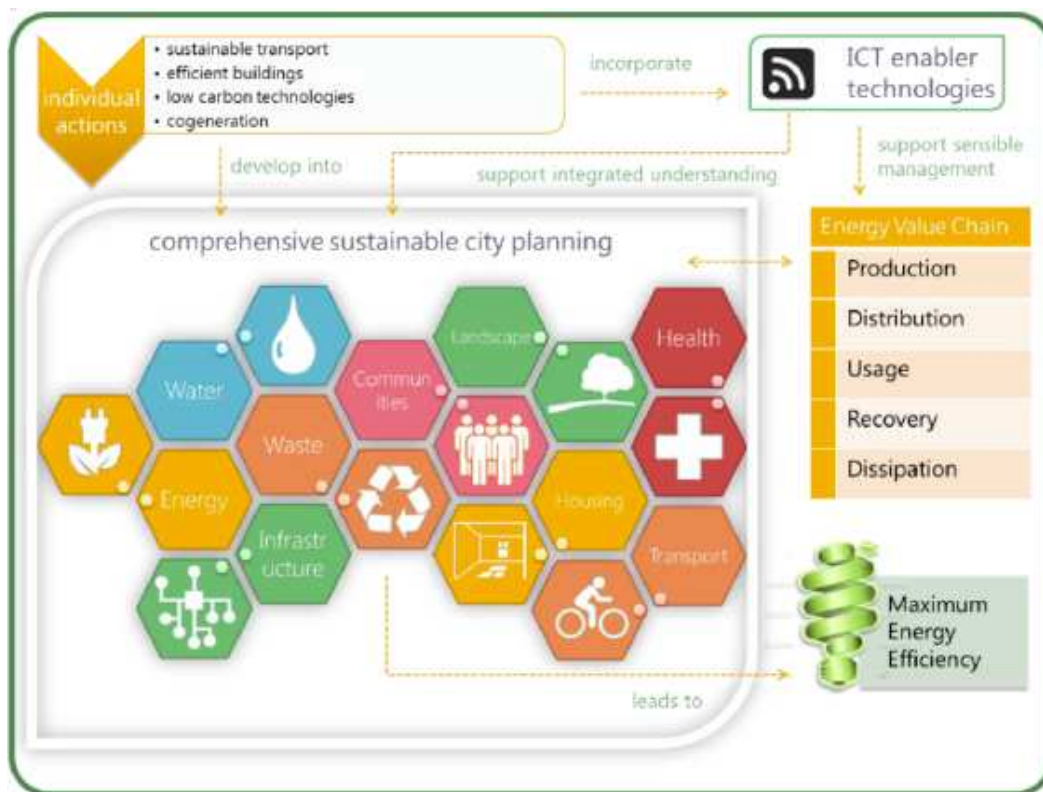
8 It is necessary to **consider the city as a complex system of processes**, where the different elements of the city are connected and one intervention in one process of the city influences the rest of the processes.

2.1 The Smart City Energy Master Plan definition and importance

Until very recently, a large number of cities have undertaken different actions aimed to promote a more sustainable use and production of energy. Generally, these actions focus on sector specific problems and are often undertaken in isolation; they do not take into account all the energy flows of the city (e.g. energy, transport, water, digital infrastructure, etc.).

Furthermore, most of the time the actions taken are not integrated into a strategic approach to urban planning, which integrates city land-use planning alongside other city planning processes e.g. economic development strategies, sustainable development plans, digital masterplanning, etc.

It seems evident, however, that the definition of integrated and comprehensive urban plans addressing the efficient energy flows across various sectors, focusing on the long term, achieves much better results and bigger impact than individual actions, since the complementarities and synergies between actions are taken into consideration.



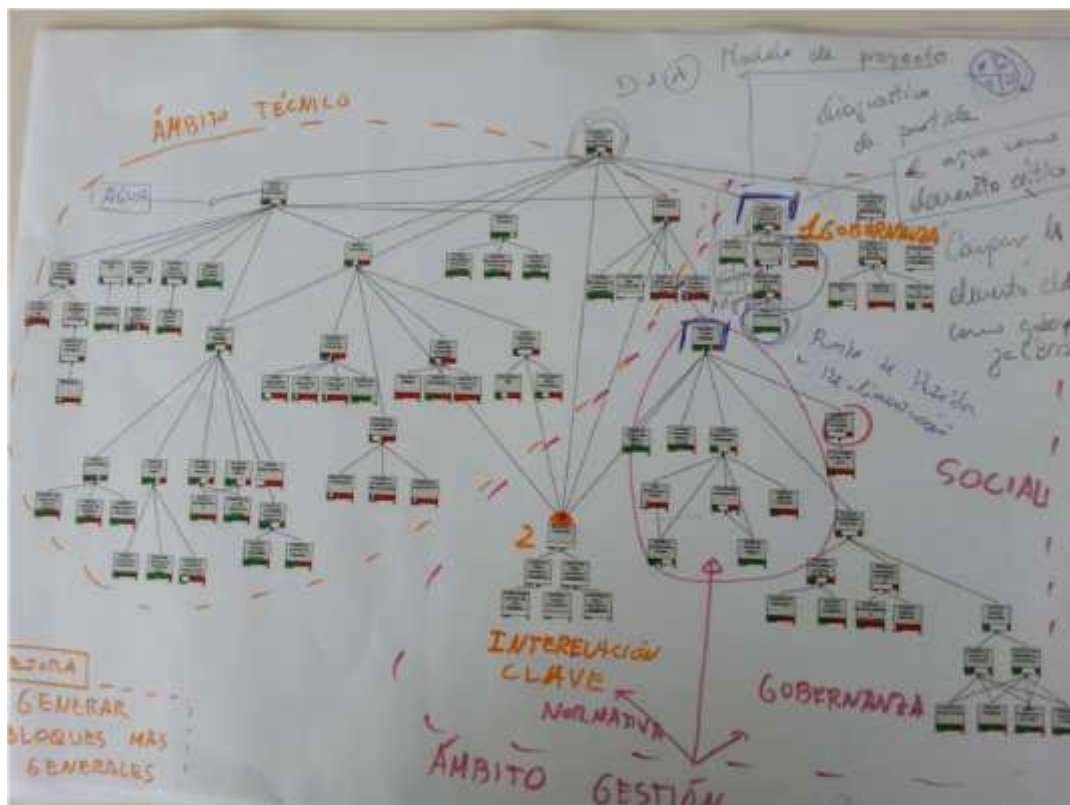
Integrated Smart City Master Plan

Energy planning ought to be viewed as a **wicked problem**, because it has to deal with situations that are not well defined, because of many uncertainties and lack of reliable data, involving many interested parties with different perspectives. There is a general difficulty in agreeing objectives of interventions which requires creating consensus amongst parties involved to be successful.

It should be highlighted that the structure of the plans is somehow recurrent (technical, regulatory, social aspects of the efficiency, mobility and ICT sectors) while going into detail in the model lower levels the actions implemented become more and more tailored to the local situation.

There is also the expectation from previous uses of Problem Structuring Methods (PSMs) such as the STEEP process that the more generic actions are likely to be about the methodology itself. There is nothing in the modelling process that prevents

participants from modelling processes that relate to the methodology itself. In the literature review conducted prior to methodology design about 50% of the processes identified were methodological in nature, as opposed to the problem content. The use of problem structuring methodology to model the process itself is recognised as valid (Checkland & Winter, 2006).



A snapshot from the modelling section in San Sebastian

Building on the work of the STEEP Project, as well as numerous other sources, we propose few fundamental Smart City themes to be developed:

- **Governance and legal framework:**

Smart Governance is a transversal factor, integrating somehow the other smart characteristics. It includes all the interactions among sectors and different levels of the public and their links to the civil society.

The influence of the legal framework is relevant and if not coordinated and in line with the smart vision it could affect the targets' achievement or at least the efforts and the time needed. The governance is as much smart as it is coordinated at a wider level in an horizontal as well as vertical perspective.

- **Making municipal organisations more efficient**

A subprocess regarding the municipal organization efficiency has been added to those found in the district models: it contains all the measures belonging to the administration which have been collected under this new branch just to focalize them and put the accent on the city's actions to play an exemplar role. This work has been done following the Sustainable Energy Action Plan philosophy, but it's up to the cities to underline this aspect or to put their own actions within the other subprocesses together with the private sector.

In all cases the public sector efficiency should be addressed, including:

- energy efficiency (municipal buildings, public lighting, sport facilities, public services, administration's mobility management,...)
- the adaptation of the internal structure to the upcoming needs of a Smart city approach
- the optimisation of the procurement procedures.

- **Energy and environment**

In this section all the issues related to energy and sustainable environment could be included: innovating energy supply offer and networks, promoting local energy production (RES, CHP, district heating/cooling, waste heat recovery,...), promoting energy efficiency in every sector (residential, tertiary and industrial) and service (water supply, waste water and waste management,...), reducing pollution, etc.

The energy and environment issues are well-known for those cities who are for example involved in the Covenant of Mayors initiative. This section could be seen as the "traditional" part of an energy plan even if it's presented with innovative features consisting in the links to all the other fields of action: the set of available technological best practices must be analysed in conjunction with the other thematics to provide a comprehensive framework.

In particular the ICT enables high innovation levels in the design phase thanks to the data available, in the operational phase enhancing interoperability and also in the monitoring and control.

- **Mobility**

The mobility concept includes the ICT support, the integration and the sustainability of the transport system.

Smart mobility should be sustainable, safe and interconnected and userfriendly.

The actions that could be implemented regard the new infrastructures (connections, new facilities, recharging networks,...), traffic and parking management, public transport optimisation, etc.

The environmental sustainability makes fundamental the promotion of non-motorised or low emission mobility, while the life quality enhancement is linked to the widespread use of infomobility.

- **ICT**

The importance of the ICT in a Smart optic has been previously stated.

A Smart City could be described as a network linking public, private and civil society. The collaboration with different stakeholders working together is aimed at achieving smart objectives at city level which include transparency and open data by using ICT and e-government in participatory decision-making and co-created e-services.

- **Prosperity**

- **Economy and financial models**

This section is not only about ICT-enabled innovation, but mostly about new services and business models.

Most of the actions included in the master plan require subsidies and useful financial schemes to be sought: the starting point is the understanding of usual business models to develop new schemes that address local objectives and establish public-private cooperation. The scaling up of the smart initiatives has to deal with their economic sustainability and social attractiveness.

- **People, living and society**

A Smart city should aim at an inclusive society that has access to decision making processes and fosters innovation and creativity.

ICT enables people to input, download and use data, government enables them to participate and cooperate.

Through proper communication strategies, innovative approaches like the System Thinking used by Steep partners or the development of exchanging opportunities like platforms, the city management should achieve a collaborative stakeholder engagement.

The city needs to achieve a deep knowledge of its society for example mapping stakeholders to gain their participation.

The territorial identity ought to be linked with the smart targets and the city has to provide support for any private activity which is in line with smart policies; a Smart city policy is also about healthy and safe living, cultural facilities, good quality of life and social cohesion.

- **Monitoring and control**

A Smart city should aim at a systematic approach to a continuous improvement in every activity with or without performance specific criteria.

Following a classic Deming cycle of every quality management system, a plan-do-check-act procedure has to be set up to avoid the master plan uselessness.

As we will see in the “vision” definition, the master plan should be “live” and flexible to fit evolutions and calibrations based on the step-by-step monitoring of the achievements.

There are technological, human and institutional factors which could be able to divert municipal policies: a proper control system will detect the weak points that must be recalibrated.

A regular assessment activity focuses attention on the plan and a benchmarking with other municipalities, which could suggest new targets and policies; moreover in this way the success of municipality’s efforts could be easily made visible and promoted. The monitoring activity, strongly supported by the ICT implementation, can count on a wide availability of data and should take into account indicators evaluating any sector of influence (social, economy, governance, environment, mobility, etc – see STEEP D4.3 key performance indicators).

The control system should be as much ambitious and detailed as the targets set by the plan.

2.2 Co-production approach: the system thinking methodology

The systems methodology used for the STEEP project is based on an interpretation of Soft Systems Methodology (SSM) using Hierarchical Process Modelling (HPM) as an almost direct replacement for Purposeful Activity Systems (PAS) modelling in SSM¹.

The systemic problem structuring method for smart energy master planning facilitates the elicitation, sharing, capturing and transformation of pluralistic perspectives, knowledge claims and values about the problem situation in a collaborative process.

¹ For a complete explanation refer to STEEP D2.1 “Energy Master Plan Process Model”

The methodology is based upon the deliberative concept of discursive decision making with the objective to find the best possible consensus. Its overarching aim is thus to enhance moral legitimacy of decisions for intervention and to reflect social and cultural values in collective decision-making.

