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International Journal of Geology, Planning and Land Safety,
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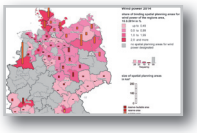

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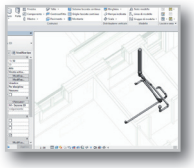

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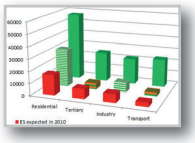

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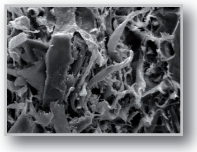

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The Issue 2/2015 of CSE has been published shortly after the United Nations Climate Change Conference (COP21) in Paris. With the agreement to be signed in New York starting from April 2016, the approximately 200 signatory countries are going to pledge to limit the rise in average global temperature of 1.5 degrees through the direct commitment of the majority of countries actually responsible for greenhouse gas emissions. However, national emission limits have not been established yet.

According to United Nations experts, the promised cuts are not sufficient. To ensure that the overall goal is met, the agreement stipulates that every five years, starting in 2018, progress in reducing emissions by all countries will be reported. The first of such reports will be undertaken in 2023. As the authors of the editorial in this issue assert, the Conference was closed satisfactorily if it is considered in terms of a "one-step-at-a-time" approach. But the urgency to find truly effective solutions to global warming and its related climate change requires that, over time, the steps become increasingly larger and more determined.

The editorial in this issue concerns environmental sustainability and security in relation to climate change and natural risks. Organized by topic, the articles following the editorial are summarized here.

PLANNING AND ENVIRONMENTAL SAFETY

Synoptic Overview of Spatial Planning in Germany (Zaspel-Heisters, Haury). The spatial planning system in federal Germany is differentiated along vertical, horizontal and sectorial lines. Planning authorities operate on four levels: federal spatial planning, state spatial planning, regional planning and local authority planning. The spatial planning framework is described by investigating various plans, procedures and the principal instruments for implementing spatial planning. Climate protection and energy efficiency are regarded as challenges in spatial and urban planning. Finally, the regulatory capacities of spatial planning and urban development are illustrated through examples regarding wind power and the management of the recent refugee influx into the nation.

SUSTAINABLE URBAN MOBILITY

Metropolitan railway systems and Transit oriented development in Italian provincial coordination territorial plans (Staricco). Transit oriented development (TOD) is receiving global attention as a planning approach that pursues more sustainable mobility patterns and the promotion of polycentric development in contrast to urban sprawl. TOD seems quite suitable for Italian metropolitan areas, where many suburban railways have recently been reorganized as integrated Metropolitan Railway Systems (MRSs). This article examines nine "Provincial coordination plans" (PTCPs) in order to verify the adoption of a TOD approach to support MRSs with special focus on the Bologna PTCP.

Methodology for the development of electrical vehicle charging infrastructure. Case study: Brescia (Maternini, Riccardi). The topic of electric mobility, in terms of both private and public transport, has recently taken on increasing importance, also in the light of recent national and international laws aiming at reducing emissions and pollution. Some European Union member states have issued Charging Infrastructure implementation plans. Italy recently published the *National Infrastructure Plan for Electrical Vehicle Charging*, a sort of guideline for the integrated development of electric vehicle charging systems.

In this article, a methodology is formulated for planning and locating electric vehicle charging stations on a municipal level. The case of Brescia, as a medium-sized urban area, is explored.

ENVIRONMENTAL DESIGN

Ways of interpreting urban regeneration: Hamburg, London, Brussels and Rome (Fratini). Over the coming decades all cities, large and small throughout and beyond Europe, will face the challenge of the regeneration of their urban peripheries. However, the problem of the fringes, in terms of urban decline and social exclusion, concerns not only the areas located on the physical edge of the city but the city as a whole. The case studies represent different ways to improve regeneration policy and action.

Rome, its region and the regeneration of the "light city" (Latini). For at least 100 years, an impressive number of derogatory campaigns have been waged against single-family-home suburbs and their consequent sprawl and alleged negative effects. In this article, following a rough, operational classification relating to economic, functional, environmental, social, aesthetic aspects, the arguments used by critics are explored as they appear in two general studies of this topic. Considering today's condition of the "light city", with large areas already affected by a conspicuous amount of casual and disorderly building, a regeneration strategy that can provide opportunities for new housing, well-designed landscapes and investment within the reach of a large number of households seems advisable and feasible.

BUILDING TECHNOLOGIES

Hypothesis of infographic digitization of the building stock: the innovative contribution of ICT tools (Barbato). The strategies of the Italian Government and public administrations are moving the interests of clients towards policies that ensure the functional recovery and renewal of Italy's extremely rich real estate infrastructure. Incentives regarding the energy, environmental and structural renewal of the existing building stock ensure that housing demand will be reduced, recording a slow but constant decline in the construction of new homes and buildings in general. Thus, the need arises for a plan to manage the nation's built heritage. In this article, a supporting methodology is proposed to foster a new strategy suitable for improving the management of the built heritage through infographic building digitization by implementing appropriate Information and Communication Technology tools (ICT).

ENERGY EFFICIENCY IN BUILDINGS AND NEIGHBORHOODS

Energy planning at the district level: an Implementation Plan as a first step towards smarter city development (Delponte). Energy policies, from initiatives launched in the 1990s right up to today's EU Smart City and Communities program, confirm the interest focused on cities for strategic interventions in the energy sector. But some questions are still open: How to manage energy issues on the urban scale and what kind of tools to put into place? The author takes into account

the methodology proposed in the FP7 project "TRANSFORM-TRANSFORMation Agenda for Low Carbon Cities" as one of the possible ways to face the challenge. According to the TRANSFORM Project, the Implementation Plan (IP) is understood as a strategic neighbourhood-scale document that can be used to support a strategy for a given urban area (Smart Urban Lab, SUL).

The hidden face of efficiency (Masullo). Efficiency is two-faced: it is necessary but sometimes it is an illusion. It is not the solution for an energy-hungry world but it is a part of the solution for a sustainable one. The author states that *exploring the boundaries of efficiency is like being inside the smallest box in a Chinese box set. If you don't open your mind to the world outside, you will stop at the walls of the smallest box thinking that you have made your best effort, ignoring the broader scenarios*. The article describes different approaches to exploring the infinite efficiency scenarios that might open in the future: efficiency could be a costly but useless exercise, with its only effect of slightly influencing the limits of an economic system that overexploits natural resources and damages the ecosystem services fundamental for life.

An overview concerning combined heat and power production: a smart way to improve energy efficiency (Kusch). Cogeneration power plants simultaneously generate power and usable heat in a single, integrated system which achieves a degree of overall efficiency that is much greater than electricity production alone. This makes better use of energy conversion and reduces greenhouse gas emissions. Combined heat and power production is already relatively common in Europe while it is less common, for example, in the USA. There is great potential for further implementation throughout Europe and globally, including the industrial sector. Cleaner production schemes offer suitable frameworks that promote the uptake of combined heat and power production by industry, in particular small- and medium-sized enterprises.

MATERIALS ENGINEERING

Industrial paper recycling procesess: suitable micronization for additive polymer application (Valente, Tirillò). The traditional paper recycling process faces problems relating to the disposal of sludge and waste, the use of incinerators and water treatment. As a result, an interesting alternative proposed by the Department of Chemical and Materials Engineering at the Sapienza University of Rome is using paper as a filler in thermoplastics or as a recycled thermoplastic matrix composite. In this way it is possible re-use paper but it is also possible to reduce the amount of polymer having an equal volume. Paper has to be subjected through grinding. The chosen grinding process is fundamental for obtaining a suitable product for the composite. After pre-grinding, the charge has to be subjected to micronization. As a result, the importance of optimizing both the grinding and micronization processes is clear.

We hope our readers will find these articles of interest.

LC

EDITORIAL

Synergies and vision for a global sustainability of lands

Fabrizio Ascione, Filippo de Rossi

Every year, worldwide, parts of the territory are interested, on time, by enormous damages, as a result of floods or related to the hydrogeological instability of large parts of the inhabited sites. Really, the role played by the nature is quite secondary compared to the human responsibility that caused an unstable equilibrium of our towns and, more in general, a delicate urban situation characterized by a lack of sustainability. Our responsibilities are evident and undebatable, testified by a poor care in constructions and building activity, filling and obstructions of the channels of drainage from highlands and hills, daredevil deforestations. These are only few examples. Indeed, if and how much the increase in frequency of extreme events is connected to the phenomena of global pollution, urban heat islands, human activity and alteration in the cycle of seasons is a complex and debated matter, that requires a careful attention, mindful words and prudence in ratings.

By neglecting uncontrollable phenomena, and thus, for instance hurricanes and cyclones that affect specific areas near the equatorial regions (Caribbean and Mexican Gulf) or the devastating rains and monsoon floods of some Asiatic regions, here we want focus merely on ordinary facts. Indeed, every year, mainly in autumn and spring, significant damages of our towns, Historical centers, cultural Goods are caused by ordinary events of few days of intensive rains. A simple check can testify the billions of euro of damages that, every year, are caused by humble alluvial episodes, everywhere in Europe.

What is sure is that our territories are fragile. Interventions for security are increasingly necessary. About it, rather than expansionary policies and further use of land, the focus should be placed in the livability and sustainability of the already built environment.

A new target of widespread sustainability, starting from today and constant in the coming years, is no longer negotiable nor postponable. Only in the last five years, many European regions as, for instance, Russia during the 2012, Germany and Austria and central European areas (2013), Balkans (2014), have been strongly damaged by heavy rains, with hundreds of fatalities. Focusing on Italy, in the same years, the Sannio, the Lunigiana, Cinque Terre, Calabria, Sicily, the Veneto and Friuli Venezia Giulia have suffered indelible catastrophes, moral and material. This is due, above all, to an unsustainable way of life, which has no care of the land, which repairs the damages without solving the risks. It is enough to think that, in the same area of Sicily, during the October 2009, the Province of Messina (Sicily) was destroyed by a flood that killed more than 30 persons. This is not a question of specific countries. No one can give lessons. Everyone can give good examples, from the southern Europe (Zaragoza, Spain) to the northern countries (e.g., Aalborg, Denmark).

The issue is absolutely clear. From the merely-energetic point of view, just the building activity and the living of our cities impact for more than 40% [1] on the energy balance of the Euro-

Figure 1 – Flash floods: left, northern-Bosnia (Elvis Barukcic / AFP - Getty Images),source: http://www.nbcnews.com/ | right, northern Italy (AP Photo/Tano Pecoraro), source: http://i.telegraph.co.uk/

pean Union Countries. A lot of valuable work has been done in recent years. On the other hand, an even greater job remains to be done. Environmental issues are more and more pressing. We are now at a stage where an intervention is necessary, not because it is motivated by an economic profitability (and therefore energy efficiency seen like a strategy for reducing the costs of utility bills), but for the necessity of ensuring a future for the planet and to our next generations.

With reference to a sustainable use of energy, since the enactment of the EPBD European Directive 2002/91/EC [1], revised during the spring 2010 by Directive 2010/31/EC and related documents [2,3], for the first time in world history, 27 countries have decided to establish a common journey toward a better future world. This is a common path of efficiency and not a mere declaration of intents, in relation to the sector that, at the EU level, is the one that most affects energy demand and pollution so closely connected to it.

The goal to reach, for a future rather close, is a building activity and construction that are not only sustainable (i.e., "nearly zero-" or "zero-energy buildings"), but suitable for sustain and support the energy balance of the territory (i.e., "plus-energy buildings"). In detail, in accordance with the national laws that receive the European Guidelines, starting from January 2021, all buildings should induce a yearly energy balance close to zero, by taking into account also targets of technical and economic feasibility, according to the principles of the cost-optimal solution in terms of investment costs and operational needs. Moreover, it is established that the date is two-years earlier (i.e., January 1, 2019) for public buildings and buildings used for public scopes.

A further document, and thus the Directive 2012/27/EC [4], establishes that public institutions should assume a role that must be exemplary, and thus it is required that they refurbish, according to criteria of energy savings, a portion of their real estate, at least equal to 3% per year. Furthermore, the public sector has to define large investments to be programmed in the medium term (until 2020).

These are, obviously, ambitious goals, that require, first of all, a front of attack to the issue that is not the traditional approach. All knowledges should be systematized. It is a cultural rather than technical matter. The finding of synergies adds value to different skills. The integration amplifies the competences.

In the last fifteen years, the level of energy efficiency of buildings has moved forward. Thousands of edifices, districts, neighborhoods, have been energy-refurbished or are under energy-retrofit. An intervention that looks to the single building is, in facts, not completely effective. It is quite enough to say that the energy balance of a building concerns a time-period equal to one year and this implies that, if the goal is to have zero energy buildings, in this period, the incoming flows of energy are balanced with the energy supplied by the buildings into the urban grids. Evidently, it is not required that energy demand and energy supply from in-situ renewable sources are contemporary, and this is within the concept of "net" zero-energy building. The goal is to ensure that a building connected to regional energy nets, and therefore typically natural gas and electricity, turns into these networks, on an annual basis, the same energy that it takes from the same grids in other seasons. This is an important goal, which can be effective as a starting point. Conversely, absolutely it cannot be a point of arrival.

The reasons are quite simple, and it is time that the scientific community firstly and the public administrators secondly consider this permanently. When, in the coming years, zero energy-buildings will be a significant number, there will be an imbalance in the regional energy flows. In our climatic regions, at the building scale, renewable energy systems based on the conversion of solar energy are the ones with the largest diffu-

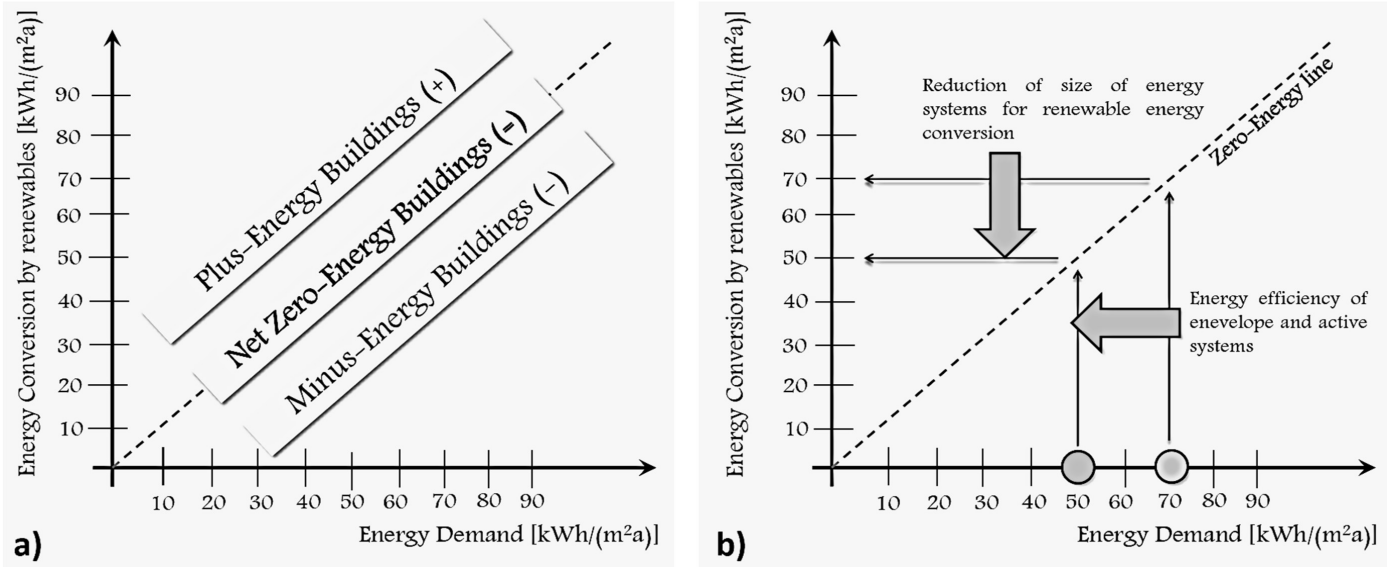

Figure 2 – Building envelope, active energy systems and renewable energy sources for net zero-energy buildings.

sion: solar thermal and solar photovoltaic systems. These do not give the same energy all around the year, so that a larger overview is required for balancing the urban supply of energy. This means that the net zero-energy buildings presently under construction compensate, given the characteristics of such systems, during summer period (when the energy conversion from solar renewable sources is high), the winter energy deficit, so that, on an annual basis, a complete balancing of energy flows can be achieved. It is clear that, the city energy grids today are fully capable in receiving energy from the few zero-energy buildings that, in summer, convert and supply more energy compared to the self-need. At the same way, it is quite obvious that, tomorrow, when a large part of buildings will have a surplus of energy in summer, this will cause an imbalance in the urban system.

This is not a close horizon. Net zero-energy buildings are, today, not the next target, so that we have enough time. On the other hand, we have to start the plan of the future, especially by establishing principles. To date, the emergency was, and still is, the lack of efficiency of our architectures. Tomorrow, the goal must be the city, the territory. You have to look at a larger control volume. All poles of energy absorption and all those able to convert it have to interact in smooth and intelligent energy networks. We are thinking to smart energy grids, in which the surplus energy converted from a sector of buildings can fuel clean industrial processes, sustainable electric mobility, for the individual citizen (e.g., bike sharing, electric vehicles for public use) or even to the collective public transport. Similarly, in the opposite direction, the industrial processes, that cause waste heat, should be connected with district heating networks of the neighborhood, even powered by an ample mix of thermal power generations (e.g., bio-gas plants), biomass, combined generation of heat and power, wind turbines, combined cycles and so on. These are just few examples. There are not unique recipes. First of all, a new awareness - not only of the technical community and politics, but also of all citizens – is needed.

The time of autonomous systems is ended. The interaction begins. Equalization and mutual mechanisms that allow the full exploitation of the energy used and converted have to be thought. Everyone is part of a system. This approach has to be applied to the single plant from renewable sources as well as for citizens. A global vision is now required, in the largest meaning, at the community scale. Even without citing Sallustio Prisco ("Concordia parvae res crescunt, discordia maximae dilabuntur") and Philip II of Macedon ("Divide et Impera"), if we think as a system, the system becomes harmony, common Good, "Res Publica" in the noblest sense that this word must have.

It can be applied to everything: rebuilding thinking to the future. Everyone has to leave something in order to make the system more efficient. It applies to citizens, it applies to all skills and involved professions.

By translating the same concept, cities, districts, territories have to be "rethought" together: urban planners, engineers, architects, administrators, citizens. It is matter of a cultural approach, like the ones of Freiburg (Germany) or Stockholm (Sweden), where a future of clean, renewable, sustainable future has been established since many years. Today, Hamburg and Copenhagen decided to become, within twenty years, totally "carbon-free" cities, Berlin has a thermo-electric power station just few meters away from Potsdamer Platz, which also supplies the district heating network of Mitte. These should be next targets for all European cities. This is also our idea of Europe: sharing best practices, looking ahead by means of mutual acquisition of the best examples. It is the moment to stop the logic of "Not in My Backyard".

Specific projects, presently under definition, are obviously welcome. These are, for instance, the substitutions of all public lighting systems with LED in Naples, Milan and in other big European cities. Of course, these are good practices, but concerning specific issues. Otherwise, is not a good practice to excavate under the urban streets, several times, channels, sub-services and traces because each service provider (e.g., telephone, electricity suppliers, waterworks and sewers) operates independently, without thinking that a unique work that allows everything could be much more rational, livable, functional.

Just looking at the whole issue, together we can win the challenge of the future. A challenge that, today, is not only an opportunity but, unfortunately or fortunately, is a necessity. We are providing these few comments just some hours after the ending of the 2015 United Nations Climate Change Conference [6], the so-called COP21, hosted in Paris in December 2015.

After eleven days of negotiations, the Conference ended with the signature of a satisfactory agreement. More than 195 worldwide countries have subscribed an historical document, although some - even justified – skeptical comments about the chance "to do more". Always everyone can do more, can do better, can do something else. On the other hand, sometimes this kind of approach paralyzes and it is a kind of declassification to failure of even small, but important steps for a change. Kyoto has established a formidable impetus to the development of renewable energy sources. The objectives of Paris – and these are something more than intentions, but, really, these seem a kind of program - may be defined as the end of the Era of fossil fuels. It 's true, the agreement does not provide clarity on sanctions to oblige countries non respectful, with strength and consistency, of the direction of the set targets. On the other hand, this is the first global agreement that sets a "threshold of salvation". For years, we have listen that, to maintain the life in the Earth, without epochal upheavals, the average temperature increase compared to pre-industrial levels should be kept below 2 °C. Well, Paris marks a more ambitious target, by fixing the increase in 2020 by 1.5 °C. Furthermore, the COP21 identified significant funding meas-

Figure 3 – 2015 Conference of the Parties (COP21): United Nations Climate Change Conference, December 2015.

ures, takes a path, which includes the required balance between greenhouse gas emissions and storage of this, the revision of targets every five years, mandatory INDCs (Intended Nationally Determined Contributions) that give a measure of the effort assumed by each country. For the first time in the history of a Conference, the most widespread comments are positive or even enthusiastic, from "left" to "right", from "laical" or "religious" point of views. Inside the agreement, indeed, also an important and unanimous consensus - without colors and flags - concerning funding and support for developing countries has been set, in order to improve universal values, and thus food supply and security, poverty alleviation, basic human rights, peace. This is the right direction, and it seems fair to conclude, for once, by subscribing the words of a political leader, the French prime minister, Francois Hollande: "In Paris, there have been many revolutions over the centuries. Today, it is the most beautiful and the most peaceful revolution that has just been accomplished - a revolution for climate change". Now, from all point of views, all citizens, politicians, leaders and common people have a new responsibility: everyone has to do its own task. The premises are satisfactory, we hope that also the outcomes will be the same.

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Planning and Land Safety

Synoptic Overview of Spatial Planning in Germany

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Keywords: Spatial Planning, Planning System, Local Authority Planning, Procedures.

Abstract

This article provides a synoptic overview of the German spatial planning system. The spatial planning system in federal Germany is differentiated along vertical, horizontal and sectoral lines. Planning authorities in Germany operate at four levels: federal spatial planning, state spatial planning, regional planning and local authority planning.

The article first presents the legal and institutional framework of spatial planning, looks at the various plans and procedures and names the main instruments for putting spatial planning into effect. The view is then directed at the local authority level. The legal framework for urban development is addressed alongside formal and informal urban development instruments. Climate protection and energy efficiency are then touched upon as recent challenges in spatial and urban planning. Finally, the regulatory capabilities of spatial planning and urban development are illustrated by the examples of wind power and refugees.

1. Introduction

Germany is a federal state in which three levels – the municipal level, the state level and the federal level – work together on the basis of shared responsibility enshrined in law. Under the German constitution, referred to as the Basic Law (*Grundgesetz*), powers to legislate are fundamentally vested in the country's constituent states (*Länder* or *Bundesländer*). The Federation (*Bund*) can only legislate in areas expressly assigned to it by the Basic Law. The Federation thus has powers to legislate on spatial planning, land reallocation, landlord and tenant law, housing benefit law and parts of tax law. It lays down the conditions, tasks and guidelines for spatial planning in the Federal Spatial Planning Act (*Raumordnungsgesetz – ROG*). The Federal Building Code (*Baugesetzbuch*), in which planning law is codified, lays down the guidelines and instruments of planning in the area of land reallocation. The states may enact laws at variance with this.

The spatial planning system in Germany is differentiated along vertical, horizontal and sectoral lines. Planning authorities in Germany operate at four levels: federal spatial planning, state spatial planning, regional planning and local authority planning. The term spatial planning (*Raumplanung*) encompasses all public overall planning at federal, state, regional and local authority level, together with sectoral spatial planning (Brohm 2002, 627).

Spatial planning includes a superordinate level (*Raumordnung*) that stands alongside local urban land-use planning and sectoral planning. As "planning for planning" (Runkel 11/2006, K § 3, at 236), spatial planning in this capacity lays down stipulations for subordinate spatially relevant public planning activities (including local urban land-use planning). It has a cross-cutting function in the planning system as "overall spatial planning" (Schink 1994, 105). In the classic definition given by the Federal Constitutional Court in an advisory opinion on building law, spatial planning in this sense is the "comprehensive, superordinate planning and structuring of space. It is superordinate because it is supra-local planning and because it brings together and coordinates the diverse types of sectoral planning" (BVerfGE 3: 407/425).

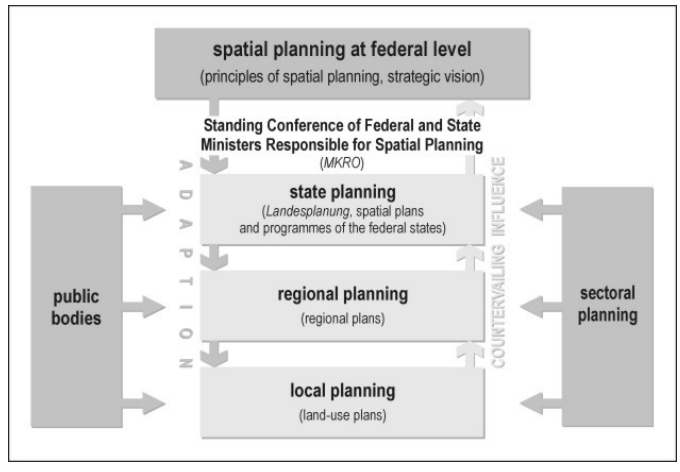

Figure 1 – The organization of spatial planning in Germany (Hoyler/Freytag/Mager 2006).

In contrast to supra-sectoral, supra-local spatial planning, urban land-use planning consists of supra-sectoral, local planning (Schink 1994, 106). It is solely through urban land-use planning that spatial planning acts upon urban development and planning (Battis/Krautzberger/Löhr 2014, § 1, at 39) and is translated into stipulations under land law that are binding on the individual subject (Runkel 12/2008, K § 4, at 283).

This article first presents the legal and institutional framework of spatial planning, looks at the various plans and procedures and names the main instruments for putting spatial planning into effect. The view is then directed at the local authority level. The legal framework for urban development is addressed alongside formal and informal urban development instruments. Climate protection and energy efficiency are then touched upon as recent challenges in spatial and urban planning. Finally, the regulatory capabilities of spatial planning and urban development are illustrated by the examples of wind power and refugees.

2. Spatial planning

2.1. Division of legislative powers between federal and state level

The main legal basis for spatial planning at federal, state and regional level in Germany consists of the Federal Spatial Planning Act and state spatial planning acts.

The most recent major revision of the Federal Spatial Planning Act (ROG) was in 2008. This was made necessary by the impacts of the 2006 federalism reform. While by the nature of the matter the Federation retains exclusive legislative powers for federal spatial planning (Durner, Greivin and Reitzig 2011, 380), the legislative remit for spatial planning in the states was transferred as a result of the reform from framework legislation to concurrent legislation. The effect of this change in legislative remit was an expansion of federal powers. In principle, the Federation now has the scope to legislate comprehensively on spatial planning law in the states. If the Federation exercises its powers to legislate under the concurrent legislative remit, any conflicting state law ceases to be applicable (Söfker 2009, 167). However, the federalism reform also gave the states an unrestricted right to enact laws at variance with such legislation in the area of spatial planning (Article 72 (3), sentence 1, no. 4 of the Basic Law). The provisions of the Federal Spatial Planning Act only apply for state spatial planning as long as the states do not enact state spatial planning acts at variance with it. This modification compensates to a certain extent for the new federal powers.

The purpose of the new Federal Spatial Planning Act 2008 was to provide the greatest possible level of legal certainty throughout the country while leaving the states sufficient leeway so that derogations remain the exception.[1]

Whereas the Federal Spatial Planning Act primarily lays down responsibilities, rules of procedure and the basic substance of spatial structure plans and makes stipulations on the instruments of spatial planning, state spatial planning acts govern the substance, organisation and procedures of state spatial planning for the entire territory of the state concerned and for regional planning at subdivision level. Due to the leeway granted to states under the Federal Spatial Planning Act, state and regional planning varies both substantively and organisationally from state to state.

2.2. Guiding principles for spatial development

The Conference of Ministers for Spatial Planning – a joint body that brings together the federal and state ministers responsible for spatial planning – formulates guiding principles for spatial development as a joint development strategy for German cities and regions. These provide important guidance for joint federal and state action with regard to spatial planning.

The informal guiding principles provide an overarching conceptual framework for spatial policy objectives and for stipulations made in the Federal Spatial Planning Act and spatial structure plans together with specific implementing measures. They thus supplement the law and identify priorities in spatial planning for the years ahead. They are intended to be implemented both via spatial planning instruments such as spatial structure plans and spatial planning procedures and via cooperation in spatial planning with spatially relevant sectoral policy areas and local stakeholders such as municipalities, associations, businesses and private individuals (BMVI 2013). The guiding principles are therefore directed not just at spatial planning practitioners at federal and state level, but also at decision makers in spatially relevant sectoral policy areas. They can also serve as guidance for private sector investment decisions.

The current guiding principles dating from 2006 are divided into three equal-ranking thematic areas: 'Growth and Innovation', 'Securing the Provision of Essential Public Services', and 'Conserving Resources, Developing Cultural Landscapes'.

The conditions for spatial planning have changed in various areas since 2006. Issues such as demographic change have become increasingly important. Climate change and the transition to renewable energy have so far not been touched upon in the guiding principles. Increasing budgetary pressures and ongoing globalisation also have an impact on spatial policy objectives. Against this backdrop, the guiding principles are currently being further elaborated and revised. As well as revising the existing guiding principles, it is planned to add a fourth guiding principle on climate change and the energy transition.

2.3. Spatial planning guidelines

The Federal Spatial Planning Act lays down general guidelines for spatial planning under which it aims to achieve sustainable spatial development that "will bring the social and

1. http://www.bmvbs.de/artikel-,302.1029638/Novellierung-des-Raumordnungsg.htm, 11.6.2009.

economic demands made on an area into line with its ecological functions and result in a stable order which will be well-balanced on a large scale", including the establishment of equivalent living conditions in all regions (Section 1 (2) of the Federal Spatial Planning Act).

Sustainable development aims to safeguard the natural foundations of our common existence for future generations. This entails reducing pressures on the natural environment and human health as a result of land take, transportation and pollution (BBR 2001). Implementing this is one of the central challenges of spatial planning. The sustainability approach requires in principle that every binding stipulation in a spatial structure plan must be evaluated against all three pillars of sustainability – economic, environmental and social sustainability (Danielzyk, Goppel, Knieling, Konze and Schmidt, 2011, 445). Economic sustainability is the most important of these for spatial planning (Benzel et al. 2011, 226). In particular, land use for development must be coordinated with open space land uses in order to create sustainable land-use patterns (Benzel et al. 2011, 234). The Academy for Spatial Research and Planning has identified a number of key areas for sustainable spatial development: decentralised concentration; functional mix of housing, workplaces and amenities; improvement of locational potential; creation and development of large-scale open space networks; land resource policy; concentration of housing development around local rail transport stops; and networking and cooperation for resource efficiency (ARL 2003, 2).

The central guidelines for sustainable spatial development are further elaborated by the principles of spatial planning in the Federal Spatial Planning Act (see section 2.4).

Alongside sustainable spatial development, the central guidelines for federal and state spatial planning policy under Section 1 (2) of the Act also include the establishment of equivalent living conditions. The establishment of equivalent living conditions is also enshrined in the Basic Law (Article 72 (2), sentence 3 of the Basic Law). The guidelines go hand in hand with the objective of establishing or maintaining standards of living that are equivalent in value taking into account regional differences.

Equivalence must not be equated in this connection with uniformity. The objective is to establish equivalent access to living space, jobs, education and training, goods and services, good environmental conditions and recreational opportunities (BBR 2001, 5).

2.4. Subject matter of spatial planning (under the Federal Spatial Planning Act)

Under Section 1 (1) of the Federal Spatial Planning Act, the task of spatial planning is to develop, organise and protect the entire territory of the Federal Republic of Germany and its regions by means of comprehensive, supra-local and supra-sectoral spatial structure plans, cooperation in spatial planning, and coordination of spatially relevant planning and activities.

Higher levels in the prevailing planning hierarchy do not have absolute priority over lower levels. A key part in governing the relationship between planning levels is played by the mutual feedback principle enshrined in Section 1 (3) of the Federal Spatial Planning Act. The mutual feedback principle can be considered the fundamental principle of the federal German spatial planning system (Brohm 2002, 624). It is a principle of countervailing influence under which the development, organisation and protection of the territory as a whole is required to make allowance for the conditions and needs of its constituent regions, while the development, organisation and protection of the regions is required to be consistent with the conditions and needs of the territory as a whole. There is no direct hierarchical line of authority between planning levels.

Spatial planning assumes a coordinating role in the reconciliation of differing spatial demands and the resolution of any conflicts. It also has the task of making provision for specific land uses and functions (Section 1 (1) of the Federal Spatial Planning Act). In this connection, the Federal Spatial Planning Act lays down a number of principles of spatial planning (Section 2 (2)) that are to be "applied in the interests of sustainable spatial development within the meaning of Section 1 (2) and further elaborated by stipulations in spatial structure plans" (Section 2 (1)). The principles relate to topics such as spatial and settlement structure, infrastructure and transportation, the economy, cultural landscapes, and environmental and climate protection.

With a view to the further elaboration of these principles in spatial structure plans, the Federal Spatial Planning Act also lays down the main substantive content of such plans. These are thus required to include stipulations on spatial structure, notably on the settlement structure to be aimed for (including spatial order categories/area types, central places and axes), open space structure (including supra-local open spaces and open space protection) and locations and routes to be secured for infrastructure (such as utilities) (Section 8 (5) of the Federal Spatial Planning Act).

2.5. Addressees and relationship with land law and sectoral planning law

As superordinate, integrated overall planning, spatial planning is distinguished from land law and from sectoral planning.

The main regulatory objects of spatial planning in its capacity as "planning for planning" (Runkel 11/2006, K § 3, at 236) are spatially relevant planning activities and other activities of public planning authorities together with public bodies that

approve relevant plans and works. It does not have direct binding effect on private subjects except where private law subjects carry out spatially relevant planning in the execution of public duties, where public bodies have a controlling interest in a private law legal entity, or where plans and works are chiefly publicly funded (Section 4 (1) of the Federal Spatial Planning Act).
Provisions concerning the local level and directly relating to land come under land law. This is restricted to urban building and planning law, which is fully codified in Germany in the Federal Building Code (Durner, Greiving and Reitzig 2011, 382).
In addition, spatial planning cannot stipulate on matters that come under sectoral planning law. This includes nature conservation law, highway law, and also for example railway law.
Spatial planning thus generally affects land use indirectly through its influence on local land-use plans and sectoral plans and on the decisions of approval authorities. In this way, spatial planning can exercise influence over the nature of land use without having to address land users directly. Successful implementation of spatial planning stipulations therefore requires direct influence on the activities of public planning and approval authorities and direct influence on the activities of land users.

2.6. Binding effect of spatial planning requirements

If state and regional planning stipulations are to be implemented, urban land-use planning has to be harmonised with state planning and regional planning (Moench 2005, 683). Uniform planning across the various planning levels can only be achieved by the application of binding effect and obligatory requirements for subordinate levels. Successful implementation is therefore contingent on the regulatory influence of spatial planning and the legal effectiveness of its instruments.
The extent to which those instruments bindingly constrain the addressees of planning in their actions depends on whether the instruments qualify as legal norms. The most important binding instruments in spatial structure planning are spatial planning requirements. These are the only such instruments with binding effect. Since 1998, the Federal Spatial Planning Act has included a statutory definition of spatial planning requirements (Section 3, no. 1 of the Act). By that definition, they include goals and principles together with other spatial planning requirements. Stipulations of a spatial structure plan are only binding if they satisfy the criteria of a goal or principle. 'Other' requirements mostly consist of the outcomes of administrative acts (spatial planning goals in the process of formulation, outcomes of formal state planning procedures such as spatial planning procedures, and state spatial planning reports) (Runkel 9/2008, K § 4, at 41). The three types of requirements each have different legal consequences for addressees. These are set out in what is referred to as the general spatial planning clause (Section 4 of the Federal Spatial Planning Act).
Thus, goals of spatial planning impose on addressees a strict duty to comply and they demand mandatory adherence to the stipulations of the spatial structure plan. This greatly limits the scope for adaptation and further elaboration by addressees and leaves no room to overrule the stipulations with own decisions based on a weighing of interests.
In contrast, principles of spatial planning and other spatial planning requirements can indeed be overruled by such decisions. The duty they impose is thus less strict and comprises a duty to give due consideration.

When it comes to the binding effect of spatial planning requirements in sectoral planning, an important part is played by special spatial planning clauses in sectoral planning legislation (Stüer, Hönig 2002, 333). Such special spatial planning clauses must at least correspond in substance to Section 4 (1) to (4) of the Federal Spatial Planning Act. Use may nonetheless be made of enhanced spatial planning clauses that go beyond the substance of Section 4 of the Federal Spatial Planning Act (Runkel 12/2008, K § 4, at 259 onwards). Such clauses may not however put the principles beyond the reach of decisions based on a weighing of interests or discretionary authority (Runkel 12/2008, K § 4, at 273). One of the most important pieces of sectoral legislation with regard to spatial planning is the Federal Building Code. This provides the legal framework for local urban land-use planning and contains an enhanced spatial planning clause (Section 1 (4) of the Federal Building Code). In connection with spatially relevant works by private subjects, Section 35 (3), second sentence, of the Federal Building Code additionally constitutes an enhanced spatial planning clause that must be complied with when building in undesignated outlying areas. This clause makes the goals of spatial planning a constituent requirement in the building law approval procedure.

2.7. Spatial planning authorities, spatial structure planning authorities and their responsibilities

In line with the federal structure and the general administrative structure at federal and state level, the tasks of spatial planning – compiling spatial structure plans, working to effect their implementation and other supervisory and coordinating tasks – are carried out by various different authorities.
As supreme spatial planning authority, the Federal Ministry of Transport and Digital Infrastructure (BMVI) is responsible for spatial planning tasks at federal level. The Ministry has coordinating and advisory responsibilities in the field of cooperation between the Federal Government and the states (Section 26 of the Federal Spatial Planning Act), notably un-

der the framework of the Conference of Ministers for Spatial Planning. Under Section 17 of the Federal Spatial Planning Act, the Ministry is additionally able to compile federal spatial structure plans. In connection with such plans, it is also responsible for any prohibition of spatially relevant plans and works (Section 22 of the Federal Spatial Planning Act).

At state level, responsibility for state-wide spatial structure planning lies with the supreme state spatial planning authorities. These are part of a state ministry and can come under a variety of ministerial portfolios (state chancellery, transport ministry, finance ministry, etc.). An exception is the Joint Spatial Planning Department (GL), which is part of both the Berlin Senate Administration for Urban Development and the Environment and the Brandenburg Ministry of Infrastructure and Agriculture.

The state spatial planning authorities compile state spatial structure plans and have advisory and supervisory responsibilities. It is thus they who approve regional plans. In specific instances, the supreme state spatial planning authorities are also responsible for carrying out spatial planning procedures.

Below the supreme state spatial planning authorities, depending on whether there are two or three tiers of administration, the states additionally have higher and/or lower state spatial planning authorities. A small number of states with three-tier administration do without one of these two levels, however. Depending on the legal arrangements in the state concerned, the higher and lower spatial planning authorities are responsible for contributing in the compilation of regional plans, issuing decisions in procedures for derogation from spatial planning goals and for the prohibition of plans and works conflicting with spatial planning goals, carrying out spatial planning procedures, submitting state spatial planning reports and carrying out spatial monitoring (Durner, Greiving, Reitzig 2011, 415).

Alongside the spatial planning authorities just mentioned there are also regional planning authorities. As the Federal Spatial Planning Act does not specifically designate the regional planning authorities, regional planning is organised differently from state to state. Regional planning may take place at state level or at the level of local authority associations. In regional planning at the level of local authority associations, local authorities and associations of local authorities join forces in regional planning communities. This organisational form is found in the states of Baden-Württemberg (regional associations), Bavaria (regional planning associations), Brandenburg (regional planning communities), Mecklenburg-Western Pomerania (regional planning association), Rhineland-Palatinate (planning communities), Saxony (regional planning associations), Saxony-Anhalt (regional planning communities) and Thuringia (regional planning community). In Lower Saxony, regional planning is carried out by the counties (*Kreise*). The state model, where local authorities merely contribute to regional planning, is applied in Schleswig-Holstein. A hybrid form is used in Hesse (regional assembly) and North Rhine-Westphalia (regional council). Regional planning here is located at the middle tier in the state hierarchy.

The main task of regional planning is the compilation of regional plans. Under Section 13 of the Federal Spatial Planning Act, regional planning is also required as part of cooperation on spatial planning to work towards effecting the implementation of spatial structure plans.

2.8. Spatial planning programmes, plans and procedures

Under Section 1 (1), first sentence, of the Federal Spatial Planning Act, the task of spatial planning is to develop, organise and protect the entire territory of the Federal Republic of Germany and its regions by means of comprehensive, supra-local and supra-sectoral spatial structure plans, cooperation in spatial planning, and coordination of spatially relevant planning and activities. Comprehensive, superordinate spatial structure plans provide the foundation for coordinating the various spatial demands giving due consideration to the principles of the Federal Spatial Planning Act.

Spatial structure plans are generally compiled as integrated plans covering all subject matter under the purview of state or regional planning and applying to the entire territory of a planning region. However, special-purpose sub-plans may also be compiled with stipulations limited to specific issues (such as securing mineral deposits or the use of wind power).

Since 2004, the Federal Government has had the power to compile federal spatial structure plans of its own for the North Sea and Baltic Sea Exclusive Economic Zone (EEZ) outside of German territorial waters. This power was further augmented in 2008. Since then, Section 17 of the Federal Spatial Planning Act has permitted the federal spatial structure plans to further elaborate on the principles of spatial planning. Although the federal spatial structure plans for the EEZ have had binding effect since 2009, a nationwide spatial structure plan that elaborates on the principles in this way is yet to be compiled.

The Federal Spatial Planning Act requires the states to perform spatial planning at state level in the form of spatial structure plans. For this purpose, under Section 8 (1) of the Act, a spatial structure plan (state-wide spatial structure plan) must be compiled for the territory of the state concerned. In the city states of Berlin, Bremen and Hamburg, the function of the state-wide spatial structure plan is fulfilled by a preparatory land-use plan.

State-wide spatial structure plans are generally designated state development plans or programmes. The Federal Spatial Planning Act does not stipulate on the legal form of spatial structure plans. They are mostly enacted as ordinances (*Verordnungen*, i.e. secondary legislation) and in some cases

as acts of parliament (*Gesetze*, i.e. primary legislation). The only instance in Germany where state spatial planning is organised in two legislative levels is state spatial planning for Berlin-Brandenburg. This consists of a state development programme adopted as an act of parliament and state development plans enacted as ordinances.

State plans vary greatly in recency (see figure 2). This is partly because they usually apply for a 15 to 20-year period.

State-wide spatial structure plans make fundamental stipulations on state development and planning, giving due consideration to the spatial planning guidelines (sustainable spatial development; equivalent living conditions) and core instruments (central places, development axes, spatial order categories/area types, etc.) and the principles of spatial planning laid down in the Federal Spatial Planning Act. Spatial planning and activities of sectoral planning authorities need to be coordinated in the process (Danielzyk, Goppel, Knieling, Konze and Schmidt 2011, 442).

Supplementary to the spatial structure plan for their respective state territory, the states are also required under Section 8 (1) of the Federal Spatial Planning Act to compile spatial structure plans for their regions (regional plans). As a result of this, regional planning is carried out almost nationwide in Germany. All states with the exception of the city states and Saarland have divided their territory into regional planning regions. Saarland has refrained from introducing regional planning of its own on account of its small size. In the city states of Bremen, Hamburg and Berlin and in *kreisfreie Städte* – cities that do not come under a county – in Lower Saxony, regional plans are replaced by preparatory land-use plans.

In the ideal case according to planning theory, a regional planning region should encompass a higher-order centre and its service area. As well as the catchment areas of higher-order or middle-order centres, however, other criteria are also important in defining the spatial boundaries of planning regions, such as regional identity or historical, local or state development policy considerations. The redrawing of planning region boundaries is a relatively rare occurrence, taking place for reasons such as municipal or county boundary reforms or territorial mergers.

Regional planning has special importance as a connecting link between state and local authority planning. Its task is to further elaborate the stipulations of state plans for the regions concerned (Brohm 2002, 642). Under the rule in Section 8 (2), first sentence, of the Federal Spatial Planning Act, regional plans must be developed from the overall conceptu-

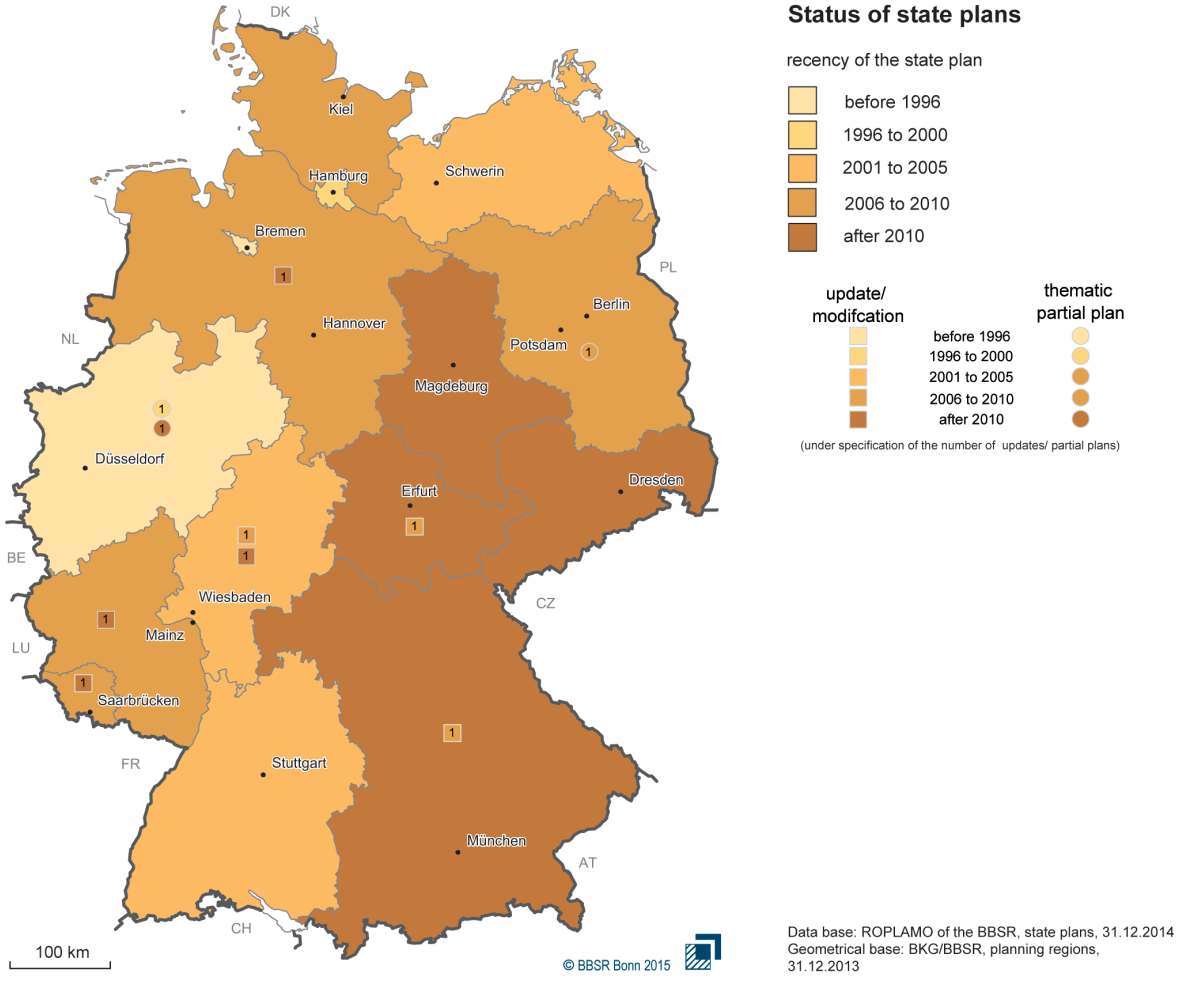

Figure 2 – Status of state plans in Germany.

al framework provided by state-wide spatial structure plans (Runkel 11/2006, K § 3, at 150).

Giving due consideration to the stipulations in state-wide spatial structure plans, regional plans therefore include a goal system for future regional structure and development. They also specify instruments to aid the attainment of the specified spatial planning goals. The amount of leeway left here for regional planning is contingent on whether the state plan predominantly falls back on spatial planning goals or principles and the scope of its framework stipulations (Mößle 2000, 77).

In line with the mutual feedback principle, preparatory land-use plans and the outcomes of other municipal urban development planning activities must also be included in the weighing of interests as part of regional planning (Section 8 (2), second sentence, of the Federal Spatial Planning Act).

Regional plans generally have a 10 to 15-year planning horizon. From a national perspective, however, they are in a state of constant flux due to updating, modification, and regional differences in planning cycles. Map ? provides an overview of the current status of regional planning in Germany.

A recent type of regional plan is the regional preparatory land-use plan. Under Section 8 (4) of the Federal Spatial Planning Act 2008, a regional preparatory land-use plan can serve simultaneously as a regional plan and a joint preparatory land-use plan under Section 204 of the Federal Building Code, which means it must comply both with the Federal

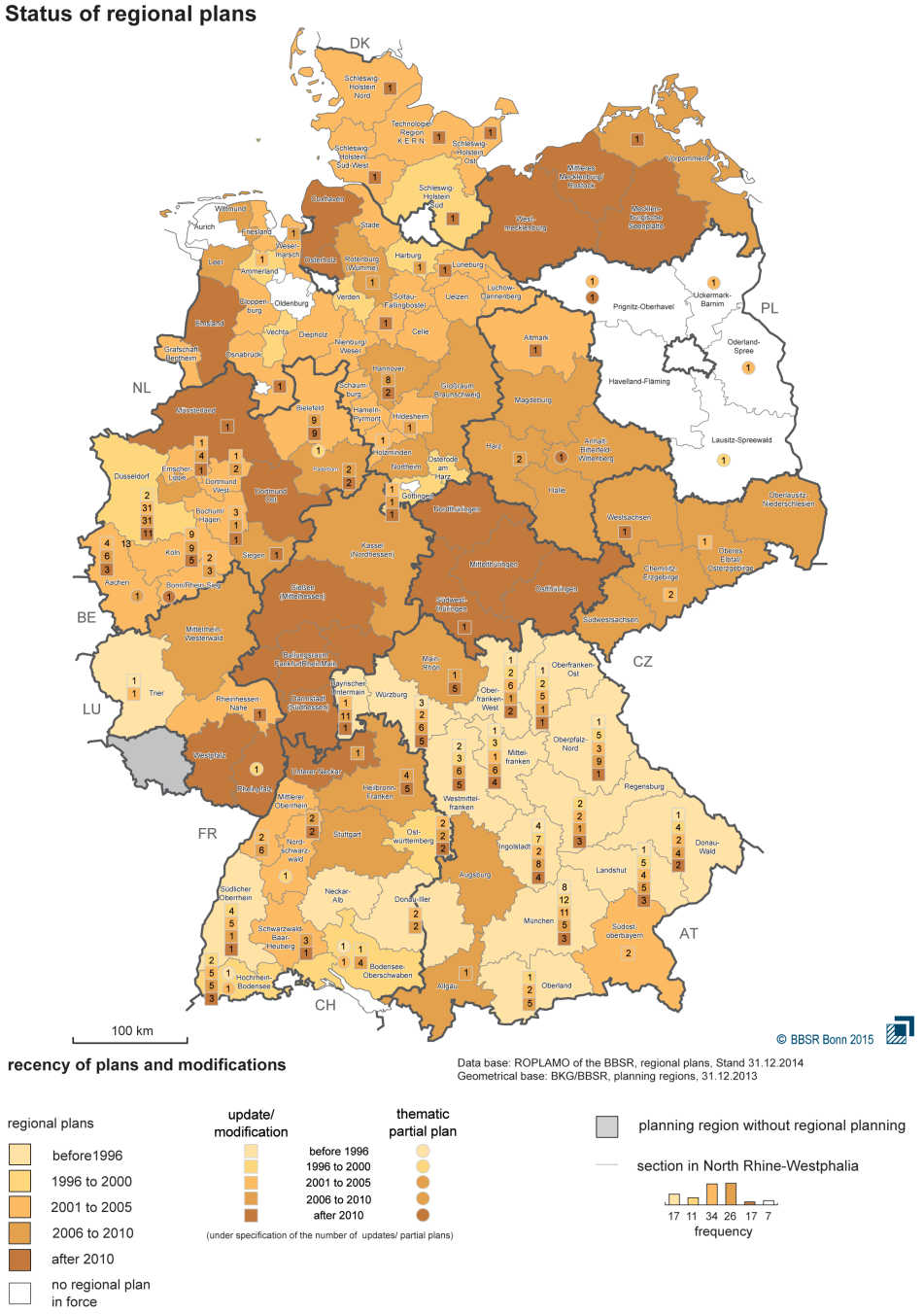

Figure 3 – Status of regional plans in Germany.

Spatial Planning Act and the Federal Building Code.

2.9. Instruments for the implementation of spatial planning

Besides the compilation of spatial structure plans, an important role for planning authorities is also played by plan implementation and enforcement. Supplementary to the duty of compliance and alignment with spatial planning goals and the duty to give due consideration in relation to spatial planning principles (see section on requirements), notable instruments available to planning authorities include the spatial planning procedure, state spatial planning reports, prohibition of spatially relevant plans, and procedures for derogation from spatial planning goals.

The spatial planning procedure and state spatial planning reports are both formal procedures to assess spatial compatibility, meaning the spatially relevant impacts of spatially relevant plans or works.

The spatial planning procedure serves to coordinate spatially relevant plans or works with one another and with spatial planning requirements. The spatial planning procedure is carried out in advance of a final decision in an approval procedure under sectoral law. The outcome of a spatial planning procedure is a state spatial planning assessment stating whether a project complies with spatial planning requirements, does not comply with them or complies subject to certain stipulations (Höhnberg, Jacoby 2011, 509). A state spatial planning assessment comes under the 'other' requirements of spatial planning under Section 3 of the Federal Spatial Planning Act. It must therefore be given due consideration in the official decision on a project's admissibility.

State spatial planning reports come into play where only the goals of spatial planning are germane to the legal assessment of spatially relevant plans or works (Höhnberg, Jacoby 2011, 514). As with state spatial planning assessments, state spatial planning reports come under the 'other' requirements of spatial planning.

3. Urban development and urban planning

3.1. Planning law

Legislative powers with regard to planning law are shared between the federal and state levels. Planning and building law is divided into urban development law and building control law. Urban development law stipulates land use within a municipality, is site-focused and is federal law. Building control law lays down the requirements for specific structures, it is building or structure-focused and it is state law (Battis/Krautzberger/Löhr 2014, Introduction, at 4).

The Federation's powers to legislate on urban development law follow from Article 74 of the Basic Law (Article 74 (1) No. 18 of the Basic Law). This gives the Federation the powers to legislate on land law, which includes urban development planning law. It is on this legal basis that the Federation enacted the Federal Building Act in 1960 – today's Federal Building Code – creating for the first time a uniform legislative framework for local urban land-use planning. Alongside the Federal Building Code, federal secondary legislation has additionally been enacted, such as the Land Utilisation Ordinance (*Baunutzungsverordnung/BauNVO*) and the Plan Notation Ordinance (*Planzeichenverordnung/PlanZVO*).

There are formulated several urban planning models that reflect contemporary trends (such as conservation of the 'European city', the city of short distances, the compact city, the climate-friendly city, the smart city, critical reconstruction, and so on). The Federal Building Code, on the other hand, formulates urban development goals that are further elaborated by cities, towns and municipalities under their own responsibility according to local needs. The instruments of urban development and land law are thus essentially neutral in terms of goals. They can be used to prepare, stipulate and implement almost all goal-determining elements of urban planning (BBR 2000).

For the general public, planning law comes into effect through the granting of building permission. The building authority examines the admissibility of building plans under planning law, meaning to what extent they conform with a binding municipal land-use plan. Building plans are also examined for conformity with building control law (building regulations). The granting of approval under building control law for members of the public therefore splices together federal planning law with state building regulations. Building can only start when building permission has been granted.

3.2. Local planning autonomy

Under the subsidiarity principle, the Federal Government and the states only assume responsibilities that cannot be provided for and dealt with at local authority level, meaning by cities, towns and municipalities. Under Article 28 of the Basic Law, municipalities have the right to regulate all local affairs under their own responsibility, within the limits prescribed by laws (partial fiscal autonomy) and under consultation of a democratically elected body representing the people (local authority autonomy). Autonomy is split down into a number of policy areas: Staffing, organisational, financial, planning and regulatory autonomy (Haury 2015).

The responsibilities of urban development and urban planning are thus included in the guarantee of local authority autonomy. An implication of this constitutional status granted to municipalities is local planning autonomy. Municipalities are thus largely autonomous in planning. Accordingly, local authorities stipulate on how cities, towns and villages are to develop by compiling preparatory and binding land-use

plans – subject to reciprocal consideration of superordinate planning levels (the mutual feedback principle). Cities, towns and municipalities thus examine local circumstances and determine in plans under their own responsibility what is appropriate to local problems and circumstances. In doing so they are required to ensure sustainable urban and housing development that reconciles social, economic and environmental needs, including with respect to future generations, along with socially compatible allocation of space and land in the common interest.

Municipalities perform this task under their own responsibility for their municipal territory and thus stipulate autonomously on land use. In the process, a very varied range of policy areas – the natural environment, economic activities, housing, transport, etc. – all impinge on the shaping of land use. Each municipality is required to coordinate the interests of these policy areas and to bring them together in supra-sectoral, cross-cutting overall planning for their municipal territory (BBR, 2000). This approach ensures that planning safeguards the public interest.

An overarching framework for urban development is provided at federal and state level through legislation and the allocation of funding.

3.3. Tasks and objectives of urban land-use planning

The main policy instrument at local authority level is urban land-use planning. This governs the legal relations between people and land use. Under the basic definition in Section 1 (1) of the Federal Building Code, "the function of urban land-use planning (*Bauleitplanung*) is to prepare and control the use of land within a municipality, for buildings or for other purposes, in accordance with this Act." Urban land-use planning is thus directed at controlling permissible land reallocation in locational and procedural terms (Kuschnerus 2001).

The development and organisational function of urban land-use planning also follows from this. It thus serves to providing the organising framework for the use of sites for building or other purposes. It is also intended to help prepare and direct the development of building and other land uses aimed for in a municipality's urban development strategy (Krautzberger, Stüer 2014).

Urban land-use planning has a general aim of serving the public interest and is expected to reconcile diverging land use interests. The public interest is incorporated at general level in the principles of land-use planning set out in the first sentence of Section 1 (5) of the Federal Building Code. This states that land-use plans must safeguard sustainable urban development and a socially equitable utilisation of land for the general good of the community, and contribute to securing a more humane environment and to protecting and developing the basic conditions for natural life.

3.4. Planning requirements

A characteristic feature of urban planning is freedom of scope. It is also a feature of sovereign planning under the rule of law, however, that it is bound by legal constraints, compliance with which in the case of urban land-use planning is subject to regulatory and judicial oversight. The Federal Building Code lays down the function of urban land-use planning (Section 1 (1) of the Federal Building Code), prescribes general objectives for it (Section 1 (5), first sentence), further elaborates on those objectives with a list of specific guidelines (Section 1 (5), second sentence), and requires municipal planners to duly weigh public and private interests affected by urban land-use planning (Section 1 (6)).

The following requirements and principles must be observed in the preparation of binding land-use plans:

- Necessity requirement (Section 1 (3) of the Federal Building Code):
  Land-use plans must be prepared to the extent that they are required for urban development and regional policy planning.
- Alignment requirement (Section 1 (4) of the Federal Building Code):
  Land-use plans must be brought into line with spatial planning goals.
- Coordination requirement (Section 2 (2) of the Federal Building Code):
  Land-use plans for neighbouring municipalities must be co-ordinated.
- Binding effect of sectoral planning stipulations (Section 9 (6) and Section 38 of the Federal Building Code):
  Stipulations under other state-level legislation must be included as a matter of course.
- Planning principles (Section 1 (5) of the Federal Building Code):
  Safeguarding of sustainable urban development, the socially equitable utilisation of land, a humane environment and the natural foundations of life; sparing use of land.
- Requirement to weigh interests (Section 1 (6) of the Federal Building Code):
  Public and private interests must be duly weighed in the preparation of land-use plans.

3.5. Formal urban development instruments

Land-use plans comprise preparatory land-use plans (*Flächennutzungspläne*) representing land-use types for the entire municipal territory and binding land-use plans (*Bebauungspläne*) containing legally binding stipulations for urban development in spatial subdivisions of the municipal territory.

Under the Federal Building Code, municipalities must prepare land-use plans as soon as and to the extent that they

are required for urban development and regional policy planning. They must be aligned with spatial planning goals and are required to ensure sustainable urban development and reconcile social, economic and environmental interests. Attention must be paid in their preparation to the requirements of environmental protection including nature conservation and the preservation of the countryside, the outcomes of any urban development strategy adopted by the municipality and those of any other urban development planning adopted by the municipality. Land is to be used sparingly and with due consideration. To reduce land take for built development, use is to be made of the scope for development offered by the utilisation of brownfield sites, infill development and other urban regeneration measures.

Interests that are material to the weighing of interests must be identified and assessed in the preparation of land-use plans. An environmental assessment is carried out with regard to environmental interests. The public is to be publicly informed at an early stage about the objectives of plans, differing solutions and the probable impact of plans. The public must be given suitable opportunity for comment and discussion. The authorities and other public agencies whose activities are affected by plans must likewise be informed and invited to comment, including with a view to the required scope and detail level of any environmental assessment.

There are other urban development instruments alongside land-use plans such as by-laws (inner zone and outer zone by-laws), other forms of land-use plan such as the project and infrastructure plan or the inner urban development plan inserted in the major revision of the Federal Building Code in 2013. The project and infrastructure plan is a special case of the binding land-use plan whose main distinguishing feature is that the plan is prepared and implemented by an (external) developer (Söfker 2012). The initiative for creating building rights thus lies with a private investor. The investor draws up the urban development plan and commits by contract to its implementation and to bear the costs of planning and of the provision of public infrastructure (Battis/Krautzberger/Löhr 2014, § 12, at 3). The project and infrastructure plan is thus an instrument enabling municipalities to enter into collaboration and contracts with third parties.

3.6. Special urban planning law and financial support for urban development

Special urban planning law, covered by Sections 136-191 in Chapter Two of the Federal Building Code, focuses on the treatment of the urban building stock in municipalities and notably urban deficits that have developed in specific neighbourhoods and how to remedy them. Special urban planning law has its own set of formal instruments and procedures:

- Urban rehabilitation measures;
- Urban development measures;
- Urban redevelopment;
- The socially integrative city;
- The preservation statute and urban development enforcement orders.

