GREECO
Territorial Potentials for a Greener Economy

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Sector Report

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Table of contents

Figures

Maps

Tables

1. Executive Summary

1.1. Introduction

The greening of buildings is arguably the most human aspect of creating a sustainable future for Europe. With the average European spending well over 80% of their lives in buildings, they are at the epicentre of our societal existence - as the structures providing us with comfort and convenience. It therefore doesn't come as much of a surprise that that over 40% of final energy consumption Europe's takes place in houses, public and private offices and other types of buildings (EC, 2011a). Likewise, the construction sector is also the second largest consumer of raw materials in the EU, and construction and demolition activities alone account for 33% of our annual waste (EEA, 2010a). Couple this with levels of waste in the residential and tertiary sector and we see that buildings are not only at the interface of human life, but of all types of resources consumption as well.

With these levels of resource demand buildings also (1) have the greatest energy savings potential of any sector (EC, 2011b). At the same time, the fact that buildings are an interface between society and various economic activities means they can (2) provide an impetus for making resource consumption more efficient in other sectors as well. Certainly not least, with the construction sector providing almost 16 million jobs in the EU (7.45% of the total labour force) a transformation to green construction practices would infer that (3) a noteworthy share of the European labour force would be contributing toward a greener economy.

Yet these green potentials are constrained by the fact that homes are often the single biggest investment residents will make, just as they represent significant investments for all types of non-residential building owners. Building owners not only take great care in their investment decision, but they almost always take a cost-minimising, profit maximising approach - that is, they want the most for their money and they typically have a fixed amount of money to spend. As such, green investments in building generally have to compete against such things as larger living space, fancier appliances or heated flooring – things that residents can begin to enjoy from the moment they move in. Yet, strictly in a cost-benefit perspective, green renovations almost always trade-off an upfront investment with a future cost-savings for consumed resources. But what if there was more, what if fiscally efficient policies could be used to entice more people to make this invest on its financial merit alone? And what if people's consciousness for the environment becomes a more important behavioural factor in the decision making process?

This report sets out to discuss the green building as a component of the green economy. It uses the three aforementioned hypotheses – the resource performance and potential, cross-sector complementarities and the importance of the building and construction sector to the labour market – to discuss the current performance and future potential of the sector to contribute to the green economy of EU regions. Additionally, it discusses the importance of territory; that is, space defined via its political, administrative, social, economic and infrastructural contexts in maximising the green potentials of the sector.

1.2. Current performance – economy and resource consumption

At the EU level, the building and construction sector is not only the largest sector in terms of people employed, but it is also the most decentralized. It accounts for more than 10% of EU GDP, represents more than 50% of fixed capital formation and directly or indirectly employs roughly 44 million workers. The engagement of these construction and trade firms responsible for supplying construction-related technologies is essential. But in a territorial perspective, it is even more relevant to note that in 2007, only 2,584 of the 3,090,144 registered construction enterprises in the EU27 had more than 250 employees, 99.9% were considered SME's and 92% were micro-enterprises with less than 10 persons employed. This means that mobilizing these actors to take up new green building skills requires governance actions operating at the same scales - simultaneously wide in scope, but also very local in depth.

The regional divisions between number of persons employed and the GVA of the building and construction show similar national distributions – where countries with the highest overall populations that have the highest gross total of employees and GVA in the sector. This alone is not surprising due to the extremely close correlation between number of people and the number of buildings that are needed to house them and support their social and economic activities. At the same time as being

inevitable, is also a crucial territorial dimension of the future potential of green building; that buildings will continue to be built where people are, and are expected, to be living.

However, the national GVA and employment divisions also show that “other factors” have a strong role to play. For instance, in Spain we know that a focus on construction has been driven by at least two interrelated factors: First, there has been a policy driven focus on building and infrastructure development during the late 1990’s and 2000’s. Most recently, we saw how the increased supply of dwellings as well as artificially low mortgage rates created a housing bubble which mirrored the collapse in the United States. As a result it comes as no surprise when news interviews with Spanish mayors reveal that roughly 20% of the Spanish housing stock sits empty.

It is also notable that after Spain, the seven countries with the highest relative size of their construction sector are New Member States (Hungary, Romania, Bulgaria, Slovakia, Cyprus and Latvia). This likely reflects the jolt national investment in the immediate years leading up to ascension as well as the additional availability of European funds directly following membership to the EU. Similarly, GVA from the building and construction sector in more established Member States is neutralized in the 8-10% range. This implies that the availability of European funds – for instance, through Cohesion Fund or the ESF is a formidable driver of greening the building and construction sector. As such, placing increased ‘green guidelines’ on the use of EU funds will have a significant impact on green building, particularly in those countries where green economies of scale are less developed.

Regarding energy consumption, extremely high variations were noted at the Member State level for per capita energy consumption and CO2 emissions, both in terms of the status quo and the changes between 2000 and 2009. In terms of the status quo, the impacts of climate, building age and economic wealth are identified as key determinants of consumption. However, where NUTS2 residential energy consumption data was available, it was interesting to note that many of the most populated urban regions showed comparatively poor rates of per capita consumption compared to less populated regions in the same country. Further investigation on the causality for this suggested quite convincingly that the relatively high number of old buildings in larger urban centres of Europe means that these areas have poor consumption than would otherwise be expected (due to smaller average living spaces, higher numbers of multi-unit dwellings, etc.)

In terms of changes in per capita energy consumption between 2000 and 2009 the results shows a rather incredible variance between Member States: with high performers reducing consumption by upwards of 13% while other countries increasing their level of consumption by over 30%. This quite clearly showed two findings. First, that increased consumption is highly correlated to increased socio-economic standing – where Most of the new Member States showed high increases in consumption. At the same time, the result showed quite well that greening can have a notable impact on reducing consumption. Considering that our attention to green building has scaled-up considerably in the past 5 years, per capita reductions in consumption of over 2% per year appear to be realistic.

Additional constraints to reduced energy consumption from buildings were also noted:

- The high amount of capital needed for making resource related improvements
- Lack of awareness on the financial benefits of making improvements, as well as the policy-based support that is available, generally from national governments.
- The split-incentives associated with dwelling and offices that are occupied by tenants (rather than owners)
- The sub-optimal manner in which construction firms develop their competencies related to green building. This is closely due to the fact that construction firms are currently very localized to given areas and workers rely on tacit/experiential-based knowledge, which resists change.
- The fact that many regions feel they have more important development concerns to worry about.
- The lack of good regional data on both economic and environmental parameters of the sector. The inability to measure performance means that actual performance can’t be used in a comparable fashion to support regions making investments, or for holding those that don’t accountable for their inaction.

1.3. Drivers and enablers: good policy & good governance

To begin the section on drivers and enablers, a few pages were dedicated to important non-policy drivers and enablers – most notably market drivers and the sector’s feedback with energy sector

developments. This places emphasis on the cost of energy and the general development of Europe's energy sector. Higher Energy Prices will present a host of opportunities and challenges for Europe. As reflected in the ReRisk project, while more people will be prone to situations of energy poverty, a higher energy price reduces the cost of green building investments by increasing the cost of either doing nothing (in terms of retrofitting) or building cheaper/browner (in terms of new buildings). In terms of energy sector development, investment towards a more connected, liberalized and common energy market, especially including the proliferation of smart grids will have important implications on green building, not only by increasing the ability to monitor energy consumption at a range of scales (from the building level to the regional level), but by eliminating the traditional barriers of space and time in the energy market. Consequently, even nations and regions with an ample supply of clean, cheap energy will then have an incentive to invest in demand-side initiatives (such as the greening of buildings) because saved energy can be sold, on a European market, to regions that are not able to produce as much energy.

One of the core foci of this paper is to highlight how green building can be driven by policy, and how the analyzing and discussing the territorial dimension of green building can inform policy-making with relevant information. From the top-down, EU policy includes a comprehensive set of thematic strategies, directives, financial incentives, the availability of regional funding and the extent of awareness information campaigns. First and foremost, this includes the 2010 Directive on the energy performance of buildings, which among other things, discusses the need for public sector initiatives to lead by example for the market penetration of green building. One aspect of this being achieved is by ensuring that resource efficiency is a guiding principle of all public investment in buildings. The 2010 Directive, like other strategies such as the 2050 Roadmap for moving to a low carbon economy and the Energy Efficiency Plan 2011, also discuss the importance of using available European funds via the ERDF, ESF, etc. to invest in green building.

With the share of Cohesion funds directed towards promoting the low carbon economy increasing during the 2014-2020 period there is a clear opportunity for the building sector. Not only do policies directly supporting green building projects create green jobs right away, but they also generate up to a 500% return on investment because of the domestic eco-innovation they rely on. This is in contrast to investment in other sectors, which are often exposed to import leakage – where policy investments are exported to other countries when domestic markets cannot supply appropriate green technologies.

However, research findings show that the bureaucratic processes attached with acquiring funding are a constraint to regions taking pursuit of such funding schemes. The efficiency of the allocation process should therefore be improved to maximize results. Likewise, additional information on the effectiveness of policy schemes is also needed. On one hand, this requires that more information at more local administrative scales is compiled and monitored regarding resource efficiency in the sector, as well as stricter guidelines enforcing that ex-ante and ex-post evaluations of policy programmes are always a part of funded initiatives.

The importance of national authorities legislating building standards and forming national-based financial incentives cannot be understated in terms of its importance for creating a strong market for green building and construction. These are the initiatives that directly respond to the capital intensity of building investments, lack of awareness and split-incentives, and they are rooted in national incentive schemes – mainly in the form of subsidies, grants, tax credits and local building regulations. These policies not only need to be further developed among the Member States in Europe, but they have to be more consistent and longer-term (which is in contract to the reality where these policies seeming come and go from year to year and place to place). Most importantly however, all Member States must take up discussion on innovative funding schemes – particularly via the formation of Energy Savings Companies (ESCO or ESCo) for supporting private sector investment in green building. In this regard, it is highly unlikely that the EU will achieve any substantial improvement of the existing building stock without the widespread (or unanimous) development of funding mechanisms that transfer the investment cost over to the payback period of the investment.

But while policy provision at the EU and national level is obviously indispensable, the reality is that local (especially municipal but also regional) governments are the ones essentially responsible for much of green building development on the ground. Municipal governments of Europe hold the main competency for land use development in Europe, and as such are the key agent responsible for making planning-related decisions on how the built environment shall be developed. While this alone is not an innovative finding, it means that proactive municipal authorities are indispensable to the green development of the sector. This places them as a key actor at the interface of national and European support schemes on one hand, and the local firms and stakeholders governing the

development of the built environment on the other hand. As such, focusing on green buildings in a territorial perspective means that local planners and decision makers must emphasis a number of underlying potentials:

- Promote concepts such as urban mining where all usable materials from obsolete buildings and infrastructure that are set for demolition is extracted and reused. Roughly 2/3 of the materials can be saved by retrofitting existing buildings compared to constructing new ones, it implies no net loss of natural land and it improves the quality of the urban built environment.
- Focus on retrofitting existing building as much or more than new buildings. This acknowledges the reality that the vast majority of current buildings will exist in 2050, and all but the newest buildings will require at least one renovation if Europe is to achieve its objective of reducing building sector emissions by 80% in 2050. Through systematic audits of the energy performance of buildings planners and decision makers will have the right information and use that information to guide realistic visions for the future.
- More compact urban development via brownfield development and infilling must be prioritized. This is a particularly relevant urban development concept in cities where shifts in the economy – from industry based production to domination of the tertiary sector – leave spaces of underutilized land. With well-planned redevelopment schemes these space can become rejuvenated centres for urban development. This is part of planning green building strategies within the wider framework of green urban systems; where underlying complementarities with mobility, leisure space and other public services are conceived together. This also touches on the potential for producing a greener building and construction sector is closely aligned with behavioral decisions on the attractiveness of urban areas as places to live. This means that integrated planning of urban areas - between issues of land use, economy, transport and leisure and recreation, and with a heightened focus on urban design - is crucial for providing people with the opportunity to choose a more desirable and sustainable urban living situation.

Urban regions therefore have special opportunities for comprehensively linking green building within wider notions of sustainable urban development. But these possibilities are greatly supported by the appropriate institutional arrangements – both across sectors (i.e. between municipal departments), among the range of important actors (i.e. urban planning, construction and utility companies, citizen groups, etc.), and between municipalities. From a top-down perspective, this reflects on the importance European and global networks such as the EU Covenant of Mayors, Build up, and the Smart Cities and Communities, among others, which are crucial for promoting local green governance through information sharing, communication of best practices and logistical and technical support. But it also emphasizes that an urban systems approach to green building that considers socio-economic context must plan across a range of competencies that are typically organized in different departments (sectors), just as it must work across traditional municipal boundaries of urban areas.

Therefore, the importance of planning and governance of the functional urban region – in other words, coordination and agreement among municipalities rather than strictly within municipalities – is absolutely crucial when planning for resource efficient growth. This notion of “metropolitan governance” emphasizes the role of building a common vision among the range of institutions responsible planning an urban territory – notably, among the range of municipalities that comprise an urban region. For instance, Stockholm’s regional development plan, RUFS 2010, highlights the importance of developing a polycentric urban structure to manage the expected growth of 550 000 residents (45%) between 2001 and 2050. But while the region’s polycentric development strategy is crucial to reducing resource consumption, it requires that all 24 municipalities can agree on a similar vision of what needs to be accomplished. Without this cooperation and agreement, underlying competition among the municipalities to attract residents and business (its tax base) promotes urban areas that are fragmented, sprawled, private-car oriented and thus less-resource efficient. The interesting perspective here is that while green building requires a scaling down of territorial strategies from the national and EU levels, it also requires an up-scaling of urban land use and development planning from municipalities – often within a greater vision for metropolitan areas.

1.4. Territorial potentials of green building

With the above discussion of policy and territorial drivers in mind, the analysis of territorial potential for green building is a policy-oriented, territorially situated approach to determine the developable potential of residential buildings in the sector. Based on the availability of data (or perhaps more accurately, the lack thereof), it uses the following measures to determine potential:

- Current levels of per capita energy consumption in the residential sector (heat and electricity, based on national data from Eurostat)
- Current levels of per capita CO2 emissions in the building sector (from heat combustion, based on national data from the European Environment Agency)
- 2009 population of NUTS2 regions based on Eurostat data
- Predicted population of NUTS2 regions in 2050
- General policy target of an 88-91% reduction in CO2 emissions in the residential sector between 1990 and 2050 (Based on target reported in the A roadmap for moving to a competitive low carbon economy in 2050 (EC 2011b).

The regional potentials described below are extremely course estimates, and ought to be treated as such. This coarseness primarily relates to the fact that a number of assumptions and proxies are necessary in order to provide regional results based on national data that is only available for selected years. Foremost, this includes the underlying fact that population density is used as an indicator to regionalize national energy and emissions data from buildings. This infers a direct correlation between where people live and where buildings stocks are located – an argument which is certainly difficult to argue against.

Nevertheless, using the aforementioned measures, we are able to provide energy- and emissions-related potentials for 2050. This provides a baseline or "no action" level of energy consumption/emissions, to which an 89.5% policy target can be applied to infer a potential for reduction in emissions. Obviously this is only considers residential buildings, but the results should be seen as indicative for all buildings.

Based on these perspectives, a prioritized order of focus for regions to improve their resource performance of existing buildings could be:

1. Considering the dire need to reduce the environmental impact of energy consumption, those regions with the highest projected savings potential for CO2 emissions (remembering that some regions (i.e., Sweden and Norway) may have right rates of consumption, but very low emissions due to their local energy mixes).
2. Assuming that a common energy market is expected to become a reality in Europe, those regions with the highest energy consumption in 2050. Even regions with high shares of renewables will be able to sell their energy on a common market in Europe. (Note map of forecasted energy consumption is shown in Section 5)
3. Considering that projected population growth provides a specific opportunity to meet demand with extremely energy efficient buildings, those regions that are expected to grow most significantly between now and 2050. (Note map of forecasted population growth is shown in Section 5)

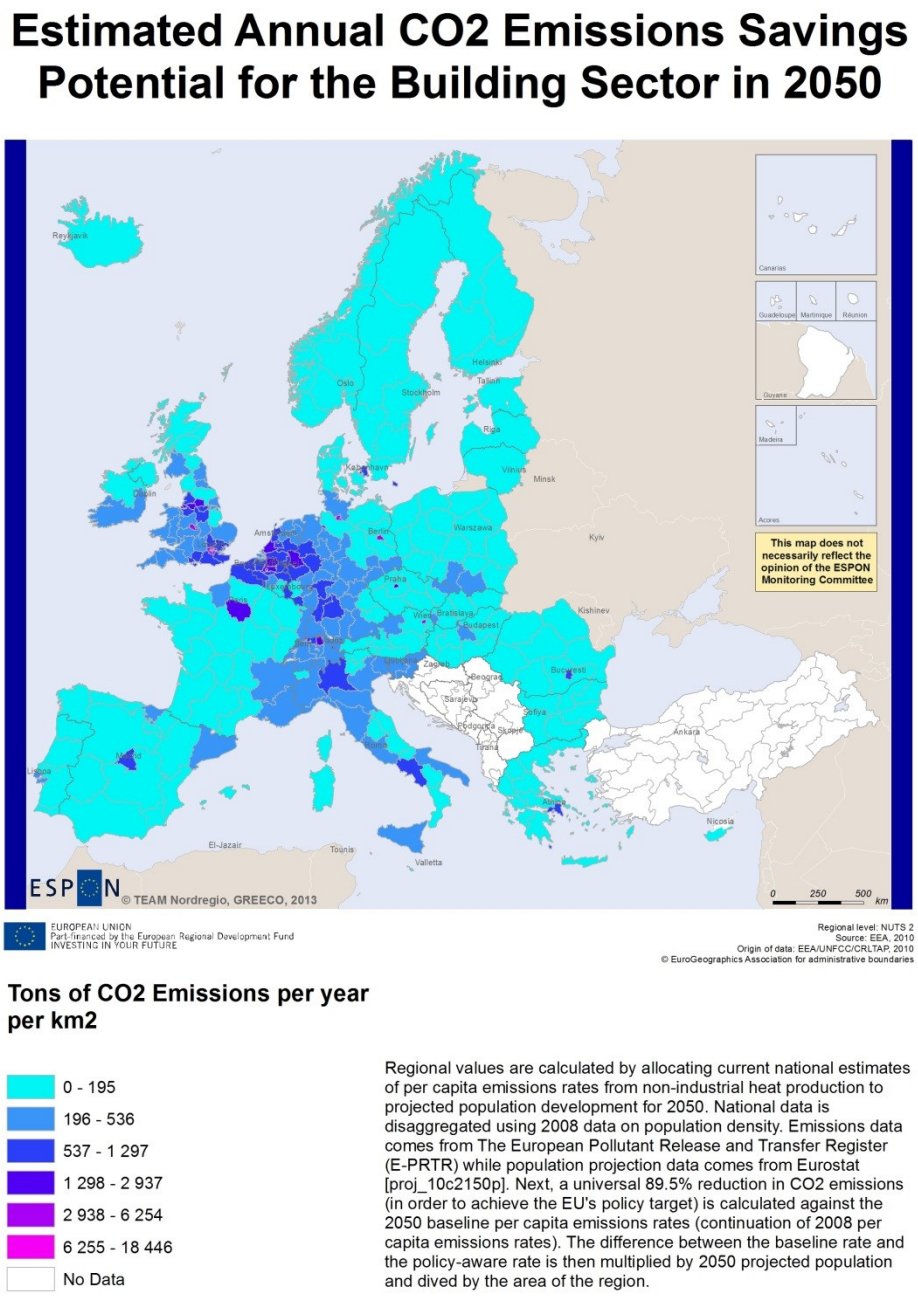
Based on the results shown in the map below, we see that the highest potentials are located in regions with relatively high population density. As such, these regions will require development of the building stock, which, through the right planning and policy perspectives, can be developed at a very high resource standard. These regions already have the highest concentrations of buildings, and therefore consume the most energy (and depending on energy source, produce the most emissions).

But in addition to the importance of density alone, the analysis of regional performance (Section 3.3) identified that population density, while being a normative driver of improved resource performance, does not appear to be currently correlated to lower per capita energy consumption. In particular, this relates to the fact that many urban centres are actually territories with comparatively old (and inefficient) building stock. As such, it shouldn't come as a surprise that dense well-established regions in the traditional "blue banana" have among the highest national energy consumption rates and therefore have the highest foreseen energy consumption and emissions reduction potential in Europe.

Another interesting perspective we see that the Nordic countries will not contribute with a large emissions reduction in the 88-91% target is met. This, of course, is due to the fact that the energy supply for building heat in these countries already produces relatively low emissions. At the same time, the most populated Nordic regions are quite clearly identified as having relatively high foreseen energy consumption. As such, in a longer term perspective, the development of a common and tradable European energy market will provide a significant incentive for these regions to invest in energy savings in the building sector.

Put together, the results indicate that populated, growth-oriented regions of Europe have the highest potential for greening the building sector. In particular, however, the largest urban regions with either high energy consumption per capita, high emissions, or both, must meet their potential improving the

performance of their existing building stock. A rather clear example of this is the fact that out of the 277 NUTS2 regions with results shown in the map below, the 10 regions with the highest reduction potential (3.6% of the regions) account for over 17% of the potential annual emissions savings in 2050. Not surprisingly, this recognizes the potential of regions with dense urban centres of Paris, Naples, Rome, Dublin and Berlin. At the same time, when results are shown in relation to area (as in the map above) the urban areas of Brussels, London, Berlin, Vienna, Copenhagen, etc. are put in focus. Based on building turnover rates that often exceed 100 years, this means that focusing on greening new buildings alone will not come close to be proactive enough to reach EU policy targets. Greening of existing buildings through retrofitting and improved operational and management practices will only become even more essential to the greening of the sector



Green building potential of NUTS2 regions according to expected emissions reductions if EU policy target is met in all regions (Source: EEA and Eurostat)

2. Introduction: Conceptual elements of green building and construction

For a vast majority of homeowners, their home accounts for the largest investment they will make in their life. People plan, devise and take great pride in building (or purchasing) and filling their homes with things that reflect their personality. Consequently, although a building can be seen a tangible structure with four or more walls and a roof, it is often filled with the intangibles of everyday life: ownership, pride, relationship and security. But with the developments of clean-tech we are also recognizing the potential for resource savings through automation and integration that create buildings as highly sophisticated and dynamic systems.

Considering the amount of time that we spend in them, it doesn't come as a surprise that that over 40% of final energy consumption takes place in houses, public and private offices and other types of buildings (EC, 2011a). Likewise, the construction sector is also the second largest consumer of raw materials in the EU, and construction and demolition activities alone account for 33% of our annual waste (EEA, 2010a). Couple this with levels of waste in the residential and tertiary sector and we see that buildings are not only at the interface of human life, but of all types of resources consumption as well.

With these levels of resource demand buildings also (1) have the greatest energy savings potential of any sector (EC, 2011b). As such, they can make incredible contributions to climate change mitigation, while at the same time, the fact that buildings are an interface between society and various economic activities they can (2) provide an impetus for making resource consumption more efficient in other sectors as well. Certainly not least, with the construction sector providing almost 16 million jobs in the EU (7.45% of the total labour force) a transformation to green construction practices would infer that (3) a noteworthy share of the European labour force would be contributing toward a greener economy.

In a very general sense, this report sets out to validate these three hypotheses by describing the relevance of green building and construction within GREECO's perspective of the green economy[1]. However, this alone is not novel work; different aspects of this have been covered in a very comprehensive manner by recent EU-funded work. Most recently, Buildings Performance Institute Europe (Economidou, 2011) published Europe's Buildings Under The Microscope in October 2012. This survey- and scenario-based report contributes to the European political debate on energy efficiency with a picture of the energy performance of existing buildings and how policies affect this situation. In line with the goals of the EU 2050 Roadmap, a set of scenarios also show pathways to making buildings much more energy efficient.

Similarly, the Europe Commission is due to release a communication for the sustainable competitiveness of the construction sector. The primary input to this work was a study on the same topic, which was completed by a consortium of institutes and led by Ecorys Research and Consulting. FWC Sector Competitiveness Studies N° B1/ENTR/06/054 – Sustainable Competitiveness of the Construction Sector (Ecorys, 2011) reflects the ability to grow the sector economically while contributing toward social cohesion, employment provision, international trade and not least, resource efficiency and negative environmental impacts.

These reports complement each other by providing a comprehensive account of how the building and construction sector can contribute toward the green economy. The BPIE's focus especially on the interface between EU policy and energy efficiency of buildings provides results at the European and national levels. The Ecorys reports focuses on interface between EU policy and the economic structures and components of the sector, with results discussed for Europe as a whole.

Discussion of the building and construction sector in GREECO will not attempt to re-discover analysis conducted these reports. As such, politicians and others reading this work would be wise to carefully read these reports as well. Instead, this report will reference information in these reports (as well as others) to describe the relevance of green building and construction for the green economy. To be novel it will have a special focus on territory, space and place. This includes, where possible, discovery of the regional (i.e. sub-national) performance and potential of green building and construction. It also includes discovering the territorial factors that drive and enable (or hinder) the greening the building and construction sector in a regional perspective. This involves direct territorial questions such as where buildings shall be located in the future, but also indirect questions such as

[1] Insert link to place in report where GREECO's concept of the green economy and its territorial dimension is placed.

which stakeholders are involved in the greening process and what spatial scale they operate. This is vital information for policy makers who, as stakeholders themselves, must have a complete picture of not only when and how, but also where and by whom green buildings can become a universal reality for Europe.

Four objectives characterize the structure of this report:

1. To introduce and elaborate a number of important concepts that, together, define the building and construction sector vis-à-vis the green economy. This focuses on a separation between buildings (as structures that consume resources through human use) and construction (as a human activity that contributes to the economy and consumes resources).

2. To analyze the sector's current state and the performance of European regions in their shift towards a greener building and construction sector. This includes a regional assessment of size of the building and construction sector in EU regions, as well as its resource consumption (in terms of energy demand, CO2 emissions and land use from built areas. It also includes a qualitative assessment that follows the European policy discourse supporting the energy and resource efficiency in the building sector.

3. To provide insight on the important drivers and enablers that need to be considered by regions for making green building and construction a reality. In particular, this includes the linkages, mutual dependencies and feedback loops that green building has with other sectors and the most relevant territorial factors that influence progress. This includes consideration of governance structures and policies that will allow the building and construction sector to contribute to the goals of Europe 2020.

4. To analyze the future regional potentials for green building and construction as a means to achieve a green economy. This includes an indication of the share of responsibility that EU regions will have for achieving an 88-91% reduction in CO2 emissions from buildings by 2050 (cf.EC, 2011b). This not only requires the aforementioned regional assessment on the current performance of the sector, but it also relies on anticipated regional patterns of population (and therefore building) development. It also includes information on impacts for different types of European territories.

2.1. Why is the building sector important in a green economy?

Reference to GHG emissions as an indicator of green performance in buildings motivates a rhetorical question: Should a country producing low levels of emissions (for instance, due to the availability of renewable energy or the politically-based decision to develop nuclear energy capacity) yet consuming relatively high amounts of energy in buildings (i.e. Norway, France, etc.) concern themselves with greening the building sector to the same extent as a country with relatively high emissions and high consumption (i.e. Ireland, Luxembourg, etc.)? The impression of the GREECO project is yes for at least two reasons.

First, a further emphasis on green building has a positive impact on creating jobs in a green economy. A recent report (Jaeger, Paroussos, Mangalagiu, et al., 2011) provides evidence that an increased focus on linking resource efficiency with economic development (through a financially supported policy initiative to raise the European climate target from 20% to 30% emissions reductions by 2020), would have a greater impact on production from the construction sector than any other sector. This is closely connected to the fact that the sector is both such a large contributor to emissions and has the greatest savings potential.

This is further supported in another article in the recent ICLEI publication "The Economy of Green Cities" (Zhang, 2012, pp 231-240). In it, Figure 1 shows three aspects that very clearly position green building as having the utmost importance in achieving a green economy. First, along with energy and utilities, it is garnering the most attention by scientific report on the green economy. Second, it is viewed as a "new" sector. While not being clear on what they mean by new, one could infer that it reflects the fact that the sector is rooted in technologically driven, growth-based, innovative economy. And third, we see that it lies right at the interface between the spheres of production and consumption.

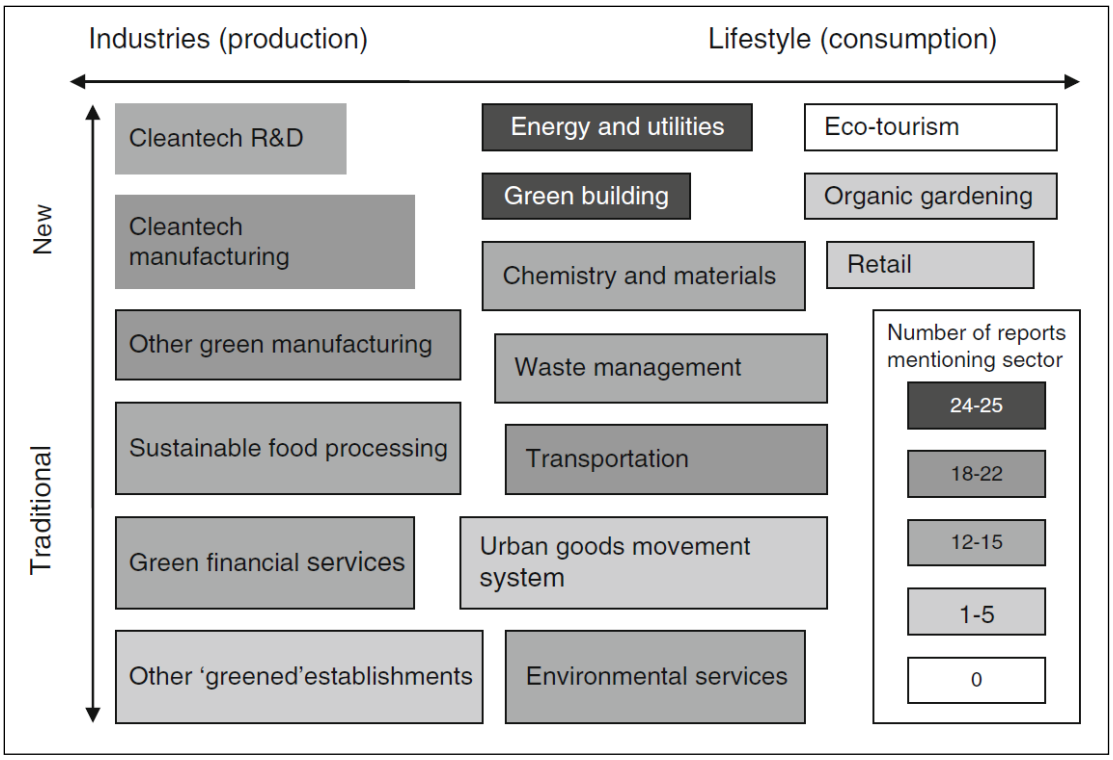


Figure 1 Sectors of the Green Economy according to recent studies (from 2008) (Zhang, 2012)

Second, the Director of DG Energy, Marie Donnelly recently argued policy investment in green building not only creates a direct transition to green jobs (thereby developing the skillsets of labourers) but provides up to a 500% return on investment (Donnelly, 2012). This "fail-safe" perspective to policy investment for energy efficiency in buildings is reiterated in the fact that such an investment by default promotes domestic eco-innovation because it involves such a high share of domestic labour and technological inputs. This is in contrast to investment in other sectors, which can often lead to import leakage – where portions of a certain policy investment are exported to other countries when an investment in a green technology cannot be supplied by the domestic market.

2.2. What is green building and construction?

A wide notion of the building and construction sector would consider anything that gets constructed; including buildings, road and transport infrastructure, energy, water and communications infrastructure, sports areas, monuments, etc. In comparison, a narrower scope would focuses on construction of human-made structures designed to contain any type of use - be it social, economic, political or cultural. The chosen scope obviously impacts the overall discussion on the sector's current and future contribution to the green economy. While the understanding taken forward in GREECO will fall somewhere in between these two perspectives, it will certainly focus in on the greening of building structures.