The following paragraphs are an attempt to explain what system thinking is:

- “Viewing situations holistically, as opposed to reductionistically, as a set of diverse interacting elements within an environment.

Recognising that the relationships or interactions between elements are more important than the elements themselves in determining the behaviour of the system

Recognising a hierarchy of levels of systems and the consequent ideas of properties emerging at different levels, and mutual causality both within and between levels

Accepting, especially in social systems, that people will act in accordance with differing purposes or rationalities”²

- “A discipline for seeing wholes. It is a framework for seeing interrelationships rather than things, for seeing patterns of change rather than static snapshots...systems thinking is a discipline for seeing the ‘structures’ that underlie complex situations, and for discerning high and low leverage change”³

Hard systems tradition	Soft systems tradition
Assumes the world contains systems that can be engineered	Assumes the world is problematical but can be explored with systems models
Assumes systems models to be models of the world	Assumes systems models to be conceptual constructs
Modelling is oriented to goal seeking, optimisation, and prediction	Modelling is oriented to learning, exploration, and commitment
Talks the language of “solutions”	Talks the language of “issues”
Advantages	Advantages
Allows use of powerful quantitative techniques (simulation, visualisation...)	Is open to all stakeholders and keeps in touch with human interests
Disadvantages	Disadvantages
May loose touch with the actual problem situation; ownership and control issues	Does not produce final answers, accepts that inquiry is never ending

The Hard and Soft systems traditions (compared/adapted from Checkland & Holwell 2004)

² Mingers & White 2010

³ Senge 1990

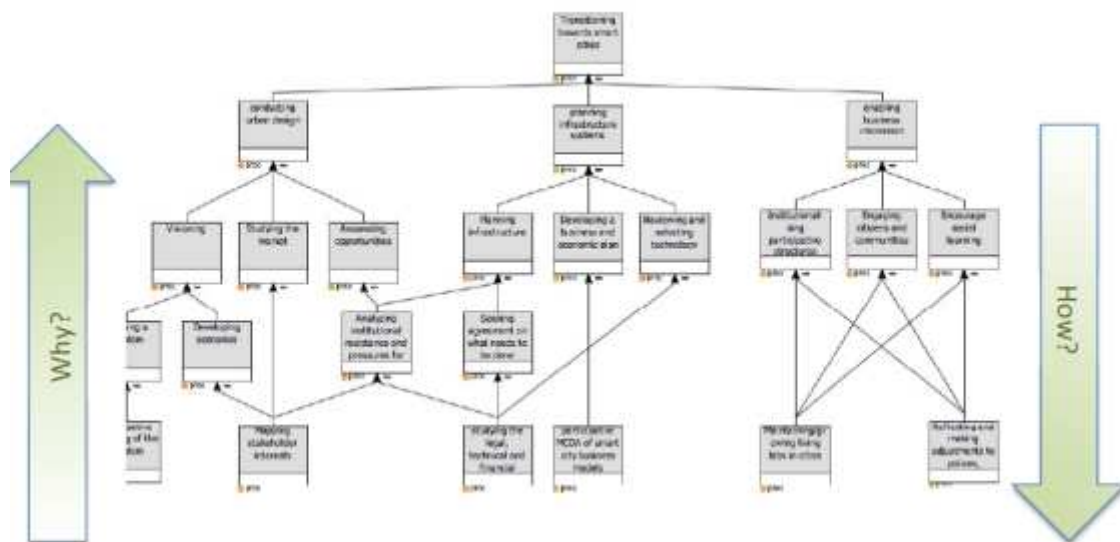
As already mentioned, the energy planning activity can be viewed as a wicked problem which could be addressed with Problem Structuring Methods (PSMs); those methods are structured and rigorous and based on diagrammatic modelling which allows for a range of distinctive views to be explored and for multiple and conflicting objectives.

The active participation of stakeholders is encouraged in the modelling process, through facilitated workshops and cognitive accessibility: the aim is for exploration, learning, and commitment from stakeholders and in the iterative procedure significant uncertainty could be expected and tolerated.

Using the soft systems tradition the system model is a conceptual device that will be used to help stakeholders decide how to design interventions.

The system has a purpose, which needs to be articulated as the starting point for the modelling process; the conceptual models consist of processes, described by gerunds, and structured into a hierarchical arrangement by decomposition, and represent the minimum processes in a system required to achieve the transformational purpose agreed for the specific problem situation.

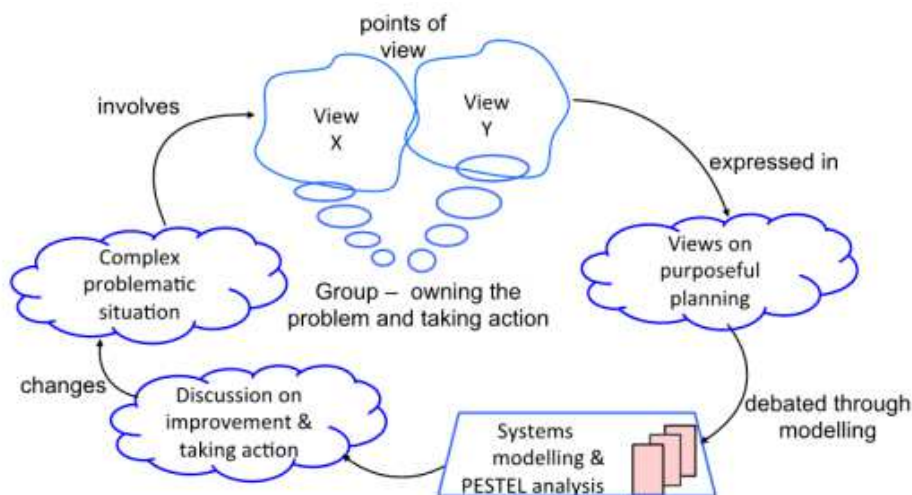
The natural limit of modelling is reached as processes no longer yield further process decompositions to the how/why question dialectic.



An example HPM based on the transformational process “Transitioning towards smart cities”. The process questions How? and Why? Illustrate how the model is both constructed and read.

The purpose of each stakeholder workshop is therefore to deconstruct and refine each of the processes needed to achieve the ultimate objective, which can then be analysed in terms of how well they are currently performing.

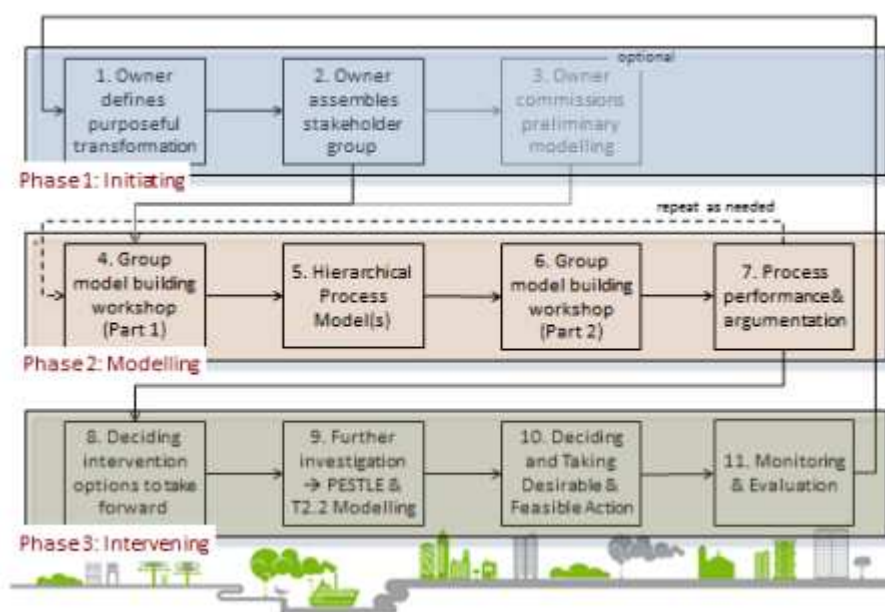
After one or more iterations of Hierarchical Process Modelling the stakeholder group should have a clearer idea about how to achieve the desired transformation and about the performances of the single processes.



Energy planning as a process (Adapted from Hindle 2011)

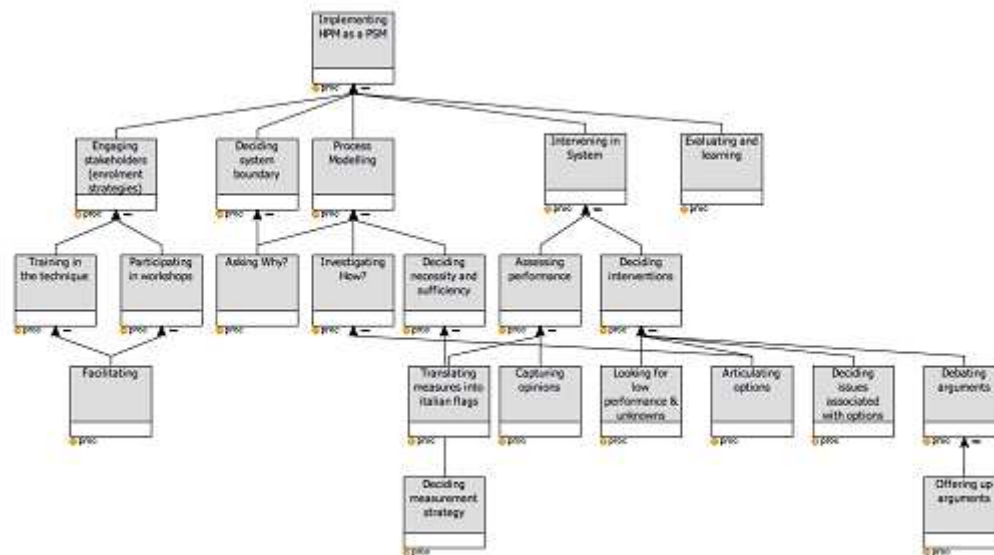
Through the process of modelling stakeholders gain a better understanding of the whole system through sharing mental models and through the discussion and argumentation (see also the chapter 3.5 Identification and prioritisation of SMART interventions).

The process, summarised in the scheme below, allows at the end to agreeing an Action Plan that is desirable, feasible and ethical.



System thinking approach: Modelling process flowchart (University of Bristol)

For completeness, what we know about the STEEP methodology as a process has been captured in its own modelling language and is shown in the following Figure.



Despite identifying these high-level processes from the experiences of the STEEP partners in Bristol, San Sebastián and Florence we urge care with placing too much consideration on this particular set. The key message from the STEEP project is that it is the planning *process* that is important; plans are inherently transitory and merely specific artefacts of the process.

2.3 Vision, objectives and targets for a SMART city

In considering what the vision is for a city it is clear that this concept concerns how future cities are visualised, what they seek to communicate and why: they typically seek to suggest how people may live, work, and move, mostly within the built environment.

Cities face the challenge of sustainable urban development: a city is something dynamic and mutant as quick as the needs of its society. To manage the inevitable changing process in a proper way there must be a long-term driving concept to be translated into policies.

Short-term political cycles can prove challenging as this impacts the ability of a city to set long-term strategic visions; instead the focus is on generating results within the short-term brought about by less strategic action planning.

“A Smart City is more than the sum of its projects. Rather, it needs a fertile environment guided by a clear vision, the participation of relevant actors (people), and the efficient and effective organisation of its processes” (See van Beurden (2011); Achaerandio et al. (2012); The Climate Group (2013).)

The vision is the guiding principle for the city policies and it defines the overall scope each plan or single measure in the short, mid or long term is contributing to achieve.

A smart city should know, first of all, what it wants to become and it has to know and foresee its citizens' needs: it's not a technological problem. The tools will evolve and will differ, but with a clear vision, the city will be able to implement ANY innovative smart solution which helps to achieve the target.

The process leading to the effective economic and social development of a smart city can no longer be defined by a few people; it requires increased, meaningful involvement of its citizens.

The first step in the modelling process is to define the starting point, i.e. the purpose of the district plan.

The STEEP methodology views Systems Thinking as the means, or process, by which an agreed transformation can be achieved. The methodology relies heavily on modelling the transformation as a system by groups of stakeholders using Hierarchical Process Models (HPM). Modelling a transformation as a system using HPM requires a top-level process to be identified that acts as a descriptor, or the purpose of the system.