The provisions on urban redevelopment were inserted into the Federal Building Code by a 2004 act revising German building law in line with European law (*Europarechtsanpassungsgesetz Bau*). They are the legislative response to profound structural changes, most of all in demographics and the economy, and the attendant implications for urban development. An immediate factor in this was empty housing notably in the eastern German states from the late 1990s onwards (Battis/Krautzberger/Löhr 2014, *Vorbemerkungen* §§ 171a-171d, at 1). The 2004 act also inserted the provisions on socially integrative city measures. These represent a further development on state-level programmes on socially integrative urban development launched back in the 1990s, laying the basis for a uniform national framework.

So that towns and cities can master the tasks and challenges of urban development, the Federal Government supports the establishment of sustainable urban structures with programmes of financial assistance for urban development. The Federal Government grants such financial assistance to the states under Article 104b of the Basic Law; it is supplemented with state and municipal funding. The federal financial assistance is made available to the states on the basis of an administrative agreement on financial support for urban development (*Verwaltungsvereinbarung Städtebauförderung*) (BMUB 2015).

The objectives of financial support for urban development are as follows:

- Strengthening the urban function of city centres and local sub-centres, paying special attention to the preservation and conservation of buildings of historic interest
- Establishing sustainable urban structures in areas affected by severe loss of urban function; indicators of such loss of function include most of all a sustained surplus of built structures such as empty housing and derelict inner city sites and notably industrial land, conversion land (disused military sites) and railway land
- Urban planning measures to mitigate social deficits.

3.7. Informal urban development instruments

'Informal' planning instruments and processes for the preparation and implementation of land-use plans play an increasingly important part at the local planning level just as they do at supra-local levels. Unlike their formal counterparts, informal planning instruments have no binding force. They nonetheless rank highly in the urban planning process as a continuous process of urban development whose program-

matic substance cannot be usefully administered through formal plans. The strength of informal planning is that it allows programmatic, conceptual and design solutions to be formulated in accordance with the primary question or task at hand and incorporated into municipal planning. The advantage of such instruments is thus their versatility.
Informal planning is often used as a complementary instrument to formal planning. A wide range of decision-making aids can be incorporated. For example, informal planning instruments can be used to identify or measure the need for planning. They are also a suitable means of illustrating plan alternatives or the likely impact of plans. Informal planning can thus help to integrate and elaborate. It can serve as a visualisation aid and so facilitate public consultation and participation. Informal planning instruments can consequently also take on a communication and coordinating role.
Informal planning ranges from draft urban development plans to urban development framework plans and general development plans, from special reports to urban development and architectural competitions, and from transport development plans to architectural designs and models.

3.8. Parties involved in urban development

Municipalities have planning autonomy and must prepare land-use plans when required for urban development and regional policy planning. The obligation to carry out planning follows for municipalities directly from Section 1 (1) of the Federal Building Code ('positive' planning requirement). This allocation of responsibility for urban land-use planning does not however mean that planned development cannot be undertaken by other means than on the basis of urban land-use planning (Battis/Krautzberger/Löhr 2014, §1, at 17). Municipalities are also free to cooperate with neighbouring municipalities, industry or civil society.
Urban development in Germany has always been a community effort involving local or regional industry and civil society to varying degrees alongside the public sector. Collaborative approaches are already used in public-private partnership models and in binding land-use plans implemented by developers.
Many innovative new forms of private initiative in urban development have emerged in recent years. These include civic trusts, participatory budgeting, citizens' boards, pop-up amenities, energy cooperatives and crowdfunding initiatives. Business improvement districts (BIDs) and housing improvement districts (HIDs) have been called into being in some places to promote cooperation between individual owners in a neighbourhood. Both of these are based on the use of public statutes under which, subject to minimum consent, all owners affected can be called upon for the private funding of a private sector project (Jakubowski 2015).
In future, municipalities face the task of organising strategic alliances and communities that share responsibility and are centred around the goals of sustainable, integrated urban development. In this way, they can gain valuable new partners in urban development.

4. Climate protection and energy efficiency

The Federal Government has identified climate change mitigation and adaptation as growing challenges for states, regions, cities, towns and municipalities.
Climate and energy issues are important priorities in spatial planning, and not only when it comes to the review of guiding principles. Also, numerous spatial structure plans have been updated in recent years with regard to flood prevention and renewable energy. In particular, spatial planning stipulations play a key part in directing the expansion of wind power in spatial terms as there is no sectoral planning for this purpose (see Section 7). In light of this, in connection with decisions to accelerate the transition to renewable energy (the *Energiewende*), the Federal Government called in 2011 for increased designation of spatial planning areas for wind power. The Federal Government and the states established a joint initiative on wind power, the *Bund-Länder Initiative Windenergie*, to improve exchange between them on the issue.
With a view to the municipal level, an act promoting climate protection in cities, towns and municipalities likewise came into force in 2011. To accelerate the *Energiewende*, climate policy aspects and a climate protection clause were incorporated in the Federal Building Code. The aim of this legislation is to create targeted arrangements to the benefit of climate protection that support practitioners and provide greater scope for action by municipalities.
To aid the ongoing substitution of conventional energy sources with renewable energy, improvements were made to the planning law instruments for repowering, meaning the replacement of old wind turbines with new ones predominantly in wind farms. It is stipulated that municipalities should indicate renewable energy or combined heat and power installations in preparatory land-use plans and can designate sites for such installations in binding land-use plans. Informal municipal climate change and energy strategies can also be given greater legal force by being incorporated in formal urban land-use planning. Municipalities have also gained the scope to make stipulations in binding land-use plans that provide for and facilitate the use of renewable energy and combined heat and power installations in new buildings. The use of solar energy on roof and exterior surfaces was also made possible in undesignated outlying areas. With a view

to built areas, climate change mitigation and adaptation concerns have also been incorporated into special urban planning law (Goderbauer, Haury 2015).

In the building sector, the Energy Saving Ordinance (*Energiesparverordnung/EnEV*) has been an important element of energy efficiency policy for many years. Among other things, it requires energy certificates to be issued for new buildings and on the modification or extension of existing buildings. A major revision of the Energy Saving Ordinance in 2013 implemented a key part of the Federal Government's resolutions on the *Energiewende*. The energy efficiency requirements for new buildings have been made 25 percent more stringent from January 2016. From 2021 there is a fundamental obligation for new buildings to be constructed to the highest energy efficiency building standard.

5. Examples: Wind power and refugees

In the following, the regulatory capabilities of the various planning levels and the links between levels are illustrated with reference to two topical examples.

As examples, two topics were chosen which currently have a high political priority: Wind energy and refugees. In addition, the examples illustrate the regulatory capabilities of the various planning levels.

With regard to the expansion of onshore wind power, the location of new wind turbines is especially determined by instruments of state and regional planning. These binding stipulations must be observed by the local authority planning.

Another topical subject of the spatial planning is the supply of the accommodation of refugees. The "Königsteiner Schlüssel" regulates nationwide how many accommodations must be provided per federal state. The states regulate subsequently after own distribution mechanisms the number of accommodations of refugees which local authority districts must establish. For local authority districts the supply of lodgings, the integration of refugees in the job market and in the neighborhoods shows a great challenge that must be overcome in a short time.

5.1. Wind power

Implementation of the *Energiewende*, the transition to renewable energy planned by the Federal Government and the states in Germany, requires a substantial expansion of onshore wind power. 1,766 onshore wind turbines were erected in Germany in 2014 alone, with a capacity of some 4,750 MW. The total number of wind turbines nationwide came to 24,867 at the end of 2014 with a capacity of approximately 38 GW. The Federal Network Agency expects that installed capacity will continue growing to as much as 63.8 GW (Scenario B) by 2025 (BNetzA 2014). The expansion of wind power means that significant amounts of land will be needed to build wind turbines.

Various factors determine where wind turbines can be put up. A key point first of all is the privileged use of wind power under the Federal Building Code (BauGB). Under Section 35 (1) No. 5 of the Federal Building Code, the use of wind power is permissible in undesignated outlying areas where there are no conflicting public interests.

A project conflicts with public interests if it contradicts spatial planning goals or representations in a preparatory land-use plan (Section 35 (3) of the Federal Building Code). The Federal Building Code also permits state, regional and municipal planning, by positively designating locations for privileged projects in undesignated outlying areas, to exclude such projects in the remaining planning area.

Various state and regional planning instruments enable the designation of specific locations for spatially relevant functions and land uses. A distinction is made between 'positive' and 'negative' planning designations (Einig 2005, 51; Domhardt, Spannowsky 2002). With regard to wind power, a positive planning designation comprises the designation of spatial planning areas for wind power. These locations are actively secured for wind power. At the same time, safeguarding a site for a different use, such as spatial planning areas for nature and the countryside or for flood prevention, can have the effect of restricting the use of the land for wind power (negative planning control).

The Federal Spatial Planning Act (Section 8) distinguishes between four types of spatial planning area: Priority areas, reserve areas or sites, areas suitable for development, and priority areas with the effect of areas suitable for development. The highest level of protection for a land use is attached to priority areas. These have the legal status of spatial planning goals and exclude all uses that contradict the priority land use. Priority designations cannot be weighed against other interests. Reserve areas or sites, on the other hand, have the status of principles of spatial planning and hence the effect of setting a parameter for a subordinate weighing of interests (Heemeyer 2006, 266). They are far weaker in terms of spatial regulation than priority areas. When it comes to the spatial regulation of wind power through regional planning, an important part is played by areas suitable for development and priority areas with the effect of areas suitable for development. Both of these area types have the effect of excluding the land use outside of the designated area, meaning that no wind turbines can be approved in the remainder of the planning area.

The designation of spatial planning areas is done in regional plans. Regional planning authorities are not free to decide what type of spatial planning area they use to regulate the building of wind turbines. Instead, plan notation ordinances,

state spatial planning acts and the stipulations of state development plans determine what spatial planning area types are available for regional planning. As a result of this, very varied regulatory regimes have developed from state to state (see

centration zones' for wind power installations in a preparatory land-use plan and consequently preclude the erection of wind turbines outside of such zones. There is no obligation to designate concentration zones, however.

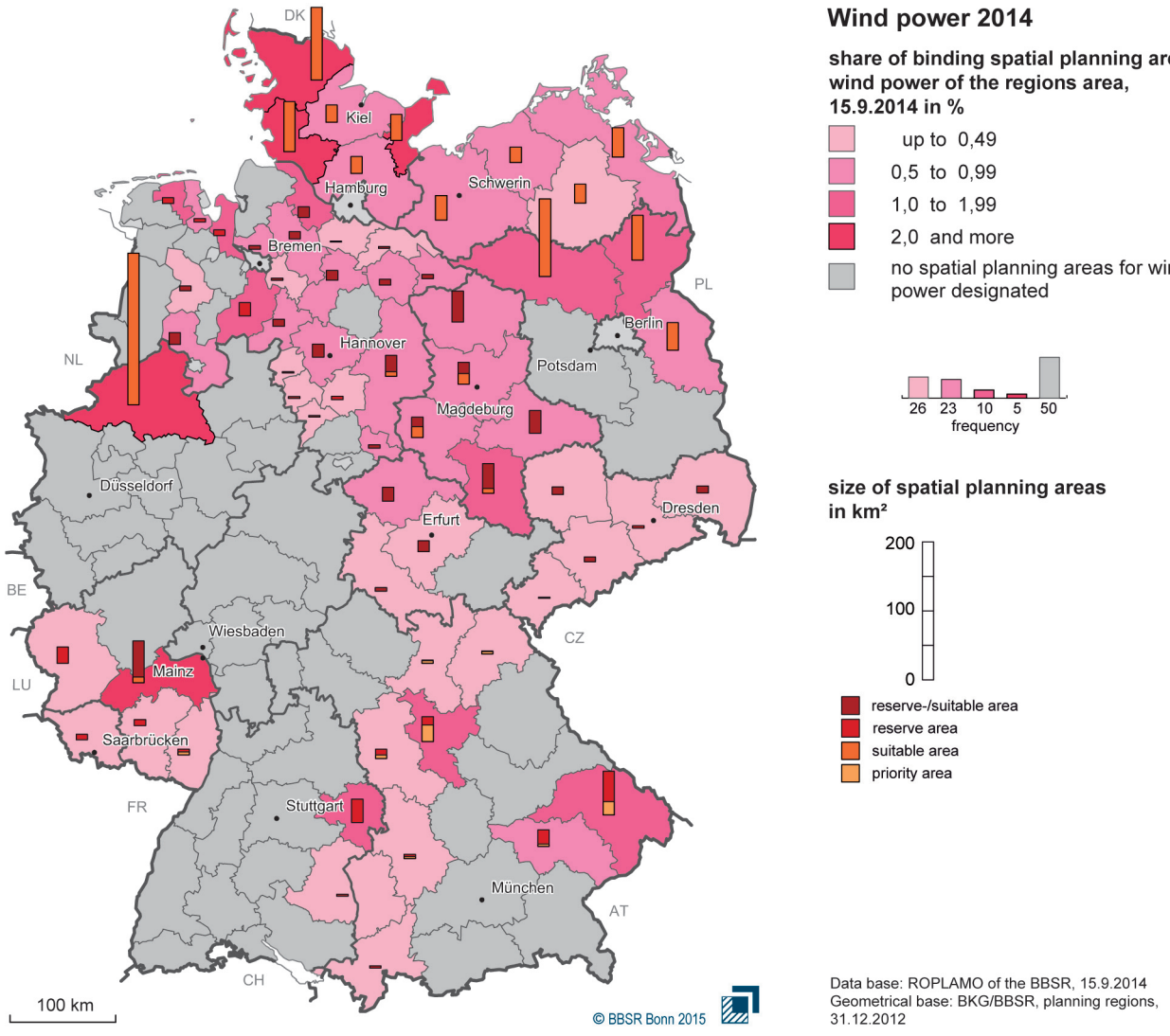

Figure 4 – Binding spatial planning areas for wind power 2014.

Map 2) (Einig, Zaspel-Heisters 2014; Zaspel-Heisters 2015).

Under Section 1 (4) of the Federal Building Code, land-use plans must be aligned with spatial planning goals. Municipalities are not therefore allowed to adopt plans at variance with spatial planning goals. If wind power is regulated in spatial terms at regional level with final effect by the designation of areas suitable for development, of priority areas with the effect of areas suitable for development or of exclusion areas, then the municipalities must heed such designations. If on the other hand regional plans make use of priority areas or reserve areas or sites, or if no use is made of regional planning for the regulation of wind power, then scope remains for regulation at municipal level.

Under Section 5 read in conjunction with Section 35 (3) of the Federal Building Code, municipalities can designate 'con-

Especially in states and regions where wind power is not regulated in spatial terms through regional planning or where such regulation does not have final effect, stipulations in preparatory land-use plans can significantly limit the amount of land available for wind power.

5.2. Refugee issues

A new act concerning planning law measures to facilitate the accommodation of refugees entered into force on 26 November 2014. Its adoption was prompted by sharply rising refugee numbers and the resulting difficulties for municipalities in providing accommodation and coping with the rapidly growing influx of refugees into Germany.

Current migration statistics from the Federal Office for Migration and Refugees suggest at least 800,000 refugees per

year coming to Germany. Providing accommodation for these people, many of whom come from crisis zones, poses a major problem for large cities where the housing market is already stretched. There is a general shortage of land needed to provide broad segments of the population with space for housing. Short-run use of other sites is often ruled out by planning law. Legislative action was therefore urgently needed in the form of a limited-term administrative measures act relating to urban land-use planning law and planning law permission for facilities to accommodate refugees and asylum seekers in order to enable and secure the rapid creation of public accommodation centres to meet demand (Deutscher Bundestag 2014).

The revision to the Federal Building Code modifies the Code in five points. These relate to urban land-use planning and planning law permission. A number of the provisions are permanent, while others are time-limited to the end of 2019 in order to test their effectiveness.

In Section 1 (6) of the Federal Building Code, "refugees or asylum seekers and their accommodation" is added to the list of urban development concerns. These aspects must thus be given due consideration and duly weighed in accordance with the requirement to weigh interests in urban development planning. Alongside further provisions supporting the accommodation of refugees in the planned and unplanned inner city zone, provision was also made for accommodation in commercial areas. Towns and cities are allowed to locate refugee accommodation in commercial areas for a limited period up to the end of 2019. Whether accommodating asylum seekers in commercial areas is a helpful solution or leads to their lasting exclusion is something that towns and cities must monitor critically through to 2019. Other possibilities for coping with the large inflows of refugees continue to be explored in the meantime.

6. Conclusion

The federal system in Germany provides for responsibility sharing in all areas. Germany consequently also has a multi-tier planning system, with responsibilities assigned at federal, state, regional and municipal level. This multi-tier system incorporates horizontal and vertical coordination at all times (the mutual feedback principle). In other words, there is countervailing influence in spatial planning between local, regional and supra-regional planning. Additionally, in all planning, the requirement to weigh interests must be observed to ensure that for spatial planning and land reallocation is as equitable and as socially accountable as possible while taking into account the largest possible array of interests.

Sustainable spatial development with its two levels comprising spatial planning and urban development is governed by various federal and state legislation. Under the subsidiarity principle, the Federal Government and the states only assume responsibilities that cannot be provided for and dealt with at local authority level, meaning by cities, towns and municipalities. Subsidiarity is a social policy principle that was also adopted for the European Union in the 1992 Treaty of Maastricht.

By way of this principle, the municipalities gain considerable scope for action (planning, staffing and financial autonomy). It assures them the right to regulate all local affairs under their own responsibility, within the limits prescribed by laws and under consultation of a democratically elected body representing the people (local authority autonomy). A principle of intensive public and industry consultation and participation (the multi-stakeholder approach) has been followed for many years in Germany. This is reflected in various collaborative planning instruments such as project and infrastructure plans and the establishment of business improvement districts (BIDs) and housing improvement districts (HIDs).

The high value placed on innovation and knowledge transfer or exchange of experience in Germany is an important factor in spatial development and a prerequisite for the ongoing substantive and procedural refinement of sustainable spatial development. Pilot trials in model projects and also experimental legislative provisions (as in the accommodation of refugees) enable key experience to be acquired and new lessons to be learned. For these purposes, the Federal Building Ministry set up the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR), which alongside ongoing spatial and urban development monitoring conducts research into new approaches and methods of spatial development under programmes on Demonstration Projects of Spatial Planning (MORO) and Experimental Housing and Urban Development (ExWoSt).

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Sustainable Urban Mobility

Metropolitan railway systems and Transit oriented development in Italian provincial coordination territorial plans

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Keywords: Metropolitan railway systems, polycentrism, transport-land use coordination, Provincial coordination territorial plans.

Abstract

In the last twenty years, Transit oriented development (TOD) has received increasing attention all over the world. It is recognized as a planning approach that allows to pursue, on the one hand, more sustainable mobility patterns that are less dependent on car and more based on rail usage; on the other hand, it is in line with strategies that promote polycentric development in contrast to urban sprawl. In this sense, it seems quite suitable to be applied to Italian metropolitan areas, where recently many suburban railways have been reorganized as integrated Metropolitan railway systems (MRSs), and polycentric development is often set as a strategic issue in regional planning. The paper examines the provincial coordination territorial plans (PTCPs) of nine Italian Provinces in order to verify if and how they adopt a TOD approach to support their MRSs. The selected PTCPs are analyzed in terms of promoted settlement model, role assigned to the MRS, rules and recommendations concerning new residential developments and the localization of manufacturing activities and metropolitan tertiary functions. The results show that in most PTCPs TOD approach is referred in generic terms, and is not systematically applied or operationally defined; furthermore, in locating metropolitan tertiary functions, PTCPs often prefer accessibility by road rather than by rail. The only – but relevant – exception is represented by the PTCP of Bologna, where a TOD approach has been adopted to mutually support the sustainability of mobility patterns and a polycentric densification, with positive effects on both rail ridership and containment of urban sprawl.

1. Metropolitan railway systems in Italian cities

In the last fifteen years, several big Italian cities have launched plans and projects to rationalise and enhance their suburban railway lines; they often took advantage of new infrastructures promoted by Rete Ferroviaria Italiana, like tunnels doubling from two to four the rail lines crossing urban core areas, or new high-speed rail lines and stations that offered the opportunity to devote current rail tracks to metropolitan and regional trains (De Luca & Pagliara, 2007). In most cases, this rationalisation process was no longer based on the traditional "line by line" planning approach; on the contrary, it was aimed at creating integrated and coordinated metropolitan railway "systems" (MRSs), like the long-established S-Bahn systems of German cities and the Parisian regional express network RER. The essential feature of these systems is the regular-interval (or clock-face) timetable, which has two main characteristics (Johnson, Shiresa, Nasha & Tyler, 2006):

- continuous, regular and periodic repetition during the whole service period. Trains always leave a certain station at the same minutes past every hour, preferably throughout a long operating day, every day (for example at minute xx.10 if frequency is hourly, at minutes xx.10 and xx.40 if services run half-hourly);
- symmetry. The service in one direction is the mirror-image of that in the reverse direction, generally around a symmetry point at minute xx.00, so arrivals and departures are symmetrical around the hour (for example trains leaving at minute xx.20 from station A arrive to station A at minute xx.40).

The regular-interval timetable has many advantages both for rail users and companies. The repeating pattern of departures across the day allows timetable to be more easily memorised, reducing the costs of acquiring information on train departure times; an impression is given of an orderly, well planned and reliable system; a fair level of service is guaranteed along the whole day and for every origin-destination pair (Wardman, Shires, Lythgo & Tyler, 2004). The symmetry allows to optimize the overall connectivity and to minimize interchange times: the structure of services can be organized so that crossing symmetric points correspond – at least approximately – to key interchange stations, where also street-based public transport can converge. For rail companies, the regular pattern across the day simplifies planning and management processes (Johnson et al., 2006), allows a fuller utilisation of the railway infrastructures (Malavasi & Ricci, 2001), increases punctuality and reliability (Avelino, Brömmelstroet & Hulster, 2006), maximizes the amount of captured transport demand (Cordone & Redaelli, 2011).

In 1938 the Dutch national Railways were the first to introduce a regular-interval timetable; now it has been adopted – at national or metropolitan level – in countries like Swiss, Germany, Denmark, Finland (Avelino et al., 2006). As it was said in advance, this kind of timetable has been – or is being – adopted also in the re-organization of most suburban

rail services of Italian metropolitan cities, even if, at least currently, at different levels of integration and overall coherence. The regular and repeating pattern of departures every hour is generally introduced in every line (with frequency of 15, 30 or 60 minutes); the integration and coordination of this pattern on the whole system (i.e. between the lines) is respected particularly where a number of lines overlap in the tunnel crossing the main city, so to create a regular high-frequency (5 to 10 minutes) intra-urban rail service (like in Turin and Milan, and the same will happen in Bologna when present infrastructural works will be completed).

In some cases (like Turin, Milan, Bologna, Rome and partially Naples), these MRSs have already been presented to the public as real "systems" (figures 1, 2, 3 and 4): they have a unique logo for the whole network (lines and stations), lines are progressively numbered, rail services are integrated not only with each other but also with other local transports (like street buses and metros) in terms of ticketing and connectivity. In Venice and Florence this model has been planned but is quite far to be completed. In Genoa its systemic coherence is quite low.

Most Italian MRSs have a radial structure: they are made up of lines converging from the suburbs on the main central city. Only in Naples and Rome a ring line is foreseen: it should connect the other radial lines and serve the (increasing) mobility demand between municipalities of the first and second suburban rings.

Figure 1 – The map of the MRS in Turin.

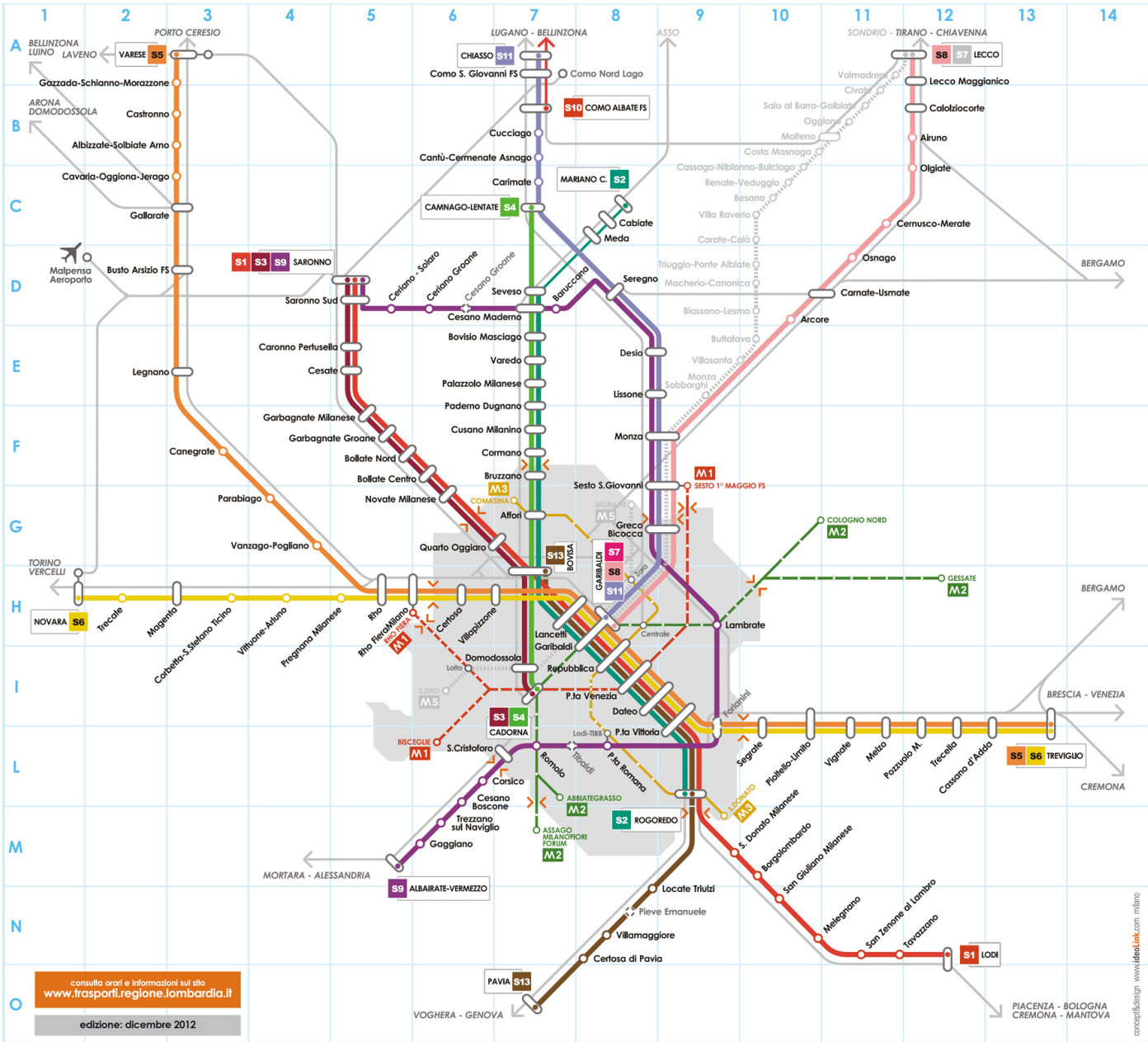

Figure 2 – The map of the MRS in Milan.

2. The Transit oriented development approach

As it is demonstrated by some European experiences in the 20th century – see, in particular, Copenhagen (Knowles, 2012) and Stockholm (Cervero, 1995) – and, more recently, by the approach of Transit oriented development (TOD) in North America, Asia and Australia, MRSs work at their best when they are not only well organized in terms of timetable, connectivity, frequency etc., but also – if not mainly – when they are supported by a consistent urban and regional planning, both at micro and macro level.

The TOD approach suggests to promote, in the areas surrounding rail stations within a radius of 500-750 meters (corresponding to a 8-10 minutes walking journey), an urban development characterized by the so-called 3D (Cervero & Kockelman, 1997):

- a medium-high (residential and/or employment) *density*, so to guarantee a substantial number of potential passengers that can reach the station without using a car;
- an appropriate *diversity* of the land uses. This would allow train passengers to perform a range of activities (not only living and working, but also shopping, entertainment, social relations and so on) near the arrival and/or departure station; at the same time, neighbourhoods around these stations would be "lived" along the whole day, and their safety improved. According to the TOD approach, the areas

Figure 3 – The map of the MRS in Bologna.

surrounding train stations should accommodate the main trip generators and attractors; in particular in the case of MRSs having a radial structure, metropolitan tertiary activities (like large scale shopping centres, conference centres, entertainment facilities, hospitals, universities etc.) should be located also near some minor stations in the municipalities around the main central city, so to attract trips from it and produce directional-flow balances in commuting period[1] (Chorus, 2012);

- a *design* of the built environment that encourages walking and cycling to the station, thanks to a grid pattern of the street network, attractive streetscape, extensive bike lanes, the presence of retail stores etc.

If local city planning should articulate the detailed plan and the precise contents of land use types, densities and facilities in the areas surrounding the stations, planning at the regional scale is supposed to set the spatial structure of TODs, in terms of hierarchical distribution of transport nodes, links, and activities. In other words, regional planning should assess how local choices can support objectives at a higher scale, and consequently steer decision making at the local level (Kamruzzaman, Baker, Washington, & Turrell, 2014). The role of regional planning is particular important for stimulating TOD around smaller suburban rail stations: their adjacent areas usually attract less interest than central stations in big

1. For example, in Stockholm during peak hours 55% of commuters travel in one direction on trains and 45% in the other direction (Cervero, 2015).

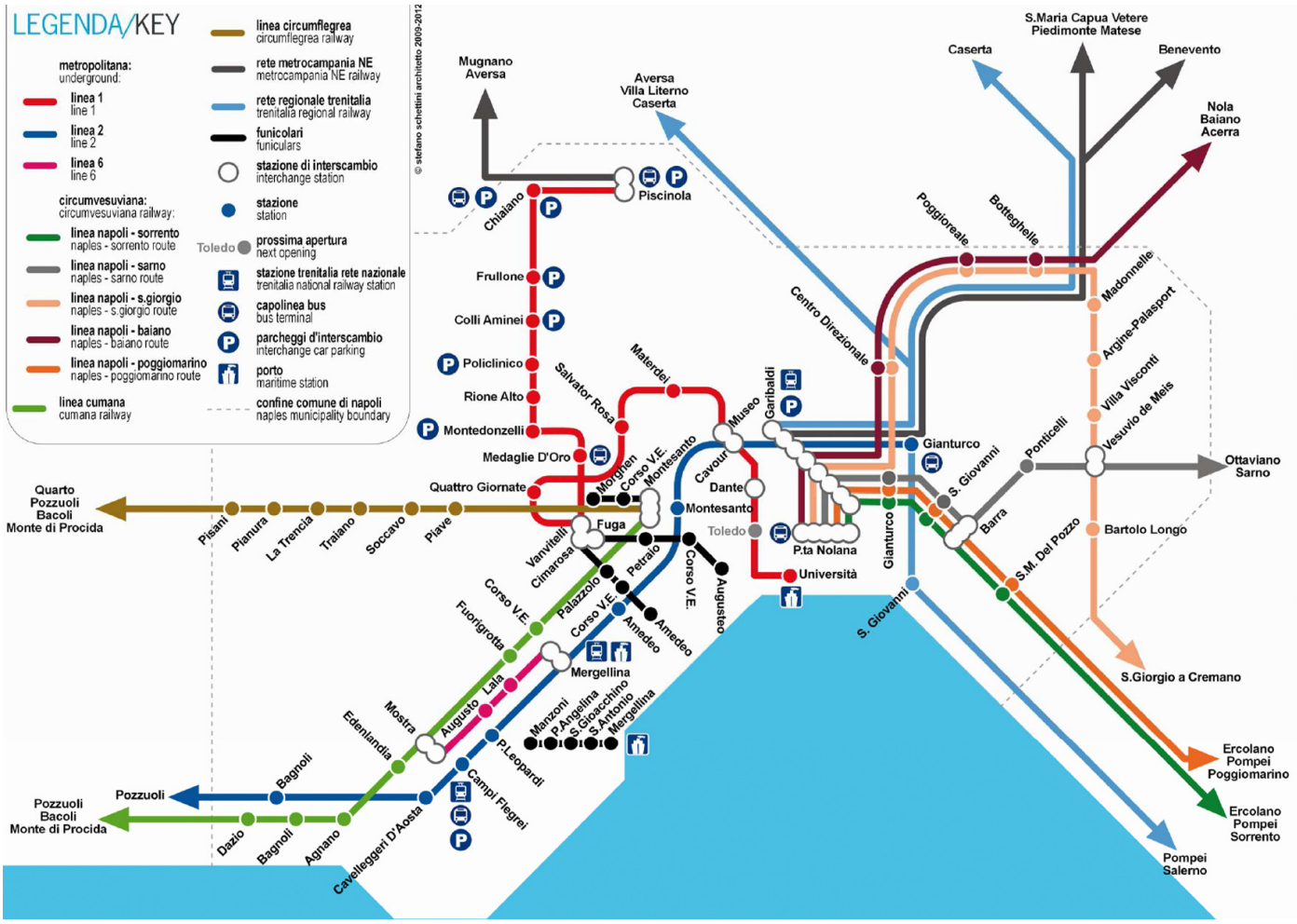

Figure 4 – The map of the MRS in Naples.

cities, and have characteristics that make it more difficult to integrate transport and planning land use (low-density, high levels of car use, distance from town centre, barrier effect of rail infrastructures, uneven availability of land, unfavourable market conditions, resistance of inhabitants and local authorities to higher density etc.) (Desjardins, Maulat, & Sykes, 2014). Conversely, TOD can support through a "decentralized concentration" a polycentric development, which is often set as a strategic objective in regional planning in contrast to urban sprawl (Jenks & Dempsey, 2005).

Till now, most attention – both in scientific literature and in practices – was focused on promoting TOD at the local level, less on the role of regional planning. Two significant exceptions are represented by the Stedenbaan project and the French "contrats d'axe".

Stedenbaan (City Line) is a project developed in Zuidvleugel, literally South Wing, a part of the Randstad in the Dutch province of South Holland. It aims not to implement new rail connections, but to improve service on the already existing rail lines between Schiphol, Dordrecht, The Hague, Gouda and Rotterdam, increasing frequency from 4 to 6 trains per hour. The cost of this improvement should be covered by a growth in rail ridership – and consequently in train ticket revenues –, due in part to the same frequency increase, in part to an intensification of land uses around the stations of the rail network. Stedenbaan adopts a dual strategy, resting on the assumption that transport and spatial development can stimulate each other (Balz & Schrijnen, 2009). Stedenbaan is promoted by the South Wing Administrative Platform (a coalition of political representatives of the five involved city regions, the province of South Holland and the cities of Rotterdam and The Hague), which in 2005 requested a spatial survey of the catchment areas (defined by a radius of cycling accessibility of 1,200 m) of 47 existing and potential rail stations. The areas were analyzed in terms of feasible developments, degree of access by public transport and by car, mix of uses and local density of inhabitants and jobs (figure 5); on the basis of these characteristics, they were matched to one – or more – of nine "Stedenbaan typologies", representing potential developments around the station (figure 6). Finally, three (densification, network, sustainability) scenarios (figure 7) were used to assess how the potentialities of the local areas could be exploited to achieve the goals set at the South Wing level (Atelier Zuidvleugel, 2007).

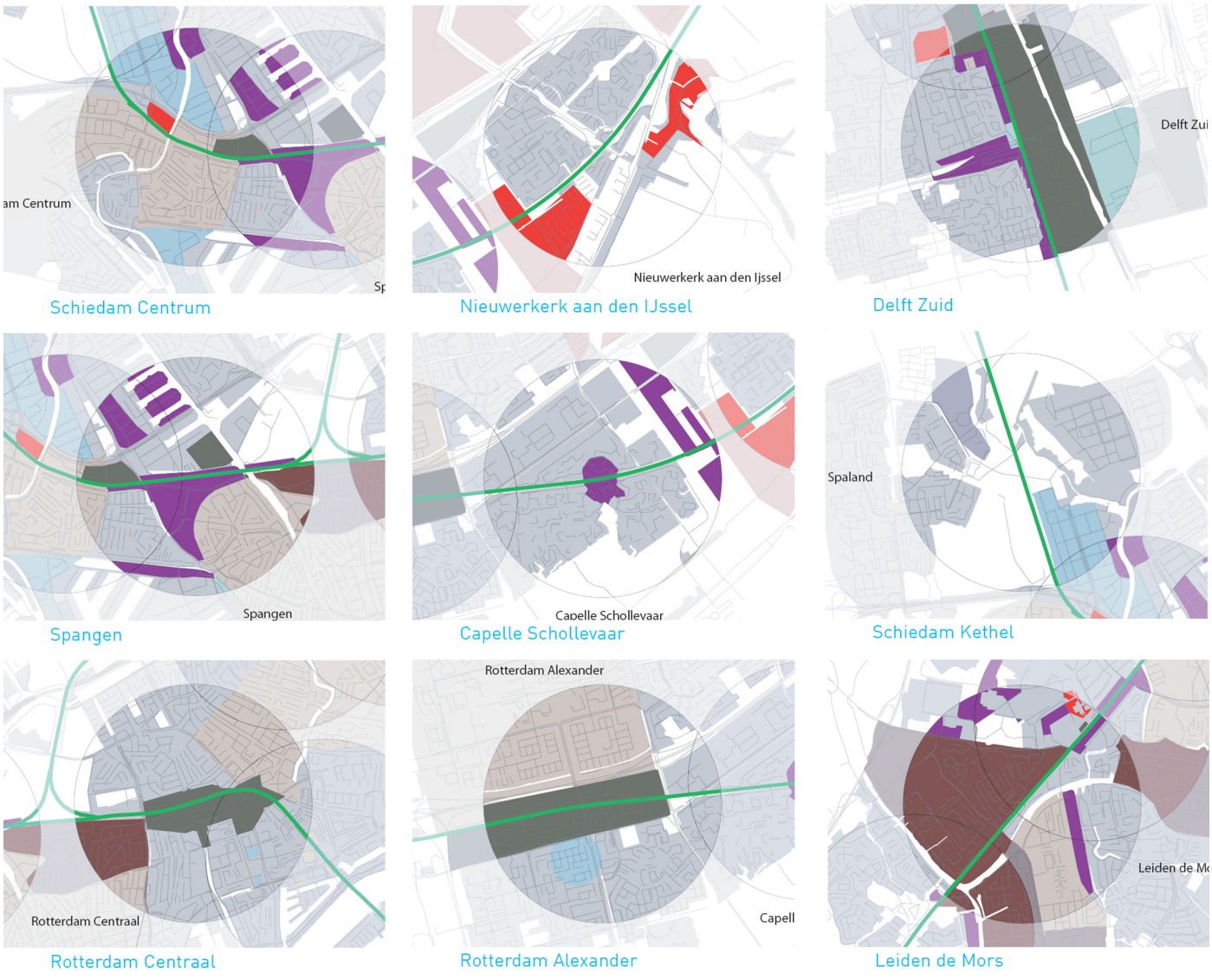

Figure 5 – The catchment areas of a few Stedenbaan stations.

The results of this survey, published in 2006, demonstrated the benefits of the regional coordination of local developments, and allowed a number of agreements to be signed to make the Stedenbaan project operational. A declaration of the intention to realize up to 40,000 new dwellings (corresponding to 40% of the newly added dwellings foreseen for the period 2010-2020 in the South Wing) and 1,000,000 square metres of office space was adopted by the city regions; another declaration of intent to increase frequency of service on the rail network was signed by the national rail company NS. Moreover, a negotiation was launched between the local municipalities to assign (quantitative and qualitative) development profiles to the local station areas – to be translated into the formal spatial land use plans of the cities –, according not only to local market demand but also and above all to the regional strategy. In the period 2006-2010, 45% of the new dwellings in the South Wing was actually built near Stedenbaan stations. In 2011 the project has been expanded to StedenbaanPlus, having a new ambitious urban development goal: 60 to 80% of all newly added dwellings in the period 2010-2020 are to be built within the catchment area of the rail stations (Geurs, Maat, Rietveld & De Visser, 2012).

A similar mechanism has recently been proposed by some French local authorities: the so-called contrat d'axe ("corridor contract") (Cabiron, 2013). The transport authorities of the metropolitan areas of Toulouse and Grenoble were the first to define the concept of contrat d'axe in 2007: they planned to develop new high capacity transport lines for suburban areas, and introduced the contrat d'axe to guarantee the socio-economic pertinence of their public investment by making public transport development conditional on increased urban density in the areas of future provision. The mechanism comprises a period of consultation and studies on infrastructure design, transport services and urban strategies near the line (500 m), a period of scenario development and selection, and finally the signature of a joint agreement between

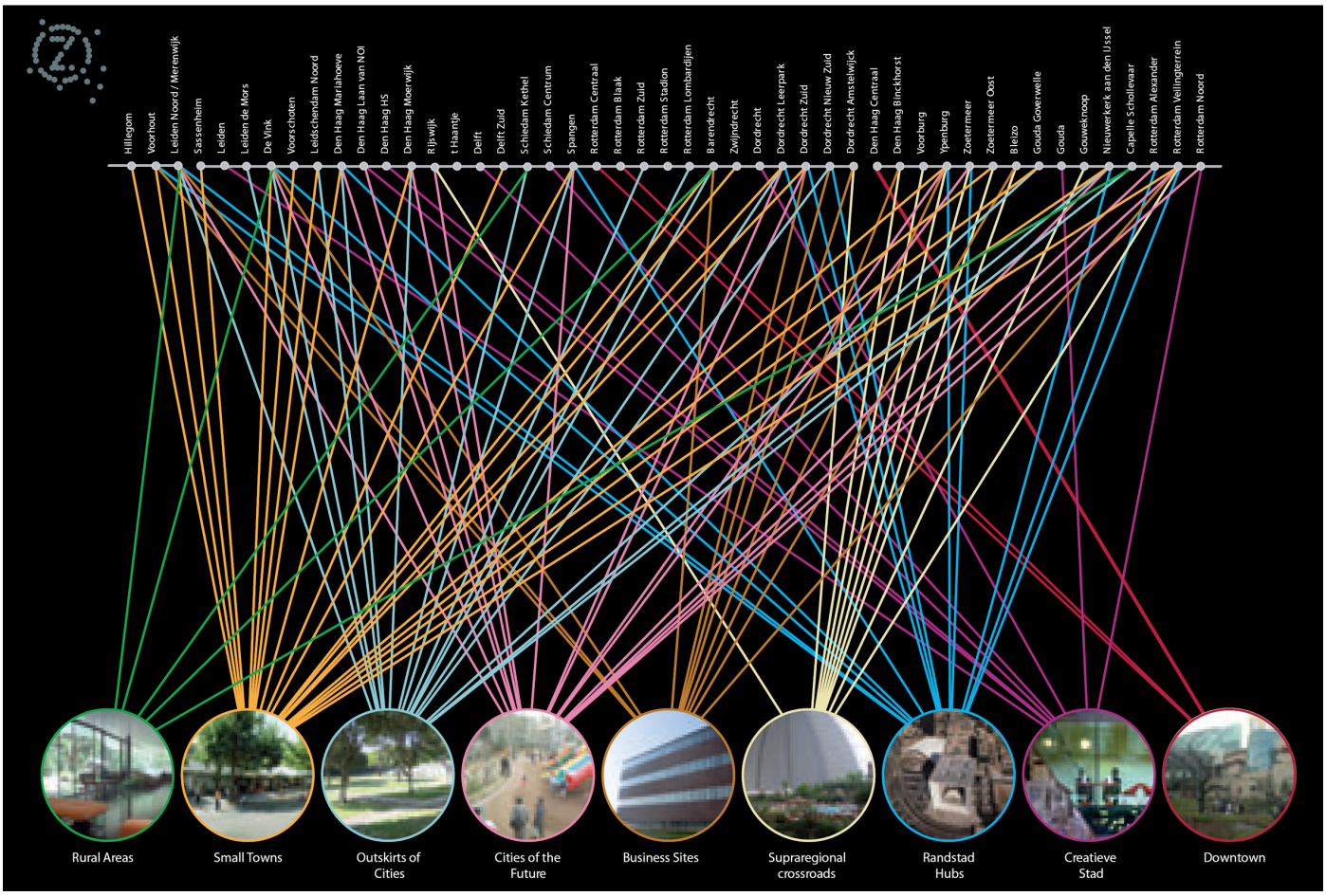

Figure 6 – The nine Stedenbaan typologies of stations.

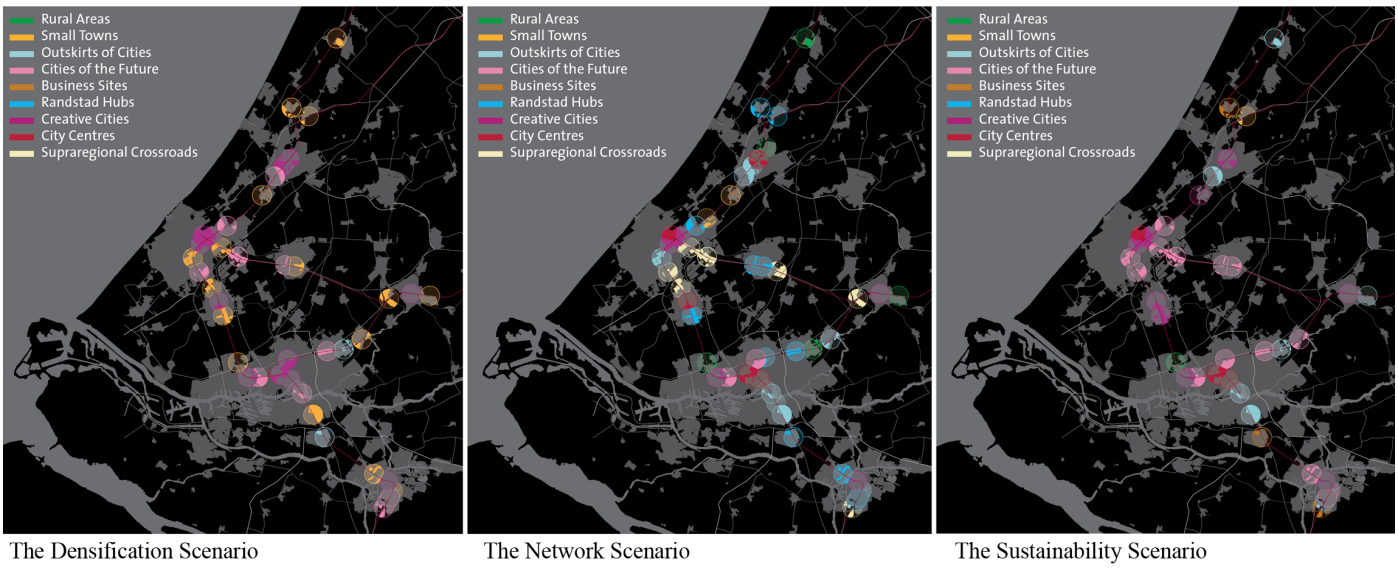

Figure 7 – The three assessment scenarios used in the Stedenbaan project.

the transport authority – undertaking to improve transport service – and local planning authorities (municipalities and inter-municipal bodies) – undertaking to promote urban density around stations. Contrats d'axe were then developed for regional rail transport in the French regions of Aquitaine, Languedoc and Provence-Alpes-Côte d'Azur (Maulat & Krauss, 2014).

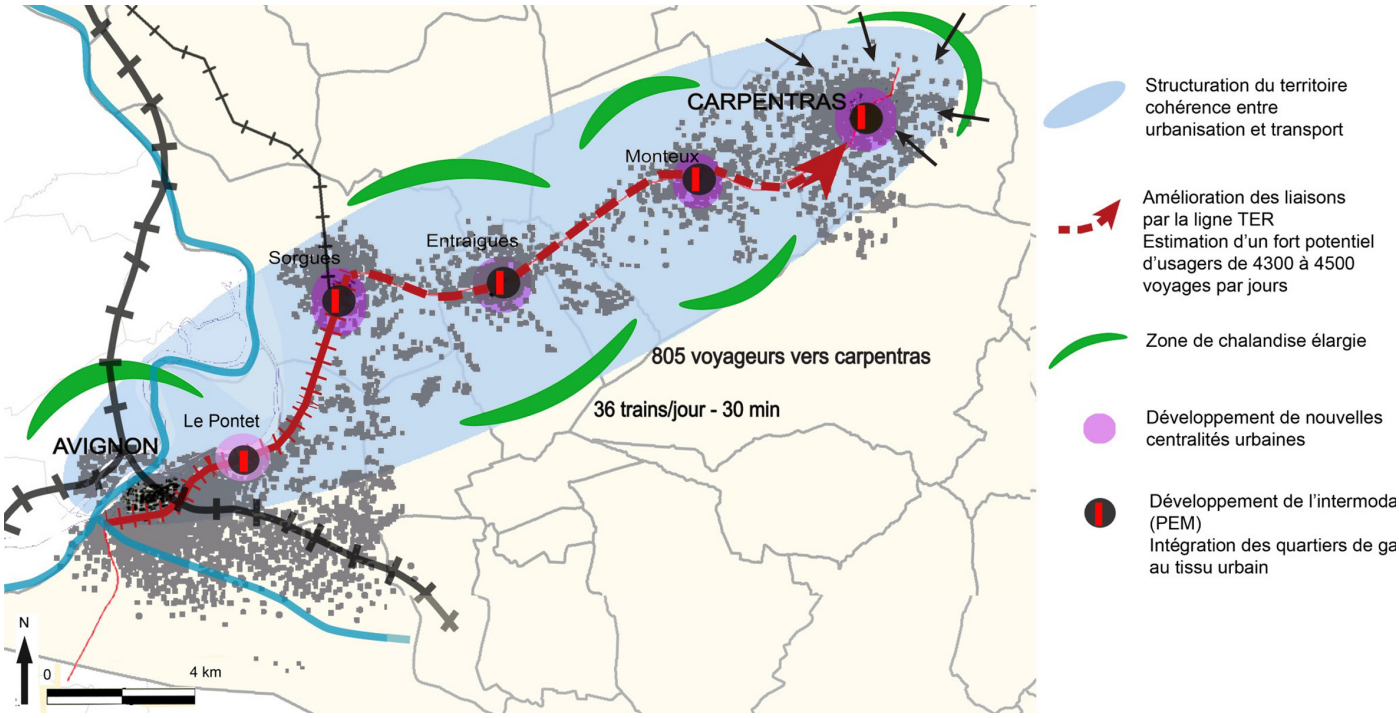

Figure 8 – The contrat d'axe Vauclusien between Avignone and Carpentras

3. Promoting TOD in Italian PTCPs

TOD approach is recently becoming subject of increasing interest not only in European Northern countries (where there is a strong tradition of integration and coordination between land use and transport planning), but also in Mediterranean countries like France (as the example of contrats d'axe shows), Spain (Zonneveld & Ortuño Padilla, 2012), Greece (Milakis & Vafeiadis, 2014). What about Italy? Were the above mentioned MRS rationalization processes in Italian cities supported by a coherent TOD-like planning approach?

As we said, TOD needs to be promoted at two administrative and institutional levels. In Italy, the local level can be identified in the municipalities, which can influence density, diversity and design in the areas through their PRG ("piano regolatore generale", physical development plan). The regional level can instead be identified in the NUTS 3 level, because MRSs generally operate at this scale; in Italy, this level corresponds to Provinces, which have the task of elaborating the PTCP ("piano territoriale di coordinamento provinciale", provincial coordination territorial plan). Through this plan, the Province can establish parameters and standards that municipalities have to respect in their PRG (for example, in terms of maximum new residential volumes that PRGs can permit) and define the localization of functions and activities which have a metropolitan or provincial scale.

In the next sections, the PTCPs of nine Italian Provinces (table 1) will be analyzed, in order to examine if and how they promote a settlement model that can support the MRSs which are present in their territory[2]. The selected PTCPs will be examined in terms of:

- settlement model that is promoted;
- role that is assigned to the MRS;
- rules and recommendations concerning new residential developments;
- rules and recommendations concerning the localization of manufacturing activities and metropolitan tertiary functions.

Table 1 – The nine selected PTCPs

Province	*Date of adoption or approval*
Turin	Approved in July 2011
Milan	Approved in December 2013
Genoa	Approved in January 2002
Venice	Approved in December 2010
Bologna	Approved in March 2004
Florence	Approved in January 2013
Rome	Approved in January 2010
Naples	Approved in October 2008
Bari	Provisional draft adopted in May 2007

2. The nine Provinces that have been selected are the Provinces that, since January 1st 2015, have been replaced by the so-called "Metropolitan Cities", according to the national Law 56/2014. They are the Provinces where the presence of a metropolitan area has been recognized by the State. The tenth Metropolitan City, Reggio Calabria, has not been selected because it has neither a MRS nor a PTCP. There are five other Provinces where the presence of a metropolitan area has been recognized by the Regions, but four of them (Cagliari, Catania, Messina, Trieste) do not have a MRS; Palermo has a 3-lines MRS, but it does not have an approved PTCP (if not for a provisional draft, that anyway does not assign any relevant role to the MRS).

3.1. The proposed settlement model

All the examined PTCPs explicitly assume that urban sprawl cannot be further promoted, for its environmental impacts (mainly soil consumption) and its consequences on car-depending mobility patterns. Nevertheless, what differs is the emphasis that plans place on the alternative settlement models to promote.

In the cases of Turin, Genoa and Venice, attention is mainly focused on containing soil consumption; this aim is supposed to be pursued restraining urban expansion and fragmentation, and prioritizing infill of empty or abandoned lots in consolidated urban areas. However, polycentrism is not postulated as an explicit objective (the hierarchic role of the centres is not defined, the interactions between the centres are not analyzed, etc.).

Bari's PTCP includes the containment of soil consumption and the enhancement of the provincial urban polycentrism as two of its six strategic lines.

In the other examined plans, polycentrism is directly identified as the settlement model to be pursued, even if in relation to slightly different reasons and objectives. In Milan, Florence and Rome a polycentric structure is recognized as already permeating the provincial territory (although in attenuation because of urban sprawl processes) and representing a strong local identity factor: the key purpose is to maintain and strengthen this structure and the specific characteristics of its centres. In these plans, the containment of soil consumption is declared as a secondary objective, just because it helps to support polycentrism.

The PTCP of Naples promotes polycentrism to balance the excessive concentration and polarization on the central city. The plan proposes a redistribution of activities and services on a limited number of suburban emerging or consolidated centres, according to their main specialization. Fulfilling this system of centres should also represent an attempt to control and influence the mobility demand generation.

Lastly, in the case of Bologna polycentrism is seen as the reference model mainly for its consequences on the mobility patterns: it is considered as the settlement structure that is more suitable to foster the use of public transport rather than private motorized transport means. Also the containment of soil consumption is put as an objective to support a more sustainable mobility demand.

3.2. The role assigned to the MRSs

The role that PTCPs assign to MRSs varies from plan to plan in terms of emphasis and importance, but it seems possible to recognise a fundamental difference which depends on the assumed settlement model. In those plans where attention is addressed mainly on containing soil consumption, the role of MRSs is associated above all to the densification processes that should be promoted by local municipal plans around stations. If a polycentric model is explicitly proposed instead, the focus on the MRS is not limited to its nodes but also and especially to its structure, which should take a network – rather than a radiocentric – shape in order to support a balanced development of all its centres.

Modest attention to the prospective role of MRSs is given in the three PTCPs of Florence, Genoa (except for the reuse of abandoned rail areas near the stations) and Bari.

The PTCPs of Turin and Venice, which have the containment of soil consumption as the fist objective, identify the stations of the MRS as barycentres of areas where processes of residential (in the case of Turin) or tertiary (in Venice) densification should be launched in opposition to sprawl.

In the PTCPs of Milan, Rome and Naples, which on the contrary emphasize more the polycentric model, the focus is mainly on the MRS structure. They fear the risk that a radiocentric railway structure could increase exaggeratedly the accessibility of the central city to the detriment of the balance of the overall polycentric system; on the other hand, this kind of structure could turn out to be inadequate to serve the tangential trips between municipalities of the first and second suburban rings. For this reason, these PTCPs give significant attention to ring and tangential connections, both through rail (in Naples and Rome) or street buses (in Milan).

Bologna's PTCP tries to combine the two above-mentioned approaches, in order to promote through polycentrism a more sustainable mobility. On the one hand, it is the only plan that systematically examines the areas around the MRS stations (within a radius of 600 m) to verify what development they could accommodate and what is their waking and cycling accessibility; on the basis of the results of this analysis, the plan assigns to local municipal plans the objective of densifying these areas for increasing the potential ridership of the MRS. On the other hand, the PTCP assumes the MRS as the key element to reorganize the suburban public transport lines on road, with the aim to effectively serve not only the trips toward the central city, but also the tangential ones.

3.3. Rules and recommendations for new residential developments

All the examined PTCP pursue their objectives of soil consumption containment and/or polycentric development through a strategy of urban infill and densification. Their strategic recommendations and their technical implementation rules often ask municipalities to demarcate through a line the urban areas from the rural contexts, and to concentrate new residential developments in empty or abandoned lots that are enclosed or contiguous to these urban areas. However, only few plans assume proximity and accessibility to MRS stations as conditions that restrict, more or less

strictly, the possibility and quantity of new residential developments.

Turin's PTCP determines that municipalities which are on hills or near the mountains and have "a significant accessibility to the MRS" can increase of 2.5% the maximum new residential volumes that their physical development plans can propose (and these volumes can be built only within or in continuity to consolidated urban areas). But this generic "significant accessibility" is operationally defined as a distance from the station that should not exceed 10 kilometres: therefore this approach is quite different from the usual TOD strategy, and its positive impact on the ridership of MRS can be questioned.

In Naples, new residential volumes should be built within or in contiguity to consolidated urban areas, "preferably" near existing or planned public transport stations; this nearness is not operationally defined by the PTCP. Rome's PTCP proposes generic incentives to new residential developments in urban centres that are served by MRS.

Only in the case of Bologna the implementation rules of the PTCP are operationally specified in a way that is in line with a TOD approach. These rules require municipal physical development plans to commensurate the permitted new residential volumes to two parameters: the presence of a MRS station in the municipality, and the range of local services (nursery and primary schools, food stores, banks, health and welfare facilities etc.). Only those municipalities that have a station and a complete range of these services do not have to define a maximum limit to the permitted new residential volumes. In the municipalities that lack a station or a certain number of services, these volumes cannot exceed 70% of the volumes built in the previous ten years. This threshold is reduced to 50% for those municipalities that lack both a station and a complete range of services. In any case, the PTCP determinates that the new residential volumes must be built "only within walking accessibility to the station", if there are void or abandoned lots; if the area around the station is saturated, or if the municipality lacks a station, the volumes must anyway be realized on brownfield sites, and not on greenfield ones, as a matter of priority.

3.4. Rules and recommendations for the localization of manufacturing and tertiary activities

As regards the localization of new manufacturing activities, the examined PTCPs generally prioritize brownfield rather than greenfield sites. The accessibility of these sites is defined in the PTCPs as a key factor that municipal plans must consider in choosing this localization, but accessibility is mainly declined in relation to road transport (e.g. proximity to a motorway junction), as this mode is dominant for goods in Italy. Rail accessibility (for example in terms of proximity – or connection through shuttle vehicles, as hypothesized in Naples – to an intermodal freight terminal) is defined as a "further" – but not essential – positive factor. Only in Milan's PTCP the technical implementation rules require that new manufacturing activities must benefit of adequate accessibility conditions with particular reference to rail infrastructures.

With respect to metropolitan tertiary activities (hospitals, universities, multiplexes, convention halls, exhibition centres, sport facilities, business districts and so on), most PTCPs adopt a decentralization strategy. This strategy aims not only to relieve the pressure on the central city, where historically most of these services tended to concentrate, but also to give real substance to polycentrism and bring some tertiary functions closer to the inhabitants of the so-called sprawled city. Some PTCPs simply provide strategic recommendations and guidelines for the localization of these activities, but let the municipalities (possibly in coordination with the Province) to identify the precise sites for them; in other cases it is the same PTCP that chooses the localization of metropolitan and provincial tertiary functions.

In this decentralization strategy, accessibility is assumed by PTCPs as a decisive factor to be considered in locating tertiary activities; but this is true for accessibility in general, only rarely rail accessibility (in terms of proximity to a MRS station) is defined as crucial.

Three approaches to the localization of metropolitan tertiary activities can be synthetically identified in the examined PTCPs:

- the plan does not provide any standards or parameters in term of accessibility. It is the case of Genoa's PTCP;
- the plan requires good levels of accessibility. For example, it is the case of the PTCP of Turin, even if it does not operationally define these "good levels" and does not specify if this accessibility concerns private or public transport; the plan envisions transport interchange hubs as "inter-municipality service centres" so to make them more attractive, but it does not bind the localization of metropolitan tertiary activities to the proximity to these hubs. Milan's PTCP articulates the levels of accessibility by rail for different kinds of tertiary functions: regional functions should be located within walking accessibility from a regional rail station, metropolitan functions within walking distance from a MRS station. In Rome, the plan identifies 20 metropolitan centres where services of excellence should be concentrated: almost all of them are near a motorway junction, some of them are "also" near a rail station;
- the plan explicitly requires good levels of accessibility by public transport. In the case of Venice, new metropolitan tertiary activities should not be distant more than 500 m from metropolitan rail stations or 250 m from other public transport stops in urban areas, while in suburban and rural

areas proximity is required to motorway junction. The PTCP of Florence defines accessibility by public transport as a key localization factor for tertiary activities, but it does not define this accessibility operationally. According to the rules of the PTCPs of Bologna, new clusters of tertiary functions should be located near the junctions of the national or regional motorway network, but a connection to a rail station is judged as necessary.

Among tertiary functions, retail activities deserve a separate analysis, in particular with reference to big shopping centres. Most PTCPs do not consider accessibility by rail as a factor to be taken into account for their localization (Milan's PTCP defines this accessibility as "not significant"). The PTCP of Rome advises against locating these centres near motorway junctions. The PTCP of Naples requires giving priority to localizations near existing or planned rail stations. In Bologna, the PTCP locates retail/entertainment integrated parks in sites near motorway junctions, selecting those offering also the "possibility" of a connection by shuttle to a rail station; medium and large-sized shopping centres should be preferably localized within walking accessibility to a MRS station. Moreover, the plan identifies 10 rail stations which are labelled as "strategic for retail activities", and proposes to insert small and medium retail stores in these stations, in order to make them more attractive.

4. Discussion

Despite integration and coordination between land use planning and transport planning is a recurrent feature in urban planning discourse, the gap between this discourse and reality remains substantial (Marshall & Banister, 2007, Desjardins, Maulat & Sykes, 2014). This is true also for TOD: notwithstanding many success cases all over the world, both formal and informal context-specific barriers impede a simple 'copy and paste' transferral of lessons learnt elsewhere (Tan, Bertolini & Janssen-Jansen, 2014).