This narrower scope focuses on the ability to the reduce natural resource demands of buildings while simultaneously contributing to the supply of construction jobs. Yet, we will go beyond this narrow scope to pursue the linkages between green building and other sectors, how they are cultivated through policy and governance, and all the while paying particular attention on those linkages with clear territorial dimensions.

For most people green building and construction is mainly about producing buildings that demand less energy, particularly for heating and cooling. This rather one-dimensional perspective is fair, especially considering that over 40% of final energy consumption takes place in houses, public and private offices and other types of buildings, and 67% of that is used for space heating (EC, 2011a). Yet we can go beyond energy to include other resource flows that, when viewed together, capture a realistic, integrated and territorial understanding of just how sustainable Europe's building stock can become. As shown in Figure 2, this perspective utilizes the distinction of embodied and operational resources. The former accounts for resources consumed by the construction process and in the construction

materials while the latter accounts for resources consumed by the day-to-day use of buildings. Together they deliver a complete life-cycle perspective to the building and construction sector.

From both a resource efficiency and especially a territorial perspective, the key is that only acknowledging operational resources fails to address important opportunities that the building sector can contribute to the green economy. For instance, continually evolving socio-economic processes, not least driven by overarching shifts in global divisions of labour, mean that buildings are not only needed for new and evolving uses, but also in new and evolving places. This implicates decisions over whether to improve the operational performance of existing buildings through renovation, or to replace under-used or vacant buildings with new ones. It also includes the question of re-developing existing urban areas or the possibilities for limiting land take[2] when the market pressures exceed the supply provided by the existing built environment (i.e. through promoting higher building densities).

As such, while issues of technology, skill development, market preparedness and policy are at the core of achieving a green built environment, so too are territorial factors including migration patterns, urban-rural relationships, functional urban development and land use. These are the issues that we attempt to bring together.

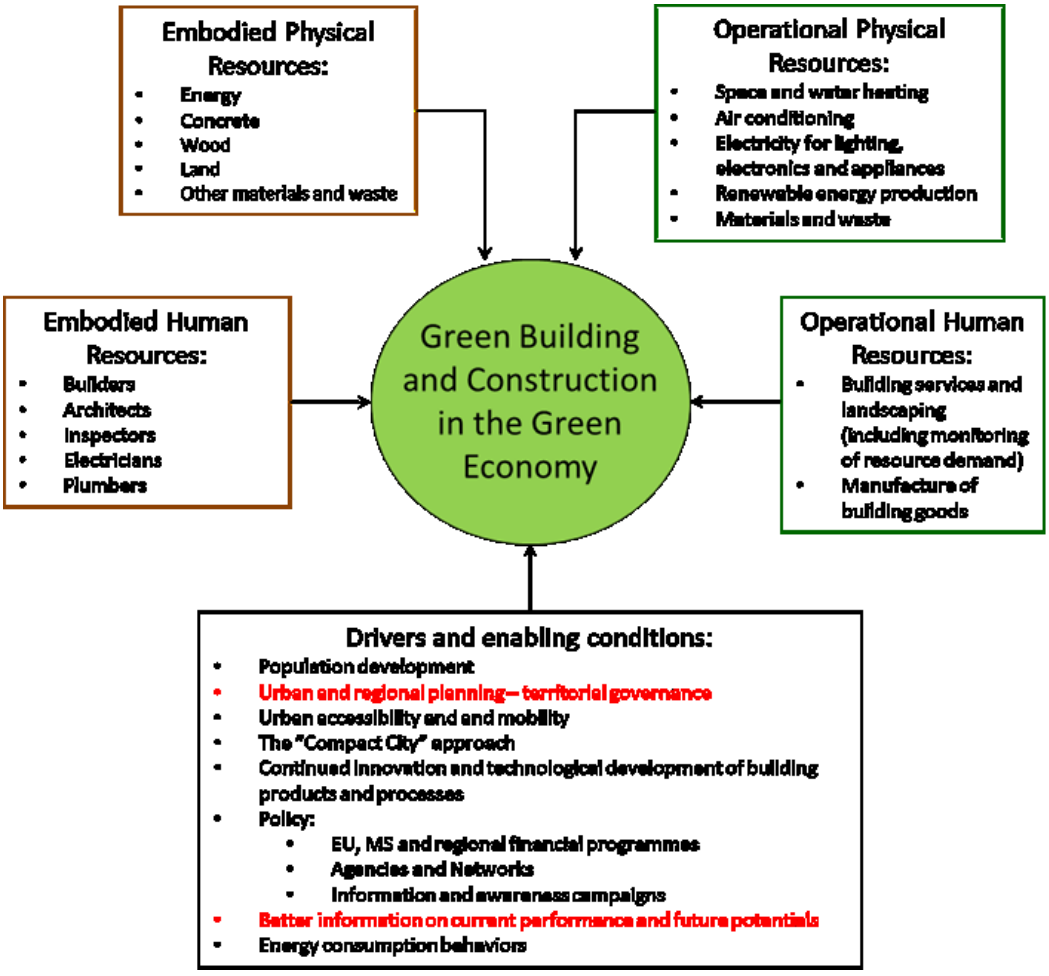


Figure 2 Vasic concept of green building to structure analysis in the GREECO project

2.3. Embodied resources

The Eco-innovation observatory (O'Brien, Wallbaum & Raimund Bleischwitz, 2011) defines embodied emissions as those produced during the construction, maintenance, renovation or alteration of a building. It emphasizes the energy needed to produce materials as well as the processes of organizing

[2] Land take is the increase of artificial surfaces (housing; industrial, commercial and transport units; road and rail networks; etc.) from agricultural, forest or natural land over time (European Communities, 2011)

them into a building (Lane, 2007). As a result of improved building standards, embodied emissions are now responsible for a much greater share of a buildings overall carbon footprint. Some suggest that what used to be an 80:20 ratio of operational to embodied energy demand is now more like 60:40 (Lane, 2007).

In a life-cycle perspective, embodied resources[3] must be put in focus for green building to continue advancing toward a formidable level of sustainability. This calls for increasing regulations on the manufacture, transport and installation of building materials. Further, with the relative importance of embodied resources being highly dependent on the type and use of the building (for instance, embodied energy makes a 62% contribution to the average lifetime carbon footprint of a distribution warehouse, compared to only 10% for the average grocery store) a call for implementation of maximum carbon footprints for buildings depending on usage appears to be needed (Lane, 2007).

For the EU-27, the average annual use of materials is approximately 16 tonnes per capita, with a majority of this accumulating in the economy and the rest converted into emissions and waste (EEA, 2010a). Overall, the construction sector (seen in its entirety, including transport and utility infrastructure, but where construction of building still accounts for the bulk of the sector) consumes the largest consumer share of material resources (O'Brien et al., 2011). According to the EIO's assessment of resource efficient construction (O'Brien et al., 2011), this is reflected by the fact that the share of minerals in domestic material consumption was 52% in 2007[4].

With these levels, it is not only essential to promote material substitution through reuse and recycling and to improve efficiency, but it also shows explicit link that the green economy entails between improved material efficiency and the waste management sector. Not only does improved material efficiency reduce waste levels overall, but materials such as cement and metals that have already been used in construction processes are increasingly being perceived for their potential as secondary raw materials.

GREECO's focus on the territorial dimension of where buildings are located makes it advantageous to include land within the variety of resources that are consumed when a building is constructed. As such, explicitly considering land is an outlet for assessing the territorial implications of green building. Yet it also helps to facilitate discussion on positive feedbacks that emphasizing green building within sustainable land use and urban planning processes will have on resource efficiency in other sectors.

2.4. Operational resources

Operational *emissions* as those associated with use of buildings, be it for heating, cooling, lighting or operation of appliances or other electronic (O'Brien et al., 2011). GREECO broadens this to also consider various resources that are consumed by humans in buildings. These include:

2.4.1. The building envelope

The building envelope is the exterior structure of a building - the barrier between the unconditioned environment on the outside and the conditioned environment on the inside. Considering over 40% of final energy consumption takes place in buildings, and 67% percent of that total is used for space heating(EC, 2011a), the importance of the thermal properties of buildings cannot be understated.

For essentially all buildings the envelope consists of four common elements: a roof, walls, windows (and doors) and a foundation. From an energy perspective, the goal of each is to provide as much of a complete thermal barrier as possible. This is achieved through the thermal insulation of each element, which is based both on its material properties and the reduction of thermal gaps between each element (see below). The performance of each element is then based on the environmental conditions with which it is situated. In warm(er) temperatures the goal is to limit warm air from entering the building and in cold(er) temperatures the goal is to limit cold air from entering and warm air for escaping.

The insulation of roofs, walls and foundations is mainly achieved through exterior cladding with good

[3] While EIO references embodied and operational *emissions,* GREECO extends this as to capture operational resources.

[4] As a vast majority of minerals are ultimately used in the construction sector, its share of total material consumption is a proxy for the construction sector.

thermal tendencies and bulk insulation to reduce heat flow (where the level of resistance to heat flow for walls, roofs and foundations is measured by the R-value[5] of each element). Insulation operates under the basic principle that denser materials conduct heat more efficiently, and conversely, the less dense it is the greater it resists heat transfer. Therefore, by being light and containing as much contained airspace as possible, insulation blocks the flow of heat in both directions. Common insulation materials include: different variations of foam, fiberglass, cotton, straw, etc. Each of these provides very cost effective opportunities for achieving an energy efficient building.

For roofs, reflection is another way to insulate. This is particularly important for buildings in warm climates where limiting the amount of heat entering a building will provide a monetary and energy savings for air conditioning. Either reflective or light-colored surfaces (with a high albedo) block the transmission of warm air into buildings. Likewise, green roofs are also used as an external layer to improve insulation.

Unlike thick walls filled with insulation, windows are thin, dense items that by nature have poor insulation qualities. However, innovative solutions have evolved to produce more efficient windows that can respond both to environmental conditions and to seasonal and daily changes to those conditions. For instance, adding a tint or reflective coating to a window glaze reduces heat gain in warm/bright conditions. Automated shutters and blinds are also a component of green building envelope, while adding layers of glazing to create and air space between them for insulation is also commonplace, especially in cooler climates. These spaces are even filled with gasses such as Argon or Krypton that are less dense than air and therefore provide better insulation.

Window frames must also provide an airtight seal for the entire window structure and materials such as wood, vinyl (PVC), metal, or a mix of multiple materials are used. While wood and PVC have relatively good thermal qualities the use of spacing design, thermal breaks and insulation is often to improve their thermal efficiency. (Efficient Windows Collaborative, 2012)

However, the benefits of highly energy efficient wall roof and window insulation can be almost entirely erased through the existence of thermal bridges in buildings. These are produced either when materials with high thermal conductivity penetrate materials with low thermal conductivity, or when assembly of different building components create unplanned passageways for warm air to pass (i.e. at the junction of windows and walls or floors and walls). The need to reduce them places an increased focus on new construction techniques (processes and procedures) as well as new products. One example is where tinted smoke is blown into junctions around frames of windows and doors to check for air-tightness.

2.4.2. Passive buildings and zero/plus energy buildings

Passive House is a concept first developed in Germany in 1990. In practice it accentuates the concepts introduced above and takes them a step further to focus on considerations such as building orientation, natural shade and ventilation to promote natural heating and cooling. The result is a building that consumes very little external energy, where, in a vast majority of climatic conditions sufficient heat is provided naturally by humans' body temperature and the operation of household appliances.

As a general rule, the requirements for Passive House certification are that total energy demand (for space heating/cooling, water heating and electricity) cannot not exceed 40kWhm²a, of which space heating/cooling cannot exceed 15 kWhm²a (Sperling, 2009). These types of certification can be an important factor in progressing green building because it provides the opportunity for policies such as subsidies and direct financial support to be tailored based on energy achievement of new and renovated buildings. Further, the evolving discourse surrounding Passive Homes has had an important role in shifting the product and performance standards of national building standards.

As the names imply, zero or plus-energy buildings combine Passive House standards with a renewable energy source to produce at least as much electricity as is consumed by the building. While the renewable energy source is in situ (on, in or in direct proximity to the building) the energy will generally be fed into the same public grid which provides electricity to the house. This is done to

[5] While wall insulation is measured by their R-value, windows are measured in terms of their U-factor. Unlike the R-value, which is a measure of resistance to heat loss, U-factor is its reciprocal and is a measure of a window's rate of heat loss (Efficient Windows Collaboration, 2012).

overcome seasonal or daily differences between the production and consumption of the energy produced.

2.4.3. Locally produced renewable energy

Depending on the local availability of natural resources, there are a number of possible renewable energy sources that can be used to augment a building's electricity demand. As buildings become greener in terms of their envelope the relative importance of small-scale, decentralized energy solutions naturally increases. These opportunities are clearly governed by locational factors, nevertheless they include:

- **Photovoltaic panel**s on the roof or sun-exposed walls of a building
- Given that 14% of household energy consumption is used for water heating in Europe (EC, 2011a)
- **solar thermal panels** or roof-top water tanks for water heating provide an opportunity for renewable sources to reduce conventional energy demand.
- **Geothermal energy**, which due to relatively steady subsurface temperatures compared to above ground is based on the use of a geothermal heat pump that utilizes exchanges air between buildings and sub-surface piping. In summer conditions warm air in buildings is exchanged with cooled air in the pipes and vice versa in the winter.
- Small-scale **wind turbines** are increasingly used especially in low density residential areas while larger private wind turbines are gaining attention in rural areas, particularly where farming activities take place.
- **Bioenergy** heat solutions such as the one shown in Figure 3 are a highly economical and efficient heat source. Although the fuel is not produced at the direct point of consumption it is nevertheless locally provided and representative of a micro-scale energy solution for buildings

Figure 3 These images show a facility used to burn wood chips as a means of heating an elderly care home in Grenoble, France. In the winter months the 30m^3 cavern is filled with the woodchips that are produced from the residual debris from timber manufacturing. The use of wood fuel has reduced the building's annual CO2 emission from heating from 50 tonnes to only 15 tonnes.

2.4.4. Building renovation

The renovation of existing buildings to improve resource performance could involve one or more of the aforementioned components. Logically, the most common improvements are ones that maximize cost efficiency for energy performance (investment payback) while simultaneously improving aesthetics. For example, improving the thermal qualities of the building envelope by insulating exterior walls and replacing windows with energy efficient ones is usually a key point of departure. As noticeable by the deep setback of the new windows in Figure 4, one of the differences for a renovation is that it is more labour intensive to add layers of insulation on the inner side of exterior walls, which is usually done when a new building is constructed. As a result, bulk insulation is added to the *outside* of existing facades to improve performance and create an updated facade. Nevertheless, retrofitting the envelope often goes hand in hand with the installation of a heat exchange pump as the main physical goods characterizing a typical (using that word loosely) building renovation.

Retrofits also often include a number of improvements to reduce electricity demand. For example, upgrading the climate control system to modern standards of automated, centralized and/or mobile control are common, as well as the installation of solar PV panels where conditions are right. Not least,

almost all buildings undergoing an energy efficiency upgrade take advantage of converting lighting to low consumption products and, where possible, increase the intake of natural lighting through skylights or light-concentrating ceiling cones.

Figure 4 This photo shows a renovated school building façade. The deep inset of the windows has been added to the building to contain the bulk insulation and a layer of contained airspace has been added to improve energy performance (Photo: by author)

The time it takes to recoup the cost of the renovation through energy bill savings depends on a number of factors; not least, the amount of energy savings, the size of the investment and the amount of government support for renovating through subsidies or tax credits. However, during a recent study trip to Grenoble, France, three recently renovated buildings were visited, and the common consensus was that investments would pay for themselves through energy bill savings in less than ten years.[6]

2.4.5. Constraints of green building and renovating for operational efficiency

The principle of most economic analysis of resource efficiency improvements assumes a cost-minimizing (or utility/profit maximizing) behavior by households or building investors as the guiding rationale for investment (Gillingham, Harding & Rapson, 2012). Likewise, each of the above resource substitution and efficiency interventions share a common feature: they are *economically* viable compared to the current cost for energy. However, their viability is conditioned by a number of mitigating factors that limit their proliferation to the market. As such, these constraints are the target of policy that motivates investment in green building beyond what can be provided by the market on its own. Some of these constraints include:

- Building turnover is usually measured in decades and centuries. This means that a green transforming the sector will be a long and drawn-out process, but it also highlights the importance of renovating existing buildings rather than concentrating only on new builds.
- Specific regions or cities may not yet have a suitable mix of firms that provide and install green building solutions to the market
- Resource efficient improvements fundamentally involve investments decisions that trade off higher initial capital costs against higher, but uncertain lower future operating costs. In its simplest form, the decision on whether to make an investment requires weighing this initial capital cost against expected savings. Here, a perfectly rational investor would almost always make an investment to

[6] For example: Building 1: Public School – Investment: 2.3Mn Euro, over 50% energy savings. Building 2: Office – Investment: 1.55Mn Euro, 7-10 year payback.

improve the performance of their building, however a number of factors limit the proliferation of such investment:

- Energy market failures take place when the price of energy does not reflect the socio-environmental cost of energy, which could be kept artificially low for a number of reasons.
- Many people and businesses simply do not have (or cannot convince secondary investors) the necessary extra capital or access to that capital to make additional investments.
- The market for green building is not supplied with enough information for investors to comprehend the level of financial savings that is available to them. In addition, the principle-agent or split-incentive problem takes place when the agent (such as the builder or the landlord) decides the level of investment in green building while the principle (the purchaser or the tenant) is actually the one that occupies the building and pays for the operational resources they consume).
- Themes of behavioral economics certainly apply to green building where, for instance, the notion of prospect theory alludes to how investors naturally calculate potential financial savings based on the current cost of resources such as energy. In contrast, we know from history that energy prices rise faster than inflation including such considerations would further justify – and therefore generate – investment.

2.4.6. Green building and construction concept: concluding comments

The above constraints show how improvements to the resource performance of buildings are based on a high degree of planning and very conscious decisions to investment in green building. As such, a main driver of resource efficiency in the sector is the improved behavior of investors. But this is driven by the degree in which investors are *informed* and *motivated* about green building. This emphasizes an undeniable link between green building investment and an overall shift toward more resource efficient resource consumption behavior.

Discussion on both embodied and operational resources highlighted a number of relevant sector linkages and territorial dimensions that important for advancing the green economy. These include:

- The role of improvements to buildings for substituting current demand for finite, environmentally degrading resources; particularly fossil fuels.
- Importance of urban-rural interactions where built environments mainly in urban areas consume a vast majority of resources in the building and construction sector. But also where access to rural areas can provide unique green building solutions, such as the bioenergy facility used for heating an apartment building (pictured above).
- Land use issues involving settlement structure, reductions of land take, re-use of land and impact on the built environment as both direct and indirect contributors to resource efficiency. Likewise, the importance of functional and sustainable urban development and links to the development of non-car transport solutions and local waste and energy infrastructure.
- Importance of local climate context that determine the types of interventions that are necessary to improve resource performance
- The role of local governance for expanding the skills and capabilities of local construction and installation firms.
- A host of connections have been made regarding the role of eco-innovation and R&D for modifying and developing new technologies to improve the efficiency of buildings.
- The importance of development scale – where larger, community projects may allow for increased resource savings and an economy of scale that can motivate changes to construction practices.

3. Current Performance of the building and construction sector

3.1. Structure of analysis

Assessment on the current performance of the building and construction sector is completed in two steps. The first is an analysis of gross value added (GVA) and employment (using NACE Rev. 2 codes) of the building and construction sector as a whole. This does not necessarily to reflect existing performance in relation to movement toward a green building and construction, but it does reflect the existing importance of the sector for providing jobs and value added to national and regional

economies The second step is an analysis of energy demand (energy consumption and GHG emissions) of constructed buildings and the factors determining such a distribution.

3.2. Measuring regional performance – economy

3.2.1. Economic activities considered for measuring economic performance

A structural definition of building and construction in general allows us to complete a quantitative assessment of performance in relation to key economic indicators. Accordingly, the coverage of the sector corresponds to NACE Rev.2[7] codes in the subject fields of (C) Manufacturing, (F) Construction, (L) Real Estate Activities, (M) Professional, Scientific And Technical Activities and (N) Administrative And Support Service Activities.

Defining the construction sector using NACE codes is a challenging task involving a host of subjective decisions. This is due to the fact that the structure of the NACE classification scheme cuts across many of the sectors under analysis. As such, some sub-sectors may be included even though 100% of their output is not related to building or construction. Likewise, some sectors with portions of its activity related to buildings may not be included.

In general, the intention has been to be inclusive of activities across different sub-sectors, but without being so detailed that we are unable to compile regional data. This follows the method used in the report ECORYS report (Ecorys, 2011) which states, "Thus, there exists a trade-off between the comprehensiveness of the subsector and the validity and completeness of the data available to describe it." (pg. 10) In fact, data availability is quickly understood as a main stumbling block for any analysis of the building sector on an international level, especially when attempting a regionalized (NUTS2) analysis. Future identification of opportunities for policy investment will be greatly aided by an increase of data comprehensiveness; not least a harmonization of national data in the EU.

Table 1 lists the sectors used in the analysis. In general, the maximum specificity is to the NACE two-digit level. For example, with the objective of European coverage, inclusion of sector C25.1 (Manufacture of structural metal products –window frames and doors) is not possible.

The quantitative analysis operates on the basic assumption that a majority of the green building and construction jobs will be transitioned from the existing stock of jobs as resource efficiency standards for buildings are realized. While this is seemingly simplistic, it very much reflects the reality of what the green economy attempts to achieve. The basic hypothesis for identifying green labour force creation could therefore be as follows: to the extent that a labour force that is linked to the development of a building stock that can meet the future energy and environmental goals of the EU, then their employment, and the value added that is associated with it, can be considered green.

Table 1 Economic activities in the energy sector (NACE Rev.2 classification)

F41	Construction of buildings	This division includes the Development of building projects and the Construction of residential and non-residential buildings. It does not include Civil engineering, including construction of roads and railways, utility projects, or other civil engineering projects.
F43	Specialised construction activities	This includes Specialised construction activities (e.g. Demolition and site preparation, Electrical, plumbing and other construction installation activities, Building completion and finishing and Other specialised construction activities).
L*[8] (L68)	Real Estate Activities	This class includes: – Buying and selling of own real estate

[7] Statistical classification of the economic activities in the European Community (NACE Rev.2).

[8] Just as in the ECORYS report on Sustainable Competitiveness of the Building and Construction Sector (Ecorys, 2011), Real Estate Services is considered an auxiliary sector to the construction of buildings, and thus real estate figures are not considered in the economic analysis. It is, however, important to understand that real estate (including buying, selling, renting and management) are noteworthy activities that when tied to green buildings become a part of the green economy.

		– Renting and operating of own or leased real estate – Real estate activities on a fee or contract basis
M71	Architectural and engineering activities; technical testing and analysis	As stated in (EC, 2011e) it is almost impossible to separate architectural and engineering activities from technical testing and analysis, even though the latter has little or no relation to the construction sector.
N81	Services to buildings and landscape activities	This class includes: – Combined facilities support activities – Cleaning activities – Landscape service activities
C16	Manufacture of wood and products of wood and cork	This class includes: – Sawmilling and planing of wood – Manufacture of products of wood, cork, straw and plaiting materials • This does not include furniture, articles of straw or plaiting materials
C23	Manufacture of other non-metallic mineral products	This class includes: – **Manufacture of glass and glass products** – Manufacture of refractory products – Manufacture of refractory products – Manufacture of other porcelain and ceramic products – **Manufacture of cement, lime and plaster** – **Manufacture of articles of concrete, cement and plaster** – **Cutting, shaping and finishing of stone** – Manufacture of abrasive products and non-metallic mineral products n.e.c.
C25.1	Manufacture of structural metal products	This class includes: – Manufacture of structural metal products (including: metal structures and parts of structures and doors and windows of metal.

3.2.2. Performance analysis based on structural business statistics

As stated by ECORYS report, the strategic importance of the construction sector cannot be underestimated. Not least, it accounts for more than 10% of EU GDP, represents more than 50% of fixed capital formation and directly or indirectly employs roughly 44 million workers, making it the largest single economic activity and employer in Europe. (Ecorys, 2011)

In Figure 5 and Figure 6 the national divisions between number of persons employed and the GVA of the building and construction show similar national distributions – where Germany and Spain are in the top three, and Cyprus and Estonia are in the bottom three for both measures. As such, it is first and foremost notable that it is the countries with the highest overall populations that have the highest shares of employees and GVA. This is not surprising due to the extremely close correlation between number of people and the number of buildings that are needed to house them and support their social and economic activities. This becomes an inevitable territorial dimension of the future potential of green building; that buildings will continue to be built where people are, and are expected, to be living. This will be taken up in more detail below on the regional analysis of energy consumption characteristics.

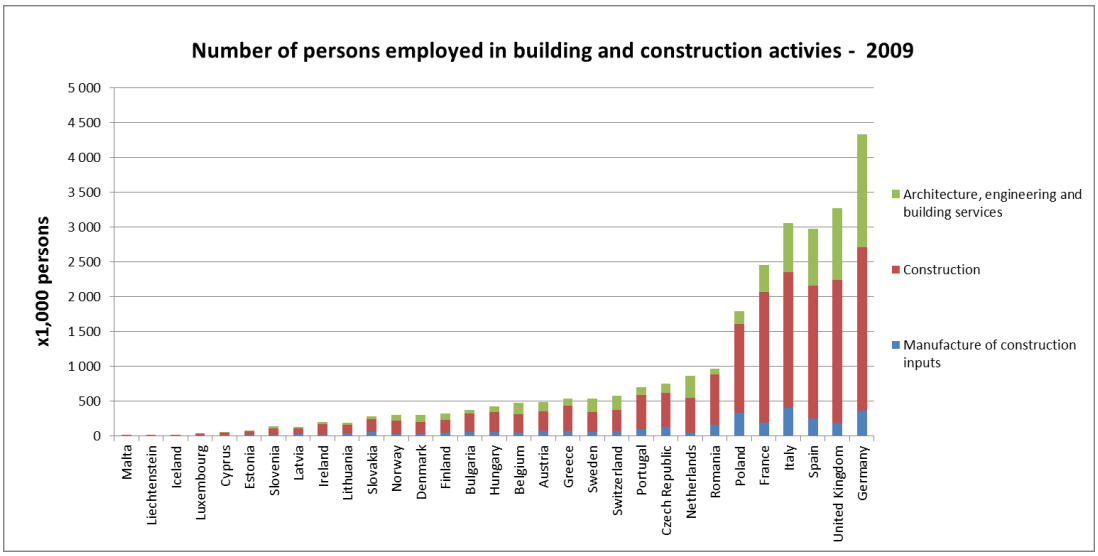


Figure 5 Construction related employment (Eurostat Statistics, 2012)

Another interesting facet of the national distributions are the variations in the sizes of the sub-sectors in different countries. For instance, Germany, the Netherlands, Switzerland, Sweden and Belgium are the five countries where over 30% of employment is tied to architectural, engineering and building service activities. Conversely, France, Ireland, Romania and Cyprus are the four countries where over 70% of economic activity is tied strictly to construction activities. The former group is particularly interesting to note due to the fact that architecture and engineering activities are not only tied to the development of green building products and procedures, but they are also activities that provide output that serves both a domestic and a foreign market.

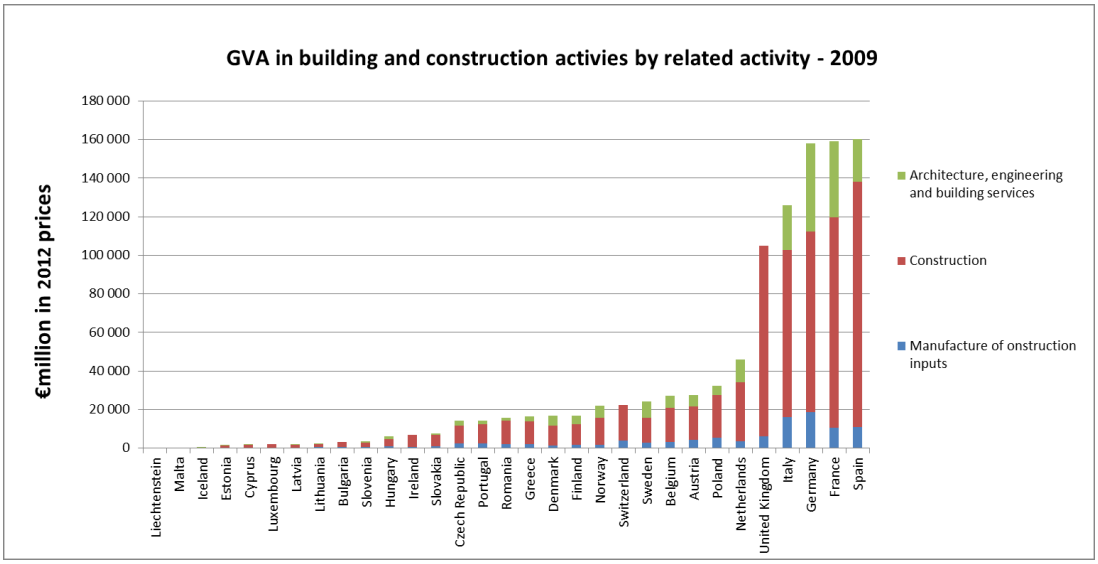


Figure 6 Construction related gross value added (Eurostat Statistics, 2012) Data limited to portions of sector coverage in Bulgaria, Iceland, U.K., Malta and Switzerland

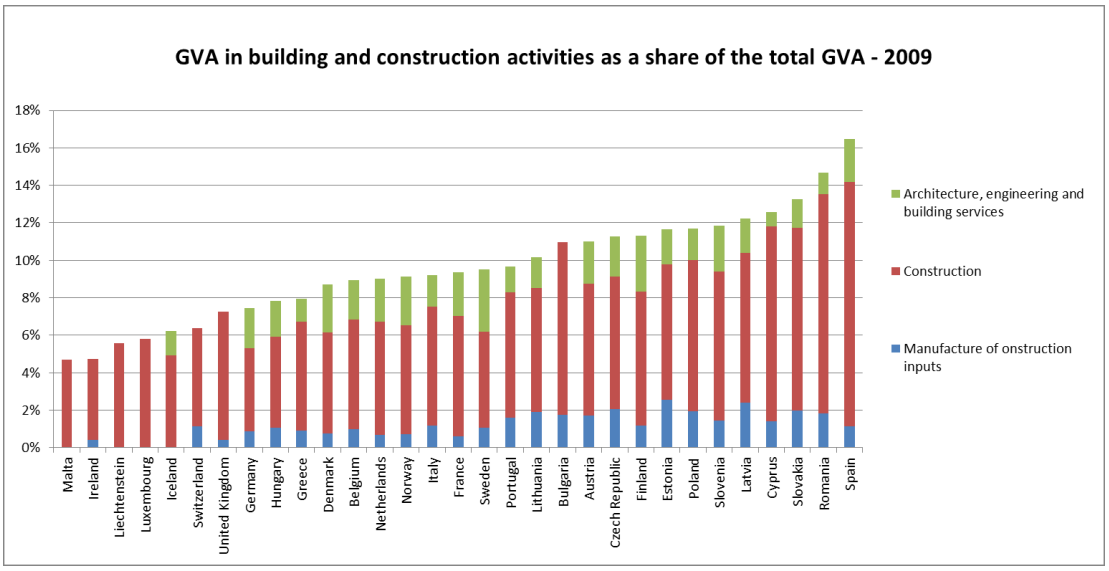


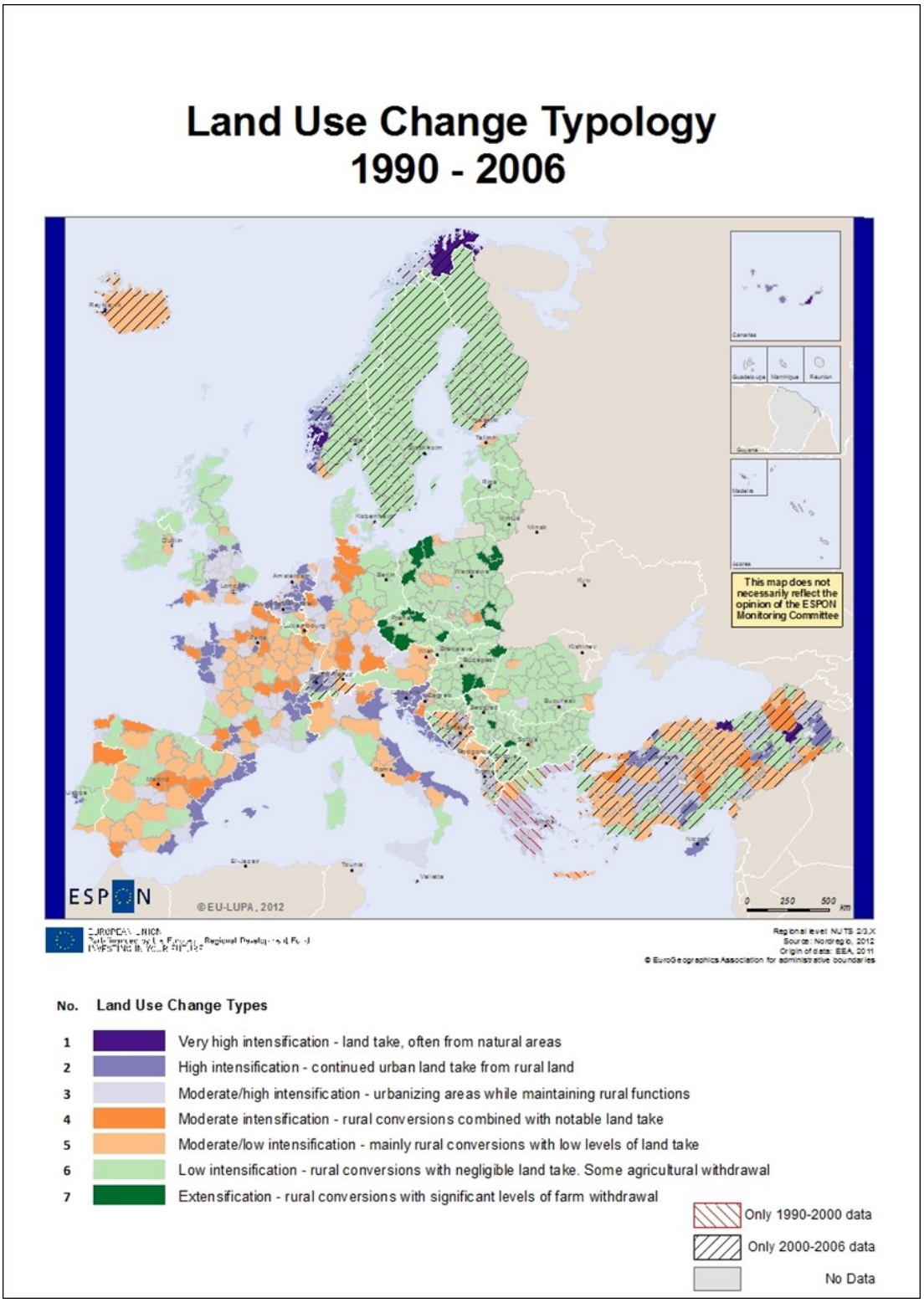
Figure 7 Share of construction related gross value added in total national economies (Eurostat Statistics, 2012). Data limited to portions of sector coverage in Bulgaria, Poland, Iceland, Ireland, U.K., Malta, Luxembourg and Switzerland

Given the strong relationship between total GVA/employment and population, it is also important to consider the size of the construction sector relative to total economic output. Figure 7 therefore reveals a more gradual trend between countries at the low end (where Malta, Ireland and Iceland are under 6% of total GVA) to countries at the high end (where Latvia, Cyprus, Slovakia, Romania and Spain are above 12% of total GVA). Rather than population being the dominant driver, here we see that a mix of "other factors" have a strong role to play.