STEEP methodology makes use of the root definition approach from Soft Systems methodology (SSM) (Checkland & Scholes, 1999), as defined using the CATWOE acronym as follows:

- Customers – those affected by the transformation
- Actors – those responsible for bringing about the transformation
- Transformation – describing the desired change in the state of an entity (e.g. a city district)
- Weltanschauung – the worldview or cognitive orientation of the group of actors trying to achieve the transformation
- Owner – those who could prevent the transformation taking place
- Environment – all of the external factors that constrain or enable the transformation to take place

Consensus amongst stakeholders regarding a high-level objective for the modelling has to be achieved; this is essential in the process for prioritising interventions, as it allows a specific focus on what can be plausibly achieved and who will own this

process. We emphasise these points as crucial to the successful implementation of the STEEP methodology:

1. There must be clear ownership of the process
2. Deciding the transformational goal and defining the stakeholder group are co-dependent activities

This consideration brings us back to the principal motivation of STEEP project, i.e. energy planning seen as a wicked problem which has to be approached in a co-productive and iterative way: it is important to mention that the transformation statement is dynamic, in that it can be modified at different stages of the process if it is considered necessary.

The “purposeful transformation”, which represents the reason of every single deriving activity in a hierarchical process scheme, should be

- sufficiently ambitious to catch the interest of stakeholders and to start the change
- realistic in scope not to waste time in fruitless discussions
- wide enough to touch every sector of influence but focussed on the topic
- flexible in approach to be able to fit future evolution and re-calibration due to the monitoring feedbacks

These considerations lead us logically to thinking about the implementation of the STEEP methodology as an ongoing planning process. The system model describes the processes that are needed to achieve the transformational goal. For any sufficiently messy problem – and energy master planning is considered such – the expectation is that the need is unlikely to be met simply with an agreed solution, but will require continuous effort to bring about alignment of stakeholders’ views on the problem and possible interventions. Whilst the STEEP methodology is designed to lead to actions, which will be documented as plans, these are not its end goal; it is the transformational system that is important.

2.4 Timescale and political commitment

A city is not an isolated planet: good city leaders also think about regional growth because as a metropolis expands they will need the cooperation of surrounding municipalities and regional service providers. Moreover it is very important to be aware of other public authorities’ plans because they could represent an obstacle if their targets, their policies or their timeframes aren’t in line with that of the cities’.

Political commitment and leadership should be sought early as they are the driving force of the overall process.

Long-term visioning is an essential consideration for any city; the time horizon for achieving high-level targets will be set out within each of the city's vision statements. To fulfil the sustainable growth needs it is recommended that a time linked path with a defined timeline, milestones and detailed actions is produced – at least for the short term; recognising that it is not always possible to plan in detail concrete actions and budgets for a long timeframe. Local authorities may distinguish between a vision, with long-term strategy and goals in the sectors, and detailed actions in the next three to five years towards achieving it.

The timescale of a Smart City Plan in conclusion should

- be long term to drive all the other regulatory tools in the same direction
- take into account all the strategies at higher levels (regional, national, EU)
- define a path which ought to be detailed with milestones and actions at least in the short term

The political commitment should

- provide the necessary impulse to the local administration to start the process and to the stakeholders to be involved
- extend the geographical area (where the Sustainable Energy Action Plan for example was limited) but also try to commit the surrounding areas to reach higher impacts/goals

3. HOW TO DO A SMART CITY MASTER PLAN

The Smart City Master Plan is an articulation of the steps involved in bringing about a smart city. The analysis required to create the plan is an on-going process that can be conceptualised as *planning*. It is planning that is the driving force that brings about or enacts change; with the plan reflecting a particular snapshot in time of the actions that are required, with their varying qualifiers (e.g. mandated, necessary, desirable, etc). Planning is thus a transformational process constantly reviewing and negotiating the goal(s) of transformation and modifying and updating plans from time to time. We might even think of planning as the process that tries to reduce the gap between imagined, planned futures and what actually happens on the ground.

Viewing planning as a continuous and on-going transformational process allows for a soft systems interpretation as defined in the STEEP methodology (Yearworth, Schien, & Burger, 2014). What this means in practice is that planning can be regarded as a type of system that is designed to bring about or enact a transformation. The Smart City Master Plan is thus an action plan emitted by the transformational planning system. Since this system is entirely conceptual we need a way of modelling it in a way that describes the actual (real) processes that are required to achieve planning. The STEEP methodology describes the method of generating these models in response to a well-defined transformational goal (*ibid*). This method uses Hierarchical Process Modelling (HPM) as the means of describing the systems model. Transformational goals are decomposed into a number of sub-processes, which provide further detail or insight into *how* the transformation is to be achieved. Each process in the model can be considered a whole system in its own right (holon) and the models thought of more as a recursive description of the transformational system (the planning system), specified at sufficient level of depth in order to adequately answer all of the ‘how’ questions surfaced during the process of modelling.

This description of the relationship between planning and a plan is an articulation of the systems thinking methodology at the heart of the STEEP project. It is completely open as to specific transformational goals agreed by stakeholders, but is well suited to complex problems such as achieving smart city transformations. However, there are a number of important considerations to be made for the methodology to be successfully applied and these have been articulated in the STEEP methodology deliverable (Yearworth et al., 2014). Here we focus on the specific issues that were surfaced in the STEEP evaluation process (Yearworth, 2014), which are particularly relevant to the problem of scaling-up the methodology; that of setting goals *and* engaging stakeholders.

3.1 Setting goals

The project has clearly learned that a key requirement for the successful application of the STEEP methodology is that setting transformational goals and engaging stakeholders are entirely *interdependent* activities. It is not possible to define transformational goals independently from identifying *who* would be the Actors (A) responsible for achieving them, and the Owners (O) accountable for the actions⁴. Likewise, a stakeholder group with no transformational goal in mind is a nonsensical construct, in *what* does this group have a stakeholding? The '*who*' and '*what*' of a transformational goal *must be defined simultaneously at the outset*, before any thought about the *how*, *when* and *why* can be discussed. The STEEP methodology defined by Yearworth et al. (2014) focuses particularly on the latter, and particularly the method of system modelling, but the learning from evaluation has shown that this preliminary step is absolutely critical to success.

However, engineering the congruence of a meaningful transformational goal and achieving engaged stakeholders matched to that goal is in itself a messy problem. There is no surprise then that the process of implementing the methodology itself can appear in the conceptual system modelling, a situation described theoretically by Checkland and Winter (2006), observed in the literature (Bhatt, Friley, & Lee, 2010; Coelho, Antunes, & Martins, 2010; Elias, 2008; Gezelius & Refsgaard, 2007; Neves, Martins, Antunes, & Dias, 2004; Pohekar & Ramachandran, 2004; Sheffield, 2004), and encountered in practice by the Bristol partners and discussed in (Yearworth et al., 2014).

A City Council, embodied in a sufficiently concrete form to behave as an actor, can always play the role of *catalyst* by supplying the political will or mandate for bringing together stakeholders who might be motivated to work on a transformational goal, assuming that there is no compelling power that any particular actor in a city can exert over a sufficiently important group of other stakeholders that would bring this about otherwise. There is nothing in the STEEP methodology that specifically deals with power and this has been recognised as a weakness (Freeman & Yearworth, 201x). The methodology assumes a plural problem context and that there is sufficient commitment amongst the stakeholders for them to want to work collectively to arrive at a shared understanding and agreement on actions. Without the power to enforce a specific transformational goal, e.g. through regulation or financial incentives on the part of governments, then it is inevitable that such a goal will be weakened in the process of encountering the interests of the stakeholders. Unless this weakening

⁴ The Actors (A) and Owners (O) are two of the three stakeholder groups identified in the CATWOE formulation of Soft Systems Methodology (SSM), the third is Customers (C). The meaning of these roles is discussed in the STEEP methodology document.

happens it is possible for an actor to believe that they own a specific goal and yet have absolutely no means with which to bring it about. Such a situation is likely to be demoralising and the unrealistic goal promptly forgotten; ignored by the very people who might be in a position to bring it about.

There is evidence from evaluating the STEEP project thus far that there are substantial differences in political context between partners (Yearworth, 2014). The problems outlined here are more acute in the UK (Freeman & Yearworth, 201x). These differences also have a bearing on the scaling up of the methodology. We can reasonably predict that regulatory or incentive power will act to bring about stronger transformational goals in the sense of ambition or scope, and vice versa. However, cities embarking on smart city master planning could improve outcomes, whatever the power landscape, by paying particular attention to the initial activity of aligning goals and stakeholders.

In the context of a smart city master plan the pertinent question then becomes one of scope. How smart, and by when? Since this question will depend on many changing factors it is thus more reasonable to think in terms of the planning process, and how that might adapt and change over time as specific goals and stakeholder combinations come together in different ways. This means abandoning the idea of one definitive master plan for all time, which does seem completely unrealistic in the face of epistemic uncertainty, and leading to the pragmatic situation of there being many plans that emerge over time, possibly from more than one planning process.

The effectiveness of STEEP methodology should be judged by the magnitude of the scope of the transformational goal that it enables at any one time. However, this must be evaluated in relation to the care and attention that was taken in the original process of negotiating the transformational goal with relevant stakeholders. A good sign of failure in this task would be to see plans emerge, but only to sit on the shelf going dusty, ignored by all.

3.2 Stakeholder analysis and engagement

It is clear that a city is a complex system in which energy flows across many different sectors, mobility affects everyday life and ICT supports and interacts with all sectors providing solutions. This system involves many different stakeholders that should be part of the planning process. Therefore there must be an Open and Innovative approach. An approach that must not only be applied to the involvement of stakeholders in the development of the Plan, but also in understanding the

contribution of interventions, identifying opportunities and barriers, as well as validating the whole process of planning.

From the perspective of municipal services to citizens, automatic and efficient management of urban infrastructure can create new services more responsive to the specific needs of citizens (improving mobility, energy conservation, efficiency improvements, etc.). And this can only be achieved by listening to citizens, operators, companies and implementing services accordingly.

The collaboration between city leaders, national, regional and local governments (administrations), academics, international and local companies, sustainability organizations and experts will achieve a higher quality of integrated planning in the following target groups:

- **Public:** improved manageability of the services offered to citizens, lower consumption of resources and promotion of the local economy.
- **Citizens:** making information usable and accessible, increasing comfort and quality of life and effecting cost savings due to lower energy consumption.
- **Private Companies:** emergence of new market opportunities, potential cost savings through efficiency and infrastructure and increased awareness of the needs of the customer.

It will, therefore, be important to identify and engage key public and private stakeholders across the whole value chain, as well as communities of interest who need to be involved in “Smart” planning.

Three subtasks were considered in the project to be effective in the engagement process:

- Stakeholder Analysis
- Diffusion events and engagement
- Stakeholder events
- Decision-making architecture

The present chapter will consider the stakeholder analysis and definition as well as the first approach to how organize stakeholder events. Both must be considered together in order to make a definition of most appropriate working groups. In the case of the collaborative stakeholder engagement platform developed in STEEP it will be part of the web platform. Based on experience in STEEP project, we suggest that the ownership of the process for engaging stakeholders over a transformational goal requires integration within existing decision-making processes i.e. an enlargement or enhancement of existing ways of making decisions that have a bearing on the desired transformation. Achieving this integration of decision-making architecture is another way of defining what it means to take ownership of the STEEP process.

3.2.1 Stakeholder Analysis

It is necessary to undertake a thorough analysis of the stakeholders that are part of the system. The analysis will depend on the definition of the Plan that each city may consider/adopt.

The concept of a Smart City, and therefore its planning, has not been agreed across the piece, either by academics or by cities themselves. We have reached a point in which even each companies present their own definition of what a Smart City means. It is not unusual to find many models, some of which are solely based on ICT interventions, while others will consider ways of living, education or other more social aspects.

Once each city has decided its approach the stakeholder analysis can be undertaken. In most cases, however, there are three groups of stakeholders that can be considered:

- Energy & Sustainability
- Mobility
- Integrated Solutions (ICT applied to the city)

These three key groups follow main trends in EU considerations towards obtaining integrated measures, smart, in European cities. In this case we are presenting a simple classification that could be helpful for the analysis and selection of stakeholders for these groups or others:

- **Local Administration:** This is a main group of stakeholders as triggers of possible changes in the city. By “local administration” we mean any department and/or company related to the city council. Among others sustainability, mobility, housing, infrastructure, urbanism, maintenance, water services or energy efficiency departments can participate.
- **Regional/National Administration:** In the case of Regional and/or National Administration the same departments can be considered. In some cases the specific weight of the Regional Government would be sufficient, in other cases the intervention of National Government should be sought depending on the responsibilities level.
- **Electricity Operators:** This is a reference group for any company related to power generation, distribution and/or commercialization (including Energy Services Companies ESCOs). All of them play an important role directly linked to the reduction of emissions by reducing consumption and electricity costs by providing and using data better managed.