The analysis in this paper shows that most Italian "metropolitan" PTCPs set objectives concerning more sustainable mobility patterns, polycentric development, containment of soil consumption etc. in their discourses, but they do not have exploited the rationalization and enhancement of MRSs as an opportunity to structure territorial policies consistent with these objectives. TOD approach is sometimes referred in these plans in general terms, but it is not systematically applied; accessibility to MRS stations is often identified as a relevant localization factor, but it is almost never operationally defined (and when it is, the maximum acceptable distances from the stations are set so high to make the impact on modal share quite questionable). Furthermore, in locating metropolitan tertiary functions, PTCPs often prefer accessibility by road rather than by rail.

It could be supposed that institutional, cultural or regulatory barriers prevent an effective transferral of TOD approaches to the Italian context, at least for the metropolitan level. Is the Province, which – by the way – has no responsibilities in the rail sector, the appropriate institution to coordinate TOD policy for MRSs[3]? Is perhaps the PTCP a too formalized and rigid planning tool for TOD, and negotiated and contractual procedures (like the ones adopted in the Stedenbaan project and in the French contrats d'axe) are more effective in overcoming the separation of power between planning and rail transport authorities, and between vertical scales of governance?

The case of Bologna's PTCP demonstrates that the answers to these two questions are negative. In contrast with the other eight examined PTCPs, this plan adopts a TOD approach systematically: it spatially analyzes the areas around all the MRS stations, provides municipalities with inputs to increase the 3D in these areas, and structures the metropolitan polycentric settlement on the MRS stations. The outcomes of this policy are relevant: between 2004 (when the MRS was launched and the PTCP approved) and 2010, ridership on the metropolitan trains increased by 48%; 63% of the MRS passengers live within 10 minutes from a station; most new residential volumes have been built in municipalities having a MRS station and in lots that are near this station (Nigro & Donato, 2013). The main feature that differentiates Bologna's PTCP from the other examined plans is the general strategic aim: sustainability of mobility patterns and polycentric development are assumed as two objectives that are not "parallel", but strictly integrated and mutually supporting, and TOD is identified as the approach that allows to put this integration into effect.

According to the Italian Law 56/2015, the new "Metropolitan City" institutions, that have substituted the examined Provinces since January 1st 2015, have the task to elaborate the Metropolitan General Territorial Plan. This plan should cover the same features that PTCPs already deal with, but also further issues, like the "metropolitan mobility" (and not only the private and public road transports at the provincial level, that were assigned to PTCPs). As a consequence, new opportunities for the integration and coordination of rail transport and land use planning emerge: the experiences of the Stedenbaan project, the French contrats d'axe and above all Bologna's PTCP can offer significant inputs to these new plans to promote MRS ridership and polycentric development through a TOD approach.

3. For example, in the case of Naples (where the railway system has a regional – more than a metropolitan – dimension), it was the Region to launch a programme for improving the design of stations and redeveloping the surrounding areas (Cascetta & Pagliara, 2009), even if the adopted approach was less comprehensive than TOD.

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Methodology for the development of electrical vehicle charging infrastructure. Case study: Brescia

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Keywords: PNire, charging infrastructure, electrical mobility.

Abstract

The topic of electrical mobility, whether it refers to private or public transport, has taken on increasing importance in recent years, in part due to the issuing of national and international lows aiming at reducing the emission of pollutants into the atmosphere. In fact, electric motors can increase road vehicle energy efficiency and contribute to the reduction of transport CO2 emissions (at a local level), leading to advantages in terms of improving air quality and reducing noise pollution in urban areas. Possible restraints on the uptake of electric vehicles may be the lack of charging infrastructures, insufficient local product positioning and the lack of standardisation on an international level.

In order to resolve this problem, several European Union member states have issued Charging Infrastructure implementation plans. Italy recently published its 'National Infrastructure Plan for Charging Vehicles fed by Electricity' (PNire – Official Journal no. 280 of 02/12/2014), which are defined as the guidelines for guaranteeing the united development of electric vehicle charging services in Italy. Arising from this plan is the need, on the part of municipal administrations, to come up with implementation plans for charging infrastructure to be included as part of the Urban Plans for Sustainable Mobility. Therefore, objectives are set to look into how careful, integrated urban and transport planning can lead to the effective and efficient distribution of charging infrastructures in Italy. To this end, a methodology has been formulated for the planning and localisation of electric vehicle charging infrastructures at a municipal level and it has been adjusted and validated in application to the city of Brescia, considered of interest due to it being representative of a medium-sized urban area. This methodology, which can be applied rapidly, envisages the selection of certain indicators, which form the basis, after the assignation of relative weights, for a map of charging demand. Comparison of the areas identified as "high demand" with the potential supply of charging infrastructures highlights the areas excluded from the possible infrastructure coverage area, thus allowing finely detailed analysis to be carried out only where strictly necessary, resulting in savings in terms of time and money.

1. National Infrastructure Plan for Charging Vehicles fed by Electricity (O.J. 02-12-2014 General series – no. 280)

A ministerial decree, signed by the Minister of Transport and Infrastructure in July 2014[1], modified the 'National Infrastructure Plan for Charging Vehicles fed by Electricity' (PNire) introduced by Article 17.7 of the Italian Law of 7 August 2012, no. 134 (O.J. General Series no. 280 of 02-12-2014).

The PNire divides the charging infrastructure development period into two main phases, which, with annual Plan updating, lead to an established policy for electrical mobility with a time frame of 2020.

The first phase of "Outlining and Development", with the time frame 2013 – 2016, is intended as a preparatory phase that lays down the foundations for the introduction of a minimum number of electric vehicles, thanks in part to a basic infrastructure that guarantees movement within the city and commuter transfers involving metropolitan areas on a national scale. This phase identifies the criteria and strands to develop a national network of electric charging[2], reference models, minimum standard characteristics of the components of the charging process and electrical mobility development incentivisation policies. Three classes of charging infrastructure are identified based on the energy supply capacity:

- normal power: "*Slow*" charge up to 3.7 kW;
- medium power: "*Quick*" charge from 3.7 kW fino a 22 kW;
- high power: "*Fast*" charge over 22 kW.

As part of the process of creating infrastructures for each

1. Source: http://www.mauriziolupi.it/

2. The PNire gives priority to the short-term implementation of infrastructures in urban and metropolitan areas (1-2 years), followed by attention being broadened to extra-urban and motorway areas in the long-term (3-5 years). According to the PNire, the introduction of infrastructures to urban and metropolitan areas must maintain an intended suitable ratio (set at 1 to 8) between the number of public charging infrastructures available to all and the total number of charging infrastructures. In order to minimize the impact on land use, each charging infrastructure must allow the simultaneous charging of two vehicles. The introduction of infrastructures to any certain area must take into consideration the existing electric car pool and the medium-term predicted purchases.

reference area (Municipality, Metropolitan Area, Province or Region), consideration must be taken of the features, such as population, population density, surface area, active population, road taxes, percentage of electric vehicles within a certain time frame, levels of CO_2 and PM10 emissions in the area in question.

The second phase of "Consolidation", with the time frame 2017 – 2020, includes the period in which common regulations will be issued and shared among Member States, in accordance with vehicle manufacturers and standardisation organisations. These regulations must be identified within a brief period of time, in order to give the car manufacturers the necessary time to put them into effect as part of their vehicle development programmes and adapt the charging infrastructures. During this phase, the charging infrastructure network must be completed so as to cover all of the Italian national territory and allow the large-scale distribution of electric vehicles.

The plan, specifying that any choices must respect urban demands and limitations, envisages three intermediate objectives for the introduction of infrastructures in Italy:

- objective 2016: 90,000 public charging stations;
- objective 2018: 110,000 public charging stations;
- objective 2020: 130,000 public charging stations.

The PNire provides the following outlines concerning the charging methods[3]:

- Method 1: "Slow" [4] charge with alternated current from a non-specialized plug. This method uses a *standard* household or industrial plug, the cord is not fixed to either the car or the socket, there are no residual-current devices on the cord and charge does not exceed 16A and single-phase 250V or three-phase 480V;
- Method 2: "Slow" charge with alternated current from a non-specialized plug with cord connected to a residual-current device. This method uses a *standard* household or industrial plug, the cord is not fixed to either the car or the socket, the cord used to connect the vehicle to the socket has a residual-current circuit breaker and charge does not exceed 32A and single-phase 250V or three-phase 480V;
- Method 3: "Slow" or "Quick" charge with alternated current using a designated charging station. This method uses a charging station with a specialized socket, the cord is not fixed to either the car or the socket, the control and protection features are permanently installed in the charging station, communication passes from car to charging station and it is "faster" than Methods 1 and 2;
- Method 4: "Fast"[5] charge with direct current using a designated charging station with external charger. This method uses a charging station that converts alternated current to direct current, the cord is permanently fixed to the charging station, communication passes from car to charging statin and it is "faster" than the three previous methods.
  For this charging method, there are two sub-methods:
  - DC *level* 1 (up to 500V and 80A, power 40 kW);
  - DC *level* 2 (up to 500V and 200A, power 100 kW).

The PNire provides the following outlines concerning development policies:

- integration within Mobility and Logistics Plans: in every municipal and regional Logistics and Mobility plan, a section devoted to electrical mobility should be included. This section should contain a local charging infrastructure installation plan, focusing on car parking plans and any additional services (such as car-sharing), technical characteristics and localisation principles for public and private charging infrastructures.
- policies related to the Italian Traffic Code: as well as the installation of charging stations, there should also be a clear no-parking rule for the area around the stations for anyone not intending to charge their vehicle. Regulations should also be included relative to the sharing of electrical mobility friendly bus lanes and limited traffic lanes.
- Urban Planning revision (incentives and obligations): incentives should be provided for the creation of integrated programmes in promotion of the technological adaptation of existing buildings. Fundamental elements for the creation of such programmes include the simplification of building activities (building plans for approval new constructions with a surface area of more than 500 square metres must include the installation of electrical charging infrastructures for charging vehicles from every covered and open parking space and from every garage), the right of access to a charging station and city planning regulations (infrastructures intended for use as electric vehicle charging stations constitute primary urbanisation works that can be carried out in the whole municipal area); regional laws establish the content, methods and deadlines in order to adapt the tools for general city planning and municipal and extra-municipal territory planning with the provision of a minimum standard of equipment for public electric vehicle charging systems, consistent with the National Plan. Regional laws envisage the adaptation of city planning tools with the provision of a minimum standard of equipment for electric vehicle charging systems for collective use in support of newly-established commercial, tertiary and production activities.
- research and development;
- electric/hybrid vehicle purchasing incentives;
- involvement by end users.

3. In Italy, charging methods 1 and 2 are not allowed in public areas or private areas with public access.

4. Approximately eight hours for a medium-sized car.

5. A maximum of one hour for a medium-sized car.

2. Methodology proposal for electric vehicle charging infrastructure localisation

The proposed methodology for the optimal localisation (and quantification) in urban areas of public (or accessible to the public) charging infrastructures is consistent with the National Infrastructure Plan for Charging Vehicles fed by Electricity described above.

The National Plan establishes that "*urban and metropolitan areas take priority, in the short-term, for the implementation of charging infrastructure*" and identifies the Urban Plans for Sustainable Mobility (PUMS) as possible references for the planning of electrical mobility in urban environments[6], more specifically for infrastructure installation plans containing the charging station localisation principles. These installation plans should contain local social analysis (including population density and characteristics of the area of intended installation) and analysis of the mobility of the area of interest, with possible detail of traffic flows that influence the final choice of infrastructure localisation, a geographical and referenced representation of existing and project coverage areas and the characteristics of the intended charging infrastructure to be installed. From here, it is essential to make proposals for planning starting points, in order to allocate correctly the available resources in the region of interest, via a "rapid" localisation methodology.

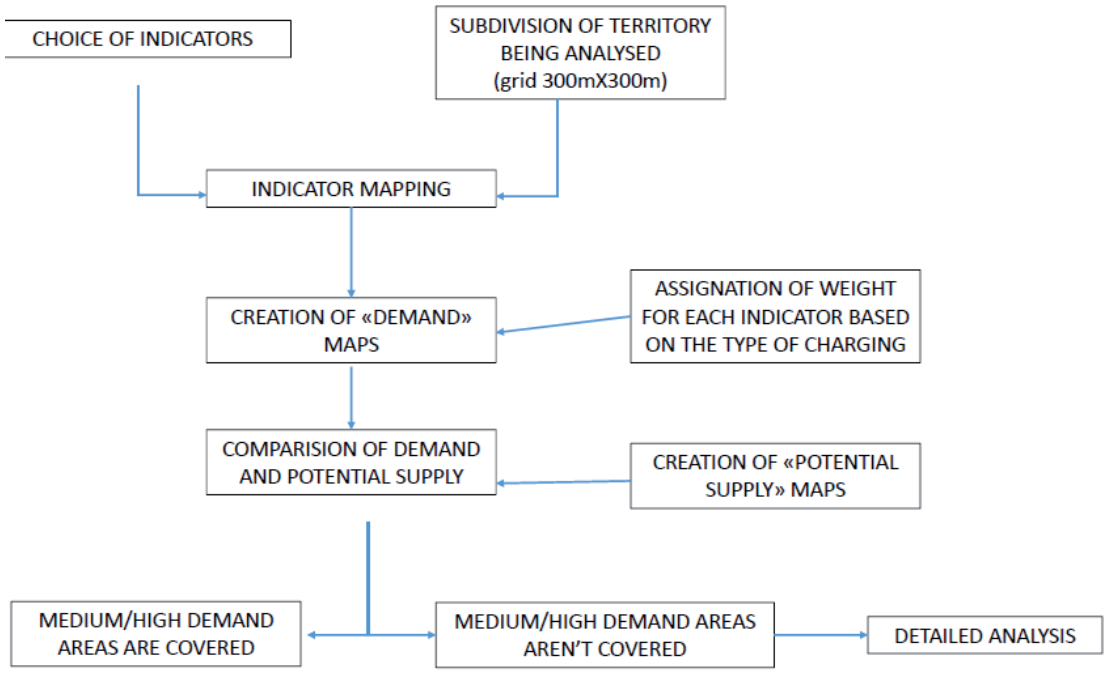

Figure 1 – Methodology for the localisation of charging infrastructure.

The National Plan also underlines the necessity to adopt a minimum equipment standard for electric vehicle recharging systems for collective use in support of newly-established commercial, tertiary and production activities. For this reason, a calculation matrix is created of the number of stalls necessary for the different types of service/hub that attract "Quick" charge traffic.

The methodology propose by municipal bodies in support of the draft Installation Plan for electric vehicle charging infrastructure, introduced in the National Plan, consists of a few systematic stages valid for every regional body, that can be adapted via the numerical parameters and specific features of the place being analysed.

The methodology is set out as follows:

a) Selection of indicators to be analysed: first of all, it is essential to select the indicators to be taken into consideration in support of the localisation choices and demand analysis. For example, the services included in the PGT (Regional Government Plan) Services Plan (including sports services, educational services, administrative services, religious services, public green areas, etc.), the main hubs that attract traffic (large and medium commercial buildings, centres of cultural attraction, restaurants and bars, etc.), public transport (railway, metro, tram, bus, bike-sharing and car-sharing stations, etc.), building car parks and modal interchange car parks, the resident population, operators, traffic flows and the functional classification of the roads etc.

b) Subdivision of the territory under examination: in order to proceed with the analysis, the territory must be divided up using a regular grid method. The recommended grid square size is that similar to pedestrian movement (300

6. The National Plan recommends that the Regional Plans follow the indications reported in the same National Plan, and that the guidelines of the Regional Plans be referenced in the Municipal Plans, in order to guarantee coordinated and integrated development.

metres x 300 metres), so as to take into consideration the sphere of influence of movement of a weak user, that is to say, movement not exceeding five minutes in duration.

c) Indicator mapping: once it has been established which indicators are to be analysed, based on the specific features of the territory under examination and on the availability of the georeferenced data, these indicators must be mapped out on the established grid. In this way, a series of thematic maps representing the territorial distribution of the various indicators are created.

d) Indicator weight attribution: a matrix must be prepared for each type of charging ("Slow", Quick", "Fast"), in which a weight is attributed in relation to the demand for charging, for every indicator evaluated. Services that involve a medium-short stay, for example, will carry a heavier weight for "Quick" charging, whilst the presence of a high number of operators or a high population density will carry a high weight for "Slow" charging.

e) Creation of demand maps: the sum of the weights for each grid cell for each type of charging allows the creation of thematic maps showing demand and urban use of the cell itself. The total given by the sum of the weights has to be subdivided into intervals in order to identify the areas of "No", "Low", "Medium" and "High" demand.

f) Choice of possible localisation areas (mapping of potential supply): as far as "Slow" charging is concerned, optimal localisation will be in private properties and shared apartment block yards. Just a small proportion will be on public ground or in building car parks, in particular for areas of high demand with a lack of private space available. As far as concerns "Quick" and "Fast" charging, optimal localisation is in building car parks, in commercial building parking areas, in petrol stations and in modal interchange car parks, etc. Thus, it is possible to identify the cells in a municipal area that include at least one optimal place of localisation and map their areas of pedestrian influence.

g) Comparison with areas of high demand: superimposing the potential supply map for infrastructure localisation with the theoretical demand map enables the rapid verification of territory coverage and the identification of "critical" areas.

h) Precise analysis of uncovered areas: once uncovered "critical" areas are identified, detailed analysis can be carried out precisely, instead of over the whole territory. For such areas, should it not be possible to identify (or create) possible infrastructure localisation sites, it may be necessary to go ahead with the relocation of existing services/attractions.

In order to define a minimum infrastructure equipment standard for "Quick[7]" charging electric vehicles, to be adopted in the City Planning, as required by the National Plan, reference is made to the guidelines of Victoria State, which propose the use of a double-entry matrix. This decision is based on the fact that it is unsuitable to establish an unequivocal standard that doesn't take into consideration the type of traffic-attracting service/hub and its location within the territory in question. A minimum standard of 2% of available stalls is estimated, corrected by a factor taken from the matrix. The matrix, represented by the table below, has an entry "from the left" that takes into consideration the type of traffic-attracting service/hub, which predicts the type of charging infrastructure, and an entry "from below" that takes into consideration the service/hub location within the intervals identified from the thematic demand maps described above.

3. Case study: the city of Brescia

The "rapid" infrastructure localisation method described earlier was applied (with the help of GIS software) to the case study of the city of Brescia, for which in-depth knowledge of the territory made calibration of the coefficients applied to each indicator a much easier task.

Table 1 – Matrix for defining a minimum standard of parking stalls devoted to electric vehicle charging. Matrix applicable to "Medium" type charging.

		Corrective factor		
Coefficient per traffic-attracting type of service/hub	High	1	1,5	2
	Medium	0	1	1,5
	Low	0	0	1
		Low	Medium	High
		Charging demand of the cell in consideration		

The Municipality was firstly subdivided into cells by superimposing a grid map with squares of 300m x 300m. This size

7. It is envisaged that a minimum standard will be indicated only for "Quick" charging, considered to be the most widespread type of charging in public areas. In fact, "Slow" charging will be localized mainly in private areas for the use of electric car owners and only a small proportion will be in public areas or private areas with public access. "Fast" charging, however, is considered too prohibitive in terms of installation costs to need a minimum installation standard and will instead be best localized within the territory based on the available resources.

Table 2 – Installation priority per type of traffic-attracting service/hub.
Source: Adapted from "Guidance on Land – use Planning for Electric Vehicle Parking and Charging – The Victorian Electric Vehicle Trial", September 2012.

Type of traffic-attracting service/hub		Installation priority (High, Medium, Low)
Health services	Doctor's surgery	Low
	Hospital/Clinic	High
	Instrumental Diagnostics Centre	Medium
	Local Health Authority services	Low
	Sports medicine centre	Medium
	Nursing Home/Rehab Centre	Low
Administrative services	Post Office	Medium
	Barracks/Headquarters (police)	Low
	Provincial Offices	Medium
	Municipal Offices	Medium
	Tribunal	Medium
	Prison	Low
	Municipal police and civil protection	Low
Educational services	Primary school	Low
	Nursery school	Low
	Middle school	Low
	High school	Medium
	University	High
Sports services	Sports field	High
	Gym	Medium
	Multi-purpose sports venue	Medium
	Swimming pool	High
	Sports centre	High
	Athletics field	Medium
Attractor hub	Shopping centre/large commercial building	High
	Restaurants and bars	Low
	Theatre	Medium
	Cinema/multiplex cinema	High

was chosen because it is considered to represent the area of influence of a possible charging infrastructure through pedestrian movement. Brescia ended up being divided into 1121 cells.

For localisation analysis of the charging infrastructure, the following indicators were considered: resident population of driving age, number of worker, educational services, administrative services, sports services, health services, large commercial buildings, bike-sharing stations, bus stops, metro stations, railway stations and petrol stations.

3.1 Indicator analysis

A thematic[8] map was built for every indicator, as described below.

• **Resident population of driving age.**

The figure for the resident population in the Municipality of Brescia is taken from 31-12-2013. Given that the parameters to be analysed had to be representative of the potential demand for electric vehicle recharging, it was decided to ex-

8. A common-base-year was not possible for all of the maps due to lack of availability. Therefore, it was chosen to use the most up-to-date data available.

clude people under 18 years of age, in so much as they are not of driving age, and those over 80 years of age, chosen as the upper age limit for driving. The resident population of driving age is mainly tied to the demand for "Slow" charging, typically carried out overnight using household sockets, for an average of eight hours.

The number of educational services is tied to the demand for "Quick" and "Slow" charging, typically carried out during staff working hours or student hours at the institution, for an average of between two and eight hours.

• **Administrative services.**

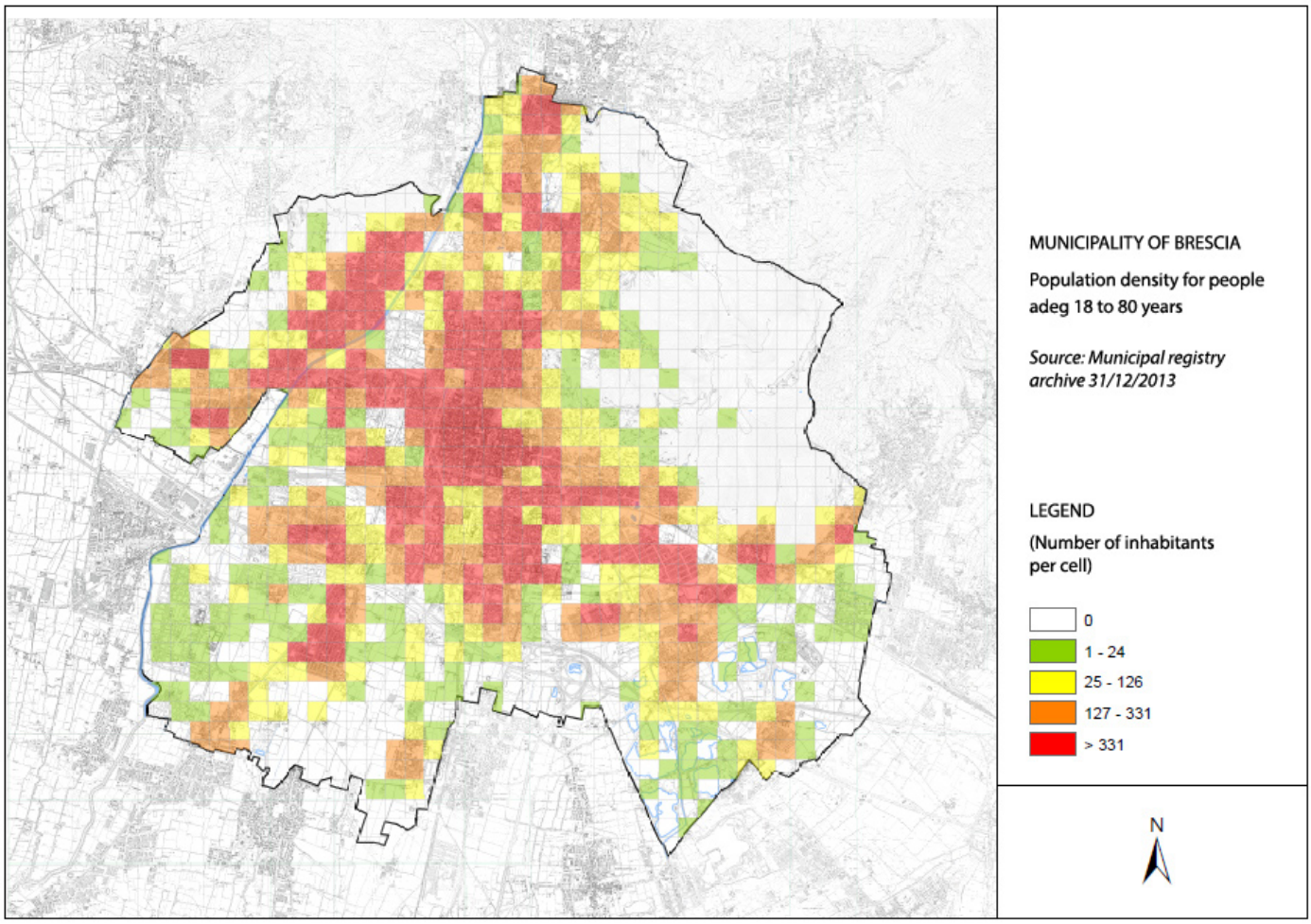

Figure 2 – Population density in the Municipality of Brescia.

• **Number of operators.**

The figure for the number of operators in the Municipality of Brescia is taken from the database of companies active in the territory as of 2011. The number of operators per cell has been subdivided into 5 intervals. From the thematic map, it can be deduced that the areas with the greatest operator density are the city centre, the northern area along the axis of via Triumplina, the "Bresciadue" area and the industrial area located in the southwest of the Municipality. The number of operators is tied to the demand for "Slow" charging, typically carried out during working hours in the workplace, for an average of eight hours.

• **Educational services.**

The figure for the number of educational services is taken from the Municipality of Brescia PGT Services Plan. Secondary level educational institutions and universities were taken into consideration. The number of educational services present in each cell has been subdivided into 4 intervals.

The figure for the number of administrative services is taken from the Municipality of Brescia PGT Services Plan. The number of administrative services present in each cell has been subdivided into 4 intervals. The number of administrative services is ties to the demand for "Quick" and "Fast" charging, typically carried out during the time spent by the user at the service location.

• **Sports services.**

The figure for the number of sports services is taken from the Municipality of Brescia PGT Services Plan. Gyms, sports centres, football pitches, basketball and volleyball courts, swimming pools, etc. were all taken into consideration. The number of sports services present in each cell has been subdivided into 4 intervals. The number of sports services is tied to the demand for "Quick" charging, typically carried out during the hours that the user spends at the sports venue.

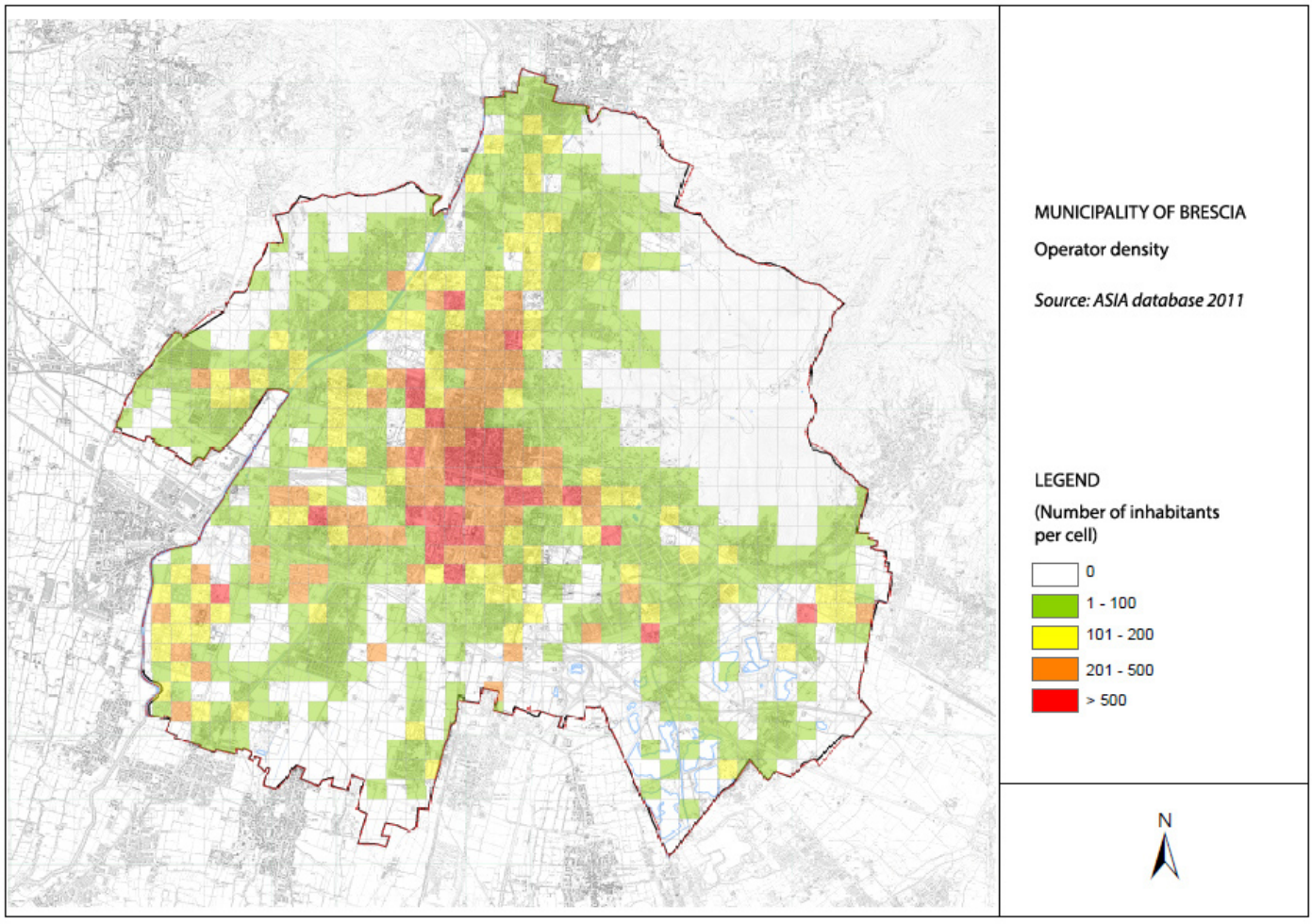

Figure 3 – Operator density in the Municipality of Brescia.

• **Health services.**

The figure for the number of health services is taken from the Municipality of Brescia PGT Services Plan. Hospitals, municipal and supra-municipal health services, doctors' surgeries, Local Health Authority buildings, etc. were all taken into consideration. The number of health services present in each cell has been subdivided into 5 intervals. The number of health services is tied to the demand for "Quick" and "Fast" charging, typically carried out during the time spent by the user at the service location.

• **Large commercial buildings.**

The figure for the number of large commercial buildings was taken from the Lombardy Region geoportal. The number of commercial buildings present in each cell has been subdivided into 3 intervals. The number of large commercial buildings is tied to the demand for "Quick" and "Fast" charging, typically carried out during the hours spend by the user at the shopping centre.

• **Bike-sharing.**

The figure for bike-sharing, updated as of 2015, was taken from the service provider. It was decided to consider the total number of bicycles available for each cell as the indicator, in that this element increases the area desirability in terms of charging, widening the sphere of influence of the charging station.

• **Bus stops.**

The figure for local public road transport, updated as of 2015, was taken from the service provider. It was decided to consider the total number of available bus stops for all bus routes for each cell as the indicator, in that, like for bicycles, this element increases the area desirability in terms of charging, widening the sphere of influence of the charging station.

• **Automatic light rail stations.**

The presence of the automatic light rail transport is considered among the indicators, in that, thanks to the system's commercial speed and frequency, it allows convenient railroad modal interchanging, which guarantees the hypothetical user of charging infrastructure positioned close to the station the possibility of reaching places of interest located at a significant distance in the time it takes to carry out "Quick" or "Fast" charging. For this indicator, mapping took into consideration the distance from the station: cells found within a 300 metre radius from the station are indicated in red and those that are found within a 500 metre radius are indicated in yellow.

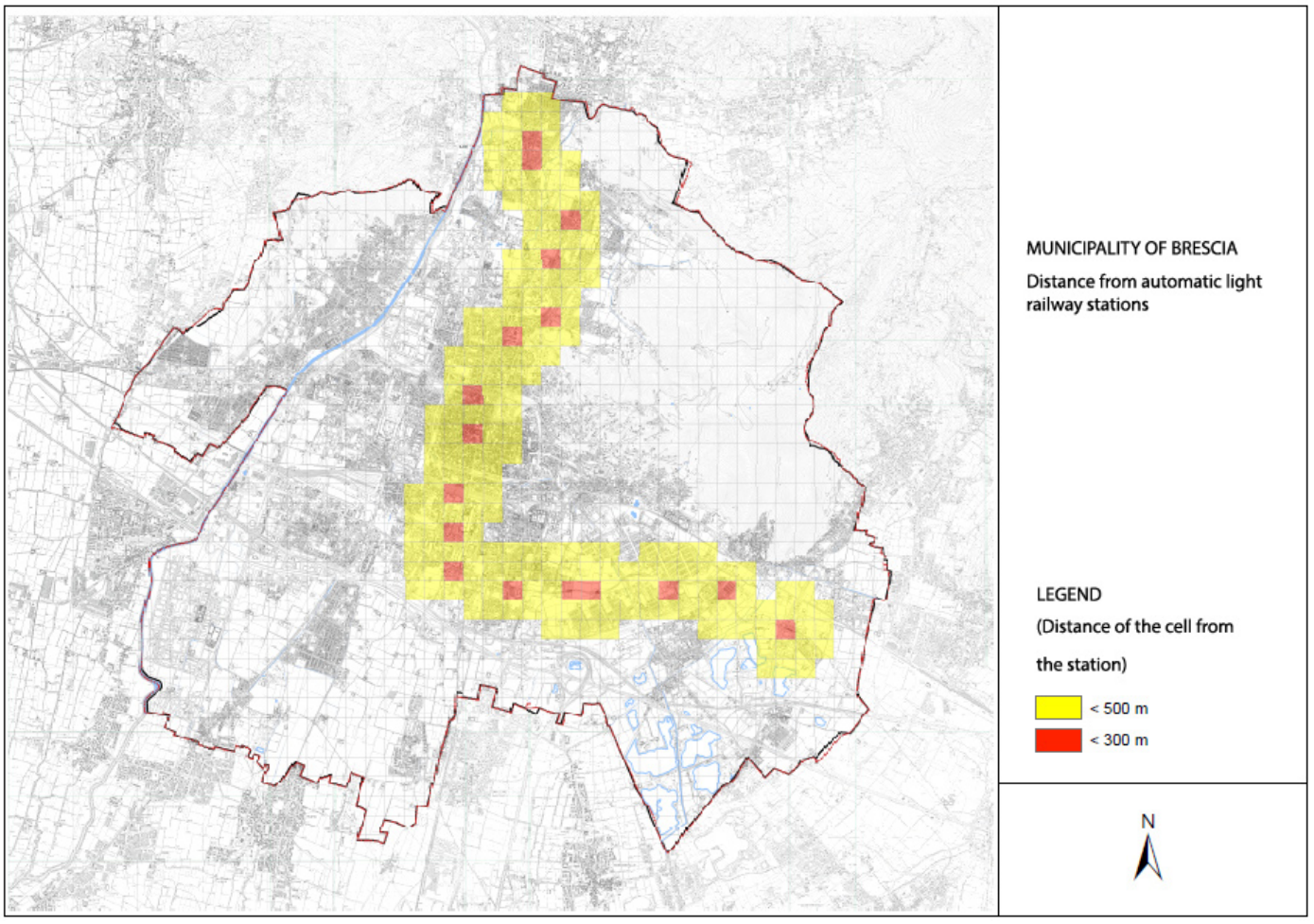

Figure 4 – Distance from the automatic light rail stations.

• Railway stations.

The presence of a railway station is considered an indicator of area "desirability", as far as "Slow" charging is concerned, typically carried out by commuters using the railway service, leaving the car parked all day. As with the light rail criteria, the railway stations are mapped according to distance. Thus, the cells found within a 300 metre radius from the station are indicated in red and those that are found within a 500 metre radius are indicated in yellow.

• Building car parks.

The presence of a car park inside a building in a cell is considered to be an indicator of area "desirability", in that it guarantees optimal charging infrastructure localisation, protected from atmospheric agents and possible acts of vandalism. Furthermore, building car parks are also considered to be optimal locations for infrastructure installation, in that they guarantee charging station "visibility" and high identifiability, thanks to the use of message display boards to indicate the number of stalls available which can potentially be used to direct the user to the charging station. Building car parks are mapped by indicating the total number of stalls in each cell.

• Petrol stations.

The presence of a petrol station is considered to be an indicator of area "desirability" as far as "Quick" and "Fast" charging is concerned, in that it guarantees optimal infrastructure localisation due to the high "visibility" of the charging station. Petrol stations were considered that have suitable space available. The petrol stations were mapped by indicating the number present in each cell.

3.2. Creation of "Demand Maps" and comparison with potential supply

For each type of charging, a matrix was created of weights to be attributed to each indicator, based on its value in individual cells.

For "Slow" charging, the indicators considered were the number of inhabitants per single cell, the number of operators per single cell, the presence of railway stations in each cell, the number of educational services per cell, the number of building car park stalls per cell. For "Quick" charging, the parameters considered were the number of operators per single cell, the number of educational services per cell, the number of administrative, sports and health services per cell, the number of building car park stalls per cell, the number of

bike-sharing bicycles per cell, the number of bus stops per cell, the presence of light rail stations in each cell, the number of large commercial buildings per cell. For "Fast charging", the parameters considered were the number of administrative and health services per cell, the number of building car park stalls per cell, the number of large commercial buildings per cell and the number of petrol stations per cell.

The total weight given to the various indicators in each cell was then divided into four intervals of theoretic demand for charging infrastructure for that cell: "no" demand, "low" demand, "medium" demand and "high" demand. For each level of demand, a thematic map was created to highlight its distribution throughout the territory.

• **"Slow" charging.**

The thematic map for "Slow" charging highlights 93 high-demand cells located in the city centre, in Bresciadue, in the area south of the General Hospital and in the Fiumicello and Primo Maggio areas of the city. Other main city areas are revealed to be medium-demand, with a total of 298 cells. There are 314 low-demand cells.

• **"Quick" charging.**

The thematic map f or "Quick" charging highlights 85 high-demand cells, which trace the route of the automatic light railway, with high density in the old town centre and the Bresciadue areas. There are 180 cells identified as medium-demand and 429 low-demand cells.

• **"Fast" charging.**

The thematic map for "Fast" charging highlights 17 high-demand cells, 51 medium-demand cells and 104 low-demand cells.

The use of these maps allows us to identify rapidly which areas are of main priority, due to there being higher demand, for the installation of charging infrastructure, thus enabling the correct territorial distribution of available resources.

More specifically, hypotheses were made related to the potential supply for each type of charging, as described below.

• **As concerns "Slow" charging**, as also indicated by the National Plan, the main infrastructure localisation is in private residential areas. For this reason, the Plan identifies construction and city planning policies to help the user manage the configuration of his own private charging station. In areas of high population density, if there are not enough areas available to be used for charging, the localisation of public "Slow" charging stations is preferable. In these areas, coverage by

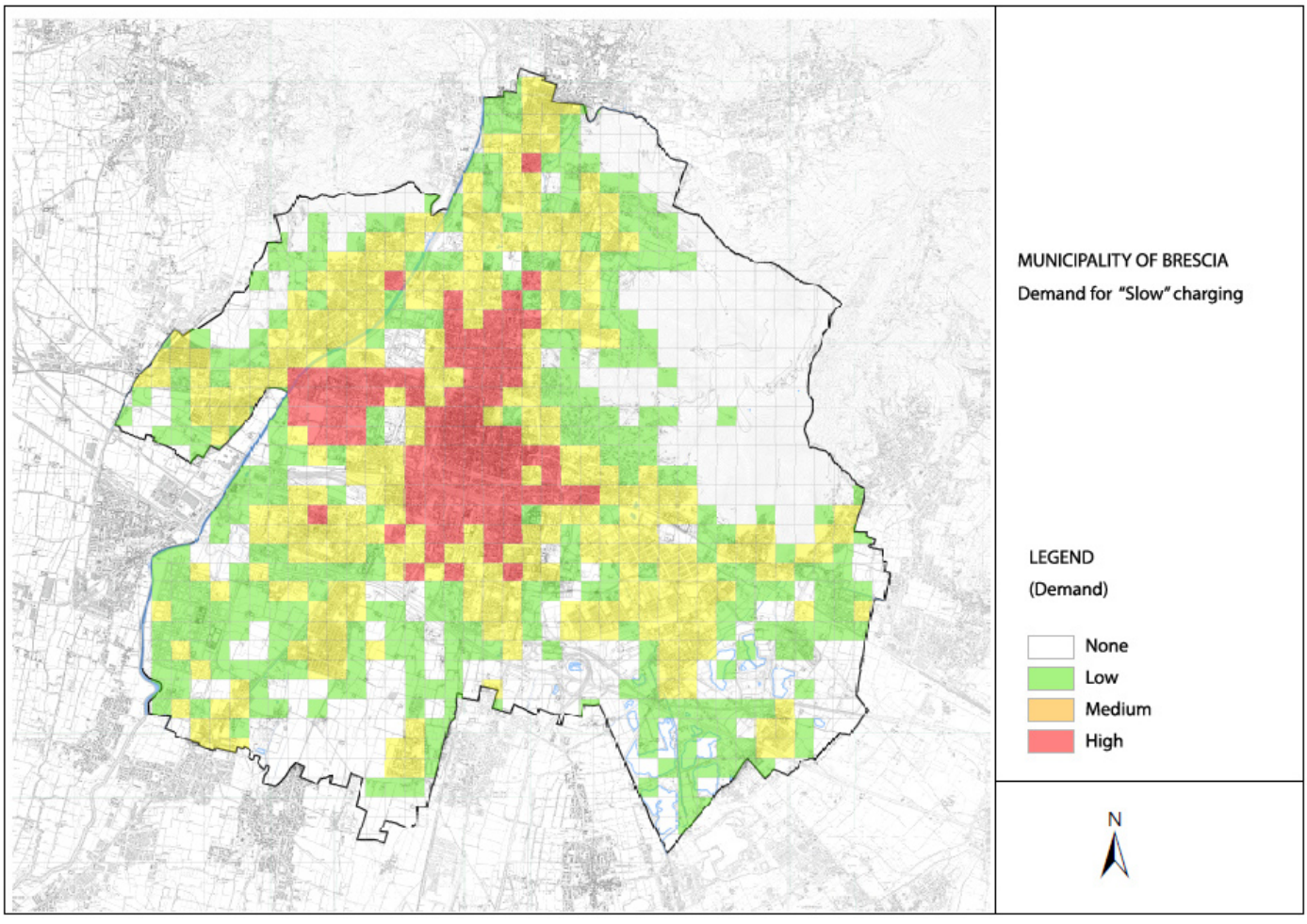

Figure 5 – Demand for "Slow" charging.

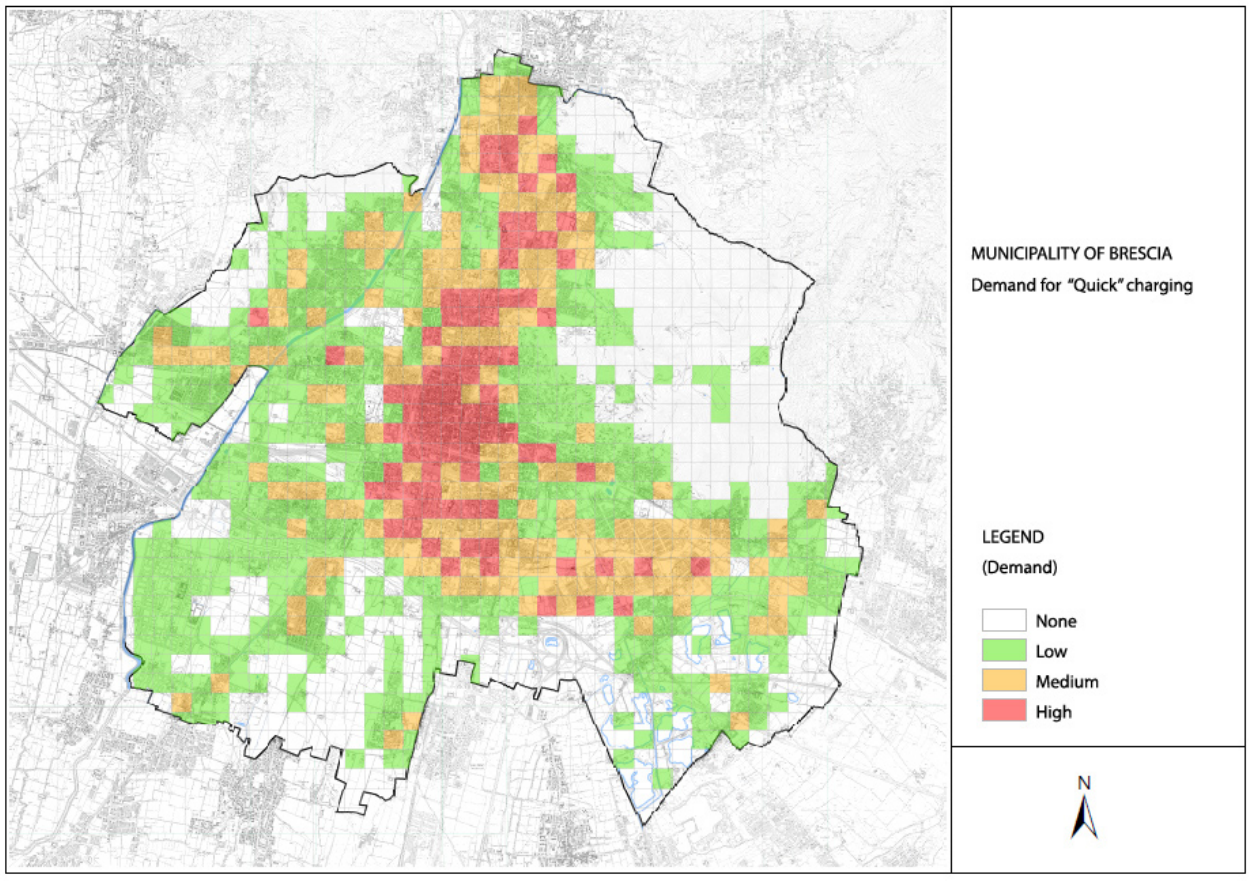

Figure 6 – Demand for "Quick" charging.

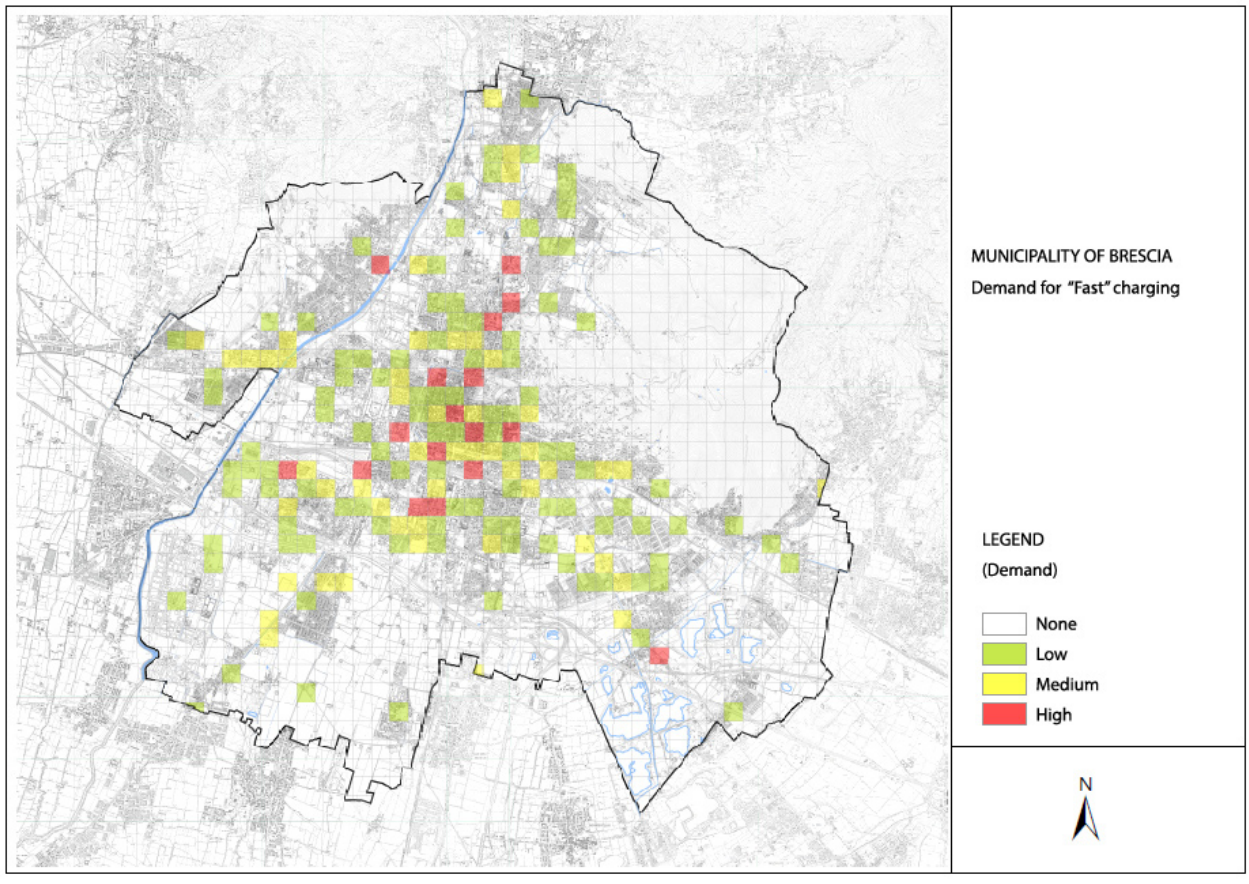

Figure 7 – Demand for "Fast" charging.

higher level infrastructure must also be examined: a "Quick" charging station, used by day by traffic-attracting services or hubs, can also be used at night by local area residents.

• **As concerns "Quick" charging**, it has been estimated that, in the first stage, charging infrastructure will be localised in all building and modal interchange car parks and in all the large commercial building car parks in the municipality. This decision was motivated by the fact that, in such areas, it is easier to identify areas possibly protected from atmospheric agents, used exclusively for charging, placed near the main entrances and easily accessed by the user.

Thus, coverage analysis was carried out of the areas of influence of potential supply, considering a radius of 300 metres, a distance easily covered on foot.

This operation allowed us to identify which areas of the city are not covered by the infrastructure localisation hypothesis, reducing detailed analysis to these areas only.

One example is the northern area of the city, in the Mompiano district. This area contains 6 high-demand cells and 12 medium-demand cells for "Quick" charging that are not covered by the theoretical area of influence of the charging infrastructure.

In this area, the "High" and "Medium" demand cells contain predominantly sports services (e.g. Club Azzurri), gyms, football pitches (e.g. Rigamonti Stadium) and tennis courts, swimming pools (e.g. Mompiano Swimming Pool), doctors' surgeries and health services (e.g. Domus Salutis), schools (e.g. Scuola Edile, Liceo e Scuola Magistrale Zammarchhi, I.T.C. Lunardi), bike-sharing stations or Local Public Transport stops/stations.

Detailed analysis of the area allowed us to identify certain parking areas (mainly private with public access) suitable for the installation of "Quick" charging infrastructure.

Therefore, a new charging infrastructure coverage area was identified with the same 300 metre radius, making sure that, with the newly identified possible locations, the critical area of Mompiano is covered. The plan extract in Figure 6.9 shows the new coverage area.

The same analysis was also carried ot for "Fast" charging, on the assumption that optimal localisation could be, as well as in the areas already taken into consideration for "Quick" charging, at sufficiently spacious petrol stations located on roads classified A to E (Italian system). No areas were identified in which the charging demand was not satisfied by the potential localisation supply.

Once the charging infrastructure installation areas, for the three types of charging, are identified using the methodology described above, the number of stalls to be equipped (for "Quick" charging) can be calculated using the matrix described earlier, carefully analysing which type of traffic-attracting service/hubs are found within the station's area of influence.

One example could be the station located in the North Hospital building car park. This station is found in an area of high demand, shown in red on the thematic map. Taking into consideration the Hospital service, this proves to be a service with a high demand for charging stalls, as per the methodology described above.

Using the matrix above, a corrective factor of 2 is identified,

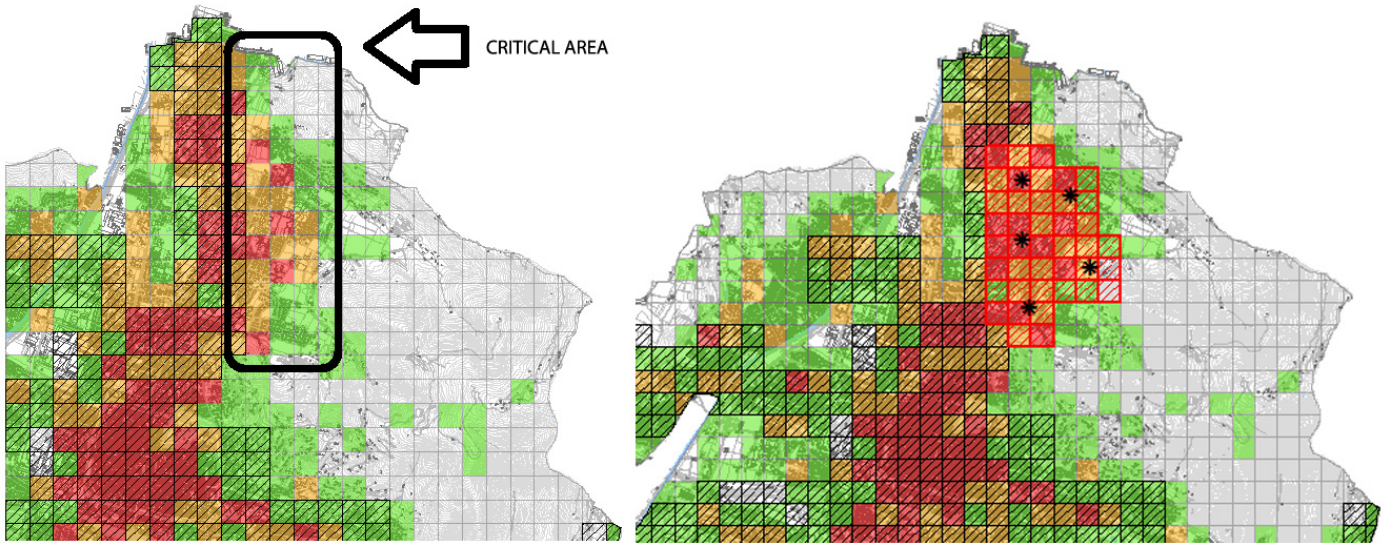

Figure 8 – Extract from the map showing the "Quick" charging infrastructure coverage area. High demand areas in red, medium-demand in yellow, low-demand in green, infrastructure coverage area indicated by the black dotted line. The black square identifies a critical area north of Brescia with high demand but not covered by the infrastructure. In the figure on the right, the black asterisk indicates the possible locations for infrastructure in the Mompiano area. The red dotted line shows the new infrastructure coverage area.

Table 3 – Double-entry matrix to determine the corrective coefficient to be used in the identification of a minimum standard of stalls to be equipped with "Medium" charging infrastructure. Case study: Brescia Hospital. The coefficients used are indicated in red.

		Corrective factor		
Coefficient for type of traffic attracting service/hub	High	1	1,5	2
	Medium	0	1	1,5
	Low	0	0	1
		Low	**Medium**	**High**
		Charging demand for the cell in question		

which, when applied to the 2% minimum of charging stalls, brings the total percentage to 4% of stalls in the building car park. Given that the North Hospital car park has 1405 available spaces, the desired number of stalls to be equipped with charging infrastructure is 56. These charging stalls should ideally be located near the pedestrian entrances to the car park, in a visible and well-protected position. The number of available charging stalls in the car park should be clearly indicated by message display boards situated outside the car park. Of these stalls, an appropriate number[9] must be made accessible to disabled users.

9. In line with international examples, it can be assumed that at least 2 disabled user stalls will be required (minimum 1 for every 50 charging stalls).

4. Conclusions

Inspired by international examples and in line with that established by our National Plan (Pnire), a new methodology is proposed, calculated and validated in the city of Brescia, for the planning of public or public-accessible charging stations. As far as "Slow" charging is concerned, it is evident that demand will mainly be satisfied by private infrastructure in the domestic environment (maintaining the ratio of 1 to 8 established by the Infrastructure Plan for the number of public vs private charging stations), whilst public stations must be planned for "Fast" and "Quick" charging.

To this end, the methodology developed, which is easily implemented by taking into consideration various indicators and assigning to these indicators a weight based on the type of charging, is deemed to be a valid tool to help draw up infrastructural installation plans quickly and with the advantage of clearly highlighting the areas in which it is necessary to focus in-depth analysis, this avoiding the waste of resources.

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Environmental design

Ways of interpreting urban regeneration: Hamburg, London, Brussels and Rome[1]

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Keywords: regeneration; urban policies and tools; sustainability.

Abstract

Over the coming decades all cities throughout and beyond Europe, be they large or small, will face the great challenge of regeneration. European Commission has promoted a "regeneration agenda" focused on an integrated sustainable approach. But, while the European Commission draws the path, European cities provide a variety of ways to transform drafts in deeds.
The four case studies described below – Hamburg, London, Brussels, Rome – give evidence that, in the last decades, every city had drawn its own "regeneration way", with a different level of sensitiveness regarding the European principles.
However, all the case studies deliver at least one action attuned to the principles of a sustainable regeneration, and it's possible to select from every experience the "good" that has been realized.

Introduction

The challenges that cities are facing have changed, as have the strategies designed to tackle old and new problems. Urban renewal, revitalization, *renouvellement*, *rehabilitation*, *riqualificazione*, *recupero*[2] have been for years the key words of the European Commission's policies, programmes (Urban, Urbact...) and tools conceived to develop the idea of a good city for all.
But globalisation, climate change, pressure on resources, environment deterioration (Toledo Declaration, 2010)[3] have transformed the urban development conditions and introduced the notion and evidence on "environmental limits".
The concept of growth in economic and urbanism as well is worn out; the "business as usual model" focused on development at all costs shall be abandoned if we want to maintain cities and territories in a liveable condition, as Tim Jackson[4] states, while a "green approach" is urgently needed.
In response to this wake-up call, the European Commission has promoted a new urban agenda focused on an integrated, smart, sustainable, inclusive development, based on a multilevel and multidisciplinary approach. That is the mean of the regeneration strategy being shared at EU meetings[5], with the hope that urban policies would shift towards sustainability and regeneration[6].
By calling for "an integrated urban regeneration and its strategic potential for a smarter, more sustainable and socially inclusive urban development in Europe" (2010)[7], the Toledo Declaration Reference Document clearly expresses this concept.
But policies, programmes, declarations have apparently not hit the target if in 2015 an URBACT II paper[8] defined "sustainable urban development" an elusive concept and proposed to clarify what we understand by sustainable regeneration.
Urban regeneration "is a way to reorganise and upgrade existing places than planning new urbanisation (Puppim de Olivera and Balaban, 2013) [;] typically urban regeneration actions involve economic, social and physical/environmental improvement measures [and] urban regeneration contributes towards the implementation of sustainable development through the recycling of land and buildings, reducing demolition waste and new construction materials, as well as reducing demand for peripheral urban growth and facilitating intensification and compactness of existing areas (Turcu 2012)"[9].
With this definition, the European Commission provides a general understanding to consider urban regeneration an integrated and sustainable oriented approach[10] and promotes strategies to support a new growth model and create the conditions for smart, sustainable and inclusive growth (Horizon 2020).
While the European Commission draws the path, European

1. *Urban regeneration in the city centre and peripheries Rome, Hamburg, London and Brussels,* Conference, Sapienza Università di Roma, Facoltà di Ingegneria Civile e Industriale, Rome, 15th and 16th March 2015, "Aula del Chiostro", via Eudossiana 18. The Conference has been organised by prof. Fabiola Fratini.
2. Key words in French and Italian used in the European Commission documents aimed at urban renewal policies and research programmes (Urban, Urbact...).
3. ec.europa.eu/archive
4. Tim Jackson, 2011.
5. Leipzig Charter on Sustainable European Cities (2007) and Marseille Declaration (2008).
6. Urbact II, 2015.
7. ec.europa.eu/archive
8. Urbact II, 2015.
9. Urbact II, 2015.
10. Urbact II, 2015.

cities provide a variety of ways to transform drafts in deeds.
The four case studies described below – Hamburg, London, Brussels, Rome – give evidence that, in the last decades, every city had drawn its own "regeneration way", with a different level of sensitiveness regarding the European principles.
Thus, the results of regeneration policies / programmes vary from city to city, and even within the same city. "Regeneration" can be considered sustainable or not; and in certain cases a *passe-partout* word used in order to apply a "politically correct" label to different urban actions.
The examination and the comparison of the cases allow to identify and name four "regeneration ways". The names given, as the descriptions, are related to the need to expose typical situations that make up the plural image of the regeneration, beyond and beside the EU suggestions.

Sustainable regeneration

Under the flag of "regeneration" Hamburg has developed two huge projects with different goals, although included in the same vision – Hamburg Spatial Vision 2020 (2013): the regeneration of the harbour area (a brownfield) with the realisation of HafenCity (started in 1997) downtown on one hand, and the regeneration of Wilhelmsburg island by IBA-Hamburg (started in 2006) – south of the city – , a 35km² area in a state of decay with a mix of low quality functions, on the other.
HafenCity is related to a global market strategy, but the guiding principles of the masterplan include sustainability and participation within a local character framework; Wilhelmsburg island's regeneration is locally oriented, but the subject of innovation in the field of sustainable architecture, developed by IBA-Hamburg, happened to realize an exhibition of solutions for the city of the future.
Both projects are integrated, multilayered and multidisciplinary, which are central criteria to obtain the "EU good practice label".

Iconic-global oriented regeneration

London is regenerated first of all using "spotlight projects" with the goal to respond to global expectations. The city has adopted a strategy focused on major renovation and maintenance projects, with much care dedicated to new iconic buildings and most visited public spaces. The city's approach has featured a number of interesting policies (like the London Green Grid) but the initiatives developed have also been tailored to boost market values and to conquer the leadership in the global imagination.