For instance, in Spain we know that a focus on construction has been driven by at least two interrelated factors: First, there has been a policy driven focus on building and infrastructure development during the late 1990's and 2000's. Most recently, we saw how the increased supply of dwellings as well as artificially low mortgage rates created a housing bubble which mirrored the collapse in the United States. As a result it comes as no surprise when news interviews with Spanish mayors reveal that roughly 20% of the Spanish housing stock sits empty.

Second, and in relation to findings of the ESPON project EU-LUPA (publication forthcoming), Map 1 shows the notable level of urban expansion that has recently taken place along the Spanish Mediterranean coast. This expansion is directly related to the construction of buildings and related infrastructure in support of the tourist economy, which is considered as one of the key drivers of urbanization in Europe (Prokop, Jobstmann & Schönbauer, 2011). The urbanization in these regions is further supported in

Map 2 below, as these regions also show high shares of total GVA and employment in the building and construction sector. Similar urbanization tendencies in other Mediterranean coastal regions of Italy, Croatia and Cyprus, which further implicates the link between growth of tourism (experience economy) and growth in the building and construction sector. Likewise, it is also shown in the chart re-printed from the EEA's 2010 State and Outlook Report on Land Use. Here, Figure 8 clearly shows Spain as among the country with the highest levels of urbanization.



Map 1 The EU LUPA's Land Use Change Typology (EU LUPA, publication forthcoming)

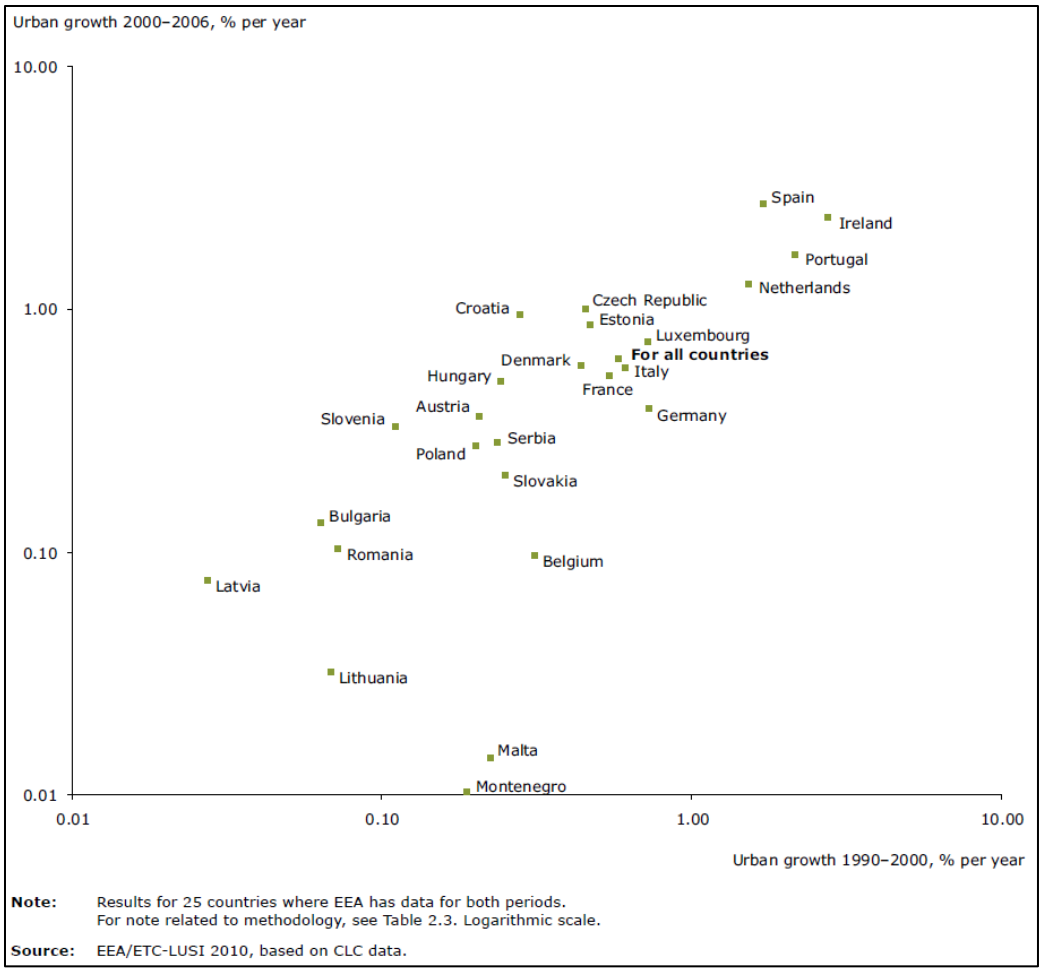


Figure 8 Growth of urban residential areas and economic areas in selected European countries, 1990-2000 and 2000-2006 (EEA, 2010b)

It is also notable that after Spain, the seven countries with the highest relative size of their construction sector (see Figure 7) are New Member States (since the last two expansions in 2005 and 2007). This likely reflects the jolt national investment in the immediate years leading up to ascension as well as the additional availability of European funds directly following membership to the EU. Similarly, GVA from the building and construction sector in more established Member States is neutralized in the 8-10% range. This implies that the availability of European funds – for instance, through Cohesion Fund or the ESF can and could act as a formidable driver of greening the building and construction sector.

The results in Figure 9 reflect the above mentioned patterns and show that growth in construction and architecture, engineering and building services has been concentrated in New Member States such as Hungary, Romania, Bulgaria, Slovakia Cyprus and Latvia. We also see the incredible reduction in persons employed in manufacturing activities related to construction. This is especially true for Ireland, Germany, Estonia, Denmark, Spain, Slovenia and Hungary. The most obvious explanation for this change is due to transfer of manufacturing to the Far East – especially to China. At the same time we also see that levels of growth are relatively low in Spain, which likely reflects the fact that growth of construction began prior to 2000 and has been sustained since then.

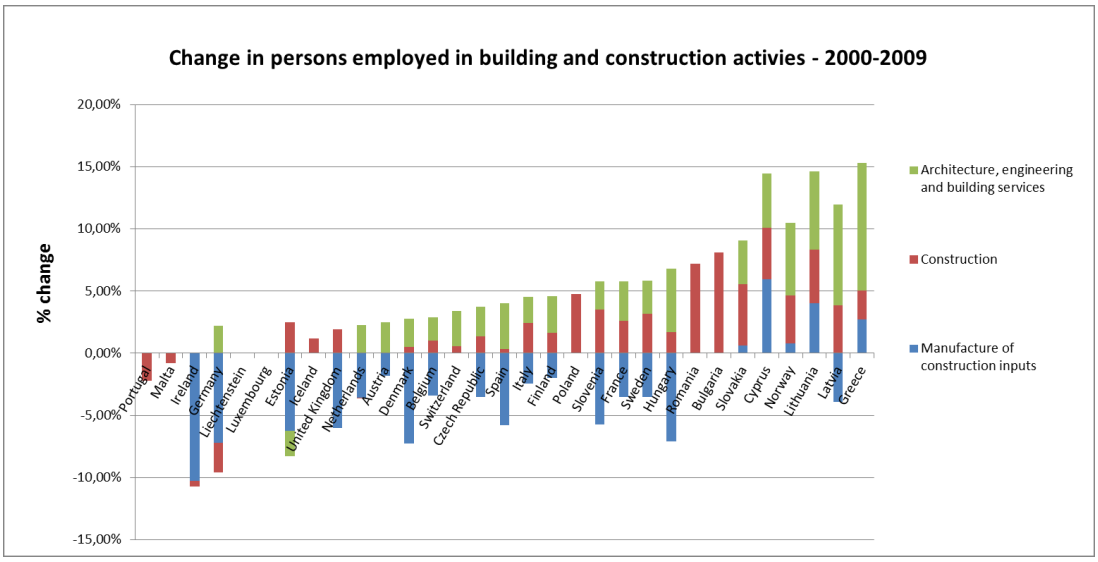
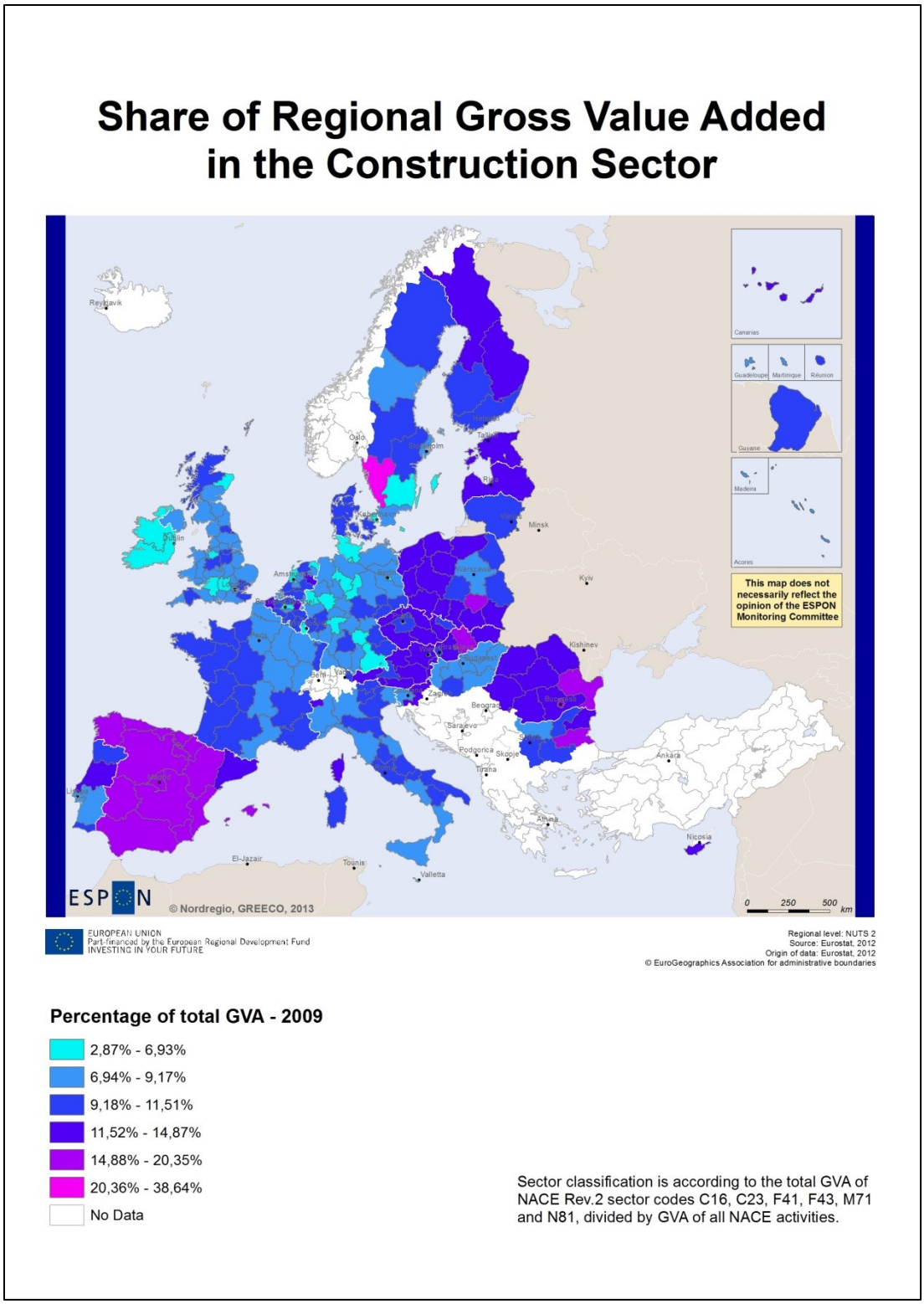
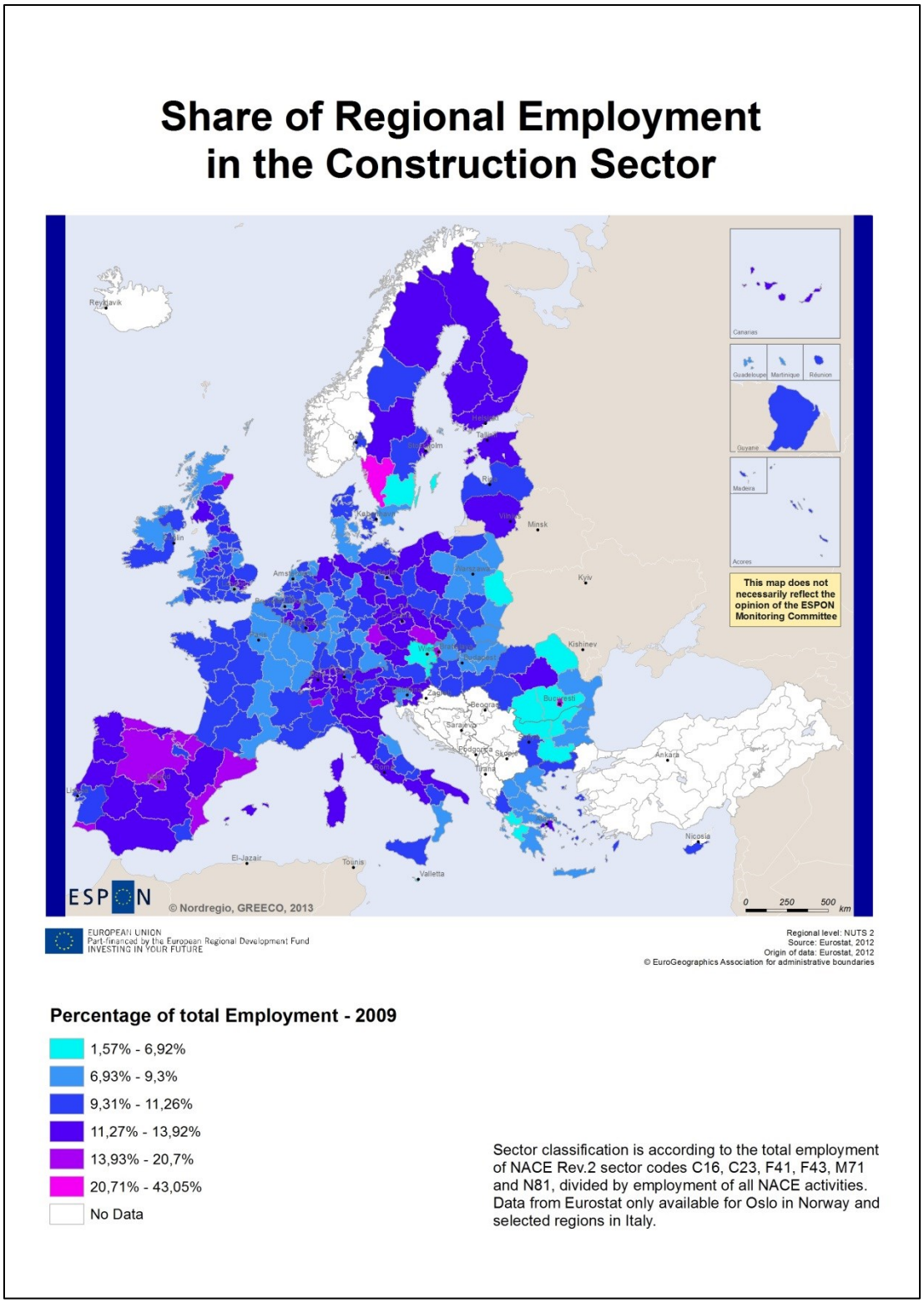


Figure 9 Changes in construction related employment (Eurostat Statistics, 2012). Data limited to portions of sector coverage in Bulgaria, Poland, Iceland, Romania, Ireland, U.K., Malta and Switzerland. Data missing for Luxembourg.



Map 2 Share of total GVA in building and construction



Map 3 Share of total employment in building and construction jobs

3.3. Measuring regional energy performance

It is crucial to understanding regional energy performance of existing buildings not only because a majority of buildings will be maintained at least to 2050, but also the fact that variations in current performance have a direct implication on greening the sector going forward (i.e. poor performance now implies greater potential). As such, while this section explains current performance, the rationales for such trends, and their associated regional distributions, are very much at the heart of discussion on underlying potential that regions will have for developing the sector. And in doing so, these rationales

are at the centre of what are territorial bound driving and enabling (or hindering) conditions of green building.

Comprehensively measuring the regional performance of green building and construction is limited by certain factors: first, the extensive list of factors contributing to energy performance of buildings highlights the complexity of measuring their performance. This is accentuated further when considering that energy is just one of the many resources that ought to be considered - and that resources are just one of the many factors included in a notion of green building. For example, green buildings, while being more resource efficient, should also be more aesthetically pleasing, linked to the availability of public transit or non-car mobility options where possible, comfortable to live in and accessible to a range of socio-economic groups Many of these types of issues are extremely difficult to measure or interpret quantitatively for Europe in its entirety.

Second, and more importantly, there is a clear lack of harmonized European data (at the national and regional level) on construction activities, building characteristics (type, age, ownership, etc.) and energy demand characteristics. As a result of these issues, and the fact that they account for 75% of all buildings by floor space area, analysis is concentrated where data is most available and on what are most commonly reflected in the notion of green building – the resource performance (measured via energy consumption and CO2 emissions) during the *operation* of residential buildings. This is not to discount the importance of other resources used in the manufacturing and construction phase, nor the other social, economic and planning factors that are in play, but we are limited in time and resources available for this analysis.

Nevertheless, we start with an analysis of national level per capita energy consumption of the residential sector for 2009. This is supported with changes in per capita consumption between 2000 and 2009. Next, the available regional data of energy consumption is presented as a basis for enriching the analysis of the drivers, enablers and hindering conditions that result in regional variations of green building and construction performance. The national data and available regional findings ultimately shows that a descaling of national data using population density is a valid means of indicating regional energy consumption and CO2 emissions.

3.3.1. Operational energy performance of buildings

As outlined in Part 1 of the *Buildings Under The Microscope Report* (Economidou, 2011), effective policy making to promote green building is contingent first and foremost on accounting and monitoring of current energy performance of buildings, and the factors that determine such performance. We will of course argue that a key factor is *where* buildings will be needed in the future as well.

Energy performance of residential buildings in Europe for 2009 is reflected in Figure 10 at the national level, and for a few available countries at the regional level in Map 4.[9] In Figure 10, we see two- to five-fold increases in consumption between Malta, Bulgaria and Portugal at the low end and Norway, Finland and Luxembourg at the high end.

But changing rates of residential energy consumption are perhaps even more important, as they can signify processes of greening the sector. Here, Figure 11 shows quite dramatic results – where statistics indicate that Slovakia, Malta, the U.K. Iceland and Belgium have each reduced their per capita consumption rates by more than 10%, while consumption has increased by more than 20% in Finland and Poland and by more than 30% in Lithuania and Latvia. Some of the other notable results in terms of territorial distribution include:

- The fact that the three Baltic countries of Latvia, Lithuania and Estonia are among the top five per capita consumers, while neighboring countries of Poland and Finland round out the top five. This clearly indicates the implications between rapid development following EU ascension, the existence of an abundance of buildings with a relatively low insulation standard and a harsh winter climate.
- The high increase for Germany (11%) and to a lesser extent Denmark (7%), especially compared to countries such as Norway (1%) and Sweden (-2%). Such increases in two countries - ones that are widely known as European leaders in terms of adopting eco-innovation into society and economy – are surprising and reflect the need for additional investment in statistics to monitor the effectiveness of policy-based investment.

[9] In 2009, residential energy demand accounted for 68% of total final energy use in buildings for Europe.

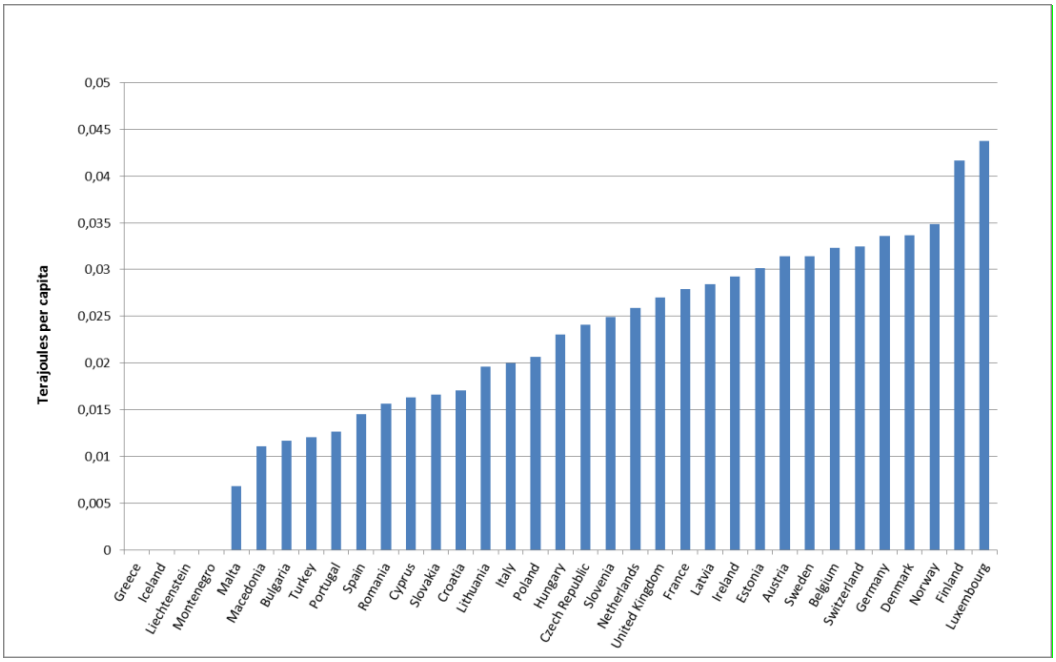


Figure 10 Residential Final Energy Consumption per capita – 2009 (Source: Eurostat)

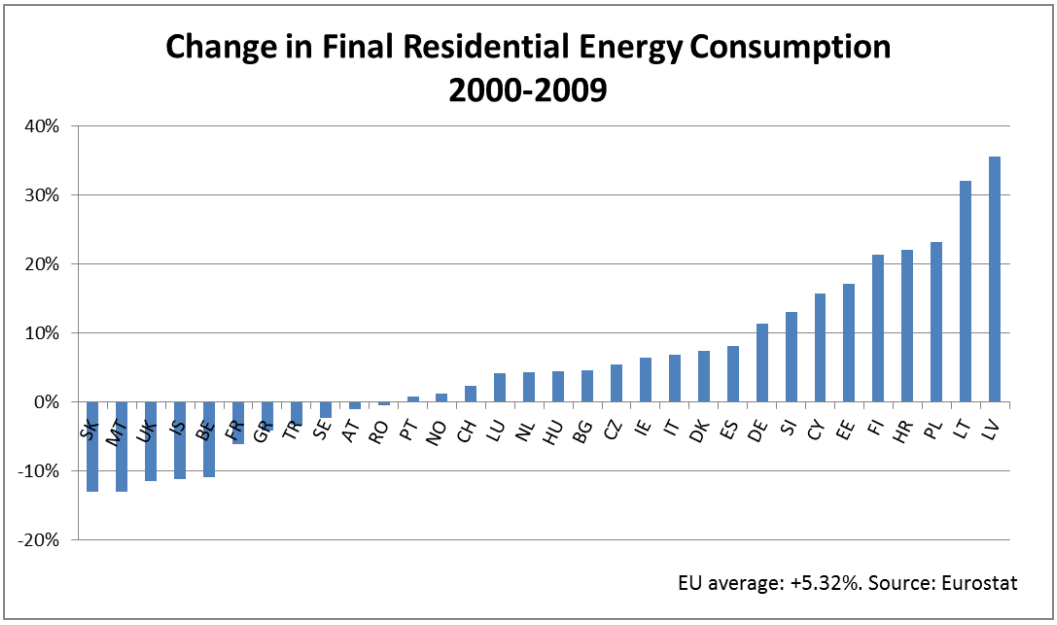
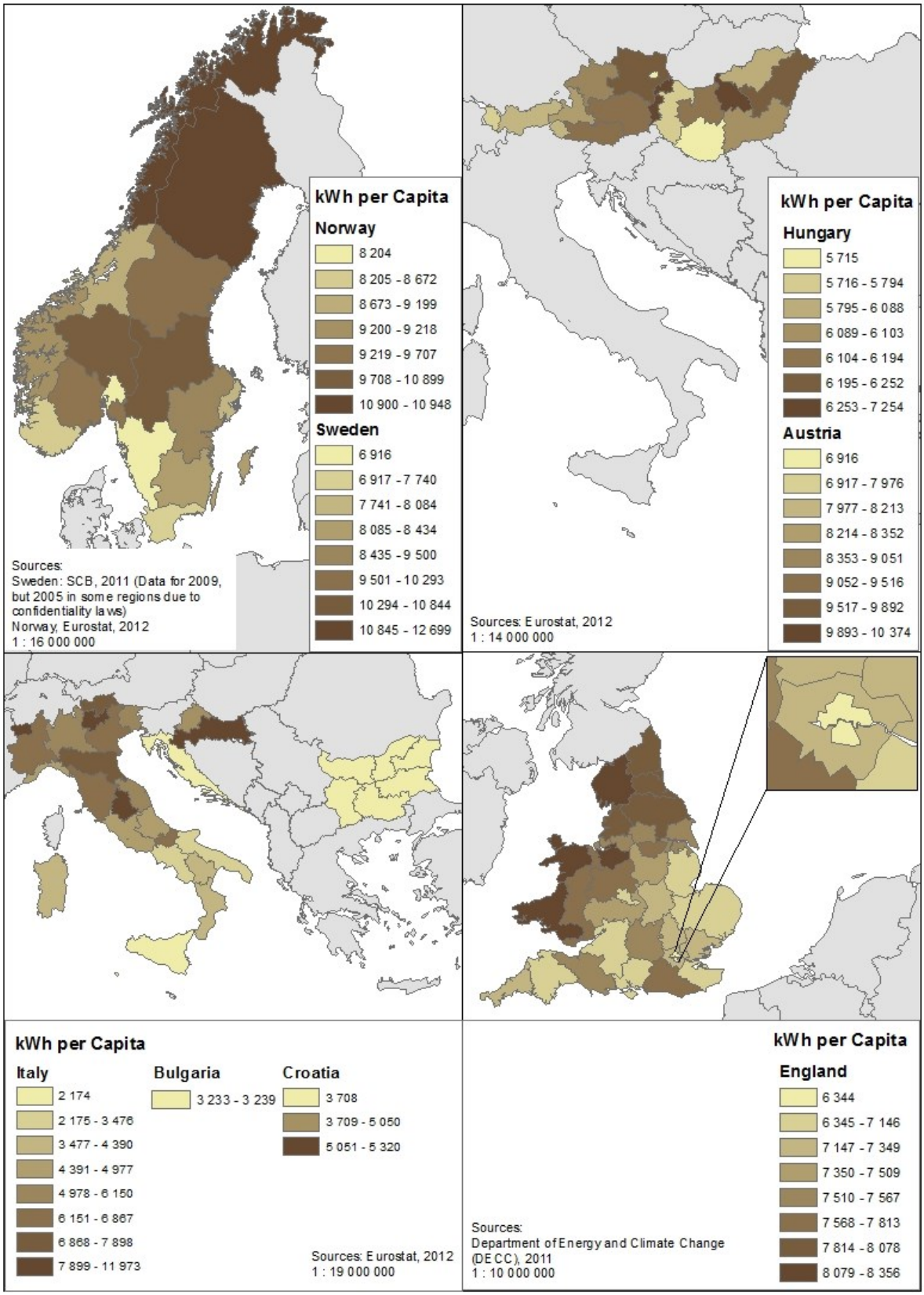


Figure 11 National changes in per capita energy consumption between 2000 and 2009, corrected to temperature variation (Source: Eurostat)

The results indicate a mix between macro regional trends (i.e. high consumption increases in the Baltic countries) and more selected national variations (i.e. seemingly poor performance in Germany and Denmark contrasted by improvements in Sweden, France and especially the U.K.).



Map 4 Energy Consumption in residential buildings – 2009

In addition to the national variations, Map 4 and **¡Error! La autoreferencia al marcador no es válida.** show that there can be substantial differences in *regional* performance within countries as well. For example, apart from Bulgaria and Italy at the low and high ends, we see an average difference of 45% between per capita residential energy consumption in the lowest region and highest regions.