- **ICT Operators:** In this group they will be included operators from the telecommunication field including internet providers, telephone operators, etc.
- **Gas Operators:** Companies that provide generation, distribution and/or commercialization of gas in the city.
- **Public Transport Companies** (usually part of the local administration)
- **Water Operators:** Operators of Water supply and disposal to the city (most of the time it will be municipal but it can be supplied by private companies as well).
- **Environmental Organizations:** Organizations, private or public, working to foster sustainability of cities through any type of actions
- **Energy Organizations:** Organizations, companies, clusters, etc. related to the Energy field that can be considered interesting as a stakeholder in each city.
- **ICT Organizations:** Organizations, companies, clusters, etc. related to the ICT field that can be considered interesting as a stakeholder in each city.
- **Transport Organizations:** Organizations, companies, clusters, etc. related to the Transport field that can be considered interesting as a stakeholder in each city.
- **Academic & Research Organizations:** Academic and Research & Development centers that can provide knowledge and innovative approaches to what the city needs and must develop. The research concept must be understood in an open sense, allowing the participation of any entity that can add something interesting to the process.
- **Financial Organizations:** Financial sector should also be involved somehow in the system thinking process. Their participation will be requested for the implementation of many actions. Therefore it would be interesting to already have and consider their assessment and information during the early stages.
- **End-users' Organizations:** This group of stakeholders gathers end-users in any of the fields of the Smart City Plan. It also includes community and voluntary organisations relevant to the district considered.
- **And Citizens' Organizations:** In this case other organizations no considered in previous epigraphs can be added. Here, even individuals (citizens) can participate if interested.

There can be as many stakeholders by identified group as each city decides. No minimum or maximum numbers have been established. Each city is very different and depending on the size of the city, the local structure, the participation or not of a regional government, the number of organizations and companies in the deployment of services and products the number will vary.

Their classification will be by thematic technologies, sectors, responsibilities, etc. to ensure that they are engaged in all relevant parts of the process to support the co-production approach. Each city will adapt the list to their context, situation and possibilities, and taking always into account the key stakeholders for the city. This means that, at least, there should be representation of each of the defined groups.

3.2.2 Diffusion events and engagement

The most difficult part of the process is the engagement of stakeholders. Usually there is a question of what is in the process for them? What kind of advantages will they have if they participate? The answer is not always clear for everybody. It could be argued that knowing and participating in the planning process could give interesting information for future developments in the city. But this is hard to measure when you don't really know the implementation level that the process will have. In any case being part of the planning process must be voluntary.

So, the question is how to engage them? What can be done?

It is interesting to disseminate properly the city planning process. The communication at all levels, press, television, newsletters, radio, etc. will give a consistent framework to the City's willingness to develop the Plan. It is a way to show compromise by the administration. The message should be clear and state that this exercise is really meaningful for the city and that it will carry direct implementation actions. It should be stated clearly that this is not only to coproduce a document but an implementation plan for the city. In this sense, the involvement of city's politicians and not only technicians is important.

Together with the dissemination across different communication mediums, it is helpful to develop events to which selected stakeholders can be invited. This is the direct way of ensuring that key stakeholders will participate in the process. It will be the chance to explain the scope of the planning process, the goals that the city intends to achieve and what kind of collaboration is requested.

In some cases direct contact should be sought. The engagement of big players is more difficult and in these cases personal interviews may help. This is also true for some departments within the City Council itself. Many times they work as silos and their willingness to get involved in this type of activity is undermined by a belief that their day-to-day work will be affected. Making direct contact can encourage participation and builds confidence into the process.

Something useful for the communication and engagement process is the development of a Stakeholder Engagement Platform in which all stakeholders can participate, share

data and information, send comments and interact with rest of stakeholders. In the STEEP project a specific platform has been developed for this purpose.

3.2.3 Stakeholder Events

As part of the engagement process it should be clearly stated how they will participate, timelines, goals, etc. One element is the preparation of specific workshops to develop, apply and work with selected methodologies. These workshops should be coordinated in advance, with explanations of the purpose of the workshop, giving details of relevant objectives and intended goals. In most cases this becomes an excellent set of information resource and the data and comments gathered can offer in depth analysis of the process.

The “transition” time between the different meetings should not derail the engagement. That is, avoiding isolated events rather than a process in which stakeholders can really collaborate and be part of.

The number of events will depend in the Smart City definition, and the number of working groups that will be established. But, at least, three events (workshops) per working group could be considered with these general purposes:

- 1st Workshop: Diagnostic of situation and pointing out main goals.
- 2nd Workshop: Elaboration of intermediate goals and defining key processes
- 3rd Workshop: Selection of projects to achieve City’s goals

3.3 Governance structure: financial and people resources

An appropriate governance structure is fundamental to successful implementation. The master plan should outline which structures are in place or how they will be organised to implement the proposed actions successfully. Local authorities should ensure that the master plan is taken into account at different levels and by different departments, including those at a national level. It should also specify the human resources required and how they will be made available, as well as the implementation and monitoring strategy. The local authority should consider training and capacity-building to avoid delays in implementation.

The creation of a central office is of vital importance and allows coordination of ideas, projects, stakeholders and beneficiaries. Local level coordination can also be important for uptake, to ensure the integration of solutions across the portfolio of initiatives.

The municipal council and local authority should further support the process by ensuring adequate human resources are in place to design, implement, monitor and adapt the master plan: this may require identifying, engaging and allocating, including

providing a clear mandate and sufficient time and budget. All the relevant departments from the local authority must be involved in the master plan elaboration process to gain their acceptance and backing. It's recommended to foresee a technical support from outside who could provide different skills completing the team (universities, experts, research institutes, local agencies,...), but the process ought to be managed from inside the municipality which is the final owner of the strategy. The composition of an ideal team is shown in the picture below.



3.4 Sense making – ICT use, data collection and mapping

Sense-making is the process of making meaning out of data through interpretation and modelling, and involves a constant cycle of information acquisition, reflection and action⁵. This process can be used to improve our understanding of complex and 'wicked' problems, and can help to shape appropriate and effective interventions within a given system. In this context, sense-making can be used to facilitate a broad and in-depth analysis of the energy system within a given area, so that an energy master-plan can be suitably targeted and its success monitored. The process set out here includes the identification and collection of useful data, and the use of ICT (including a collaborative mapping tool) to help explore the wider system.

⁵ <http://www.jonkolko.com/writingSensemaking.php>

3.4.1 ICT use

As previously stated describing the Smart City concept, the role of ICT is essential. ICT has the potential to lead to a structural evolution towards products and services which are less resource intensive (save energy in buildings, networks, transport,...), are more intelligent, i.e. much tailored on costumers needs, and more widespread. Thus, ICT has a direct influence on the actions that will be carried out in relation to the efficient management of energy and transport, but also can effect behaviour change through instruments such as social networking.

Information and Communication Technologies (ICT) are key enablers of a Smart City, they can support more efficient real time measurement and management of resources flows including energy (e.g. smart grid, smart metering of energy and resources in general like water, intelligent transport systems, telehealth etc.) and also create innovative digital platforms to support behavioural change e.g. social networking sites.

In a Smart City, these networks are linked together, supporting and positively feeding off each other. The technology and data gathering used in Smart Cities, should be able to:

- 8 constantly to gather, analyse and provide data about the city to pursue wellbeing, competitiveness and sustainability
- 8 to act multi-functionally, providing solutions to multiple problems from a holistic city perspective.

3.4.2 Data collection

The data collection phase of the sense-making process should be viewed as a two-stage process. The first step in this process is for project teams to identify the datasets that are already available and held by key stakeholders (as identified, for example, through the process modelling exercise), and to compile relevant information into a metadata catalogue. During the STEEP project, partners used the following list of data categories to help initiate and guide this process:

- Building characteristics
- Digital infrastructure and communications
- Economics and finance
- Emissions, climate data, and natural resources
- Energy generation and supply
- Environmental constraints to development
- Existing landscape features, buildings and infrastructure
- Governance and local authority structure

- Policy data
- Social and demographic
- Stakeholder identification and community engagement
- Transport and mobility
- Waste treatment and disposal

Whilst teams may find it easiest to begin collecting data in simple spreadsheet format, this can quickly become unwieldy. In order to address this, and to aid in the facilitation of collaborative working, a wiki-based tool can be used. As covered within Deliverable 1.4, the [STEEP wiki](#) is based on the Semantic Mediawiki software package, which is open-source and free to use. Online tools such as this allow multiple users to contribute information simultaneously, and from any location.

Each individual dataset can be added to the wiki in a separate page, along with its corresponding metadata. Where possible, this information should be provided in line with the guidelines set out under the 2007 EU INSPIRE directive⁶ in order to ensure consistency. For every entry, this should include parameters such as a description of the dataset, a source reference, the date it was published, its resolution and the format of the file.

To help 'harmonise' the data, the datasets identified can be placed into categories within the wiki. For the purposes of the STEEP project the categories were defined in line with those listed above, however these can be easily adapted to suit the needs of an individual project.

Project teams may wish to appoint a data coordinator to take ownership of this collection process, particularly for larger projects. In such cases, the coordinator may want to create a template for data entry, with specific required fields and defined category options. This is a good way to ensure that data collection and categorisation occurs effectively and that the descriptions of the data are thorough.

Once the first set of information has been uploaded to the wiki, users can browse the information according to the pre-set categories, or by filtering the datasets based on specific characteristics. For example, a user may conduct a search for datasets that are listed as being in shapefile format, and that have been updated within the last year. The ability to compare and contrast features of the datasets in this way can allow users to identify synergies between them and to explore and develop options towards developing an energy master-plan.

⁶ <http://inspire.ec.europa.eu/>

When a shortlist of relevant datasets has been produced the team members should then begin to collect the actual data. It is important to remember to give proper consideration to the licensing conditions of each dataset.

As the project progresses it is likely that the need for new types and sources of data will become apparent, therefore the process outlined here will need to be regularly reviewed and repeated.

It might be assumed that where a large geographical area is to be analysed, obtaining enough data to cover the entire zone may be more problematic.

Where multiple, similar datasets are required, there is a greater risk that they may overlap, be in different formats, have different levels of granularity or make use of different symbology or notation. It is also possible that a lot of people will need to be involved in the collection process, many gaps in the data may become apparent, and a great number of licensing conditions will need to be acknowledged and complied with.

In the STEEP project many of these problems have already been addressed to a certain extent by the move from a spreadsheet-based data management tool to the web-based wiki tool described above. The software also has a flexible structure which can be easily adapted to accommodate different scales or quantities of data. Finally, the 'open' nature of the tool may mean that a larger number of users have the opportunity to modify its underlying configuration, which could result in a constant process of improvement whereby new and innovative solutions to issues of increased complexity and incompatibility of datasets may be developed.

3.4.3 Mapping

The [STEEP mapping tool](#) can be accessed via the link on the wiki Main Page of the Collaborative Stakeholder Engagement Platform. The aim of the mapping tool is to allow users to create visual representations of data relevant to energy master-planning, which they can share with other stakeholders who can then explore and interrogate the data and contribute to the development of new ideas.

Visualising an energy plan geographically is useful because it allows us to see patterns which may not be obvious from the raw data. It allows us to target areas more intelligently, and to identify regions where additional interventions may be required. Maps could be also used, for example, to identify groups of people who will be affected by the plan, allowing their active engagement as stakeholders.

Data can be added into the mapping tool in either shapefile or JSON format, or in CSV format where simple data points and corresponding x and y coordinates are available. When a new layer of data is added, the tool will list the dataset within the 'layer control box', and will automatically create a legend for it.

Users can navigate around the map manually (by panning and zooming), by using the search bar at the top right hand side of the screen, or by clicking on the name of a dataset within the layer control box to zoom to the area covered by that data. It is possible to select a ‘home location’ once an area of focus has been identified, so that it can be easily returned to after exploring elsewhere.

The appearance of the map can be altered to suit the purpose of the user in a number of ways. Firstly, the user can select one of five background map options to suit the kind of information they are trying to portray. For example, ‘OpenStreetMap’ could be used to display data in relation to local infrastructure, facilities or area designations, or the ‘ESRI Relief’ option could be used where topographical information is of particular interest. The layer control box can be used to alter the colour and transparency of the data points, and also to bring up a table containing the data associated with each layer. The tables may be used to sort and interrogate the data, to identify specific data points on the map, or to select a new range of values (i.e. a new column) from within the same dataset to display. The layer control box and the legend can be moved around the screen or removed completely depending on how the user wishes the map to appear.

For projects based in England only, the mapping tool incorporates the [National Heat Map]. The heat map was created for the Department of Energy and Climate Change (DECC) by the Centre for Sustainable Energy, and provides high-level resolution mapping of heat demand by area. It is built from a bottom-up address level model of heat demand in England, and is based on published sub-national energy consumption statistics. There is an intention to continue developing the functionality of the STEEP mapping tool and to incorporate other similar tools that can be used to provide indicative information on the integration of low or zero carbon technologies within a map. For example, this may include the ability to calculate estimated cost or energy savings for technologies such as solar PV or wind turbines, or alternatively for energy saving measures such as insulation.