Multipolar-sustainable regeneration

Brussels offers examples of the complexity of a regeneration focused on the local. The regeneration strategy implemented regards sensitive neighbourhoods located in the most deprived municipalities of the city-region, where the problem of marginalization has reached emergency levels and the process of regeneration has involved an integrated-participatory approach first (1991), that switched to sustainability later (2013).
In Brussels, the instrument used to regenerate the city-region is the "Neighbourhood Contract – Contrat de Quartier CdQ" (1991), a tool that focuses on small areas, combining urban and social interventions. From 2009, in response of the new urban challenges, the CdQ evolved in a new, sustainable and green tool, the "Sustainable Neighbourhood Contract – Contrat de Quartier Durable CdQD".
Thanks to this approach, the regeneration actions are flexible, local oriented, sustainable and spread in the city-region municipalities where the needs are evident.

Immaterial regeneration

The attempt to regenerate Rome's periphery took place in the '90s with specific tools: Pru, Priu, CdQ[11]. But after the first decades of experimentation – which are difficult to appreciate – regeneration activities seem to slow down.
San Basilio is the case study chosen to illustrate the situation. When the direction and financial resources are lacking, the regeneration may turn out to be "immaterial".
San Basilio's regeneration is spotted with, light actions due to local actors helped by public institutions. In a way, these practices are rooted in the "laboratori di quartiere" experiences of the '70s, especially in the neighbourhoods located in the outskirts. Thanks to this heritage, social activities, although "immaterial", can help to achieve important goals as proactive citizenship and community building.
"SanBa" murales, school/university mapping and community walks have been the ingredients of a self-made regeneration with no ambition to last too long, but which may be the seeds for a more liveable future.

The combination of the themes outlined here and the various case studies may suggest new points of view and offer food for thought regarding what regeneration is and should be to provide better future for both cities and people.

Sustainable regeneration in Hamburg

Hamburg is a "good practice" example according to the sustainable regeneration definition diffused by UE documents.
Urban regeneration in Hamburg is concentrated on two major areas located south of the city: HafenCity and Wil-

11. Pru – Programma di recupero urbano; Priu – Programma di riqualificazione urbana; CdQ – Contratti di Quartiere.

helmsburg. Both are key projects of "Hamburg Spatial Vision 2020"[12] – released in 2007 – , linked with the goals to concentrate the future development in the geographical centre of the city and to "bridge the gap" between Hamburg and the islands south of the Elbe river.[13]

So, on one hand, in 1997 the municipality decided to regenerate the area of the former harbour − south of the city centre − and develop the new district of HafenCity as a new downtown.[14] On the other, with the "Leap across the Elbe" project (2002), the city government and local inhabitants promoted the regeneration of Wilhelmsburg Island − south of HafenCity − through a complex strategy. [15]

Both projects belong to a common metropolitan planning framework issued in 2007 aimed at, among other goals, connecting the individual projects in the city, reinforcing the urban qualities in northern and central neighbourhoods, regenerating the southern peripheries and preserving the character of Hamburg as a "green and blue" metropolis.

Figure 1

HafenCity (1997 - ...) is designed as a central, new district complementary to the heart of Hamburg (and not in competition, according to the designers), to house, in 25 years, 12,000 inhabitants, 40,000 workers, 80,000 visitors.

A huge laboratory of design capable of involving urban planners and architects, investors and builders. The aim is to give shape to an idea to become a European urban model: a city open to the culture of globalization, however, "faithful" to its historical roots, sensitive to environmental issues and energy saving.

The idea became reality in 2000, when the municipality decided to launch a competition for the master plan concerning the regeneration of the area of the disused harbour.

The winning team − ASTOC, coordinated by Kees Christaanse − drew a city of "short distances", dense, compact, mixed, formed by neighbourhoods and structured through the design of public space, in line with the principles envisaged in the documents of the competition. The proposal runs over an area of 157 hectares − 40% of the surface of the city centre − divided into 127 hectares of land and 30 of water. [16]

The plan elaborates the theme of reconciliation between city and nature through 10.5 km of riverside walks and pro-

12. "The spatial vision, draft abridged version – Hamburg", 2007.
13. Ingrid Beckner, 2015.
14. HafenCity Hamburg, 2013.
15. IBA_Hamburg, 2012.
16. HafenCity Hamburg, 2013.

vides 41.9 acres of open space available to citizens and visitors (28.1 of which public and 13.8 for public use). [17] But still the residents claims the lack of "green" especially along the promenades in Santorkai and Dalmannkai quarters.
However, the network of the public spaces draws the physical structure of the district and helps to boost social and outdoor activities.
The buildings that shape the form of the district host residences (30%), offices (48%), universities, schools, cultural activities, hotels (13%), trade and gastronomy (9%). Each building generally houses a variety of functions. To reduce energy consumption, investors are encouraged to produce buildings with low environmental impact through the granting of "ecolabel" certification.[18]
Architecture enlivens volumes, draws the prospects, frames backgrounds and substantiates the landmarks while the users walking through the public space network liven up the urban scene - especially during the weekend.
The landmarks are entrusted to the expert hands of archistars and, as the architecture of the background, evoke the fashionable style characteristic of many skylines of this millennium (figure 1). Unique but similar to others, buildings produce an "urban déjà-vu", which is struggling to find its harmony. Yet in HafenCity, as in Copenhagen or Moscow, "celebrity copyright" seduces planners, investors, inhabitants, employees and tourists. The awareness of acting at a global scale pushed decision-makers to focus on the aesthetics of urban design that, here as elsewhere, becomes part of the process of formation of the new centre and its success. A shimmering success, for now dedicated to a select audience, because of the square meter cost, the activities' brand, the glittering shops and restaurants, the "luxury" background.
In 2007, the "Hamburg Spatial Vision 2020" declared that the city should be a growing metropolis that resonates well in the international perception, be more competitive on the international stage and develop spotlight projects which are the key to forming a successful global image.[19]
Thanks to HafenCity, Hamburg is now part of the global geography of the places that matter: ten years after the "laying of the foundation stone", HafenCity has already done "the world tour".
What remains to be seen is whether, in the end, the new district will be able to integrate the demands of the market and be a "city for people", to quote Jan Gehl[20]. Concerning the regeneration topic, is HafenCity to be considered an "integrated urban regeneration, ... sustainable and socially inclusive"? − to quote Toledo Declaration.

17. Ibid.
18. Ibid.
19. "The spatial vision, draft abridged version – Hamburg", 2007.
20. Jan Gehl, 2010.

Wilhelmsburg is a huge island (35 km^2) located south of the city centre and south of HafenCity. The area has been developed during the XIX century as an industrial place linked to the harbour activities.
The reasons for the regeneration of the island are to be found in its geographical and historical features. The area, partially below the sea level, is cut off from Hamburg by the Elbe river. The separation also covered the administrative boundaries. In fact, the island was run by a separate municipality and only after 1937 the territories of the south were annexed to the city to ensure its expansion.
The flood of 1962 − which caused more casualties, homeless and destruction there than elsewhere in Hamburg −, contributed to build a negative image of the island, adding to the feelings of distance, insecurity and abandonment.
The flood devastation and the consequent declining population left the island in a state of decay. Year after year the island was at the receiving end of land uses that fitted nowhere else: dumpsites, containers, power lines, highway intersections, high density and low quality buildings.
In 2000, active Wilhelmsburg residents − in the name of a mixed population of 100 different nationalities, mostly Turkish, with high rates of unemployment and low incomes − decided to change the fate of the island.
They became promoters of surveys and proposals aimed at increasing the awareness of the local opportunities. In 2002 the results of these activities were substantiated in the "White Paper on sustainable economic and social development of the islands". A "springboard of ideas" that pushed the municipality to launch in 2004 the "Leap across the Elbe" project.
The project recognizes a great potential in the island as regards the availability of areas for urban development and, at the same time, with concerns as to the presence of environmental resources. Wilhelmsburg is set to become the "green heart" of Hamburg.
It is within this framework that, in 2007, the IBA - Hamburg has developed a multidisciplinary strategy on four levels − urban, social, cultural, environmental − designed to redevelop open spaces and transform areas both built and to be rebuilt.
The regeneration strategy included the ''International garden show", the construction of new settlements, the test of building techniques and materials with low environmental impact (such as Hybrid house and Water house) and a master plan for the centre of the island designed by Jo Coenen.
The new centre now hosts different buildings (residences, offices, retails, equipment) on a 30 hectares area. Among them, the Ministry of Urbanism and Environment, a "coloured stripe building" (Sauerbruch Hutton design) which became the landmark of Wilhelmsburg (Figure 2). Yet, despite the efforts, the area seems to lack a "sense of place".
However, with over 60 projects focusing on three main

Figure 2

themes − Metrozones, Cities and climate changes and Cosmopolis − the IBA initiative develops an idea of the city aimed at demonstrating that it is possible to work on the existing city, even in its peripheral and abandoned parts and promote innovation, for the protection and enhancement of natural resources.

London global-iconic regeneration

A Sustainable regeneration approach has been introduced by the Blair government (1997) with the Urban Task Force (UFT) work coordinated by Richard Rogers. [21] The UFT developed a new vision, described in a report, which would be pursued through *Urban* [sustainable] *Renaissance* policies (*Toward an Urban Renaissance* - 1999).

With the principles of the *Urban Renaissance,* the government intends to setting out an alternative vision to the current state of the British city, setting out principles, guidelines and models aimed at urban regeneration, at promoting better economic and social conditions within the framework of a sustainable development.

With regard to the reality of London, the UFT report highlights the particularity of the great metropolis within the British landscape and its importance as a financial and business centre. According to UFT studies, London has some of the distinctive features of the proposed *Urban Renaissance* model. However, the report considers it necessary to define some corrections such as, for example, a governance referring to the city as a whole and a vision capable of integrating objectives and actions developed by each borough, that would strengthen the functional mix and develop an increased concern for the housing sector and the quality of the public realm.[22]

Since the late 90s, parallel with the release of the UFT report[23], the future of London was taking shape with the aim of enhancing the attraction of international markets, encouraging tourism flows and promoting international investments. Those are also the years of global cities theorizing and worldwide competition between power nodes, to quote

21. John Punter, 2010, p. 2.

22. Marion Roberts and Tony Lloyd Jones, 2010, p. 169.

23. Urban Task Force, 1999.

Saskia Sassen.[24]
From 1993 to 2007, in London of course, but in other British cities too, the property boom encouraged an unprecedented amount of speculative development activities.[25]
The combination of these elements has determined a development linked to the pursuit of profits by maximizing quantity. A goal that suited the private sector and local councils as well, both involved in entrepreneurial strategies, implementation of major regeneration projects and public realm improvements for the sake of small investors ("buy-to-let"/ "buy-to-leave" practices[26]) and extra-large developers.
Therefore, the initiatives of regeneration that have been promoted in London are mostly the result of these conditions and are aimed at a global market visibility and for business purposes. The projects intend to spread a new and vibrant image of the city through entertainment events and great regeneration plans; new architecture icons; cultural offers; upgraded public realm; facilities, attractions including shopping for tourism both mass and elite.
The *Urban Renaissance* principles suggested balancing the pressure of investors with strategic planning, driving of the transformation processes by local government and defining clear public-private commitments.
But in reality things turned out otherwise. "The Urban Renaissance most dramatic physical impacts have been concentrated in the city centre" with a typical combination of "central retail, hotel, leisure and eating/drinking sectors, a reflection of the growth consumerism".[27]

Events. The Millennium event, which celebrated the transition to the twenty-first century, was nothing more than an excuse to turn the light onto the city and to spot new locations for further development through spectacular projects.
The *Millennium Wheel* is a perfect example of the kind; a masterpiece of marketing policy. The London Eye was created for the 2000 celebrations on the South Bank of the Thames. The "extra-large" structure was built to establish the record of the tallest Ferris wheel in Europe and to become a global star. The work, now sponsored by Coca-Cola, attracts 3.5 million visitors per year and has become an identifying landmark of the city along with the Tower Bridge and the "Gherkin".
The starting of the *Millennium Dome*[28] was certainly less glittering, even though it was meant to be another successful urban symbol in the mind of the decision-makers[29].
But the location of the "white elephant" − as it has been tagged −, on the Greenwich Peninsula in South East London, far from the centre; its considerable size too large to fill (365 meter in diameter; 52 meter in height at its centre) and its costs too high to be balanced by the benefits did not help to make it an "urban star".
Unused for years, in 2005 the Dome was sold and rebranded "02 Arena" by a mobile telecommunication company and is now the centre of an extensive regeneration plan for the peninsula. The latest version of the master plan (2015) is sponsored by Henry Cheng Kar-Shun − a Hong Kong billionaire − teaming up with the existing developer Quintain, and proposes high buildings for wealthy customers in just the same style as the Docks.[30]
Certainly the *Millennium Bridge*[31](figure 4) is the project more attuned to the principles and guidelines of the *Urban Renaissance* compared to those mentioned above.
It is a pedestrian bridge integrated into a broader project called "Thames path" − a walkway along the Thames banks started in the '70s.[32] The new infrastructure is an important link within the pedestrian network along the river. In fact, the bridge connects the New Tate and St Paul Cathedral sewing up the two banks. Thanks to the bridge and the Thames path it is now possible to stroll between Westminster and the Tower Bridge and appreciate the monuments along the new route.

Architectural icons (or just tall buildings). Regeneration also means boosting the real estate sector and reshaping the horizon line. The new century offers a profile in London that pierces the clouds, crammed with skyscrapers and cranes.
The annual survey released by New London Architecture (NLA) and GL Hearn (2015) shows 263 buildings over 20 floors approved or under construction (70 of which under construction) within Greater London, with a significant increase of towers under construction (+36%). 62 of the 70 towers are residential and could provide 14,800 new homes[33].
Concerning the location, East Central and South London will see the biggest rise in tall buildings with 93% of new towers on the way to be delivered.
A trend that will "enhance the leading world position of the city alongside with a dynamic and evolving skyline", as Deputy Mayor of London for policy and planning Sir Edward Lister stated. The Mayor is sure that a strategic approach, robust planning rules, and the fact that the majority of tall buildings are being built in carefully planned clusters will ensure the quality of the results[34].

24. Saskia Sassen, 1994.
25. John Punter, 2010, p. 331.
26. John Punter, 2010, p. 325.
27. Ibid., p. 327.
28. Designed by Richard Roger, 1999
29. Robert Collins, 2007.
30. Dave Hill, 2015.
31. Arup project, 2000.
32. Marion Roberts and Tony Lloyd Jones, 2010, p.175.
33. http://www.newlondonarchitecture.org/docs, 2015.
34. "Central London Economic Assessment 2010: Paper 5. Place",

Thus, "very tall buildings have led to the fiercest debate and most prominent urban design policy shifts" as Roberts and Lloyd Jones noted[35].

Not only tall and not only for the sake of the real estate customers, new buildings can also be architectural icons, cultural symbol and kick-starting transformation processes as well.

Figure 3

The Regional Planning Guidance (1991) worked on the basis of the protection of the strategic views of the key landmarks; then, in 1999, the LPAC issued its Supplementary advice on High buildings and strategic views in London; later, in 2003, the English Heritage produced its guidance on Tall Buildings revised with CABE in 2007[36].

The result: written policies are good in intent but not specific enough and open to a range of interpretations.

Clearly, there are conflicting demands behind the pressure to build higher and the resistance to that. And with this trend, in a handful of years the skyline will look definitely different. Thanks to the Foster's Gherkin, the Renzo Piano's Shard and "the others", the London sunsets look more and more like any other thriving city of the "Far East" (Figure. 3). Despite the restrictions on tall buildings the phenomenon seems unstoppable thanks to foreign financing flows from the Emirates to China.

The Tate Modern Southbank can be considered a masterpiece of architectural regeneration and the greatest symbol of success of London cultural policy. The New Tate[37] built in 2000 on the site of the disused power station, located just in front of St Paul Cathedral, is a cultural landmark for million visitors from all over the world (Tate Modern claims it has established itself as the most-visited art gallery in the world).

On the other hand the Gallery has become the centre of a wider regeneration development. A phenomenon which could be considered a good opportunity if not only aimed at saturating free spaces and at spreading a monocultural urban design approach.

Public realm. The topic of public realm should take a central space in an agenda of changes influenced by the principle of *Urban Renaissance*. And so it is in London; first of all in the central area which is the engine of an urban economy

2010.

35. Marion Roberts and Tony Lloyd Jones, 2010, p. 181.

36. Ibid. p. 171.

37. Designed by Herzog and de Meuron.

consumerism-oriented.[38]
Therefore, the city centre (Zone 1 / 2) is the place where the initiatives dedicated to enhancing the quality of the public realm are thriving; but within the same framework it is possible to identify different approaches.
Some projects, such as the "squares word" (1996), concern global reference places and are definitely oriented to global customers. Thanks to "squares in the world," the image of London is regenerated at the level of pedestrians, through the upgrading of spaces, symbol of an iconography that will appeal to a world audience: Trafalgar Square, Piccadilly Circus, Whitehall and Parliament square.[39]
The same care can be found, for instance, along the busiest streets belonging to Zone 1 and around the underground stations between Zone 2 and Covent Garden. Here the towns of Camden, Westminster and City of London along with Transport for London (TfL) and private lenders promote the Clear Zone Partnership aimed at redesigning public spaces.[40]
The fact of enhancing the quality of the city at "eye level" helps the commercial activities to thrive. The logic is distilled in a study done by "Transport for London" (TfL): the "streets for walking are better for business."
To reshape the central London shopping streets the regeneration actions include the spread of pedestrian areas, redesign of spaces, reorganization of signs, lighting and parking along the streets.
A network of "walking routes", designed according to this criteria, has been developing along the busiest streets and around the metro stations between the boundaries of Zone 2 and Covent Garden and in the heart of the city. The best example: Great Queen Street in Covent Garden and Holborne.

Among the initiatives which concern the public realm in central areas some try to match the quality of authenticity, a good urban design and a marketing approach.
For instance, straddling mobility, interventions on public space and support to local businesses are the goals of the redevelopment of the area around Seven Dials, near Covent Garden, Marylebone High Street, or St Christopher's Place. These interventions have become "places of worship" of customers looking for authenticity and stylish regeneration.[41]
Here, the quality of the location and the partnership with "enlightened" private entities allow the realisation of the principles of *Urban Renaissance* through the creation of an urban environment on a human scale, calibrated on a soft mobility, made attractive by the quality of the design. The ambience has been imagined to fully enjoy a select audience with fashionable boutiques and restaurants mixed with street food and weekly market.

Another approach with similar goals but other design references is the one that features the Southwark Bank. Thanks to the new initiatives involving the bank of the river, it is possible to observe a colonization by office buildings, food and shopping facilities. The anonymity of the design of public spaces is framed with granite, glass and steel and ground floor activities led by international chains −" starbucks-zara-benetton-sephora".
The use of similar elements creates a "curiously corporate ambience with a feeling of compound", which is "replicated in new commercial developments across London − for example at Tower Place, Cardinal Place, and Exchange square"[42] − and corrupts the authenticity of places.

At last a different strategy. In 2012 the Greater London Authority delivered *All London Green Grid* (2012) which can be considered a framework plan aimed at regenerating urban territories through a sustainable ingredient: the green. The plan is aimed at promoting the design and delivery of "green infrastructure" across London[43], defining a network of green spaces (street trees and green roofs), providing a range of benefits (recreation, amenity, healthy living, ecological resilience...).
The same year, the city pursues the way to regenerate neighbourhoods again through nature and extra-small projects - called the "100 pocket parks" - spread all over the city. A sort of "urban acupuncture" strategy.
The initiative has been promoted in 26 municipalities of London with £2 million funding for 100 public spaces.[44] The goal is to increase the quality of roads, squares, gardens, canals and riverbanks. It cuts out small areas in the city where, thanks to a special design on a microscale, it is possible to find comfortable seating, flowers, shrubs, trees.
In this regard, Mayor Boris Johnson said: "investing in public space transforms the city in a pleasant and attractive place for residents and visitors, in an environment where business can grow."

Ultimately, the urban regeneration in London is primarily a *renaissance* to measure a global node that favours business and investments, focusing on a continuous renewal of the urban image through icon products (architecture, features, spaces), which are able to turn the international interest towards the city. However, the economic and symbolic importance of this phenomenon opens new lines of experimenta-

38. John Punter, 2010, p. 327.
39. Marion Roberts and Tony Lloyd Jones, 2010, p. 174.
40. Tim Long, 2014, p. 8.
41. Marion Roberts and Tony Lloyd Jones, 2010, p. 177.
42. Ibid., p. 176.
43.All London Green Grid SPG – Greater London Authority, 2012, https://www.london.gov.uk/
44. http://www.london.gov.uk/ pocket-parks.

Figure 4

tion such as the design of the public realm.
Nevertheless, considering the added value produced by these years of commercial real estate boom, perhaps the city could proceed towards greater redistribution of opportunities, widening the actions of regeneration in those parts of the city and for those citizens less illuminated by the spotlight of globalization. However, the green strategies adopted after 2012 seem to oriented the city policies towards a green and sustainable regeneration concerning "*All London*"[45].

Multipolar-sustainable regeneration in Brussels

Urban regeneration in the Brussels Capital Region concerns degraded neighbourhoods of the city centre, and the urban policies are rooted in the local dimension through the implementation of Neighbourhood Contracts (CdQ - 1993)[46]: an innovative multidisciplinary "micro - local" fixed term scale tool (4 years + 2).[47]

The CdQs (1993-2009) intervene incrementally, in the municipalities of the first ring of the city-region, home to the dynamics of decay. The choice of the CdQs' location draws a "patchwork" that corresponds to a strategy of "step by step" redevelopment. The size of the area is proportional to the budget and implementation capacity of the Region and the municipalities involved.
Given the complexity of the issues, the law provides for three major fields of intervention: the real estate, the public space, and the "social" involvement.

The real estate. The basic idea of regeneration related to real estate is to promote public / private partnerships to renew dilapidated buildings within the border of the CdQs area.
However, a final assessment of the first CdQs (1994-1998) highlights the prevalence of interventions funded by public bodies.[48] Especially in the more derelict thus less attractive neighbourhoods (as in Anderlecht or Molenbeek municipalities).
As everywhere, the developers' strategy aims at protecting investment and acting in safe conditions. Most of them prefer to intervene in the downtown areas of the City of Brussels, around the former Canal (St Catherine area), where a

45. All London Green Grid SPG – Greater London Authority, 2012, https://www.london.gov.uk/

46. "Ordonnance", 7 octobre 1993; "Arrêté du gouvernement de la Région", 3 février 1994.

47. Fabiola Fratini, 2003, pp. 42-44.

48. Fabiola Fratini, 2004, pp. 89-100.

set of policies (not only CdQs) implemented by the municipality have already obtained good results in the field of regeneration.
But even in better locations, such as in central Brussels, the developers select the buildings to transform with care. They prefer to wait for the improvement of the quality of a specific neighbourhood under CdQ's policy and take advantage, at a later date, of the enhancement of the urban ambiance.
Nevertheless thanks to CdQ's regeneration processes could start, involving the urban tissues of derelict neighbourhoods, and now are spreading through a greater number of central municipal areas. The good results can be observed in the renewed public realm and urban fabric.
And if the kick-start comes first from the public sector and thereafter from the private sector, one of the principal evidence is that the tool has been able to shift from negative to positive the urban quality and the life of a good number of residents in a relatively short term.

The public space. Interventions on public space are the first to go and the first to be completed. The law requires that the construction site shall be concluded, with no exceptions, by two years from the beginning of the CdQ.
The redevelopment of public space is seen as a driving force to attract private investors and solicit the intervention of spontaneous renewal. The convenience of the intervention for individuals is linked to the quality of streets and squares that determines, in turn, an increase in the market value of property.
The design philosophy which runs through interventions on the public space seems to be inspired by a kind of "minimalism" and the quality obtained is the result of the combination of a few basic elements: tree alignments, grand old trees, natural stone pavements, benches, lighting, bollards for parking, speed bumps.
The choice of the elements complies with the characters and qualities existing in the neighbourhoods, hard to find tarmac, granite, glass and steel.


Figure 5

The social involvement. Participation contemplated in the processes of designing space intersects with actions under the "social" and, together, affect the welfare of the inhabitants and the livability of the neighbourhood.[49]
The population of CdQs is characterized by the presence of

49. Fabiola Fratini, 2005, pp.117-127.

immigrants (North and Central Africa, Turkey) of predominantly Muslim religion, poorly integrated, suspicious, little accustomed to consultation practices.
The associations involved in the social activities are financed by CdQs to earn the trust of local population through: building a tolerant coexistence; developing the respect of the inhabitants for neighbourhood spaces and enhancing the desire to participate in its transformation.
For example, cooking classes help the women of North African origin to participate in social activities and prepare them to be involved tomorrow in a community design process. Other examples are the campaigns to keep public spaces clean activated in schools, designed to disseminate a new way of feeling the space as a collective good.
The direct involvement of young unemployed people in the physical construction of the public space increases the feeling of identity and reduces the incentives for vandalism.
The "neighbourhood fairs" of the district are designed to invite people to use the space and create opportunities for interaction between different populations.
Unfortunately, all these activities generally come to an end with the completion of CdQs. At the end of four years, the survival of these initiatives is linked to the ability of municipalities or associations to find other funds. The risk is that once "the light" of attention to the neighbourhood and people is turned off at the end of CdQs' validity, everything reverts back to the way it was before.
The assessment of the first CdQs now completed can be done by just strolling through the renewed neighbourhoods. Generally, the request of the CdQ law to start the renovation from the public realm and to close the construction site within 2 years has been a strategic decision. The consequent enhancement of the quality of the ambiance has attracted developers and encouraged private owners to renovate their own house.
The respect of the timing by the municipality gave the neighbours a new sense of dignity, demonstrating to them that something good has been really done for an improved livability of the neighbourhood.
Obviously not all the CdQs can be consider successful. But, step by step, something has been done to move the silent stillness of the neglected areas.

Figure 6

After 2009 the CdQs were transformed into "Contrats de Quartier Durable" (CdQD). The CdQDs are aimed at creating a sustainable urbanity through a major involvement of the residents. The main goals: reduce energy consumption, waste production, water waste; promote a better use of public spaces; built social cohesion; change un-sustainable citizen's behavior.
Besides the CdQD will help to build new housing for a mixed population in a sustainable environment.
The most important CdQD will be developed on *Tour & Taxis* area (45 hectares), along the Canal, with

1000-2000 houses, a variety of functions and a public park (10 hectares).[50]
With the CdQD the size of the site involved in the regeneration project has dramatically increased – from less than 5 hectares to 45 hectares – and the areas concerned are no longer located exclusively on the built fabric of the city but on the un-built ones too. The "urgency for sustainability" seems to have changed the philosophy of the former CdQ. In a better way? Certainly in an intensive one.
After more than 20 years the demands of the Brussels city region are changed and new tools are requested. The CdQDs are framed within a multi-level vision: the "Plan Guide pour la Rénovation urbaine durable" adopted in 2013 by the city region. The plan promotes a multi-scalar strategy and provide to articulate the urban renewal projects at different scales, from micro to macro – block, neighbourhood, cluster of neighbourhoods, mobility axe, ... -, to carry out integrated nd sustainable actions across the city.

"Immaterial" regeneration in San Basilio, Rome[51]

In San Basilio, IV municipality, eastern part of the city of Rome, there is no program or project of urban regeneration. Yet, despite some positive features, first among them the presence of green, the area has all the conditions that justify an appropriate policy that can strengthen the quality of the urban environment and to restore the confidence of citizens.
In the meantime, waiting for things to change, associations and local public institutions, with the help of the University[52], try to do their best organizing activities to mitigate social problems, develop a positive perception and enhance the knowledge and the appreciation of the neighbourhoods of San Basilio's area.
The actions that are covered within this frame stand for "lightness" and act on relationships and perception.

Thus the regeneration of San Basilio takes place through "intangible" and low cost actions, in line with the financial constraints of a long period of crisis that diverts resources from the municipalities. Low cost but constructive, immaterial actions combine to create a conscious citizenship and an environment ready to face the future regeneration processes.
So, the intangible actions are made with and without targeted funding, thanks to the attention and active participation of local actors, such as the local Cultural Centre, the Nicolai School, a dense network of associations, and the Sapienza University[53].

This category includes the project "*Well - Fare*"[54]; the "*walking workshop*"[55]; "*San Basilio mapping by school and university*", which took shape through a drawing session shared by university students and school pupils[56].
The initiative "*SanBa*" [57]complements the actions above. The goal of "*SanBa*" is to strengthen the positive image of the district through a public art project. The idea is to integrate works of street art and a bottom-up process involving artists and school students. The murals painted by famous artists (Liqen, Iacurci, Hitnes) accompany the walks, are identified as references that dot the process of appropriation of the places by the inhabitants and inspire new mental images of the area, acting on the perception of the neighbours.

The "*walking workshop*" is a collective action, involving the inhabitants of San Basilio, others neighbourhoods of Rome and other European cities.[58]
It is a learning experience through the neighbourhoods and a dynamic activity to encourage the possession of a territory, to build relationships and to transform the *mental maps*[59] of the inhabitants from exclusionary to inclusive. The *workshop* promotes San Basilio as a place of experimentation and active knowledge.

50. Bernard Decleve, 2015.

51. Fabiola Fratini, 2015.

52. Sapienza University of Rome, Department of Civil, Building and Environmental Engineering, Engineering Faculty, prof. Fabiola Fratini, course of Urbanism 1 in collaboration with prof. Claudia Mattogno.

53. Sapienza University of Rome, Department of Civil, Building and Environmental Engineering, Engineering Faculty, prof. Fabiola Fratini, course of Urbanism 1 in collaboration with prof. Claudia Mattogno.

54. Supported by the City Hall IV and built by local associations (Eureka First, Parsec Metropolis and Europe).

55. Arranged by the University in collaboration with the local Cultural Centre and the Nicolai School (15 March 2015).

56. The "drawing session" was organised with the participation of the students of the Sapienza University and the pupils of the V elementary class of Nicolai School - San Cleto neighbourhood -, 4th May 2015.

57. The initiative was supported by the Cultural Centre and the municipality of Rome (2014 - 2015).

58. The first day of the *Urban regeneration from city centre to peripheries Rome, Hamburg, London and Brussels* Conference consisted of a workshop/fieldtrip in San Basilio, the Roman periphery that had been chosen as one of the case studies to be included in the comparison of realities, approaches and results illustrated during the Conference.
The workshop was designed by prof. Fabiola Fratini based on the involvement of a mixed audience: students and teachers; representatives of local associations; students and professors of the Faculty of Engineering, Sapienza University: prof. Paolo Colarossi; prof. Nino Cappuccitti, prof. Claudia Mattogno; the professors of European Universities: prof. Ingrid Breckner of the University of Hamburg, prof. Bernard Declève of the University of Louvain-la-Neuve and prof. Matthew Carmona of the Bartlett School of Planning at University College London.
The workshop is part of a research organised by prof. Fabiola Fratini with the collaboration of the students of the course of Urbanism 1 (prof. Fabiola Fratini and prof. Claudia Mattogno).

59. See Kevin Lynch, 1960.

Figure 7

The scheduled activities start with the choice of the walking tour. There are three routes proposed for the walk. One centred on San Basilio, another including Casal Tidei and San Basilio, the last one around San Basilio and Torraccia. The places chosen as nodes of the paths are targeted to illustrate the character of the urban landscape and the positive landmarks. The three walks have in common the *SanBa* murals.

The walking tools distributed at the beginning of the workshop are: a street map which helps those who need to be oriented in the neighbourhood ("I am here"); a photographic map representing the different parts of the area and help with the recognition of the places; a hard cover map with streets and landmarks in which the participants can draw their diary during the walk; a pencil.

On the latter map, participants trace the walk that took place, identify activities, urban objects, places that strike them and report on the observations accompanying the visit.

The last stop of the workshop is the Senior Centre of San Basilio. Here participants shared maps, opportunities and problems of the neighbourhoods, the images which can be glimpsed behind the urban reality.

The workshop closed with the hope that the fragments of "happy cities" – to paraphrase Italo Calvino[60] – lurking in many of the reports presented, would take shape and hybridize the whole neighborhood.

"*Mapping San Basilio by school and university*" aims to tell the story of the area, encouraging creativity, supporting the exchange between school pupils and university students.[61] "Mapping San Basilio" proposes drawing as a means of describing a place by a plural, rich and underground narrative of the city. The proposal comes across similar to "*Mapping Manhattan. A love (and sometimes hate) Story in Maps*" by Beckey Cooper.

There are no formats, no specific requests but to illustrate their own emotional geography through colours, symbols, collages and words.

To leave room for creativity, San Basilio is represented in a basic map, compressed into the size of an A4 format. The

60. Italo Calvino, 1972.

61. "Mapping San Basilio by School and University" is a research led by prof. Fabiola Fratini with the collaboration of the students of the course of Urbanism 1 (prof. Fabiola Fratini and prof. Claudia Mattogno), professors and pupils of the Istituto Comprensivo via N.M. Nicolai of Casal Tidei (headmaster Gabriella Romano, prof. Maria Gabriella Ballette).

Figure 8

sketch represents San Basilio as an *archipelago* formed by urban islands − every neighbourhood such as San Cleto, Torraccia... − and a sea constituted by the open spaces that separate and surround them.
Thanks to this representation, San Basilio, like Manhattan, seems to be suspended. The few perimeter tracks give way to the story.
So, with few instructions and a drawing, two hundred school pupils and university students met in the classrooms of the Nicolai School in San Cleto to illustrate and describe the *archipelago* through their emotions. Each student was accompanied by a pupil. Together they discussed San Basilio, the map, the mode of representation of their ideas. The available time was that of a football match. Two hundred maps and many stories were the result of the day. But not only that. Besides the maps there is the result of the many reports that came up among pupils and students. During the ninety minutes spent talking of the city and of related feelings, a sharing experience took place between those who knew San Basilio and those who just crossed it.
The final experience was illustrated in a public presentation. The maps were exhibited at the Cultural Centre in San Basilio, and the authors were invited to comment on them. The drawings delineate an "anthropological footprint of the city" and testify the affection that binds the city and its citizens in San Basilio as in Manhattan.

Conclusion: lessons learned

Besides the need to stress a prevalent concept, all the case studies deliver at least one action that can be considered a "good practice" attuned to the principles of a sustainable regeneration according to the Toledo Declaration.
The following list offers the opportunity to select from every experience the "good" that has been realized.

What a regeneration programme needs:

Sustainable-integrated vision
As the Hamburg case shows, the regeneration should be the key action of a long-term sustainable-integrated vision ("Hamburg Spatial Vision 2020"), connecting individual projects in the city, reinforcing urban qualities, upgrading

derelicted areas and preserving local character.
The Brussels Plan Guide model interprets the same need of a multi-level and multidisciplinary vision, using a variety of tools concerning small-scale interventions and broader-strategical actions, which include the territory of more than one neighbourhood.

Good city model
The regeneration strategy should provide a good city model as the case studies of Hamburg and Brussels highlight. A city of "short distances", dense, compact, mixed, formed by neighbourhoods and structured through the design of public space (HafenCity) with a special focus on sustainability and therefore oriented at reducing energy consumption, waste production, water waste; promoting a better use of public spaces; building social cohesion; changing un-sustainable citizens' behavior (Brussels' CdQD).

Regeneration as acupuncture
The "small is beautiful" slogan can lead to a successful regeneration strategy implemented with local driven small and "extra-small" actions.
The lack of resources and the need to give quick responses to people for a better environment may suggest a regeneration process driven by "acupuncture" actions.
For instance, the size of the Brussels' CdQ interests a tiny group of blocks within a neighbourhood's boundaries and therefore makes the regeneration process more flexible and cost-less, the realization easier and the respect of the timing more likely. London's "100 pocket parks" can be considered an example of the same kind, even though the implemented actions concern a specific topic (the green) and deliver a less complex response to local needs. Thus, in any case, green actions can be deemed essential for the liveability of the city even if they are pint-sized.

Green actions
Green interventions are core actions of a sustainable regeneration strategy. In other words, a regeneration should be green.
In Hamburg both HafenCity and Wilhelmsburg development plans involve greening initiatives. Wilhelmsburg is set to become the "green heart" of Hamburg, whilst the master plan of HafenCity provides a green network of riverside walks and open spaces. CdQD tools (Brussel's Plan Guide) are aimed at enhancing the green spaces and thanks to the "quartier verts" tool, every local actor (associations or inhabitants) can promote green initiatives for the sake of the people wellbeing.
At last, the "green infrastructure"[62] promoted by the All London Green Grid plan will help to regenerate, in a sustainable way, the urban territories across London.

Innovation & sustainability
According to EU regeneration principles, sustainability and innovation should be considered part of the same strategy, and the integration of the two concepts can support the development of a new green economy. But both need a shift regarding behaviours.
IBA-Hamburg shows that sustainability can support economic growth, promote innovation for the protection and enhancement of natural resources.
Concerning the topic of the need to change behaviours, incentives can help the growth of sustainable innovation as well as the change of developers approach. In HafenCity, investors are encouraged to produce buildings with low environmental impact through the granting of "ecolabel" certifications.
Both the "quartier verts" tool designed by the Brussels Region and the London "100 pocket parks" can be considered instruments of a "go green" campaign locally oriented to sensitize people to nurture and care any kind of green within urban environment. Which is another way to support a change of behaviours.

Public space
Public spaces of good design quality are required to regenerate the city. In Brussels the CdQ experience exemplifies that regeneration in derelicted neighbourhoods should start from the renewal of public spaces. The redevelopment of public space is felt by the inhabitants as a "care initiative" driven by the municipality and enhances the liveability of the neighbourhood.
The same principle is shared by the London case study, even though in London the concern of the quality of public space is oriented first of all to places of tourism and consumerism.[63]
An extended public realm network and a variety of good design spaces are the ingredients of the success of HafenCity. From one of the Brussels neighbourhoods' new tree-lined street to the renewed Trafalgar square the lesson learnt is: public space, public space, public space.

Social involvement
Sustainable regeneration should be conceived in a citizen-shared process; social involvement is a key action within the regeneration processes. Social involvement should concern all the key stakeholders and regard the change of people's behavior to ensure the implementation of sustainable regeneration goals.
HafenCity is a particular case of inhabitants' self-involvement. Here the inhabitants are the active part of the par-

62. https://www.london.gov.uk/

63. John Punter, 2010, p. 327.

ticipation process due to their cultural, economic and social background. Wealthy and middle class households, with professional skills, able to negotiate, belonging to a good social network are an easy proactive partner within the decisional process.
Things change within "sensitive" neighbourhoods. In Brussels participation, tolerant coexistence, respect for the public goods are the key words of the social involvement in CdQ's process and of the success of people's integration.
San Basilio's regeneration is the social involvement process which took place and meant a learning experience and the implementations of dynamic activities to encourage the possession of a "not-always-friendly" territory, to build relationships and to transform the *mental maps*[64] of the inhabitants from exclusionary to inclusive. Which can be considered a sustainable regeneration action aimed to help people to feel "at home" in their city.

64. See Kevin Lynch, 1960.

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Rome, its region and the regeneration of the "light city"[1]

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Keywords: Light City; Urban Regeneration; Sprawl Repair; Urban Design; Landscape Planning; Suburbia Retrofit.

Abstract

Despite a climate of broadly shared hostility towards low-density settlements, in recent years, several authoritative studies, projects and policies have dealt with different declensions of this model with a positive attitude.

For at least 100 years, an impressive number of derogatory campaigns have been thrown against one-family-house suburbs, the deriving sprawl and the supposed consequent negative effects. This article attempts at first a rough, operational classification relative to the aspects considered (economic, functional, environmental, social, aesthetic) and mentions the arguments used by critics as they appear in two overall studies on this topic.

Nevertheless, if one considers the settlement type rather than its negative products, none of these charges seems to withstand the test of an accurate scrutiny but one. In fact, a considerable amount of studies – here references, taken from the same overall studies and from some more recent contributions, and arguments adopted are mentioned as well, following the same classification – has argued that low-density settlements can produce better results than the high-density ones or, at least, comparable from a general sustainability point of view and produce many favourable effects. Thus, rather than on the parameter of density, positive products depend on good, context sensitive design.

However, low-density settlements in their making may replace – and cause an irreparable loss of – beautiful pristine natural or agricultural landscapes. This very fact might suggests that public policies should curb development or force it towards dense and compact settings, regardless to the considerable disadvantages deriving from this choice.

Nevertheless, in specific circumstances, a composition among conflicting goals may be found through design. Considering the actual condition of the "light city" – most of the settlements surrounding major centres, that is – as in Rome and its region, where large areas are already affected by a conspicuous amount of casual and disorderly building, a strategy of regeneration seems advisable and feasible. This would provide opportunities for new housing, well-designed landscape and investments within reach of a large quantity of households.

The ideal thing would be to have a good American suburb adjacent to a very concentrated Italian town, then you'd have the best of both worlds.

Colin Rowe[2]

1. The evolving fortunes of the garden city

1.1. Garbatella, Giovannoni, garden cities

A celebration of Garbatella, this inclusive, plural, welcoming Roman suburb, which was designed according to the criteria of the garden city and which everyone seems to love, is a good opportunity to ask ourselves what is, or even whether there is, a plausible future for the garden city in our contemporary national culture, apparently dedicated as it is to stigmatize and curb the shortcomings of low-density settlements.

When I was a student, in the '70s, Giovannoni, who designed the original core of Garbatella, he was not a positive reference: it was considered an academic, a reactionary.[3] Only in the following years, his contribution to history, technology, architectural design and, above all, urbanistics, including both design and planning, has been fully appraised.[4] His attitude was complex, multidisciplinary and inclusive, capable of dealing in synergy with both historic centres and, of course, garden cities. For many years, Giovannoni was the victim of an ideological – in the sense of pre-conceptual – ostracism.

1. This is an update of the introduction to the final round table of: " La Garbatella, la città giardino di domani e la città leggera. La via pacifica della vera riforma" [Garbatella, the garden city of tomorrow and the light city. The peaceful path to real reform] which was held at the Casa dell'architettura in Rome, on 9 April 2015. Selected cases and related illustrations are taken from the materials used in the author's contribution to the international conference: "Rowe Rome 2015. The Best of Both Worlds. Urban design and regeneration of the light city", hosted by the Camera dei Deputati on 15 and 16 October 2015. Illustrations have been selected with Rachele Passerini and are based on studies and drawings made by: Manola Colabianchi, Rachele Passerini, Gabriele Tontini, and Giulia Vignaroli. The full text of the latter report, including a complete set of images, is in https://colinroweconference2015.wordpress.com/materials/ where I propose a normative outline, as well, as an operational framework for a possible application of the ideas expressed in this text.

2. Ingersoll, Richard, "Interview", *Design Book Review*, 1989, also in Rowe, Colin, *As I Was Saying. Recollections and Miscellaneous Essays*, Vol. 3 "Urbanistics", edited by Caragonne, Alexander, The MIT Press, Cambridge, 1996, 325 ff.

3. See as an example: Zevi, Bruno, *Storia dell'architettura moderna*, Einaudi, Milano, 1975 (1950), 186.

4. See as mere examples: Del Bufalo, Alessandro, *Gustavo Giovannoni*, Edizioni Kappa, Roma, 1982; Zucconi, Guido, "Gustavo Giovannoni, la naissance de l'architecte intégral en Italie", *Les annales de la recherche urbaine*, 44-45, Decembre 1989, 185-194; Choay, Françoise, *L'orizzonte del posturbano* (edited by d'Alfonso, Ernesto), Officina Edizioni, Roma, 1992; Id., *L'allégorie du patrimoine*, Éditions du Seuil, Paris, 1992; Giovannoni, Gustavo, *Vecchie città ed edilizia nuova*, edited by Ventura, Francesco, CittàStudiEdizioni, Milano, 1995 (1931).

Often in architecture and, especially, in urbanistics ideology does prevail.

1.2. Recent fortune of the garden city

The monumental volume *Paradise Planned*, by Robert AM Stern et al.,[5] which, with its publication in 2013 marks an important historiography revival for the garden city, pays special attention to Italy and dedicates a broad description to Garbatella.

The book ends hoping for: "... a new kind of metropolitan community with plans broad enough to permit both the intensity of the inner city and the passivity of nature. Without both, cities as we know them will cease to exist. The garden suburb may well hold the key to the future of our cities".[6]

Similarly, in 2013, Jean Taricat, a French sociologist of the École d'architecture de la ville & des territoires à Marne-la-Vallée, published a book on low-density settlements which title seems evocative: *Suburbia. Une utopie libérale*;[7] in 2014, *L'urbanisme de la vie privée*, by Olivier Piron, was put in print.[8] Further, in 2011, Andrés Duany, founding father of the American New Urbanism, produced *Garden Cities* for the Prince of Wales Foundation.[9]

It is not just a theoretical revamp. In England, the prestigious Wolfson Economic Prize 2014 was awarded to David Rudlin for its proposal of a Garden Cities Act, a law for the construction of 40 new garden cities. In fact, with a substantial agreement of the three major British parties – the New Labour promotes the creation of sustainable new towns at least since the Gordon Brown days – two garden cities are already beginning their implementation process: Ebbsfleet, Kent and Bicester, Oxfordshire.

On April 14, 2014, Deputy Prime Minister Nick Clegg, issued a statement of support for "locally lead" creation of garden cities.[10] In parallel, in Almere, Netherlands, another country of pronounced liberal democracy, an experiment on the direct realization by the citizens of a garden city has just started.[11]

The treatise by Stern et al., mentioned above, shows that the garden city or garden suburb is a settlement type with important and innumerable design and implementation applications in the Anglo-Saxon cultures. But important examples have been designed in other countries, including Italy, as reported in the same text, with many variations and the main characteristic of being low-density, low-coverage, flexible, mostly peripherally located and therefore sub-urban.

1.3. Merits of the garden city

The low-density suburbia, which seems appropriate to look at as the most common implementation and popularization of the garden city model, keeps enjoying a strong public sympathy. A house with a garden is the ambition of many. It is also "desire for the country", to quote the title of the book by sociologist Valerio Merlo,[12] and, therefore, contact with nature, freedom, open spaces, privacy, but there are other reasons as well.

A disciple of Franco Karrer, Maria Rita Schirru, a few years ago published *Il periurbano: crescere intorno alla città* [The suburban: growing around the city] that has, among many merits, clarified, through a "by-agent" cost-benefit analysis, the advantages (and disadvantages) of the low-density suburban expansion, specifying the effects on the different subjects involved.[13] Among the advantages are the public and private savings related to congestion, the increase of job opportunities but, above all, a strong compression of the economic rent for both residents – especially those who recur to custom-build and self-build housing – and for economic activities, and therefore lower costs and a wide, evenly distributed attribution of land-development surplus values. With a kind of resort to crowd-sourcing financing, household savings can be used without excess intermediaries. Often the public or private choice of the garden city is the most formidable tool to make "inhabiting" more liberal.

1.4. Reaction to the garden city and to the low-density settlements

But many flaws are attributed to low-density settlements and the deriving sprawl, too. In Italy, charges against sprawl are often associated to its prevalent illegal and non-designed nature. "Villettopoli" – the one-family-house spread – as nicknamed by Pier Luigi Cervellati in many of his texts, has several different characters than the American suburbia[14] and yet the many analogies allow for adopting similar considerations.

A review of these vices and a history of reactions to the spread of settlements are both in the essay by Schirru and in a key reference for the studies on sprawl: *Sprawl. A Compact*

5. Stern, Robert A. M; Fishman, David and Tilove, Jacob, *Paradise Planned. The Garden Suburb and the Modern City*, The Monacelli Press, New York, 2013.

6. Ibid. 961.

7. Taricat, Jean, *Suburbia. Une utopie libérale*, Éditions de la Villette, Paris, 2013.

8. Piron, Olivier, *L'urbanisme de la vie privée*, éditions de l'aube, 2014.

9. Duany, Andrés & DPZ, *Garden Cities. Theory & Practice of Agrarian Urbanism*, The Prince's Foundation for the Built Environment, London, 2011.

10. Department for Communities and Local Government, *Locally-led garden cities: prospectus*, April 14, 2014.

11. Thorpe, David, "Why Can't England's Proposed Garden Cities be Like the Netherlands'?", *Sustainable Cities Collective*. (August 4, 2014); Feary, Thomas, "Inside Almere: the Dutch city that's pioneering alternative housing", *The Guardian*, (December 15, 2015).

12. Merlo, Valerio, *Voglia di campagna. Neoruralismo e città*, Città aperta edizioni, Troina, 2006.

13. Schirru, Maria Rita, *Il periurbano: crescere "intorno" alla città. Strumenti e metodi di governo per valorizzare i benefici e limitare gli effetti negativi del periurbano*, Gangemi Editore, 2012.

14. Cervellati, Pier Luigi, "I piani di Pier Luigi Cervellati per Palermo e Catania", *Urbanistica*, 108 (1997), 70-71.

History by Robert Bruegmann.[15]

Low-density settlement and the deriving sprawl are quite common in history but it is after its popularization, precisely with the introduction of the garden city idea, that it has provoked strong reactions. The first significant one was possibly in England in the '20s, when the British artistic and literary *élite* and the rural aristocracy attacked the mass possession of the country.[16] In 1927, Clough Williams-Ellis published *England and the Octopus*. "A dull democracy" replaces an "enlightened autocratic control" writes Williams-Ellis. Sprawl is ugly, consumes farmland and generates traffic congestion.

After World War II, the anti-sprawl reaction revamps.[17] *Fortune* magazine, editor William White, promotes the conference and the book *The Exploding Metropolis*, 1957, and highlights the flaws of this settlement pattern.

Since then, the literature against sprawl is immense and I refer to the two texts cited above for a thorough review. Here it seems suitable to attempt an expeditious classification on the claimed shortcomings of the low-density settlements and urban sprawl based on these two texts, which could be used as a reference for a systematization of the arguments, without any claim of completeness. Also in consideration of the recurring nature of the arguments used by criticism throughout the decades, a thematic rather than a chronological outline is adopted.

Following is a list of five areas of issues, often intertwined, used by the critics of the low-density, peri-urban settlements:

- Economic,
- Functional,
- Environmental,
- Social,
- Aesthetic.

The most common objection to low-density settlements has to do with the public cost of construction and maintenance: networks length, with equal population size, is greater in this urban type (and especially in spontaneous, not-designed arrangements). Moreover, the per-capita construction cost, including the cost for individuals, is greater than that of the dense city. Studies that promote this thesis are countless. To name a few: *Use of Land: A Citizen's Policy Guide to Urban Growth*, 1973, sponsored by the Rockefeller Brothers Fund;[18] the monumental *Costs of Sprawl*, in three volumes, 1974;[19] *Cost of Sprawl Revisited*, 1998, and *Cost of Sprawl - 2000*, 2002, by Robert Burchell of Rutgers University.[20] During the same years 2000-2002, the research on "Le couts de la desurbanization", by the Ministere Region Wallonne, is carried out.[21] In Italy, the research about the province of Milan, published in 2002 by Camagni, Gibelli and Rigamonti,[22] and *No Sprawl*, 2006, by Gibelli and Salzano are well known.[23]

All these studies, along with many others, highlight the high cost of use as well: in particular, the costs of mobility. Longer commuting imposes higher costs – there are greater distances from the centre and from services – and fewer opportunities for synergies since – the public transport needs concentration and low density requires an extensive use of the car that in turn creates congestion.

Between the late '50s and early '70s in particular but also during the following years, the production of studies against the car (and against the construction of new roads) is massive: for example, *Cities and Automobile Dependence*, 1989,[24] extended by *An International Sourcebook of Automobile Dependence in Cities, 1960 - 1990*, by Jeffrey Kenworthy and Felix Laube with Peter Newman in 1999.[25] In 1992, the European Commission – DGXI (Environment) produces a study for the city without cars.[26]

The massive use of the automobile embodies a system of flaws: congestion, waste of time for commuting, pollution, waste of energy resources, and land consumption for the construction of new roads.

One could add the higher costs related to thermal control (winter heating and summer cooling) of single-family homes compared to multi-family residential buildings, due to the different ratios between external surfaces and volumes. Also in this case, they result in a worse energy balance and in a higher emission of polluting residues. All higher energy costs, also become factors of pollution and environmental degradation, as well as agents of the phenomena of global warming caused by the greenhouse gases. See, for example, *Once There Were Greenfields*, 1999, by F. Kaid Benfield.[27]

Paradoxically, a way of life close to nature seems to be, in fact, one of the worst threats to nature. Low-density settlements are very harmful from an ecological point of view for the inefficient use of land in the sense that each potential resident produces a loss of natural landscape incomparably greater than a resident of the dense city.

Besides, large areas dedicated to agricultural cultivation are destroyed, resulting in a severe production cost for society.

15. Bruegmann, Robert, *Sprawl. A Compact History*, The University of Chicago Press, Chicago-London, 2005.
16. Bruegmann, 117-18.
17. Ibid., 121-22.
18. Ibid., 135-36.
19. Ibid., 122-23 and Schirru, 45-47.
20. Bruegmann, 139-40.
21. Schirru, 60-66.
22. Ibid., 56-60.
23. Ibid., 66-69.
24. Bruegmann, 140.
25. Ibid., 279.
26. Commissione delle Comunità Europee, "Proposta per un programma di ricerca sulle città senza auto. Rapporto finale", gennaio 1992.
27. Ibid., 155.

The loss of agricultural land is a constant motivation in both the criticism by the British avant-garde in the '20s, in the American post-war protests and in today's reactions to land consumption.

It seems paradoxical, but the growth of the suburban city in the United States is seen responsible as much for the phenomena of obesity, for the strong drawing upon the need for a car, as for the threat of famine, derived from the reduction of agricultural land.[28] See for example: *The Squeeze,* by Edward Higbee, 1960[29] or *The Population Bomb*, by Paul Ehrlich, 1968.[30]

The "garden city", then, designed or spontaneous, produces social imbalances, deriving from reduced interaction, alienation and dissatisfaction. The low-density neighbourhoods are often factors of social segregation both for the upper classes and for the weak and the marginalized, which choose them as a residual solution.

Finally, low density produces an unpleasant landscape. The aesthetic problems are always present among the charges: from Williams-Ellis, mentioned above, to the evocative rhetoric by Townscape, starting from *Town and Countryside*, by Thomas Sharp, 1932.[31] Even the more recent texts of the New Urbanism – such as *Suburban Nation: The Rise and Decline of the American Dream*, by Duany, Plater-Zyberk and Speck, 2000 – criticize sprawl from the point of view of aesthetics.[32]

It's hard to blame them if one looks at the vast majority of low-density settlements: both most of the dull and repetitive American suburbs and the chaotic and uneven Italian sprawl, such as those around Rome.

All these reasons seem to confirm that the garden city is a model, even though loved by the people and useful to the economy, in fact unsustainable, particularly at this conjuncture.

1.5. Refutation of the arguments against low density

The criticism of the low-density settlements converges therefore from several fronts:

- from critics of the specific type of settlement, because inefficient and vicious,
- from critics contrary to urban expansion, with many facets, and in favour of an overall reduction of "land consumption",
- and, finally, from critics supporting a limitation of the total production of new buildings, in particular of residential ones, with various accents and motivations, most frequently linked to the so-called calculation of needs, that is to the comparison between optimal quantity of rooms available and number of inhabitants or between housing units and families.[33]

The numerous reactions against the low-density settlements have highlighted the problems, have set them out and have exposed them to a more careful scrutiny, causing in turn confirmations or refutations. It is useful to refer to the texts already mentioned as well as to some recent research cited below.

Many authors have focused on the shortcomings of these criticisms, often including more concurring themes. Sometimes these "criticism of the criticism" have highlighted the weaknesses in their logical-scientific construction, sometimes have revealed their true or complementary motivations. Among the latter, for example, there is the early *Geography and Urban Evolution in the San Francisco Bay Area* by James Vance, 1964. The positions contrary to the dynamics of growth, despite the apparent altruism, seem actually to be promoted by an unprecedented partnership, for direct conveniences: the business *élite* of the inner city, intolerant of the competition coming from the outskirts, and the earlier suburban inhabitants, protective of their isolation. Though for different reasons, both parties are against any additional use of peri-urban areas. Besides, under the banner of democracy, lies an attempt to impose individual or small groups' aesthetic preferences to the entire population.[34]

On several occasions, it is the logical, methodological and scientific theses contrary to low density that are subjected to scrutiny and refuted as in the case of the famous review of "The Costs of Sprawl", by Alan Altshuler, 1977,[35] or in the study *Demain l'espace* by the Mayoux Commission, 1980,[36] both examined in detail by Schirru.

The authors engaged in this work of refutation are many: among them, Duane Windsor, Richard Peiser,[37] Wendell Cox and Joshua Utt,[38] Anthony Downs[39] on the cost of urban sprawl; William Fischel[40] and Joel Kotkin on recessionary and inflationary effects of urban containment; Alain Bertaud, on the consequences of a strict top-down planning;[41] Randall

28. Ibid., 256.

29. Ibid., 133.

30. Ibid., 128.

31. Ibid., 118.

32. Ibid., 151-53.

33. The latter appears to be specific of the Italian milieu but it is becoming a common outcome of opposite and converging pressures on the one hand against suburban densification and, on the other, in favour of urban growth boundaries, in other countries such as the United States as the present debate testifies.

34. Ibid., 136, 254.

35. Schirru, 47-50, Bruegmann, 251.

36. Schirru, 50-56.

37. Bruegmann, 251.

38. Ibid., 254; Cox, Wendell; Utt, Joshua, "The Costs of Sprawl: Measured in Benefits?", Demographia, The Public Purpose, #83, 10 August 2004 (http://www.demographia.com/pp83-sprbene.pdf).

39. Bruegmann, 155, 263.

40. Fischel, William A., "Comment on Carl Abbot's The Portland Region: Where Cities and Suburbs Talk to Each Other and Often Agree", *Housing Policy Debate*, 8/1/1997 and Latini, Antonio Pietro, "Standard e limiti di crescita urbana", *Urbanistica informazioni*, 162 (1999).

41. Ling, Anthony, "Interview with Alain Bertaud", *Market Urbanism*,

O'Toole, Peter Gordon and Henry Richardson on the alleged functional disorders, especially those relating to mobility;[42] the same Gordon and Richardson and Samuel Staley on the issue of the loss of agricultural land;[43] Anthony Downs for the refutation of the perverse effects of the expansion on the city centre;[44] Melvin Webber for the aesthetic issue.[45]

I can only touch on some of the most important issues, trying to follow the outline that I used above. As for the economic aspects, firstly, low density appears more expensive only to a superficial exam. Much depends on the specific circumstances and, even in general terms, different performances are not as pronounced: indeed, often overturned. Single-family homes have, on average, higher construction costs (but not market costs, as is known) than apartments only because they are usually larger. From the point of view of public costs, nature, size and characteristics of urban networks are not comparable to suburban ones, which are much simpler and therefore with much lower parametric costs.

Also, it does not seem to hold even the thesis of higher costs of use, in particular for mobility issues. Many authors argue that congestion is caused, in fact, by a more intensive land use and, with it, energy consumption and therefore pollution. This assumption seems counterintuitive if one does not take into consideration the polycentric metropolitan configurations in which the spontaneous dynamics are permitted or encouraged and, therefore, the very fact that destinations seldom remain placed in the major city centre and often relocate following criteria of dispersal.

Most importantly, mainly within recent years, several arguments have emerged, showing a severe economic shortcoming of policies unduly limiting and concentrating development. In fact, evaluations of real estate dynamics, also recent ones, show that overly restrictive planning policies and a concentration of development rights in few areas and in favour of a limited number of operators – as it happens in dense-only planning choices and in situations where development opportunities are overly limited – significantly hold back the general economic development, widen the social gaps and drastically reduce the ability of the weakest subjects to afford a decent dwelling. See, for example, the study by the London School of Economics, *Links Between Planning and Economic Performance*[46] *and a few recent concurring essays from different sources that I referred to in a short text, recently published,*[47] *as well as a research, just disclosed, edited by Wendell Cox.*[48] *By the way, the late Sir Peter Hall had already written on this subject in a well-known report in the early '70s.*[49]

In addition, low-density settlements – in particular the self-built and custom-built ones, with a short production and distribution line, so to speak – allow for direct investments, in higher number, small size and greater flexibility.

The energy consumption and pollution per capita, deriving from the use of the car compared to public transport, is greater but the difference is in fact negligible in view of both the progress of engines and fuels efficiency and the low-intensity, low-efficiency, use of public transport for most of the day.

True, the public service is more easily organized in high-density settlements – although at considerable cost – and coverage optimization in low-density ones certainly requires a greater design attention. However, a recent study by Jeffrey Wilson, Dalhousie University,[50] shows a substantial equivalence in overall production per capita of greenhouse gases between the inner city and the suburbs and higher production only for outside areas with very low density. Clearly, the local effects of pollution in higher density settlements are concentrated and therefore more severe.

Another recent study, coordinated by Hugh Bird and elaborate by the University of Lincoln, England, by the New Zealand Energy Centre and by the University of Auckland, New Zealand,[51] argues that, despite the stereotypes, the low-density city is much more energy efficient because the urban sprawl potential for renewable energy generation is much bigger than that of dense and compact settlements. Each house, while having large roof surfaces to install solar panels and/or ways to use wind turbines can cover all its needs of heating, and of running the house and of related (electric) vehicle mobility; also it can produce a surplus of energy to be entered in the network, therefore generating hardly contestable energy and environment benefits.

Many submissions have refuted the claims regarding the protection of agricultural areas because their reduction appears to be due, on the whole, to the fact that the area to be cultivated is a gradually less and less relevant factor of

(January 15, 2015).

42. Bruegmann, 274, 279 and 141, 157-58.

43. Ibid., 279.

44. Ibid., 261.

45. Ibid., 263.

46. Cheshire, Paul; Leunig, Tim; Nathan, Max; Overman, Henry, *Links Between Planning and Economic Performance: Evidence Note For LSE Growth Commission*, 2012.

47. Latini, Antonio Pietro, "Consumo di suolo e disuguaglianze", *Urbanistica informazioni*, 261-62, pp. 93-95 (2015).

48. Cox, Wendell, *Income Housing Affordability and Urban Containment Policy*, Frontier Center for Public Policy, 2015.

49. Hall, Peter; Thomas, Ray; Gracey, Harry; Drewett, Roy; *The Containment of Urban England*, George Allen and Unwin, London, 1973.

50. Wilson, Jeffrey; Spinney, Jamie; Millward, Hugh; Scott, Darren; Hayden, Anders; Tyedmers, Peter, "Blame the exurbs, not the suburbs: Exploring the distribution of greenhouse gas emissions within a city region", *Energy Policy*, 62 (2013), 1329-35.

51. Byrd, Hugh; Ho, Anna; Sharp, Basil; Kumar-Nair, Nirmal, "Measuring the solar potential of a city and its implications for energy policy", *Energy Policy*, Vol. 61 (2013), 944-52.

production, rather than to the aggression of human settlements. So much so that most of the areas withdrawn from agriculture do not turn into settlements but into wooded or fallow areas.

Besides, observers concerned about international equilibriums suggests that the Western world should pay more attention to the fact that, with the massive forms of subsidy to domestic agriculture, it in fact sustains an unfair competition against poor countries that may have a real competitive edge only in the agricultural sector.