The sub-sections below seek to outline the rationales for why we see the differences that we do in terms of the important factors determining regional operational energy performance of buildings. We begin with first discussing the climate factor, which is followed by issues regarding residential building type, density and age, issues of ownership and not least, economic issues.

Table 2 Regional disparities in residential energy consumption between selected countries shown in Map 4.

Regional Disparities in Residential Energy Consumption			
	Lowest Region	Highest Region	Differential
Bulgaria	3 233	3 239	1,00
Hungary	5 715	7 254	1,27
England	6 344	8 356	1,32
Norway	8 204	10 899	1,33
Croatia	3 708	5 320	1,43
Austria	6 916	10 374	1,50
Sweden	6 916	12 699	1,84
Italy	2 174	11 973	5,51
Average	5 401	8 764	1,90

Climatic Conditions

Figure 12, shows the high correlation between differences in heating degree-days (generalized as "climatic conditions") and energy consumption for space heating. Given that 67% of energy consumption in the residential buildings is used for space heating (EC, 2011a), it comes as no surprise that outdoor temperature is a key territorial factor determining energy consumption in buildings. At the same time, it is noted that increased use of air-conditioning in regions with hot summers has also increased overall energy demand. While the possibilities for green building technologies to regulate high temperature conditions are relatively lower than is less than for protecting against low temperatures, passive cooling techniques such as ventilation, natural shade and building orientation can significantly reduce the need for energy-based air cooling.

In Map 5 we see a Europe-wide south-to-north gradient in terms of the need for heat generation, as well as, to a lesser extent a west-to-east gradient in the mid-latitudes of continental Europe. As a result, the Nordic and Baltic countries show the highest number of degree days, while coastal Mediterranean regions show the fewest. In these latter regions, energy demand for air-conditioning will likely represent and important share of overall operational energy demand of buildings.

Measured at 0.67, there is a moderate—high correlation between per capita energy consumption in residential buildings (Figure 10) and the aggregated national distribution of actual heating degree days (reflected in Map 5). This is substantiated by analyzing the distribution of regional energy consumption in Map 4 Energy Consumption in residential buildings – 2009 with the regional distribution of heating degree days in Map 5 Climatic based demand of energy for heating of buildings, especially for countries with a north-south orientation (England, Norway, Sweden and Italy). For each of these countries an underlying north-south gradient is obvious.

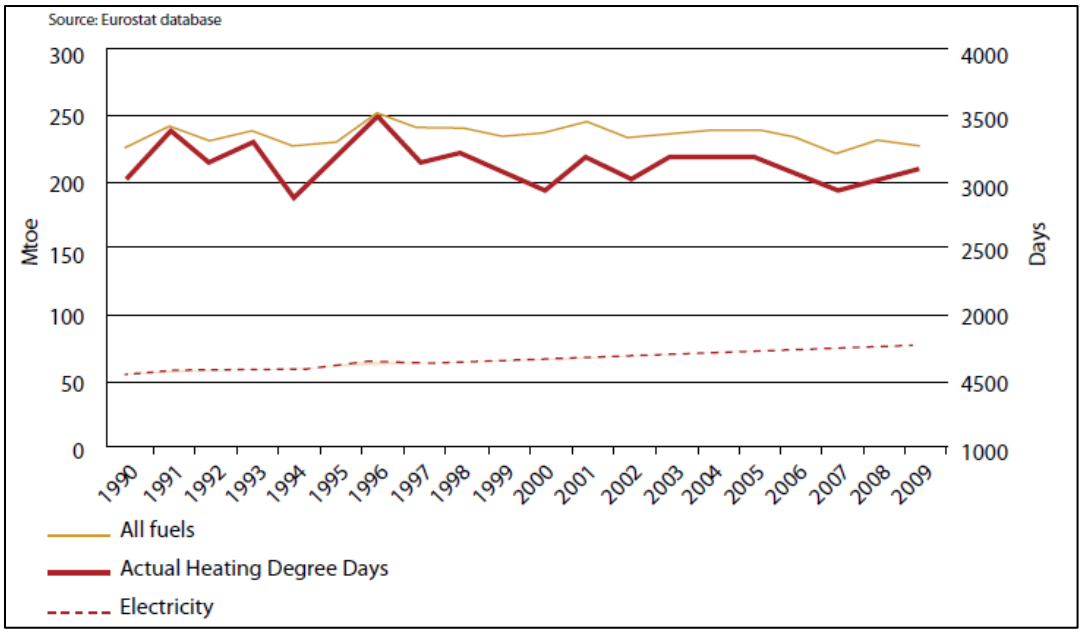
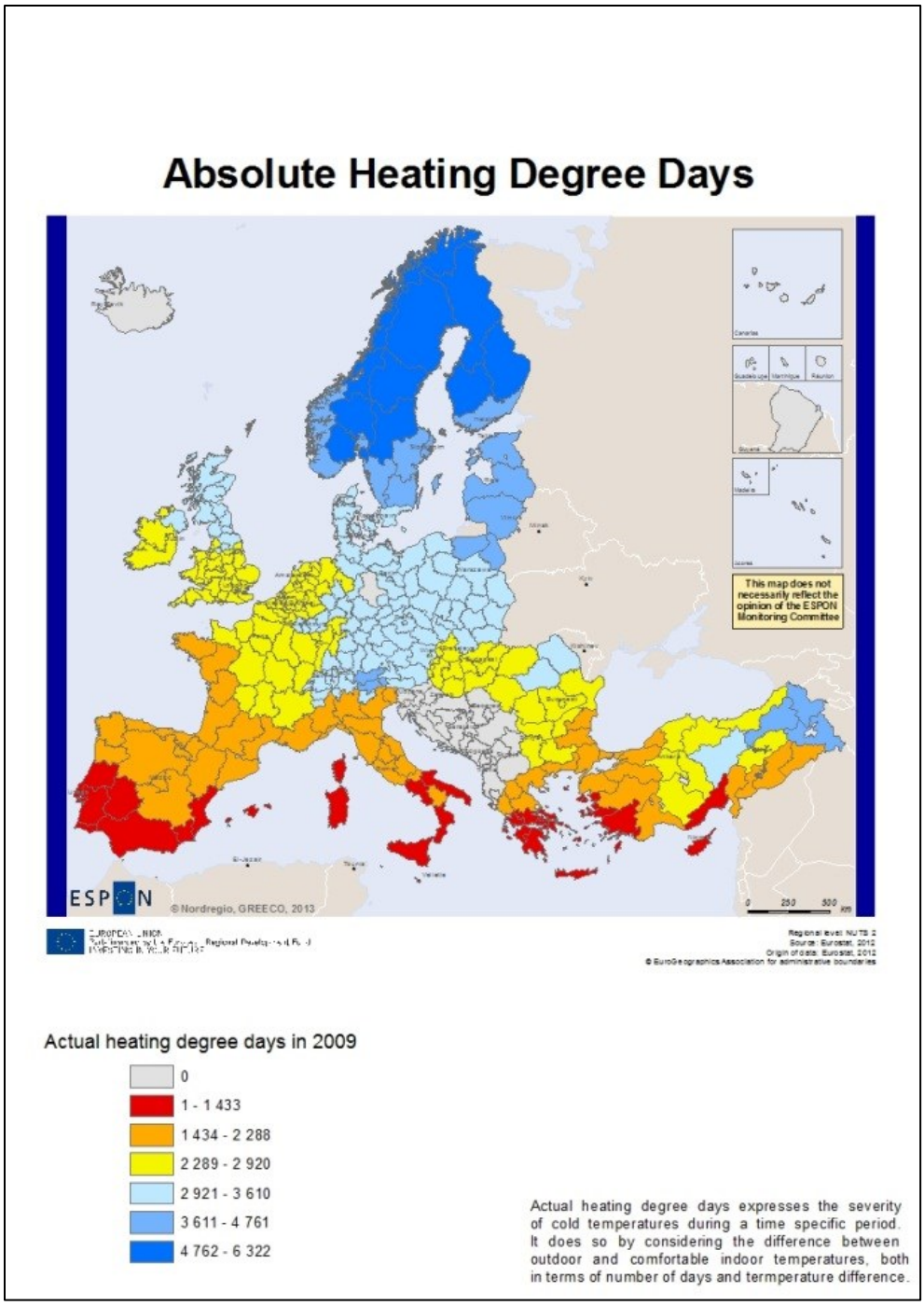


Figure 12 Final energy use in residential buildings in EU27, Norway and Switzerland (Re-printed from (Economidou, 2011)

However, even though climate is extremely important for dictating energy demand of buildings, we can also see that some countries quite clearly deviate from this pattern. For example, Poland has a perceptually lower level of per capita consumption relative to their degree days, while the opposite is the case for Luxembourg. These are interesting because it means that other territorial factors are playing important roles in determining energy consumption in buildings.

Furthermore, it is also important to note that while some countries show a rather homogeneous regional distribution of degree-day levels (i.e. Spain, Portugal, the Nordic and Baltic States, etc.), others show a rather heterogeneous distribution of levels. A clear example of this is in Italy, which includes four of the six classes shown in Map 5. From a climatic perspective this motivates the need for a comprehensive mix between national guidelines/regulations and regional or approaches that can be tailored to the local conditions as needed.



Map 5 Climatic based demand of energy for heating of buildings

Building Type - Density

Unfortunately, there is little in the way of good indicators to measure regional variations in terms of dwelling type and building age. This makes it difficult to provide clear findings on the impact of these issues in relation to green performance of the existing building stock. Nevertheless,

Figure 13 shows that European countries differ greatly in terms of the share of single family homes to apartments. This is a main issue in formulating policy development for greening the residential sector, not least because of the very different constellations of stakeholders involved in the decision making process of performing a green retrofit of existing buildings. The cause for these differences varies from country to country and region to region, but some factors undoubtedly relate to the dynamic interplay between culture, history of population development, wealth and not least, the concentration of residential buildings in urban settings.

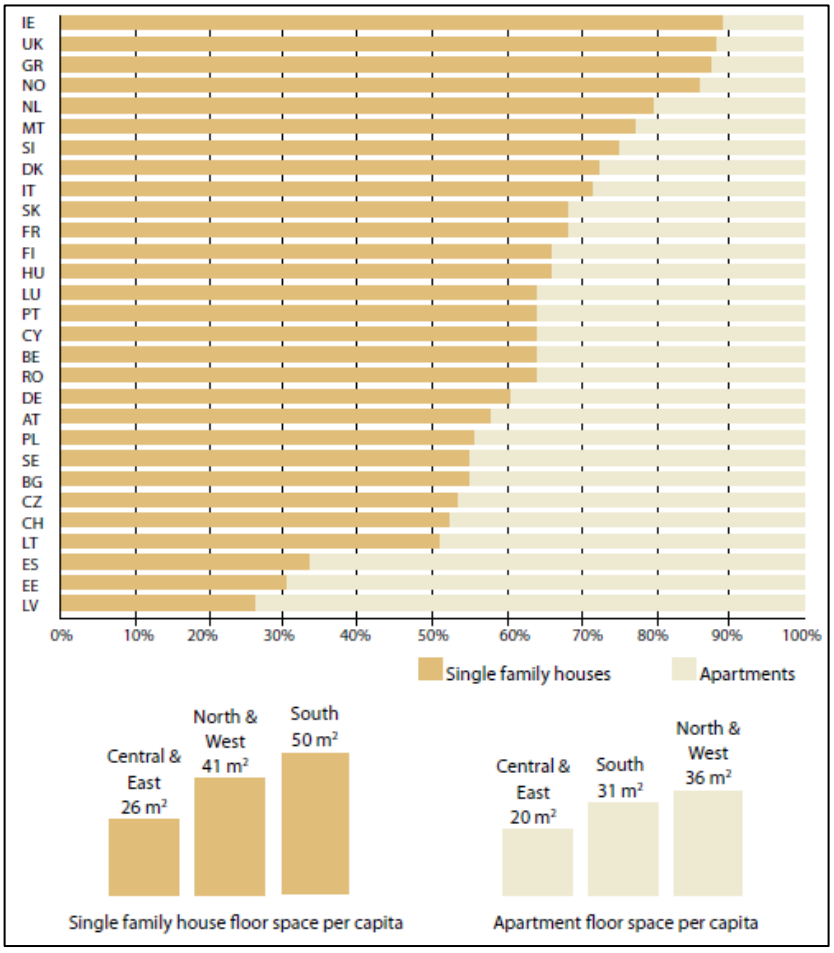


Figure 13 Distribution of single family and apartment buildings (Economidou, 2011)

Cultural differences are not necessarily related to economic rationales. For example, we know that single family dwellings and row homes are an extremely popular building typology in the U.K. and Ireland, while Greeks have a tendency to cohabitate with relatives further into their adulthood than in other countries. This is reiterated in the results which show that only 10-15% of the residential buildings in these countries are multi-dwelling apartments. In contrast, in Sweden it is very common for people to live in their own apartments from a young age and shared accommodation (roommates) is relatively uncommon.

Building age is not only an important factor determining the energy performance of buildings (see below), but it has also had an impact on the *type* of buildings that have been constructed during different periods. A perfect example of this is the Million Homes Programme in Stockholm, Sweden – where 1 million housing units were constructed in the 1960's and 1970's to solve the region's population-driven housing deficit. The only way to meet the demand for housing was to build large scale apartment "superblocks" on unused land. These buildings have been the target of a great deal of

criticism from planners, mainly in relation to the modernist planning and the architecture period of function over form.

Thus, it comes as no surprise that some of the nations with very high shares of buildings constructed in the modernist period (1961-1990) (ie Latvia, Estonia, Lithuania, Sweden, etc.) also have relatively high shares of their population living in multi-dwelling housing units (cf. Figure 13 and Figure 15).

In the BPIE's report (Economidou, 2011) it is notable that there is no discussion on the relationship between existing building density and energy performance. However, many other reports comment that single family homes tend to be more resource demanding due to larger spaces for heating, increased number of exposed walls, the larger properties for maintaining, etc. At first sight, the results in Map 4, showing the capital regions in England, Norway, Austria and to a lesser extent Sweden with lower per capita energy consumption than their surrounding regions, seems to validate this notion. This parallels the notion that higher housing density is essentially a prerequisite for a plausible future of green building – in relation to resource efficiency of the building, critical masses to support for non-car mobility options, and even for improved quality of life. In speaking of the need to reduce GHG emissions, this is exemplified in the ESPON project SIESTA, which comments:

> "And, taking into account that it is clear that metropolitan areas concentrate GHG emissions, it is also clear that particular urban strategies for each individual city seem to be suitable. All this has direct implications in spatial and urban planning, for instance the need to reduce sprawl and to favour a compact urban model. As it has been suggested by several scholars, the world needs a double revolution: achieving a reduction of GHG emissions and building better urban environment, given that people are concentrated in cities. They are both absolutely inter-related. However, much the discussion around these issues is placed in the context of new buildings and developments, rather than the existing stock of ever-aging buildings." (Compostela, 2012, pp.37)

In response to this, and to the results in

In addition to the national variations, Map 4 and **¡Error! La autoreferencia al marcador no es válida.** show that there can be substantial differences in *regional* performance within countries as well. For example, apart from Bulgaria and Italy at the low and high ends, we see an average difference of 45% between per capita residential energy consumption in the lowest region and highest regions.

The sub-sections below seek to outline the rationales for why we see the differences that we do in terms of the important factors determining regional operational energy performance of buildings. We begin with first discussing the climate factor, which is followed by issues regarding residential building type, density and age, issues of ownership and not least, economic issues.

Table 2 showing the large regional differences in residential energy consumption, GREECO has compared the regional data on residential energy consumption with population density (as an indicator of housing density). This seeks to determine if higher levels of *existing* building density are correlated to reduced per capita residential energy consumption.

The first step in this process is to eliminate the climate factor using the regional distribution of degree days. This has been done by indexing the regional degree days in relation to the national average and then compensating regional energy consumption based on climate differences. It was decided to do this at the national level rather than Europe-wide to not turn a blind eye to other factors that undoubtedly affect consumption in different Member States (i.e. national differences in building age, quality of construction, floor space, economic wealth, etc.). These corrected consumption values are then compared to regional population density, both quantitatively in terms of overall correlation, but also qualitatively in terms of how the region with the highest density each country performs. The results are reflected in Table 3.

Table 3 Indication of relationship between energy performance and building density

Impact of population density on residential energy consumption		
	Correlation between per capita residential energy consumption(corrected for temperature) and population density	Rank of capital region in the national setting
Bulgaria	0,51	1 of 6
Hungary	-0,74	7 of 7
England	-0,12	4 of 30
Norway	-0,66	4 of 7
Croatia	-0,02	2 of 3
Austria	0,16	3 of 9
Sweden	-0,33	4 of 8
Italy	0,31	11 of 20
Average	-0,11	49th percentile

The results allow for a number of relevant findings in relation to territorial dimensions of green building. In terms of existing performance, at -0.11 we quite clearly see that, overall, there is almost no correlation between per capital residential energy consumption and population density. What is even more incredible is that in a number of countries there is a quite strong negative correlation (i.e. -0.74 in Hungary, -0.66 in Norway and -0.33 in Sweden). This indicates that regions with the lowest density actually have the better energy performance in buildings than regions with higher density. The analysis of performance of regions with the highest density supports these findings. Only the capital region of Yugozapaden in Bulgaria has the lowest per capita consumption, and in this case it is notable that the energy differential is virtually zero between the highest and lowest performing regions of Bulgaria! Even more telling is the very poor performance in the capital region of Hungary, which has the highest per capita consumption of all Hungarian regions. The mediocre performance in Oslo and Stockholm is also quite surprising given the widespread dominance of multi-family dwellings in these regions, as well as the focus of developing eco-communities in Stockholm.

The results are clearly surprising given that it would be expected that smaller average living spaces in a denser built environment would produce a lower per capita consumption. So one must ask what a rationale is behind these findings. Why do denser, urban regions seemingly perform poorer than less dense regions? Two rationales are described below: the dynamic relationship between larger, denser, more established cities and the tendency for buildings to be older and thus less energy efficient; and the issue of ownership – where there is likelihood that fewer dwellings are owner-occupied in cities. As will be discussed, this creates problems in promoting investment in resource efficiency upgrades to existing buildings.

Building Type - Age

As one would expect, the age of a building very likely has a close relationship to its energy performance, particularly for buildings that have not undergone an energy retrofit (Economidou, 2011). As such, the distribution of building ages per country in Figure 15 reveals some notable results:

- Country-by-country variations are pronounced.
- In a vast majority of reporting countries (except Ireland, Spain and Poland), 75% of the building stock is at least 22 years old.
- A number of countries, including Sweden, Denmark, France, United Kingdom, Luxembourg, Belgium, Latvia and Italy have proportionally high number of old buildings (pre-1946).
- Most countries reveal an abundance of buildings from the modern period (between 1961-1990), which reflects historical trends of population development (where population surges create the need for parallel increases in housing supply). Not only does this have a great impact on existing

performance, but it also infers the importance that future population development will have on determining where new buildings will be needed in the future.

Current Policy Performance

The technical and economic potentials of green building have advanced substantially in the last 5-10 years. For instance, the recast Directive on the energy performance of buildings – 2010/31/EU – foresees that nearly zero-energy buildings will be mandatory for all new buildings by 2021, and long term targets suggest upwards of a 90% reduction in CO2 emissions from building by 2050 (EC, 2011d). This implies that at some point in the next 30-35 years almost all existing buildings in Europe will have to undergo a green retrofit.

Policies are needed to support and facilitate investment in greening buildings both new and old. This includes awareness campaigns regulations and legislation. But before regulations can be implemented (setting a new market standard) a necessary level of uptake must have already penetrated the market – in order to test new technologies, facilitate construction firms acquiring the right skills, influence market behaviors, etc. Especially the last fact is crucial because regulations are ultimately political acts which must bridge between public sector goals and public (voter) acceptance. It is especially during this stage of gaining traction for green technologies where financial mechanisms are absolutely fundamental to marketing eco-innovations in the sector. Tax burdens, subsidies and direct grants serve to ease the capital intensity burden associated with building investments – where upfront costs are invested against an expected payback in the future. With this in mind, a general appreciation of the number of financial policies at the Member State level provides an indication of the attention – and resources – being dedicated to the matter. **As such, it provides territorial evidence on the performance of Member States in relation to greening the building and construction sector.**

Figure 14 therefore shows that all Member States have at least one (and up to 11) financial instruments in place to support green building investment. For instance, it is notable that the UK and Belgium show the highest number of policies and are among the five in terms of change in per capita energy consumption from 2000-2009 (Figure 11). A similar relationship holds true for other countries with reduced consumption, notably Malta, Slovakia and Austria.

However, Figure 14 cannot be taken for granted as the current situation because we know from personal experience that there is current NO national funding available in Estonia (which states three policies in the figure), Sweden (also three) or Ireland two). Regional and local stakeholders have commented directly that not only are European funding sources incredibly complex and bureaucratic to comply with, but national policies schemes seem to “change by the day”. As such a clear policy recommendation is not only to emphasis the importance of financial mechanisms (especially at the national level) but also to ensure that they are consistent enough for local and regional actors to base their investments decisions.

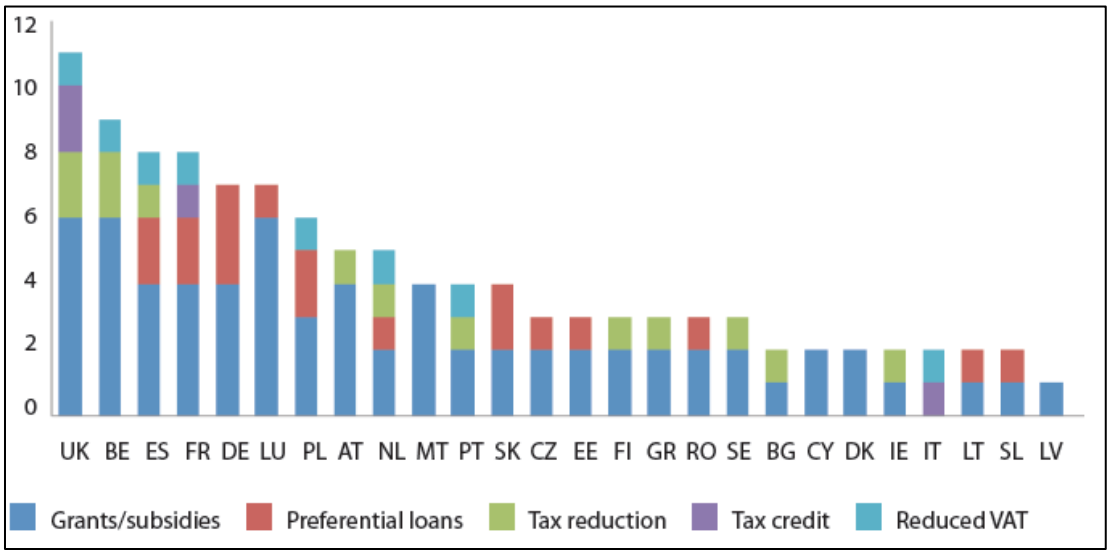


Figure 14 Number of financial instruments in place supporting green building (Maio, Zinetti & Janssen, 2012)

With that being said, consideration of building age identifies additional points that ought to be considered when interpreting territorial potentials of green building. First, it reaffirms that **population development ought to be seen as a key indicator determining green building potential, which means that data on population projections can be used as a means of suggesting where potential exists for green jobs in the building sector.**

Related to this, the number of relatively old buildings and the incredible rate of construction during the modern period indicate that a vast majority of buildings in Europe are ripe for an energy retrofit. In terms of "old" buildings, we have to look no further than the fact that Luxembourg clearly dominates in two trends related to buildings: the number of very old buildings and the by far the highest per capita energy consumption.

It is also apparent that sincere attempts to improve building efficiency must acknowledge the vast number of large-scale, modernist apartment blocks. Yet this also means that achievements can be made with the decision to retrofit just one or a few buildings. Third, more comprehensive knowledge of buildings is certainly needed - both within regions and among regions. For example, regions must know the age of their building stock, which buildings have undergone some sort of energy retrofit in recent years and which should be targeted for retrofit in the near future. Likewise, better interregional statistics allow for improved efficiency of policy support, particularly from the EU level.

Ownership

Closely related to wealth and building typology, ownership issues can negatively impact energy consumption reductions in buildings in at least two ways. First, there is often a reduced tendency for renovations, both overall and in terms of the depth of energy savings realized by such renovations. Second, payment for energy services (especially heat) in many countries often only goes to the building level, rather to the level of individual dwellings.

The BPIE's survey data, shown in Figure 16 below, reveals high variations in the national tenure characteristics between countries (Economidou, 2011). For example, in Switzerland, owner-occupied residences count for only 35-36% of all residences while in Spain, Hungary and Romania the over 80% of residences are owner occupied.

	Year	<1919	1919-1945	1946-1970	1971-1980	1981-1990	1990-2000	> 2000
Austria [1 2]	2009	15.2	8.2	28.0	15.2	11.5	13.6	8.3
Belgium [3 4]	2009	17.1	24.2	24.2	13.7	20.8		
Bulgaria								
Cyprus [5 6]	2001	na	7.4	16.9	20.7	27.4	27.1	-
Czech Republic [1 5]	2005	10.5	14.2	25.4	21.8	15.8	7.9	3.4
Denmark [7]	2009	19.7	16.1	26.4	16.6	9.1	5.4	6.7
Estonia	2009	9.4	14.2	30.0	21.5	19.6	2.0	3.3
Finland [4]	2009	1.5	8.1	27.6	21.5	18.5	11.5	9.8
France [1 8]	2006	17.0	13.2	17.4	25.2	10.2	8.5	8.4
Germany [9]	2006	14.4	13.6	46.3		13.2	9.2	3.3
Greece	2001	3.1	7.2	31.8	24.5	19.1	14.4	na
Hungary [10]	2005	-	20.8	27.2	23.1	17.8	7.9	3.2
Ireland	2002	9.4	8.0	15.9	14.2	13.2	19.5	19.8
Italy [11]	2001	14.2	9.9	36.8	18.8	12.2	7.9	-
Latvia	2008	13.8	13.1	22.1	19.4	20.2	7.0	4.4
Lithuania	2002	6.2	23.3	33.1	17.6	13.5	6.3	-
Luxembourg [3]	2008	21.8	25.6	29.2	11.6	5.1	4.5	2.2
Malta [12]	2005	12.2	10.0	22.1	16.2	19.1	17.0	3.4
Netherlands [13]	2009	6.9	13.9	27.0	17.0	15.4	12.0	7.9
Poland [14]	2002	10.1	13.1	26.9	18.3	18.7	12.9	-
Portugal [3]	2008	7.4	10.0	21.9	16.1	18.8	17.7	8.1
Romania [15]	2002	3.9	11.5	37.3	23.8	14.8	7.3	1.4
Slovak Republic [1 5]	2001	3.4	6.6	35.1	25.6	21.0	6.2	0.6
Slovenia [16]	2004	15.1	7.8	27.7	23.2	16.0	6.9	3.4
Spain [17]	2001	8.9	4.2	33.5	24.1	13.6	15.7	-
Sweden	2008	12.1	14.7	37.0	16.8	9.4	5.5	4.6
United Kingdom [18]	2004/5	17.0	17.0	21.0	21.8	20.0	na	na

Dwellings classified by the period in which the construction of the building containing them was completed.

1 (Permanently) occupied dwellings
2 1919-1944, 1945-1970, 1991-2000
3 Estimate
4 From 1981 and onwards
5 Difference of percentage totals 100% due to unknown age of stock
6 < 1945 covers convential dwellings
7 < 1919, 1920-1945, 1945-1969, 1970-1979, 1980-1990, 1991-2000 > 2000
8 <1915, 1915-1948, 1949-1967, 1968-1981, 1982-1989, 1990-1998, >1999
9 <1919, 1919-1948, 1949-1978, 1979-1986, 1987-1990, 1991-2000, >2000
10 <1944, 1945-1969, 1970-1979, 1980-1989, 1990-1999, >2000
11 <1919, 1919-45, 1946-71, 1972-81, 1982-91, >1991
12 <1920, 1921-1950, 1951-1976, 1977-1985, 1986-1990, >1990
13 <1906, 1906-1944, 1945-1970, 1971-1980, 1981-1990, 1991-2000, >2000
14 <1918, 1918-1944, 1945-1970, 1971-1978, 1979-1988, >1988
15 <1910, 1910-1944, 1945-1970,1971-1980, 1981-1989, 1990-1999, >1999
16 Data include holiday dwellings
17 Main residences only: <1920, 1921-1940, 1941-1970, 1971-1980, 1981-1990, 1991-2001
18 <1919, 1919-1944, 1945-1964, 1965-1984, >1984

Source: National statistical institutes
CZ Population and Housing Census 2001
DK Housing Census 2009
FR Enquête logement 2006
GR Housing Census 2001
MT Census of Population and Housing 2005
ES Censo de poblacion y viviendas 2001

Figure 15 Age structure of residential floor space (Haffner, 2010)

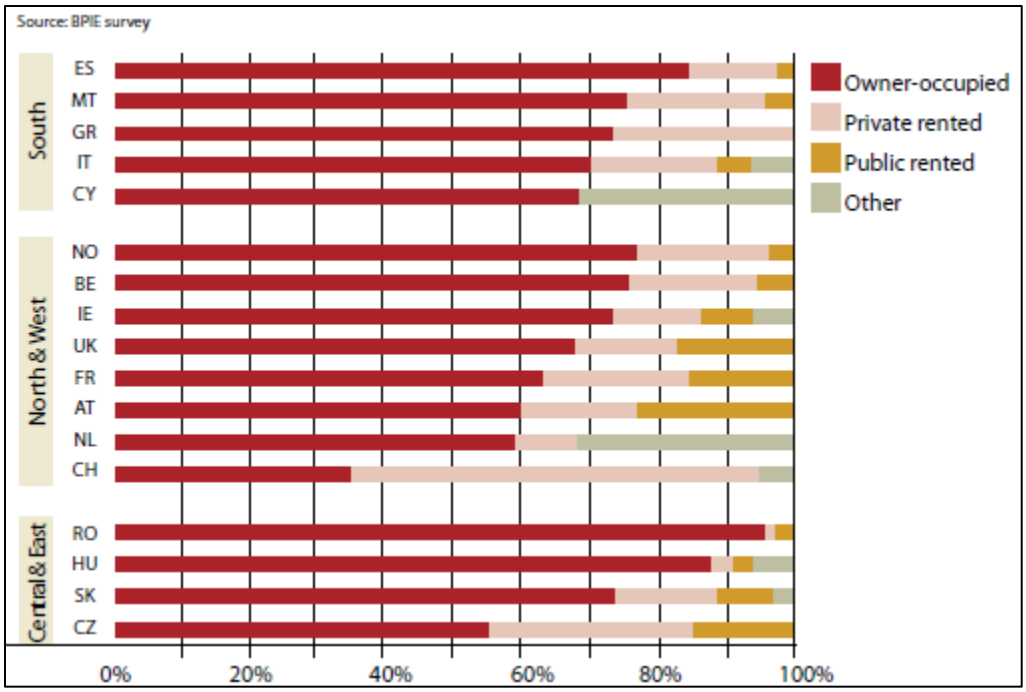


Figure 16: Tenure of residential buildings by number of dwellings in Europe (except for France which is in m^2) (Re-printed from Economidou, 2011)

But renter-owner situation can impact green building investment in both directions. On one hand, public rented housing, including social housing, offers an opportunity for public investment in green building, which not only improves energy performance but also propagates the potentials of green building and provides economies of scale to support skill-development and green building manufacturing activities inside regions.

On the other hand, countries with relatively high shares of private rentals face problems when deciding on who provides the capital investment for making energy upgrades. This is referred to as principle-agent problems such as the renter's dilemma, or split-incentives. Here, at least two situations cause an under investment in energy efficiency upgrades and/or an over consumption of energy. First, when the principal – the building owner – pays for heating or cooling and the agent – the tenant – pays a fixed rate for energy. And second, when tenants pay for heating or cooling and cannot influence the energy efficiency investment made by the owner. In both cases, neither the owners nor the tenants are motivated to make an investment in an energy improvement to the building.