Once a map has been created, it can be saved onto the tool. When a new map is saved it will be assigned its own URL, which can be emailed to other stakeholders to allow them to view the map directly. Alternatively, the user can import their map into a report format within the tool. Reports are produced as new pages within the wiki and can be generated using the relevant link on the wiki’s Main Page (note, only registered users can create new content within the wiki). The Visual Editor tool (located on the ‘Create’ tab of the new wiki page) can be used to add and format text, and to import images as well as map documents and other media. Some users may prefer to work instead in the ‘Create source’ tab, which will allow them to edit at source using wiki markup language. Editing on this tab also allows for the creation of tables within a report, and users with experience of the using the ‘R’ programming language can use this to produce charts (alternatively charts and tables can be created in other

programmes such as Microsoft Excel or Word and imported as images via the Visual Editor tool). When a new report is saved a new URL is created from the filename. Reports can be shared either by emailing the URL to other users or by exporting the document into PDF format⁷.

At present, any registered user can access and edit a report or a map that is saved within the tool. This is designed to facilitate collaborative working, however it is possible that access controls may be added to the tool at a later date, should they be deemed necessary following wider consultation.

Effective version control is integral to the functioning of the tool as a facilitator for collaboration. Within the wiki, the 'View History' tab allows users to review, compare and reverse changes made to a report by themselves or by other users, and the 'Permanent link' function within the left hand side menu can be used to scroll back and forth through different versions of the same report (a time and date is provided for each revision). Similarly, within the mapping tool the 'History' slider within the toolbar at the top of the screen can be used to show how the map has been amended over time, and edits can be rolled back in small increments using the up and down arrows. When an alternative version of the same map is created it is also possible to save it as a completely new document if required. Users can control which version of a map they import into a report by using the 'lock to version' option within the import tool of the Visual Editor.

A more detailed user manual containing full step-by-step guidance for the tool has been put together and can be accessed from the wiki's Main Page. The source code for the STEEP tool is freely available under an open license therefore it can be downloaded, used and modified by any individual or organisation that has the skills to do so.

Both the data collection and sense-making processes are ongoing and iterative, and as such should be revisited regularly as the project progresses.

⁷ The export to PDF format facility is under development at the time of writing.

3.5 Identification and prioritisation of SMART interventions

Exploring the relationships between the different actors of the energy value chain (e.g. generation, distribution, consumption, recovery and dissipation) in a city is key to selecting the most appropriate array of sustainable actions to include within a Smart City Plan taking into account complementarities and synergies. An integrated perspective will also deliver greater efficiency in energy flows.

The vision of a SMART city, that has to be defined at local level, is articulated into several subprocesses, commonly recurring in the pilot plans, decomposed in possible actions with a high replicability level. All those actions have been collected in a preliminary model (D 4.1) which, together with the “low carbon technologies study”, could be presented to stakeholders in the initial workshop for them to analyse and modify. This will serve as a starting point for discussion.

The set analysed involves different kind of measures: the options included in the plans are

- Implementable general processes
- Implementable technological detailed processes
- Implementable non technological detailed processes
- Planning process interventions

It is important to note that the STEEP ‘systems thinking’ methodology adopts an ‘holistic’ approach to solving difficult or complex problems, (in this instance – achieving a city’s carbon reduction targets) and therefore it identifies the various non-technical interventions that should be taken as well as which technologies may be adopted. The STEEP methodology explicitly tries to explore the potential organisational and behavioural interventions that could/should be made in addition to new or innovative technological solutions.

The purpose of each modelling workshop is therefore to deconstruct and refine each of the processes needed to achieve the ultimate objective, which can then be analysed in terms of how well they are currently performing. This is also the point at which connections between different processes are defined using the notions of ‘sufficiency’ and ‘necessity’, I.E is a sub-process sufficient for the overall process to be successful, or is necessary. If a process is identified as not necessary then these processes can be excluded or de-prioritised as areas for further action.

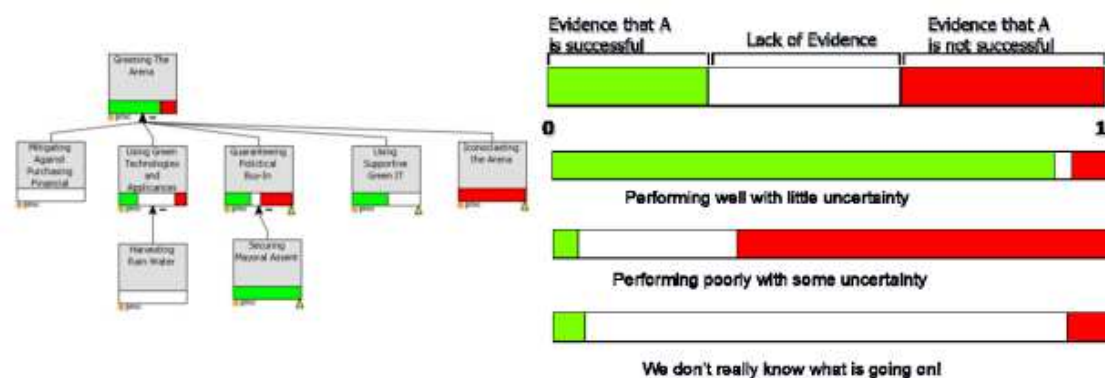
The sufficiency and necessity parameters are used to capture the dependency conditions between the processes of the model:

- i. Sufficiency – How much of the evidence is directly relevant to the parent process?

ii. Necessity – Will the parent fail if the sub-process fails? Takes over if evidence against is large.

iii. In this type of projects these parameters can be used as evidences for the prioritisation of interventions phase.

The Italian flag is a colloquial name that can be used to describe the method based on internal numbers that is used for example in the STEEP project models (Perimeta tool) to express knowledge about process performance. Using the “Italian Flag” notation allows us to capture both measures of performance and also uncertainty.



Perimeta tool submodel and “Italian flag” description

When rating the performance of the various sub-processes, stakeholders can utilise quantitative as well as qualitative measures. This initial assessment forms the first phase of prioritisation of interventions as it highlights where there is poor existing performance and therefore where further attention should be focussed.

The development of successful hierarchical models which clearly describe the processes involved in achieving the high-level goal is therefore the primary method for prioritising interventions.

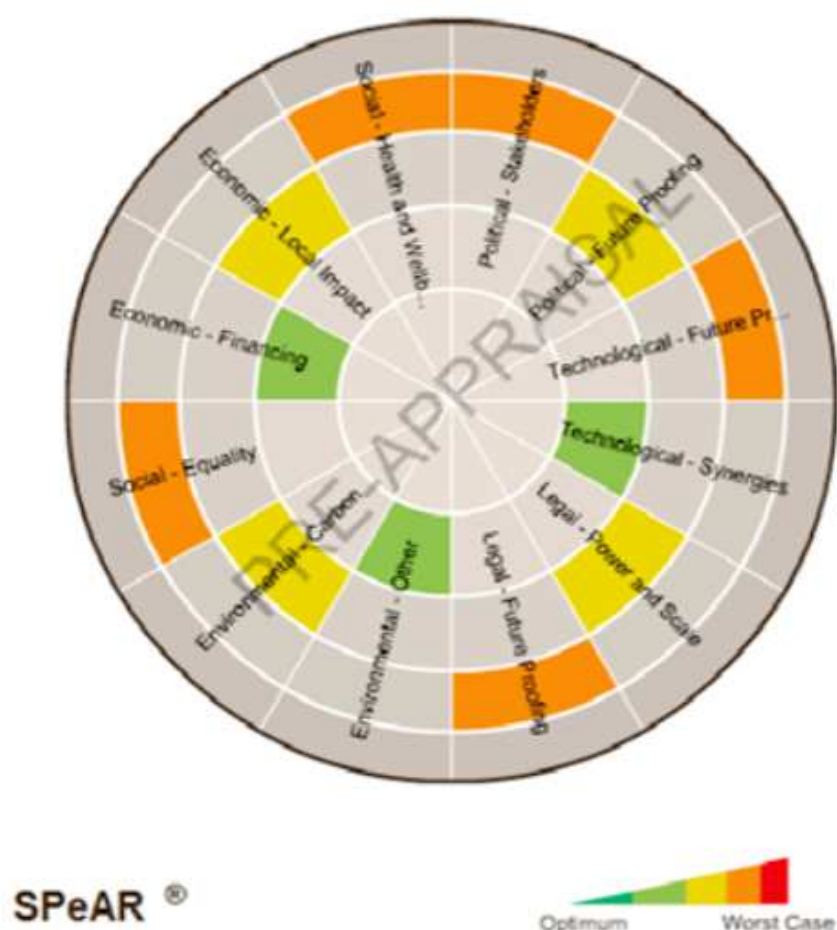
Once the process of identifying arguments for/against specific options is complete, there will be a resulting list of possible interventions that can be taken onto the next stage: sense-checking. Although the modelling process is the main vehicle for prioritising interventions, it must be considered that the outputs from this process will be the products of only the individuals who took part within the workshop discussions. At this stage of the methodology therefore, the ‘actionable’ options should be subject to a *‘sensechecking’ process* whereby they are considered by the ‘owners’ of the transformational statement and other experts external to the workshop process itself. This sensechecking will provide a list of options that are both feasible and desirable in

the particular context of the city involved. This is intended to be a first phase of a quality assurance process that helps refine the list of potential interventions.

The next step to prioritising interventions is to apply a *strategic analysis*. In the STEEP methodology, we have adopted the PESTEL analysis. The objective of the PESTEL analysis is to evaluate the feasibility of each initiative considering the different Political, Economic, Social, Technological, Legal and Environmental implications for each.

Based upon the results of the Pestel, the intervention will be given a corresponding 'likelihood of success rating' which will further define which interventions to take forward.

Performance of a given action is rated from 'exemplary' to 'best practice', 'good practice', 'minimum standard' and finally the 'sub-standard'.



Example of PESTEL graph with the results obtained with the SPeAR tool used in STEEP

PESTLE Framework	Consideration
Political	Is the proposal likely to attract significant criticism from a section of the political spectrum, pressure groups, or the local populace? Is there a risk of substantial growing criticism in the future? To what extent have stakeholders been involved in the development of the proposal?
	Is there existing political support for the proposal? Is there cross-party support and is this likely to be maintained by successive governments or local political institutions?
Economic	Have potential public or private financing mechanisms been identified for the project, does it offer a return on capital and are mechanisms likely to be lost or new ones created in the future?
	Does the proposal offer the opportunity for wider local economic benefits, such as a local supply chain or other benefits for local businesses?
Social	Does the proposal promote equality? I.e. Does a wide cross-section of society benefit from the intervention, or only a specific group? Has the ability of vulnerable groups to participate been considered?
	Does the proposal promote healthy lifestyles, wellbeing and happiness within the general populace? Does it promote community cohesion?
Technological	Has the proposal ever been proven as an effective energy intervention before, and is it 'future proofed' against changes in technology, and can it be adapted and improved over time?
	Will the proposal significantly restrict, or support, other interventions (including those less concerned with technology) that help to meet the same objective?
Legal	If any new legal frameworks or policies need to be put in place, does the city government have the power to implement these?

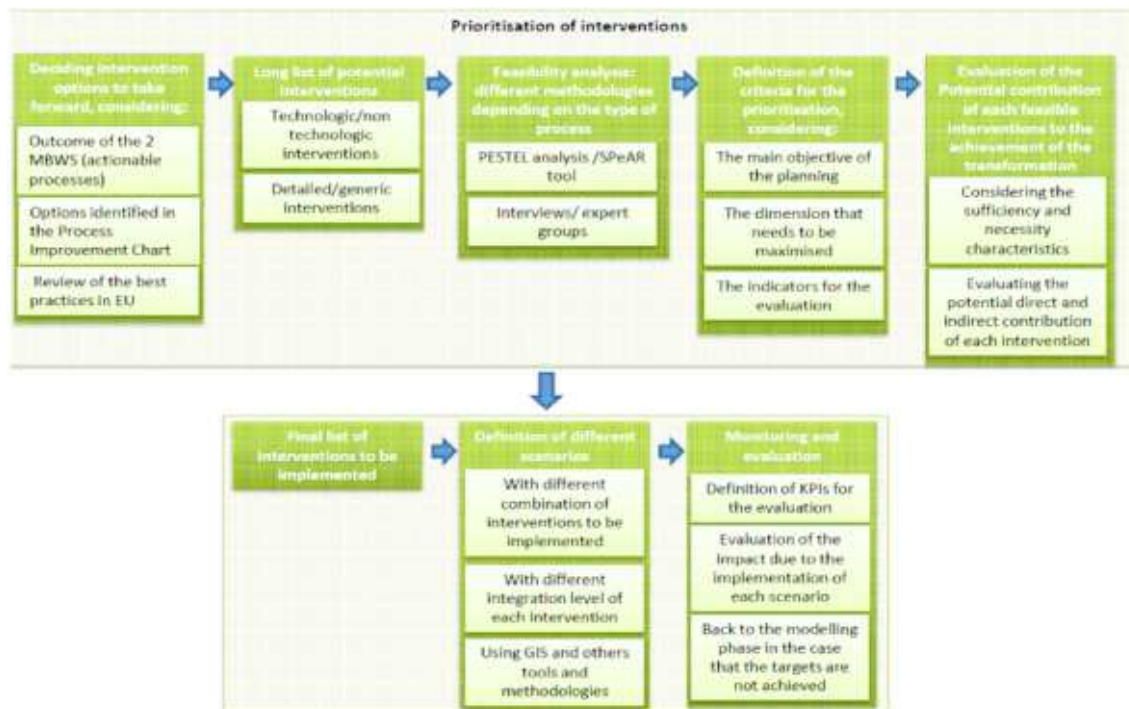
	Does the intervention comply with existing policy and legislation (including planning regulations) and is it 'future proofed' against changing government or European policy, new legislation and top-down targets?
Environmental	<p>What are key environmental factors over the lifetime of the intervention such as:</p> <ul style="list-style-type: none"> - Waste and Resources - Air quality - Water environment, including quality and use - Biodiversity and ecosystems - Noise - Landscape and townscape - Soil and land - Heritage
	Is the intervention likely to contribute to a net atmospheric greenhouse gas (GHG) reduction?