Here it should be added, with particular regard to Italy, that many of the "official" agricultural areas around city centres are, in fact, such only due to one of the greatest phenomena of collective hypocrisy, which prevents to recognize them for what they are actually: low-density – sometimes unreasonably low because of planning restrictions – residential areas.

On the social issue, then, it is enough to mention Herbert Gans, well-known sociologist at Columbia University, author of *The Levittowners: Ways of Life and Policy in a New Suburban Community*, who stated: "I have never seen any persuasive evidence that sprawl has significant bad effects, or high-density development significant virtues. Indeed, I doubt that the density itself has much impact on people, except at levels at which it produces overcrowding or isolation. I therefore believe that people should be able to choose the density levels they prefer".[52]

On all these fronts, therefore, it is difficult to defend the thesis on an alleged primacy of the dense and compact city over the low-density suburbs or on greater connotations of progress in the model of growth containment.

Even a holistic assessment, produced by the ponderous study coordinated by Marcial Echenique of Cambridge University, with Leeds University and Newcastle University,[53] has demonstrated through an extraordinary wealth of apparata, that the models of the implosive, centripetal city, the perimeter-growth city, the new-towns-growth city and the spontaneous, *laissez-faire* city are substantially equivalent from a point of view of overall sustainability.

Besides, from a social sustainability point of view, to quote Bruegmann once more: "... anti-sprawl policies have tended to be highly inequitable. Although they are often beneficial for an "incumbents' club" – families who already have many of the urban amenities they want and who benefit from the rise in land prices that have accompanied anti-sprawl regulations – these same policies can place a heavy burden on exactly that part of the population least able to protect itself".[54]

To which conclusions should we arrive to? Should we say that – contrary to what we tend to do today – the garden-city model should be encouraged and that the dense city prevented? That urbanistics should shift from the imposition of a model to the imposition of the opposed one?

We should pursue none of this. In fact, as discussed, it is possible to list many studies, just as authoritative as the ones mentioned above, of opposite inclination. The truth seems to be that the issue is too complex to allow for all-encompassing certainties, applicable to all cases.

The – temporary – conclusion is therefore that there is no reasonable evidence against low-density settlements, good enough to justify the imposition of a model of life that could be considered superior, more sustainable, more progressive, etc. Therefore, the criterion to be possibly applied is that of the preferences, of the expectations and of the desires of citizens, to which the technical knowledge should give their best form, in a framework of greater freedom.

Perhaps all of us have to engage in a further effort to reconcile the love for our land that drives us to be prudent with the spirit of service that suggests listening and accompaniment, with good will, and without prevarication.

1.6. Landscape consumption

The reasoning attempted so far could be considered complete, were it not for the remaining uncovered questions relating to landscape quality. In this regard, it is worth two brief remarks. First, what discussed above authorizes considering the expression "land consumption", which today is often referred to, rather vague. It is – says Bruegmann – widely prejudicial and specious and therefore misleading. Planning and, in general, human activities can predispose land to different uses and functions, each one with advantages and disadvantages for public administrations, for specific groups, for individuals, including their owners.

I would argue that the parallel concept of "landscape consumption" is much more tangible and defensible, having to do with the visible transformation of natural (or agricultural) landscape – something our present culture assigns an increasing public value to – into something else. Then, the core of the question is the balance between the aesthetic qualities before and after transformation.

Secondly, the scarce quality of several low-density suburbs does not authorize us to attribute an overall negative judgement to this settlement type. Many authors – such as Melvin Webber and Robert Stern – have highlighted the aesthetic qualities of garden suburbs.

As an example of positive aesthetic judgements of suburban housing sprawl *ante litteram*, one could quote the statements by two authoritative witnesses of the Italian Grand Tour.[55]

52. Bruegmann, 126.

53. Echenique, Marcial H.; Hargreaves, Anthony J.; Mitchell, Gordon; Namdeo, Anil, "Growing Cities Sustainably: Does Urban Form Really matter?", *Journal of the American Planning Association*, 78:2 (2012), 121-37.

54. Bruegmann, 11.

55. I am grateful to Marco Romano for these references.

According to Montaigne (1580) a low-density settlement surrounding a city centre – Florence in this specific case – can be seen as a beautiful landscape: "Firenze è in una piana circondata da infinite colline assai ben coltivate, bello è invero contemplare l'infinita moltitudine di case che riempiono i colli tutt'in giro per due o tre leghe almeno. E questa piana dove essa s'adagia e che si estende, a occhio e croce per due leghe in lunghezza, giacché par che si tocchino, tanto sono fittamente disseminate".[56] A century and a half later, Montesquieu (1728) testified the beauty of the housing sprawl along the coast between Genoa and Portovenere: "Lungo quasi tutta la costa, specie verso Genova, si vedono le montagne coperte di casette, che fanno un bellissimo effetto".[57]
From the point of view of aesthetics, all models – high- and low-density, and all intermediate solutions – can be declined in the best and in the worst way, depending on the dedicated attention and on design expertise. However, low-density sprawl – but also the city made of tall and/or bulky buildings, which affects the form of the territory from afar – implies a significant transformation and therefore a potential depletion of landscape, in its making. Given the unsurpassed public value we attribute to undeveloped landscapes, and even though the transformation of the territory can produce formal results of the highest quality, these outcomes often cannot compensate the corresponding loss of agricultural or natural landscape.
It is, therefore, the concern for "landscape consumption" that might lead us to restrict the changes to those cases where the overall benefits are actually relevant and extraordinary. In order not to lose agricultural or natural landscape we may find ourselves having to drastically limit transformations and curb development, although this will continue to cause recessive and inflationary effects, especially to the detriment of the poorest and of the aspirations of the majority.

2. Regenerating the light city

2.1. Dealing with existing sprawl

The reasoning thus far seems to lead to some provisional conclusions. First of all, there are serious doubts on whether to restrict the production of new housing on the sole basis of intrinsic motivations such as those that supply far exceeds supposed needs. In fact, building limitations fuel the phenomenon of economic rent, raise prices, and the resulting "affordability gap" and aggravate social inequalities, hitting the weakest.[58]
Specific restrictions are appropriate where they are supported by exogenous reasons such as preservation of landscape values. So it is recommendable to strike a balance through virtuous planning and design practices that maintain high levels of competitiveness thanks to a large availability of opportunities for transformation.
Secondly, low-density settlements, heirs of the garden city, are not less sustainable than those in higher density per se. In this case, it seems appropriate to facilitate sustainability through forms of intelligent design, while guaranteeing an offer that is plural, in line with the variety of demand.
Finally, one could argue nevertheless, that the transformation of natural areas (or dedicated to agriculture) may constitute an impoverishment of the landscape that remains, particularly in certain cases such as the Italian, an especially valuable collective good to be protected. The goal is, therefore, to seek appropriate solutions that allow for a satisfaction of people's desires, for a strong containment of affordability gaps as well as for a limitation of the waste of undeveloped landscape.
The latter goal deserves, however, a clarification. Practices of densification, infrastructuring, reduction of discontinui-

56. Montaigne, *Viaggio in Italia*, Editori Laterza, Roma-Bari, 1991, 138: "Florence is in a plain surrounded by endless hills very well cultivated. Beautiful is indeed to contemplate the infinite multitude of houses that fill the hills all around for two or three leagues at least and this plain where it lays down and that extends, more or less for two leagues in length, so that it seems that they touch each other, so that so they are so densely disseminated". (My translation).

57. Montesquieu, *Viaggio in Italia*, Editori Laterza, Roma-Bari, 1990, 109: "Along almost the whole coast, particularly towards Genoa, the mountains are covered by little houses which perform beautifully". (My translation).

58. Since the first draft of this text and the publication of my text mentioned above (2015), a number of relevant contributions on this subject have come to light, at least partially converging from sources of different standings. They deserve a special attention not only for the heuristic but also for their implications in the practice. Here are some of the most relevant: Ikeda, Sanford; Washington, Emily, "How Land-Use Regulations Undermines Affordable Housing", Mercatus Research, Mercatus Center. George Mason University, Arlington, VA, November 2015; Furman, Jason (Chairman of the Council of Economic Advisers of the White House), "Barriers to Shared Growth: The Case of Land Use Regulation and Economic Rent", The Urban Institute, November 20, 2015; Krugman, Paul, "Inequality and the City", *The New York Times*, November 30, 2015 http://www.nytimes.com/2015/11/30/opinion/inequality-and-the-city.html?_r=2; Cox, Wendell, "White House Economist Links Land Use Regulations, Housing Affordability and Inequality", *newgeography*, 12/01/15: http://www.newgeography.com/content/005111-white-house-economist-links-land-use-regulations-housing-affordability-and-inequality.
This concurrence has lead to propose a most welcomed cross-ideological consensus on the need to avoid unreasonable and overly restrictive zoning: Somin, Ilya, "The emerging cross-ideological consensus on zoning", *The Washington Post*, December 5, 2015: https://www.washingtonpost.com/news/volokh-conspiracy/wp/2015/12/05/the-emerging-cross-ideological-consensus-on-zoning/; Cox, Wendell, "Land Regulations Making Us Poorer: Emerging Left-Right Consensus", *newgeography*, 8 January 2016: http://www.newgeography.com/content/005139-land-regulation-making-us-poorer-emerging-left-right-consensus; Twyford, Phil; Hartwich, Oliver, "Planning rules the cause of housing crisis", *New Zealand Herald*, 29 November, 2015: http://m.nzherald.co.nz/business/news/article.cfm?c_id=3&objectid=11553128 Even though it is clear that some authors use these arguments to support a free-market attitude towards urban expansion and others to back infill projects, this development of the debate seems promising and fosters fertile developments.

ties, density homogenization, in short, urban regeneration in existing low-density settlements, are not forms of landscape consumption. Rather, they are suitable and evident efforts of virtuous redevelopment. For this reason, the arguments against sprawl repair, when considered as an activity of sprawl perpetuation, seem moved by ideological preconceptions rather than by a solid rationale.

2.2. Sprawl regeneration in the United States

For many years, research and professional practice in the United States – but also in other countries of the Western world – have dealt with the redevelopment of the low-density suburbs. This production can rely on a set of theoretical contributions and design experiments, reforming the discipline of the landscape, with two lines of development, which, again, I try to summarize.

A line derives from the interpretation of the territory by a continuity of type-morphological zones. The so-called urban-rural "transect", proposed by the American New Urbanism, has taught us that the net opposition country-city is a misleading abstraction and that there are intermediate situations that need to be recognized, studied and designed.[59]

The other line has developed a specific analytical[60] and design[61] attention to the suburban realm with hypotheses and applications of regeneration, so-called "retrofit" or "repair". One could suggest that the goal is analogous to the one prefigured by Colin Rowe in the quote in the epigraph: have a compact centre surrounded by a suburb of good quality. Often in many countries, particularly in Anglo-Saxon countries, there are suburbs, heir to the tradition of the garden city, whereas the compact centre is missing. This is why redevelopment projects propose dense hubs, rich on services and community activities, easily accessible, pedestrian friendly. Moreover, suburban settlements, while designed, often are not of good quality: they are anonymous, repetitive, lacking from a landscape, functional, environmental and sustainability point of view. Therefore, many redevelopment projects also propose densification strategies as well as formal and functional improvement of public spaces.

2.3. Sprawl repair and regeneration in Italy

In Italy, despite the attention long paid by scholars for the phenomenon of diffusion, it does not seem to have been able to produce either an overall strategy, weighted on the size of the facets of the problem, nor a proactive engagement.

It is likely that the main conditions that have fostered this situation are in line with those mentioned above. First, the alleged excess of supply over demand plays a major role. The Italian disciplinary debate has shown a growing and now radical distrust of production of new residences whereas there is no doubt that any serious strategy for urban regeneration needs, alongside the recovery activities of existing building, the morphological and economic contribution of mainly private new buildings. The containment of production is, nevertheless, the common goal of many current or under discussion public policy acts.[62]

Second, and consequently, the aversion for low-density settlements as inefficient is the common, widely shared, attitude.[63]

Finally, an important role is assumed by the environmental impacts, hardly contestable in their landscape aspects, which are induced by the production of new low-density neighbourhoods – but of high-density ones, too. Regarding the latter argument, however, the distinction between undeveloped, natural or agricultural, landscape and already-developed landscape remains opaque.

The different attention to the problem of the redevelopment of the peri-urban settlements in Italy than in other countries would rest on the fact that, while the residential expansion on the model of the garden city is massive elsewhere – say in the English-speaking world – in Italy it would be a marginal phenomenon. To this assumption, however, it is worth dedicating a short reasoning.

2.4. The "light city" in Lazio and around Rome

Our Italian culture is fond of a model full of quality, symbolism, and rationality. As in the fresco by Lorenzetti, "Buon Governo", our conceptual world is divided into dense and

59. http://transect.org/transect.html; Duany, Andrés, "Transect Planning". *Journal of the American Planning Association*, 68, 3, Summer 2002, 245-246; Duany, Andrés; Talen, Emily, "Making the Good Easy: The SmartCode Alternative", *Fordham Urban Law Journal*, 29, 4, 1445-68; Duany, Andrés et al., "The Transect" (special issue), *Journal of Urban Design*, 7, 3 (2002).

60. Among the most recent contributions: Keil, Roger (ed.), *Suburban Constellations. Governance, Land, and Infrastructure in the 21st Century*, jovis Verlag GmbH, 2013; Mace, Alan, *City Suburb. Placing suburbia in a post-suburban world*, Routledge, Milton Park, 2013.

61. Calthorpe, Peter, *The Next American Metropolis. Ecology, Community, and the American Dream*, Princeton Architectural Press, New York, 1993; Dunham-Jones, Ellen and Williamson, June, *Retrofitting Suburbia. Urban Design Solutions for Redesigning Suburbs*, John Wiley and Sons, Inc., Hoboken, 2011 (2008); Tachieva, Galina, *Sprawl Repair Manual*, Island Press, Washington, 2010; Williamson, June, *Designing Suburban Futures. New Models from Build a Better Burb*, Island Press, Washington, 2013; Talen, Emily (ed.), *Retrofitting Sprawl. Addressing Seventy Years of Failed Urban Form*, University of Georgia Press, Athens, 2015. For a French example, see Guilpain, Laureline; Loyer, Simon Jean; Rapin, Aurore; Shaefer, Tiemo; Stablon, Jérôme (École nationale supérieure de la ville & des territoires à Marne-la-Vallée), *s(t) imulation pavillionaire*, Archibooks + Sautereau Éditeur, Paris, 2014.

62. See, as an example, the parliamentary debate on the proposed act: "Contenimento del consumo del suolo e riuso del suolo edificato" (Camera 2039), presented on 3 February, 2014, presently under discussion.

63. See for instance the position clearly against low density shown by the official proposal for the Italian Planning Act: "Principi in materia di politiche pubbliche territoriali e trasformazione urbana" as published for an on-line public consultation by the Working Group "Rinnovo Urbano" of the Ministero delle Infrastrutture e dei Trasporti, on 24 July, 2014.

compact cities and undeveloped agricultural and natural country. The border is clear, symbolically represented by the town walls. The Italian legal framework follows and supports this concept.[64]

Therefore, in the representation of our cities they are solid and contained in comparison to others of similar importance. Suffice it to compare, for example, the representations in figure-ground on a large scale of Rome and other similar ranking cities, as proposed by Bosselmann.[65]

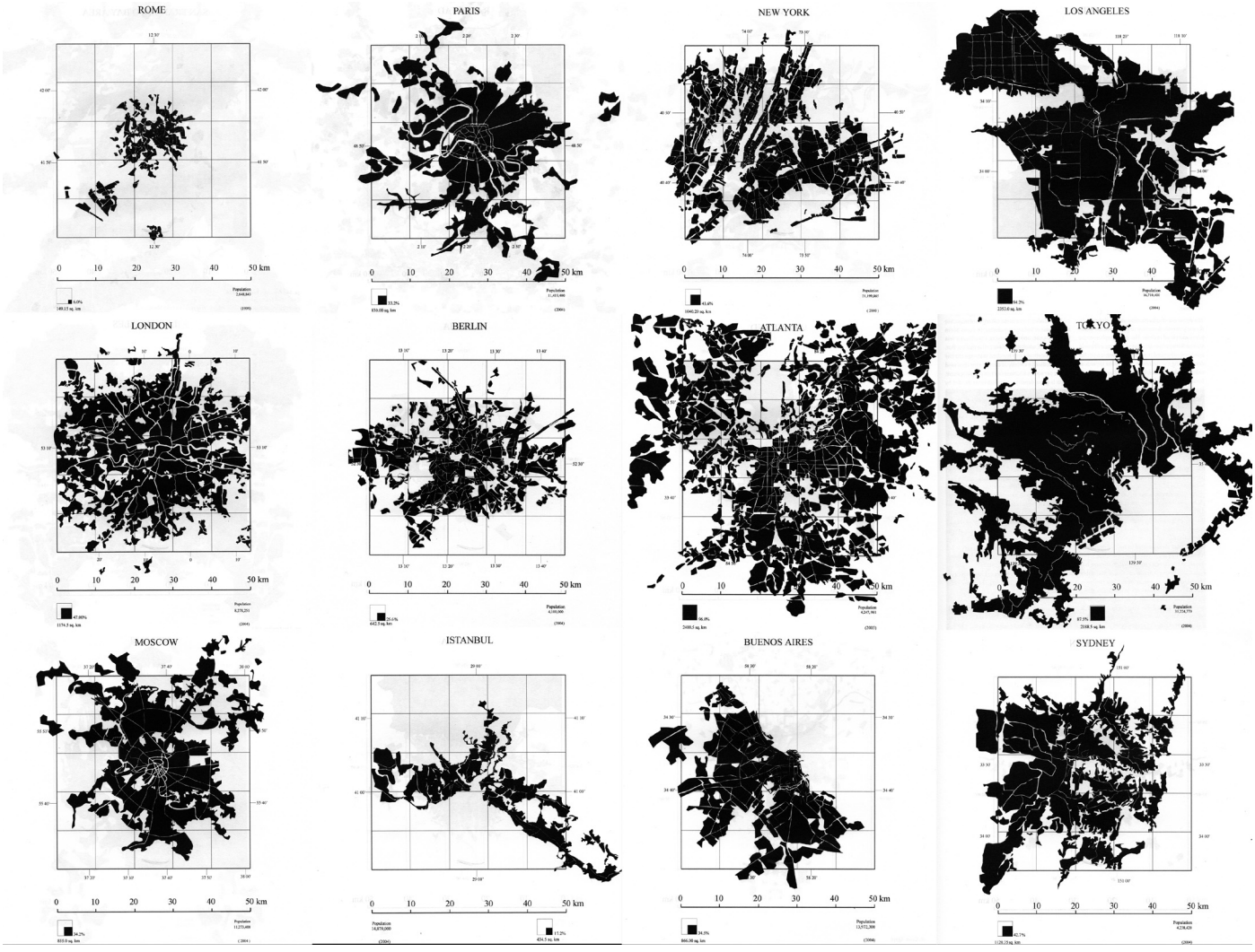

Figure 1 – Ground layout of Rome compared to analogous ranking cities [from Peter Bosselmann].

This representation, however, could be endorsed – not without some problems – half a century ago. In view of the dynamics of the last decades, it is impractical. To find evidence of this, it is sufficient to follow the settlement dynamics in the area of Rome since the beginning of the '60s.

We urbanists tend to adopt an idealized reality, as we would like it to be: the compact city surrounded by agricultural and natural land, with nothing in between. This applies even when – as in most cases – the green areas are in fact city: they are a declension of the *ville légère*, "light city", to use this effective interpretive category, recently adopted in the studies devoted to the "Grand Paris" metropolitan area.[66] Not recognizing this evidence, however, we bar the possibility to regenerate that city by design.

The abstract representation that we adopt also determines the urban tools by which territorial dynamics are governed. As shown in the illustrations below, there are, for example, some areas, undeveloped, that are officially "agricultural" and other areas, developed, albeit partially and low-density, which are officially ... "agricultural", too. Classification and, therefore, planning regimes are similar for both types. Can the same rules be effectively applied to situations so clearly different?

The reality is much closer to the excellent operational representation of the so-called urban-rural transect, mentioned

64. Here I refer, in particular, to the zoning classification prescribed by the D.I. 2 April 1968, 1444, art. 2, which recently regional administrations have been allowed to modify but have not so far.

65. Bosselmann, Peter, *Representation of Places. Reality and Realism in City Design*, University of California Press, Berkeley, 1998.

66. LIN Finn Geipel + Giulia Andi et al., "Micro-centralités – Systèmes immanents de la ville légère. Systèmes metropolitains", Berlin, Septembre 2013: http://www.ateliergrandparis.fr/aigp/conseil/lin/LIN_Systeme.pdf. I owe this reference to Rachele Passerini.

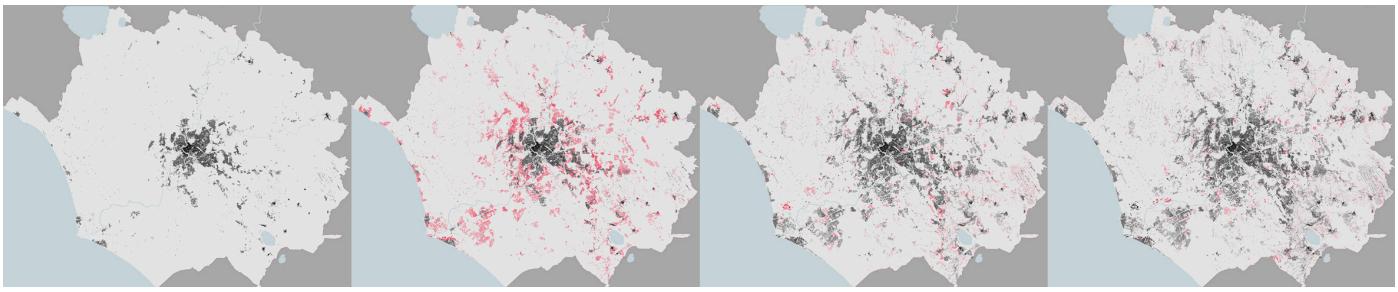

Figure 2 – Development dynamics in the Roman area (1961, 1991, 2001, 2008) [Rachele Passerini].

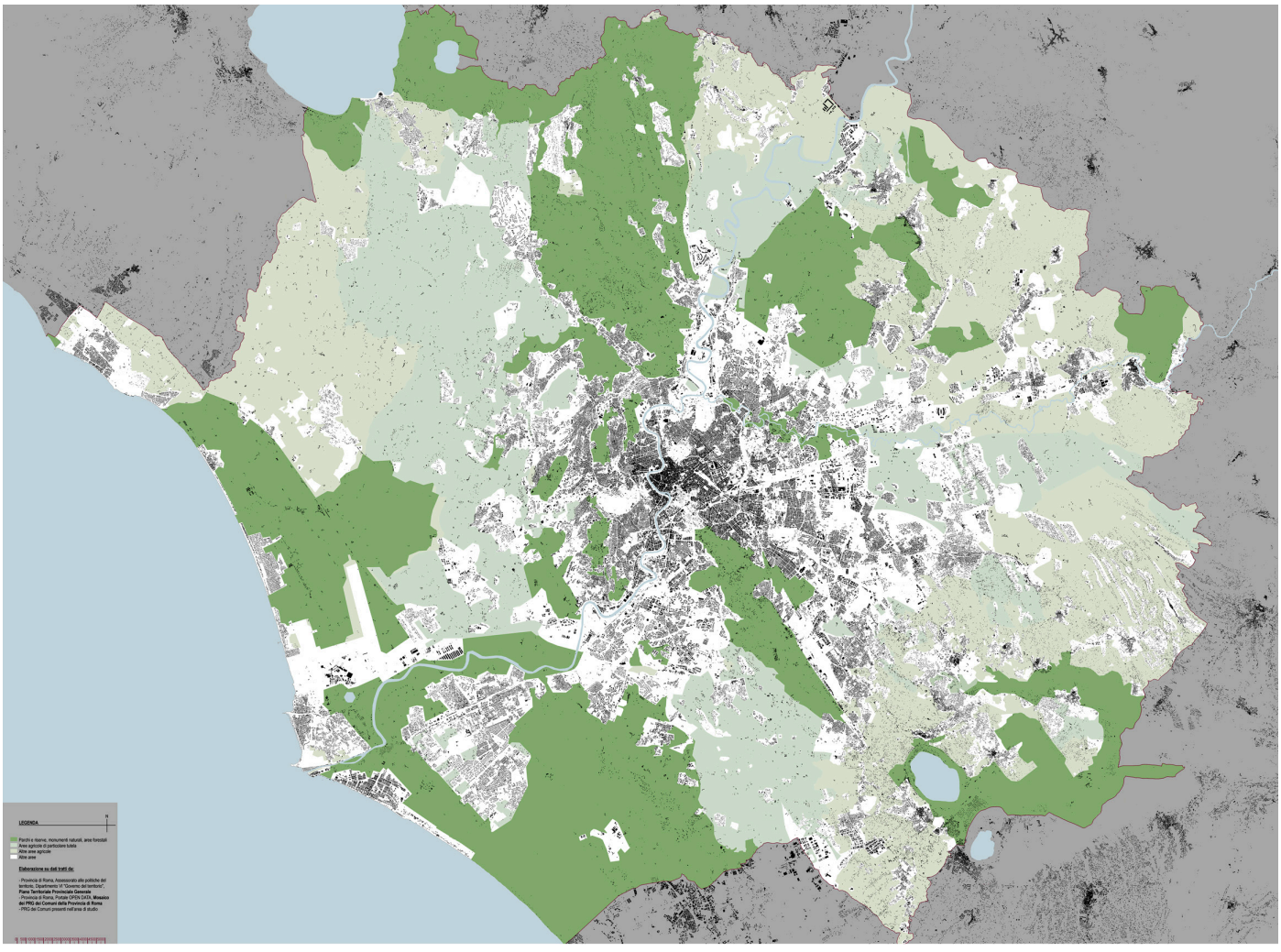

Figure 3 – Natural reserve (dark green) and "agricultural" zones (light green) superimposed to settlements (black) in the Roman area [Rachele Passerini].

above. Not recognizing the existence of type-morphological continuity, i.e. disregarding the intermediate zones, does preclude the possibility of adequately responding to the problems of those realities.

To further clarify the issue, let's consider two examples: one is a section of Sea Ranch, California: a high quality residential compound, designed by masters such as Lawrence Halprin, Joseph Esherick, Charles Moore, among others. Subjected to a set of strict but not punitive rules, it is a masterpiece of high economic value, too. The other example is a part of the so-called Castelli, south of Rome.

The densities in these two cases are comparable but, officially, the second is made up of agricultural areas or agricultural landscapes, though it is unlikely to be inhabited by farmers and agricultural production is hardly more than marginal. As officially agricultural, however, these areas are subjected to regimes that follow the criteria of agricultural production and their development is based on the impertinence of those

Figure 4 – Bracciano: aerial views (left) and zoning (right) of different "agricultural" areas, cultivated (white) and wooded (green) [Rachele Passerini].

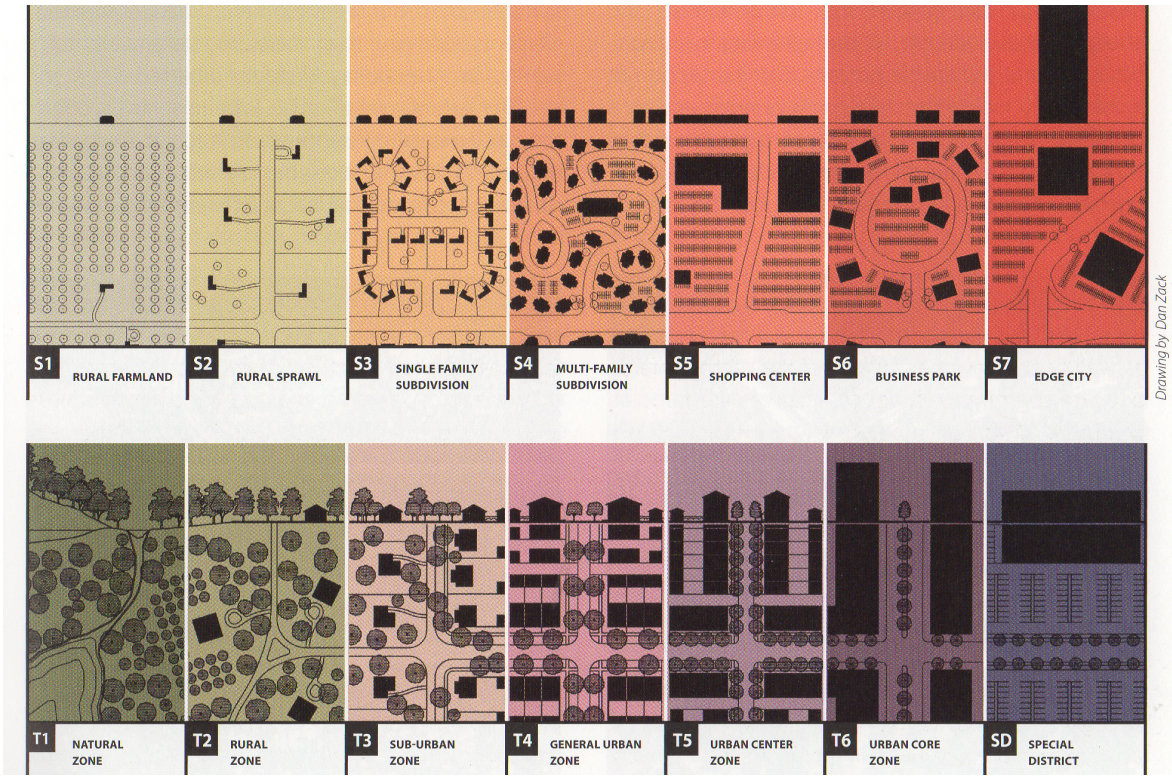

Figure 5 – Urban-rural transect in sprawl and traditional urbanism [Galina Tachieva].

Figure 6 – Two low-density settlements compared: resort in Sea Ranch, California (left) and "agricultural" settlements in Montecompatri, Lazio (right).

who aspire to build a single-family home and is not covered by detailed type-morphological rules but just to general prohibitionist rules, often broken, as an out-of-reach low density and inefficient minimum lot sizes.

This type of settlement is very frequent in the areas surrounding major centres, as the Roman area, and consists of spontaneous artefacts, chaotic and random settings, with no urban design. Often it is the indolent and, frequently, vulgar response to the need to bypass economic rent and the desire to access a building type, and type of life, that official town planning is unable and/or unwilling to provide for.

If we consider a municipality near this area, Monte Porzio Catone, the representation used by the planning instruments is the ideal one, made of dense centres surrounded by country-

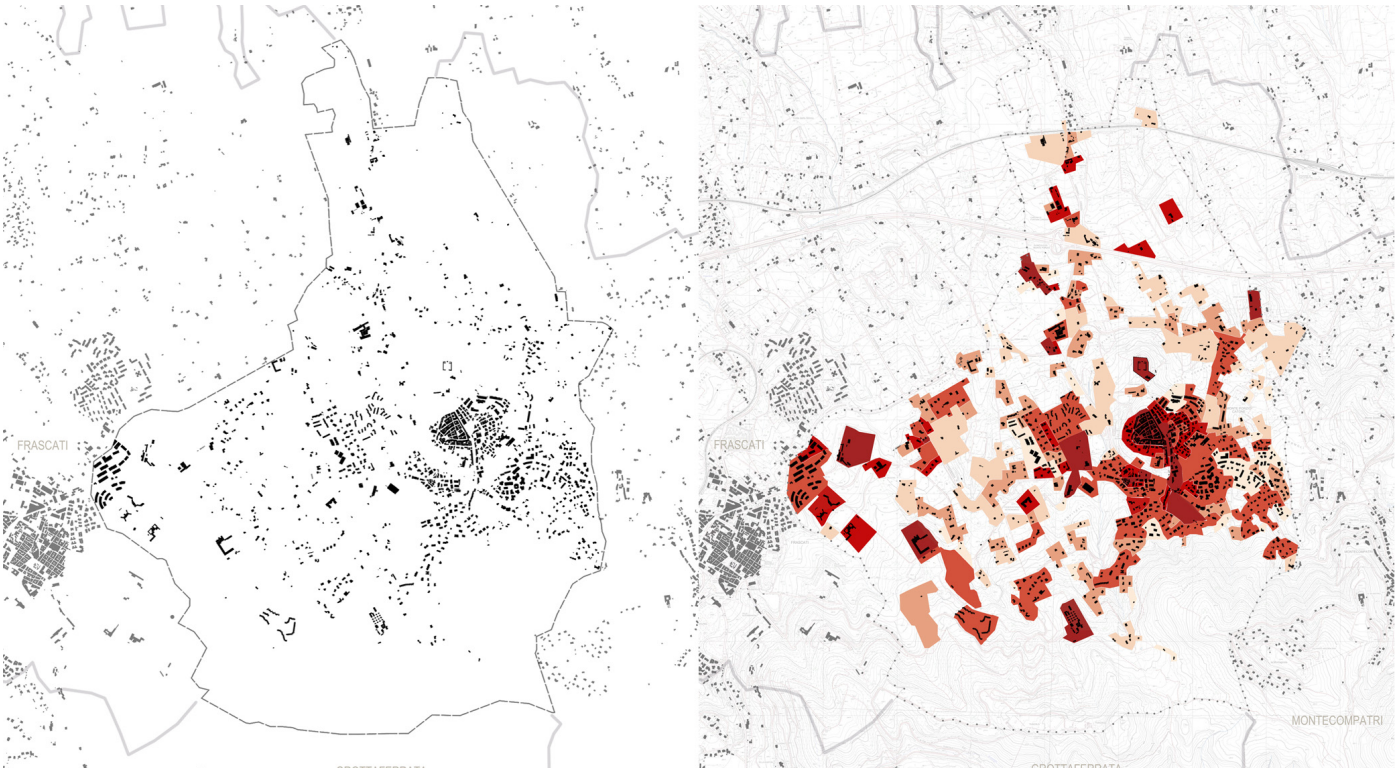

Figure 7 – Monte Porzio Catone, Lazio: settlement layout (left) and implementation dynamics (right. Dark red to pink sequence shows older to more recent plot developments) [Giulia Vignaroli].

side. In reality however, a large part of that country consists of diffused settlements that are formed over time, regardless of any design frame.
The overall quality of this landscape is generally disappointing although full of potential prospects. Official planning and, in truth, the disciplinary culture prevalent today insist that, despite the evidence, these are agricultural areas to be, in fact, frozen and substantially preserved in their current state. Often, given the criticality of these areas, they are, very suitably and yet paradoxically, subject to special building restrictions by the national office in charge of landscape protection. In fact, if the bonds do not translate into guidance towards conversion, they are doomed to remain an unfair theatre of stabilized unbalance.
Technical common sense seems to suggest that, through a process of rigorous design, they are regenerated as "good suburbs", dotted with centres of higher density, easily accessible, as in the image suggested by Colin Rowe's statement.
Analogous situations are anything but episodic. In Viterbo, for example, a beautiful city north of Rome that Paolo Colarossi and I have recently studied, about 20% of the municipal area – about 8,000 hectares – consists of "light city", mostly residential, not of poor quality but largely spontaneous and not covered by any kind of urban design.
If we observe some specific cases, we find a few recurring circumstances worth noticing. In some "agricultural" areas, as in the area of Querciaiolo, most likely resourceful and nonchalant citizens, who interpreted the planning rules in a rather flexible fashion, have developed many lots. Other landowners, strictly following the rules, abstained.
The result is a landscape uneven and of uncertain quality, both because there are no detailed type-morphological rules, guiding buildings or open spaces, and because undeveloped lots tend to be, understandably, less maintained than others.
In other "agricultural" areas, as in the case of Ponte di Cetti, the settlement is even more accidental even though careful design could have ensured not only a broader and more uniform quality but also the possibility to best use the possibility of well serviced existing or potential centres, adjacent to infrastructure corridors, as the rail network.
In other "agricultural" areas yet, as Palomba, it seems that the planning demand for very large lots has transformed partly unused and undeveloped lots into a wasteland.
In all these cases, it seems desirable to access a program of urban densification and landscape regeneration, which is rigorous and well supported by solid rationales but free from rules that are laid down on the basis of agricultural production.
To conclude, it is helpful to evaluate, albeit roughly, the magnitude and, therefore, the relevance of low-density settlements in the area considered.
Rachele Passerini has studied the type-morphological characteristics and the spread of the Roman settlement. A "natural" Roman metropolitan area, extending from the sea to the West, to the Tiburtini elevations to the East, from Lake Bracciano to the North, to Lake Albano to the South, consists of 29 municipalities, including Rome, to a total of about 230,000 hectares.[67]
This is a very well infrastructured territory, potentially served by 100 kilometres of railway within and 450 kilometres outside the Grande Raccordo Anulare, the Roman beltway.
About half of this area is actually made up of agricultural landwhile a quarter is dense city, including the interstitial spaces. 5% is used for special purposes such as, for example, the airport. Just over 20% – more than 45,000 hectares – is, in reality, "light city" with all the features of lack of urban design, lack of homogeneity, small discontinuities, uncertain quality and legality, high fractionation in ownership and functions, high flexibility. Inhabitants are mostly families whose main income is not from farming.
From a strictly aesthetic or functional point of view, these are neither dense city areas nor actual farmland. They are definitely areas of other type, with high landscape potential, but very critical at present.
Also for this reason, many of these areas are very appropriately placed under protection. A significant portion of them – approximately 7,500 hectares – are in areas of natural protection. Of the remaining ones, including those affected by the phenomena of urban sprawl in a more intense form, a part, to some 6,500 hectares, has been, quite rightly, the subject of "declarative constraints" (vincoli dichiarativi). Another part, for about 4,000 hectares, is, as appropriate, identified as "identity areas of the Roman countryside" (zone identitarie della campagna romana) and equally restricted.
This has certainly restrained transformations, and probably, very commendably, avoided some disasters. However, it has not yet favoured rehabilitation processes, needing instead strategies. In fact, these may be more viable and effective if applied starting precisely from these areas.

2.5. Two ways ahead

We are facing a crossroads. There is a way very dear to many of us: it is the path along which the planning culture prevalent today gathers and that is inclined to "curb" – "arginare" to use the keyword of the recent Landscape Plan of Tuscany. This inclination is easy to understand if you think about how a few decades of unregulated building activity have managed to impoverish our territory, our landscapes. But it is also a paradoxical position if it results in the substantial confirmation *in aeternum* of the present critical conditions.[68]

67. In order to provide a dimensional reference, the scale of the area - with a radius of 25-30 kilometres from the centre of Rome - is roughly comparable to the metropolitan area of Portland (Or.) included in the well-known "urban growth boundary" in its present state.

68. When this article was in a version close to the final, a brand new

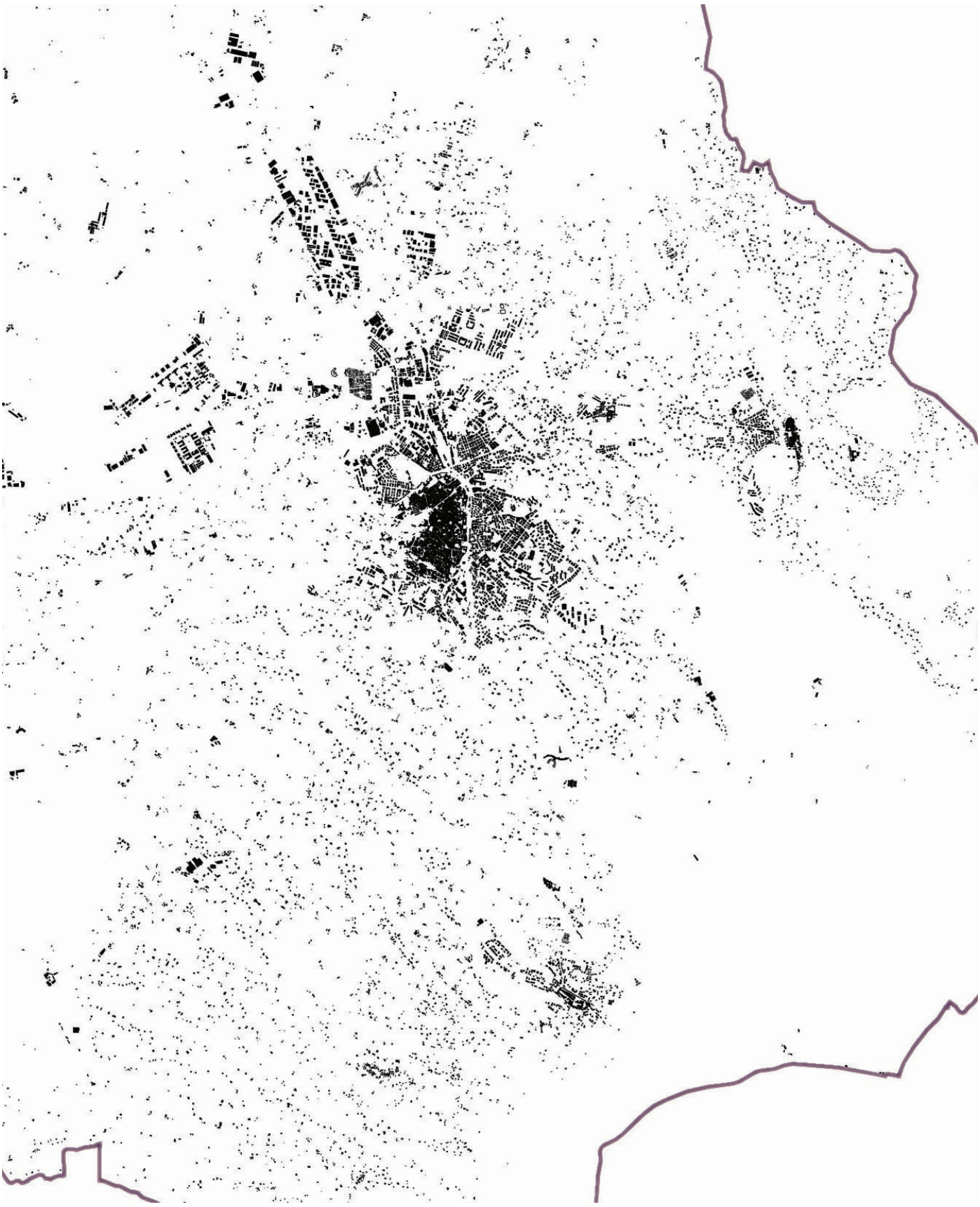

Figure 8 – Viterbo, Lazio: settlements layout around the centre city [Gabriele Tontini].

Regional Planning Law was proposed by the current administration of Lazio (Testo Unico delle Norme sul Governo del Territorio, December 14, 2015). Despite the overt, repeated reference by this proposal to the need of making all possible efforts towards regeneration policies, an accurate reading of the articles suggests that these efforts are supposed to be limited to the dense city and exclude the part of

Figure 9 – Viterbo, Lazio: landscape context (left. Yellow areas show the zones that the Landscape Plan considers "Valuable agricultural landscapes", orange areas are "Highly valuable agricultural landscapes", green areas are "Natural landscapes" and gray areas are "Urban settlements") and settlements (right. Gray and patterns show plots likely connected to a house) at Querciaiolo [Manola Colabianchi].

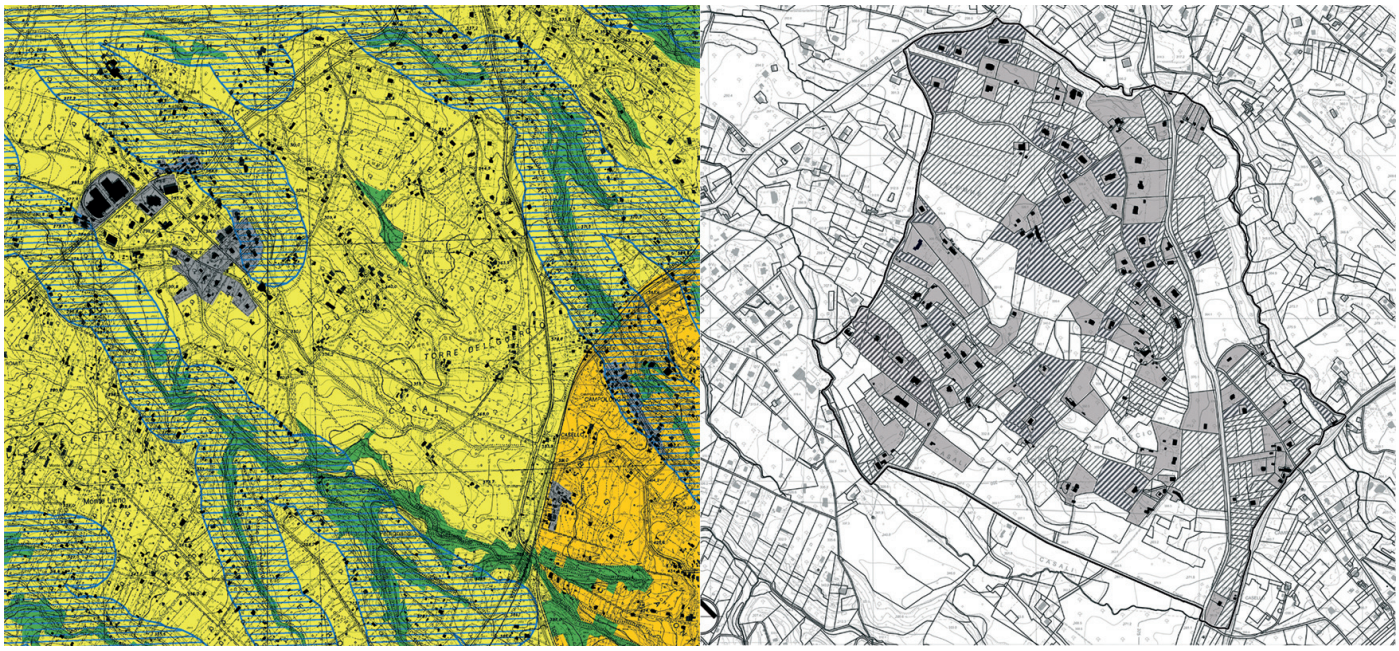

Figure 10 – Viterbo, Lazio: landscape context (left. Yellow areas show the zones that the Landscape Plan considers "Valuable agricultural landscapes", orange areas are "Highly valuable agricultural landscapes", green areas are "Natural landscapes" and gray areas are "Urban settlements") and settlements (right. Gray and patterns show plots likely connected to a house) at Ponte di Cetti [Manola Colabianchi].

It is hard to impose on the local communities and to our fellow citizens that the landscape of urban sprawl – that we ourselves declare to be critical – should be "preserved" as "agricultural" area or "agricultural" landscape – as, in fact, quite clearly is not – without this being seen as an unjust and despotic whim of planning.

The risks, anything but remote, are not only that unjust and irrational rules are defended, that healthy regeneration processes, positive economic dynamics and reductions of social

the region with the most pronounced need of regeneration and the highest strategic impact: the low-density suburban sprawl. Should this proposal be confirmed in the present form, it would very likely offset sine die any substantial effort of regenerating the Light City.

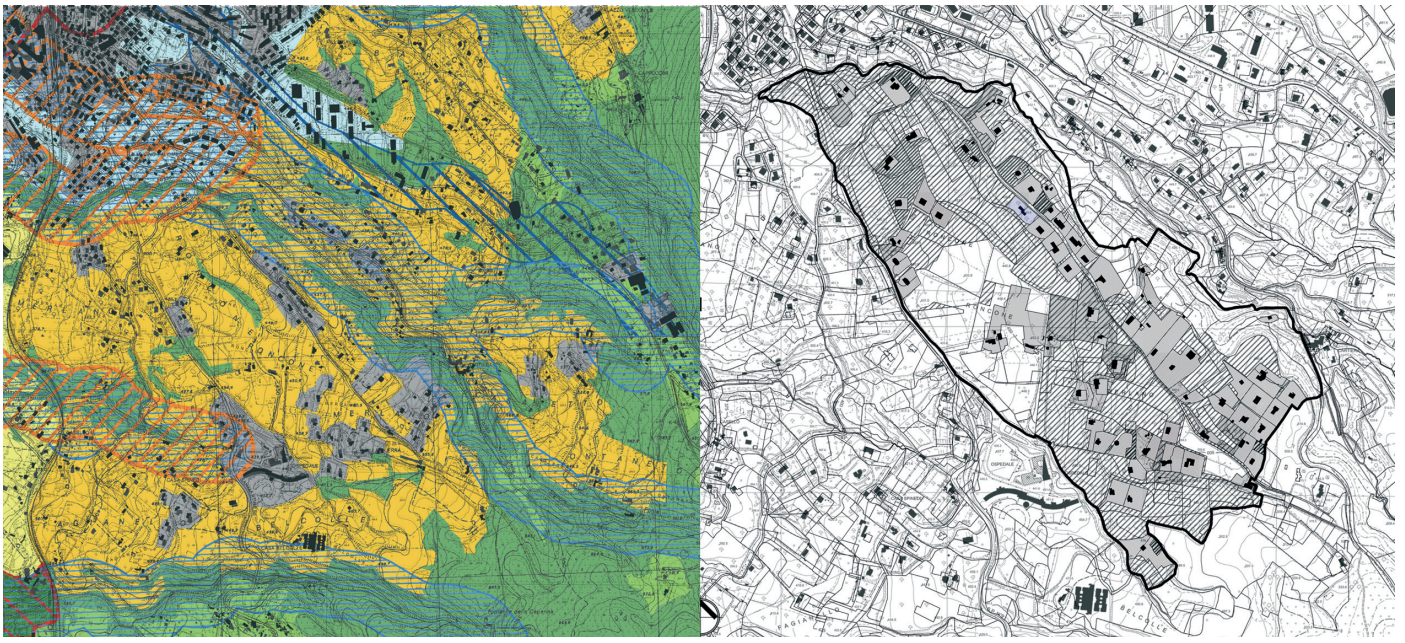

Figure 11 – Viterbo, Lazio: landscape context (left. Yellow areas show the zones that the Landscape Plan considers “Valuable agricultural landscapes”; orange areas are “Highly valuable agricultural landscapes”, green areas are “Natural landscapes” and gray areas are “Urban settlements”) and settlements (right. Gray and patterns show plots likely connected to a house) at Palomba [Manola Colabianchi].

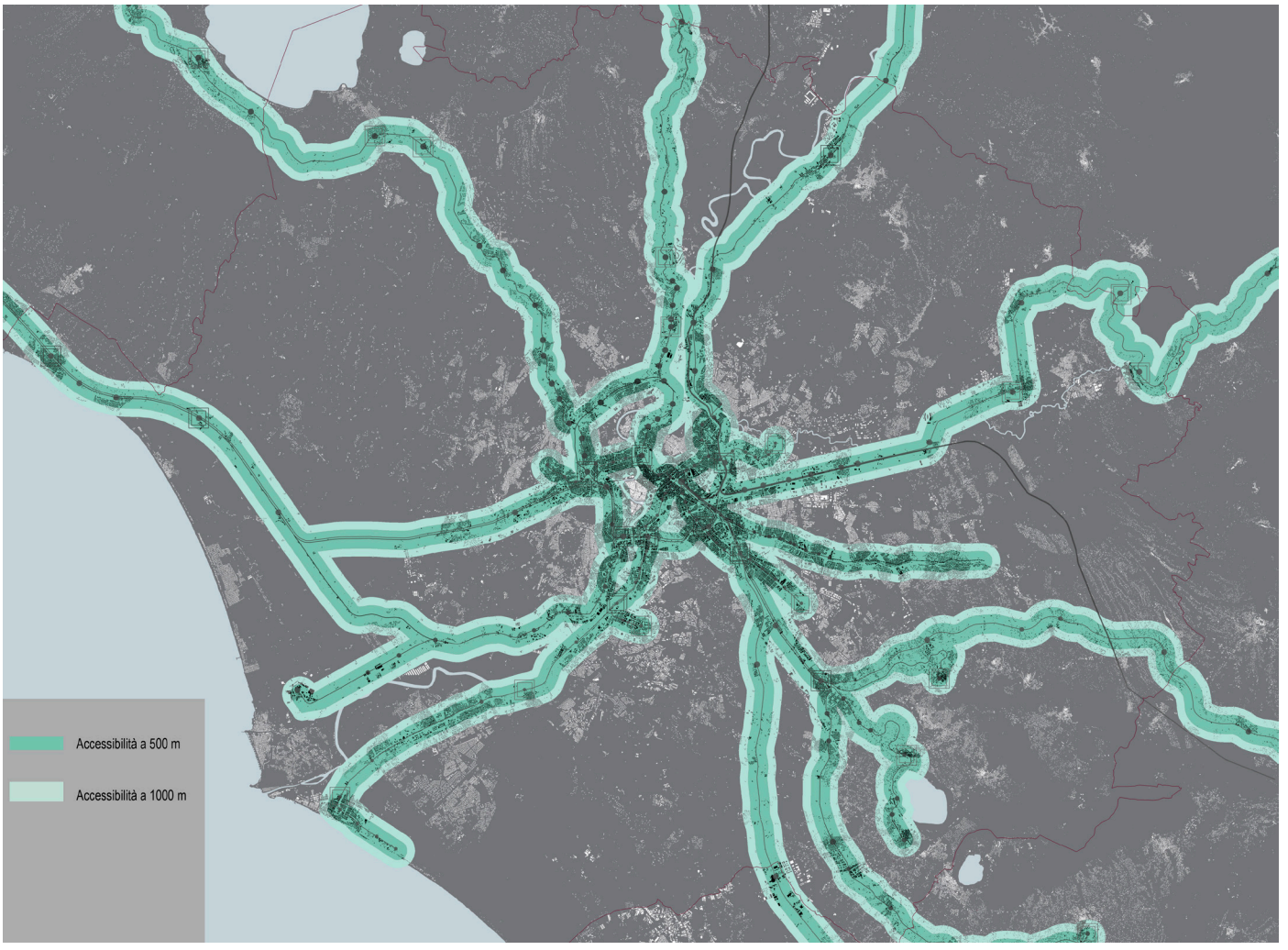

Figure 12 – Roman area: railroad and subway system (high-speed rail is not shown) [Rachele Passerini].

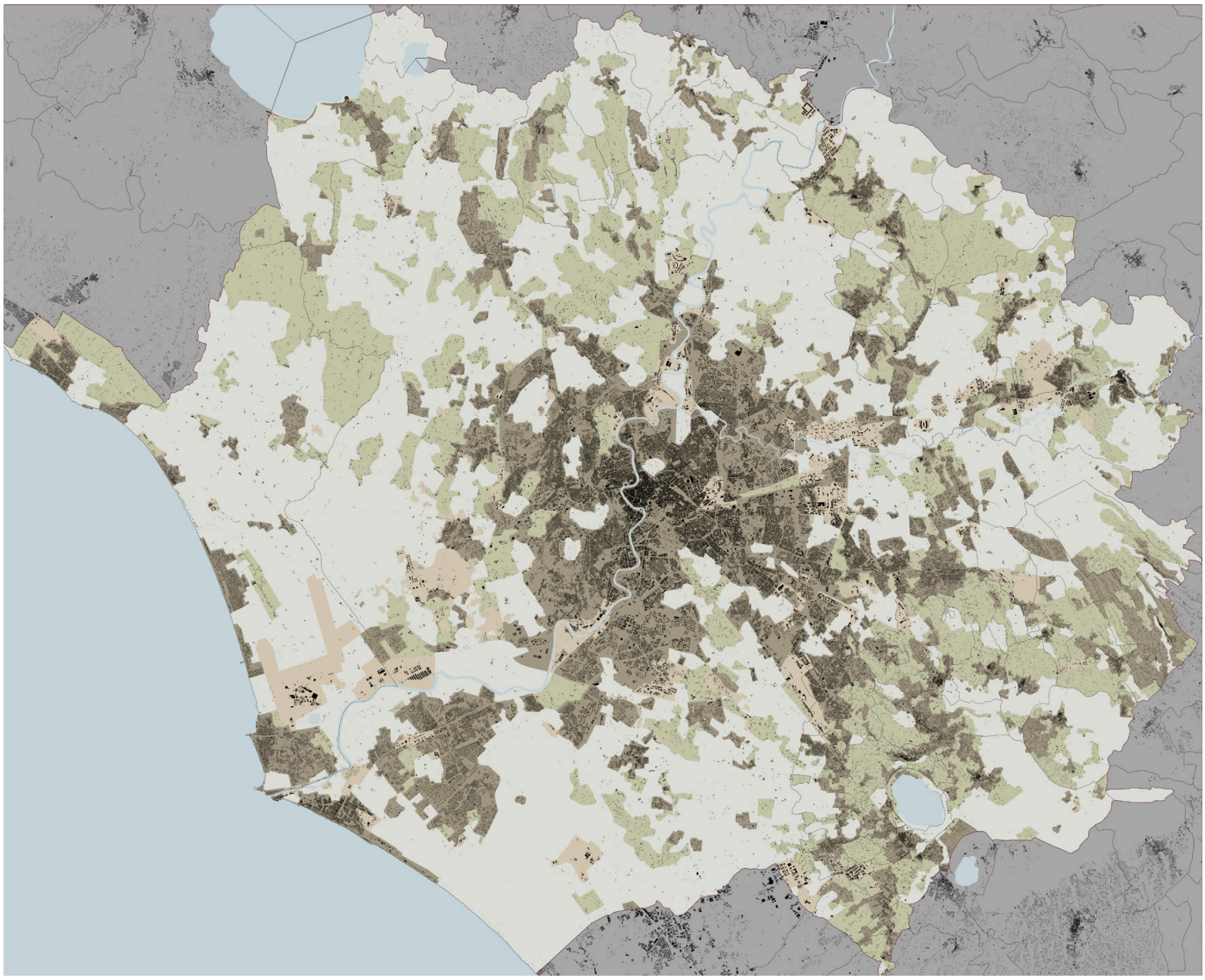

Figure 13 – Roman area. Approximate distribution of type-morphological zones: compact (dark brown), farmland (white), special-use (pink) and "light city" (light brown) [Rachele Passerini].

gaps are impeded, that the perception of planning – and of politics associated with it – by citizens further deteriorates but also that standards and planning tools are challenged in court and easily disassembled.

Is it appropriate to consider another way: that of the proactive project in the spirit of "building new coherent and integrated landscape values", as required by the Italian Code for the Landscape (Codice del paesaggio, art. 131) and identifying compatible transformations with a conscious, measured and thrifty use of resources. This attitude could take care of the type-morphological and functional quality of buildings – both existing and new but in already partially developed landscapes – energy sustainability and well-designed public and private open spaces.

In the case of the light city around Rome, it would be to plan a slight densification, homogenization and a reduction of the small-size discontinuity, a slight infrastructural and small service re-functioning, and a strong landscape and vegetation improvement. This action should begin exactly with the areas identified by the bonds. They are among the most affected by sprawl and those most in need of regeneration rather than the cage where the official planning seems determined to condemn them. The designed transformations could and should be driven by private resources, highly controlled in their morphological and functional aspects by a competent – and not sadistically punitive – public rationalization.

Such a proactive attitude seems to promise some considerable advantages. First of all, it would allow for the pursuit of landscape quality in those areas where the hand of man has threatened to definitively damage. This goal is, of course, tied to a competent and careful design but also to an appropriate regulatory basis.[69]

69. An outline proposal (in Italian) for a norm in this direction is in https://colinroweconference2015.files.wordpress.com/2015/11/latinirowerome2015text.pdf

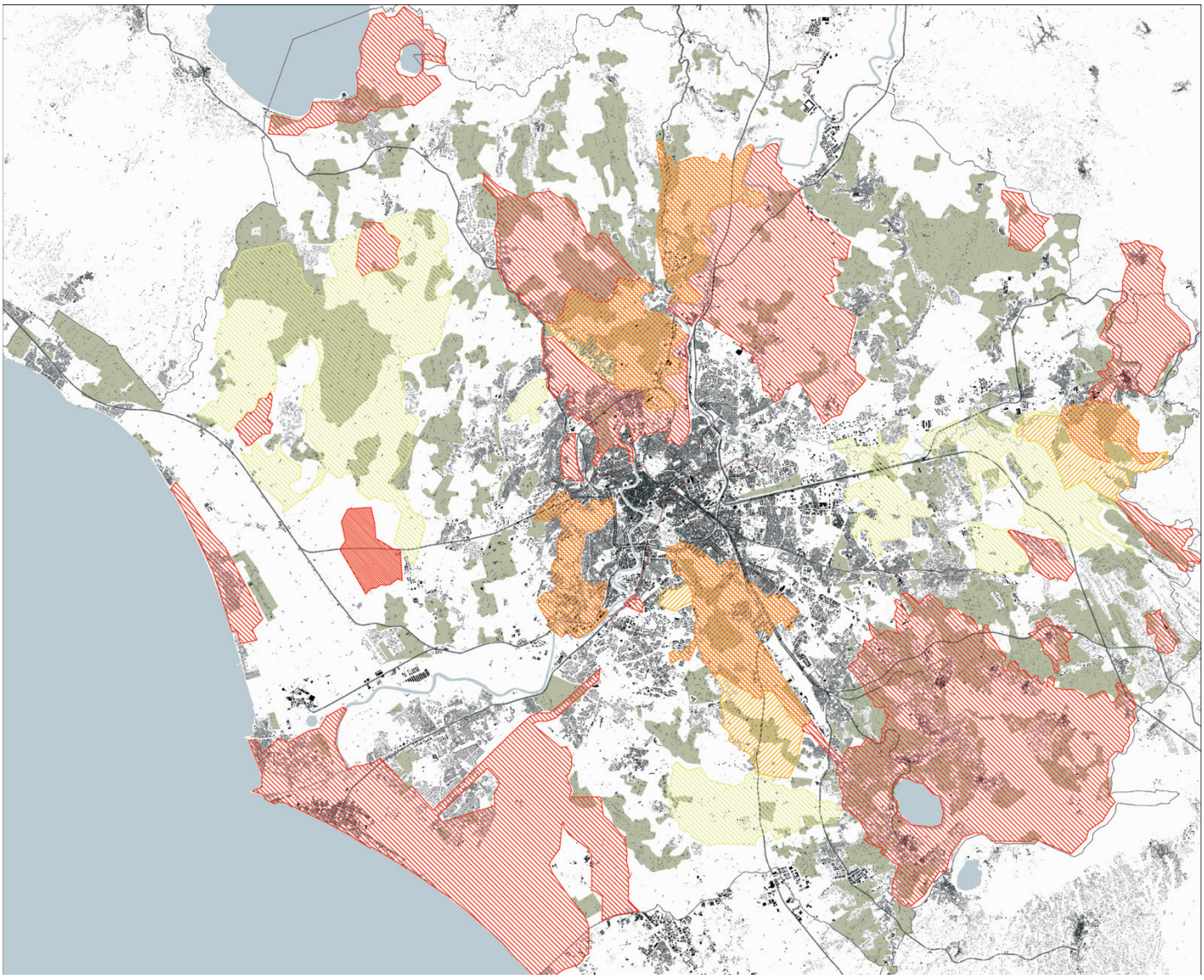

Figure 14 – Roman area. Preservation zones. Zones in red are restricted as “Areas with traditional aesthetic value and panoramic beauties”; in yellow are “Identity areas of the Roman countryside”, in orange “Areas with archaeological value” [Rachele Passerini].