The impact of these problems has been extensively investigated within the field of behavioral economics. In their recent article titled *Split Incentives in Residential Energy Consumption,* Gillingham et al. (2012) found evidence that tenants who pay for heating are 16% more likely to turn down their heat at night, and owner-occupied dwellings are 20% more likely to have their roof insulated and 13% more likely to have improved wall insulation. Their report also reflected on a 2010 article suggesting that apartments in New York where tenants do not directly pay for energy "expend at least 30% more electricity year-round than their counterparts.

As a result of the ownership and tenure we see a clear territorial implication, where regions that have a relative abundance of renter occupied housing should seek out appropriate energy efficiency standards or regulations to govern these split incentives. Thus a clear driver of improved energy efficiency will be the development of smart grids in builds that allow for the monitor and payment of energy at the dwelling level, rather than equal rates for all tenants in a building.

3.3.2. Performance indicators for resource efficiency in the building sector

In addition to the policy-related discussion above, and given the high correlation between total residential energy consumption and population density, coupled with the lack of correlation between regional population density and per capita energy consumption, a simple but effective indicator of regional performance has been developed. Map 6 shows national data on per capita energy consumption, which has been corrected for temperature variation and regionalized based on NUTS 2

regional population density. By default, this implies that national capitals (densely populated regions) perform worse than their peripheral neighbors, simply because they have more people consuming energy in a greater number of buildings. Yet national trends are still apparent - for instance, countries with high overall consumption (i.e. Luxembourg, Germany, the Baltic States, etc.) are emphasized, but we also identify good performers. For example, Belgium and The Netherlands perform much better than their neighbors Luxembourg, The U.K., Germany and France.

In addition to demand-side issues, another reality of green building is that the ability for the EU to reach its short- and long-term climate and energy goals will rely at least as much on reducing the emissions intensity of energy supply. In particular, the extent that residential heat and electricity supply is decarbonized matters as much, or more, than the energy performance of buildings themselves. Complementing the findings in terms of energy performance, the emissions perspective is acknowledged nationally in Figure 17 and regionally in Map 7.

Figure 17 shows the incredible dispersion of emissions between countries, which is based very much on fuel type. We see Norway with the lowest emissions, but the third highest per capita energy consumption. Similar divergences are notable for Sweden, Finland and France. However, assessing emissions vis-à-vis energy consumption identifies that the countries performing worst are clearly those with high emissions alongside high consumption. As such, Poland sticks out as having the 4th highest emissions alongside above average per capita consumption. A similar situation reflects performance in The Czech Republic and Latvia; and in Germany we see that the 5th highest energy consumption nationally is a driver of above average emissions. However, Luxembourg sticks out again as exemplifying a region at the upper end of both energy consumption and emissions. Similarly, Ireland produces by far the most emissions per floor space and their population consumes well above the average in terms of per capita energy.

In a territorial perspective, national emissions levels from Figure 17 have been regionalized in Map 7 through grid-level data provided by the European Pollutant Release and Transfer Resister (E-PRTR). The fact that E-PRTR disaggregates national data using a basic population density surrogate, adds validity to our chosen method of disaggregating national energy consumption data, which is shown in Map 6. As such, it also serves to bring together the energy supply and population density dimensions as an indicator of green building performance.

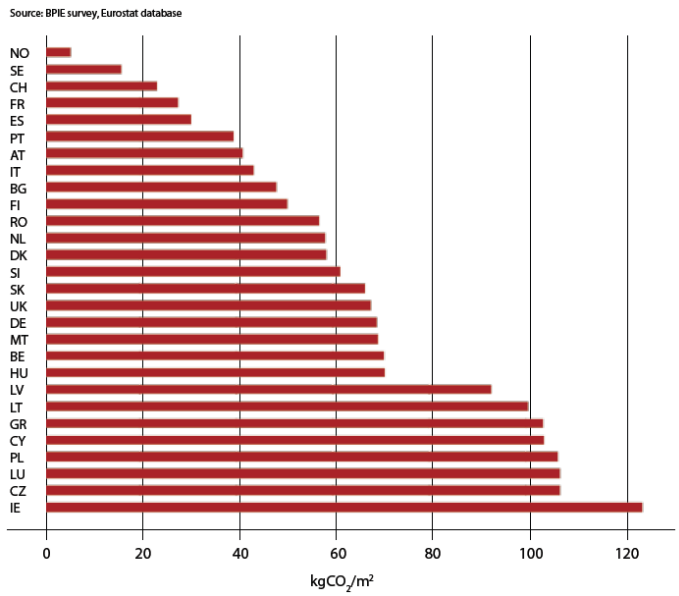
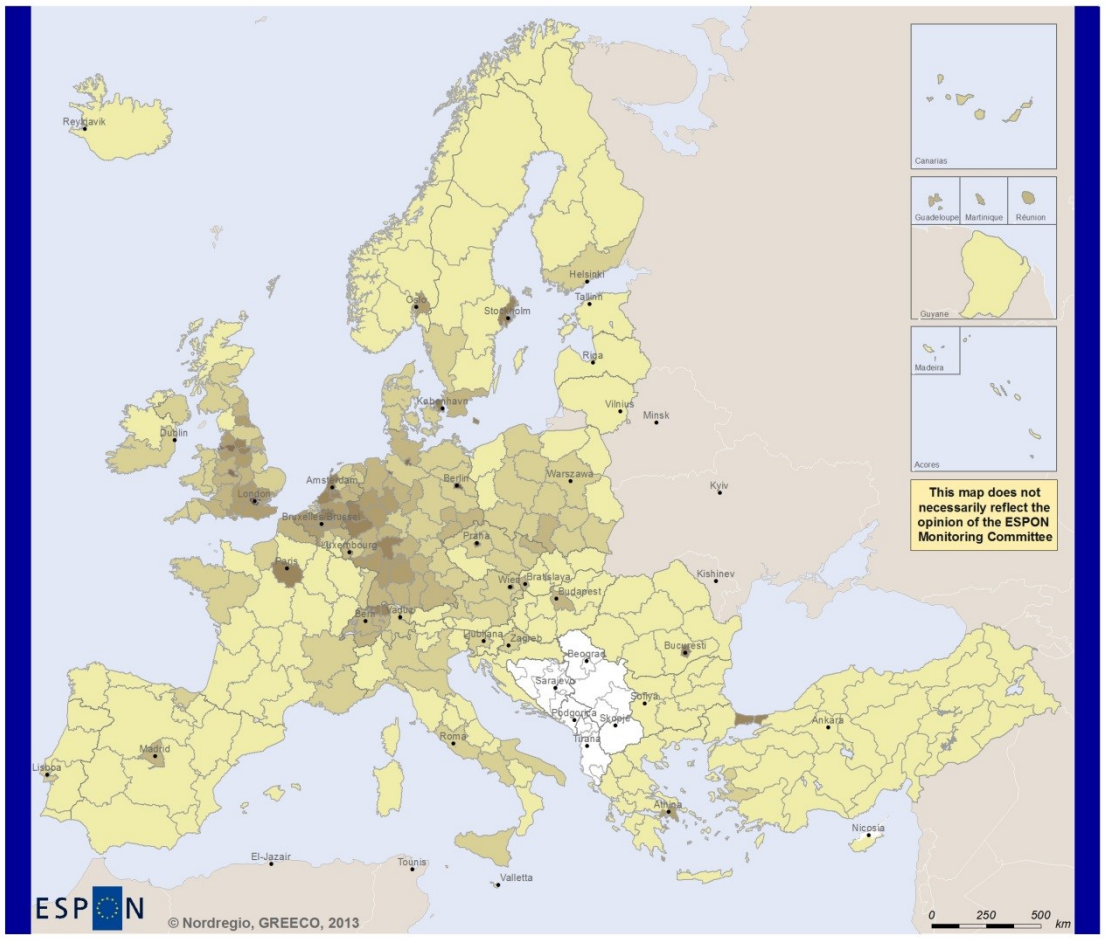


Figure 17 CO2 emissions per useful floor area (re-printed from Economidou, 2011)

2009 Energy Consumption from Residential Buildings



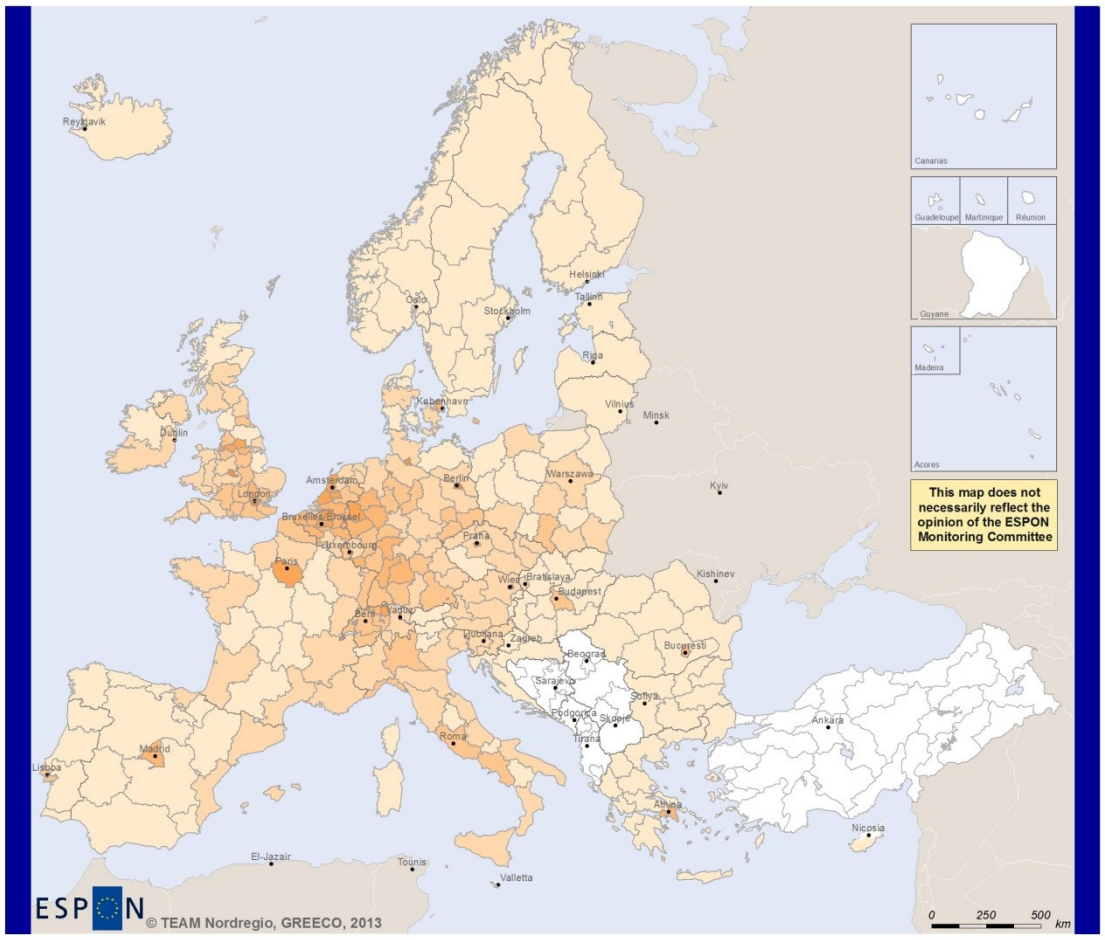
Total residential energy consumption NUTS 2 regions (corrected for heating degree days) kWh/year/km2

- 16 930 - 634 700
- 634 800 - 1 512 000
- 1 513 000 - 2 663 000
- 2 664 000 - 4 592 000
- 4 593 000 - 9 699 000
- 9 700 000 - 23 840 000
- 23 850 000 - 39 730 000
- 39 740 000 - 80 100 000
- No Data

Regional values are based on NUTS0 data from Eurostat on Final Residential Energy Consumption. The Raw totals are corrected for temperature variation using national averages of absolute heating degree days. The results are then regionalised using the share of national population in each NUTS 2 region and shown on the map in terms of energy consumption per square kilometer. The results are therefore mainly indicative of population density (the most important driver of energy consumption in the residential sector), but they are also conditioned by underlying national variations in energy consumption for the sector.

Map 6 Performance Indicator #1 - total energy consumption in residential buildings corrected to temperature variations

CO2 Emissions from Residential Combustion for Heat - 2008



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Regional level: NUTS 2
Source: EEA, 2010
Origin of data: EEA/UNFCC/CRLTAP, 2010
© EuroGeographics Association for administrative boundaries

Estimated Total Residential Emissions CO2 in [kt/year] / Area (km2)

- 0,00 - 0,15
- 0,16 - 0,35
- 0,36 - 0,67
- 0,68 - 1,18
- 1,19 - 2,55
- 2,56 - 4,78
- 4,79 - 11,35
- 11,36 - 16,75
- No Data

Regional values are based on aggregated data derived through the European Pollutant Release and Transfer Register (EPRTR). The input data used for the spatial distribution of residential combustion was provided via National emissions of CO2 (available from the EEA website for 2008) (EEA/UNFCCC v.11, 2010) and National Emissions reported to the "Convention on Long-Range Transboundary Air Pollution) (EEA/CLRTAP v.10, 2010)

This data was gridded to a 5km2 x 5km2 grid using the population density indicator, due to a lack of other surrogates (i.e. building density) (See methodology in Theloke et al.,2009, pp.51 - Methodology development for the spatial distribution of diffuse emissions in Europe).

Map 7 Performance Indicator #2 - emissions from heat generation in the residential buildings

4. Drivers and enablers of green building and construction

Within the scope of this project it is not possible to provide a concise, comprehensive and/or comparative indication for what potential regions have for greening their economy through a greening of the building sector. There are two reasons for this. First, as shown throughout the entire previous section, there is insufficient regional data in Europe relating to issues of energy consumption, particularly in the building sector. While this data is available in some countries from national statistics institutions, it is far from a complete dataset. As such, it comes as no surprise that there is still no comprehensive understanding of regional variations in energy performance of the building sector in Europe.

The oft cited report by the BPIE (Economidou, 2011) represents the most complete analysis completed to date, and even in this case research was a) based on survey data, b) only provided at the national level, and c) not provided with full European coverage. This reflects an increasingly apparent understanding, that the availability of European data for providing relevant analysis to inform decisions on policy *implementation* is not sufficient relative to the direction of recent policy *formation* – in this case the EU2020S and its energy and climate objectives. Naturally, this means that a starting point for the green economy must be the mandate to set better set better goals. But this can only start with measuring the RIGHT things – particularly energy consumption patterns at scales that can reflect territorial trends in population densities and building age. The key is to produce data that is clear and that does not hide places with poor performance and high potential.

Second, a comprehensive understanding of potential considers that there are so many other, grander, factors outside the control of the building sector itself that will influence the developable potential for greening the sector. At the same time, the discussion of the complexity regarding the array of factors (and the relationships between them) actually becomes a way to introduce what we are able to say about ***drivers and enablers*** of the future potential of green building.

We will begin with asserting that future potential of the sector is based on some overarching drivers and enablers, which govern green building from a global or at the very least a pan-European perspective. This precedes a more detailed analysis of the following drivers and enablers:

1. Those linked to policies motivating *demand for green building products and services*. This includes an overview of how green building is acknowledged by European policy frameworks (Strategies, Frameworks, Directives, Roadmaps, etc.) as well as governance-based engagement arenas (networks, information portals, agencies, etc.).
2. Those which will influence the *supply of green building products and services.* This includes many of the aspects covered in Section 2 on the concept of green building.
3. Those which are most *territorially explicit*. Some of these will be based on the findings in the previous section on the current performance the building sector, while others will consider additional factors mentioned within the conceptual perspectives of green building and construction.

4.1. Increasing demand for green building products and services

The most important factor determining the extent buildings will become greener is, and will continue to be, the market. In other words, a building owner will almost always base an investment decision on a cost/benefit analysis (where an additional investment of X dollars is recouped by a savings based on a mix between reduced energy service costs (the energy payback period), increased comfort and a higher property value. In the perspective of directly influencing the investors' decision within the cost/benefit perspective, we can say that three of the most important drivers and enabling conditions will be: **the cost of energy**, the general development of **Europe's energy sector**, and a third group of factors which we can collectively call **policy conditions**.

Higher **Energy Prices** will present a host of opportunities and challenges for Europe. As reflected in the ReRisk project, while more people will be prone to situations of energy poverty (have troubles to fund their energy needs), a higher energy price reduces the cost of green building investments by increasing the cost of either doing nothing (in terms of retrofitting) or building cheaper/browner (in terms of new buildings). It therefore increases the benefits of low-carbon energy solutions on both the supply and demand side. However, energy prices are driven by a highly complex, mutually enforcing and therefore unpredictable set of factors within political, geo-technical, environmental and not least, market-based private sector domains. But in general, we can say that as supplies of accessible fossil fuels decrease, the cost of energy will go up.

Linked to the energy market, we can triangulate cause and effect between: key decisions influencing development of **Europe's energy sector** as a whole, potential energy savings available in the building sector, and the EU's 2020 and 2050 goals for emissions reduction. At the intersection of these factors, we can first and foremost envision institutional innovations towards a more **liberalized and common energy market**. But this can only be facilitated in part through a massive investment in technical innovation to Europe's electricity and gas transmission grid and the associated infrastructure. The goals of such an investment are expressed throughout the key documents of Europe's energy policy, including its Energy Roadmap 2050[10], Roadmap for moving to a competitive low carbon economy[11] and regulation on the guidelines for trans-European energy infrastructure[12].

It is suggested that approximately EUR 120 billion in EU funding will be required for high voltage electricity transmission systems up to 2020, and in total, between 1.5 and 2.2 trillion Euros between 2011 and 2050 will be needed to transition Europe's energy system to support a decarbonized supply. This especially includes the proliferation of smart grids – from a one-way flow between centralized production and decentralized consumption – toward a two-way network that prioritizes energy savings and decentralized energy production from renewables. Keys of a smart grid include increased measurement of consumption for all end uses (residential, commercial and industrial), the connection of decentralized energy sources to the common grid (i.e. wind and solar photovoltaic), new methods of power storage and replacing existing transmission lines with new cable that reduces energy loss.

The point of this joined-up perspective is that if a European energy market becomes a reality, the traditional barriers of space, time and isolated energy markets are eliminated. Consequently, even nations and regions with an ample supply of clean, cheap energy will then have an incentive to invest in demand-side initiatives (such as the greening of buildings) because saved energy can be sold, on a European market, to regions that are not able to produce as much energy. Therefore, in addition to being a driver for increasing the overall potential for green building in Europe, it also highlights the clear link between development of the energy sector and its impact on a greening of the building sector.

Collectively speaking, **policy conditions** can influence the costs and benefits of green building in a myriad of ways, but it is neither the scope nor the objective of this report to account for all of these ways. In fact, asserting that we could cover this field comprehensively would reflect that we are not in touch with the true nature of policy making – its dynamism and its need for almost constant interaction and negotiation between scales of government, as well as state, non-state and semi-state actors.

With that being said, one of the core foci of this paper is to highlight how green building can be driven by policy, and how the analyzing and discussing the territorial dimension of green building can inform policy-making with relevant information. As such, this third perspective of policy as a driver and enabler receives extra attention by providing an overview of the way in which green building is acknowledged by European policy.

4.1.1. Overview of European policy influencing the proliferation of green building

In reference to the cost-benefit perspective of determining investment in green building, policy development can have four key impacts:

1. EU legislation and policy: Thematic strategies, Roadmaps and other "headline policies" create the framework conditions that dictate the implementation policy packages under them. Also, legislation, via directives or regulations, does not reduce costs per se, but they change the rules of the game; by informing countries of the types of rules and operating conditions they shall implement, thereby dictating what decisions are available to building investors.
2. Economic instruments, such as tax incentives, subsidies or grants directly reduce the costs of investment.

[10] COM(2011) 885/2 final

[11] COM(2011) 1123final

[12] COM(2011) 658 final

3. Non-economic instruments develop the governance aspects of green building by providing the right information to stakeholders. This could be other policy-makers, private sector actors or the building investors themselves. It is crucial because it can influence the cost-benefit in a number of ways. For instance, it can provide information to regional and local actors who can develop the necessary inputs to produce a viable supply of green building labour, products and services in order to either make green building available or to reduce transaction costs. It also provides investors with information and awareness on the key issues so that they can make an *informed* decision when doing a cost benefit analysis.

Table 4 EU legislation and policy

Type of policy	Short description
EU Roadmaps	***Europe 2020*** Released March 3, 2010, Europe 2020 (EC, 2010a) is the official growth strategy of the EU for the current decade. It acts as a bridging policy concept at the interface of the economy (problematized by the current crisis), the environment (problematized by climate change, energy scarcity and ecosystem degradation) and society (problematized by the need for cohesion). It calls for "smart, sustainable (green) and inclusive growth" to simultaneously propel a long-term and sustainable vision of development for the EU. While anchored in each of these priorities, policy at the interface of green building and construction and the green economy is predominantly taken up by the discourse on sustainable growth; or promoting a more resource efficient, green and more competitive economy. Europe 2020 includes five headline targets that illustrate the investment oriented goals of the Commission. Two of them have a clear relationship to buildings and construction: 1. 3% of EU's GDP in R&D: Focused on core areas of climate change, energy, resource efficiency, health and demographic change; 2. The 20/20/20 target: particularly through investment in renewables and modernizing the transport, energy and building sectors. ***A Resource Efficient Europe & A Roadmap for moving to a low carbon economy in 2050*** As a result of Europe 2020 Flagship Initiatives a series of seven Flagship Initiatives were also prepared, one of which being "Resource Efficient Europe" – to help decouple growth from the use of resources, support the shift to a low carbon economy, promote renewables, modernize transport and increase energy efficiency (EC, 2010a). The Commission in turn released the communications: A Resource Efficient Europe – Flagship Initiative under the Europe 2020 Strategy, in January 2011 and A Roadmap for moving to a competitive low carbon economy in 2050 in March 2011. A key component of the 2050 Roadmap is its sectoral perspective stating that the residential and tertiary sector will have to contribute with an 88-91% reduction in GHG emissions in order to achieve the EU's goal of a 79-82% reduction overall. This relative importance not only clearly implicates the building sector, but also reinforces the importance of building refurbishment in addition to new construction.
Thematic strategies	***Energy 2020*** As a direct result of Europe 2020 (and its heightened focus on resource efficiency) there has been an extensive overhaul of EU energy policy to facilitate the 20/20/20 emissions target. Energy 2020 (EC, 2010b) was released as the Union's strategy for improving the low carbon energy performance in the EU until 2020. As a point of departure Energy 2020 it lists five priorities, with Priority 1 including Action 1 – Tapping into the biggest energy savings potential – buildings and transport. Energy 2020 also acknowledges the previous discussions on the importance of considering tradeoffs between embodied and operational resources. It mentions, "materials to improve insulation can significantly reduce the amount of energy required to heat a building, but could be more energy-intensive to produce" (EC, 2011c, pp. 5). While validating the importance of a life-cycle approach, the report quite clearly alludes that the crucial link between building and construction, sustainable energy development and the green economy. ***Energy Efficiency Plan 2011 (EEP)*** The EEP notes that the single greatest energy saving potential lies in buildings; and that overall, energy efficiency can be "Europe's biggest energy resource". But it also goes

	into depth on the role of public authorities to invest in constructing greener buildings as well as greening existing building stocks as a means of achieving energy savings *and* spreading innovative solutions (see discussion on Directive 2010/31/EU below). Along these lines, the 2011 Energy Efficiency Plan notes that electricity and heat performance of existing public buildings must be improved through at least a doubling of current renovation rates. They also mention the need for local and regional governments to develop market-based and other types of policy mechanisms to enhance energy efficiency. For example, one paragraph in Energy 2020 reads, "The public sector needs to lead by example. Ambitious objectives ought to be set for public sector consumption. Public procurement should support energy efficient outcomes. Innovative integrated energy solutions at local level contributing towards transition to so-called 'smart cities' should be supported. Municipalities represent a major actor of the required change, thus their initiatives like the Covenant of Mayors should be further strengthened. Cities and urban areas, which consume up to 80% of the energy, are at the same time part of the problem and part of the solution to greater energy efficiency." (pp. 7) The EC also targets the role of Member States to utilize available EU Regional Policy funds to improve the efficiency of public buildings. For instance, the EEP notes that electricity and heat performance of existing public buildings must be improved through at least a doubling of current renovation rates. At the same time, the EEP recognizes aforementioned constraints including "split incentives" (also known as the renter's dilemma) and the lack of training for energy efficient building solutions in many regions of Europe. In terms of the former, the Commission says they will bring forward legislative provisions requiring Member States to introduce measures – in line with property law – to address the problem, but these have so far not been developed. For the latter, the BUILD UP Portal and BUILD UP Skills (Sustainble Building Workforce Initiative) support Member States and regions in accessing the collective knowledge of the EU in terms of green building and how to transition their existing construction workforces. ***Energy Roadmap 2050*** Energy Roadmap 2050 (EC, 2011d) was released in December 2012 as a scenario analysis of policies packages that extend the horizon of the EC's energy strategy to 2050. First and foremost, it reiterates the commitment of the EU to extend the 20% emissions reduction by 2020 to 80% by 2050. It states that transforming the energy system must still primarily rely on energy savings and efficiency, but it also calls for immediate action because energy infrastructure and buildings that people will be using in 2050 are now being built, which means that patterns of energy production and use are being set today. Accordingly, it says that nearly zero-energy buildings will be the norm in 2050 and that a key driver will be the much greater access to capital for consumers and new, innovative business models that will help transition investment behaviors. But again, it reiterates that the role of **local organizations and cities** will be much greater in the energy systems of the future.
Other important communications	
Green papers (only important ones)	
White papers	
EU Directives	***Directive 2010/31*** [13] The most relevant Directive for improving the operational efficiency of resources (energy) of buildings is Directive 2010/31. It aims to deliver concrete guidelines on how energy savings in buildings can contribute - as the sector with the greatest energy savings potential - to the 20/20/20 target of the EU. As adapted directly from the points of interest in the document (EP and the Council of the European Union, 2010, p. 1-5), the most relevant aspects in relation to green building and its territorial dimensions that must be transposed into national law are summarized as follows: • Member States set their own minimum requirements for energy performance. These

[13] A more detailed analysis of Directive 2010/31/EU on the energy performance of buildings is provided in Section 8.2.

	should be set with a view to achieving the cost-optimal balance between the investments and the energy costs saved throughout the lifecycle of the building, but **without prejudice** to the right of Member States to set minimum requirements beyond those that are considered cost-optimal energy in the larger context of the EU. • Member States should use harmonised instruments, for testing and calculation methods and energy efficiency in relation to the Directives 2009/125/EC (on ecodesign labelling) and Directive 2010/30/EU (energy labelling) and their associated regulations mentioned below. • Given the long renovation cycle for existing buildings, new, and existing buildings that are subject to major renovation, should therefore meet minimum energy performance requirements adapted to the local climate. As the application of alternative energy supply systems is not generally explored to its full potential, alternative energy supply systems should be considered for new buildings. • Measures to increase the number of buildings which not only fulfil current minimum energy performance requirements, but are also more energy efficient, are encouraged. Member States should draw up national plans for increasing the number of nearly zero-energy buildings and regularly report such plans to the Commission. • Member States should draw up lists of existing and proposed measures, including those of a financial nature, other than those required by this Directive, which promote the objectives of this Directive. For instance, measures aiming to reduce legal and market barriers, encourage investments and other activities to increase the energy efficiency of new and existing buildings. Such measures could include free or subsidised technical assistance and advice, direct subsidies, subsidised loan schemes or low interest loans, grant schemes and loan guarantee schemes. • The prospective buyers and tenants should be given correct information about the energy performance of the building and practical advice on improving such performance in a buildings' energy performance certificate. • Public authorities should lead by example and endeavour to implement the recommendations included in energy performance certificates. Member States should include measures supporting public authorities to become early adopters of energy efficiency improvements within their national plans. As such, buildings either occupied by public authorities or frequently visited by the public should set an example by showing that environmental and energy considerations are being taken into account. Information on energy performance should be enhanced by clearly displaying energy performance certificates and other relevant information to the public (for instance, shopping centres, supermarkets, restaurants, theatres, banks, hotels, airports, etc.). • Increased focus must be placed on optimizing thermal performance in warmer climates to reduce the energy demands of air conditioning. Measures include shading and passive cooling techniques that improve indoor climatic conditions and the microclimate surrounding buildings. • In each Member State there should be a common (an independent control mechanism) approach to certification of buildings as well as regular maintenance and inspection of heating and air- conditioning systems to ensure optimal performance. • Local and regional authorities are critical for the successful implementation of green building and should be consulted and involved in the development of programmes to provide information, training and awareness-raising, and, in general, the implementation of this Directive at national or regional level. Such consultations also promote the adequate guidance to local planners and building inspectors to carry out the necessary tasks. • Member States should enable and encourage architects and planners to properly consider the optimal combination of improvements in energy efficiency, use of energy from renewable sources and use of district heating and cooling when planning, designing, building and renovating industrial or residential areas. • Member States, through the activities under the Intelligent Energy Europe Programme, shall continue to ensure that builders and installers are being equipped with the necessary skills to integrate energy efficient and renewable energy technologies in buildings.
EU regulations	Under the aforementioned Directive 2010/31 a number of regulations either directly or

	indirectly pertain to the building and construction sector: ***No 244/2012*** provides a comparative methodology for calculating (and reporting) cost-optimal levels of minimum energy performance requirements for buildings and building elements. Member States should use this framework to compare the results with the minimum energy performance requirements which they have adopted. ***No 1059/2010*** *on energy labelling of household dishwashers* ***No 1061/2010*** *on energy labelling of household washing machines* ***No 1062/2010*** *on energy labelling of televisions* ***No 1060/2010*** *on energy labelling of household refrigerating appliances* ***No 626/2011*** *on energy labelling of air conditioners* ***No 392/2012*** *on energy labelling of household tumble driers* ***No 106/2008*** *on a Community energy-efficiency labelling programme for office equipment (Energy Star)* ***No 327/2011*** *on ecodesign requirements for fans driven by motors with an electric input power between 125W and 500 kW* ***No 206/2012*** *on ecodesign requirements for air conditioners and comfort fans* ***No 1015/2010*** *on ecodesign requirements for household* *shwashers* ***No 643/2009*** *on ecodesign requiremewashing machines* ***No 1016/2010*** *on ecodesign requirements for household dints for household refrigerating appliances* ***No 642/2009*** *on ecodesign requirements for televisions* ***No 347/2010*** *on ecodesign requirements for fluorescent lamps without integrated ballast, for high intensity discharge lamps, and for ballasts and luminaires able to operate such lamps* ***No 859/2009*** *on ecodesign requirements on ultraviolet radiation of non-directional household lamps* ***No 244/2009*** *on ecodesign requirements for non-directional household lamps* ***No 1275/2008*** *on ecodesign requirements for standby and off mode electric power consumption of electrical and electronic household and office equipment*
Voluntary instruments with EU coverage	

The above thematic strategies and roadmaps show a number of recurring (but underlying) perspectives. These link the previous discussion on the concept of green building with its role for helping the EU achieve its overarching energy and resource efficiency goals. For instance,

- That improving the energy performance of buildings is viewed as an “act now” approach to energy efficiency and emissions reductions. Buildings technologies are already available to the market while solutions for other sectors are either still in the development phase (i.e. electrification of transport, CCS, etc.) or require a threshold of investment that goes beyond the current scope of European and global agreements mitigating climate change (i.e. a pan-European conversion to smart grid infrastructure)
- That due to the decentralized scale of energy consumption in buildings, local governments play a vital role in developing the energy systems of the future. **This is especially crucial in relation to leading by example through green public procurement and the retrofitting of public buildings.**
- That the renovation of existing buildings (both public and private) is just as important (if not more) than the construction of new green buildings.
- That the energy consumption behaviors of citizens, businesses and governments, as both building users and building investors are crucial for growing the scale of investment in energy efficiency.

In terms of financial instruments, the reality of the building and construction sector is that a majority of the financial incentives are rooted in national incentive schemes – mainly in the form of subsidies, grants, tax credits and local building regulations. With that being said, there

are a number of EU programs that particularly target non-residential or public buildings as a means of initiating regional best practices in the building and construction sector.