Example of spreadsheet for the PESTEL analysis developed by ARUP in the STEEP project

Both the modelling process and the strategic assessment can be used to prioritise interventions: these processes are analytical in nature and should be complimented by a parallel process of data-modelling that will indicate where best to implement certain solutions.

As already described in the previous paragraph, part of the STEEP open-methodology is an online 'Stakeholder platform' which will include visualisation of existing energy data sets: the visualisation element of this platform is a vital element of prioritisation of interventions as it allows the effects of a number of possible actions to be visualised prior to adoption. This could be via the use of existing data sets that support the adoption of a technology (i.e. current heat demand profiles), or via data modelling which can be used to predict the effects of an intervention.

By adopting a 'systems thinking' approach to problem-structuring and engaging in a discursive process that is by nature iterative, the process involves a 'causal loop': the final step therefore in prioritising interventions is closing the 'causal loop' whereby any action taken should be fed-back into the process to see if this has altered the operation of the model in anyway. If not, then these interventions should be either reviewed or discounted in the next phase of activity to achieve the ultimate goal.



Prioritization of intervention process flow chart

4. HOW TO PUT A SMART CITY PLAN INTO EFFECT

One of the critical issues for a plan is to become “effective” and not to remain a static work of analysis and design.

The influence of a planning tool derives from its hierarchical importance and from the political support it has been able to obtain when adopted.

Another important point is the finance availability which can affect the measures implementation: new financing models must be investigated to boost the realisation of the actions, overcoming the critical requirements of the municipalities' balances.

The monitoring activity is fundamental to evaluate the achievements, to maintain the attention on the process and the stakeholders and citizens involvement.

4.1 Adoption strategies

Strong political support by municipal council or equivalent decision-making body is a prerequisite for the successful implementation and monitoring of a Master Plan. Local authorities must ensure that the vision and actions proposed are aligned with and integrated into relevant EU, national and/or regional plans

It is very important to ensure long-term political support to the process: establishing broad political consensus at all levels about the master plan goals is highly recommended. It provides stability, regardless of changes in political leadership.

As the highest responsible entity and authority, the municipal council ought to approve the plan and, being an iterative process, it must be closely informed of the follow-up of the implementation.

The key decision-makers of the local authority should further support the process by allocating adequate human resources with clear mandate and sufficient time and budget to drive the planning process and its follow-up (see 3.3)

On the other hand a coproductive methodology itself, involving different stakeholders and interests, represents a guarantee for the continuity of the process and the control of its performances even if under the PA's ownership.

4.2 Financing models

The Smart City Master Plan should foresee a specific part dedicated to the financial strategies for the realisation of the measures: it's a complex aspect because it involves

the exploitation of different existing tools, already active at national or EU level, to be used for the targets achievement.

The major issue in attracting private investments consists in carrying out a reliable cost benefit analysis, which is able to take into account the cross-cutting nature of the Smart city actions and the deriving “externalities” instead of making an evaluation at single solution level considering only energy or time or GHG savings which are easily linked to monetary aspects.

On the other hand the externalities are not valuable benefits for the investors and this is why governments or PAs in general are always the engine of this kind of action plans.

The challenge is to achieve a cooperation between public and private funding, making extensive use of PPP. However this practice is not very common because of many problems in finding the right balance avoiding complicated procedures and market distortions.

The involvement of stakeholders in the planning process will support the identification of specific tools for the implementation of measures and projects. We refer to agreements and protocols with financial institutions or corporations to support the implementation of interventions. These are agreements that ought to be defined locally, with simplified procedures and methods in order to meet the needs of the end-users (protocols with financial institutions for loans for the implementation of energy efficiency measures in the residential and tertiary sector, agreement with associations to install high-efficiency equipment, etc. as the ones active in STEEP partner cities).

These are tools that must be defined locally, but that must be processed by the governance structure of the Smart City Master Plan in order to monitor their implementation.

The integrated planning, in parallel with the co-production approach developed in the STEEP project, makes it possible to enhance public investments by acting as a catalyser of private investments in cities. Several interventions show the potential of partnerships in buildings retrofitting (through energy saving companies-ESCOs) or transport (with OEMs), etc. But it is also true that PPPs are not the only answer. For instance, in many cities, municipal companies are playing the role of investors and operators in energy projects and managing the city’s broadband networks.

The analysis on new types of partnerships and social innovation will need to be conducted using appropriate lenses to ensure that the business models make suitable recommendations for policy that address the issue of energy poverty, bring about consumer empowerment and resilience and improve security of energy supply.

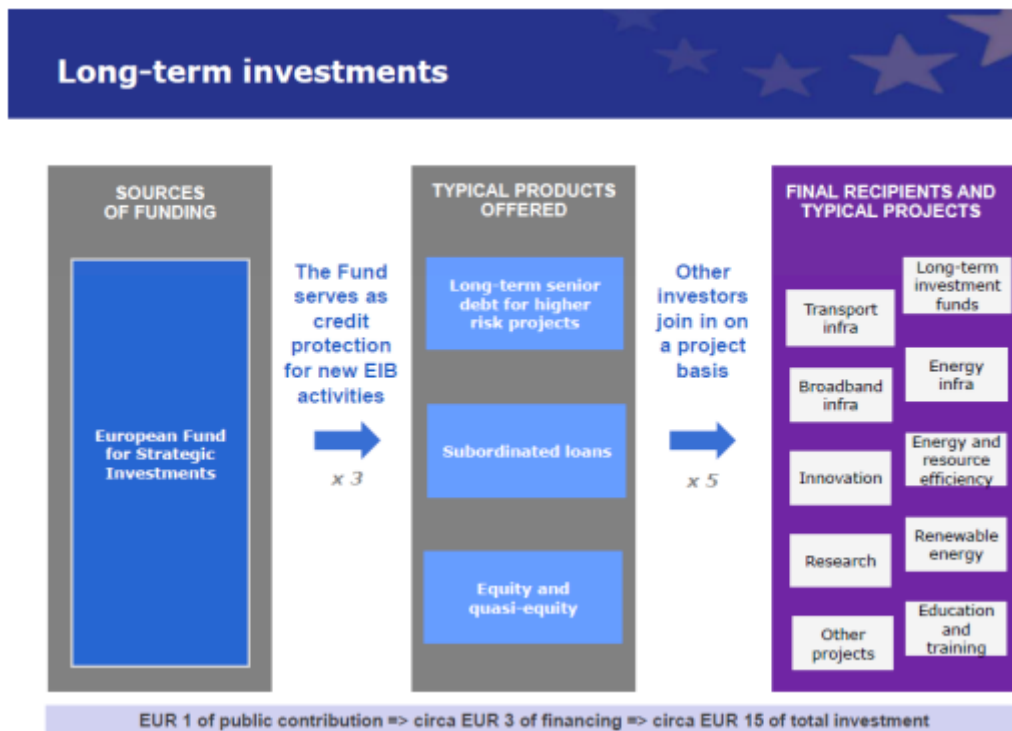
4.2.1 The EU initiatives

The Commission Communication of 19 October 2011 on "A new framework for the next generation of innovative financial instruments – the EU equity and debt platforms" (COM(2011)622 final) presents the Commission's view on the future of innovative financial instruments in EU budget spending. Innovative financial instruments have the potential to play an important role in achieving the Europe 2020 Strategy's objectives of smart, sustainable and inclusive growth.

Spending through innovative financial instruments is another way of spending EU budget than giving grants or subsidies. Innovative financial instruments cover a rather broad range of interventions such as participations in equity (risk capital) funds, guarantees to local banks lending to a large number of final beneficiaries, for instance small and medium-sized enterprises (SMEs) or risk-sharing with financial institutions to boost investment in large infrastructure projects (e.g. the Europe 2020 Project Bonds Initiative). The aim of such interventions is to boost the real economy through increasing the access to finance for enterprises and industry producing goods and service

(http://ec.europa.eu/economy_finance/financial_operations/investment/innovative_financial_instruments/index_en.htm)

According to a task force report under the Juncker Plan, in most parts of Europe, the challenge remains to attract a sufficient scale of investment into improving energy efficiency from private resources. This challenge can be addressed in part through dedicated project development assistance, potentially complemented with targeted use of public resources, to share risk with private financial intermediaries.



The European Investment Plan (Source Vice-President Jyrki Katainen presentation)

These financial instruments should go hand in hand with implementation of related legislative framework, namely the Energy Performance of Buildings Directive and the Energy Efficiency Directive. Improving access to finance would contribute to boosting demand, helping this way also the construction sector which is characterised by high concentration of SMEs and strong potential to create local jobs.

– The Europe 2020 Project Bond Initiative

Many cities are provided with a program for the most important infrastructures at long term: major efforts are needed to facilitate infrastructure projects' access to private finance and to develop alternative ways of debt financing for them. Privately financed infrastructure projects in Europe rely heavily on bank lending, which is not readily available at maturities which would reflect the long-term life-cycle of an infrastructure project.

In order to improve projects' access to financing and develop a vibrant infrastructure bond market, where private initiatives have made little progress so far, the EU intends to cooperate with the EIB in order to create a facility to support the private issuance of project bonds, the Europe 2020 Project Bond Initiative.

Past experience has shown that a pilot phase is needed for stakeholders to familiarize themselves with the novel financing structures and for final changes to optimise the design.

Even though the scale and scope of the pilot phase would be limited, it is expected to stimulate market behaviour towards an increased acceptance of capital market debt financing and thus lay the ground to improve the initiative and implement it as a fully-fledged proposal in the next multiannual financial framework. <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52011DC0660&rid=1>

- European Local ENergy Assistance

For the implementation of actions with a high financial attractivity, the European Commission created a series of tools aimed at supporting the public authorities in the design phase to be able to handle correctly the interaction with the private investors.

Many EU towns and regions lack the necessary technical expertise and organisational capacity to implement large energy efficiency and renewables projects. ELENA (“European Local ENergy Assistance”) run by the EIB, it is funded through the European Commission’s Intelligent Energy–Europe programme.

ELENA covers up to 90% of the technical support cost needed to prepare, implement and finance the investment programme. This could include feasibility and market studies, programme structuring, energy audits and tendering procedure preparation. With solid business and technical plans in place, this will also help attract funding from private banks and other sources, including the EIB.




- The European Energy Efficiency Fund

The EEEF therefore aims to support the goals of the European Union to promote a sustainable energy market and climate protection.

EEEF contributes with a layered risk/return structure to enhance energy efficiency and foster renewable energy in the form of a targeted private public partnership, primarily through the provision of dedicated financing via direct finance and partnering with financial institutions. Maximizing its impact, EEEF facilitates investments in the public sector, which offers an enormous potential, but in which projects are often hindered or decelerated due to budget restrictions and lack of experience with this kind of investments.

- New instruments

The European Commission and the European Investment Bank are launching two new financial instruments to drive investment in energy efficiency, efforts to preserve

	<p>Project no. 314277</p> <p>STEEP PROJECT</p> <p>Systems Thinking for Comprehensive City Efficient Energy Planning</p>	 
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natural capital, and adaptation to climate change. The instruments will unlock public and private investments by combining EIB funding with financing under the EU LIFE Programme for Environment and Climate Action.