Secondly, there is the opportunity for a “smart” compliance to the desires of many citizens, of many families who aspire to the model of life offered by the garden city: that is, efficient, sustainable and without wasting true agricultural or undeveloped natural areas; at the same time, it would make it possible to promote a supply-side policy aimed at containing the increasing “affordability gaps” and to reduce inequality.

Finally, we must fully consider the prospect of activating investments, major as a whole, generated by the convergence of many small-scale investments, within reach of families, that can easily be activated, if it is true that the savings of Italians – some Italians – at this critical stage of the economy, are accumulating but are not available for perishable uses.

Thus, it seems suitable to clear this middle landscape from its two-faced marginal position. It should be treated neither as an incomplete and peripheral city, nor as a corrupt country to be redeemed to its alleged – and imposed – agricultural vocations, but rather as a habitat with its own characteristics, to be completed and enhanced.

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Building Technologies

Hypothesis of infographic digitization of the building stock: the innovative contribution of ICT tools.

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Keywords: BIM, AR, ICT, InsidAR, Management of the building heritage.

Abstract

For years now, the strategies of the Italian Government and public administrations are moving the interests of the clients towards politics apt to ensure the functional recovery and renewal of real estate infrastructures of which our country is extremely rich. The strong incentives regarding the energetic, environmental and structural requalification of the existing heritage in the construction industry ensure that the housing demand will be reduced recording a slow but constant decline in the construction of new homes and buildings in general. The asphyxia of the Italian real estate market is certainly due on the one hand to the economic crisis and on the other hand to the necessity to reduce the soil consumption for new buildings. However, if the new constructions are decreasing, the interventions on the built are recording a constant growth especially in recent years thanks to the economic and social policies aimed to an increment of the investments for the energetic, environmental and structural requalification of the existing heritage.
However it follows the need to prepare a management plan of the same building heritage able to guarantee the correctness of the implemented data and feedback of the same in order to define the possible planning guidelines for the future building projects.
In view of those considerations, in this contribution it is proposed a supporting methodology to adopt a new strategy suitable for improving the management of the building heritage and such as to realize the infographic digitization of the building through the implementation of appropriate information and Communication Technology tools (ICT), such as: the Building Information Modeling (BIM) and the Augmented Reality (AR): the result will allow to prepare a new design methodology of the building project - weather maintenance work but also a new construction - ensuring a growth in the productivity and an improving of the planning and executive efficiency of the work in question.

An overview on the Italian Building Heritage

In a reality like the Italian one in which the building heritage is overmuch compared to the housing demand and the current needs, the necessity to renovate the real estate infrastructures is greater than the need to build new homes and new construction in general. The Italian housing stock is so large and widespread, but at the same time ancient and under somewhat obsolescent, to require relevant interventions of building recovery and requalification.
These evaluations are also supported by some economic indicators about the construction market which, although providing a slight increase of the investments in new housing over the current year, confirm the 2016 will be the year of the ordinary and extraordinary maintenance with about two-thirds of the total building turnover, relegating at less than one-third the investments in the new buildings (Figure 1).
As Brandolini asserted (2004) at the turn of the. new millennium it seems inescapable the condition of having to work, in close relationship with the existing. Until about twenty years ago this could appear a principle or ideology choice, but today this is no longer a choice, but a necessary condition, of which you can not do without. Circumstances that pushed administrations and governments to promote recovery and

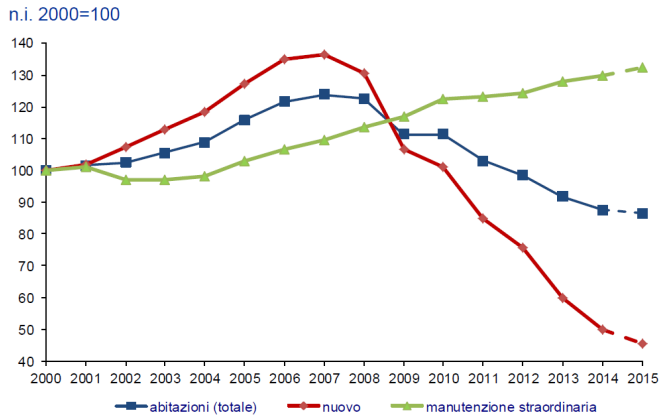

Figure 1 – Investments in the construction industry (ANCE).

restoration initiatives of the urban and territorial pattern, highlighting the need to reformulate the processes of intervention on the urban areas, encouraging the research for a structured path among governance, companies and local communities, with the emission and subsequent extension of rules – including important tax benefits – for building renovations and energy efficiency.
Unfortunately, the absence of this management and long-

term culture about the building work has discouraged the business operators minimizing the investments. In fact it is during the development of the planning strategy on the existing building heritage that the difficulties come to light and the flaws of an outdated regulatory system which is rooted in an impulsive way of building and that gives too little consideration to the managerial vision of the work in project become evident.

Therefore it would be more appropriate to shift the focus from the policies of the new to those of the existing, from the construction of new buildings to the conservation of those already in place, and thus to the redevelopment of disused settlements, with such implementation policies as to transform the organization of the renovation, maintenance or reclamation intervention in general, to management of the intervention good – and thus quality management – transforming a building project into a managerial action.

A management vision of the work would amplify the quality of the work itself simplifying the planning and the execution of any work that must be implemented on the existing building heritage, and also allowing the achievement of the optimum design. This would mean a long-term vision of the building contract/commission, which, at this point, would not be more limited to the alternation of three consequential operative moments such as the project, its start up and its enjoyment, but to a broader, global, all round vision that includes the whole life cycle of the property being studied, including inevitably the same stages of planning and testing, but not just this.

These in fact represent just a part of the long life that characterizes a property. Certainly it is not easy to invalidate a culture like the building one already consolidated, the transformation would be momentous, but the considerable advantages and the researches in this sense demonstrate it.

And yet talking about a management presentation of the work, we do not want to mean nothing but the custody of the data over time, the preservation of a technical memory of the all executive projects that allowed the realization of the architectural event, and that also contains the basic data indispensable for the programming of the future interventions to be implemented in an effective and economically advantageous manner/way.

CAD and Information Management

A first fundamental step in the evolution and improvement of the management of information is represented by the need to gather data in other formats which are currently presented in a CAD environment or in a paper format.

The relocation of data in CAD digital format into other more efficient ones represents the starting point for building heritage management. Almost thirty years ago – the first line in CAD was drawn in 1982 for building representation – the Computer–Aided Drafting software represented the point of arrival for building design. Yet, it was able to produce a mere two–dimensional or three-dimensional representation of a building or of an engineering project, which, nonetheless, presents an undeniable technical value.

It is true that both the standard requirements as well as an increase in communication standards have improved the diffusion of infographics (three–dimensional models, rendering and immersive videos) which are able to engage and attract the users directly.

Nowadays, however, it is not enough to communicate the “shapes”, the “materials” and the “colors” of an engineering work – this is still an enormously important factor – but also, and especially, the “information” enclosed within the work itself , meaning with them aspects related for example to the costs, to the stages of work, to the technical characteristics of the used materials, to the annual and multiannual management plans that these elements require.

Inevitably, the change in needs modifies the methodological approach used for planning, which becomes smart and planned management of the work planned: the working efforts are concentrated mainly during the first phase of the selection of design strategies, methods for achieving goals and in the choice of the technical and performance characteristics of the materials used.

The implementation of this innovative technology makes the design phase essential to the construction phase of an engineering work. In fact, it can allow for an accurate building inspection by improving the overall quality and, at the same time, providing an accurate virtual reproduction of the building. The basic idea is “design as you build”, this axiom can allow one to anticipate the difficulties that usually occur during the construction phase and during the preliminary planning phase. The advantages are considerable since they reduce misunderstanding of planning, delays and confusion between the different phases and design disciplines, which could otherwise mean changes to the plan with a consequent increase in errors, costs and inefficiency.

ICT tools for the management of the building process

In the construction industry, the need to share information is the basis for any planning condition, so the construction industry is employing more and more tools and technology that can improve the usability and speed of sharing.

Unfortunately, the absence of a true unified approach, and more precisely, the lack of education on real estate manage-

ment, highlights the complexity in the execution of operations, which, in our digital era, should require a simple click and not, as it so often happens, endless waiting due to bureaucratic matters which are often fruitless.

At the heart of these considerations, the need – and the proposal – arises to substantially modify the system so that it allows one to record the individual planned events related to the realization of an engineering work, for a more elaborate system capable of simultaneously recording all the design and construction events that occur successively during the building process. Therefore, this system must be able to collect all the necessary information for proper building management.

The benefits are evident and are proven by the major respect for the work itself, but especially, by a sharp reduction in research and survey costs.

The idea comes out through the existing buildings and through the enormous difficulties that are found during maintenance or recovery work. Therefore, the proposed methodology is an opportunity to define valid modus operandi for intervention on existing buildings and as a methodological approach for interventions on new buildings.

It begins through the enormous potential seen in the Information and Communication Technology (ICT) tools considered a set of technologies that allows one to create and communicate information through digital means. Their impact on modern society is deep since they drastically change the way one understands the market and they allow for the progress of globalization which, in some ways, is shared.

Considered a possible solution for controlling the interdisciplinary inefficiencies that regularly occur, the Building Information Modeling (BIM) is currently well-established in the world of design and property management at the international level. In fact, it is able to handle a large flow of information related both to the activities directly associated with the design (architectural, structural, engineering, etc.), but also to the enormous flow of information related to the management. Of utmost importance is the conservation of assets and, thus, the building heritage in general.

ICT does not waste information and it records it in a timely manner ensuring a real continuity between the phases of the building life–cycle: the design is automatically recorded and the "data", memory and informational knowledge used is stored.

The model is divided into parts from which it is possible to build a virtual document database, connecting the concept of interoperability throughout the design phases to the synchronization of three–dimensional visualization which facilitates the exchange of visual information, maintaining reliability. Therefore, the building, being in three dimensions, also acquires the features of a computerized, digital model, endowed with information of a technical, economic, and performance–related nature, whether they are physical–environmental (with implementations of the thermal characteristics of the elements that make up the shells), structural (with the calculation of the load bearing elements and related scaffolding), or numerical (with the extrapolation of materials list and related quantities).

The BIM–based design allows for everything, permitting the creation of an informational model of the entire building which proves that graphical representation is a valid communication tool. However, the documentation extrapolated from the use of imaging is an indispensable tool for the project.

Even though the potential of BIM in managing new interventions is well–known, there is still much to be done in regards to research into the modality of preservation and use of data over time.

BIM was created to produce new things. It has all the traits needed to consolidate a database as well as the possibility of gathering information that plays a key role in the building–related process.

Even though data storage is quite immediate in the database design (Figure 2), due to the adoption of a design methodology which places the BIM at the fulcrum of operations, visualization turns out to be more complicated; for instance, the execution of interventions located in the structure or even for research of essential information on site.

Unlike BIM, which is a big container of data, *Augmented Reality* (AR) could constitute a valuable tool for their use directly on site. AR is an instrument included among ICT tools, which is achieving more and more use in various industrial sectors. There are essentially two types of uses regarding interactivity with the scene and advanced visualizations. It has several applications, including the medical field, the fields of industry and maintenance, the IT field and even in the advertising, entertainment and military sectors.The term was coined at Boeing in 1990 by the researchers Tom Caudell and David Mizell. The two scientists, while working on a prototype capable of replacing the flight instruments, developed a device worn on the pilots' face used to rapidly view the route and all the information related to takeoffs and landings. The reality observed from this perspective was named augmented reality, because another type of information was added to the real world. Then, in 1992, the same term was by used by Ronald Azuma defining it as "[...] Augmented Reality (AR) is a variation of Virtual Environments (VE), or Virtual Reality as it is more commonly called. VE technologies completely immerse a user inside a synthetic environment. While immersed, the user cannot see the real world around him. In contrast, AR allows the user to see the real world, with virtual objects superimposed upon or composited with the real world. Therefore, AR supplements reality, rather than completely replacing it. Ideally, it would appear to the user

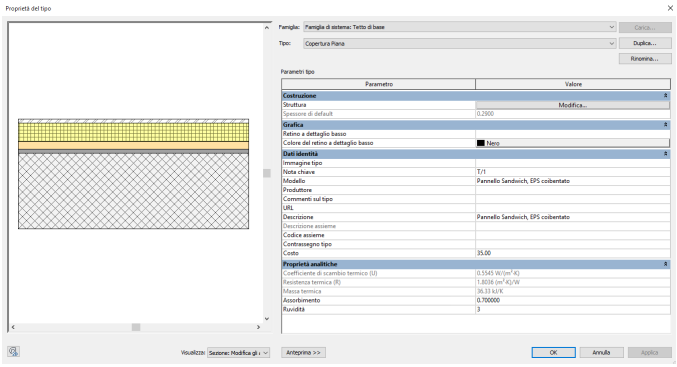

Figure 2 – Example of input data BIM.

that the virtual and real objects coexisted in the same space, similar to the effects achieved in the film "Who Framed Roger Rabbit?" (1997, 355).

Figure 3 – Augmented Reality (Wikitude APP).

Unlike Virtual Reality (VR), which replaces the vision of the real world with the creation of an artificial one, augmented reality enriches the perception of the world by adding interactive objects which, in some cases, could be created through virtual reality. Therefore, it could be defined as un extension of virtual reality because in augmented reality the user continues to perceive the real environment. However, it could be overlapped and integrated with some digital images or with some data produced ad hoc which enriches the reality with useful information in order to resolve complicated situations. Therefore, it is known as a combination between the digital and the real world through which users continue interacting with objects in first person.

Interdisciplinarity for the management of building heritage

The concept of BIM–based interoperability is described as "[...] ability to manage and communicate electronic product and project data between collaborating firms and within individual companies, design, construction, maintenance, and business process systems" (Gallaher et al, 2004) and also applicable to disciplines that, at first glance, have very little in common, namely Augmented Reality. In this case, interoperability means interdisciplinarity and even the ability to exchange data between software and several applications in the area of several disciplines without losing information or generating useless redundancies. The benefits are obvious, proving themselves in the increase of productivity involving mapping and data use as well as the implementation of operational processes in order to increase the efficiency of planning and execution of engineering projects. Therefore, the idea of creating a point of contact between two tools developed in the time for need between their unknowns like BIM and Augmented Reality. The circle connecting the two ICT tools is completed in an application for tablet or smartphone developed ad hoc to keep apparently different tools in direct communication with one another.

InsidAR is the application for smartphones and tablets planned and implemented to "augment" the perception of reality in a building environment: that is to be able to produce from the information through three–dimensional models and technical documentation that allows the user to be immersed in the augmented reality and content. Taking advantage of the communicative capacity of Augmented Reality, the APP allows one to view technical information used during the design process in a BIM environment on the mobile device's video. It is the most suitable and innovative tool for performing infographic digitalization of the building, moving management and maintenance toward new horizons, definitively relegating the large amount of daily–produced, technical, printed documentation to a marginal role.

The development of the Augmented Reality application has seen the modern use of two applications, the interpretation of images taken from the mobile device's camera and the reconstruction of the image. To this end, Software Development Kit (SDK), meaning the packet of tools for software development, has been used for image recognition. In order to implement applications of any kind of SDK requiring environment of development software known in IT as Integrated Development Environment, or also Integrated Design Environment or Integrated Debugging Environment (IDE), meaning software in the stage of planning that helps the programmers with the development of the code coming from a program: for example, pointing out the code synthesis errors directly during the process of writing plus an entire set of support tools and functionality during the development phase as well as debugging. The connection between the SDK and IDE applications is realized through an alternative software that also works through the development platform and consists of connecting the database generated from the SDK, processing it in IDE systems and then visualizing it on the screen of your own smartphone or tablet (Figure 4).

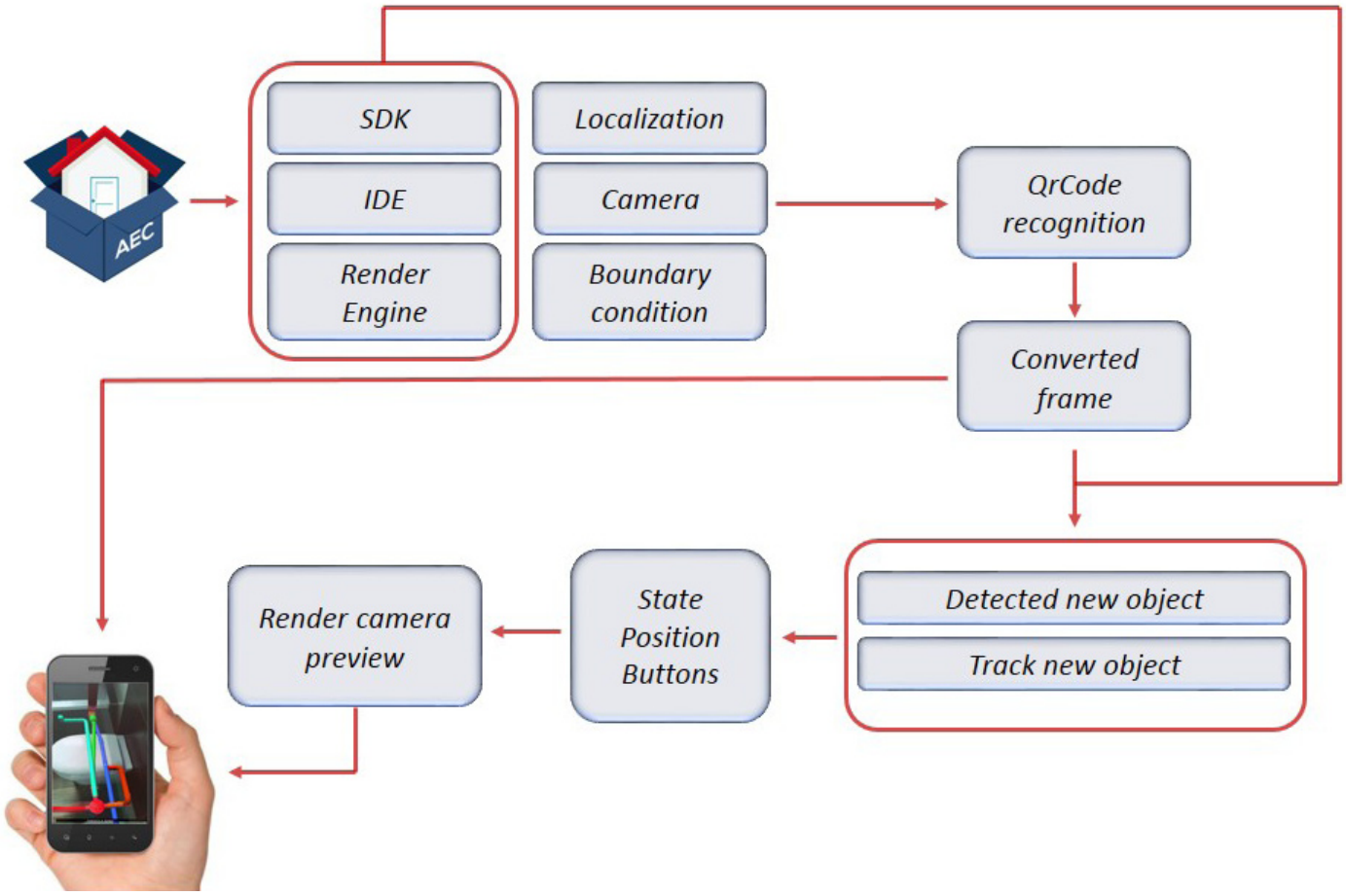

Figure 4 – Scheme of the InsidAR software architecture.

The identification of the scene to be linked to the setting and then the visualization via video on the mobile device is done using a Quick Response Code (QrCode): when it comes to images that the software is able to identify and control, the accuracy depends on the number and on the peculiarity of said images, for example, high contrast, the lack of repetitive themes, the abundance of details. So, once the APP is started, when the mobile device's camera focuses on the QrCode, it superimposes the infographic model onto the – document, or parts of three–dimensional models – previously linked to the BIM database. Once the target is recognized, the APP will follow the image throughout the camera's entire visual field. The icon chosen for the APP – an opened box out of which a stylized house appears (Figure 5) – is meant to highlight the concept of "container of information" for AEC (Architecture, Engineering and Construction): all the input data in the design phase (architectural, engineering, construction and others) are contained inside it, a simple tap on the mobile device's screen is enough to create a unique QrCode – conveniently located at the point of interest and linked to the digital database – the AEC container is opened and the experience of navigating the scene linked to the target in Augmented Reality begins.

The BIM is the box, Augmented Reality is the means of communication between the virtual world and the real one, and the App is the tool for viewing the contents of the box on the device's screen and virtually "saving" it inside. Through the InsidAR application, a representative environment is created that actually allows one to view objects or three–dimensional elements that would otherwise be invisible right on the mobile device's screen. Specifically, the APP is able to superimpose, first of all in virtual reality and than onto reality (Figure 6), the three–dimensional reconstruction of an apartment's drainage system as it is designed during the BIM planning phase: even if it is completely hidden, given that the entire floor area and the interior walls are included in the design and therefore not always visible, InsidAR easily allows one to examine their position and therefore, in case of maintenance or inspection, intervene where necessary, without wasting or losing time.
The user is free to move around the image being viewed, the mobile device can be inclined, and the object can be moved. The advantage of Augmented Reality for such devices is tied to the fact that there is total freedom of movement allowing visualization of the scene in reality and virtual reality from every angle.

Figure 5 – InsidAR icon.

Conclusions

In conclusion, the demand to deal with the existing building heritage is strong, especially in Italy. This is a demand tied to the need to retrofit the existing real estate with respect to technology, functionality and energy while recognizing that it is unprofitable to abandon the building heritage on the one hand, but that there is limited potential for growth of urban centers on the other hand. Undoubtedly, the recovery and urban redevelopment may mean a time of growth for all the stakeholders involved in the construction sector. The interventions on existing building heritage, however, highlight the limits of traditional methods of "doing construction" in Italy. Indeed, these methods should be more dynamic; placing the management phase on the same level as the design and construction phases.

The aim of this paper is to propose a methodology that allows both the planning of interventions (either of a new construction or of a renovated one) and the management of work done. Therefore, the modeling is also stored as data. Furthermore, the enormous potential of representation and analysis typical of Augmented Reality linked to BIM–based design allows one to implement the methodology for both existing buildings and new ones. The interoperability and the design of the BIM document database, added to the visualizing capacity of Augmented Reality, makes InsidAR a valid and innovative tool for the management of real estate. The relationship between the two ICT tools is represented by the App which carries out the digitalization of the building and its parts.

We are immersed in a virtual world where the perception of things is augmented, the scene responds to the actions of the user who modifies it until placing it back inside the box: every single event is recorded into the database and then placed inside the "box", opened and queryable. So it becomes a real container of digital information.

Nowadays the extreme fragmentation of documentation that the Italian technicians have to deal with could be replaced by a more fruitful digital database loadable through a simple tap on a box. Since management implies coordination, it is definitely impossible to coordinate without knowing and then measuring how much is at the work site and there is no doubt that, to date, Information and Communication Technologies are providing considerable support to revolutionize the current building design and management system.

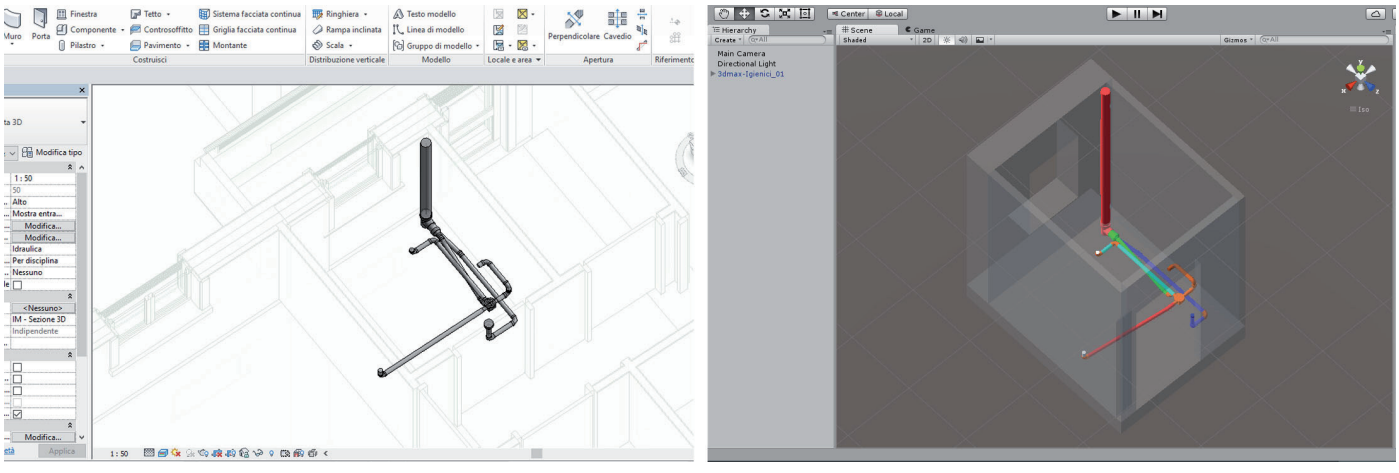

Figure 6 – From BIM to Virtual Realty.

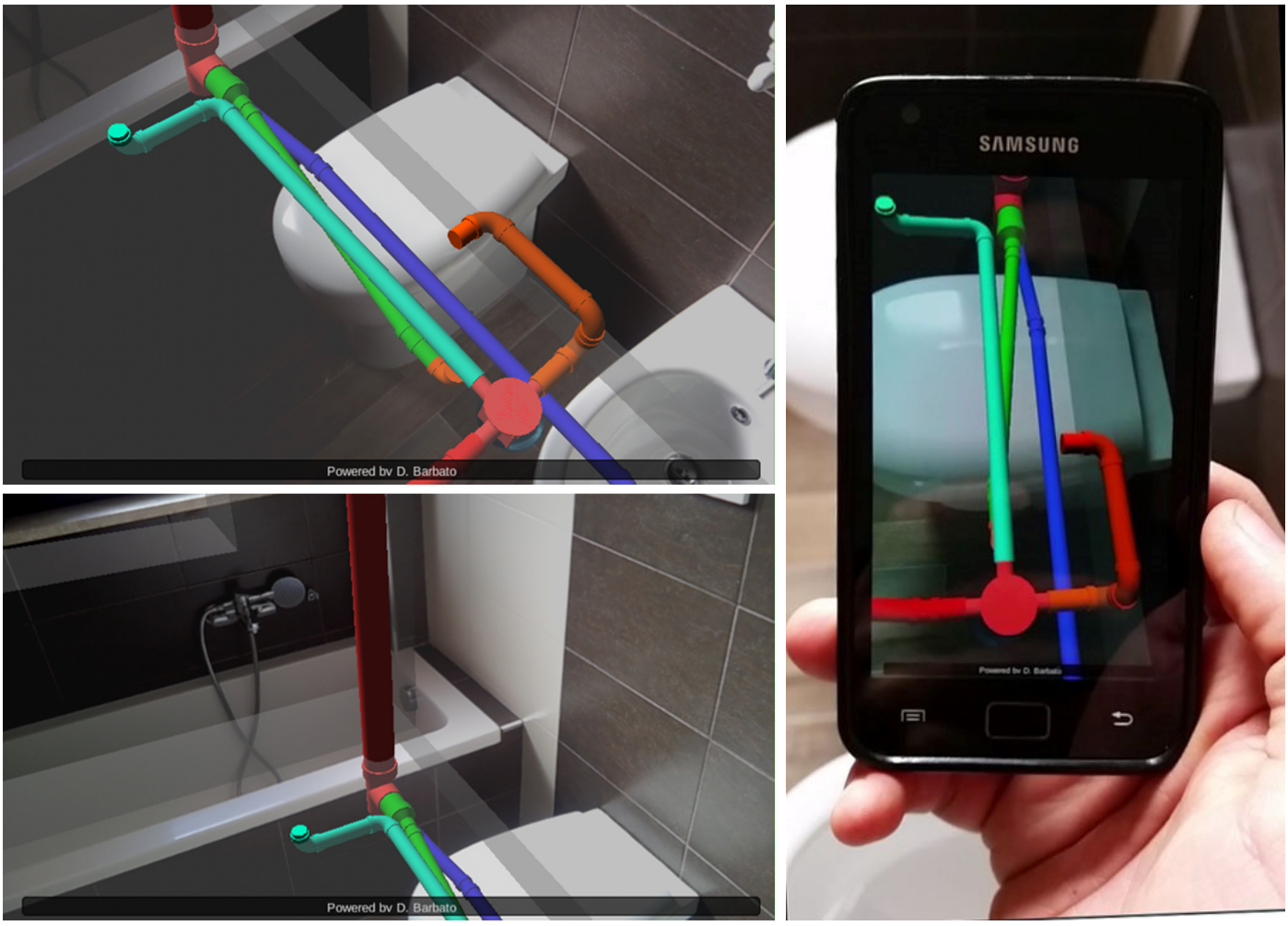

Figure 7 – Screenshot and picture of APP in work.

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Energy Efficiency in Buildings and Districts

Energy planning at the district level: an Implementation Plan as a first step towards smarter city development

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Keywords: energy planning; district scale.

Abstract

Energy policies have recently been developed and funded, from the Nineties' initiatives right up to that of the actual EU Smart City and Communities confirm the interest focused on cities for strategic interventions in the energy sector. Nevertheless, many questions are still open about this: how to manage energy issues at the urban scale and by means of which kind of tool? In order to contribute to the debate around this topic, the author takes into account the methodology proposed by the FP7 project "TRANSFORM-TRANSFORMation Agenda for Low Carbon Cities" and its results, as one of the possible pathways to face the challenge. According to the TRANSFORM Project approach, the Implementation Plan (IP) is understood as a strategic document at the district scale which can be used to support the development of a strategy for an urban area (Smart Urban Lab, SUL).

From the collected case-studies within TRANSFORM's framework some general outputs can be underlined in order to draw concluding reflections from the methodological point of view. To verify the method proposed within the project frame, in particular the case study of Voltri district in Genoa (IT) and its implementation plan are discussed. After considering this example, the paper is, then, able to abstract some general remarks concerning energy planning at the district level and positive and negative aspects of the implementation of energy measures at this scale, resulting from the drawing up of IPs in TRANSFORM's devoted phase. Features of the district, energy potential and designed interventions are explained in order to observe light and shadow of the implementation of energy planning measures at the district level and its future perspectives.

1. Introduction

Global concern regarding climate change has brought about several different approaches to manage and reduce greenhouse gas emissions connected with energy generation and consumption, at both global and local scales (Wilbanks & Kates, 1999; ICLEI, 2009). In this trend, a leading role has certainly been played by the European Union which, since the early years of this century, has been implementing environmental policies to face climate change scenarios and favor low emission actions (Mertens, 2011, European Commission, 2013a). The Lisbon Treaty put Energy at the centre of the European initiative and gave it a legislative basis not yet comprehended in previous acts (Braun, 2011).

Nevertheless, turning general determination into operative policies is not easy; the transition from a statement of principles and objectives to implementation of actions may be complex. It is therefore crucial to involve the institutions closest to citizens and stakeholders, beginning with municipalities, the basic unit of public administration in much of the world (Satterwhite, 2008; Kennedy et al., 2009). Energy policies have recently been developed and funded, from the Nineties' initiatives right up to that of the actual EU Smart City and Communities confirm the interest focused on cities by the EU for strategic interventions in the energy sector.

Many questions are still open about this matter: how to manage energy issues at the urban scale and by means of which kind of tool? In order to contribute to the debate around this topic, the author takes into account the methodology proposed by the FP7 project "TRANSFORM-TRANSFORMation Agenda for Low Carbon Cities" and its results, as one of the possible pathways to face the challenge. The paper also investigates the characteristics of the urban planning tool suggested by TRANSFORM, the implementation plan (IP), an operative tool to be developed at the district scale. It compares the project's approach to the aspects related to the right scale of energy planning in the evolution of EU policies, focused so far on regional- and urban-scale applications. To verify the method proposed within the project frame, the case study of Voltri district in Genoa (IT) and its IP are discussed. After considering this example, the paper is then able to abstract some general remarks concerning energy planning at the district level and positive and negative aspects of the implementation of energy measures at this scale, resulting from the drawing up of IPs in TRANSFORM's devoted phase.

According to the steps mentioned, the paper is structured as follows:

- the following section shows a summary of the international debate around urban energy issues and their recent declination from the regional, urban, to the district scale;
- then, the third part is dedicated to the methodology proposed by TRANSFORM and, in particular, to choosing the district

area as the right urban dimension to tackle energy efficiency and smart development matters. The project activity carried out by each partner-city on drawing up the implementation plans for their own district is also seen in depth;
- the case study of Voltri, Genoa is the focus of the fourth section. Features of the district, energy potential and planned interventions are explained in order to observe light and shadow of the implementation of energy planning measures at the district level;
- starting from the reported case, conclusions of general interest are drawn, adding materials for further discussion.

2. Energy issues and smart initiatives in eu policies: the increasing role being played by municipalities and districts

Recent policy from the EU comes from the evidence that generic declarations of intent are not sufficient to produce an effective change in trends towards an increase of emissions. This fact was clearly demonstrated by the limited effects of the governance actions implemented during the early years of this millennium: the environmental policy to reduce CO2 emissions needs to be adjusted to the actual situation and customized to the specific territorial conditions.
Summing up briefly the steps of the engagement process by the EU in the energy sector, a particularly meaningful moment was when (after a European Heads of State meeting), in 2005, the need was explicitly expressed for a shared policy at the UE level around these topics. The first result of this alarm was the publication, in 2006, of the Green Paper on Energy "A European Strategy for Sustainable, Competitive and Secure Energy", which anticipated (and confirmed in 2007) the necessity of common planning on energy efficiency and RES (Renewable Energy Sources) exploitation.
In 2007 the Action Plan for Energy Efficiency was drawn up for the 5-year period 2007-2012, which contained the targets of a 20% reduction and also the definition of the fields of intervention to achieve the target of reducing energy demand. In 2007, the so-called SET (Strategic Energy Technology) plan was also promoted, a strategy dealing with the new technologies to be implemented in the energy sector. It aimed at accelerating the introduction of innovative devices (with high performance) in order to minimize fossil resource dependency, favoring renewable sources. In 2008 the engagement of the EU reached meaningful levels by means of a fundamental instrument: the 2nd Strategic Energy Review, which introduced the well-known "20-20-20" strategy.
More recently, the European Commission has presented the "Roadmap for moving to a low-carbon economy in 2050". This Roadmap aims at a reduction of greenhouse gas emissions in the EU 27 by at least 80% in 2050 vis-a-vis emissions in 1990. In a general spirit of solidarity among Member States, the EU policy around the energy sector intends to guarantee the safety of the energy supply chain of the Union and the regular course of the market; thus, promoting energy saving, efficiency and interconnection of energy networks, together with the development of renewable sources. This could be considered as the first answer to be implemented in order to tackle the worst environmental challenges such as the lasting carbon footprint and how to reduce greenhouse gases (GHG). This approach, consolidated as the years went by, was oriented to radically changing the way Europe produces and consumes energy, setting up the basis of a new "industrial revolution", able to build up a high-level, efficient and CO2-low-emission economy.
European choices, which have characterized the economic and industrial policies in the first decades of this century, are running straight along the Kyoto Protocol perspective (even though controversial) which, as well known, establishes that Industrialized and Transition Economy Countries must achieve different targets of atmospheric emission reduction (Hickman and Banister, 2007). The European Union wishes to pursue these objectives through innovation in energy technologies and the proposal of market-and-finance instruments controlled at the EU level, also thanks to the involvement of the world of research.
After the issuing of European Directives, the Member States have adopted the targets, drawing up National Action Plans for emission reduction, since the early years of the third millennium. But as a consequence of the adoption of the Renewable Energy and Climate Change Package in 2008, the European Commission reckoned to launch, at the local government scale, the initiative of the Covenant of Mayors (CoM), with the aim of sparking and supporting the efforts made by Municipal Administrations in the process of actualization of energy and climate change policies. The CoM initiative and the planning tool it promotes, the Sustainable Energy Action Plan-SEAP, is located within this framework. Adhesion to the CoM involves Municipalities in a voluntary long-term project with the purpose of reducing more than 20% of CO2 emissions before 2020. In this way, the decisive role of municipalities has been acknowledged, above all taking into account that 80% of energy consumption and production of CO2 is associated with urban activities.
In this way, the EU considers cities as producers of environmental externalities, but at the same time also as protagonists of the related policies. It assigns them a primary role in dealing with GHG effects and the problem of surplus of energy consumption, attributing a great commitment and responsibility to public administrators and citizens (Betsill and Bulkeley, 2006).

Municipalities, at the same time, directly suffer the effects of the increasing of energy demand and consequent pollution but, on the other hand, they may also play a relevant part as experimental places of innovative policies (Musco, 2012), focused on sustainability and resilience in a wider sense (Alberti and Marzluff, 2004; Derissen et al., 2011). In all OECD countries, national governments have increased the level of autonomy of cities so much that the local authorities are now facing difficult political decisions and are pushed by conflicting interests.

The increasing percentage of people living in cities, which is also occurring in some parts of Europe, raises urban policies to being a main priority, especially declined along the lines of the smart paradigm. Considering a holistic definition of the so-called "smart city", from the literature it is seen as a place where good governance, participation and education of inhabitants, easy logistics and transport, ICT applications, security/safety and efficient and sustainable energy are unavoidable pillars. As is well-known, the term "smart" is referred, on the one hand, to the principles established by the Smart Growth Network 1 and addressed to the development of sustainable communities and places that are attractive, convenient, safe, and healthy (ICMA, EPA, 2006; Inam, 2011). On the other hand, it is meant for cities where investment in human and social capital and in communications infrastructure actively promote the overall urban performances and, above all, the quality of life of citizens and the management of natural resources by optimizing energy and water, through an effective use of ICTs (Caragliu, Del Bo, Nijkamp, 2009; Papa, Gargiulo, Galderisi, 2013).

With the launch of the first call of the FP7 Cooperation Work Program on Energy Area, focused on Smart Cities and Communities, the shift to the urban scale of the energy issue became more and more evident. As part of the SET-Plan, the framework of Smart Cities and Communities' Initiatives encompassed a broad range of energy-related topics such as energy efficiency, energy networks and renewable energy production, as well as other urban area issues like electricity, heating and cooling, transport, waste and water management. One basic assumption comes out clearly from these recent documents: European cities are diverse in terms of size, economic morphology, organizational structure, climatic conditions, proximity to transport networks and progress towards sustainability achieved so far. So, the call was intended to promote replication of successful projects through clustering of cities with similar framework conditions or similar ambitions.

The intention of the FP7 (2011) of sponsoring a call on smart energy planning, addressed mainly to municipalities, was to start a new phase of the smart paradigm, not limited to the theoretical side but operative-oriented, in order to provide, for other "follower" cities Europe-wide, the first sample-cases concerning energy interventions. The arising need to light the phase of implementation and testing at the urban level of the above-mentioned energy policies (requested by the call) drove the first committed municipalities to start thinking about urban areas (within the city boundaries) where the expected transformation might be more feasible and governable. So, the districts, decided at the central level by cities, were selected as testers of smart energy planning measures. It is a new era for districts, which are not considered yet so crucial as a level in energy policies by the EU. As a further confirmation of the upcoming role of districts in energy policy evolution, the EU Lighthouse Project Call (launched in 2015, integrating Energy, Transport and ICT sectors) affirms, not even 5 years after the cited FP7 call, that the key challenges for Smart Cities and Communities are "to significantly increase the overall energy efficiency of cities and to exploit the local resources better, implementing and optimizing measures at the level of districts".

The Lighthouse Project call has just closed and the projects funded have not yet been published (as of September 2015). In order to go deeper with the open questions presented in the introduction, about the right scale of urban energy planning and its tools, the author pays attention to the results of the FP7 project TRANSFORM-TRANSFORMation Agenda for Low Carbon Cities, financed by the mentioned call, which ended in June 2015. Firstly, the overall project approach is analyzed in order to frame the initiative and its contents; then, the focus is concentrated on the activity referred to the partner-city districts and the planning tools adopted.

3. The TRANSFORM method to face the challenge

The FP7 project TRANSFORM-TRANSFORMation Agenda for Low Carbon Cities proposes a transversal survey on integrated energy planning Europe-wide, considering experiences from all partner cities: Amsterdam (beneficiary), Copenhagen, Lyon, Hamburg, Vienna and Genoa. TRANSFORM improves the integrated energy policy and decision making process of cities, both at a strategic and operational level, by providing the cities with a framework based on overall planning experiences, in-the-field projects and qualitative and quantitative analysis support models (Delponte, 2014).

The overall objective is to draw up a TRANSFORMation Agenda (TA) which may be useful to address, firstly the partners and secondly the other interested urban contexts, in the process of transition towards a smarter way of planning, designing and living in cities. The particular focus of the project concerns the energy sector as a qualifier of the smart paradigm, as the call requested. The project starts from a very deep analysis of the towns involved: this for two main reasons. On

the one hand, because of the sharing of mutual knowledge and the building up of a computer science tool in support of the planning activity. On the other hand, the survey of data (by means of Key-Performance-Indicators) had the aim of selecting those indicators which can take a picture of city performance that is walking along an evolutionary scenario, from the "rough" level to a "smart" one.

The philosophy of the project sustains that to meet the 2020 and 2050 targets, a strategic TA is needed for the city as a whole. A TA should have the flexibility to look beyond the political borders of cities to the functional 'energy' borders, thus including the metropolitan hinterland of the core cities. Therefore, such an outlined TA addresses the main components influencing the chain of energy production and consumption at city level: main infrastructure and sources of energy (thermal energy, electricity, gas,...) and efficiency potentials. It also deals with the possible energy efficiency in flows of water, waste, ICT and mobility. It includes urban planning, regulation and the participation of end users. It is based on qualitative and quantitative insights and contains a strategic financial strategy. During the project, each city develops a TA, containing energy efficiency measures and actions that need to be taken by stakeholders, in order to make a city smart.

In other words, the project wants to answer to this question: is the district scale the right one to cope with the urban energy challenge and by means of which sort of tool?

According to the method, the TA is expected to be brought to the operational level in the form of an Implementation Plan (IP), which will be drawn up for specific city districts. These districts are selected for the project under the name of 'Smart Urban Lab' areas (SULs). The designed process concerns city regulators and decision makers, private companies, and other relevant stakeholders. In fact, part of the TRANSFORM method is to organize in each SUL a three-day wrap-up meeting (named ILS, Intensive Lab Session), where all the selected stakeholders are invited in order to identify and discuss the main goals to be achieved in the area.

Evidently, morphology, urban density, functional mix, demographic aspects, infrastructures and energy networks vary from district to district, but the activity of the project consists of developing a long-term integrated concept for an energy-optimized city district using appropriate technologies, products and solutions, that will be mostly tailor-made and site-specific. The districts where Smart Urban Labs are located are transformation areas undergoing redevelopment at the moment, in need of initiatives to be deployed by means of a comprehensive tool. Thus, each IP is supposed to be a product made locally (in a joint effort by all relevant city stakeholders) which includes, for example, renovation of the building stock, heating and cooling possibilities, domotics, improvements to both electric and thermal networks, the potentials of existing water systems, innovative (electrical) transportation possibilities and urban greenery. It includes quantitative aspects such as indicators, but also reports participative practices made for mapping and involving stakeholders. And lastly, in each IP there are references to feasibility, for example the insertion of preliminary achievable business plans, which take into account the costs, pay-back periods, regulatory issues and market conditions. In the picture the table of contents of the IP template is shown.

1. BACKGROUND AND CONTEXT INFORMATION ON THE SUL AND THE CITY
   1.1 Description of the area and its overall development
   1.2 Structure of population and businesses
2. DEVELOPMENT PROCESS (SO FAR)
   2.1 Insight in the ongoing development process
   2.2 Basis for decisions – available data and detailed knowledge
   2.3 Legal framework, tax incentives, aid schemes
   2.4 Achievements and experiences
3. STATUS OF THE ENERGY SYSTEM AND RELATED THEMES AND ENABLING THEMES
   3.1 Energy systems and networks
   3.2 Buildings, industry and services – energy demand and energy efficiency
   3.3 Local renewable energy sources
   3.4 Mobility
   3.5 Use of ICT and smart grids (enabling theme)
   3.6 Other important issues (optional, e.g. Water, Waste)
4. OVERALL DEVELOPMENT VISIONS, OBJECTIVES AND TARGETS, FUTURE ORGANIZATION AND MANAGEMENT OF THE SUL FROM THE POLICY PERSPECTIVE
   4.1 Objectives, targets and KPIs, development vision and end-state of urban development
   4.2 Development strategies and priorities of future development activities
   4.3 Future management and organization of the SUL
5. IMPLEMENTATION MEASURES, KEY ACTORS FOR FUTURE REALIZATION
   5.1 Energy systems and networks
   5.2 Buildings, industry and services – energy demand and energy efficiency
   5.3 Local renewable energy sources
   5.4 Mobility
   5.5 Use of ICT and smart grids
   5.6 Other important issues (optional, e.g. Water, Waste)
   5.7 Measures concerning the legal framework, tax incentives and aid schemes
6. REFLECTION – PRELIMINARY ASSESSMENT

Figure 1 – Table of contents of the TRANSFORM IP template.

The project tries to link the district scale with the city and metropolitan one, by means of the preparation of the IP: namely, the proposed approach tries to link local developments with strategic supra-territorial choices made on (energy) infrastructures implementing a planning process as far afield as at the district level.

The methodology of the drawing up of the IP needs to be addressed to a couple of crucial questions: how to lead a city's quarter to become a 'smart urban area'? How to find investors and projects contributing to the area's transformation, and how to link local development approaches to the wider city strategies? How and with whom to implement projects, that contribute directly to the main TRANSFORM Key-Performance-Indicators (CO2 reduction, energy demand reduction, increase of renewable energy production or energy efficiency)? Moreover, this drawing up of IPs involves the use of existing plans and ongoing planning processes and brings them to a comprehensive format.

Within the TRANSFORM project, the idea of selected Smart Urban Labs (SULs), as test beds of increasing energy efficiency, was created from several observations:

- new technologies are being applied first in individual experimental projects, where testing can take place and learning for future improvements is being sought;
- smart urban technologies, however, need to be bundled and rolled out in a minimum of scale and applications, in order to provide a realistic test for further spreading out: buildings, grids, energy production and energy storage facilities need to be developed and linked in a more coherent way;
- local networks and exchange of energy, renewable energy produced locally, the use of waste heat – all these relevant types of projects in a 'smart neighborhood' related to energy and CO2 reduction – need to be integrated in real urban uses, be they residential, services, offices or manufacturing;
- the 'real life' implementation in selected target areas, provided by TRANSFORM, is needed in order to develop realistic strategies for overall city-wide development. This is particularly relevant in terms of the impact legal and economic framework conditions form for local implementation, but also with respect to technological innovations, which may be of quite different relevance in various parts of a city.

In other words, the TRANSFORM approach proposes an energy planning process where smart future neighborhoods are considered as the basic tesseras. The TA is, then, the tool which fully contains the mosaic formed by the neighborhoods, gathered together by a unique Municipal vision.

It can be seen as working both ways, top down as an element in a city-wide transformation strategy or bottom-up, as an experimental way of learning and testing in order to develop the city-wide transformation strategy. Ideally, the aggregate contributions of the numerous urban districts should form the basis for the achievement of the goals set at city-level. Since urban areas are most differentiated in terms of uses, densities, building types etc., the general, city-wide transformation strategy needs quite substantial adaptations at the sub-city level. Therefore, performance targets will also have to be different between e.g. old urban quarters and newly built areas, where the latest technologies and know-how can be applied. The situation of partners at the kick-off is very diverse, and they have all different targets to achieve, according to the features of their SUL areas.

Specifically, the main "intention" regarding IPs by the partners ranges from:

- a visionary framework in a rather open, bottom-up process (Amsterdam),
- to a process-orientated strategy to organize (Lyon) or structure a platform of dialogue between the most important stakeholders in order to come to a comprehensive strategy for the area (Vienna, Liesing Groß Erlaa),
- and finally to a more content-related, comprehensive strategy development (Copenhagen), the sharpening, deepening and enhancing of an existing strategy (Vienna, aspern Seestadt, the second SUL selected by Vienna) or the speeding up of the implementation process in the next phase (Hamburg).

In the case of Genoa, due to the early stage of the SUL, the IP also aims to support the promotion and the actual decision for a realization. The understanding of the IP is closely connected to its embedding in the municipal landscape of programs and strategies, which are variously related to the smart city conception.

SUL type: G = Greenfield T = Transformation	Area	Population today (2013/14)	Projected population	Jobs today (2013/14)	Projected jobs	Year of projection
Amsterdam, Energiek Zuidoost T	300 ha	18,000	20,000	18,000	18,500	2025
Copenhagen, Nordhavn G	250 ha/ 350 ha	0	40,000	5,100	40,000	2040
Genoa, Mela Verde T	280ha	12,758	12,800	n/a	n/a	n/a
Hamburg, Wilhelmsburg T/G	3,500 ha	55,000	69,160	n/a	n/a	2050
Lyon, Part-Dieu T	135 ha	5,000	7,100	45,000	80,000	2030
Vienna, aspern Seestadt G	223 ha	0	26,000	1,200	23,000	2030

Figure 2 – Different characteristics of TRANSFORM SULs: Mela Verde is the name of the area of Voltri where the project's focus was located (Source: TRANSFORM Synthesis Report).

4. The case study: the Voltri district in Genoa (IT)

The experimentation district for Genoa is in the neighborhood of Voltri.

Voltri is located in the innermost point of the Gulf of Liguria and in the far western suburbs (Municipio VII Ponente) of Genoa, about 17 km away from the city centre. The Voltri area has strong historical and cultural identity and in the past it played a significant role in the local economy. In 1926, Voltri's autonomy was removed by incorporating it into the city of Genoa the economic structure axis rotated and the networks of relationships have focused mainly on the coastal axis resulting in an imbalance of the ancient links with the city center.

The SUL located in this area is represented by a few remaining residences as well as a building devoted to commercial activities and motorized mobility assistance, the local police force barracks, a hotel and car park, several sports facilities, a shipyard, several clubs and sports associations, bathing establishments and shops, and port activities.

The western area of Genoa has been affected in recent years, on the one hand, by the closing of industrial activities, and, on the other, by the transformation of the infrastructure system with the construction of the new commercial port of Voltri, the rail connection with the lines of the mountain pass and connection to the highway network. The road that connects Voltri to the city center separates the coastal strip from the historic area that lies behind, characterized by residential typology.

The new port has given a different connotation to the entire area by strengthening the economic structure and a consequent rebalancing of the economically active population. The territory of Voltri also presents different small and medium enterprise realities, sometimes limited by weak transport infrastructures. There are numerous cases of unused buildings the state of abandonment of which has brought about, in some cases, situations of deterioration and dilapidation of the associated buildings.

Here, some stakeholders' groups asked themselves about what is essential for a real urban regeneration. Their suggestions are renewable energy, improvement in public mobility services (a new metropolitan railway system will have an important node in Voltri) and safeguarding the Mediterranean characteristics of the building stock.

The SUL area addressed by this framework occupies a surface area equal to approximately 30 hectares, mostly public: RFI (Italian railway Network) areas and buildings, predominantly Port Authority land in concession to associations and operators, with private residential buildings located on the margins.

The two main stakeholders (RFI and Port Authority) are very large and powerful and are connected to the urban system in a vast number of issues so the decision on how to develop the SUL could be influenced by external factors, also including national economic and financial issues.

This means the local fact of Voltri is directly linked to supranational matters. So, the strategy to be performed for the

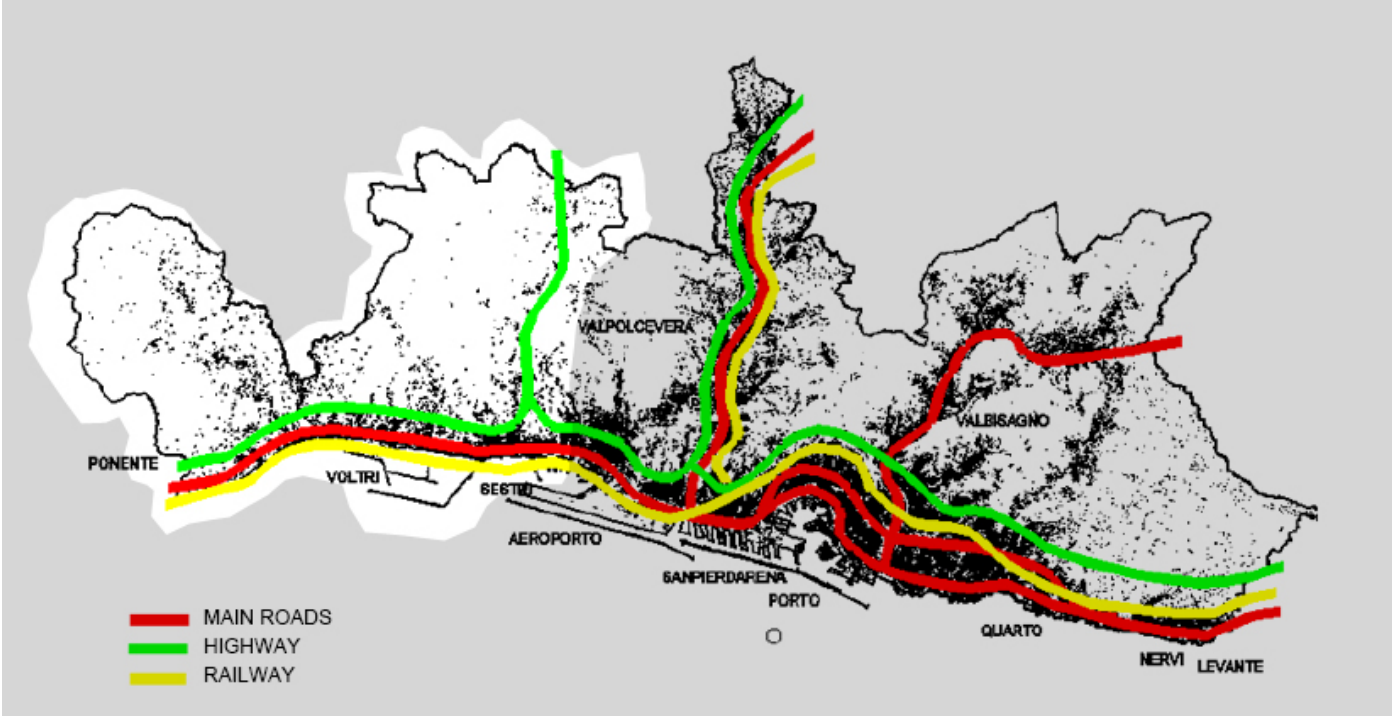

Figure 3 – Voltri district (in white): main road, highway and railway networks (Source: TRANSFORM Voltri Implementation Plan).

SUL foresaw the involvement of the two main public stakeholders in order to reach a shared vision to, then, build up a set of interventions on selected themes considered decisive to trigger the process.

It appears quite clear that economic recovery is related to infrastructure interventions to be started under a careful use of public resources, in dialogue with local power, first of foremost the District Council, where, with a large consensus, a very-well known resident of the area was twice elected President.

Within the Regulatory Masterplan (PUC in Italian) many development actions are focused on Voltri on different topics.

In particular:

- concerning the socio-economic and infrastructure development:
  - the enhancement of connecting infrastructure north-south and east-west from the Municipality of Genoa foresees the realization of the metropolitan railway service Voltri-Nervi (the eastern part of the city);
  - the enhancement of intermodality and use of public transport push Voltri neighborhood towards the realization of interchange parks and the strengthening of public transport to hill areas;
  - the re-launching of housing policies sees in future years the conversion of some of the former buildings into health and social service centers;
- concerning the spatial organization of the city and qualification of the urban image:
  - promotion of the compact city and enhancement of public space through the creation of more pedestrian areas of quality;
  - architectural, landscape and environmental promotion of the city crossing axis and redevelopment of the image of the city with the requalification of Voltri's historical center;
  - strengthening of the link with the sea and promotion of interventions increasing the visibility of water, the accessibility and usability of the waterfront through reduction of built-up areas and visual barriers creating new public beaches, accessible by means of pedestrian and cycle paths and completing the eastern promenade.

During the participative phase promoted by the project and carried out by the Municipality, three key-issues were chosen as priority for the SUL development. They are energy, mobility and ICT and smart grids.

To assess the interventions thought for the Voltri SUL on the selected themes, CO2 reduction was considered as the Key Performance Indicator that would contribute to the general achievement of the overall city-goals.

ENERGY

The SUL is served by a gas network and by an electricity network. All buildings are heated by either natural gas or fuel oil. No district heating or energy storages are in place in the area nor significant renewable energy plants. No CHP (Combined Heat and Power) is present in the area and no waste heat is generated. As far as the area is concerned, the only smart grid technology currently in place is the Smart Meter System.

One of the two greatest challenges here is energy saving in buildings. Given the location of the area along the coastline, one of the most promising options being proposed and investigated by the TRANSFORM project team is to improve efficiency and to achieve significant energy (and probably also cost) savings for final consumers. It could be thought as feasible by replacing the currently adopted heating systems using fossil fuel boilers (mostly natural gas) by installing and adopting sea-water coupled heat-pump systems. This action will however need to involve citizens and local stakeholders as well as identifying possible financial solutions to promote investments.

The second important challenge is the retrofitting of public/social buildings throughout the area (a swimming pool, medical practices, a library, schools, etc.).

Specifically, the basic idea behind this proposal is to exploit the nearby sea as an enormous heat-source for space heating and any other low-temperature heating purpose (e.g. domestic hot water etc.) as well as for cooling in summer. Many variables still pending do not allow us to reach an estimation of the required investments. Splitting the intervention into 4 phases of implementation, the expected benefits will be the reduction of 5586 MWh/year in energy consumption and 1065 tons in terms of CO2/year.

Another action that was foreseen, related to the energy sector (not precisely calculated yet), is the replacement of conventional and low-efficient public lighting systems with LED technologies, which will enable energy savings along with the cost reduction related to the maintenance of the system.

MOBILITY

Genoa has about 600,000 inhabitants who live in 73.53 km^2, representing 31% of the municipal area. About 302,000 trips are recorded during the morning peak hours in the urban territory.

The national highway network, with its 7 toll gates located in Genoa, is very important in the distribution flows in the urban area: one toll gate "Genoa Voltri" is located to the east of the SUL and also connects the western entrance to the port.

The presence of 21 railway stations and ticket integration between buses and railway has brought about the growth of the use of rail to move within the urban area (along the coastline).

The most relevant infrastructural intervention in Voltri will regard the "metro" railway station which will connect the western outskirts of Genoa directly to the city-centre thanks to a frequent service of small trains, very similar to a metro

system. A node with public transport terminal bus will be built near the new railway station. Moreover the urban mobility plan foresees the creation of an interchange parking area (Park & Ride).
The contribution of the Metro Railway system in Voltri and the realization of the related intermodal hub will amount to about -772,2 MWh/year and -206,5 tons/year in terms of CO2 reduction.

ICT AND SMART GRIDS

The main Smart Grid measures that have been planned in the SUL are the following: Electricity Grid preparation and empowerment and Active Demand/Smart Info. Some interventions in the ICT sector were foreseen in previous plans and they are now ongoing or completed. Moreover, throughout the City of Genoa there are 17 Electric Vehicle recharging infrastructures that are managed and controlled by an ICT application called the Electric Mobility Management System (EMMS). The main functionalities of the EMMS are: data acquisition and transmission of every single charge procedure, remote monitoring and availability check, recharge process remote control, customer info through display (Localization of the EV recharge stations).
The reduction of energy consumption as a consequence of Enabling infrastructure interventions can be estimated as -2222 MWh/year and -555 tons CO2/year.

After looking firstly at Voltri, then, the project question about the suitability of the IP method can be posed: is this an useful format for each city?
What comes out of the Voltri IP is a photograph of different colors: on the one hand the work already done permits us to take into account the complexity of the case; on the other, such mindfulness makes the Municipality and the other actors involved aware of the limits and the gaps of the process so far. This is also due to the early stage of the Genoa SUL, in comparison with the others selected by partner-cities. Starting from the results, *further studies should be made* into technical aspects, such as development of sea-water coupled heat-pumps or implementation of smart grid connected tools, but especially into business models useful to trigger works in the current overall economic crisis hitting the Italian (and not only) economy, thus permitting a virtuous cycle leading to the district's transformation, job creation, energy efficiency and reduction of consumption.
A first reflection can be drawn directly from the results of the way of working (locally) on Voltri IP.
Designing projects at the Voltri district scale, the need for a database tool as a technical means to gather information with an adequate level of sophistication and functionalities, suitable for an energy dashboard (able to revise the current stage but also the drawn out forecasts) come up seriously. The use of local and detailed data, the possibility of bringing in end users for the generation of data, the opportunity to do practical applications, the report of analytics to search for better economies within scenario alternatives, are crucial points in a smart city planning process and for assessing feasibility aspects. The district's focus shows the lasting gap between, on the one hand, the designed and planned actions that could be theoretically realized and, on the other, the characteristics of the territory. A good result of the IP's preparation was the scientific preliminary assessment of local energy needs and the corresponding availability of local renewable resources. But, without an intermediate and more in depth step, able to verify the correspondence of the two sides, the potentials of the area risk not being exploited and the planning actions being programmed without a consistent background of information.

5. Concluding remarks

As shown in the paper, the project proposes a common method for implementation of energy planning measures, leaving cities free to adopt them locally by means of a tool, the Implementation Plan (IP). This, first of all, in order to shed light on the richness of diversity of urban approaches to planning, but also the criticalities experimented among partners in applying EU directives, the gap standing out between the institutional documents' urban strategies and the consequent implementation at the local level (Papa et al., 2014). The activities of the project confirm how the declination of the energy strategy in the local context, to evaluate successful aspects and lacking points, is crucial for the city government and the attention paid by the project to that issue matches the expectations of municipal administrations. In fact, a matter of scale for the correct declination of smart energy planning concerns is still pending.
To sum up: is the district scale the right one to manage the energy issue and by means of which kind of tool?
From the collected case-studies within TRANSFORM's framework (and in particular the one of Voltri), some general outputs can be underlined in order to draw concluding reflections from the methodological point of view.
TRANSFORM addressed the question of scale "by combining the district scale in smart urban labs with the level of the city as a whole – the strategic level where TRANSFORMation agenda's will be made".
Some good points can promote the district level as a starting point for smart energy thinking in an urban environment, considering that the EU promotion of the district level in energy planning is "in its infancy". In this perspective the Lighthouse Project's results will provide new and deeper an-

swers to the issue: it will finance neighborhood-level projects which demonstrate that they optimize and balance integrated measures, aiming to become a nearly zero or low energy district, integrating energy, transport and ICT sectors.