In terms of regional policy, the revamping of EU energy policy following the release of Europe 2020 created a number of headlines on what the EU must do in order to achieve its climate and energy goals. But as stated by Waciega (2011), out of all of these documents there was one 'headline grabber': that EU total investment (public and private) in the electricity and gas sector between 2010 and 2020 can be estimated at EUR 1 trillion. With this in mind, it is clear that the goals of Europe 2020 will not be achievable by financial support formulated at the EU or national level alone. In contrast, private investment will play the leading role, but private investment needs to be facilitated through the right mix of national, regional and local public investment. This includes direct financial support and market-based incentives.

However, with the exception of a limited number of programmes the current EU financial schemes for the energy sector provide little in the way of direct financial support. It turns out that the main instrument for developing energy improvement initiatives (including those in buildings) is via regional policy; namely the European Regional Development Fund (ERDF) and The Cohesion Fund (*The Funds*) (Waciega, 2011).

These Funds are structured to enable local and regional participation in a proactive, place-based policy approach that takes advantage of situated conditions providing growth opportunities. Available funding is allocated in a number of different directions. For example, direct grants or low interest loans/interest rate subsidies are used to facilitate individual projects while other types of investment include: physical investment in energy efficiency in public buildings and housing, district heating infrastructure, education and training in the building sector, innovation well as support for SME's and building sector start-ups.

Determining exactly how much money the EU has earmarked towards low carbon investment in these funds depends on who you ask or what source to check. Generally, speaking aapproximately €104 billion of the €344 billion budget for 2007-2013 is directed towards environmentally-related projects - €44 billion for direct environmental investments and €60 billion for indirect environmental improvements (EC, 2011c). Direct environmental investments are mostly for interventions that are legally required for regional compliance to EU environmental legislation. Indirect investments predominantly relate to transport, sustainable energy and urban rehabilitation (EC 2010c). For direct environmental investment, EUR 4.468 bn (1.3% of The Fund's total) is available for "energy efficiency, co-generation and energy management" (Berkowitz, 2012). Beyond this, it is beyond the scope of this research to determine exactly how much of this has been directed specifically toward green buildings.

Two of the many examples of the use of such funds to green the building sector have taken place in Estonia and in France. In Estonia the KredEx loan has been established to promote the thermal insulation of existing buildings, including new windows and facades, new and renovated heating systems, ventilation systems and installation of renewable energy devices in buildings. Compared with commercial loan rates of 7% to 10%, KredEx offers loans at a favourable rate of 4.3-4.8%. (Burkowitz, 2012)

In France, it has been a political decision to concentrate additional funds toward social housing. They have taken advantage of the ability to re-allocate up to 4% of their ERDF toward the renovation of social housing. EUR 320 mn of funding has triggered total (public and private) investment of up to EUR 2.2 bn in 110 400 dwellings. This has created 31 000 jobs and decreased the average heating cost of renovated dwellings by 40% (EUR 30-90/month/dwelling). This not only increases annual purchasing power by EUR 360-1000 per household but it also shows how investment in buildings is not a cost on national budgets but an investment opportunity that returns money to state coffers. (Donnelly, 2012)

Table 5 Financial Instruments supporting green building

Type of instrument	Short description	GREECO implication
Structural and cohesion policy	ERDF	Peter Burkowitz, Head of Unit for Policy Conception at DG-Regional Policy, has stated that the ERDF will increase its focus on energy efficiency, particularly in relation to support of SME's, as well as in public infrastructures and residential buildings (2012). As a clear example of this, it is

expected that the ceiling on aforementioned ability for Member States to shift up 4% of their ERDF funding will be removed in order to enable even greater investment in green building. This quite clearly indicates that investment in green building is viewed as a highly efficient, and even an optimal, means of creating jobs, supporting SME's, and boosting growth while simultaneously creating a built environment that can support Europe's resource efficiency goals.

A precise financial breakdown for the next Multi-Annual Financial Framework (2014-2020) is still unclear. Nevertheless, the thematic objectives are to be geared abound the Europe 2020 headline targets and flagship initiatives. This means that it is almost certain that additional emphasis will be put on merging low carbon goals with policy.

Marie Donnelly, Director of DG-Energy, indicated that proposals include a doubling of Cohesion funding toward energy efficiency and renewables - to EUR 17 bn – while EUR 6.5 bn would be allocated to low carbon energy R&D (2012). This is certainly a step in the right direction as it adds a precedent especially for less developed Member States.

The ELENA (European Local Energy Assistance) facility provides local towns and regions the necessary technical expertise and organisational capacity to implement large energy efficiency and renewable energy projects. The facility was originally funded through the Intelligent Energy Europe Programme - which has thus far supplied EUR 49 mn - but it is run by the EIB. It currently supports 18 projects with 32 million but it expects to mobilize EUR 1.7 bn in investments in the next few years (Alario, 2012).

The European Energy Efficiency Fund (EEE-F) was launched by the EC in July 2011. EUR 146 mn has been invested in a financial facility and the EEE-F will invest in energy savings and efficiency projects, particularly in urban settings, that match the 20/20/20 target by achieving at least 20% energy saving or GHG/CO2 emission reduction. So far the fund has established a volume of EUR 265 mn, of which EUR 75 mn was provided by EIB. The fund offers junior and senior loans, guarantees, and equity support mainly for local and regional authorities to promote investments where at least 70% of the investment is geared towards energy efficiency (Alerio, 2012).

Formed in 2008, JESSICA (Joint European Support for Sustainable Investment in Cities) is a joint initiative between the European Commission and the EIB (in collaboration with the Council of Europe Development Bank). Member States are given support to use some of their Structural funding toward

***Incentives**, like grant programmes*

Initiatives via the European Investment Bank (EIB)

As the EU's long term lending institution in support of European policy, the EIB acts as a main catalyst to enable financing in for resource efficiency in buildings. Total lending in 2011 was EUR 60.9 bn, of which EUR 12.8 bn was directed to energy investments, EUR 5.5 bn to renewable energy and EUR 1.2 bn to different types of investments toward energy efficiency.

Examples of investments in green building made through the EIB are mentioned to the right.

sustainable urban development investments, including redevelopment of brownfield sites, office space for SME's, public buildings and energy efficiency improvements (EIB, 2008).

Feasibility of potential JESSICA-type financial instruments for the 2014-

2020 period:

- Establish evidence-base of market failures/sub-optimal investment situations
- Estimate level / scope of public investment needs
- Recommendations on financial instruments to be used to deploy EU resources 2014-2020

National Aid

As previously shown, the following chart provides an inventory of national policies supporting energy efficiency in buildings for EU Member States.

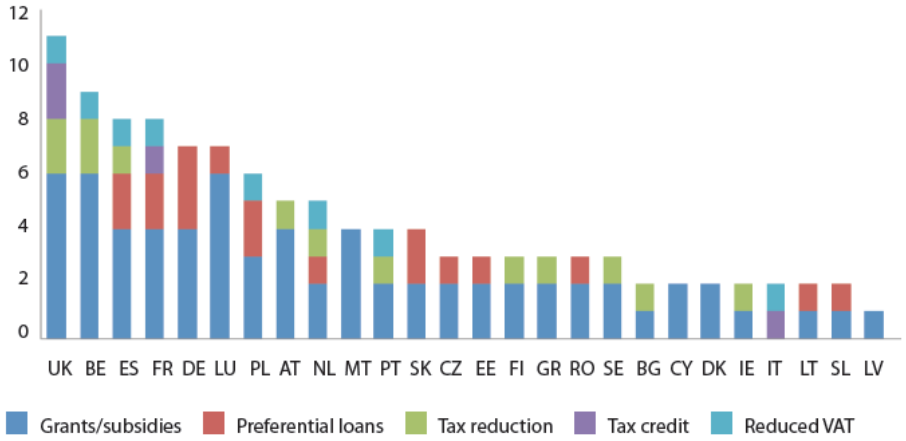


Figure 18 Inventory of national policies supporting energy efficiency in buildings for EU Member States (Maio et al., 2012)

Policy instruments with a direct economic impact are both supplemented and integrated with non-economic instruments designed to improve knowledge development and dissemination across a range of types of actors. Not least these include: public administrations (particularly at the local and regional level), a range of potential investors ranging from banks all the way to individual building owners and tenants, as well as firms that supply labour and technological solutions to the sector.

While trans-national networks may not necessarily provide direct financial support (and some do), they offer much needed central body for distributing information and awareness, providing technical support, creating a platform for forming agglomerations to lobby for funding, and perhaps most importantly, an institutional setting for local and municipal agencies to exchange ideas and communicate knowledge in a network environment.

At the same time, involvement of (mainly) local and stakeholders (including government bodies) in these transnational networks brings to light an incredible territorial dimension in relation to governance. It shows how even though such an important responsibility for the building sector comes via local ideas and decision making – from the bottom-up – there is still an important need for trans-local, trans-national networks to provide tools and understanding from the top top-down. This in turn shows that the issue of governing green building cannot be identified only as a bottom-up or top-down governance process, but one that emphasizes the importance of flows between these territorial scales. Consequently, situations where cities and regions go through processes of institution building from within is important when considering future policy mechanisms to help these sub-national agents overcome political barriers to financial resources.

Many of these networks are maintained through funding from Europe's ***Intelligent Energy Programme*** – a top level European programme initiative used to manage a variety of smaller funding programmes and schemes across many themes related to energy efficiency.

Table 6 Additional (non-economic) instruments – transnational governance networks

Type of instrument	Short description
Networks	***The EU Covenant of Mayors*** The Covenant of Mayors was founded upon the rationale that while 80% of Europeans live in urban areas and 80% of energy consumption takes place in these environments, European funding for energy improvements at the urban (municipal) level is not sufficient for realizing sustainability objectives of the EU. As such, the Covenant is motivated by a number of founding beliefs. For example: • That energy policy must be integrated through all government levels, but motivated local and regional actors are the most important for designing and implementing change in metropolitan areas. • That local authorities are most proximate to the general citizenry. This puts them in an optimal position to understand constituents' concerns, and to foster behavioural changes that in turn promote private investment in energy solutions, including in buildings. • That urban transport and building improvements are best conceived, planned and implemented by regional and local institutions that are responsible for land-use and building planning. • That while structural funds are administered to regional and local initiatives, its distribution is strongly governed by national institutions. Pedro Ballesteros, who came up with the idea to create the Covenant of Mayors, notes that local agencies could efficiently benefit from up to 4% of the funding budget, yet they directly receive only a fraction of this amount. • That networking approaches will hasten the development of clean energy solutions in cities. This takes place through the exchange of information and more intensive lobbying from local governments to receive structural funds directly from the EC; and through helping to engrain an environmental mentality directly within communities. • That cities are increasingly motivating themselves rather than relying on impetus from senior political scales. • That local governments must devise their own policies tailored to local conditions. (Ballesteros, 2009) Once joining the Covenant of Mayors, a central component is that local governments must create an action plan for sustainable energy development. These plans include: a baseline emissions inventory; an action plan that sets out reduction targets, timetables of specific actions; and submission of implementation reports for monitoring progress. The greening of public buildings through retrofit or reconstruction is virtually always a central component of these action plans. ***The Smart Cities & Communities Communication*** Smart Cities & Communities is funded through "Horizon 2020" and during the next multiannual financial framework (MFF) the Commission will substantially increase funding (i.e. from € 81 million in 2012 to € 365 million in 2013). It aspires to connect public authorities of cities directly with eco-innovation industries in the local areas to increase the efficiency of *how a city functions.* This is especially interesting on at least two levels: First, it emphasizes the importance of incubating and continually supporting local firms in an effort to reap the both the sustainability and economic rewards from investment. The is exactly in line with the basis of Smart Specialization – a strategy framework that is now necessary for obtaining financing through any of the EU's structural fund programmes (find out more on the Smart Specialization Platform at: http://s3platform.jrc.ec.europa.eu) This explains how environmental initiatives can not only be used for improving resource performance, but can also be a tool for developing research and innovation industries across a range of fields. Second, the notion of how a city *"functions"* emphasizes the connection

	between resource efficiency and an integrated systems approach to making cities more sustainable. Here, the physical planning of the key elements of a city's built environment – its different types of buildings and the transport connections between those buildings - along with the technology used to monitor and control resource consumption in these elements become focal issues that must be planned together. As such, successfully funded projects will be ones that emphasis the importance -and potential - of integrated technological solutions. "Lighthouse Projects" will offer businesses the opportunity to test their technology on the ground and show that they can be environmentally and economically viable. Starting already in 2012, EU funding will be concentrated on a limited number of demonstration projects with a high impact. These projects will be selected competitively and even though the most important aspects and issues have not been identified formally, it is expected that successful project bids will relate to: • 'smart buildings and neighbourhood projects'. These will integrate increased energy efficiency (in heating and electricity) with renewable energy production, and will market the benefits of nearly zero-energy and positive energy communities. • Urban (multi) mobility, with efforts to not only electrify public transit but also develop a transit fleet that *produces* energy (through braking and accelerating energy) and exchanges it with the energy system. • Smart and sustainable digital infrastructures that promote intelligent (intuitive) heating cooling and lighting solutions. This also includes smart supply and demand service projects that provide end users with information on their energy production/consumption characteristics. Using the "less is more" approach, Smart Cities & Communities will only support projects at a sufficiently large scale Lighthouse Projects to promote market uptake and roll out afterwards. Accordingly, the lighthouse projects will be accompanied by a "Smart Cities & Communities" Stakeholder Platform to ensure that experience and knowledge is shared proactively.
Awareness programmes	Funded through the IEE (200-2013) programme, Build-up is managed by the Executive Agency for Competitiveness and Innovation (EACI) on behalf of the European Commission. The primary element of the Build-up is to support EU Member States in implementing the Energy Performance of Buildings Directive (EPBD). To do so, its web portal is a two-way communication platform for collecting and disseminating Europe's collective intelligence on energy reduction in buildings. Build-up is oriented for a variety of audiences at a range of territorial scales. For example, it aims to involve umbrella organizations such as energy agencies, industrial associations and NGO's in spreading awareness of best practices. It also provides public authorities with access to information and resources (on legislation, toolkits and guidelines) produced by other cities. It also supports the private sector, too. It supports building professionals by providing the latest industry information on legislation, just as it provides an outlet for individual homeowners to gather practical energy-saving advise pertaining to their own country or region.

4.1.2. The essential aspect of national funding and innovative policy schemes

The table above discusses European financial aid promoting green building, but also hints at a previous discussion on national financial aid supporting the sector. As mentioned, the reality of the building and construction sector is that a majority of the financial incentives are rooted in national incentive schemes – mainly in the form of subsidies, grants, tax credits and local building regulations (See Figure 14). It was also said that these policies not only need to be further developed among the member States in Europe, but they have to be more consistent and longer-term (which is in contract to the reality where these policies seeming come and go from year to year and place to place).

In addition to this, much discussion is currently on the role of innovative funding schemes – particularly via the formation of Energy Savings Companies (ESCO or ESCo) for supporting private sector investment in green building. In short, these are innovative funding models (cf. the current

development of the UK Green Deal) where companies can come in and assess the potential for completing a green retrofit then pay for the optimal retrofit at no cost to the owner or tenant. The cost of the retrofit is then provided to the ESCO by the cost saving derived from the energy savings, during the so-called "payback period". Development of the UK Green Deal has not come without its share of headaches, but it is highly unlikely that the EU will achieve any substantial improvement of the existing building stock without the widespread (or unanimous) development of funding mechanisms that transfer the investment cost over to the payback period of the investment. In other words, their importance of development cannot be understated.

4.2. Increasing the supply of green building products and services

Using a life-cycle perspective, Section **¡Error! No se encuentra el origen de la referencia.** introduced that while a majority of resource consumption of a building takes place once construction is complete, an increasingly important share takes place during the pre-construction and construction phases. This share will continue to increase as buildings become greener because even though building operations can essentially become energy self-sufficient the materials required to construct a building will always rely on relatively fixed resource inputs. With that being said, there are a range of products and construction practices that can contribute to more resource efficient buildings. But while these technologies are available in principle, the reality of the fact is that they need to be *implemented* by planners, construction workers and trades people in local areas.

At some point in the coming year it is expected that the European Commission will release Construction 2020: a formal communication for the sustainable competitiveness of the construction sector and its enterprises. As an input to this communication, DG Enterprise and Industry launched a study in 2010 to look into the background, needs and feasibility of developing a new competitive and sustainable agenda for the EU construction sector. The contract to carry out the study was awarded to the Dutch group: ECORYS SCS Group, which recently released its findings. Likewise, the Eco-Innovation Observatory released a thematic report on resource efficient construction in 2011.

These reports reflect the state of the art on the perspectives that should be drawn upon to improve the supply of green building products and services. Most notably – and in a territorial perspective – they include sector developments that consider:

1. reducing the embodied resource intensity of buildings, through changing the very materials that go into the construction process
2. increasing the resource efficiency of the construction process, including the skill sets of construction workers and tradespeople

4.2.1. Reducing the materials and resources consumption in construction processes

Section **¡Error! No se encuentra el origen de la referencia.** mentioned that, per capita, approximately 16 tonnes of material are consumed in Europe each year, with the construction sector consuming the largest share. As such, any ways that can limit this amount will significantly reduce overall material consumption as well as the resources used to refine those materials. In a territorial perspective, three closely related aspects are the most crucial drivers and enablers for reducing this level of resource consumption: *urban mining, brownfield re-development* and *retrofitting versus demolition*. Each perspective needs to be explicitly prioritized by local and regional planning policy that promotes reuse and infilling rather than continued urban sprawl.

Urban mining

Urban mining involves the process of extracting usable materials from obsolete buildings and infrastructure that is set for demolition. It views the existing built environment as providing a number of key resources supporting future (re)development. As such, it necessitates shifting approaches in the building and construction sector. On the supply side, resource-blind demolition needs to move toward selective demolition practices. But to achieve this, policies that support new processes of systematically organizing municipal stocks of materials in the building sector, both in terms of their location and life-cycle are needed (O'Brien et al., 2011). On the demand side, while increased resource scarcity appears to be a driver for urban mining, the volatility of resource prices (which often do not reflect their environmental externalities) has hindered the investment needed to generate economies of scale. Likewise, material recycling simply has not been supported through effective policy that supports more resource efficient construction processes. Both perspectives reiterate the

importance of political will and support for increasing landfill tariffs, especially relating to those specific materials that are shown to have a clear potential for recycling.

The EIO (2011) reports that if developed and implemented properly, existing companies in the waste business could adapt their existing strengths and knowhow to create new business models that focus on mining opportunities. For example, the cement and aggregates industry is known as a main component both of the building sector's material demand and production of emissions. This isn't surprising considering that the average houses demands approximately 400 tonnes of concrete (R. Bleischwitz & Bahn-Walkowiak, 2007). Yet, not only does cement demand produce environmental problems related to its extraction (i.e. land use change for mining and quarrying) its use (the sealing of fertile land) and its disposal (in landfills) but it is also related to environmental pressures including resource depletion and CO2 emissions (O'Brien et al., 2011).

Even though recycled concrete currently has slightly inferior attributes compared to its first generation counterpart, improved attention in the planning process can lead to alternative uses within the construction process. At the inferior scale, recycled concrete and stone can be used as backfill constructions sites, it can fill wire cages to be used for retaining walls, or can at even be used as fill for "mounding" recreation space, for creating water features and for its architectural beauty.

As one such example of this is shown in

Figure 19 - an open space in the eco-district of De Bonne, which is a brownfield, mixed-use development on a former military barracks in Grenoble France. Instead of transporting aggregates from demolished buildings to landfills, a majority was used in situ to create added value, for the project. In this case, it was used as fill material to mound the opens spaces, which saved over dump-truck loads to and from the construction site. As shown in the photos, building materials were also utilized for their natural beauty – to create retaining walls and water features.

There is also a high potential for innovative solutions for recycling aggregates into cement with comparable structural attributes as first generation cement. This places demand for supporting additional research and development of processes for improving the structural qualities of cement that is more efficiently produced or is made from recycled cement (O'Brien et al., 2011).

Reduced land take and Brownfield Development

GREECO's focus on the territorial dimension of *where* buildings are located means that the issues of land use are considered within the variety of resources that are consumed when a building is constructed. But such an importance goes beyond the benefits of preserving land in and of itself (i.e. reducing agricultural loss, landscape fragmentation, loss of open space, etc.). Rather, it includes the important factors that more compact urban development can provide a greener building typology and can reduce dependency on the private car (and the emissions and energy demand that results from it). As such, land use efficiency, especially in existing urban areas that are expected to grow in population, must be a planning priority. Here, we can make two policy based recommendations:

1. That guidelines are needed at the European level to control how Member States and Regions are creating urban areas at the expense of rural land. In particular, there must be additional conditions to the allocation of structural funds that require region's (and the governments within them) make all feasible efforts to ensure that land take is minimized or eliminated.
2. That information on land take (i.e. land use typologies or information on rates of land take in EU regions, derived through CORINE data) can used to assess performance, and to better inform regions that are performing poorly.

Both of these perspectives illustrate a simple point – that we need increased monitoring and accountability of the way in which regions are developing spatially; because its connection to green building and transport reflect the cross-sector, multitude of impacts it will have on sustainability.

But as will be discussed in Section 4.3.3 below (in terms of the fact that local governments have the main competency for land use planning in Europe) the priority to reduce land take and urban sprawl is often undercut in favour of ensuring (at almost all cost) investment within municipalities or regions. The effects of such processes are notable throughout the world, not least in the fact that since the 1950's, the European population has expanded by 33% but cities have expanded by 78% (EEA, 2006). Similarly, we see urban centres such as Newcastle, England where existing built areas of both homes and former industry are completely vacated while new development is taking place on the outskirts of town. Such traditions must be overcome to promote a more territorially-aware perspective; where cooperation of municipalities within regions can generate more effective (efficient) spatial development. This will result in improved resource performance of buildings through higher densities that are more integrated in existing urban areas.

Brownfield development is the redevelopment of previously developed land. It is a particularly relevant urban development concept in cities where shifts in the economy – from industry based production to domination of the tertiary sector – leave spaces of underutilized land. In their current state and context, these areas have often lost their market attractiveness, but with well-planned redevelopment they can become rejuvenated centres for urban development. This is especially the case when redevelopment is coordinated with transit development and maintenance of cultural or heritage features.

Figure 19 Reuse of materials from demolished buildings for both functional and design elements of the recreational space in the De Bonne development (Photo by author)

Countless examples of this are evident in Europe, not least shown in

Figure 19, where the highly successful redevelopment if the De Bonne district in Grenoble France – which includes low energy, passive energy and plus energy buildings – shows the mix between new buildings and the preservation of an existing military barrack.

Retrofitting versus demolition

The focus on retrofitting existing buildings is crucial from multiple perspectives for green building. First, and closely connected to both urban mining and brownfield development, roughly 2/3 of the materials can be saved by retrofitting existing buildings compared to constructing new ones. Second, it implies no net loss of natural land to produce a well-performing building and it improves the quality of the urban built environment in existing areas. Third, and most importantly, viable green building policy must recognize the reality of an average building turnover rates, and that the vast majority of current buildings will exist in 2050. Therefore, all but the newest, most efficient buildings will require at least one renovation if Europe is to achieve its objective of reducing building sector emissions by 80% in 2050.

This is a perspective that has been addressed in a number of ways by European policy. For instance, Section 4.1.1. identified a number of European policies which clearly mention how public administrations need to lead by example, by proactively identifying and retrofitting existing public buildings to improve resource performance. Along these lines, the 2011 Energy Efficiency Plan notes that electricity and heat performance of existing public buildings must be improved through at least a doubling of current renovation rates.

4.2.2. Increasing the resource efficiency of the construction process

Closely related to changing the materials used in the construction process through different forms of recycling, reuse and retrofitting is also the ability for the construction sector to reduce the amount of embodied materials that it takes to construct a building. As such, additional drivers and enablers will be those actions that increase the resource efficiency of the construction process itself. Current research on the subject points to the need for new business practices that streamline construction processes to make them as lean as possible. This is usually referred to as industrialised construction.

There are at least three components of industrialized construction, the first two can be referred to as product industrialization while the latter is process industrialization:

1. Off-site industrialization – refers to prefabrication and modular construction that gets assembled on site. It decreases cost, waste and inefficiencies caused by interaction of trades, while improving working conditions, control and consistency (Bougrain, Forman & Haugbolle, 2010). The only clear disadvantage is the tendency for prefab to be perceived (often rightfully) as boring, tasteless structures. Here, investment support providing increased customization of fabrication process through ICT and robotics ought to be put in focus as a formidable link between R&D, eco-innovation and the building sector.

2. On-site industrialization – refers to the application of advanced tools and technologies on building sites that also make construction leaner and more efficient. Examples include just-in-time deliveries and systematized identification of materials using bar-codes. These practices are seen to reduce waste, both in terms of building materials, but also the array of natural resources that indirectly contribute to the construction process (i.e. fuel, electricity, human resources, etc.)
3. Process industrialization – is concerned with how agents in the construction process are cooperating contractually and informally (Bougrain et al., 2010).

When trying to determine the mechanisms that can support development of the drivers and enablers for improving resource efficiency of the construction process, the relevant question is then, "what holds the sector back from developing these processes and actualizing the potential resource benefits and added value"? The EIO along with other authors (including Van Egmond & Scheublin, 2005; Landin & Kaempe, 2007 and Bougrain, Forman & Haugbolle, 2010) point to a number of parallel aspects:

- Different drivers for innovation, diffusion and application; particularly where the traditional construction process involves a number of different actors often participating at different stages and places in the construction process. This leads to poor cooperation inability to learn from one project to another and therefore lost opportunities for resource efficiency.
- Related, it consists of a number of locally-embedded, small firms that lack economies of scale to innovate towards industrialization. This fragmentation is supported through the process of subcontracting where individual firms have little incentive to invest time in building cooperation.
- Building and construction knowledge is tacit and experiential, which hinders the learning of new processes and leads to reinvention in a circular rather than progressive manner.

These new practices highlight that constructors and tradespeople need to be trained with the proper skills to take part in more efficient construction processes, and to construct and install more efficient technologies. The challenges listed above – most notably the large number of small firms their decentralized organizational structure, and the importance of experience-based knowledge – imply that while drivers and enablers can be conceived at regional, national or European scales, they will inevitably have to be implemented by locally engaging, policy-led initiatives. Yet this can be considered in conjunction with one of the implicit benefits of a vast majority of the aforementioned construction practices and processes that promote increased efficiency: they are generally characterized as incremental adjustments rather than wholesale changes. This means that even though there are underlying obstacles, there is in fact a special possibility for transitioning existing workers toward new practices. One example of this was noted in Grenoble, France where job skills needed for the redevelopment of De Bonne into a new green community were facilitated by the municipality, which organized seminars inform and teach prospective subcontracting companies about the necessary standards and products to be used during construction (Bufierre, 2012). This is a clear example of an innovative and locally driven policy tool for transitioning the existing labour force towards new construction norms.

4.3. Territorially explicit factors and drivers of green building and construction

4.3.1. Managing existing assets

With such clear ambitions to double renovation rates in Europe, the GREECO emphasis on the territorial perspective stresses the importance of **focussing policy and strategy on existing urban areas, and especially those, in the short term, with poor performance in terms of emissions**[14]**.** This is due to the fact that the greatest potentials for greening the building and construction sector will be where a vast majority of buildings are already constructed – in urban areas.

Yet, it is also important to draw on the previous regional analysis on the correlation between higher building densities and consumption of operational energy in buildings. In Section 0, the available data

[14] As mentioned previously, the development of a true (and tradable) European energy market will de facto promote a focus on buildings with poor energy consumption regardless of emissions performance.

rather surprisingly showed basically no correlation (even a slightly negative correlation) between higher building density and better residential energy performance. What's more, in Hungary, Norway, and to a lesser extent, Sweden, there is a rather convincing negative correlation – regions with the highest building density have relatively poor per capita energy consumption in the residential sector. As was mentioned, this likely reflects that key drivers of energy performance in existing buildings goes well beyond issues of building density and includes buildings' age and construction quality. This specifically targets existing large urban areas – areas with high shares of very old building as well as extremely inefficient modern buildings constructed during the post-war period.

At the same time, the EEA's (2010b) analysis on land use shows that the average "urban" European consumes approximately 29% less energy non-urban residents. At first glance, this does not align with the regional sampling of the relationship between density and energy performance. But if the poor performances of existing buildings are acknowledged, the positive relationship between density and resource performance becomes much clearer. In summary, this reflects the combined effects of the following green building drivers:

- The ability to focus on existing buildings in urban areas
- The expected continued growth of urban areas in Europe
- The higher density of buildings and smaller per capita living spaces compared to a sprawled or rural settlement structure that promote efficiency
- The ability to create mixed uses in urban areas, thus reducing the need for private car transport
- The feasibility of public transport in urban areas for limiting overall car use.

Put together, while the EEA (2010b, pp 22) states, "The relationship between the urban layout and the potentials for energy and transport efficiencies is complex and needs further research" it is very likely that building and construction taking place in urban - rather than rural - is a key driver of green building.

As such, all urban areas should have clear policy frameworks that include action plans for systematically how and when they intend to go about greening their existing buildings. This includes a systematic audit of the energy performance of buildings to determine which ones are in the most need of retrofitting. A natural starting point is public buildings, which represents approximately 12% of the EU's building stock (EEA, 2010a), as well as social housing, which may or may not be publically owned. Eventually, this should go a step further into the private dwelling stock as well. The results will show which buildings ought to be prioritized for refurbishment; and for the private stock, it could act as the basis for locally customized incentive schemes to target the poorest performing buildings.

Furthermore, the advent of ICT in the building sector has resulted in the ability to have automated energy control for buildings at the urban scale. Multiple international firms provide technological solutions that allow for the centralized control of almost all aspects of energy consumption in buildings; ranging from individual buildings to the entire stock of a municipality's public buildings. This is an investment that some municipalities have already made (i.e. Grenoble, France) and is one that all municipalities should consider.

4.3.2. Managing growth

While buildings in all urban areas should be put in focus for their inherent potential to become greener, local and regional building development policy must explicitly consider territorial dynamics, especially regarding demographic changes and the fluidity of migration. While the population of many regions is foreseen to grow substantially in the coming decades, research suggests even more regions should expect to shrink within the same period. Housing development policy must carefully consider expectations for its respective region, even though for many regions this is not an appetizing prospective.

Quite simply, a territorially aware housing development policy for a shrinking region will in no way receive a long term benefit by continuing to add to its stock of buildings! In all likelihood this will generate more sprawl and will only add to the perceived unattractiveness of the region. In contrast, strategies for these regions should focus on planned redevelopment of the existing built environment, with a focus on green building that simultaneously promotes a sense of community and local ownership.

At the same time, those regions expecting high population growth should be especially focused on having high green building standards governing new construction projects. Again, with the use of territorial evidence on population forecasts we can infer which regions should bear in mind the importance of having appropriate green building standards governing city planning and development.

Even though the multi-sector dimension was introduced in in the previous section, this is even more important for growing regions, where only replenishing or incrementally adding to the existing building stock in will not be enough to meet the demand for buildings. As such, development of the building stock will have to include larger development projects. In addition to the need for larger developments to accommodate growth, this represents a relevant territorial dimension – where existing examples indicate that larger urban development projects comes provide the opportunity to implement ambitious, multi-sector green building ideas.

For example, there are a few innovations at the intersection of buildings and community scale energy and waste systems that can be important components of constructing a green urban area. Co-generated heat and power (CHP) facilities are often used at the municipal level to efficiently produce energy from a variety of sources, including renewables such as waste. CHP have been included within a number of eco-districts (e.g. the Vauban eco-district in Freiburg, Germany) as a distinct component of the integrated green building concept for the development. Likewise, a great example of a community waste management system is in Stockholm's green district of Hammerby Sjöstad. There, residents separate organic and non-organic waste and recyclables and dispose of them at specific drop-off points in the community. The waste is directly fed to a central incinerator, recycling and composting facility where it provides a source of electricity and biogas for 100 000 area residents. These types of community solutions this can be taken even further, because when green building developments reach a certain scale they begin to motivate even larger public transport infrastructures that serve the immediate areas of the new development as well as other points along new corridor (cf. Norra Djurgårdstaden and Hammerbey Sjöstad in Stockholm or the Rieselfeld and Vauban in Freigburg).