The first instrument – Private Finance for Energy Efficiency (PF4EE) – aims to increase private financing for energy efficiency projects designed to help Member States achieve the EU's agreed targets on energy efficiency. The Commission has committed €80 million for 2014–17, anticipating an 8-fold leverage effect.

The PF4EE will combine lending from the EIB to intermediary banks in Member States with protection against losses associated with making loans for energy efficiency projects. It will be complemented by technical assistance to financial intermediaries.

The instrument targets SMEs, private individuals, small municipalities and other public sector bodies undertaking small energy efficiency investments. It will be implemented through banks in Member States. The size of the loans could range between €40 000 up to €5 million or more in exceptional cases.

The second instrument – the Natural Capital Financing Facility (NCFF) – will provide loans and investments in funds to support projects that help preserve natural capital, including adaptation to climate change. Eligible projects will include payments for ecosystem services, green infrastructure, biodiversity offsetting and investments for innovative pro-biodiversity and adaptation businesses.

A budget of €100–125 million is available for the period up to 2017. The European Commission provides up to €50 million as a guarantee for the investments with an additional grant support facility of €10 million for technical assistance.

Recipients for NCFF could include public and private entities, including public authorities, land owners and businesses. Project size will typically be between €5 and €15 million.

At any time, potential project developers can contact the EIB to express an interest in the facility and discuss the suitability of their ideas. Proposals will be considered for approval by the Bank, after satisfactory due diligence and selection by the Bank, within the constraints of the available budget.

The instruments will mobilise public money to generate new private investment, without creating new debt. They will help remove market barriers by investing in projects that would not be funded otherwise because they are perceived as too high risk.

By doing so, they will demonstrate that investments in low-carbon technology and resource efficiency sectors not only pay off in the longer term, but also contribute to achieving EU's 2020 goals in resource efficiency, biodiversity and climate action, putting Europe on the path of sustainable growth.

A very useful quick reference guide has been developed by the Covenant of Mayors (http://www.covenantofmayors.eu/IMG/pdf/Financing_Opportunities_Matrix.pdf) where all the initiatives are summarised in a clear matrix.



4.2.2 EPC contracts and ESCO market

The measures implemented by private investors must be driven by several factors which could ensure the achievement of the energy efficiency expected targets.

The operators should be highly qualified (ESCOs) and the contractual forms adapted (Energy Performance Contracts).

An Escos is a company which is able to develop, implement and finance projects based on energy performance improvement and maintenance costs saving, acting on buildings/plants owned or in use by the "client", ensuring the final result.

The lack of a common definition, clear and simple identification of ESCOs was regularly quoted as main barriers to the wider spread of the ESCO model in Europe, because it

resulted in problems with trust and therefore a limitation in ESCO project demand (Marino et al. 2010).

Definitions have been provided lately, which are meant to be used Europe-wide and as a consequence it has become somewhat easier to overcome problems with understanding and trusting the ESCO concept. The first common standard meaning was put forward by the EN 15900 standard in 2010, and later by the Energy Efficiency Directive (EED, 2012/27/EU) in 2012.

The EED defines an ‘energy service provider’ as a “natural or legal person who delivers energy services or other energy efficiency improvement measures in a final customer’s facility or premises”, while ‘energy performance contracting’ (EPC) is understood as a “contractual arrangement between the beneficiary and the provider of an energy efficiency improvement measure, verified and monitored during the whole term of the contract, where investments (work, supply or service) in that measure are paid for in relation to a contractually agreed level of energy efficiency improvement or other agreed energy performance criterion, such as financial savings”.

The JRC use a slightly different definition of an ESCO (an energy service provider, an energy efficiency provider or energy service company), i.e. herein an ESCO is “a company that offers energy services which should include implementing energy-efficiency projects (and other sustainable energy projects). Many ESCOs work on a turn-key basis.”

The three main characteristics of an ESCO are as follows:

8 ESCOs guarantee energy savings and/or provision of the same level of energy service at lower cost.

8 The remuneration of ESCOs is directly tied to the energy savings achieved;

8 ESCOs can finance, or assist in arranging financing for the operation of an energy system by providing a savings guarantee.

The ESCo bears the commercial risk of the operation, in respect of execution of a contract and has to deal with the retrieval of capital; an Energy Performance Contract may follow the “shared savings” or the “guaranteed savings” model: this distinction reflects the different distributions of investments, savings and risks between the client and the ESCO (Langlois and Hansen 2012).

In contrast to EPC, “Delivery Contracting” (DC, also known as Supply Contracting or Energy Supply Contracting (ESC)) is focused on the supply of a set of energy services (such as heating, lighting, motive power, etc.) mainly via outsourcing the energy supply.

Integrated Energy Contracting (IEC) is a new model, which combines EPC and DC and thus increase the amount of energy cost savings. When designing the project, demand

side measures are planned as a priority, and the remaining level of energy needs are covered by more energy efficient supply, when possible. Therefore an IEC combines the benefits of the demand and supply side measures, therefore reaching a higher cost-benefit. At the same time, the contract is simpler than a normal EPC, which also reduces expenses (Bleyl 2012; Wargert 2011).

An ESCO project is beneficial from several viewpoints, even beyond the participants. While ESCOs are not the universal remedy for energy demand growth and sustainable development, they definitely have an important role to play in the energy efficiency markets and in achieving micro and macro level goals.

Property owner (client) <ul style="list-style-type: none"> • Energy cost savings (or other utility cost) • No or low upfront cost • Healthier indoor environment • Increase of comfort • Building value increase • Additional renovation components (aesthetics, status improvement, extension, etc.) • Public image/prestige 	Municipality/community <ul style="list-style-type: none"> • Jobs – more balanced community • Growth of the value of the building stock and more attractive district/area • Healthier district • Independency • Development of communities <p>-> competitive benefit</p>
ESCO/contractor <ul style="list-style-type: none"> • Workplace • Profit • Long-term, reliable partnership • Possibly further contracts with the same partner 	Macroeconomy <ul style="list-style-type: none"> • Jobs • Development of real estate market – growth of GDP • Motivation of residents' and/or investors to spend money locally • Growth of energy security, decrease of need for

Benefits of ESCO projects (source Esco update report JRC)

There are three standards which could support the ESCO market:

- In April 2010 the UNI CEI 11352 has been published: on voluntary basis, it defines the general requirements for an esco and provides a check list to evaluate the energy service companies.
- The EN 15900 standard sets the requirements for the service to be provided
- The ESCO should implement an energy management system according to the ISO 50001 standard, and it should be able to develop a similar system also for the end-user.

To have a comprehensive vision of the ESCO market, we suggest to consult the the European ESCO Update Report and the ESCO market report which are regularly published by the European Commission's JRC

(<http://iet.jrc.ec.europa.eu/energyefficiency/tags/european-energy-service-companies-esco>)

A recent study published by the EFIG analyses in details the drivers affecting demand and supply in energy efficiency investments in building sector: the table below shows how the drivers can differ by market segment and how the ESCOs availability, the regulatory framework as well as the information would be important.

Buildings Sector	Commer- cial	Public	Public Rental	Owner Occupied	Private Rental	Average Rank
Standardization	6	3	1	11	2	4.6
Clear Business Case	1	7	9	9	4	6
Effective enforcement of regulation	4	6	6	8	6	6
Awareness at Key Decision Maker Level & Leadership	2	2	2	12	13	6.2
Buildings Regulation, Certification and Energy Performance Certificates	5	4	3	13	11	7.2
Tailored Financial Product availability	18	11	7	5	3	8.8
Transaction costs / simplicity	10	16	12	2	5	9
Regulation which impacts on timing and scope of renovation	7	8	4	15	14	9.6
Regulatory Stability	3	9	10	19	9	10
Facilitation/ Technical Assistance	22	5	8	10	15	12
Fiscal Support	14	25	22	4	1	13.2
Body of Evidence (including Social Benefits and Costs)	13	13	11	16	17	14
(Individual/ Owner) Payment Capacity	23	22	18	1	8	14.4
Awareness of appropriate timing for energy efficiency measures within the traditional building cycle	16	15	13	18	10	14.4
Awareness. Communication & Marketing	20	20	24	6	7	15.4
Measurement, Reporting & Verification (MRV) and Quality Assurance	9	10	15	22	21	15.4
"Green Premium" / Brown Discount	8	23	23	14	12	16
Rules on public authority accounting, procurement and reporting	25	1	5	25	25	16.2
Price of energy	11	19	21	7	24	16.4
Mandatory Energy Audits	15	14	17	21	19	17.2
Availability of Data	12	17	19	20	20	17.6
Definition and common understanding of the value of energy cost savings	17	18	16	17	23	18.2
Human Capacity	19	12	14	24	22	18.2
Behavioral Economics (personal priorities)	24	24	25	3	16	18.4
Communication between market actors	21	21	20	23	18	20.6

EFIG – drivers affecting demand in energy efficiency investments in building sector

A template for the EPC contract has been published by the Energy&Climate Change department of the UK Government in early 2015 and it is available at <https://www.gov.uk/government/publications/energy-performance-contract-epc>; the accompanying contract guidance notes provide organisations with help on understanding the structure and specific areas of the contract.

The best practices guide has been designed to help users identify points for consideration when using the contract, and is based on experience from similar successful projects.

4.3 Monitoring and adaptations

A Smart city, to deserve this attribute, should be aware of its compliance with the citizens' needs and with the higher standards of wellbeing. From the policy makers' point of view it's very important to evaluate the impact of different choices and also to analyse strengths and weaknesses of their territory.

The measurement of city performance is one of the critical ways in which we can assess the complexity of urban change, and judge which approaches are successful or not.

Based on the total quality management systems, the Deming cycle (Plan-Do- Check-ACT) is the best methodology which could ensure the effectiveness of a planning activity. Each measure and policy should foresee a proper monitoring methodology with a set of indicators and timeframes. The monitoring plays an important role also to obtain a continuous interest and useful data regarding the results for the communication. The control methodologies should imply also a business as usual trend assessment and different scenarios to adapt the action set to the global vision.

Consistent with the STEEP 'systems thinking' approach, the method of monitoring the successful implementation of interventions is split into four tools which are going to influence the modelling iterative procedure:

1. Italian flag and modelling meetings
2. key performance indicators
3. data mapping
4. stakeholders engagement on the platform

In the same way that those methods can help in the prioritisation of interventions, so too they can help in the monitoring process once these interventions have been made.

While points 1, 3 and 4 have not been explained yet, the indicators system developed is fully reported in STEEP D4.3.

The STEEP project aims at defining an open-source methodology so that the Smart City Plan Guidelines can be put onto the open-source collaborative web-based stakeholder platform; they will need to be supported by a set of Smart City Key Performance Indicators (KPI) to measure the progress of the Smart City Plans.

The indicators have been developed so that they are open–source. They will be made available on the platform including the benchmark of the three partner cities.

Full details of the platform can be found in deliverable STEEP D2.2, but there are three main ways in which the platform can be used to monitor interventions (see STEEP D2.4):

- i. The data that is shared on the platform can be utilised by third parties and other stakeholders to model scenarios based upon the effect of various interventions.
- ii. The platform is also designed to be an online communication tool whereby interested parties can discuss the data being presented and potential solutions. Feedback via this method will not only stimulate debate regarding potential solutions, but inter–alia provides assessment of the progress of implemented interventions.
- iii. Published data can also be used by developers to build ‘applications’ and potential providers of interventions can also use the platform to identify solutions which may be unknown to participants.

To measure how the Smart city Master Plans perform we need to choose an indicators system which could be able to underline achievements and critical points as well. Depending on the scope of the objectives, the type of indicators selected will also need to be different.

The proper indicators set, provide a unique resource for the administrators and plans makers to learn about city strengths and weaknesses, and assess the progress of new policies in a fast–evolving economy.

The Smart City’s KPIs have to be:

- open
- reliable and valuable
- standardized,
- consistent and
- comparable over time, across cities

The indicators selected in STEEP, few more than 50 (see STEEP D4.3 “Key Performance Indicators”) are generally easy to work out and they are distinguished in mandatory and optional fields. Some other supporting data will be required to enhance the homogeneity of the values and the consequent comparison opportunity (for example the population, the degree days value, ...)

The approach is consistent with the ISO 37120 philosophy: it's not aimed at classifying the Smart cities to gain a podium place, but rather to evaluate their strenghts and weaknesses, to cooperate with other cities and mostly to monitor their progress in a continuous improvement process.

4.4 Public consultation and strategies for the mobilization of the civil society and communication

To implement and achieve the objectives of the plan, the adhesion and participation of the civil society is essential: communication plays a very important role in creating the so called “culture of accountability” making all individuals responsible for progress towards the vision. Even a well designed plan or a good project could fail if it's not supported by a proper information strategy which is able to create the consensus and multiply the results.