Considering a district as a portion of the city, its positive side in order to plan out energy solutions is the opportunity to have *homogeneous characteristics, derived directly from its location*. Usually, within a neighborhood solar exposure can easily be the same, the territorial altitude, the presence or not of a river or sea,... on to the features related to buildings, which often, in a proximity context, were built almost in the same years. Distinctive characteristics could allow a district to perform *certain energy strategies* that might not be supported by another, with a different layout, as seen for Voltri. For the heating and cooling system, the geographical proximity is an important input, too: for a preliminary survey, the district could be a suitable site to begin an energy exploitation feasibility study. The Genoa SUL was an adequate-sized area where it was possible to calculate the opportunities for exploitation of a water-sea-pump, considering the estimated consumptions and future needs of the limited cell of Voltri, although there are many unknown quantities derived from economic analysis. Therefore, the district, from the urban fabric point of view, can be considered as *a basic cell for thinking about interventions*. Even when, within the boundaries of the district, there are not common features, other operative sub-perimeters can be hypothesized on the basis of specific aspects that do not permit a complete homogeneity.

Also from the participation point of view, *the scale of the district accepts a direct involvement of citizens* that are sometimes still linked by ordinary and daily relationships. Moreover, in many cities, district councils are still operative and active and the leadership by the district President is admitted and acknowledged; the case of Voltri is one of those. At this scale, almost everybody knows who the key-local-stakeholders are and who the "opinion-leaders" are or the fundamental actors to get committed. The case of Voltri shows a very homogenous identity of local residents who are organized into associations where all inhabitants can recognize themselves*: for the central administration it is easy to achieve a precise map of actors*. It was a crucial aspect of the preparation of the IP, also thanks to a series of meetings held in Voltri in order to update and share strategies and local will (such as during the Intensive Lab Session, ILS).

In favor of district scale, several regeneration projects, funded by the EU, can also be mentioned. Generally speaking, for a renewal or a transformation initiative within the city, we refer quite automatically to the neighborhood level. Also from the governance point of view, the administration is used to managing interventions following the area's needs (in dialogue with the District Councilors) and, consequently, according to their boundaries.

Nevertheless, there are many points lacking when thinking about the energy solution at the district scale: some of them, come out clearly from the case-study.

As in the case of Voltri*, the local solution does not work at all if the area and its future are not inserted in a more complex city-vision*. Starting from the TRANSFORM results, one of the most common points, observed transversally among partners, is that if the SUL interventions do not have a crucial position in the Transformation Agenda (the upper level of city strategy), the contents of the IP, even if well-designed have very few possibilities of being attained. Therefore*, a fundamental political support*, aware that the future of an existing city is made by its neighborhoods, is needed: each of them takes part in achievement of the city goals, even in the energy sector. The collaboration between technicians (able to show potentials and future scenarios) and politicians (who make consistent a general intention on local contexts) is the first suggestion which can be shared so as to put an active, programmatic city-district connection into practice.

Another *very critical point is the matter of data*, as just mentioned in the previous paragraph concerning Voltri. It is difficult to envisage a quantitative result of an energy hypothesis (for example regarding local renewable resource exploitation) at the neighborhood scale, lacking a tool where scenarios can be analyzed in a detailed territorial way (which considers geographical features, energy potentials, binding urban planning instruments and so on). *Some statistics are available at the city level but not at the district one*; and after an in-depth survey, not consolidated literature (mainly related to the design-side – Ratti and Steemers above all - rather than to the planning-one) treats this topic at the district level. For this reason, to many partners it seems to be worthwhile to develop and adopt a Decision Support Tool or an Energy Atlas or similar, in order to complete and make the tool kit, provided by the project for a correct energy planning task force, efficient.

Other remarks arose taking into account the tool proposed by TRANSFORM for district planning, its contents and its methodology.

One of the project's objectives is transferability and dissemination towards new "environmentally virtuous" cities which want to follow the pathway led by the TRANSFORM frontrunners. The added value, replicable by followers, of a tool like the implementation plan, proposed as a unique way of implementing local designs, is questionable. The Smart Urban Labs selected by partners provided an excellent variety of urban development phases, including the transformation of brownfield sites, former harbor areas, as well as redevelopment of fully built up and living districts. In this way, a realistic sample from European cities, also covering a wide range of geographic situations and different policy making traditions,

is represented in this project. Therefore, the *template is quite general but at the same time adaptable*.
Thinking also about the case of Voltri IP, could this format be considered as a tool, or can each city foresee another more suitable to its own case?
Regarding Genoa SUL, it was quite clear that the IP template built this way is not useful to make the area advance in its process, because of the early stage of the ideas on Voltri. Some reflections on the Voltri IP are sometimes general and do not reach the real "core" of the problems that are not well deployed yet: therefore, the IP template is expected to be correctly used only when the implementation phase is really started up.

To conclude, the nature of the tool is very operative and the generic contents do not blend in with the structure of the document. *Suggesting it as a sort of "guideline" for collecting contents* (tailoring themes and technical aspects) could constitute a softer way to propose the tool to "buddy cities" not accustomed to these kinds of projects yet, without reducing the methodological elements of the IP's proposal (for instance, the suggestion to also insert obstacles and barriers concerning tax schemes and legislation that are sometimes the main reasons for inapplicability of innovative and experimental solutions).

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The hidden face of efficiency

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Keywords: efficiency; sufficiency; sustainability; circular economy.

Abstract

Efficiency has a double face: it is necessary, but sometime it is an illusion. It is not the solution for an energy hungry world, but is a part of the solution for a sustainable world. Exploring the boundaries of efficiency is like to be inside the smallest box of a Chinese boxes set; If you don't open your mind to the world outside, you will stop to the walls of the smallest box thinking to have done the best possible, ignoring the largest scenarios to be explored. In this article are described the different approaches to explore the infinite efficiency scenarios that can be opened in the future. Efficiency could be an as costly as useless exercise, with the only effect to move a little bit on the limit of an economic system that is overexploiting natural resources and damaging the ecosystem services fundamental for life. To avoid it is necessary to drive investments to create an efficient economic and human environment, building specific infrastructures, like smart grids, and heat pipes, promoting energy exchanges among different end uses. In other words, before promote efficient appliances on the consumerist market, it is necessary to define a pattern of sufficiency to create a new efficient scenario of a qualitative wellbeing looking forward to a circular and sustainable economy.

1. Introduction

Among the several "evolutionary pathways" that a living system can cover in its history, the one that prevails is always that which is able to preserve the greatest quantity of energy and matter made available by the ecosystem in which it belongs, "transforming it in organisation." Thus, there is an evolution from disorder towards order that involves in a coordinated way all the living systems belonging to a certain ecosystem, and tends towards the maximum efficiency of available resources exploitation.

If we extend such remarks to the whole planet, we can say that the evolutionary history of the Earth is a walk towards higher levels of organisational complexity that keep it progressively farther away – from equilibrium of maximum entropy, from every possible exhaustion of difference, from the end of life, from the end of existence in the homogeneity of absolute disorder.

We have seen that the world tends spontaneously to annihilate all differences and consequently to exhaust all possible transformations. But some parts of the world, those we call living parts, seem to take the opposite direction, seem to invert time direction marked by the process of differences reduction. Living systems tend to improve their capability for storing energy and to increase their distance from equilibrium with the outside environment, namely to increase differences. They do it mainly in two ways:

1. Quantitative: increasing the physical dimensions and consequently the flow of captured solar energy; this allows a higher capture of the incident solar radiation, but this implies also a higher energy of maintenance.
2. Qualitative: improving its organisational complexity so that the received solar energy and materials can circulate for a longer time inside the system.

The second way implies an increase of the genetic information and thus of complexity. The system (organism or ecosystem) tends to become energetically more efficient and normally carries more information (the organism doing so with a more complex genetic code). Biodiversity increases. The number and the specialisation of ecological niches increase. Overall, information, namely that of genetic and biochemical complexity, increases. We can say that if a system is crossed by a continuous flow of energy, it moves away from thermodynamic equilibrium and selects the components and the organisation that brings to it the higher flow of useful energy through the system and thus to the storage of the highest possible quantity of energy in the form of organisation.

The outcome is a system where the entropy increase is minimal because, while the system evolves, the speed of growth of stored energy is higher than the energy lost. This leads to an increase of the potentiality of the success in evolution of the system, which is called "ascendancy" (Ulanowicz 1997). The higher the ascendancy, the greater the ability of the system to respond to external perturbations, gaining a further progress in evolution in terms of efficiency.

The evolutionary aim of efficiency emerges at every scale level in this thermodynamic interpretation, from the single unicellular microorganism to the most complex systems, from the Earth to the entire universe (Masullo 2013).

The growth of efficiency in natural systems has no limits because they grow in quality by the model of circular economy. Human linear economy growing in quantity and efficiency is only one way to move the limits of growth slightly into the future.

When we talk about efficiency related to human economy, we assume that it is in any case a positive issue; but this is

not always true. We can find many examples in which the most negative purpose is pursued with the highest efficiency. There is nothing worse than going with the highest degree of efficiency in the wrong direction. To consider efficiency as truly positive we have to be sure to proceed in the right direction. For example, to cut 50% of greenhouse gases by 2050, it is not sufficient to improve efficiency by 50% if we accept that, with the trend of growth of the last 40 years, energy consumption will double. Our economic system is based on a continuous growth of the Gross Domestic Product (GDP); it can be pursued essentially in two ways:

1. The growth of per capita demand of goods;
2. The growth of population.

Economists suggest following both ways in concert, with both resulting in an increase of energy consumption. According to *2013 Key World Energy Statistics*, published by the International Energy Agency, in 2011 the world Total Primary Energy Supply (TPES) amounted to 13,113 Mtoe[1]; for a population of 6,958 million this results in a TPES per capita of 1.88 toe. But we have to consider the inequality of supply: for the OECD countries[2] the TPES was 4.28 toe/capita; for China it was 2.03 toe/capita; for Africa it was 0.67 toe/capita. Assuming that a worldwide 2.00 toe/capita could be a good target for an equal and sustainable world in 2050, people living in an OECD area must halve their per capita supply, while China must maintain it stably, India must grow from 0.60 toe/capita and Nigeria from 0.73 toe/capita. Unfortunately, India, China, and Nigeria will be the three most populous countries in 2050, with 1.652 billion people, 1.314 billion people, and 440 million people, respectively. And China is looking forward to reaching the OECD model of consumption as their target.

Nevertheless, supposing to reach this ambitious world target of 2.00 toe/capita, in 2050 we will need to provide for the 10 billion people populating the world with a total primary energy supply amounting to 20,000 Mtoe. During the thirty-nine years from 2011 to 2050 we would need to deliver to the world population 563,901 Mtoe. To have an idea of the dimensions of this challenge, consider that the global reserves of the principal fossil fuels, oil, coal and natural gas, amount to 1,025,180 Mtoe[3]. Therefore, in this scenario in 2050 we will have exploited 55% of the global reserves of fossil energy known today. This shows on the one hand the dramatic importance of efficiency and on the other hand its insufficiency and of the ultimate necessity to redefine efficiency.

Furthermore, in the affluent part of the world – which in our scenario needs to halve its energy consumption – another uncertainty can obliterate the gains made on efficiency: individual behaviour.

A study made in 2002 by E.C. Alfredsson for the Swedish Institute of Growth Policy Studies (ITPS)[4] posited that there are many doubts that changes in the patterns of consumption could produce effective benefits in energy and CO_2 reduction. By switching to "green consumption", energy use and CO_2 emissions can only be reduced in the short term, but in the long term this will increase at the same rate of economy. Alfredsson considered changes in food consumption, in transportation and in housing. This means that if we don't change the structure of an economy based on growth, every effort spent on efficiency will be ineffective: efficiency without sufficiency does not make a large difference. If we don't reduce the level of consumption, efficiency risks only being a short-term palliative (Alfredsson 2003).

The challenge is the transition from an "energy-hungry world" to a "sustainable world". In other words, energy efficiency could be a strategy to contain the negative effect of an *energy-hungry* world during the transition to a *steady state economy*. Efficiency that is effective for CO_2 emissions reduction must be applied not only at the energy end-use level, but to all of the economic system, trickling down in the energy chain to the end-use.

2. Exploring the limits of efficiency: a problem of scale

Usually, when we want to improve efficiency, we consider durable goods (i.e. refrigerators, freezers, air conditioners, washing machines, domestic lighting, ICT equipment) and review the market leaders. Finally, we choose the most suitable within our budget (figure 1a). This is the Best Available Technology (BAT) approach. If we use only this criterion we risk making a big mistake: falling into the wrong use of the right criterion. For example, if we want to improve efficiency in our heating, ventilating, and air-conditioning (HVAC), we consult a catalogue for heating/cooling device prices and performance. We are enthusiastic while exploring the first part of the graph in figure 1a, where a slow growth of cost corresponds to a fast growth in efficiency. When we arrive at the dotted line of the graph we stop because any little growth of efficiency corresponds to a high growth in cost; so we believe we have reached the top of an economically consistent efficiency.

The same thing occurs if we desire to be more efficient in transportation. Most people think that the solution is to simply buy a new car. Also, in this case we will stop at a point where we believe we have reached the best we can on an individual scale.

But this is absolutely not the peak of efficiency. We can envis-

1. Mtoe means millions of tons of oil equivalent.
2. Industrialised countries that are members of the Organisation for Economic Co-operation and Development.
3. Calculated from data reported in the WEC 2013 report, using standard conversion factors.
4. Swedish Institute of Growth Policy Studies (ITPS), Student plan 3, SE-831 40 Östersund, Sweden.

age a new scenario, as in figure 1b.

In the case of household air-conditioning requirements, if we change the scale of our analysis and shift our attention from the device itself to building performance, we enter a new scenario of efficiency to explore with much more possibilities to consider: we have entered a shared or multiple-option scenario. We can insulate windows and walls, change the heating and cooling distribution system, introduce a passive system as shading or as a solar air heater, improve air circulation, and so on. In the case of transportation, we can choose among different transportation modes available, having many more possibilities to consider, and with different combinations of more than one mode; in other words we may explore the possibilities of an intermodal solution. Also in this case, where the slope of the graph declines we reach a point that we consider most consistent with our budget. But again we can open a new scenario (figure 1c) on an urban or district scale.

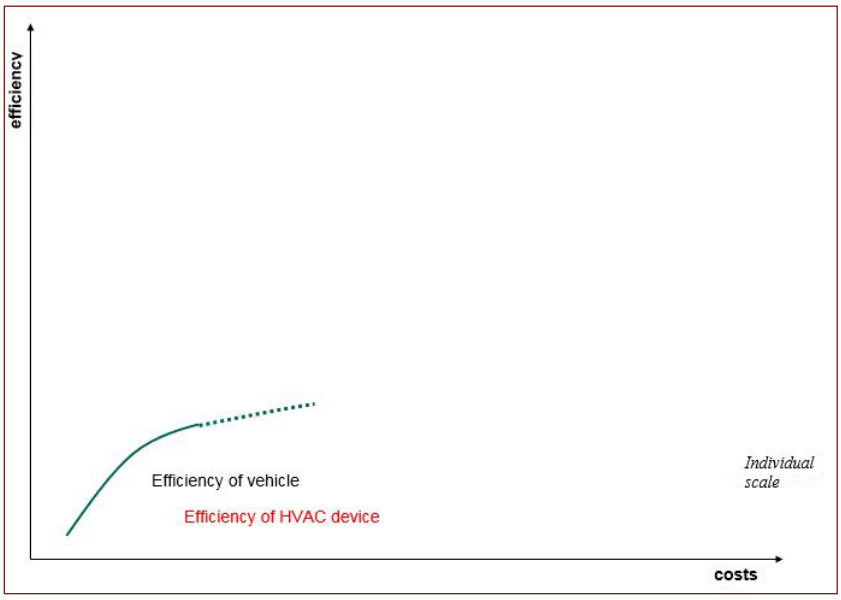

Figure 1a – The best available technologies.

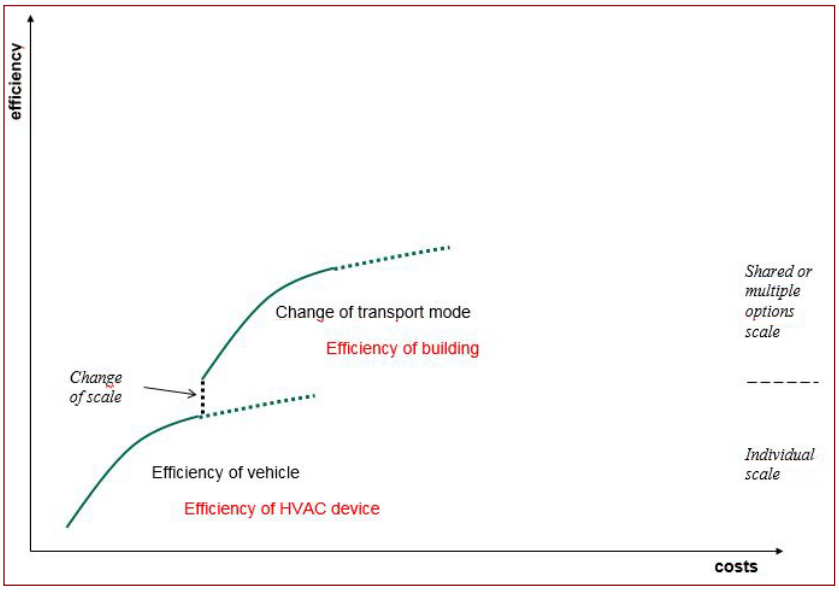

Figure 1b – Optimised energy service.

For the household air-conditioning requirement we can drive our attention to an integrated energy system such as a micro-tri-generator that uses a geothermal heat pump, to solar energy, or to implementation of a local smart grid for a group of buildings or for the entire city. In this case it is possible that the device considered in our first step would not actually be needed, or that its dimensions could be much smaller. For transportation we can consider how much our transportation requirement is due to a poorly organised life, or to an inefficient organisation and distribution of social, cultural, sanitary, administrative services, etc., or to a lack of transportation services offered by the local administration; therefore we can basically reconsider our transportation requirement.

The uppermost step is to think on a national or international scale (figure 1d) and consider the efficiency of the entire chain, from primary to secondary energy commodities (IEA 2005). Primary energy is that extracted or captured directly from nature. In any case we use technologies to extract it – drills to extract oil and gas, solar panels to extract heat from solar radiation, photovoltaic devices to convert solar light to electricity. In the case of oil, methane, or coal extraction, we consider efficiency as the ratio between energy return and energy invested (EROEI); this ratio dramatically decreases with the necessity to exploit deeper and deeper gas and oil fields and coal mines despite an increase in efficiency of drilling technologies. The energy invested includes the quota of the energy spent for the production of all machinery used relative to each unit of energy extracted.

For solar heater and photovoltaic devices, efficiency can be defined two different ways. The first way is the ratio between the energy spent to produce the device and the energy collected or converted during its life. The second way is the consideration, in the case of a solar heater, the ratio between the heat transferred to the thermovector fluid (diathermic oil, water, or air) and solar radiation. In the case of photovoltaic we can consider efficiency as the ratio between the electricity produced and solar radiation. Considering the whole spectrum of solar radiation can help us to understand what is the most efficient use of a surface exposed to sunlight: a photovoltaic device or a solar heater.

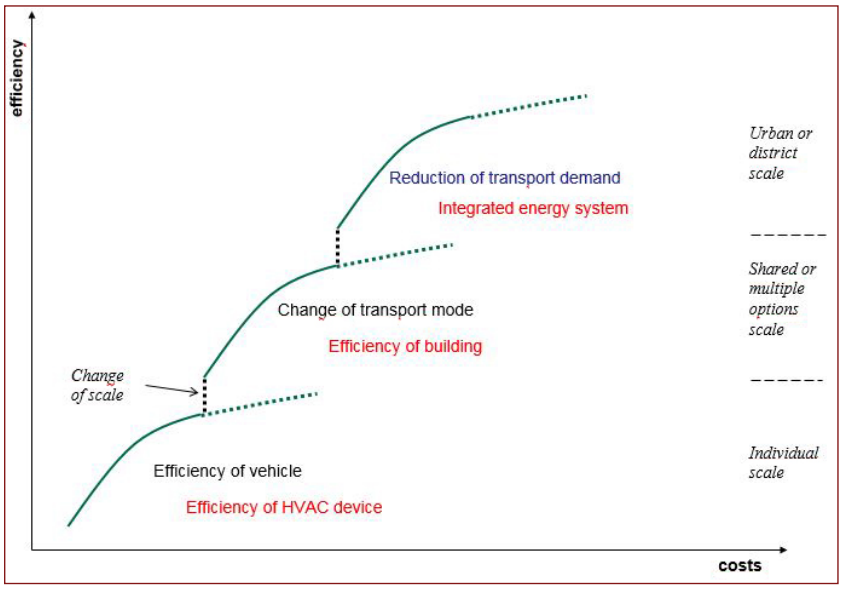

Figure 1c – Optimised system organisation.

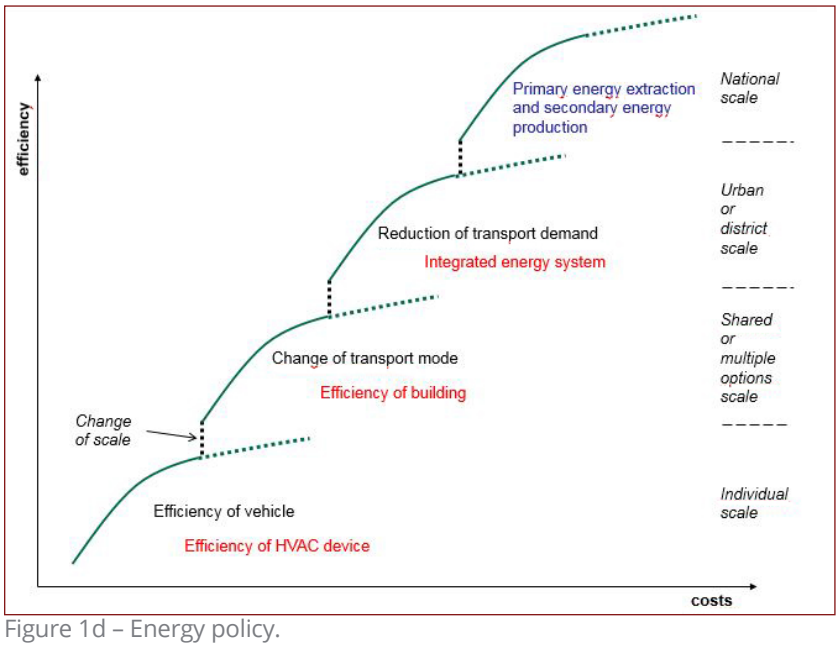

Figure 1d – Energy policy.

Now we have to consider the efficiency of conversion from primary to secondary energy, including in oil refineries and thermoelectric power plants. At the end of the chain we can evaluate the efficiency of the distribution system: pipeline, coal transport, electric grid.

Only at this point is it correct to consider the efficiency of the local supply system and of end uses.

3. What is efficiency from the end-use point of view

At this point we can see that in a systemic approach, efficiency assumes a new light and a new possibility to become strategically effective in reducing CO_2.

We can clear up what is efficiency in a sustainable pattern.

To begin, we will show what happens in a **supply side approach** (figure 2a), the most commonly adopted. The box with the question mark is a generic system that requires energy; you can imagine a house, a building, a city, or an industrial district. Each user asks the utilities/companies to satisfy their energy needs. The company is not interested in which are the final needs of the user: the user is a customer and the need is a demand. It sells the customer the energy requested. This is its business.

The energy supplied flows through the system, producing the desired effect and then is lost in the environment. The only effects we can monitor are the growth of entropy, the environmental impact, and the level of user satisfaction.

To reduce the impact of the system we can adopt an **end-uses approach** (figure 2b), watching inside the box and finding the energy sources that match best the quality requested by each end use. For example, if the system is a house, to produce sanitary water we will use a low-temperature heat source, such as a solar collector. For cooking, we will use a high-temperature heat source such as natural gas, and so on. The result will be a similar quantity of energy lost, but a lesser increase of entropy and probably a lower pollution rate.

The scenario starts to change significantly when we use an **end-uses efficiency approach** (figure 2c), shifting our attention from energy itself to energy services. Our point is no longer to calculate how much heat at low, medium, and high temperatures is needed, or how much electricity, but which are the services I want to obtain by using this energy. For residential, it is needed for light, music, computer use, preservation of food, cleaning clothes and washing dishes, transportation, an agreeable temperature in winter as in summer, etc. For an industrial district, the services needed are power for equipment, light, transportation, process heat, etc. We can save energy using the best available technologies in lighting, washing, air-conditioning, television, computers, and more efficient industrial equipment.

The **system approach** (figure 2d) is the only way to achieve significant and enduring results in terms of energy use and CO_2 emission reduction.

For instance, in the case of an industrial district, energy output of equipment using high-temperature heat can easily be used as energy input for a process that requires low-temperature heat. With a review of the processes implemented

inside the industrial district, we can implement the recycling of materials among the different activities, thereby reducing waste production. Modifying in a proper way the industrial processes, we can optimise the materials and energy exchange inside the system, such as what occurs in an ecosystem. Efficiency in a sustainable pattern means optimising the material and energy flows passing through the system, maintaining for the longest possible time its circulation inside the system to produce the most useful effects before being lost as output. Only after having optimised the system in such a way can we usefully consider the choice of the more efficient appliances and devices as elements of the system. Therefore, we can finally create an **intelligent integrated system** (figure 3) able to produce multiple services. The integration of the largest available pattern of renewable resources will open new markets for renewable energy, avoiding problems related to each single technology (low intensity, intermittence, etc.) and giving to the customer the most flexible, reliable, economically and environmentally efficient system. As in computer science, which matured when the sector switched from hardware to software, the same will happen with energy. It is the same as occurs in biology when a system evolves from a poor state (a quarry) to a very high-level state (a tropical forest) by an enrichment of biodiversity. In a sustainable system, the role of biodiversity is covered by the *technological diversity* that ensures a high resilience to the system, making it able to adapt to variations of conditions, just as in the sources in the market of technologies and sources (Jackson 2009).

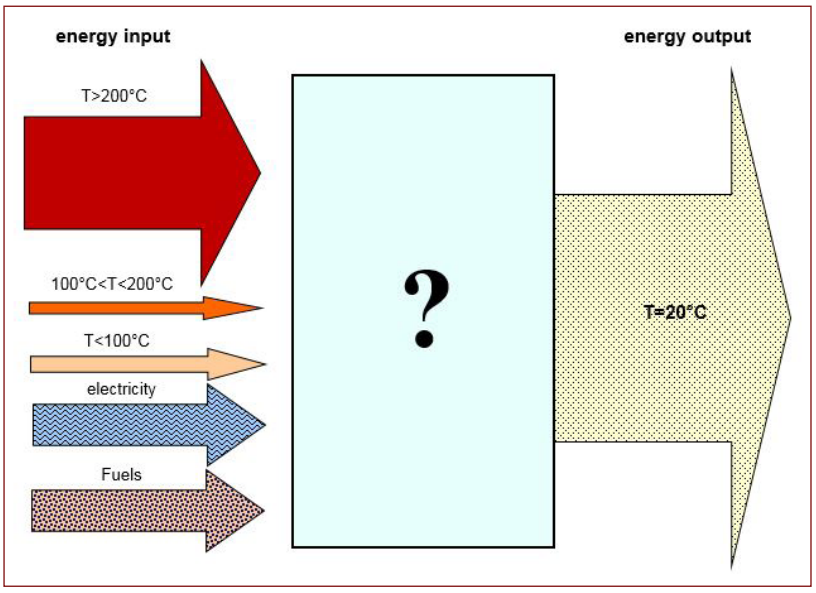

Figure 2a – Supply side approach.

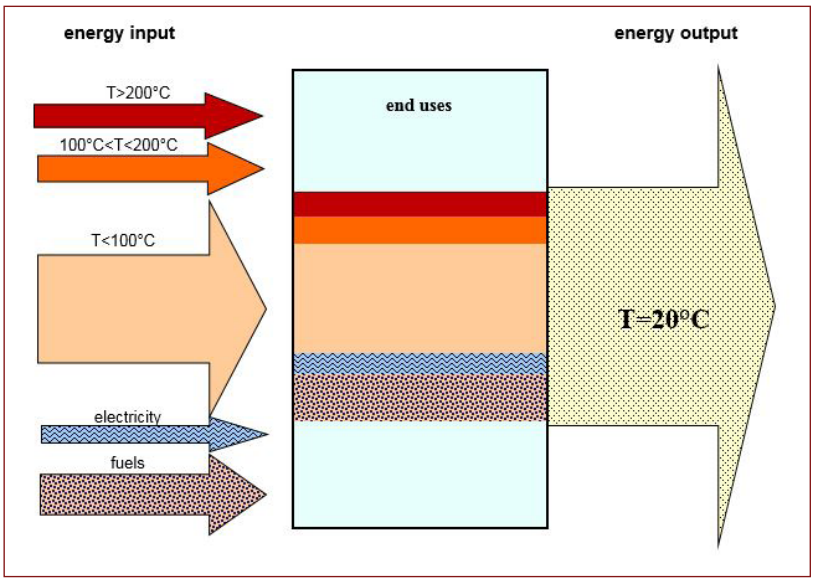

Figure 2b – End-uses approach.

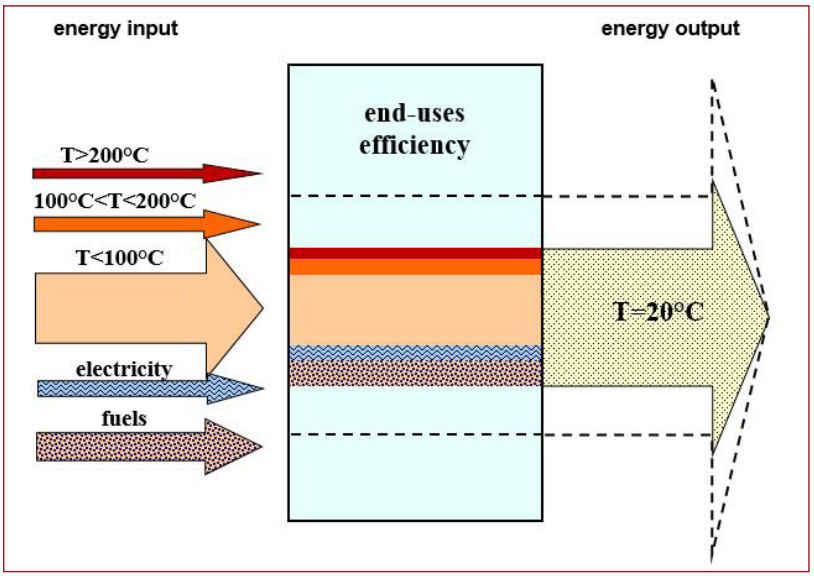

Figure 2c – End-uses efficiency approach.

4. Energy efficiency in the economy

In national reporting, the efficiency of the energy intensity of GDP is often considered. This is very misleading; it brings us to say that a country whose economy is based on tourism is more efficient than one whose economy is based on, for example, the steel industry, without evaluating the efficiency of hotels, restaurants, the transportation system, and all the other services and activities related to tourism. Energy intensity of GDP could be useful if a country is ready to transform deeply its economy, phasing out the most

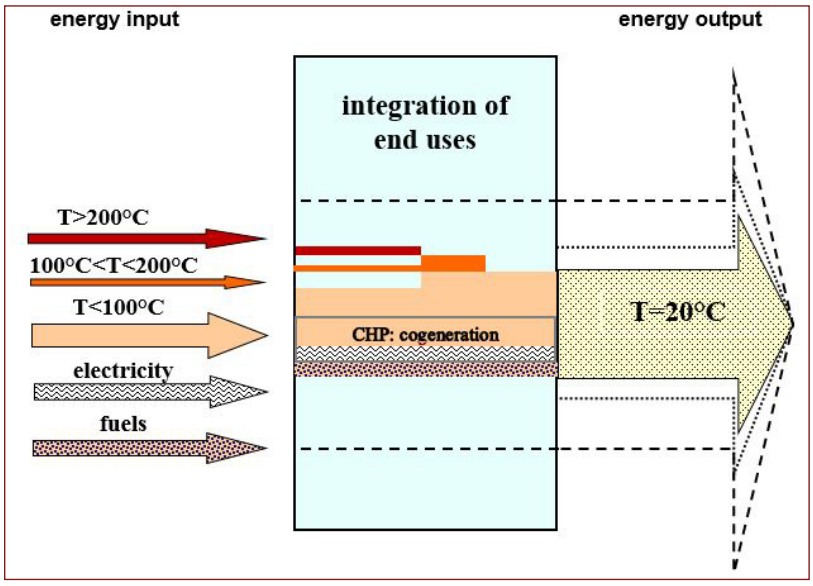

Figure 2d – System approach.

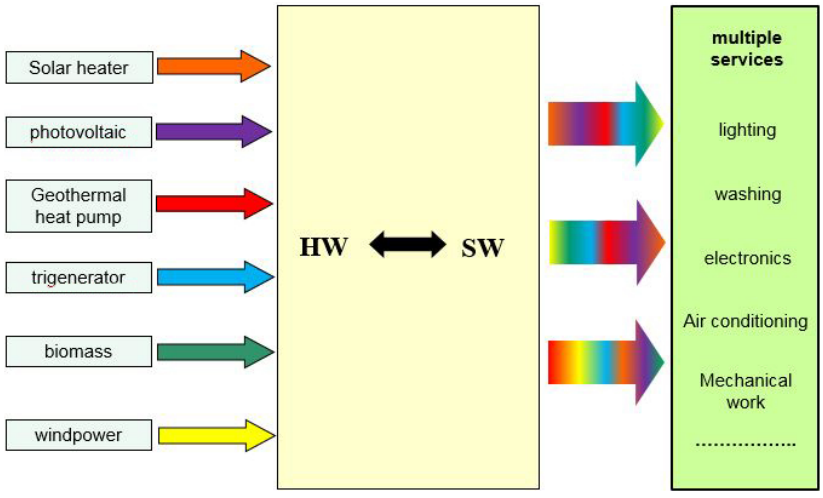

Figure 3 – Intelligent integrated system.

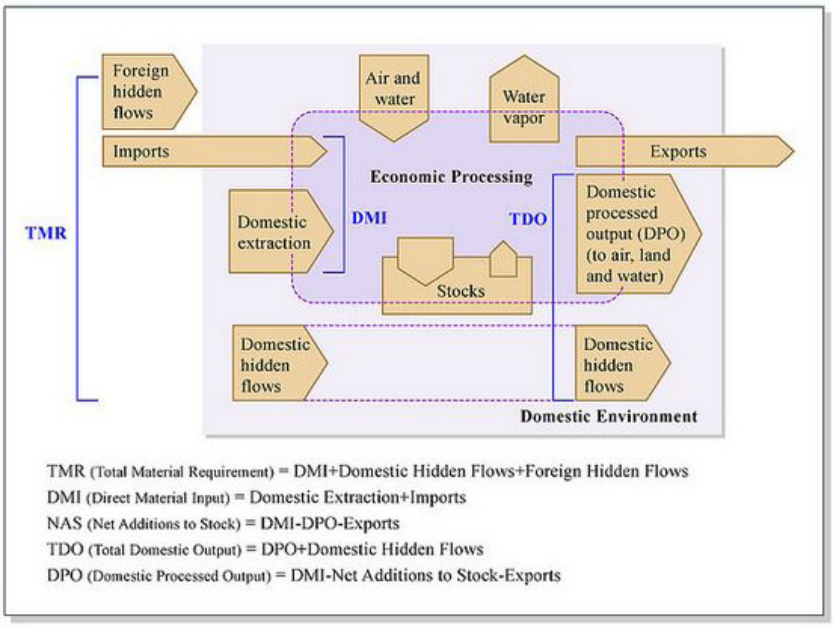

Figure 4 – Material flow (WRI–The Weight of Nations).

energy-intensive activity. Income and GDP are not parameters in which is found the definition of efficiency. For the economy, efficiency is converting the greatest quantity of natural resources in value in the shortest time. It implies the production of the greatest quantity of goods that have the shortest durability acceptable by consumers. It is the opposite of the definition of scientifically based efficiency.

Another component of economy efficiency, and one which is often inopportunely disregarded, is the energy flow that crosses the economic system, embodied in goods and materials, including the hidden flow related to extraction and production activities that are implemented outside national boundaries (see figure 4). This depends on the organisation of the national market and the industrial system and can allow us to have an exhaustive balance of energy used, directly and indirectly, to feed the national economy. Efficiency in this case is the sum of energy used in each branch of the economy, compared to the best available technologies. All the inputs related to each activity could be evaluated using an input/output matrix like that in figure 5. It is formed by the following submatrices and vectors:

Matrix A: contains goods input to each sector.
Matrix B: contains goods output from each sector.
Matrix C: contains the primary input to each sector.
Matrix D: reports how much of each good is requested to satisfy final demand.
Matrix E: reports how much primary inputs are requested to satisfy final demand.
Vector F: reports the total demand of goods from sectors and final demand.
Vector G: contains the total outputs for each sector.
Vector H: contains the total primary inputs.
Vector J: contains the total expenditures for all goods and all primary inputs.
Vector K: represents the total output of goods.
Vector L: represents total inputs to sectors.
Vector M: represents total inputs supplied to satisfy final demand.
Matrix N: contains the quantity of wastes disposed in ground, water and air to satisfy the final total demand of goods represented by matrix F.
Matrix O: contains the quantity of wastes produced by each sector and disposed in the environment.
Matrix P: contains the total amount of waste output from the economic system.

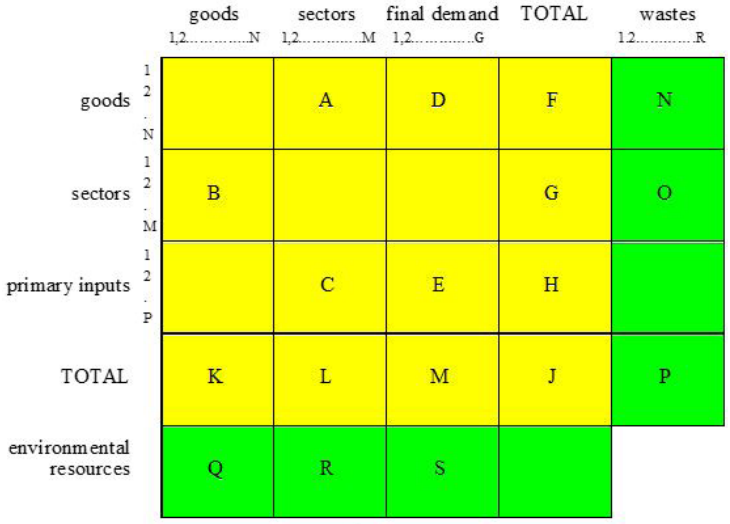

Figure 5 – INPUT/OUTPUT matrix.

Matrix Q: contains the input of natural resources requested to produce each type of good.
Matrix R: contains the input of natural resources requested by each sector.
Matrix S: contains the total input of natural resources to satisfy final demand.
If we substitute in each voice of this matrix the energy embodied in weight for quantities, our matrix will describe the energy flow throughout the economic system.
We can produce two matrices: one representing the real input/output of the economy, and the other one filled with energy data related to the best available technologies, representing a sort of best reference. Comparing the two matrices, we will consider the range between them as representing the efficiency of the economic system.

5. A case study: light and shade in the Italian Efficiency National Action Plan (PAEE)

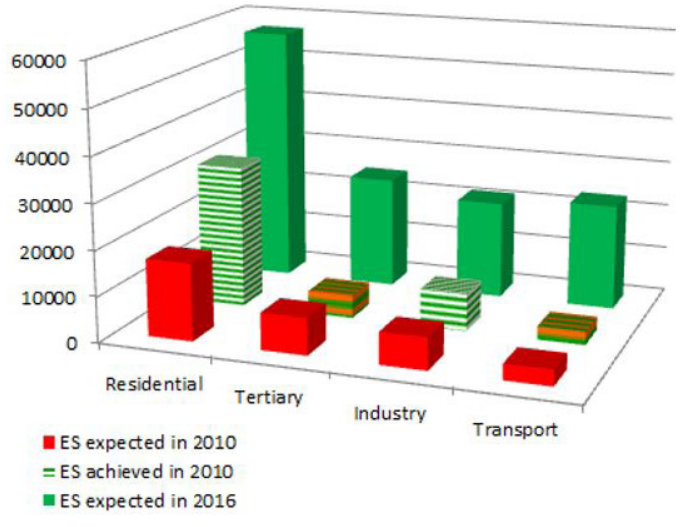

Figure 6 – Annual energy saving (ES) - source PAE 2011 (GWh/y).

The first PAEE was presented in July 2007 to implement European Commission Directive 32/2006. The plan was updated in July 2011 according to the 2020 European target of -20%. The plan fixes targets for 2016 for the residential, tertiary, transportation, and industrial sectors. The intermediate targets of 2010 have been over passed by about 50% in the residential sector, while those of the tertiary reached only 8% of target, industry 47%, and the transportation sector 85%. It is interesting to look at the details of these results.
In the residential sector, big success resulted in the type of actions that have an immediate and durable effect on important aspects of the family budget, such as insulation of walls and windows and replacement of inefficient heating plants with more efficient ones reaching, respectively, 156% and 171% of target. Less attractive seems to be the substitution of washing machines for market presence of less efficient appliances at a lower cost. In this case, less than 8% of target has been reached. But the target would seem less difficult if we were to put a lower limit to the efficiency of marketable products, as has been done in phasing out incandescent light bulbs; in this last case the success is evident: the result was more than double the target.
The evident failure of action proposed to the tertiary sector is probably due to the fact that the price of services is less dependent on energy and goods as on commercial activity, and in many cases the cost is covered by public administration, which usually pays less attention to the less important component of final costs. In this case it is important to induce or to force more responsibility of the actors on environmental grounds.
Particular attention needs to be paid to the failure of the plan in the industrial sector, where less than half of the target was reached. Regarding the substitution of electric engines with more efficient ones, only 1.5% of the action target was achieved. The revamping of machines in this sector failed completely while the use of high efficiency combined heat and power (CHP) systems enjoyed great success. Industries seem to be interested in improving efficiency in their energy self-production but not in a better end use. Probably, this is due to the prevalence in the Italian industrial system of small- and medium-size industries and manufacturers (SMEs) that are reluctant to make important investments in machinery dedicated to specific operations in the industrial process without long-term certainties regarding economic and market scenarios. In this, case the solution could be to support and promote the cooperation of more enterprises to implement efficient common-energy services, leaving more capital available for specific single actions (Bertini et alii 2011).

6. The importance of a network initiative

Some actions are required to implement energy efficiency in a sustainable pattern, according to the three levels below:

- Politics;
- Education/information;
- Direct action.

Actions must have a synergistic effect to stimulate a network initiative. They must produce interchangeable results and experiences and must be so flexible as to be adaptable in different contexts.

Politics

1. Introducing in national legislation a law that submits to an *Energy Efficiency Assessment* (EEA) any activity or project that implies a significant energy use related to the energy services the project wants to provide. The EEA must be determinant for authorisations, licenses, and public financing.
   For instance, the EEA for a transportation infrastructure project must be evaluated with an energy analysis of both the construction phase and of the transportation service offered. The evaluation must be comparative with other possible solutions (motorway, railway, maritime transport...).
2. Substituting plans for new, conventional high-power plant construction with plans for integrated local networks of renewable energy plants connected to smart grids.
3. Implementing of national and local energy plans oriented to local generation in integrated smart grids promoting energy efficiency both in the energy supply and demand chains. The plans must include enhanced energy performance requirements for appliances. The plans must contain a strategy for phasing out the most inefficient appliances and devices.
4. Establishing financial support for the creation of smart industrial districts.
5. Linking of licensing for building up industrial, commercial, or housing projects in respect to high-efficiency standards.

More of the actions listed above have been considered in recent legislation that implements the EU directive on energy efficiency, but there is still a lack of a systemic pattern that organises such actions into a hierarchy that also includes the synergies among them.

Education/information

1. Initiatives to introduce into educational programs the basic concept of efficiency
2. Information campaign to promote efficient solutions such as LED lighting, sustainable mobility, efficient vehicles, efficient buildings
3. Green-point creation in shopping centres to deliver information about efficient solutions
4. Agreements with public and private partners to spread market information on the availability of efficient solutions.

Also, the actions listed above have been introduced into plans and financial initiatives supported by local and national administrations, although the actions implemented are sporadic and fragmented and not producing an economic scenario for the future.

Direct actions

1. Promote the constitution of citizens' trusts and commonwealths, or popular shared companies to develop the project of a local integrated efficient system
2. Promote projects of energy "independence" for communities.
3. Promote the constitution of zero-emission communities.
4. Form citizen networks for diffusion of zero-emission solutions.
5. Form legal initiative to oppose project inefficiency and installation of coal-fired and nuclear power plants.

7. Conclusions

Efficiency is not an objective value but, if scientifically based, is actually a subjective value. The importance of pursuing efficiency depends on the purpose we have based it on. It can imply both quantitative and qualitative evaluations. If we define the efficiency of a killer as the number of bullets he needs to shoot to kill his victim, it is better to be inefficient. If we define the efficiency of an ice cream maker as the number of ice creams per hour he can produce, maybe it is better to change ice cream parlours! But anyway it would be fair to ask the ice cream maker to use a high-efficiency class refrigerator.

We can conclude that efficiency has a double face: it is necessary, but sometimes it is an illusion. It is not the solution for an energy-hungry world, but is a part of the solution for a sustainable world. Exploring the boundaries of efficiency is like being inside the smallest box in a set of Chinese boxes; if you don't open your mind to the world outside, you will stop at the walls of the smallest box, thinking to have done the best possible but in fact ignoring the largest scenarios yet to be explored. The different approaches to explore the infinite efficiency scenarios that can be opened in the future are described in this paper. Efficiency, if solely applied, could be a costly exercise insufficient to drive humanity towards a sustainable future, producing as its only effect that of moving a little bit on the limits of an economic system that is overexploiting natural resources and damaging the ecosystem forces fundamental for life. To avoid this, it is necessary to drive investments to create an efficient economic and human environment, building specific infrastructures like smart grids and heat pipes, promoting energy exchanges among differ-

ent end uses, and recycling materials. In other words, before promoting efficient appliances on the consumer market, it is necessary to define a pattern of sufficiency to create a new efficient scenario of a qualitative wellbeing looking forward to a circular and sustainable economy. In this sense, efficiency is much more than operating a machine with the lowest energy supply, but it is how to produce the highest wellbeing using the lowest amount of resources.

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An overview concerning combined heat and power production: a smart way to improve energy efficiency

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Keywords: energy efficiency; CHP; cogeneration; heat; electricity; cleaner production.

Abstract

Cogeneration power plants simultaneously generate power and usable heat in a single, integrated system, which achieves a degree of overall efficiency that is much greater compared to electricity production alone. This makes better use of energy conversion and reduces greenhouse gas emissions. Combined heat and power production is already relatively common in Europe while it is less common, for example, in the USA. There is great potential for further implementation throughout Europe and worldwide, including in the industrial sector. Major challenges are the short potential distances for the transport of heat and the fact that consumers' heat demands vary in quantity, mainly due to seasonal effects, and in quality as different applications require different temperature levels. Cleaner production schemes offer suitable frameworks to foster uptake of combined heat and power production by industry, in particular by small and medium sized enterprises.

Introduction

Energy conversion and use account for around two thirds of global greenhouse gas emissions (IEA, 2015a). Decarbonisation of the energy sector is a fundamental requirement to limit a long-term global rise in temperature as a consequence of anthropogenic climate change and can be, therefore, understood as a prerequisite to enable all future development. Energy efficiency, the switch of energy sources to a more widespread adoption of renewable energies and CCS (carbon capture and storage) are the three main pillars in strategies to reduce energy-related greenhouse gas emissions in terms of equivalent carbon dioxide (IEA, 2011).

Cogeneration schemes are designed to supply both power and heat simultaneously. By including heat, they valorise energy that would otherwise be considered waste heat (excess heat). Recovered waste heat can be used for heating buildings or other areas, for providing hot water, for covering industrial demands and in some cases for driving a second engine for additional electricity production. Assessment of the actual impact of cogeneration on climate change mitigation remains a difficult task (Bianchi et al., 2014; Heinonen et al., 2015). It is evident that the supply of heat to consumers replaces other heat sources. Today, the vast majority of heat demand, worldwide and in Europe, is covered by fossil fuels (European Commission, 2015). Cogeneration therefore leads to overall energy savings and greenhouse gas reductions in the energy system. This indicates that heat valorisation from cogeneration power plants has huge potential to make a vital contribution to decarbonising the energy system. Cogeneration can, therefore, be considered a powerful scheme to improve energy efficiency (IEA, 2011).

Cogeneration is also known as combined heat and power (CHP). Although no precise differentiation exists, the term 'cogeneration' often refers to central power stations delivering electricity to the general grid, and heat valorisation in this context is often in the form of district heating. The term 'CHP' is more common in decentralised applications, industrial settings, local community energy supply or individual applications such as energy valorisation of a biogas plant.

The power in cogeneration schemes (CHP units) is usually electricity but it can also be mechanical energy for operating technical equipment such as fans, compressors or pumps (Carbon Trust, 2010). To implement cogeneration, three basic processes need to occur: power production, heat recovery and heat use (Carbon Trust, 2010). Cogeneration is neither a new idea nor an application that is limited to large power plants. A common example of applied cogeneration is the automobile heater, which makes use of heat from the engine to enable comfortable temperatures in the interior of the automobile (Bridgeman, 2011).

The concept of cogeneration is smart and very appealing but in practice, a range of challenges need to be met and carefully assessed in order to ensure successful implementation. Electricity can be moved over long distances without significant losses, however, this is not the case for heat for which transport is limited to short distances. Another major challenge lies in the fact that consumers' heat demands vary both in quantity (heat amounts) and in quality (temperature levels). District heating, which is closely linked to urban planning and can be fostered and promoted directly by the public sector, is often a focus in assessments on how to increase

uptake of cogeneration while potential implementation in industrial settings is less well addressed. The industrial sector has more complex and more diversified conditions, and the potential uptake of CHP by small and medium sized enterprises (SMEs) is particularly challenging.

This study elaborates an overview of benefits, applications and challenges related to implementation of combined heat and power production. The aim of this publication, therefore, is to contribute to more widespread and successful implementation of cogeneration and, in particular, to explore combined heat and power production as a cleaner production measure in industrial settings.

The dominant role of heat in the energy sector

The topic of energy in the climate change debate is often focused on electricity and transport while less attention is given to heat. However, heat demand is actually higher than demands for other key energy forms (IEA, 2014; 2011). Data on heat demand are difficult to obtain, especially as heat produced on site by single consumers is not systematically recorded, therefore assessments need to be based on estimations. Globally, the share of heat in total final energy consumption today exceeds 50 % (IEA, 2014) which puts heat at the level of the sum of electricity and transport shares together. In highly industrialised countries, the share of heat in total final energy consumption is somewhat lower, but on average still exceeds the individual shares of transport and of electricity (IEA, 2011). Figure 1 illustrates the shares of electricity and heat in final energy consumption of industry in the European Union (EU) and reveals that on average, heat accounts for around 40 %. This dominant share of heat in energy demand indicates that transition towards more energy efficient heat supply has a huge potential to reduce energy-related greenhouse gas emissions.

Globally, most heat is needed by the industrial sector (more than 40 %), while the residential sector is the second largest consumer (if residential sector and commercial and public services are combined into a common category of 'buildings sector', this aggregated sector would be the main heat consumer, accounting for around half of final energy use for heat) (IEA, 2011). This highlights the fact that both the building and the industrial sectors need to be addressed as a priority when aiming for more efficient heat supply systems.

Key benefits of cogeneration

Around two-thirds of input energy is lost in traditional electricity generation (IEA, 2014; 2011) which means that only one third of energy contained in the exploited energy carriers is actually made available to the final consumer. The lost share of the energy content implies huge emissions of carbon dioxide and represents high opportunity costs. The vast majority of losses occur at the power plant during electricity generation, and the high losses are critically linked to thermodynamic limitations and basic conditions of the predominant energy conversion processes. Heat is an unavoidable by-product of power plants based on thermal processes. The conversion chain from chemical energy (contained in the energy carrier) through thermal energy (released through combustion) to mechanical energy using heat engines and finally into electricity results in a scheme that converts less than half

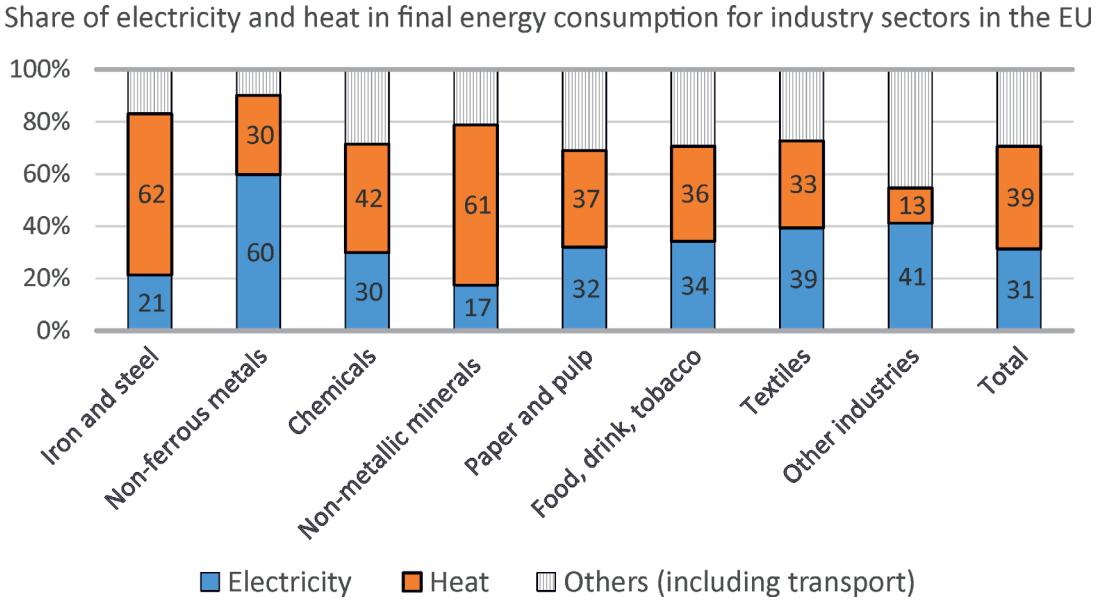

Figure 1 – Relative demand for electricity and heat in industrial sectors of the EU economy (data source: Pardo et al., 2012, there based on estimations using industry energy data of the year 2009).

of the energy content of the energy carrier into electricity.
The average global efficiency of fossil-fuelled electricity generation remained stagnant for decades at 35 to 37 % whereas advanced technologies today can approach 45 % efficiency (IEA, 2011). Historically, heat was dispersed with cooling towers, gas flues or by other means. Cogeneration allows conversion of 75 to 80 % of fuel inputs into useful energy, and up to 90 % in the most efficient plants (IEA, 2011). The full benefit, however, can rarely be captured and in 2012, cogeneration of heat and power had a global average efficiency of 58 % (IEA, 2015b), which is considerably lower than the theoretically possible benefit but still significantly higher than the efficiency of conventional thermal power generation.
Cogeneration in itself does not increase the power supply for a given plant but by supplying useful heat alongside useful electricity, it increases overall energy efficiency and allows the same level of end-use energy demand to be met with fewer energy inputs (IEA, 2011). Conventional heat supply is substituted by cogeneration heat. This results in decoupling fuel consumption from energy demand. As this reduces greenhouse gas emission, cogeneration can be considered a low-carbon energy solution.
At the same time, valorisation of waste heat can generate significant economic benefits, which is the central driver for implementation of cogeneration in the industrial sector, in particular in industries with high heat requirements. Cost savings are more difficult to quantify than energy savings as prices for energy vary between sites and can fluctuate (Carbon Trust, 2010). Economic benefits might vary significantly for sites within one country and will certainly vary between countries, depending on the relevant frameworks and policies. Nevertheless, combined heat and power production is a highly promising element in cleaner production schemes, with a view to both environmental benefits and economic advantages.

Implementation of cogeneration in different countries

Many thousands of CHP systems are in operation worldwide but the untapped potential is still huge. Challenges are not limited to engineering aspects; they include setting the right incentives by policy makers (Colmenar-Santos et al., 2015). Cogeneration is varyingly common in different countries. Scandinavian and continental European countries have a longer tradition in using cogeneration, which can partially be explained by higher fuel costs compared to other regions such as North America (Waskey, 2007). Another factor is that European cities are quite densely populated with many people living in apartments rather than single houses, which facilitates heat supply and distribution (Bridgeman, 2011). With the CHP Directive, the EU formally incorporated cogeneration into its energy policy a few years ago. Implementation of cogeneration is often fostered by different programmes and in some cases by specific regulations. This can include investment subsidies but also regulations whereby buildings near a cogeneration plant are required to use the waste heat of the plant to cover their heating demands (Bridgeman, 2011).
In the EU, slightly less than 12 % of all electricity is produced in cogeneration mode (Figure 2). The share has increased by 1.5 percentage points during the last ten years, although more recent years show a stagnation.

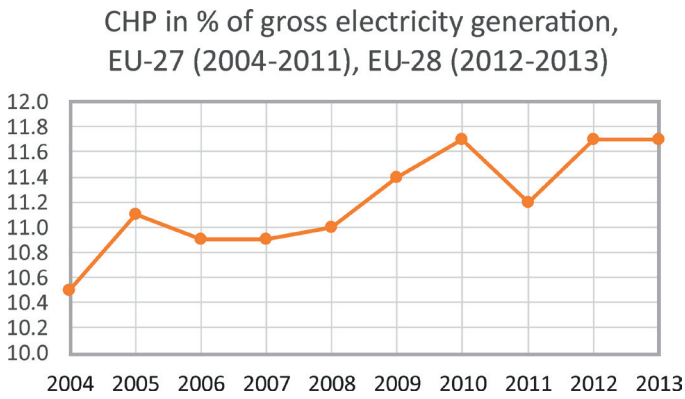

Figure 2 – Share of electricity produced in cogeneration mode in the European Union (data source: Eurostat, 2015).

There are significant differences among European countries: some countries have hardly any cogeneration facilities while for others, application of cogeneration is very common (Figure 3). According to Eurostat (2015), in 2013, 77 % of all electricity in Slovakia and 51 % in Denmark was produced in cogeneration mode. Other countries with particularly high implementation of cogeneration are Latvia (38 % of electricity generated in cogeneration mode in 2013), the Netherlands and Lithuania (35 %) and Finland (34 %). It must be considered that these figures refer to all electricity produced in a country, not only electricity from thermal power plants; therefore, they do not allow direct conclusions towards how well the potential of cogeneration is being exploited. In Finland for example, a major share of electricity comes from hydropower and actually more than 80 % of thermal power plants in the country use cogeneration. The EU country with the highest installed cogeneration capacity is Germany, although in 2013 only around 12.5 % of the country's electricity was generated in cogeneration schemes (Eurostat, 2015).
The first central power plant in the USA started operation in 1882 in New York City and was operated as a cogeneration plant, delivering heat to nearby buildings. During the course of the 20th century, however, rising electrical demand drove utilities to build ever-larger power plants that could not be located in cities because many of them were fuelled by coal (Bridgeman, 2011). The large distance to potential heat con-

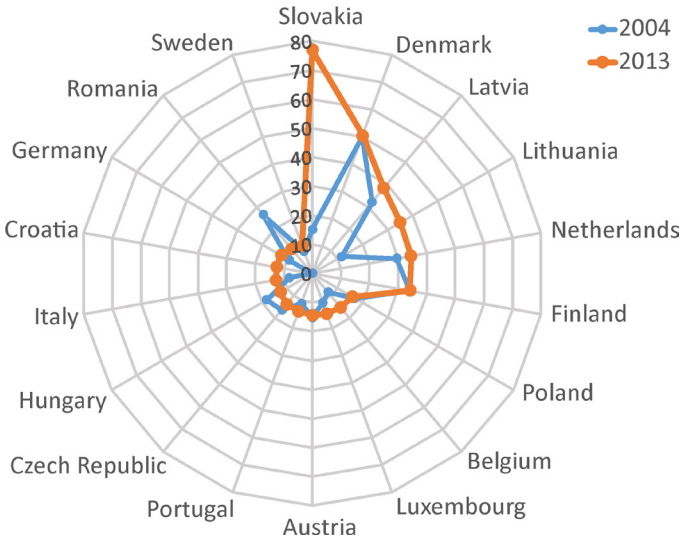

Figure 3 – Share of electricity produced in cogeneration mode in EU countries in 2004 and 2013, in percentage of gross electricity generation (only countries with more than 10 % of electricity produced in cogeneration mode shown) (data source: Eurostat, 2015).

sumers is one explanation of why cogeneration is not widespread in the USA. Another reason is the absence of incentives to improve energy efficiency throughout most of the 20th century. The Public Utilities Regulatory Policies Act of 1978 created a major boost to cogeneration implementation in the US, resulting in cogeneration rising to approximately 8 % (Ehrhardt-Martinez & McKinney, 2011). The Act allowed competition in the generation of electricity and required public utilities to purchase electricity from alternative sources, which included solar power, wind power and cogeneration (Waskey, 2007). Nevertheless, cogeneration has remained less common compared to Europe, in particular compared to those European countries with high shares of cogeneration.

Globally, absolute cogeneration has increased moderately but its share of electricity generation has not changed significantly over the past decade, plateauing at 9 to 10 % of global electricity (IEA, 2015b). District heating represented 10.8 % of global heating energy use in 2012 (IEA, 2015b). The vast potential to create more sustainable energy systems by implementation of cogeneration has not yet been extensively deployed.

Technologies

At the heart of a CHP unit, there is the so-called prime mover or heat engine. Heat from a hot fluid is used to do mechanical work, providing the power to drive the electrical generator. Heat that remains in the fluid will either be dissipated or can be recovered and used. Cogeneration plants are not all based on one single technology, therefore there is not one standard technology (Ehrhardt-Martinez & McKinney, 2011). The majority of plants in operation use a gas turbine with heat recovery, but diverse configurations of technologies exist and have evolved over time (Carbon Trust, 2010). Steam turbines and internal combustion engines are also in widespread use. Recently emerging technologies include fuel cells, sterling engines and ORC (Organic Rankine Cycle) (Carbon Trust, 2010).

The great variety of technical solutions enables high flexibility, which means that cogeneration can meet very different requirements. Fossil-fuel based operation of facilities is most common, but cogeneration processes can also be based on biomass such as wood pellets, biomass-derived energy carriers such as biogas, and waste materials. Waste-to-energy plants, with electricity production via incineration of municipal waste, are typically operated as cogeneration plants. CHP units are standard at biogas plants, as the digester itself requires heat for the process (Köttner et al., 2008). Coupling cogeneration and renewable energy sources creates particularly strong low-carbon benefits (strongly reduced emissions of carbon dioxide: carbon-neutral energy source coupled with high overall energy efficiency) (IEA, 2011; Karschin & Geldermann, 2015).