While these types of projects should take place through brownfield development if possible (all of the above examples are brownfields), the reality is that much of the demand will be met will have to be met through other forms of urban development, including infilling or strategic densification of suburban areas. Compared to retrofits, each of these provide an opportunity for green building to be harmonized with energy, mobility, recreation and business development when planning for growth. This underscores the importance of coordinated and comprehensive urban planning and governance – planning and oversight that not only connects departments within municipal administrations, but also brings the multiple municipalities comprising a single metropolitan area together (Please see the next section for the role of metropolitan governance as a driver of green building).

4.3.3. Local, place based and functional governance for supporting green building

From a policy perspective, urban regions facing growth have special opportunities for comprehensively linking green building within wider notions of sustainable urban development. But these possibilities are greatly supported by the appropriate institutional arrangements – both across sectors (i.e. between municipal departments) and among the range of important actors (i.e. urban planning, construction and utility companies, citizen groups, etc.). Yet they also imply that part of the potential for producing a greener building and construction sector is closely aligned with behavioral decisions on the attractiveness of urban areas as places to live. This means that integrated planning of urban areas - between issues of land use, economy, transport and leisure and recreation, and with a heightened focus on urban design, is crucial for providing people with the opportunity to choose a more desirable and sustainable urban living situation.

Nevertheless, it is clear that action-oriented discussions cannot be separated from the local places and spaces they are constructed. This emphasizes that municipal or regional public authorities are almost universally responsible for land use planning and development issues in cities, and must therefore lead by example. Yet, this can only take place once they are informed of what they can actually achieve through their own efforts. From a top-down perspective, this reflects on the importance European and global networks such as the EU Covenant of Mayors, Build up, and the Smart Cities and Communities, among others, which are crucial for promoting local green governance through information sharing, communication of best practices and logistical and technical support.

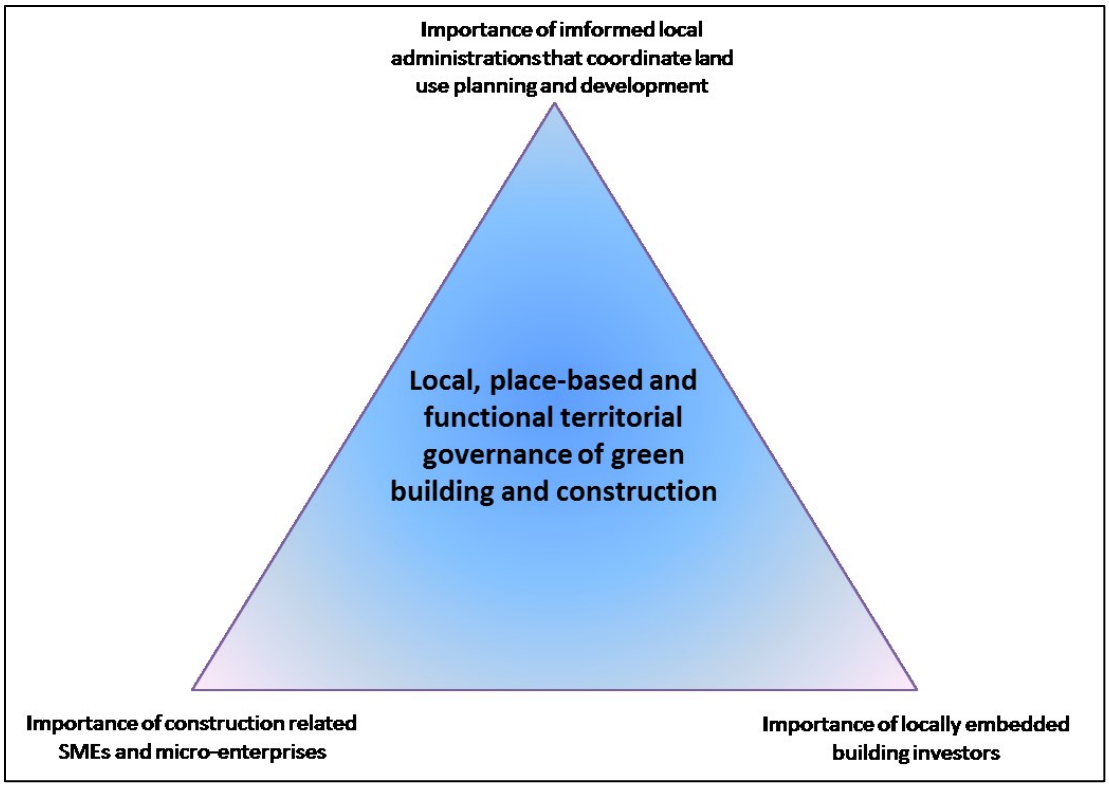


Figure 20 The importance of locally embedded governance for greening the building and construction sector

Again, one of the novelties of the building sector is that such a large share of responsibility for improving building performance ultimately comes down to planning and investment decisions by an extremely decentralized network of investors. The result is that growth of green building and construction in a greener economy will especially rely on local, place-based development strategies for sustained growth of functional regions. As reflected in Figure 20, there are a number of parallel dimensions to this perspective that ought to be highlighted:

- As mentioned, municipal administrations are generally responsible for a majority of land development taking place in their areas. For example, they are likely involved in the decision making process for all land use issues; and while regional or national authorities may have central roles in the development of infrastructure, municipal administrations are generally control housing and non-residential building development.
- The engagement of construction and trade firms responsible for supplying construction-related technologies (both product and process) are absolutely essential. In this connection, it was mentioned that by directly or indirectly employing upwards of 44 million people the construction sector is the largest individual employer in Europe. But in a territorial perspective, it is even more relevant to not that in 2007, only 2,584 of the 3,090,144 registered construction enterprises in the EU27 had more than 250 employees, and 99.9% were considered SME's. Even more telling, 92% were micro-enterprises with less than 10 persons employed (Ecorys, 2011).
- The cost-benefit perspective characterizing the decision making process to invest in green building showed that a majority of those responsible for investing in green buildings are also very much locally embedded - as firms doing business within the local or regional market, local associations that own public buildings (including social housing) or individual homeowners.

Based on the above discussions, it is clear that regional and local green building action plans should be tailored to regions depending on regional specificities of planned growth and development. Depending on such factors, the greening of existing buildings and new development opportunities can be facilitated through policies that promote:

- protocol for systematic audit of the energy performance of buildings.

- Creating official networks (green building councils, associations, etc.) at the local level to bring together key actors responsible for planning land use and construction development. This includes urban and regional administrations, local construction enterprises and those making building investments (all sorts of locally-embedded public and private sector actors, including individuals)
- linking green building plans in multi-sector dimension of green growth for urban regions. This especially includes consideration of mobility issues and providing incentives for existing jobs related to the development of buildings and infrastructure to be made greener
- providing local and regional incentives that are directly based on knowledge of the performance of the existing building stock
- Use public funds to increase focus on greening social and publically owned housing. Here, Figure 13 not only showed that publically owned rental housing can comprise over 20% of the residential stock in Member States, extends all of the merits of green building (increased comfort, residual effects of energy consumption behaviors, etc.) to demographic groups that otherwise may be excluded.
- providing local information and awareness campaigns that target the investment and consumption behaviours of building owners, including individual citizens and particularly youth.

4.3.4. Functional metropolitan governance – new regional paradigms

In addition the above perspective, one of the most crucial drivers of green building is also the most territorially explicit. Not only does it deserve special attention, but it reflects the need to move beyond traditional territorial constructs that have guided development since industrialization. From the profound importance of administrative-based territorial distinctions (between municipal, regional and national levels of planning and government) and toward regional distinction that both respond to- and promote place-based development of functional areas.

The importance of planning and governance of the functional urban region – in other words, coordination and agreement among municipalities rather than strictly within municipalities – is important when planning for growth, but absolutely crucial when planning for resource efficient growth. This notion of "metropolitan governance" emphasizes the role of building a common vision among the range of institutions responsible planning an urban territory – notably, among the range of municipalities that comprise an urban region.

Stockholm's regional development plan, RUFS 2010, highlights the importance of developing a polycentric urban structure to manage the expected growth of 550 000 residents (45%) between 2001 and 2050. In a recent Nordregio Policy Brief, it was noted how this polycentric development is based on the fact that the greatest potential to accommodate growth without consuming green areas is through densification of areas outside of the inner city (Nordregio, 2012). It also mentions that through targeted building densification along metro lines and around transportation nodes will reduce land take as well as the need for private car transport - and both can be done while producing multi-functional communities with highly energy efficient buildings.

Yet the Policy Brief also highlights that while the region's polycentric development strategy is crucial to reducing resource consumption, it requires that all 24 municipalities can agree on a similar vision of what needs to be accomplished. Without this cooperation and agreement, underlying competition among the municipalities to attract residents and business (its tax base) promotes urban areas that are fragmented, sprawled, private-car oriented and thus less-resource efficient. This is exactly what was reflected in another recent Nordregio publication (Galera-Lindblom, Weber, Reardon, et al., 2011), which showed how a lack of metropolitan governance in Newcastle, England has effectively maintained the role of market competition between the area's five municipalities. In Newcastle, very little in the way of municipal cooperation takes place (outside of the cooperation between Newcastle and Gateshead regarding development of the city center), and this has been further supported by the abolishment of the regional planning tier in the U.K.

The report shows that due in part to this lack of cooperation, Newcastle is not only unable to effectively develop its underused or vacant housing areas, but the municipality's largest residential/commercial development project is located on the outskirts of the municipality – mainly detached or semi-detached homes with poor public transport offerings and in an area that was previously farmland and green space. The main reason for this is that these are the dwelling types that are in high demand in the region and Newcastle is forced into the position whereby if they don't build the housing stock that is under demand then another municipality in the region certainly will. As a result, market forces and competition win out over attempts to develop cooperate and create interest and demand for more integrated and resource efficient growth opportunities.

This short comparison highlights the importance of formulating governance arenas at the metropolitan scale. The interesting perspective here is that while it requires a scaling down of territorial strategies from the national and EU levels, it also requires an up-scaling of urban land use and development planning. But the challenge is that implementing such an approach means overcoming the underlying fact that many municipalities are in reality competing against each other rather than working together. Not only does this require innovative policy and governance solutions to bring them together, but it also accentuates a shift to the way we identify regions – from largely administrative-based structures toward ones based on the location and movement of people, materials and resources.

5. Potential for green buildings to contribute to a green economy

With the above discussion of policy and territorial drivers in mind, the analysis of territorial potential for green building takes forward a policy-oriented, territorially situated approach to determine the developable potential of residential buildings in the sector. Based on the availability of data (or perhaps more accurately, the lack thereof), it uses the following measures to determine potential:

- Current levels of per capita energy consumption in the residential sector (heat and electricity, based on national data from Eurostat)
- Current levels of per capita CO2 emissions in the building sector (from heat combustion, based on national data from the European Environment Agency, which is calculated accoring to the E-PRTR Regulation)
- 2009 population of NUTS2 regions based on Eurostat data
- Predicted population of NUTS2 regions in 2050
- General policy target of an 88-91% reduction in CO2 emissions in the residential sector between 1990 and 2050 (Based on target reported in the A roadmap for moving to a competitive low carbon economy in 2050 (EC 2011b).

Based on the above parameters it is clear that only energy related issues are being considered. Unfortunately, due to the multitude of variables, there is no way to comprehensively predict the relative size of economy related to green construction activities. For instance, in Section 3.2 it was shown how regional performance in terms of GVA and employment (for both the state of the art in 2009 and changes between 2000 and 2009) was driven very much by policies either at the national level (i.e. Spain) or in terms of development trajectory (i.e. ascension of new Member States). As such, rates of construction do not necessarily operate on a continuum and inferring they do would promote unrealistic potentials for many regions. With that being said, we saw that, on average, the sector accounts for 10.2% of GVA and 10.7% of employment in all NUTS2 regions (Map 2 and Map 3 respectively). Using these figures we can therefore say that if the policy goals stating that all homes built after 2020 should be nearly zero energy are realized, then at least this share of jobs will be contributing to the green economy. But in terms of policy, if the EU is to achieve its energy consumption and emissions reduction goals they have set (see discussion below) then even more overall construction jobs will be needed to retrofit the huge stock of relatively inefficient buildings. But what is also clear is that these jobs will be concentrated in urban centres with the highest number of existing buildings, and especially in those centres that are expecting to grow (c.f. Map 8 below). Here, we are reminded of Marie Donnelly's presentation stating how all policy investment in green buildings largely remains internalized in local economies due to the nature of relations between construction firms, the products they produce and the markets they serve. As such, these regions with growth potential in this sector are well served to invest in generating the labour competencies for supporting the development of green building.

The regional potentials described below are extremely course estimates, and ought to be treated as such. This coarseness primarily relates to the fact that a number of assumptions and proxies are necessary in order to provide regional results based on national data that is only available for selected years. These assumptions include:

- That the population density indicator is used as a proxy to regionalize national energy and emissions data from buildings. This infers a direct correlation between where people live and where buildings stocks are located – an argument which is certainly difficult to argue against.
- That the distribution of national populations between regions in each Member State will remain the same through 2050. This is a necessary assumption due to the fact that only national data on population assumptions and net migration are available with European coverage (where population assumptions of domestic growth based on TFR and Mortality rates at and Net Migration are regionalized based on the current regional distributions of population in each

country. Note that the totals do not include fertility rates of migrants). While other projections have been made (i.e. scenarios population scenarios in the ESPON DEMIFER project), these are considered unrealistic due to the extraordinarily high growth and decline rates they portray for different types of regions (which is mainly due to the fact that they used assumptions that population developments during short time periods (i.e. five years) would continue indefinitely. Global growth rates, including national projections in rapidly growing countries such as China and India show this to be highly inaccurate. It is well understood that many rural regions of Europe will have difficulty retaining their levels of current population, but urban regions will continue to expand, both in terms of absolute population and relative to rural regions (but hopefully not in terms of space they consume!). While this measure does not consider this trend, it does allocate the highest shares of energy consumption/emissions production to urban areas because of the higher shares of population that live there. As such, further growth of urban regions will only accentuate the results shown below, therefore implying that urban regions have an even greater potential (responsibility) for greening their building sectors.

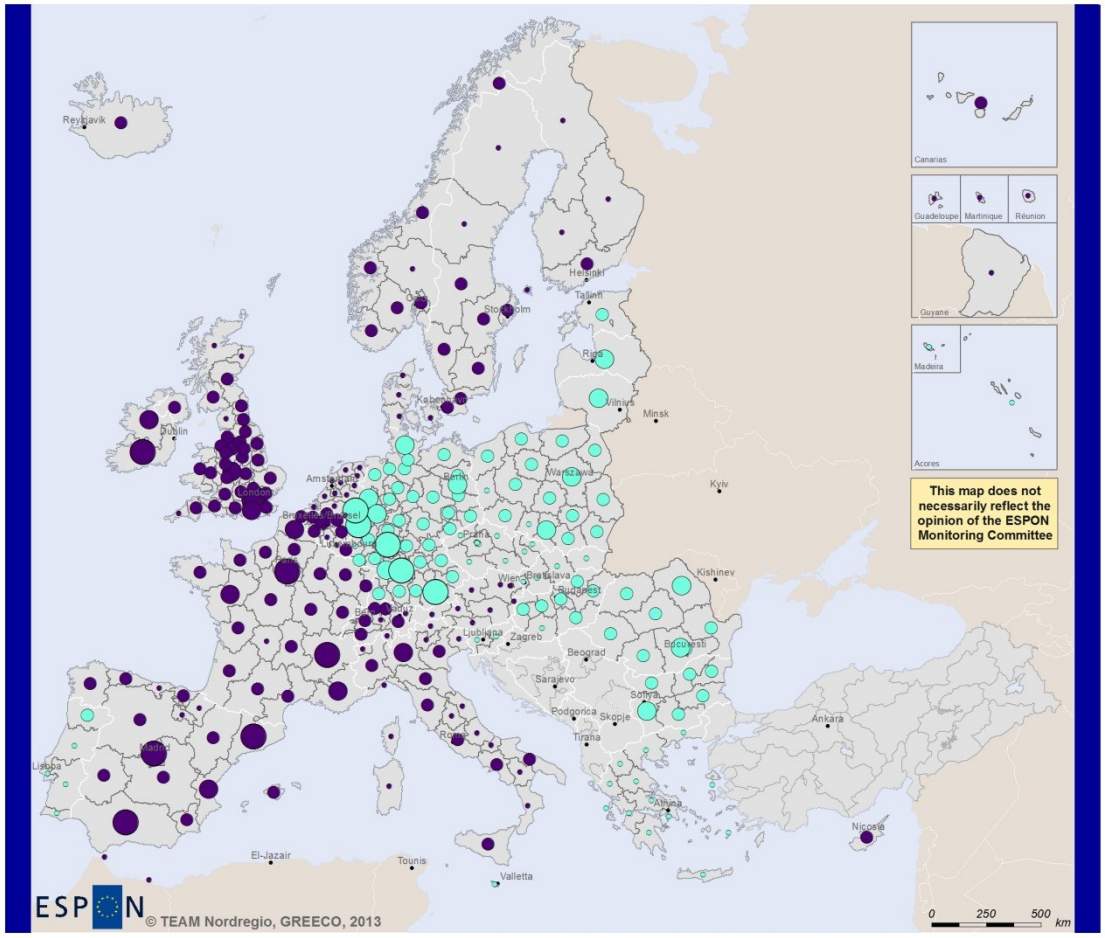
- That no greening of the sector has taken place between 1990 and 2009. This assumption is based on the fact that policy targets suggest an 88-91% reduction in annual CO2 emissions in 2050 (compared to 1990), but we do not have the available data to make such a calculation. However, this is perceived as an acceptable assumption due to the fact that, in reality, energy consumption and emissions in European buildings have actually increased between 1990-and 2009 (cf. Figure 11). It is also valid due to traditional perspectives of innovation and development showing that lag periods between innovation role out and market penetration are typical.

Considering the above data (complete with the assumptions and shortcomings) we are able to provide energy- and emissions- related potentials by regionalizing national data (again, using the estimates on regionalized population projections for 2050 as a proxy). In short, current annual rates of energy consumption and CO2 emissions for the residential sector are carried forward to 2050. As such, this provides a baseline or “no action” level of consumption/emissions, to which an 89.5% policy target can be applied to infer a potential for reduction in emissions. Obviously this is only considers residential buildings, but the results should be seen as indicative for all buildings.

Based on these perspectives, a prioritized order of focus for regions to improve their resource performance of existing buildings could be:

- Considering the dire need to reduce the environmental impact of energy consumption, those regions with the highest projected saving potential for CO2 emissions.
- Assuming that a common energy market is expected to become a reality in Europe, those regions with the highest energy consumption in 2050.
- Considering that projected population growth provides a specific opportunity to meet demand with extremely energy efficient buildings, those regions that are expected to grow most significantly between now and 2050.

Population Development Forecast - 2009 - 2050



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Regional level: NUTS 2
Source: Eurostat, 2012
Origin of data: Eurostat, 2012
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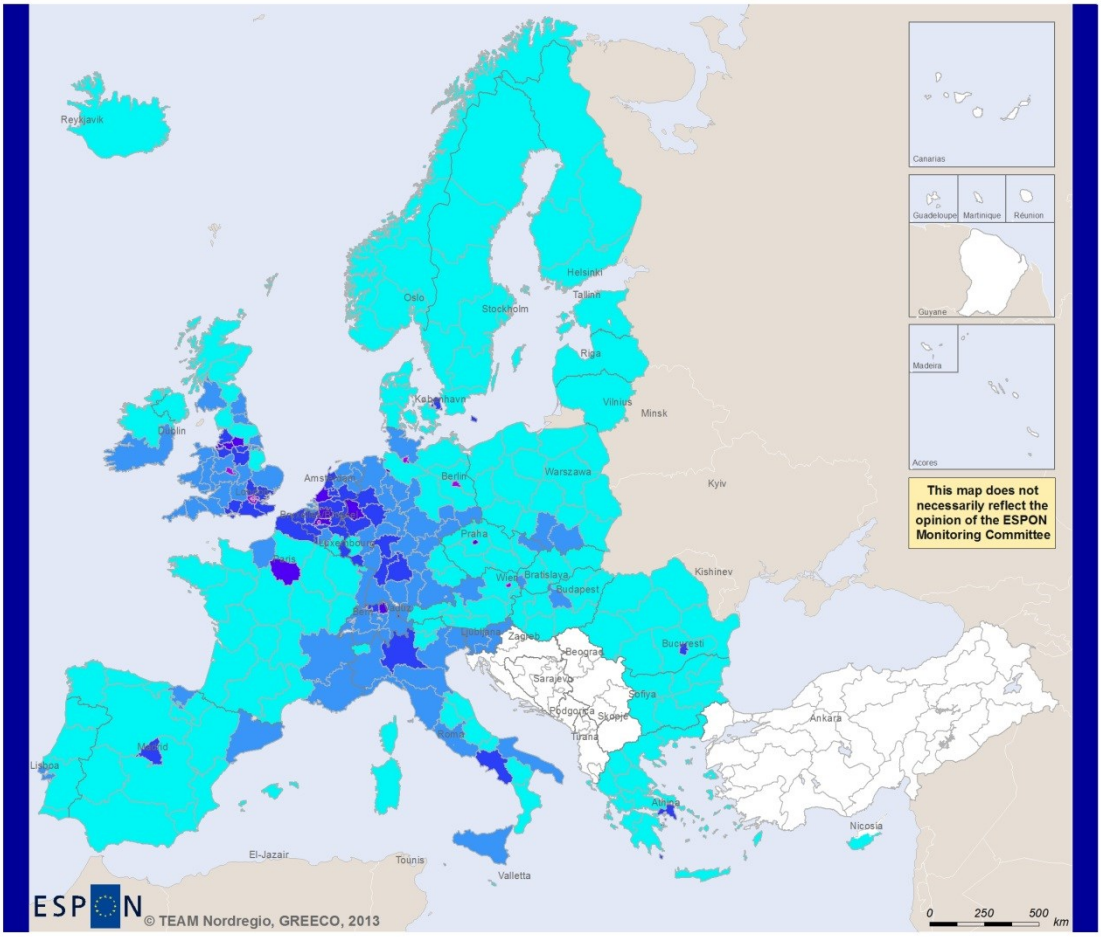
Legend

- + - 1 to100 000
- + - 100 001 to 400 000
- + - 400 001 to 600 000
- + - 600 001 to 1 415 538
- Reduction in population
- Growth in population

Projections are based on national data from Eurostat on population assumptions using basic demographic indicators (TFR and Mortality) plus total net migration. National indicators are regionalized using current population density. Note, indicator does not account for births/deaths related to the migrant population.

Map 8: NUTS2 population development forecast (Source: Eurostat)

Estimated Annual CO2 Emissions Savings Potential for the Building Sector in 2050



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Regional level: NUTS 2
Source: EEA, 2010
Origin of data: EEA/UNFCC/CRLTAP, 2010
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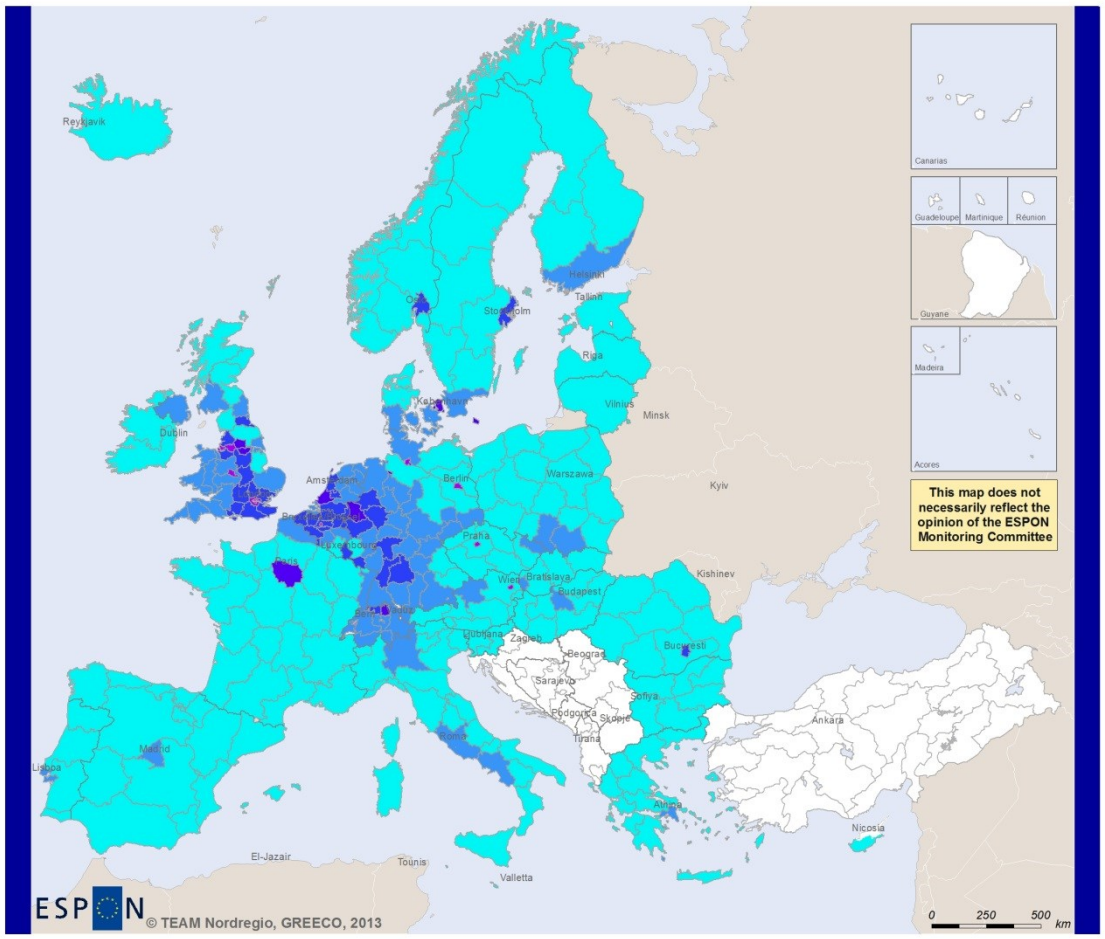
Tons of CO2 Emissions per year per km2

- 0 - 195
- 196 - 536
- 537 - 1 297
- 1 298 - 2 937
- 2 938 - 6 254
- 6 255 - 18 446
- No Data

Regional values are calculated by allocating current national estimates of per capita emissions rates from non-industrial heat production to projected population development for 2050. National data is disaggregated using 2008 data on population density. Emissions data comes from The European Pollutant Release and Transfer Register (E-PRTR) while population projection data comes from Eurostat [proj_10c2150p]. Next, a universal 89.5% reduction in CO2 emissions (in order to achieve the EU's policy target) is calculated against the 2050 baseline per capita emissions rates (continuation of 2008 per capita emissions rates). The difference between the baseline rate and the policy-aware rate is then multiplied by 2050 projected population and dived by the area of the region.

Map 9: Green building potential of NUTS2 regions according to expected emissions reductions if EU policy target is met in all regions (Source: EEA and Eurostat)

Status Quo Energy Consumption in the Residential Sector in 2050



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Regional level: NUTS 2
Source: Eurostat, 2012
Origin of data: Eurostat, 2012
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kWh/year/km2

- 33 152 - 1 101 158
- 1 101 159 - 2 827 218
- 2 827 219 - 6 172 085
- 6 172 086 - 15 563 823
- 15 563 824 - 40 333 174
- 40 333 175 - 93 514 332
- No Data

Regional values are based on allocating current national estimates of energy consumptions to forecasted population development for 2050.

Map 10: Expected energy consumption of residential buildings in 2050 based on current rates of consumption (Source: Eurostat)

Based on the results in the three maps above, we see that the highest potentials are clearly located in regions with relatively high population density. A number of rationales justify this assertion. First, existing urban regions will be ones that will continue to attract the highest population growth. Based on this characteristic alone, it is clear that the countries such as Sweden, Norway, Spain, France, Italy, U.K and Belgium all have a distinct potential. As such, these regions will require development of the building stock, which, through the right planning and policy perspectives, can be developed at a very high resource standard. Second, these regions already have the highest concentrations of buildings, and therefore consume the most energy (and depending on energy source, produce the most emissions).

But third, the analysis of performance identified that population density, while being a driver of improved resource performance, does not appear to be currently correlated to lower per capita energy consumption (cf. Table 3, pg. 33). In particular, this relates to the fact that many urban centres are actually territories with comparatively old (and inefficient) building stock. For example, Figure 15 (pg.36) shows that Luxembourg (47.4%), Belgium (41.3%) and the U.K. (34%) are the three countries with the highest share of their residential floor space being over 65 years old. As such, it shouldn't come as a surprise that these dense regions have among the highest national energy consumption rates (Figure 10, pg. 27), and therefore have the highest foreseen energy consumption (Map 10) and emissions reduction potential (Map 9) in Europe.

Another interesting perspective to note is the minor, but important differences between Map 9 (emissions) and Map 10 (energy consumption). Here, we see that the Nordic countries will not contribute with a large emissions reduction in the 88-91% target is met. This is due to the fact that the energy supply for building heat in these countries already produces relatively low emissions (To a lesser extent, the same principle is noted in the U.K., where potential energy consumption levels are extremely high, while potential for CO2 emissions reduction is slightly lower).At the same time, like the U.K., the most populated Nordic regions are quite clearly identified as having relatively high foreseen energy consumption. As such, in a longer terms perspective, the development of a common and tradable European energy market will provide a significant incentive for these regions to invest in energy savings in the building sector.

Put together, the results of Map 9 and Map 10 indicate that populated, growth-oriented regions of Europe have the highest potential for greening the building sector. In particular, however, the largest urban regions with either high energy consumption per capita, high emissions, or both, must meet their potential improving the performance of their existing building stock. A rather clear example of this is the fact that out of the 277 NUTS2 regions with results shown in Map 9, the 10 regions with the highest reduction potential (3.6% of the regions) account for over 17% of the potential annual emissions savings in 2050. Not surprisingly, this recognizes the potential of regions with dense urban centres of Paris, Naples, Rome, Dublin and Berlin. At the same time, when results are shown in relation to area (as in Map 9) the urban areas of Brussels, London, Berlin, Vienna, Copenhagen, etc. are put in focus. Based on building turnover rates that often exceed 100 years, this means that focusing on greening new buildings alone will not come close to be proactive enough to reach EU policy targets. Greening of existing buildings through retrofitting and improved operational and management practices are absolutely essential. This includes the host of possibilities identified in Section **¡Error! No se encuentra el origen de la referencia.**.

6. Conclusion and key recommendations

This report has undertaken an investigation into the prospect for greening the building and construction sector. It first laid out some of the general principles of green building – making a distinction between embodied resources (those resources used to produce a building) and operational resources (those resources consumed during the operation of buildings). In a territorial perspective, it described the importance of reducing land take as being a key component of green building - not only for its role to limit ecological impact, but also for promoting the multiple resource benefits attributed with compact city development. This includes promoting densities of scale that not only reduce energy demand in buildings and promote non-car forms of mobility through cities of functional distances. As such, the report showed that green building is as much about green urban planning – with an urban systems approach to planning – as it is about building greener buildings themselves. For starters, this emphasises that the individual resource efficiency goals relating to green building, to urban and local mobility, to provision of high quality leisure space, to integrated waste and water management systems, etc. are actually greater when planned and developed in an integrated manner than the summed technical potentials of the individual components alone. Whether this perspective alongside

an increased policy focus on green growth and a greener economy justifies the increased development of urban policy at the European level should certainly be up for discussion.

The next section laid out current performance of the sector, both in terms of size of the economy, but also in terms of resources such as land, energy consumption and emissions production. In terms of economy, we saw that based on employment, GVA and number of firms, the construction is the largest individual sector of the economy in Europe. Significant territorial differences were also noted in terms of the Balearic Peninsula, where favourable policies have driven growth in the sector.