There should be first an internal information within the local authority to make all the departments part of the vision. Then the municipality could decide a different communication involvement for each phase of the planning process (definition, adoption, implementation, follow up).

The coproductive approach is very useful in this optic involving from the first stage a group of stakeholders in the planning definition. However the communication strategy should target also those city users who have not been selected in the stakeholders list but who are fundamental for the wide implementation of the actions.

The platform developed in the STEEP project is one of the tools, but to enlarge the audience several other instruments could be set up starting from the social networks facilities or the public consultation meetings.

A best practice from Florence where the SEAP and the structural plan have been debated in 100 squares all around the city:

http://www.comune.fi.it/export/sites/retcecivica/citta_firenze/100luoghi.html

And now the Smart City Plan as well as all the major changes in the city are debated during the “listening marathons”: a specific theme is brought to the attention of a public debate through different sectoral ruond tables. Each table, coordinated by an animator, debate the problem in detail, analyzes the potential and the obstacles and offers some solutions. All the solutions identified in the different table´s debate are presented to the audience to catch any more tips. The mayor at the end summarizes the conclusions which are then distributed to the participants and the public. It is an effective solution even if it requires a strong commitment by all the town council; in every discussion table both the political (Councillor) and the technical part of the City are represented.



Pictures from the “Maratona dell’ascolto” to present the SCP in Florence (July 2015)

As well as the iterative planning process, the monitoring activities must be ongoing from the beginning of the master plan implementation process. Furthermore the communication plan should be maintained and revised regularly to adapt the strategies to the citizens’ needs and to the ICT evolution.

5. CONCLUSIONS

Which is the best way a city can tackle these problems, and therefore, define an optimal Smart City Plan? The three cities consider that it will be possible if they use:

8 A system thinking approach that considers the city as a complex system. Systems thinking is a framework for problem analysis and solving that allows making reliable inferences about behaviour of complex systems by developing an increasingly deep understanding of underlying structure, and which is very suited to urban environments.

8 Digital Modelling of the energy flows and systems that affect energy efficiency of districts that are representative of the main issues of each city, composed by different layers in a digital geospatial information system. This will allow to better understand how different combinations of interventions will influence the system, in order to extrapolate this knowledge for the definition of a Smart City Plan.

8 Open Innovation for engaging the stakeholders, and open standards to ensure interoperability, and open-source to maximise uptake and impact.

Building up a Smart City is a significant commitment and requires time, resources, clear vision and strong leadership. To be successful a Smart City strategy has to be based on the four I's:

- Integration of all possible sectors and aspects which are in the municipal influence
- Innovation spread as wide as possible: a smart city has to be a forerunner in technology implementation and in testing innovative approaches or services
- Involvement of stakeholders in setting very ambitious “visionary” targets compared to the actual situation
- Information in terms of ICT as a tool for the relation with the citizens and for the monitoring and control of the strategies.

In order to be put in practice, the SMART vision requires a committed change in the internal organisation of the city authorities and in its approach to the planning the activities. The city governance needs a comprehensive methodology to put the theory into practice and to allow constant revisions and improvements to this. Once the cities initiate the smart city actions, they should not be influenced by change in government or bounding conditions but should continuously move forward.

A comprehensive SMART city plan committing the city to the holistic approach represents a fundamental step in this path. The plan is going to include a long term vision and strategy, mid and short term actions, organisational chart with responsibilities, targets and milestones as well as costs and resources identified.

Systems thinking and modelling approach to City Planning

The method used by systems thinking is to explore the relationships and changes in a system, and try to develop a comprehensive picture of how the system works. It also spurs the emergence of new important questions which help better understand the system.

Systems thinking thus views problems as the products of some structure of relationships, in contrast to conventional linear thinking, which instead explains patterns in terms of simple causes and effects between separate things.

Moreover, this approach allows for the modelling of the parameters of the systems, and how the modification of these parameters will impact the whole system. It can be used to found leverage points, parts of the structure that significantly influence the system's overall behaviour and that represent opportunities for changing system behaviour with relatively little effort.

Systems theory has been put to practical use in the business world for decades. More recently, systems thinking concepts have been incorporated into a number of strategic planning methods for local governments. These and other tools can help cities better understand the complex systems that exist within them, and the larger networks to which they belong. Systems thinking will also help cities to understand the role of key inputs and outputs like energy, water, waste and transport and to identify how municipalities are vulnerable to changes in the availability and price of those inputs.

Modelling a city is a technique that permits deriving practical lessons from an otherwise abstract picture of a system. It is reckoned that systems thinking is a natural approach for exposing and finding the optimal mix of integrated measures needed to achieve ambitious energy efficiency targets that can later be incorporated to strategic sustainable urban planning.

Validating and enriching the model through Open Innovation

Open Innovation is a new strategy for research and innovation in which companies go further away from the boundaries of their organisation and in which cooperation with external experts carries a key role. It means combining internal knowledge with external expertise to deliver R&D initiatives. Furthermore, companies will use both internal and external channels to get their innovative products and technologies to

market. Under this context, universities, research labs and technology centres offer new perspectives and solutions to companies using this innovation model.

In this sense, the proposal of this is considering that many of the ideas and possible interventions for smartening a city will come from outside sources, be it individual citizens, private organizations or other public bodies. Additionally, even if some of the ideas or interventions may not fit the scope of this project, involving stakeholders of many sources will support the future implementation of these ideas within some other initiative. The involvement of stakeholders makes the goals and values of the planning activity accessible to the broadest possible audience and adds additional problem-solving capabilities to the process. Involving the public in the programme is not just worthwhile for the reasons outlines above, it is also interesting from the point of view of empowering citizens.

6. FAQ

1. What is the transformational statement and what role it plays in the intervening process?
2. What is the PERIMETA software? Is it necessary for the energy planning?
3. What are the sufficiency and necessity parameters and what are they used for in this methodology for energy planning?
4. What is the “Italian flag” and how is it used?
5. What is a PESTEL analysis and what is it used for in this process?
6. What is the SPeAR tool and what is it used for in this process?
7. What is the IBIS argument map?
8. What is a GIS and what is it used for?
9. What are the energy scenarios?
10. How this methodology can be used only for the energy planning at a district scale?
11. Which kind of stakeholders should be involved in these types of processes?
12. What are KPIs?
13. How to determine which level to stop modelling the sub-processes themselves
14. Explanation of how working in different subprocesses can make it difficult for those in attendance to propose integrated interventions
15. What is the “sense-checking process”?
16. Explanation of which ways a community can follow a coproductive approach

1. The transformational statement is a narrative that describes the main purpose or the expected transformation due to the implementation of an activity (in this case an energy planning process). It can also describe the context of the transformation and the actors involved among other optional aspects. This statement provides implicitly some guidance for the definition of the criteria for the prioritisation of interventions that will be implemented in order to achieve this transformation.




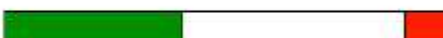
2. The "performance through intelligent management" (PERIMETA) software is a tool developed in the Systems group of the University of Bristol in order to support evidence based reasoning under uncertainty. The software tool allows the processes, representing the system being modelled, to be drawn as a connected graph of nodes. It is not necessary to use this kind of tools in this type of projects but in any case it is

recommended. For energy planning problems it can be used for the definition and visualization of the structure of the problem, the interaction between processes and performance of the model.

3. The sufficiency and necessity parameters are used in PERIMETA software to capture the dependency conditions between the processes of the model. Here we make use of the following definitions;

- i. Sufficiency – How much of the evidence is directly relevant to the parent process?
- ii. Necessity – Will the parent fail if the sub-process fails? Takes over if evidence against is large.
- iii. In this type of projects these parameters can be used as evidences for the prioritisation of interventions phase.

4. The Italian flag is a colloquial name that can be used to describe the method based on internal numbers that is used in the PERIMETA tool to express knowledge about process performance. The result can usually contain the colours green, red and white. The green indicates that the process is certainly true, the red indicates that the process is certainly false and the white indicates the belief that the process is unknown.

- $P(E)=[1.0,1.0]$ 
- $P(E)=[0.0,0.0]$ 
- $P(E)=[0.0,1.0]$ 
- $P(E)=[0.4,0.9]$ 

5. The objective of the PESTEL analysis is to evaluate the feasibility of each initiative considering the different dimensions; Political, Economic, Social, Technological, Legal and Environmental. The PESTEL analysis in this case is part of the methodology for energy planning, more precisely is part of the prioritisation of initiatives phase.

6. The SPeAR is a tool developed so that it can be used to monitor and evaluate project performance and support informed decision making throughout the project life cycle. For this methodology the indicators that are used in the tool have been defined in a way that can reflect the dimensions and the questions developed for the PESTEL analysis.

7. The Issue-Based Information System (IBIS), was developed to provide a simple yet formal structure for the discussion and exploration of "wicked" problems. The IBIS approach makes the argumentation visible i.e. provides documentation/reporting. In this case PERIMETA supports:

- Issues: a point of discussion to be resolved about the performance or state of knowledge about a process
- Options: a possible intervention to resolve the issue
- Arguments: support or refute an option and they appear as elements in the process map under processes in the order

8. The Geographical information systems (GIS) is a computer system for capturing, storing, checking, and displaying data related to positions on Earth's surface. Many different kinds of data can be shown on one map. This enables people understand patterns and relationships. In the case of energy planning can be used to show energy demands, energy generation points, renewable energy availability, etc.

9. An energy scenario is a model developed considering a set of assumptions that allow the estimation of for example the evolution of the energy demands and consumptions depending on the fulfilment of these assumptions. In this case it can be used to evaluate the adequacy of different strategies (different combination of renewables, etc.) to meet the objectives of the energy planning.

10. The described methodology has been tested for the case of energy planning problems both at a district scale and at a bigger scale. In both type of problems energy planning of district scale and city scale there is a need of a prioritisation of interventions.

11. The stakeholders that can be involved to attend and participate in the Model Building Workshops are among others, developers, community groups, local council representatives, businesses, trade associations, supply chain, utility companies and government agencies.

12. The Key Performance Indicators (KPI) are a set of quantifiable measures that are used to evaluate the success of a particular activity.

13. This is a question that can arise in relation to the Process Improvement Chart and it is important to recognise that there is no correct answer to this, as the moment to start to analyse issues can vary depending on the sub-models that are listed. In some cases common sense will determine which processes are specific enough to start with the next stage. There is therefore an inherent risk at the end of the Model Building Workshops, that there will be a different level of definition for each sub-model and therefore the relevance of the identified interventions. However, a useful heuristic that can be applied by the workshop facilitator is to keep pushing at the ‘how’ questioning to derive further detail about necessary processes. At some point the group in question will respond with the recognition that there are multiple answers to the question ‘how’ and these demonstrate that the understanding in the group is shifting away from a process view to one that is articulating specific *options*.

14. Working in different subprocesses can make it difficult for those in attendance to propose integrated interventions that respond to a high-level transversal strategy for the district. Conscious effort needs to be made to transmit this view and interest to all the stakeholders to ensure consensus regarding future interventions. Again, this is something that needs to be addressed by the workshop facilitator to bring sub-groups back together in plenary session to try and recover the transverse view. However, it is recognised that this is difficult when dealing with large groups and is something of a live research issue in the problem structuring methods academic community. See for example (Shaw, Westcombe, Hodgkin, & Montibeller, 2004).

15. Although the modelling process is the main vehicle for prioritising interventions, it must be considered that the outputs from this process will be the products of –only– the individuals who took part within the workshop discussions. At this stage of the methodology therefore, the ‘actionable’ options should be subject to a ‘sense-checking’ process whereby they are considered by the ‘owners’ of the transformational statement and other experts external to the workshop process itself. This sense-checking will provide a list of options that are both feasible and desirable in the particular context of the city involved. This is intended to be a first phase of a quality assurance process that helps refine the list of potential interventions.

16. Another issue is that if a community is interested in a coproductive approach, there are a number of ways in which it can do this. The following are suggestions about how to involve the stakeholders in the planning process of the whole city:

- The preliminary model is developed mainly by “experts” in community policy and administration. Stakeholders are involved in a second stage during the preliminary model discussion and evolution




- In communities which are divided into independent districts it could be a good idea to divide the planning team into a professional co-ordination team, (comprising community employees) and several “habitat teams”. The habitat teams consist primarily of local stakeholders and each team is supervised by a member of the co-ordination team. These teams concentrate on their immediate surroundings or “habitat” (area, district etc.).

- As an alternative to forming habitat teams, it is also possible to divide members of the public into specialist teams (e.g. transport, town planning, alternative energy sources etc.). However, the focus on the immediate surroundings is lost as a result of the specialisation of citizens’ activities.

Use of the STEEP Collaborative Stakeholder Engagement Platform could be used to speed-up the process of moving between different groupings of stakeholders and potentially remove some of the barriers to participation that might exist for some.

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