CHP schemes can be categorised into three groups according to the installed electrical capacity (Carbon Trust, 2010):

- large-scale (power output of more than one megawatt, ranging up to hundreds of megawatts), mainly operated in large industrial sectors with high energy demand, such as chemicals, oil-refining, paper, food and drink, and in large community heating schemes;
- small-scale (around fifty kilowatts up to one megawatt), usually installed at smaller industrial sites, buildings and community heating;
- micro-scale (less than fifty kilowatts), used in very small businesses or commercial applications and in domestic settings; the term 'mini-CHP' is used for systems that generate the equivalent of more than five kilowatts.

Up to a range of one megawatt (small-scale CHP and micro-CHP), installation is often as a packaged CHP which is supplied as a complete unit ready for installation. Packaged CHP systems are designed in a modular fashion and are manufactured on a large scale, thus benefitting from economies of scale. The prime mover in packaged CHP units is usually an internal combustion engine. Internal combustion engines operating on petrol, diesel or gas are favoured because they are reliable, require relatively little maintenance and are flexible in their operation; that is, they can respond well to load changes (McKenna, 2011). In such applications, a heat exchanger commonly recuperates heat from both the engine cooling system and the engine exhaust gas, typically in comparable amounts. This achieves high efficiency but the provided heat in practice is often below 100°C. The engine

cooling system usually operates at around 80°C, and up to 120°C in adapted units, while the exhaust gas delivers higher temperature.

Large-scale applications are custom-built, generally consisting of complex systems installed on-site. Due to their high overall efficiencies and reliabilities, the prime mover of large-scale applications is generally a gas or steam turbine or at high power outputs, combined cycle (gas and steam) turbines (McKenna, 2011). Units larger than fifty megawatts power output often use a combined cycle gas turbine (Carbon Trust, 2010). Although a wide range of sizes exist, cogeneration plants are usually designed to be smaller than conventional power plants, since the waste heat from electrical power production in a cogeneration plant must be used locally (Bridgeman, 2011). Heat recuperation mode depends on the selected prime mover type and can include partial steam recovery or steam generation from exhaust gas.

Heat utilisation

Heat can be valorised if the demand for heat exists. Heat demand, in particular from the buildings sector, is highly seasonal and moreover shows variations linked to weather conditions and throughout the day as well, which is a key challenge in heat valorisation. Another challenge is transport. Unlike electricity, heat - even with good insulation - cannot be transported without significant losses over large distances. Transport of heat requires its own infrastructure, which means additional investment costs, and is economically only viable for relatively short distances of a few kilometres (Köttner et al., 2008). Heat, therefore, needs to be generated in physical proximity to the consumer. Large operations such as health care centres, hospitals, hotels, universities, industrial plants or other facilities that consume large quantities of both power and heat are the most suitable locations for cogeneration on site (decentralised schemes). Centralised, large power (electricity) production facilities with continuous generation of high amounts of heat are often the starting point to implement district heating in nearby city quarters or villages via heat pipes. Such facilities are often public facilities and might encompass various partnerships. The pipes supply heated water, and heat exchangers transfer the heat to the building's utilities.

Meeting heat demand is not only a question of quantity but also of quality (heat temperature level). It is not sufficient to focus on required heat quantities; it is necessary to ensure that there is no mismatch between the quality of heat supplied and that actually needed by the customer. Heat demands span a wide range of temperatures. Buildings require temperature regulation to around 20°C to provide comfort to users, while at the upper end of temperature requirements are industrial processes, of which some need heat of 400°C or higher (IEA, 2011). Heat demand can be classified into three segments (Euroheat & Power, 2006; IEA, 2011; Pardo et al., 2012):

- low temperature heat demand (below 100°C), primarily for space heating and for hot water;
- medium temperature heat demand (100 to 400°C), which corresponds to processes of drying and evaporation, and is normally produced by steam;
- high temperature heat (over 400°C), for transformation processes that take place in industry, such as reduction of ores, calcination, electric induction.

With a view to the quantitative heat requirements of buildings, wide variations exist due to not only geographic location as well as season and time of day but also due to age, architectural characteristics and design, and materials of the building. Industrial heat demand varies hugely both in quantity and quality. There is a lack of data on industrial heat demand and shares of temperature levels in many countries (IEA, 2011). No official statistics are available to reveal the heat demand fully and continuously, but elaborated estimations allow an assessment. In Europe, the estimations indicate that around 40 (IEA, 2011) to 55 % (Pardo et al., 2012) of industrial heat demand is in the high temperature segment. Sectors with significant demands for high temperature heat are the iron and steel industry, the chemical industry, non-metallic mineral production and the basic metal industries (Figure 4). Quantitative heat requirements in the medium and low temperature segments are at a comparable level and together the two segments account for around 45 (Pardo et al., 2012) to 60 % (IEA, 2011) of total industrial heat demand.

The data reveal that in the industrial demand, high temperature heat overall has the highest share but clearly the demand is not always for high temperatures and many different types of process result in a wide diversity of needs with regard to temperature levels. This indicates that industry specific peculiarities need to be taken into account in CHP projects. The data further indicate that the following industrial sectors in particular have favourable heat requirement patterns (medium and low temperature heat) with a view to implementation of combined heat and power production: the chemical industry, food sectors and the paper and printing sector.

At large-scale power plants, significant heat quantities occur at higher temperature levels and in such cases heat can further be used in a second engine to produce smaller amounts of electricity, thus increasing the overall electricity production from the input fuel. This reduces the amount of waste heat occurring but does not eliminate it, and therefore still offers potential for the valorisation of heat.

At sites without significant heat requirements, requirements

	High temperature heat [PJ]	Medium temperature heat [PJ]	Low temperature heat [PJ]
Iron and steel	1044	53	50
Non-ferrous metal	98	5	10
Chemical	346	180	351
Non-metallic mineral products	826	53	57
Ore extraction (except fuels)		5	7
Food, drink, tobacco		162	256
Textile, leather, clothing	13	36	23
Paper and printing	92	246	175
Transport equipment	4	10	29
Machinery	10	22	67
Other industries	29	58	119
Total	2462	829	1142

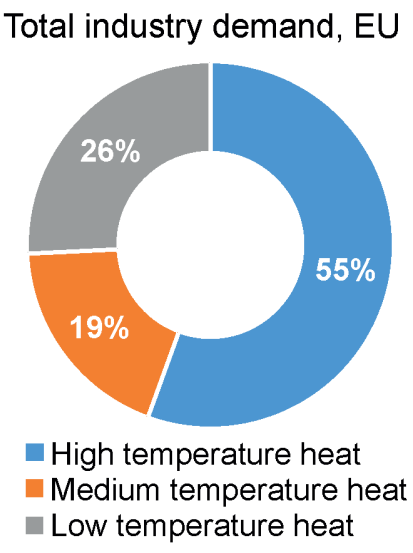

Figure 4 – Breakdown of heat demand in the industrial sectors of the European Union (EU27) according to heat levels, as estimated for the year 2009 (Pardo et al., 2012).

for cooling should be assessed as a priority since waste heat can be valorised to cover cooling demands. Such an option might turn an economically unviable CHP project into a project with business profit. Tri-generation is presented in the next section of this study.

Tri-generation

Combined heat and power production that produces heat, electricity and also cooling is termed 'tri-generation' or CHCP (combined heat, cooling and power production). Tri-generation can be highly effective in improving overall energy conversion efficiency by satisfying a variety of energy requests (Ascione et al., 2014). It can replace conventional electrical cooling systems, thus reducing electricity consumption and carbon dioxide emissions. In this concept, heat energy is transformed into energy for cooling/chilling. Heat can be used to achieve air-conditioning in buildings through absorption chilling technology. While conventional air conditioning infrastructures are used for distribution, specific equipment is installed to produce chilled water by using heat energy. Implementation is still marginal but commercial use exists. Tri-generation is particularly suitable at sites with limited heat demand but high heat availability (IEA, 2011). It can improve economic viability of energy projects at sites with limited demand for heat but high demand for cooling, thus turning unviable projects into viable ones.

One challenge is the achievable temperature level. Chilling to around 8°C can be considered state-of-the-art and is sufficient to regulate temperature in buildings. However, other applications require lower temperatures (such as freezing or cold storage of food) but the energy level contained in excess heat is often too low to achieve such temperatures with common technologies, and therefore such applications require further research and development (Köttner et al., 2008; Lira-Barragan et al., 2014). Other challenges are comparable to those associated with distribution of heat; the main problems are that only short distances are feasible and that often the overall demand for such energy within reachable distance is limited. One very positive factor is that heat and chilling demands have different seasonal patterns. Excess heat from CHP installations is particularly high during the warm season, which is when chilling is most required.

Modern district cooling networks can achieve efficiencies five to ten times higher than traditional electricity-driven cooling systems (IEA, 2015b). District cooling might account for about 2 % of cooling demand in Europe, and it is more common than in other regions worldwide, but availability of data is limited (IEA, 2015b; DHC+, 2012). District cooling, similarly to district heating, can be influenced directly by the public sector and is often a focus in assessments of how to increase uptake of tri-generation and cogeneration, while the potential implementation in industrial settings is less well focused. The industrial sector has more complex and more varying conditions, and industrial projects require adapted approaches.

Basic requirement for successful implementation of CHP (CHCP): precise assessment of electricity and heat (and cooling) demands and of technical and economic feasibility

Cogeneration power plants (CHP units) only generate environmental and economic benefits if they are running, and are only viable if there is a high and constant demand for heat.

This is similarly the case for tri-generation (CHCP units) and in the following therefore, tri-generation is not discussed explicitly, since the elaborated information is directly transferable.
Electricity output per unit of fuel (electrical efficiency) is generally lower in CHP units compared to electricity-alone installations. Only if significant amounts of heat can indeed be valorised is a CHP a suitable choice for an industrial site, a community energy scheme or a private setting. As a general rule, a significant and constant demand for heat should exist for at least 4,500 hours per year (more than half of the year) (Carbon Trust, 2010).
Figure 5 illustrates that energy savings associated with implementation of a CHP unit are closely linked to heat utilisation and replacement of a conventional heat supply method. If heat is not sufficiently needed by the consumer, implementation of a CHP unit will neither be economically viable nor will it be of environmental benefit. Therefore, a decision in favour of CHP implementation at a specific site should be based on a detailed individual assessment, including a precise feasibility study and a detailed calculation of economic viability under consideration of current and future electricity and heat (quantity, continuity and quality) requirements.
While meeting the actual heat demand and enabling proximity to the heat consumer are the main challenges in implementation of CHP projects, further challenges exist and can have a decisive influence on the success of a specific project. Typical challenges occurring in practice include the following aspects and should therefore be considered during the planning phase:

- Is the existing grid (electricity grid, heat grid if available) suitable to connect the new facility? Is grid reinforcement necessary? Is the grid generally available for connection, i.e. is a regulation in place that obliges the operator to connect the new facility or are negotiations necessary? What costs are relevant in this context?
- Is it technically and managerially feasible to integrate the CHP unit into the existing infrastructures, including the existing control systems of production units?
- Are there any circumstances which hinder the switch from current energy supply to a CHP scheme, such as long-term binding contracts for electricity and heat supply?

Often, the most advantageous situation is when the existing

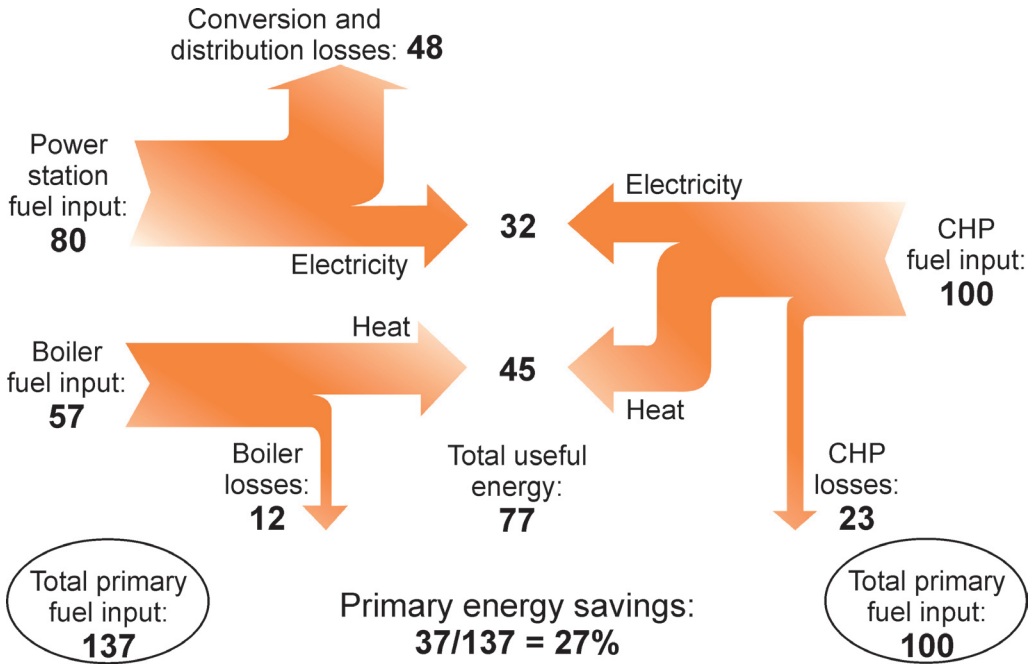

Figure 5 – Energy savings through a small-scale CHP unit installed at the site of the energy consumer compared to conventional energy sources (electricity from grid and on-site heat generation with boiler) (shown in units of energy). The example assumes that the central power station operated on fossil fuel has an efficiency of 40 %, while the remaining 60 % of the energy is lost, mostly as heat via cooling towers and to a smaller degree in electricity transmission. The example further assumes for the CHP unit an overall conversion efficiency of primary fuel to usable energy (power and heat) of 77 %. For 100 units of fuel, the CHP would produce 32 units of electricity and 45 units of heat. To produce an equivalent level of heat and electricity, the conventional power station and boiler would need around 137 units of fuel, so CHP yields primary energy savings of around 37/137 or 27 %. (partially based on: Carbon Trust, 2010).

equipment (such as the boiler for heat generation) needs to be replaced anyway, when investment is to be made for the plant and infrastructures or if an increase in demand for heat is expected (Carbon Trust, 2010).
Even if environmental benefits can easily be assessed and are clearly given, implementation of a CHP project in a business environment will only be attractive if the two other dimensions of cleaner production are ensured as well: economic viability and no risk of a negative impact on the quality of the company's products. This is closely linked to maintaining or ideally strengthening the market position of the company. The cleaner production triangle in Figure 6 illustrates the company perspective which sets the framework for implementation of projects in practice.

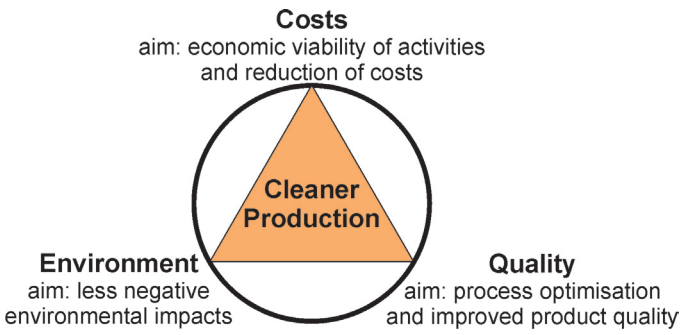

Figure 6 – Cleaner production objectives under company perspective (source: VDI, 2005, adapted).

In industrial settings, know-how and availability of resources can be major factors, in particular for SMEs. Those industrial sectors with favourable heat requirements according to Figure 4 are characterised by presence of a high number of SMEs. This indicates that implementation of combined heat and power production by SMEs has considerable potential. At the same time, implementation of combined heat and power production is among the measures that require significant financial investments and need to be aligned with existing infrastructures and strategies of a company. Therefore, a detailed and professional assessment of the project is highly advisable as well as a structured approach in order to cope successfully and efficiently with the level of complexity of such a project. In this context, cleaner production programmes and schemes can be highly valuable.
The cleaner production concept was developed in the early 1990s by UNEP (United Nations Environmental Programme) and UNIDO (United Nations Industrial Development Organization) to reduce the environmental impact of industry, and was defined as "the continuous application of an integrated environmental strategy to processes, products and services to increase efficiency and reduce risks to humans and the environment" (UNEP, 2015). Today cleaner production represents one central element in the transition to more sustainable consumption and production.
In its application, cleaner production can be seen as a simplified version of an environmental management system pursuant to ISO 14001 or EMAS (UBA, 2015). It is tailored to acceptability in practice and rapid uptake by companies, including SMEs, and focuses on a range of central elements that address preventive environmental protection. Access to knowledge, financial assistance and guidance to a structured implementation of cleaner production measures are among the central benefits. SMEs are major beneficiaries of external expertise, due to the fact that they often do not have the capacity to employ a cleaner production expert themselves. The cleaner production approach aims at gradually improving environmental performance of companies by subsequently identifying and implementing most promising measures at a given site. The cleaner production framework offers a structured approach to assessment and implementation of measures. Such measures are not limited to the actual production processes, but include infrastructures, supply and management of resources, general procedures, etc.
The cleaner production approach has demonstrated its success in practice, and cleaner production programmes and/or cleaner production centres have been established in several countries, including Germany, Slovakia and France. From Germany alone, around 2,500 case studies are available (UBA, 2015; Webportal about Cleaner Production and Pollution Prevention, 2015), all of which have received state support and have been facilitated by cleaner production schemes. Implementation of CHP as cleaner production measure is documented in some cases and in different industrial sectors, in general in the context of implementation of renewable energy. Under such a framework, a CHP project can be implemented similarly to other cleaner production measures, which ensures an approach tailored to the actual needs of the company.
In cleaner production projects, replacement of conventionally produced heat by heat from a CHP unit should not remain the single focus when looking at improving the heat requirement of a process or a company. Cascaded use of heat energy (from high to low temperature levels) and reduction of the necessary temperature level (for example, through process modifications) are further options that can be successfully implemented in practice.

Conclusions

Cogeneration of heat and power has the potential to save significant amounts of fossil fuel and to reduce energy-related greenhouse gas emissions drastically. Although cogeneration is a sufficiently well proven technology in practice, its

potential is still highly underexploited. District heating is a prominent and very suitable scheme to valorise excess heat from central power plants. Despite the similarities of the underlying technologies and processes, industrial application of combined heat and power production should be considered differently and in the specific context of the individual company. A viable approach is to define a CHP project as a cleaner production measure and therefore to assess it as part of the integrated environmental strategy of a company and to make use of the associated framework of well-proven procedures for successful implementation of such measures. A better consideration of CHP in the scope of cleaner production seems a very promising option to foster more widespread implementation in the industrial sector, including better uptake by SMEs.

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Materials Engineering

Industrial paper recycling process: suitable micronization for additive polymer application

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Keywords: Paper recycling, natural fibre thermoplastic composites, cellulose fiber HDPE interface.

Abstract

The traditional paper recycling process has problems related to the disposal of sludge and waste, the use of incinerators and water treatment. Because of that, an interesting alternative proposed from dep. of chemical and materials engineering of Sapienza University of Rome to Carlucci industrial typography, is using paper as filler in thermoplastics or recycled thermoplastic matrix composite. In this way it's possible re-use paper, but it also possible reduces the amount of polymer with equal volume. The paper has to be subjected by grinding. The chosen grinding process is fundamental to obtain a suitable product for composite. After a pre-grinding process obtaining 5-10 mm of paper fragments, the charge have to be subjected to a micronization process. In this study are selected two different type of micronization: the superfine grinding mill SF, a micronization process based on system that uses simultaneously the impact and friction action, and a knife mill that uses instead the cutting and friction action. Thanks to the first process, it is possible obtaining fibres with diameters of about 15-20 microns and lengths of the order of 250-500micron: a product therefore suitable for the application of filler in composites. This process unfortunately causes the production of fluff, as will shown in figure 2, because of the interfibrillar bonds between the fibers: an optimal dispersion of the fibers is necessary to avoid agglomerates which would decrease the composite properties. From the second process it is possible to obtain both fiber than particles as illustrated in figure 3. This morphologies mix allows to achieve a higher fluency preventing agglomerates. The turbomixer equipment realizes the production process of the composite, this process allows to introduce a higher percentage of filler respect the traditional injection moulding technique. The resulting composite is subjected by a morphological and mechanical characterization: look at the SEM analysis of the fracture surface, the fiber-matrix interface is weak, in spite of this, however, from the tensile test there is a constant elastic modulus and in some cases growing respect to the matrix devoid of fibres. From these results, the importance of optimize the grinding and micronization processes is clear and there is the opportunity of additives introduction to improve fiber-matrix interface.

Introduction

In Italy almost 9 millions of ton of cellulosic products are consumed, this shows the importance of recycling process to reduce the environmental impact.

From all the cellulosic waste, the 64% is used in recycling process, the 14% is sent to incinerator for thermovalorization and the last 22% is used for other applications (for example fireplace) or it is sent in waste dump. [1,2,4]

Paper recycling, economically speaking, is more advantageous than its incineration or its disposal.

Paper waste cost, avoiding collection costs and features plant used for the disposal, is near to 96-192 euro/ton. The recycling process, instead, allows a cost reduction to 40% less [3].

Paper, without ink, can be subjected to composting with other vegetable and animal materials to produce a fertilizer to improve soil property.

Paper recycling process has advantages like raw material's lower cost, the chance to use waste as fuel for steam production, the reduction of the amount of waste, of the storage cost and trees' consumption. [4]

There are also some disadvantages: the possibility to reuse paper at least for 5-6 times, after that is not possible another use of the same so the waste paper again becomes a solid urban waste and needs disposal [5], the production of variable amount of slug and waste that have to be recovered and have to be subjected to different treatment, the CO_2 and NO_x emission if is used gas as fuel and also SO_2, dust and heavy metal if is used oil or coal.

Another pollution source is the incinerator both for the dust that developed in the process that for the residual material that hasn't completed the combustion [6].

Concluding, despite great economical advantages and the reduction of environmental pollution due to recycling process there are still problems because of disposal of slug and waste, the use of incinerators and water treatment. Moreover ink paper or additivated one (for example with polymeric film) can't be subjected to traditional recycling process and must accordingly be disposed as special waste.

In this contest fit the will of Carlucci, industrial typography, to find a new opportunity to manage its paper scraps; They think that the chance to use different kind of cellulosic waste as dispersed phase in composite materials with HDPE or other thermoplastic polymer matrix is interesting and participate at this project also thanks to a public founding (regional founding VAPETORE). In order of that the micronization process to obtain a product suitable for this application has to be optimized.

Materials and Methods

Materials

Eraclene MP90, commercial name of high density polyethylene (HDPE) from General Electrics (GE), has been chosen as matrix. Its properties are a melt flow index (MFI) of 7.0 g/10 min (190°C/2.16Kg), a density of 0.96 g/cm^3, a tensile strength of 17 MPa, a flexural modulus of 1.45 GPa, a Shore D hardness of 69.

Paper used in recycling process or in thermovalorization was previously subjected to grinding by knife mill: it was possible to obtain in this way fragments of few centimetres.

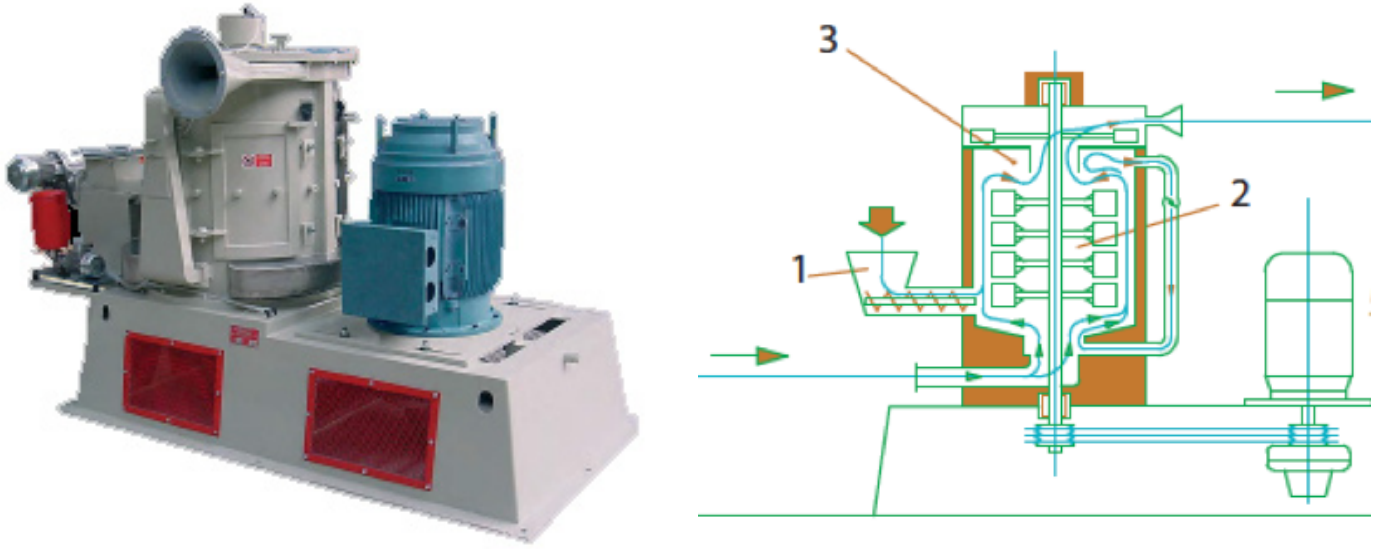


Figure 1 – The micronizing unite of the superfine grinding mill type SF: in the process scheme 1 is the feeder, 2 is the mill and 3 is the static classifier.

In order to obtain paper suitable for incorporation in polymeric matrix, micronization treatment is needed: in this study two different kind of micronization process were conducted and below exposed.

1. Superfine grinding mill type SF

Paper used in recycling process or in thermovalorization is previously subjected to grinding, in this way fragments of few centimetre are produced.

In order to obtain paper suitable for incorporation in polymeric matrix, micronization treatment is needed: a far from simple process due to the fibrous nature of the same.

A pre-grinding process in hammer mill is previously adopted, obtaining paper fragments of 8-10millimetres to realize a product suitable for the next step, the charge is then sent to micronization mill that exploits simultaneously the action of impact, shear and turbulence [7]. It is a superfine grinding mill type SF from Cimma, which works in the design and construction of machines and systems for powder technology, in particular machines and grinding plants and pulverizing, screening, air classification, drying, dust filtration, pneumatic conveying and mixing. The figure 1 shows the micronizing unit of the adopted plant.

The process is here presented: the paper is introduced by a screw feeder or through a current of air sucked downward into the grinding chamber. At the exit of the grinding chamber, the ground product, swept upward by the airflow, is classified by the separator placed in the higher part of the mill. The fine material is discharged upwards and collected into a filter, while the reject of the separator is recycled into the mill.

Thanks to this process the complete opening of paper in cellulosic fiber of steady diameters of about 15-20 microns and lengths of the order of 250-500micron are obtained: a product therefore suitable for the application of filler in composites. The images below represent the fibres obtained.

2. Knife mill SM 300

After a pregrinding treatment, adopted also in the previous process, to obtain 8-10 mm fragments of paper, the charge is sent to a knife mill. The process adopted is a knife mill SM

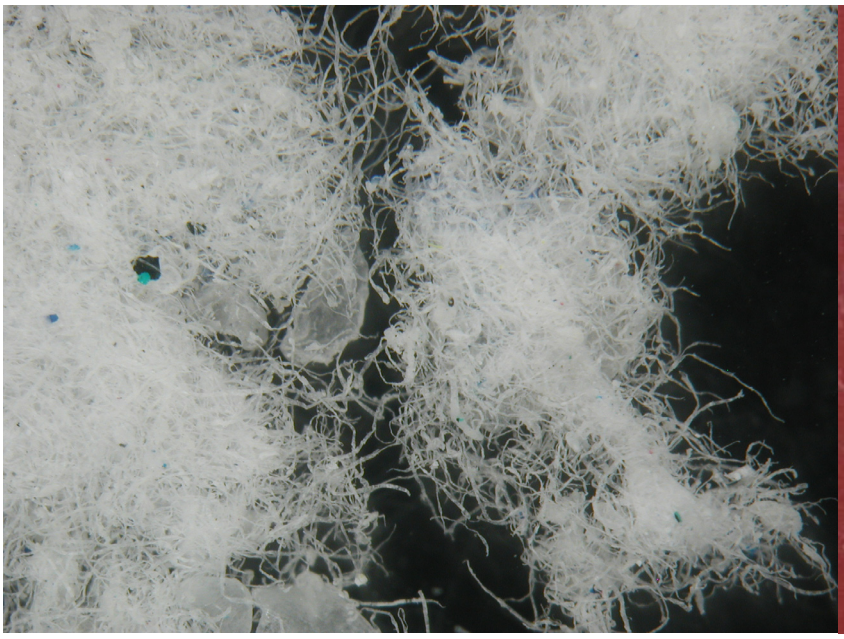


Figure 2 – (on the left) Micronized paper observed by stereomicroscope. Figure 3 (on the right) Micronized paper.

300 from Retsch, a German company that is active in the fields of neutral-to-analysis sample preparation and characterization of solids [8]. The figure 4 represents the scheme of the adopted knife mill.

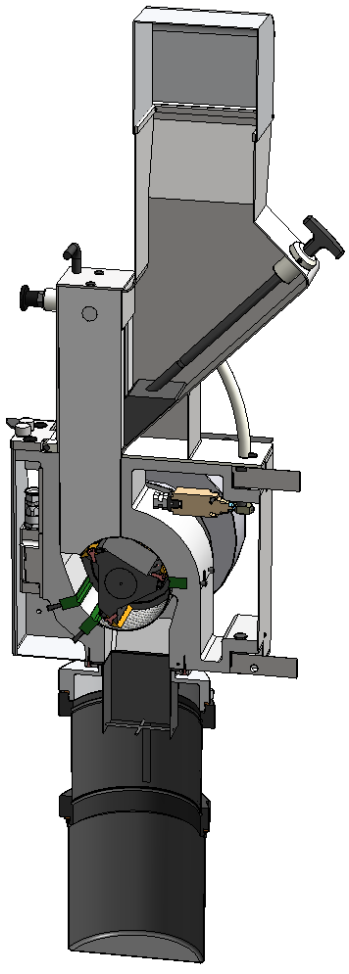


Figure 5 – The scheme of the adopted knifle mill SM300.

Cutting bars of stainless steel are used in this mill.
The charge is introduced through a hopper into the grinding chamber. Here it is in contact with the rotor and it is subjected to size reduction as a result of the cutting and friction action. To increase the number of the cutting during the grinding, it is equipped with cutting bar with double cutting effect. The residence time of the charge in the chamber is generally short and depends on the type of sieve adopted: in this study sieve from 1 mm and 0,5 mm are used. the charge, once reached the size to pass through the mesh of the sieve, it is collected in a container. The speed of rotation varies between 700 and 3000 round/min: in this way a rapid reduction in the size is possible. The product obtained from this process is very different from the fibre obtained by the superfine grinding mill: in this case the charge is reduced in fragments from which some fibres are isolated.
The images below represents the product obtained from the knife mill.
The obtained product, using a sieve of 1mm, is composed mainly of fragments of paper, there is instead a lower amount of fibers. The fragments are about 500-800 micron, higher dimension compared to the fibers.

The composite production

The main problem of the traditional injection moulding process is the low percentages of fibers that can be introduced and their poor dispersion, as we exposed in the previous work presented at 5th International Conference on Innovative Natural Fibre Composites for Industrial Applications [9] in which is clear the poor mixing dispersion with one screw extrusion implant. A new batch implant of mixing has developed in order to improve the fibres percentages in the poly-

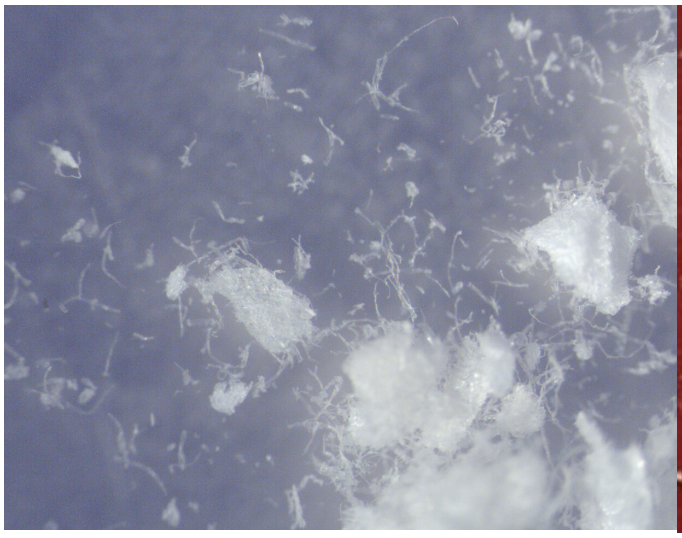



Figure 5 (on the left) and figure 6 (on the right): the charge obtained from knife mill with a sieve of 0,5mm observed with the stereomicroscope (fig. 5), the knife mill product (fig. 6).

meric matrix: the turbomixer (the results and the implant presented are to be placed in the "Project for the promotion of a culture of innovation and technology transfer – marine sector" approved and funded by the Region of Lazio with determination n. B03034 of 22/05/2012. The actuator of this Project is the Polo interprovinciale formativo della nautica Rome-Latina and the I.I.S.S."G. Caboto "is the leader).
The turbomixer is composed of a cylindrical stator and a rotor with attached blades. The figure 7 represents the HDPE matrix and the cellulosic fibers introduction in the turbomixer.

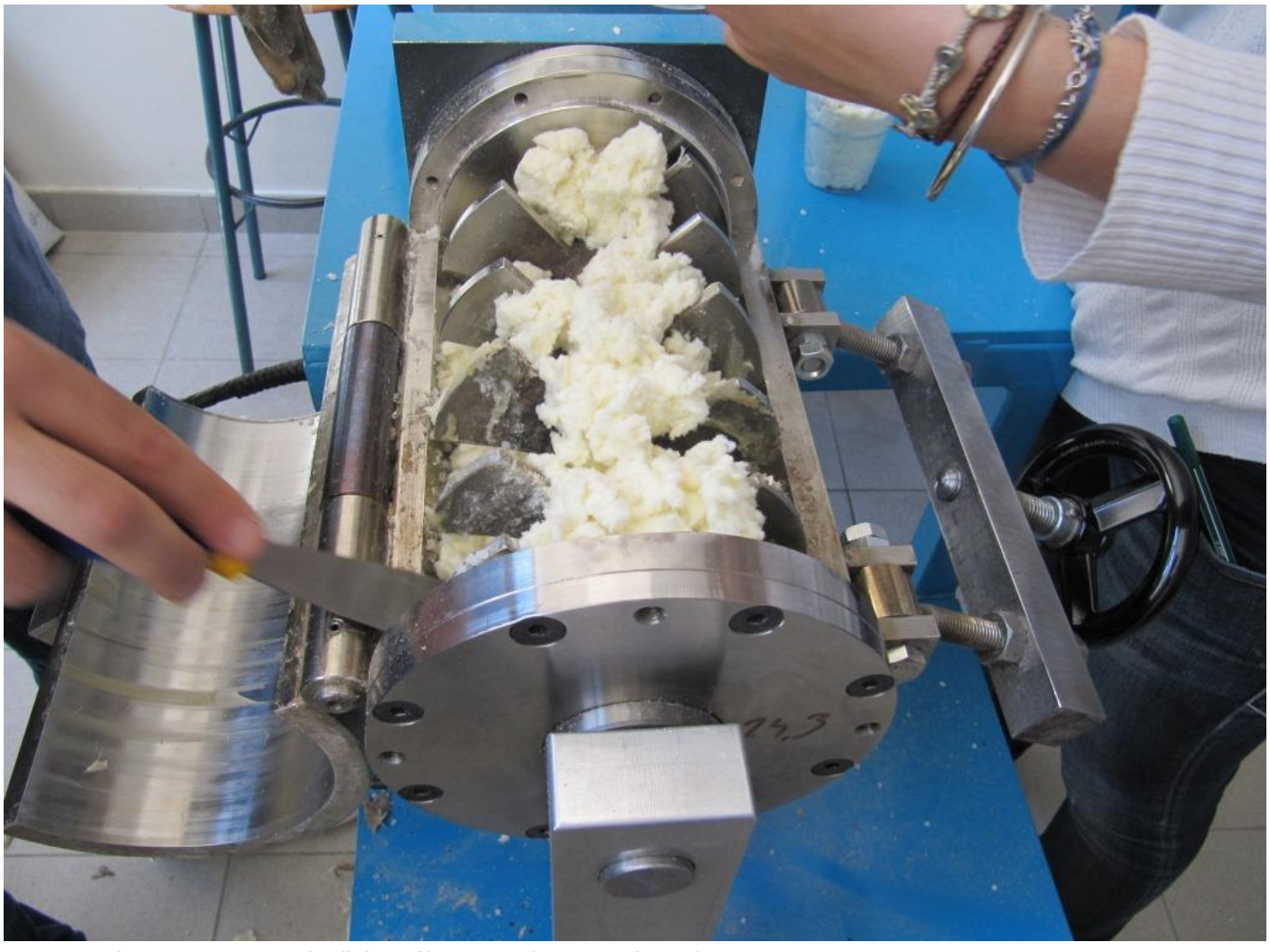


Figure 7 – The HDPE grains and cellulosic fibers introduction in the turbomixer.

The blades are oriented with different angles, because of the rotation in this way a suitable mixing is possible. The heat develops thanks to the conversion of mechanical energy into thermal one due to Joule effect.
There are three thermocouples to record the temperature: one of them is on the cylinder wall, one in the peripheral area and the last one in the centre zone.
Even if the heat develops in the same way of the endless screw of the extrusion system, in this case it is possible to reach a speed up to 3000 round/minute due to the only mixing of the charge without the possibility of progress in the mixer.
With this process the charge reaches the melting point, using HDPE the temperature is near to 170-180°C thanks entirely to heat develops from friction, the presence of additional heat source like electric heaters, is not necessary.
The turbo mixer has batch working: at the beginning there is the charge of the material, after that the closer of the cylinder, the activation of the mixing and in the end the hand discharge of the material.
The melted charge is then subjected to moulding under pressure, in this way it is possible to obtain tables from which specimen are derived.
The specimens are obtained with different percentages of filler: it is possible to introduce up to 20% of paper and it is also possible a better dispersion of the same.
The specimens are produced both with the product of the superfine grinding mill and the knife mill. The family samples tested are 10% of fibers derived from the superfine grinding mill and 20% of fibers derived from both the superfine grinding mill and the knife mill, the higher percentages of fibers has been chosen to compare the product from two different mill. Each family of different fibers percentages is composed of five samples.

Methods

The tensile test

The tensile test is carried out to measure the breaking load and the elastic modulus of both fibers produced with the superfine grinding mill and particles and fibers obtained from the knife mill.
The test was conducted in accordance with the norm ASTM D 3039 using a Zwick/Roell Z010 and a 1.8 MPa preload was applied. The specimens, obtained from 100mmx200mmx2mm (LxWxT) plates, have dimension of 200mmx12,5mmx2mm (LxWxT). The crosshead speed was 5 mm/min.

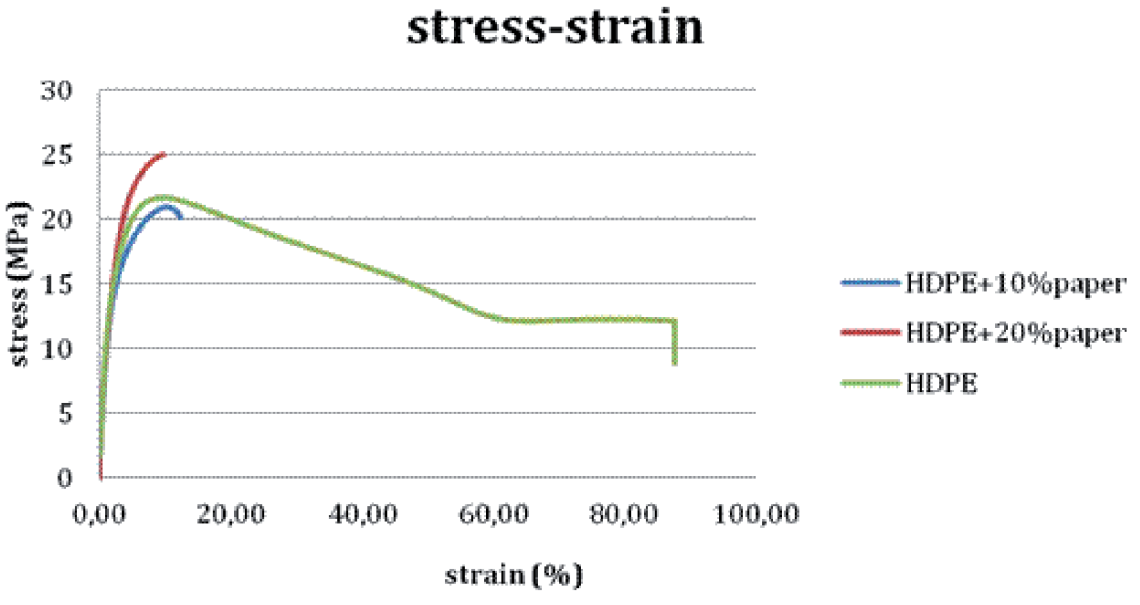
The scanning electron microscopy

The specimens were observed with SEM (Philips XL40) in order to analyse the fibers and particles dispersion in the matrix and the interface quality.
The samples were sputter-coated with gold particles before the surface characterization.

Results and Discussion

The tensile test

The specimens obtained from the turbomixer are subjected to tensile test.
The graphic below represents the stress and strain curve of the specimens with different percentages of fibres produced with the superfine grinding mill compare to polyethylene without fibers.



Graphic 1 – The stress and strain curve conduct with 1,8 MPa preload with fibers from the superfine grinding mill and without them.

The elastic modulus slightly increases or is constant with the introduction of fibers. The same behaviour is shown by the breaking load, which is affected of a visible improvement with the higher percentage of fibers. This leads, however, a marked loss of material toughness.
The table 1 summarizes the main results of the tensile tests.

Table 1 – the main results of the tensile test for the samples with fibers from the superfine grinding mill. For each family, five samples were tested.

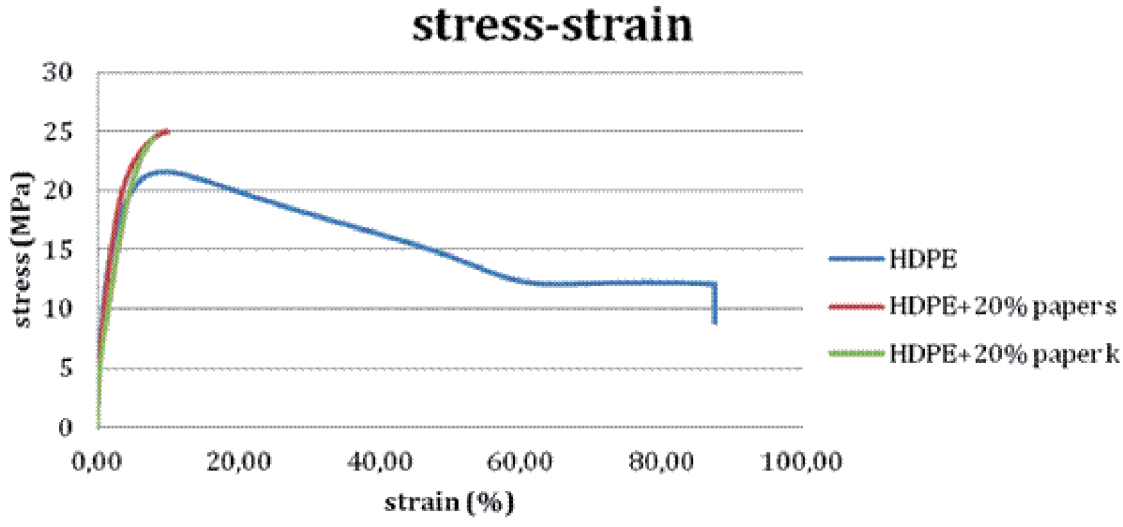
	Elastic modulus (MPa)	Breaking load (MPa)
HDPE	1160±86,6	21,59±0,18
10% fiber	1090±31,62	20,89±0,67
20% fiber	1250±18,26	24,61±1,22

The graphic 2 represents the stress and strain curve of the specimens with 20% of fibres produced with the knife mill compare to polyethylene without fibers and the composite with 20% of fibers produced with the superfine grinding mill.
The s after paper in the graphic means the paper produced with the superfine grinding mill, the k instead is for paper treated with the knife mill.
The composite obtained with the knife mill product (paper k) is more particulate, as underline before, this morphology doesn't change the elastic modulus while the mix of fibers and particles seems to contribute to the breaking load. The paper k moreover will lead to achieve higher percentages of filler thanks to its best ease of mixing.
The elastic modulus of the composite produced with fibers from the knife mill is lower then polyethylene without fibers but the breaking load is higher, the value is near to the composite produced with fibers from the superfine grinding mill with the same amount of fibers.
The table 2 summarizes the main results of the tensile test.

Table 2 the main results of the tensile test of the composite produced with 20% of fibers from the superfine grinding mill and the knife mill. In each family five samples were tested.

	Elastic modulus (MPa)	Breaking load (MPa)
HDPE	1160±86,6	21,59±0,18
20% fiber s	1250±18,26	24,61±1,22
20% fiber k	1067±77,6	24,75±1,68

SEM analysis
All the specimens are observed by scanning electron microscopy (SEM).
The SEM fracture surface analysis underlines the poor fiber matrix interface: a predictable result considering the hydrophilic nature for the fiber and hydrophobic one for the matrix. This behaviour is shown both from the specimens with the fibers of the superfine grinding mill and from the knife mill.
Thinking of paper s, we expected to obtain a better superficial grip because of the high mechanical activity on the surface of fibers during the micronizing process. Unfortunately this result wasn't found in the analysis performed.
The figures 8 and 9 represent the absence of fiber-matrix interface for specimens produced with 10% of fibers derived from the superfine grinding mill (Figure 8) and with 20% of fibers from the knife mill (Figure 9).



Graphic 2 – Stress-strain graphic comparing the mecanical properties of the composite produced with fibers from superfine grinding mill and knife mill.

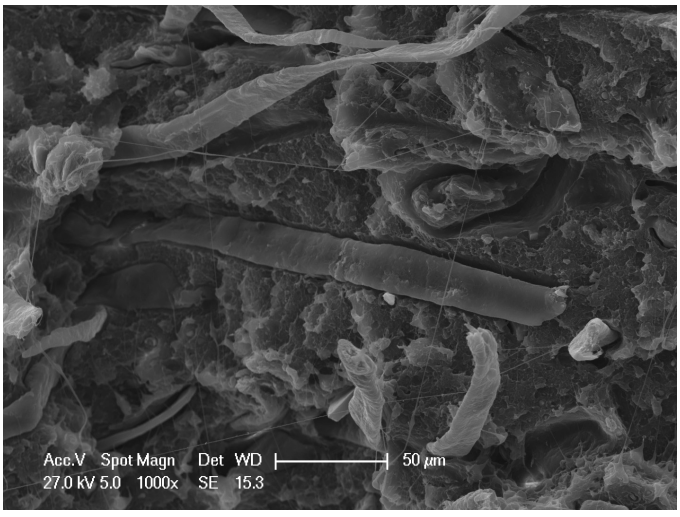


Figure 8 – SEM analysis of the specimens with 10 % of fibers S.

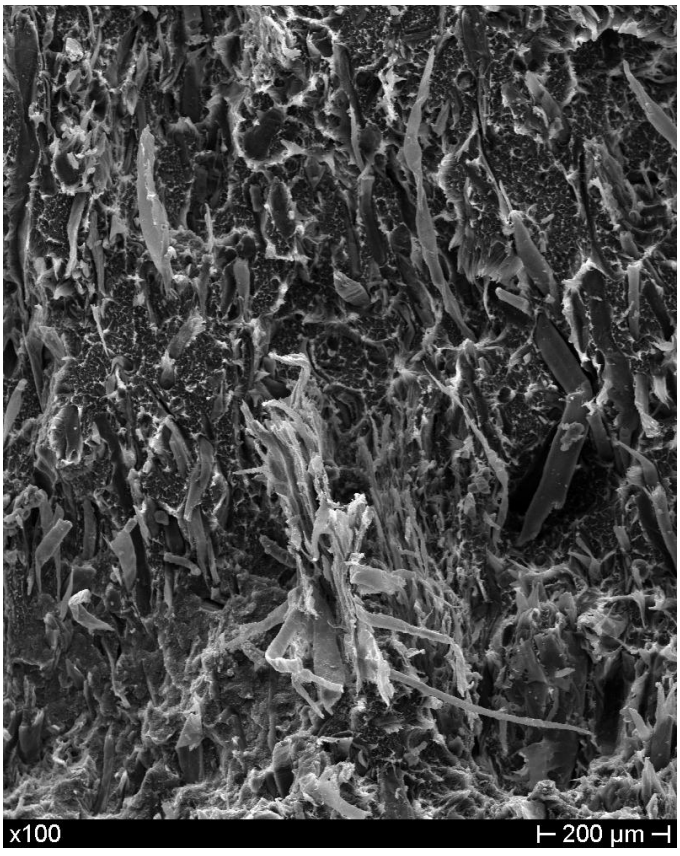


Figure 9 – SEM analysis of the specimens with 20% of fibers k.

The SEM analysis is also useful to study the fibers and particles dispersion.

A good dispersion of fibers is evident for the composite produced with fibers of superfine grinding mill with 10% and 20% of fibers. The composite with fibers derived from the knife mill is characterized by the presence of particles and isolated fibers. There are some agglomerate of fibers near the fragments. As future development the target is to achieve a better dispersion of the fibers avoiding this agglomerate.

In order to improve this result, it is necessary to introduce an additive, which would work both on better dispersion of the fibers and on improving fiber-matrix interface. The chosen additive is polybond 3029 from Addivant, it is specifically designed for use in wood and natural fiber-filled polyethylene composites. It is a polyethylene with a very high maleic anhydride functionality [10].

The figures 10 and 11 shows the fibers dispersion in the matrix.

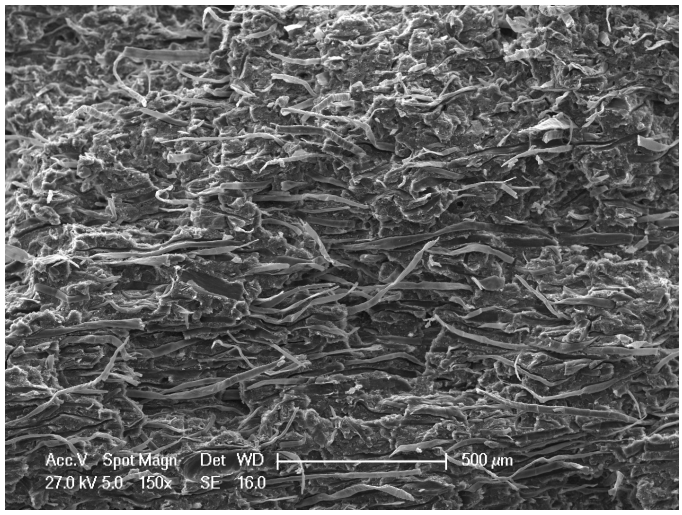


Figure 10 – SEM of the composite produced with 20% of fibers from the superfine grinding mill.

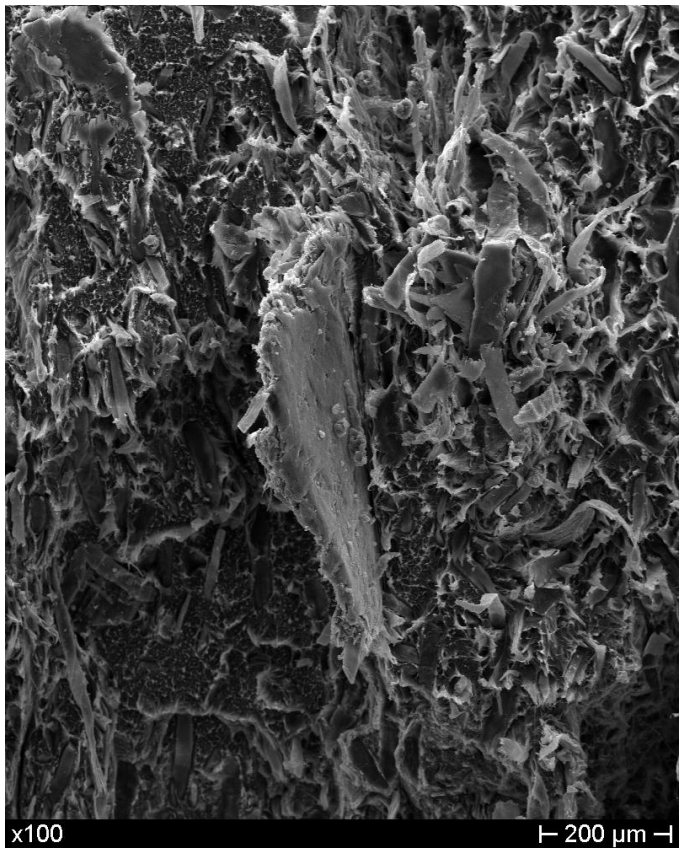


Figure 11 – SEM of the composite produced with 20% of fibers from the knife mill. A paper particle in the HDPE matrix with other paper fibers is shown.

Conclusion

The analysis of the results obtained shows that the paper can be used as reinforce in composite with polymeric matrix thanks to encouraging tensile test data.
A different morphological product is obtained from two grinding process: both of them could be used as filler in polyethylene matrix improving different properties, for example future studies will focused on the use of knife mill output in order to improve damping and acoustic isolation.
The superfine grinding mill allows to obtain fibers as agglomerates which are more difficult to disperse homogeneously in the matrix, the knife mill instead produces a mix of fibers and particles which allows to achieve a better fluency and higher percentages of charge introduced.
There is also the possibility of improving the quality of the product using a double step process: the first step is the turbo-mix in order to achieve the high percentage of fiber and the good dispersion, there is an intermediate grinding process, and then the second step is the injection moulding to produce the specimens.
The SEM analysis shows the very poor of the interface both with the superfine grinding mill and the knife mill. There is the possibility of interesting improvements for mechanical properties with this filler thanks to interface's modifier and mixing ceramic recycled fiber and wood flour [11].

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Book Reviews

BOOK REVIEWS

Cement Replacement Materials

Ali Akbar Ramezanianpour – Springer, 2014

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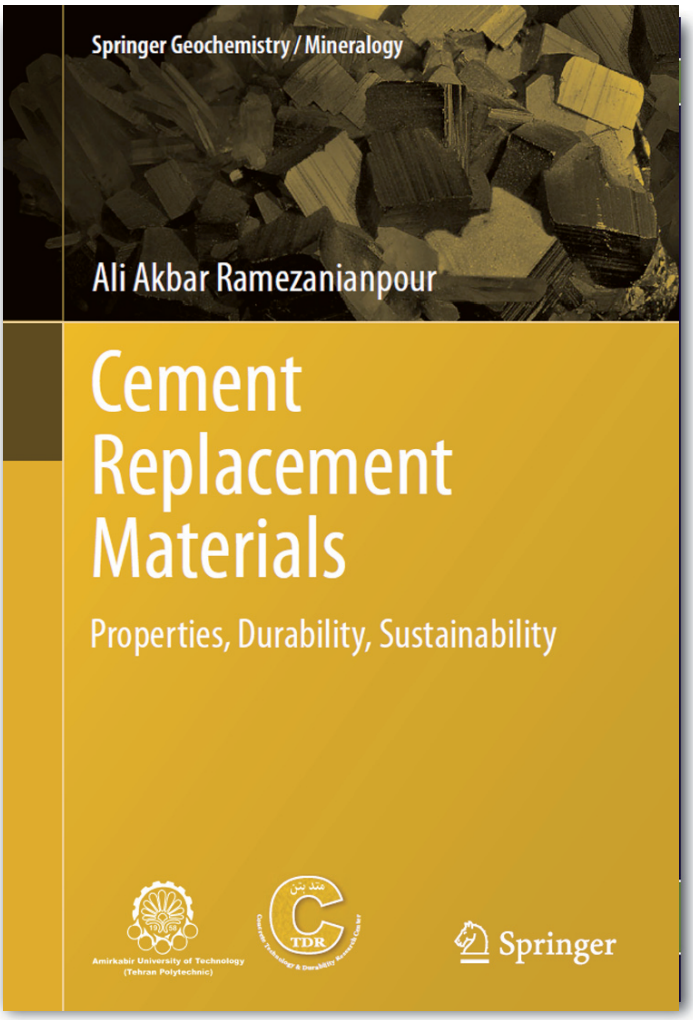

From the environmental point of view, the construction industry can be considered as an unsustainable industry: it is accounted for up to 30% of carbon dioxide emissions, and a raw materials consuming of about 3000 Mt/year which yields the depletion of large amounts of nonrenewable resources (*Construction and Building Materials, 2011, Volume 25, Issue 2, p. 575*). Particularly, the environmental issues associated with CO_2 will play a leading role in the sustainable development of the cement and concrete industry during this century. This is remarkably serious in the current context of climate change and meltdown of the world economy (*N. Stern, Stern review on economics of climate change, 2006, Cambridge University Press*). Due to the increasing demand for urbanization, which is a dramatic development in the emerging countries, the construction industry will grow at a speed and on a scale never before found in human history. For instance, China will need 40 billion square meters of combined residential and commercial floor space over the next 20 years – equivalent to build one new city of the size of New York every 2 years.

In order to achieve a more sustainable construction industry, the European Union recently established that in a medium term raw materials consumption must be reduced by 30% and that waste production in this sector must be cut down by 40%. Therefore, the use of more sustainable construction materials and construction techniques represents not only a major contribution to the eco-efficiency of the construction industry and thus to a more sustainable development, but also an imperative commitment for researchers in the field of building materials.

In the last years an increasing attention has been payed to new kinds of building materials, which can be considered more eco-friendly if compared to concrete and steel. For example, there is an increasing interest for structural composites and for nano-technologies applied in various fields related to the construction industry. In some cases, the advantages of using such materials can be seen only in higher specific performances while costs and durability are often disregarded.

On the other hand, the building technologies based on concrete and steel will indisputably represent the most applied construction techniques also in the future. However, the growing attention for the eco-sustainability is pushing both the research and the industry towards an increasing awareness regarding the use of resources.

Thus, in the recent years, the eco-compatibility and the sustainability of building materials is being related to their durability. The concept of durability cannot be ignored in the evaluation of sustainability of constructions. Durability is the characteristics of those objects or materials that maintain their properties over time. Durability ends when the object or material has to be replaced. A durable material or object is useful for longer. Actually, it is well known that concrete has a high permeability that allow water and other aggressive elements to penetrate, leading to corrosion of steel rebars which is the main reason for infrastructure deterioration. As far as construction is concerned, if we increase the durability of concrete works from 50 to 500 years, their environmental impact would decrease 10 times (*Building and Environment, 2007, vol. 42 pp. 1329–1334)*.

Many efforts have been conducted by researchers to arrive

at some alternatives that are able to significantly reduce energy consumption and environmental impact of cement and concrete.

There is plenty of scientific literature on durability, life cycle assessment and sustainability associated to building materials and in recent years a new concept of concrete has emerged: the green concrete.

Green concrete is defined as a concrete which fulfills various sustainability requirements: it contains more eco-friendly or even waste materials as at least one of its components; its production process does not lead to environmental destruction, and it has high performance, durability and life cycle sustainability.

Actually, some cleaner and more environmental friendly technologies in concrete production are well known, such as substituting relatively high percentage of cement by other sustainable materials for higher performance in terms of strength, stiffness, and durability.

In particular, resources savings can be accomplished by the substitution of part of the cement with fly ashes, natural pozzolans, alkali-activated cement, magnesia cement, and sulfoaluminate cements, and the use of alternative aggregates such as recycled aggregates and vegetal fibers. (*Procedia Engineering, 2014, vol. 95, pp. 305 – 320*).

In other words, besides the use of new technologies and advanced materials, there is another perspective to achieve the eco-sustainability of the concrete industry. Indeed there are quite many opportunities to improve both sustainability and durability of concrete by the use of "Supplementary Cementing Materials" (SCM). Moreover a higher awareness of the importance of mix design for concrete can lead to the enhancement of its durability.

On the basis of the above concerns, the reading of "Cement Replacement Materials: Properties, Durability, Sustainability" may give a new vision of concrete technology.

The book reports in details both the basic information and also more recent findings in the field of the most common natural and artificial materials that can be used as cement substitutions or cement supplementary. In particular, it provides a deep assessment of the properties, the applications and the durability of blended cements.

The eight chapters of the book are settled following a logical thread starting from the most ancient hydraulic cementing aids represented by natural pozzolans, whose durability is well demonstrated since it was used with lime by Greeks and Romans for monuments, which in some cases are still in use.

Subsequently the analysis of the properties of more recent SCM are reported: fly ash, granulated furnace slag, silica fume and metakaolin. The author describes in details in which way these materials affect all the properties of blended concrete, taking into account both the mechanical performances and the transport phenomena of water, gases and chlorides, which strongly affect concrete durability.

A particular attention is paid to Rice Husk Ash (RHA), an artificial pozzolan obtained from the combustion of rice husk. RHA is an agricultural waste, and is classified as "a highly active pozzolan" because it possesses a very high amount of amorphous SiO_2 and a large surface area, which can be used to produce high performance concrete.

The last chapter of the handbook describes the role of supplementary cementing materials on sustainable development and takes into account all the issues related to the environmental impact of concrete technology, from the embodied energy to the green-house gas emission.

The book is devised as an in depth manual for technicians, academics and researchers in the fields of cementitious materials. The bibliography is relatively large and allows the reader to get an overview regarding the possible strategies for the realization of concrete structures that are designed with an increasing focus on environmental sustainability.

Therefore, if I should define a motivation to consider the reading of "Cement Replacement Materials: Properties, Durability, Sustainability", I would refer to the roots of Horizon 2020. Hopefully the sustainability concerns of Horizon 2020 (resource efficiency and climate action) will have a strong impact on the future of the European construction industry. Indeed, the influence of resource efficiency on building sector is clearly expressed by the recently issued Draft Horizon 2020 Work Programme 2016-2017:

"The objective of the Societal Challenge 'Climate action, environment, resource efficiency and raw materials' is to achieve a resource – and water – efficient and climate change resilient economy and society, the protection and sustainable management of natural resources and ecosystems, and a sustainable supply and use of raw materials, in order to meet the needs of a growing global population within the limits of the planet's natural resources and eco-systems".

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