However, one of the critical observations of the section – and of the report as a whole – was the overwhelming lack of good regional data on both economic and environmental parameters of the sector. Given the high regional variations that were observed, coupled with the fact that greening potential of the sector is directly related to existing performance, this lack of data is a major limitation for determining in which regions ought to focus their efforts on developing the green economy with green building as a chief component. Additionally, the inability to measure performance means that actual performance can't be used in a comparable fashion to support regions making investments, or for holding those that don't accountable for their inaction.

Nevertheless, we investigated as best we could the likely set of rationales for poor existing resource performance of buildings and why regions have been slow in the uptake of available technologies. High regional variations in performance were identified among a variety of resources. Notably, this included the issue of land use, and more directly, land take. Touching on the conceptual discussion of an urban systems approach to green building, a key recommendation is the need for policy at all levels to further emphasize reduced land take through brownfield and greyfield development. Not only does this have important environmental benefits, but is also a key agent in promoted more efficient (accessible, connected and integrated) urban development. Therefore more effective land use planning (through more effective and coordinated spatial planning) can promote improved energy efficiency. This implies the importance of using information on land consumption and urban sprawl more actively within the formulation of policy, planning practices and the dispersal of EU funds.

Regarding energy consumption patterns for buildings, extremely high variations were noted at the Member State level (and where available at, the regional scale as well) for per capita energy consumption and CO2 emissions, both in terms of the status quo and the changes between 2000-2009. In terms of the status quo, from NUTS0 scale data we could clearly see the impact of climate, building age and economic wealth as key determinant of consumption. But, given that buildings are de facto constructed where people live and work, population density was be used to make regional assessments from national data on energy consumption and CO2 emissions. In some cases NUTS2 residential energy consumption data was available. While expecting to see that per capita consumption would be lower in denser regions compared to more typical rural or peri-urban population densities, the opposite was in fact the case for many regions. Further investigation on the causality for this suggested quite convincingly that the relatively high number of old buildings in larger urban centres of Europe means that these areas have poor consumption than would otherwise be expected (due to smaller average living spaces, higher numbers of multi-unit dwellings, etc.) This clearly reflects the incredibly high potential for retrofitting the building stock in these regions in order to have convincing improvements in actual levels of consumption.

In terms of changes in per capita energy consumption between 2000 and 2009 the results shows a rather incredible variance between Member States: with high performers reducing consumption by upwards of 13% while other countries increasing their level of consumption by over 30%. This quite clearly showed two findings. First, that increased consumption is highly correlated to increased socio-economic standing – where Most of the new Member States showed high increases in consumption. At the same time, the result showed quite well that greening can have a notable impact on reducing consumption. Considering that our attention to green building has scaled-up considerably in the past 5 years, per capita reductions in consumption of over 2% per year appear to be realistic.

Also, the fact that high energy consumption was shown to not necessarily correlate to high CO2 emissions production, illustrates that potential greening in the sector has many dimensions operating in parallel, and these cut across traditional sectors. For instance, depending on underlying territorial conditions of energy supply, some regions should focus more on greening their building stock directly, while other ought to focus also on greening energy supply to buildings.

In addition to simply establishing territorial performance, a goal of this section was to identify key constraints to greening the building sector. The following bullet points note the findings:

- The high amount of capital needed for making resource related improvements
- Lack of awareness on the financial benefits of making improvements, as well as the policy-based support that is available, generally from national governments.
- The split-incentives associated with dwelling and offices that are occupied by tenants (rather than owners)
- The sub-optimal manner in which construction firms develop their competencies related to green building. This is closely due to the fact that construction firms are currently very localized to given areas and workers rely on tacit/experiential-based knowledge, which resists change.
- The fact that many regions feel they have more important development concerns to worry about.

Reflecting each of these constraints (especially capital intensity of building investments, lack of awareness and split-incentives) the issues of national funding mechanisms and innovative policy mechanisms were given a special focus as an absolutely crucial aspect of the policy that needs to be further addressed for the EU to achieve its goals for a low carbon economy. In particular, the reality of the building and construction sector is that a majority of the financial incentives are rooted in national incentive schemes – mainly in the form of subsidies, grants, tax credits and local building regulations (See Figure 14). While it was noted that the number of national policies delivering financial incentives to the building sector can be viewed to gauge territorial performance towards greening the building sector it was also said that these policies not only need to be further developed among the Member States in Europe, but they have to be more consistent and longer-term (which is in contract to the reality where these policies seeming come and go from year to year and place to place).

Furthermore, there was also discussion on the crucial role of innovative funding schemes – particularly via the formation of Energy Savings Companies (ESCO or ESCo) for supporting private sector investment in green building. In this regard, it is highly unlikely that the EU will achieve any substantial improvement of the existing building stock without the widespread (or unanimous) development of funding mechanisms that transfer the investment cost over to the payback period of the investment. In other words, their importance of development cannot be understated.

In addition to the discussion on national financial policies and innovative funding schemes, the report elaborated on the key drivers and enablers of green building, which began with an overview of existing European policy. This included overarching thematic strategies, directives, financial incentives, the availability of regional funding and the extent of awareness information campaigns. Perhaps the most interesting aspect here is how policy investment in green building not only creates a direct transition to green jobs (thereby developing the skillsets of labourers) but also provides up to a 500% return on investment because it by default promotes domestic eco-innovation. This is in contrast to investment in other sectors, which are often exposed to import leakage – where portions of a certain policy investment are exported to other countries when domestic markets cannot supply appropriate green technologies.

Another of the crucial policy-related findings was the importance of public authorities leading by example for the market penetration of green building. One aspect of this being achieved is by ensuring that resource efficiency is a guiding principle of all public investment in buildings. Coupled with the high retention of policy investments when directed toward the building sector, this quite clearly shows that EU funding streams should feel safe directing even more funding toward green building projects highlighted for their direct environmental impacts. But in addition to this, findings of policy related research and analysis show that the bureaucratic processes attached with acquiring funding are a constraint to regions taking pursuit of such funding schemes. The efficiency of the allocation process should therefore be improved to maximize results. And a third aspect relates to the dire need for additional information on the effectiveness of policy schemes – both in terms of EU funds, but also national policies. On one hand, this requires additional information is compiled and monitored regarding resource efficiency in the sector, and on the other hand it reiterates the need for stricter guidelines enforcing that ex-ante and ex-post evaluations of policy programmes are completed at the appropriate scale.

The remainder of the discussion on drivers and enablers focused on the critical role of local (especially municipal but also regional) governments for promoting growth via green building and a green urban systems approach to developing the built environment. The reason for their importance is multi-faceted, but rather straightforward. First and foremost, municipal governments of Europe hold the main

competency for land use development in Europe, and as such are the key agent responsible for making planning-related decisions on how the built environment shall be developed. While this alone is not an innovative finding, it means that proactive municipal authorities are indispensable to the green development of the sector.

Likewise, the discussion on firm dynamics also not the extremely local/place-based nature of a majority of construction firms – firms that can by motivated and supported municipal institutions functioning on the same territorial scales as the firms. One example was noted from Grenoble, where to meet the green building goals that the city had set for the redevelopment of the De Bonne district, the municipality had to hold training seminars to convince the local trades firms of the skills they needed and how to obtain them. This is a clear best practice example of local and regional intervention to motivate green development of the sector.

However, the local perspective was then investigated even further from a territorial perspective to especially focus on the role of aspects territorial governance for supporting green building and green urban development through increased cooperation. In particular, it was noted that:

- As also taken up in the current work of the ESPON TANGO project, increased knowledge sharing, cooperation and complementing between traditional (sector) departments of local and regional governments must be emphasized. These include improved linking between departments with competencies for: economic development, transport, civil engineering, waste, parks and leisure, and building and construction. Here, the role of planning departments for connecting these departments is paramount.
- Increased cooperation among the range of local actors at the local level is necessary (i.e. urban planning, construction and utility companies, citizen groups, etc.).
- Increased cooperation between municipalities comprising metropolitan areas (where the term metropolitan governance is derived) was placed in special focus for its paramount role in fostering improved resource efficiency not just in terms of buildings, but also across a broad range of sectors.

The role of the this report was to ultimately shed light on the role of green building in the development of the green economy, and to focus on the territorial perspectives and implications of such development. As such, a synthesis of common territorial factors and outcomes in relation to the green economy is provided in Appendix 8.1. One clear example of this was taken up in the final section on potentials – where the link between future population growth and potentials for the sector were highlighted. Likewise, the importance of the compact city – with increased densities and promotion of functional distances – was reiterated, just as was the need to increase public investment to both green existing public buildings as well as provide policy funds that give a convincing incentive to retrofits in the private sector.

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8. Appendix

8.1. Synthesis of territorial factors of green building in a green economy

Table 7 Territorial factors of green building

HOUSING Are the following ***territorial factors*** **important in relation to greening of the sector:**		
1. Settlement types	***y/n***	***Why? Why Not?***
i. Urban areas	***Y***	***What is the current situation?*** • The relation between green building and urban areas is crucial because of the simple reality that buildings are constructed where people live, or are expected to live. And for more than 75% of the European population, this is in cities, towns and other urban agglomerations. • Approximately 29% less energy non-urban residents. In terms of the building sector, however, this does not align with the available data on regional energy consumption in the residential sector, which showed basically no correlation (even a slightly negative correlation) between higher building density and better residential energy performance. What's more, in Hungary, Norway, and to a lesser extent, Sweden, there is a rather convincing negative correlation – regions with the highest building density have relatively poor per capita energy consumption in the residential sector. As was mentioned, this likely reflects that key drivers of energy performance in existing buildings goes well beyond issues of building density, and especially relates to and includes buildings' age and construction quality. • Given that the E-PRTR on emissions in the residential sector disaggregated national data using a basic population density surrogate, it adds validity to the notion that performance and potential are both closely related to population density. ***What can be expected with a greening of the sector?*** • If the surprisingly poor performances of existing buildings in urban centres are acknowledged, the positive relationship between density and resource performance potential is actually emphasized because urban areas are not only the places that can be

			the most energy efficient, but they represent the concentration of existing buildings to be retrofitted. This promotes concepts such as urban mining and brownfield development. Related to the issues of land take, it implies no net loss of natural land to produce a well-performing building and it improves the quality of the urban built environment in existing areas. • Viable green building policy must recognize the reality of an average building turnover rates, and that the vast majority of current buildings will exist in 2050. Therefore, all but the newest, most efficient buildings will require at least one renovation if Europe is to achieve its objective of reducing building sector emissions by 80% in 2050. As such, the 2011 Energy Efficiency Plan proposes that public authorities should double their renovation rate of buildings. Territorially, this implies a strategic focus on existing urban areas, and in the short term, especially those with poor performance in terms of emissions. • As the European population continues to urbanize, these areas continue to be accentuated for their green building potential. • With their higher densities, urban areas promote the ability to create mixed uses and functional mobility distances that promote non-car mobility (walking, cycling and public transport – especially high level rail transport. This accentuates the parallel territorial implication of the link between green building and more comprehensive urban planning for sustainability.
ii.	Rural areas	***N***	Based on the discussion above, rural areas have relatively less importance on greening the building sector – both due to the fact that fewer buildings are located in rural areas and the fact that the EU population continues to urbanize.
iii.	Urban-rural interactions	***Y***	***What is the current situation?*** • Continually evolving socio-economic processes, not least driven by overarching shifts in global divisions of labour, mean that buildings are not only needed for new and evolving uses, but also in new and evolving *places.* The movement away from natural resource intensive sectors, towards a service-based and innovation led economy has resulted in the aforementioned pattern of shrinking rural regions and growing urban regions. Again, this directly impacts where buildings are constructed. • Urban areas consume a vast majority of resources, especially in the building sector, while rural areas produce the goods and services that buildings consume. • While compact city development, urban renewal and brownfield development are clear goals of green building, urban sprawl into peri-urban areas continues to be the dominant trend of land take. Related to this, it is clearly shown that European countries differ greatly

			in terms of the share of single family homes to apartments. ***What can be expected with a greening of the sector?*** • Urban areas will become more well-defined in relation to rural areas and new types of interactions will be promoted. This includes new types of production and consumption dependencies, for instance, to supply CHP plants with biofuels. • At the same time, linkages with the energy sector and the need to more efficiently take advantage of throughputs (waste, residual heat, etc.) means that urban areas must look within to take advantage of available resource inputs around them.
2.	Land and land-based resources	***y/n***	***Why? Why Not?***
i.	Land consumption or dependence	***Y***	***What is the current situation?*** • Buildings and their associated infrastructure are the dominant driver of land take in Europe, with is crucial in a green economy perspective because of it negative impacts on biodiversity (habitat destruction, degradation and fragmentation) As such, explicitly considering land is an outlet for assessing the territorial implications of green building. • As mentioned in terms of urban-rural interactions, while compact city development is a clear goal of green building, urban sprawl into peri-urban areas continues to be the dominant trend of land consumption. • What can be expected with a greening of the sector? • Concepts such as urban mining, brownfield development and urban regeneration have materialized from rhetoric to realities of urban development. Existing urban centres are managing growth without additional land take, especially through brownfield development and innovative ways of linking higher building densities with market demands for housing. • Related to the previous, a heightened focus of urban leisure means that public spaces are accentuated for their role in making cities rewarding places to live. • Mixed land use is a fundamental component of building sector development, and provides clear linkages to greening of the transport and mobility sector and the waste management sector in cities. There is increased monitoring and accountability of the way in which regions are developing spatially; because its connection to green building and transport reflect the cross-sector,

			multitude of impacts it will have on sustainability. For example, • That guidelines are needed at the European level to control how Member States and Regions are creating urban areas at the expense of rural land. In particular, there must be additional conditions to the allocation of structural funds that require region's (and the governments within them) make all feasible efforts to ensure that land take is minimized or eliminated. • That information on land take (i.e. land use typologies or information on rates of land take in EU regions, derived through CORINE data) can used to assess performance, and to better inform regions that are performing poorly.
ii.	Material Consumption or dependence	***Y***	***What is the current situation?*** • For the EU-27, the average annual use of materials is approximately 16 tonnes per capita, with a majority of this accumulating in the economy and the rest converted into emissions and waste. Overall, the construction sector consumes the largest consumer share of the 16 tonnes per capita of material resources that get consumed in Europe every year (O'Brien et al., 2011) (EEA, 2010a). ***What can be expected with a greening of the sector?*** • All aspects of green building are emphasized with the need to reduce consumption of material resources. This especially relates to factors brought up in other territorial factors. In particular, this includes reduced operational consumption of energy resources (i.e. fossil fuels) and in terms of embodied resources, a focus on industrialization and greening of construction processes, preservation and retrofit of existing buildings, urban mining, increased building density, etc.
iii.	Energy consumption or dependence on specific energy types or systems	***Y***	***What is the current situation?*** • More energy is consumed in buildings than in any other socio-economic activity. Due to the fact that over 67% of energy is consumed to heat buildings, and that renewable energy resources contribute predominantly to electricity supply (rather than heat), the energy sector is highly dependent on fossil fuels. • The fact that the three Baltic countries of Latvia, Lithuania and Estonia are among the top five per capita consumers of energy in the residential sector (while neighboring countries of Poland and Finland round out the top five), clearly indicates the implications between rapid development following EU ascension, the existence of an abundance of buildings with a relatively low insulation standard and the effect of climate conditions on energy

			consumption. • The results indicate a mix between macro regional trends (ie high consumption increases in the Baltic countries) and more selected national variations (i.e. seemingly poor performance in Germany and Denmark contrasted by improvements in Sweden, France and especially the U.K.). • There is a moderate—high correlation between per capita energy consumption in residential buildings and the aggregated national distribution of actual heating degree days. ***What can be expected with a greening of the sector?*** • In the short term, a particular focus should be placed on the greening of buildings in regions where energy production results in relatively high levels of CO2 emissions. • In a longer term perspective, however, there is a strong connection between a liberalized, common energy market in Europe, and incentives to reduce residential energy consumption in all regions regardless of current emissions levels. In principle, this is due to the fact that energy supply will become less territorially defined, and in contrast, will be tradable and transportable throughout Europe. • Green building is directly tied to making buildings more energy self-sufficient. In particular, this includes responding to local climatic conditions with innovative measures to improve the thermal characteristics of a building's façade; thereby reducing the need for external sources of energy. • Apart from the previous, green buildings are also based on the use of locally available energy supply and production/transmission systems. There are a number of possible renewable energy sources that can be used to augment a building's electricity and heat demand: o Photovoltaic or solar thermal panels/tanks on the roof or sun-exposed walls o Geothermal energy o Small-scale wind turbines are increasingly used especially in low density residential areas while larger private wind turbines are gaining attention in rural areas, particularly where farming activities take place. o Co-generated heat and power solutions can provide efficiently produced and clean electricity and heat to individual buildings or to entire communities.
iv.	Management of ecosystem services (types of ecosystems/landscapes; spatial characteristics of ecosystems;	***N***	This has not been brought up in relation to the building sector because the focus has been on buildings, which, by nature, do not directly contribute to managing or enhancing ecosystems. With that being said, it is well understood that land take is a main driver of ecological

	options for maintaining and developing these services)		degradation, fragmentation and destruction. As such, a focus on limiting land take through urban renewal, retrofits, brownfield development and planning for more compact cities will not only reduce resource intensity of the building sector, but will also meet ecosystem management objectives. Additionally, the climatic characteristics any given location was shown to be a key driver of the resource intensity of the existing building stock, but also the types of interventions that are necessary to improve resource performance. This motivates the need for a comprehensive mix between national guidelines/regulations and regional or approaches that can be tailored to the local conditions as needed.
3.	Market relations (Production; consumption; export, import) and innovation	***y/n***	***Why? Why Not?***
i.	Local/regional markets	***Y***	***What is the current situation?*** • By directly or indirectly employing upwards of 44 million people the construction sector is the largest individual employer in Europe. But in a territorial perspective, it is even more relevant to not that in 2007, only 2,584 of the 3,090,144 registered construction enterprises in the EU27 had more than 250 employees, and 99.9% were considered SME's. Even more telling, 92% were micro-enterprises with less than 10 persons employed (EC, 2011e). • These of locally-embedded, small firms often lack economies of scale to innovate towards greener construction practices. • The cost-benefit perspective characterizing the decision making process to invest in green building showed that a majority of those responsible for investing in green buildings (building consumers)are also very much locally embedded - as firms doing business within the local or regional market, local associations that own public buildings (including social housing) or individual homeowners. ***What can be expected with a greening of the sector?*** • The extremely decentralized structure of construction firms clearly reiterates that a focus on cultivating local and regional production markets are absolutely integral for creating a labour force with the necessary skills to implement green building technologies. Here, local governments leading by example to green public building stocks helps to create a demand for local firms to learn how to construct greener buildings. As discussed below, based on

			the fact that this only requires a transitioning of existing skills (rather than developing new skills altogether) these new skills can then become local industry standards if local demand is also conditioned. • Director of DG Energy, Marie Donnelly recently argued policy investment in green building not only creates a direct transition to green jobs (thereby developing the skillsets of labourers) but provides up to a 500% return on investment (Conference presentation, 2012). This "fail-safe" perspective to policy investment for energy efficiency in buildings is reiterated in the fact that such an investment by default promotes domestic eco-innovation because it involves such a high share of domestic labour and technological inputs. This is in contrast to investment in other sectors, which can often lead to import leakage – where portions of a certain policy investment are exported to other countries when an investment in a green technology cannot be supplied by the domestic market. • There are at least three components of industrialized construction - each of which requires increased coordination in terms of construction practices. As such, they infer a link between a scaling-up of firm size in the construction sector and improved efficiency in terms of embodied resources: o Off-site industrialization – refers to prefabrication and modular construction that gets assembled on site. It decreases cost, waste and inefficiencies caused by interaction of trades, while improving working conditions, control and consistency (Bougrain et al., 2010). o On-site industrialization – refers to the application of advanced tools and technologies on building sites that also make construction leaner and more efficient. Examples include just-in-time deliveries and systematized identification of materials using bar-codes. These practices are seen to reduce waste, both in terms of building materials, but also the array of natural resources that indirectly contribute to the construction process (i.e. fuel, electricity, human resources, etc.) o Process industrialization – is concerned with how agents in the construction process are cooperating contractually and informally (Alinaitwe, Mwakali & Hansson, 2006 in Bougrain et al., 2010).
ii.	National markets	***N***	While the construction materials and energy consuming products in buildings are tradable on national, EU and Global markets, production-consumption relations are inseparable from their local context. This is due to the fact that buildings are, for the most part, not transportable. Their assembly is either takes place in-situ or in direct proximity to its final location.

iii.	EU markets	***N***	As above
iv.	Global markets	***N***	As above
4.	Inter- and intra-territorial relations	***y/n***	***Why? Why Not?***
i.	Within territories (place based; local cultures; relating to territorial/national policies)	***Y***	***What is the current situation?*** • The distribution of buildings with countries and their regions is directly related to a host of place based contexts, not all of them with an economic or political rationale. • For instance, it is a clear reality that different types of residential buildings are demanded by different cultural or demographic groups. In the U.K. and Ireland, single family dwellings and row homes are an extremely popular building type, where even single people or couples without children often live in homes with one or more roommates. In Greece and other Mediterranean countries, there is a tendency for young adults (even those beginning a family) to cohabitate with relatives further into their adulthood than in other countries. This is reiterated in the results which show that only 10-15% of the residential buildings in these countries are multi-dwelling apartments. Yet in contrast, in Sweden it is very common for people to live in their own apartments from a young age and shared accommodation (roommates) is relatively uncommon. • Analysis of current performance also showed that the distribution of building ages is not only an important factor in determining the resource performance of buildings, but these are highly differentiated between European regions. This is why regions such as national capitals have higher densities (often seen as a driver of green building), but have older buildings and thus a less than expected energy performance in their buildings (often much less efficient than the per capita energy performance of buildings in a surrounding regions). ***What can be expected with a greening of the sector?*** • Creating plans and strategies for greening the building sectors requires that the aforementioned place-based factors are not only acknowledged, but directly considered with development strategies. For instance, immediately proposing to develop high-density apartments in areas with a long history of single family homes or row homes runs the risk of hurrying a more efficient building typology to the market, which will not receive consumer support. • The need to consider local conditions/culture emphasizes the importance of steady, incremental development of the built environment, which further supports the role of

			retrofitting existing buildings as a key contribution to the greening of the sector. • Much more regional information needs to become available in terms of the energy performance of buildings (and the associated drivers of performance) (i.e. energy consumption per square meter, average building age, average floorspace per capita, etc.). This not only needs to be understood by local and regional governments (to coordinate direct investments) but also by research and policy at the European level in order to help coordinate the distribution of funds supporting European policy.
ii.	Between territories (networks; competition)	***Y***	***What is the current situation?*** • National development strategies necessarily direct investment in buildings and infrastructure to occur in certain places rather than others (i.e. core-periphery strategies centered on national capitals versus a more polycentric development model). As such, some regions are forecasted to grow, while others will shrink, and it is in those growing regions where a clear focus must be placed on developing the local competencies for supporting green building. • Similar to above, while buildings in all urban areas should be put in focus for their inherent potential to become greener, local and regional building development policy must explicitly consider territorial dynamics, especially regarding demographic changes and the fluidity of migration. While the population of many regions is foreseen to grow substantially in the coming decades, research suggests even more regions should expect to shrink within the same period. Housing development policy must carefully consider expectations for its respective region, even though for many regions this is not an appetizing prospective. ***What can be expected with a greening of the sector?*** • Quite simply, a territorially aware housing development policy for a shrinking region will in no way receive a long term benefit by continuing to add to its stock of buildings! In all likelihood this will generate more sprawl and will only add to the perceived unattractiveness of the region. In contrast, strategies for these regions should focus on planned redevelopment of the existing built environment, with a focus on green building that simultaneously promotes a sense of community and local ownership. • At the same time, those regions expecting high degrees of population growth should be especially focused on having high green building standards governing new construction projects. Again, with the use of territorial evidence on population forecasts we can infer which regions should bear in mind the importance of having appropriate green building standards governing city planning and development.

			• Population development is a crucial indicator determining green building potential. This means that data on population projections (i.e. ESPON DEMIFER) can be used as a means of suggesting where potential exists for green jobs in the building sector.
iii.	Across territories (cross-border supply and demand)	***Y***	***What is the current situation?*** • Typically taking place within the confines of individual municipal administrative bodies, urban and land use planning appears to lack recognition of the spatial scales in which cities actually function. In contrast, competition for investment between municipalities in the same urban area can lead to uncoordinated, sprawled development. • Consumer demand for buildings can be highly influenced by proximity and the development of infrastructure between regions, even those in different countries. Many examples of this are available. For instance, southern England can be portrayed as one large urban area, and greater Geneva area consists of various satellite communities in France that are connected by public transit. Similarly, construction of the Oresund bridge has resulted in a unification of the Copenhagen/Malmö housing markets). ***What can be expected with a greening of the sector?*** • The importance of considering spatial scales characterizing urban areas as a whole (often made up of a number of municipalities) is put in focus to ensure that land is being consumed as efficiently as possible and the built environment is being developed to promote synergies in terms of resource efficient mobility. 'Metropolitan governance' also seeks to bridge the need to develop the compact city with the underlying importance of considering consumer demand for adequate, high quality leisure and green space. • In terms of the previous, new institutional arrangements could lead to the sharing of tax revenues between municipalities, thus providing the opportunity for individual municipalities to consider a 'metropolitan vision' within their underlying need to ensure economic sustainability. • Higher Energy Prices will present a host of opportunities and challenges for Europe. For instance, it will make more people prone to situations of energy poverty (have troubles to fund their energy needs). At the same time, they will reduce the cost of green building investments by increasing the cost of either doing nothing (in terms of retrofitting) or building cheaper/browner (in terms of new buildings). Higher prices therefore increase the benefits of low-carbon energy solutions – on both the supply and demand side. However, energy prices are driven by a highly complex, mutually enforcing and therefore unpredictable set of factors within the political, geo-technical, environmental and not least,

			market-based private sector domains. • In addition to higher prices, the policy goal of a truly European energy market is expected to be facilitated through a massive investment scheme in Europe's electricity and gas transmissions grid and their associated infrastructure. The goals of such an investment are expressed throughout the key documents of Europe's energy policy, including its Energy Roadmap 2050, Roadmap for moving to a competitive low carbon economy and regulation on the guidelines for trans-European energy infrastructure. If a European energy market becomes a reality, the traditional barriers of space, time and isolated energy markets are eliminated. Consequently, even nations and regions with an ample supply of clean, cheap energy will then have an incentive to invest in demand-side initiatives (such as the greening of buildings) because saved energy can be sold, on a European market, to regions that are not able to produce as much energy. Therefore, in addition to being a driver for increasing the overall potential for green building in Europe, it also highlights the clear link between development of the energy sector and its impact on a greening of the building sector.
	5. Place-based factors	***y/n***	***Why? Why Not?***
i.	Competitiveness through strong local economies	***Y***	***What is the current situation?*** • In factor 3 on market relations and the importance of local and regional markets, it was stressed that the construction sector is unique in that it employs such a large number of people, but these workers are distributed among an incredibly high number of firms operating within relatively localized areas. • As such, green building competencies are highly varied from region to region. Regions that have little or no experience in green building are contrasted by other regions where institutional norms are in place to ensure that all buildings are constructed to relatively high standards. • Green building accomplishments are largely restricted to the well-developed, more affluent regions of Europe. In other words, it is still perceived almost as a luxury development opportunity, with many regions likely believing that more basic investments are most important for their region (i.e. mobility and communications infrastructure). ***What can be expected with a greening of the sector?*** • While the decentralized structure of the construction sector creates an obstacle in terms of developing technological innovations for green building (which is accentuated by the

			importance of tacit, experiential, and place based knowledge) is also means that the role of local governance structures for incubating skill development is absolutely necessary. Thus we see that local scale of governance are mainly responsible for developing green building both on the demand side (i.e. through policies and investment in greening public buildings) and the supply-side (in terms of triggering firms to develop their competencies in line with those needed to construct greener buildings.
ii.	Multi-functionality	***Y***	***What is the current situation?*** • As mentioned, urban sprawl is still the dominant form of urban land take. Segregated land uses based on notions of mono-functionality (i.e. suburbia and strip malls versus central business districts) lead to extremely low urban population densities and private car oriented mobility. ***What can be expected with a greening of the sector?*** • Increasing the density of existing urban areas through strategic infilling and brownfield development leads to more resource efficient cities. Yet, the most common phrase of sustainable urban development is undoubtedly 'mixed use'. It highlights the importance of providing people with a built environment where they can live, work and play within proximity to each other. This promotes trip joining and reduces the necessity of private car transport while also promoting reduces land take and more efficient building types.
iii.	Tacit/experiential knowledge	***Y***	***What is the current situation?*** • By default, construction skills must respond to local factors including, but not limited to climate, availability of resources, local demands for architectural characteristics, etc. it is also highly experiential where learning-by-doing is key and new skills are based on the principle of iteration as much as they are on innovation. • The lack of formal institutions governing the relationships between the many firms required for an individual construction to take place hampers the rate of change for implementing new technologies or making construction processes more efficient. This can lead to reinvention in a circular rather than progressive manner. This leads to poor cooperation inability to learn from one project to another and therefore lost opportunities for resource efficiency. ***What can be expected with a greening of the sector?*** • To some extent at least, the construction sector will likely go through some form of

			centralization, characterized by increasing number of larger firms and thus perhaps fewer numbers of individual firms. This is due to the fact that these larger firms have the economies of scale to invest in green building R&D, thereby putting them at a strategic advantage for delivering green building solutions. • Some level of industrialization of the construction process (in line with the perspectives outlines above) including firms that provide competencies across the range of trades needed to complete a building. This has been the case in Sweden for example, where only a few large construction firms completely dominate the sector.
iv.	PROXIMITY	***N***	See discussion above on multifunctionality. The only other important consideration is in terms the availability and opportunity to use locally available resources.
6.	Consumer relations	***y/n***	***Why? Why Not?***
i.	Are development and innovation consumer-demand driven?	***Y***	***What is the current situation?*** The resource performance of buildings is based on a high degree of planning and very conscious decisions from building owners to invest in green building. • The capital investment to build or retrofit a building means that resource performance is based on a high degree of planning and very conscious decisions from building owners to invest in green building. Investment decisions must consider upfront capital investments in resource efficiency against the amount of time required to pay off such investments. • From the consumer perspective, ownership issues are crucial because they can negatively impact energy consumption reductions in buildings in at least two ways. First, there is often a reduced tendency for renovations, both overall and in terms of the depth of energy savings realized by such renovations. Second, payment for energy services (especially heat) in many countries often only goes to the building level, rather to the level of individual dwellings. ***What can be expected with a greening of the sector?*** • Local policy will respond to the nature of ownership and tenancy in the housing market. For instance, with a relatively high share of renter occupied housing should seek out appropriate energy efficiency standards or regulations to respond to these split incentives. • For instance, a potential driver of improved energy efficiency will be the development of smart grids in buildings, allowing for the monitor and payment of heat and electricity at the

			dwelling level, rather than equal rates for all tenants in a building. • A main driver of resource efficiency in the sector will be the improved behavior of investors. But this is driven by the degree in which investors are informed and thereby motivated about the economic and social potentials tied to green building investment. This emphasizes an undeniable link between green building investment and an overall shift toward more resource efficient resource consumption behavior. • Consumer demand in terms of where population growth –and therefore development of the built environment – will take place clearly provides the strategic opportunity for incorporating in the construction of new buildings.
ii.	Are development and innovation producer driven?	***Y***	***What is the current situation?*** • A host of connections have been made regarding the role of eco-innovations for modifying and developing new technologies to improve the efficiency of buildings. These include measures relating to: insulation, windows, doors, heating and electrical systems, building automation and decentralized renewable energy production. As such, technologies are already available on the market to produce plus energy buildings. Based on the subsidies and feed-in tariffs in many Member States, these can be produced within pay-off horizons of approximately 10 years. • As mentioned, however, many regions may not yet have a suitable mix of firms that provide and install green building solutions to the market. ***What can be expected with a greening of the sector?*** • Continued development of product technologies will take place on a globally tradable market, especially in terms of decentralized energy systems and energy efficient appliances and heating systems. • However, other energy efficient products related to the building envelope (walls, windows and doors) will continue to rely on innovations taking place in Europe. The challenges listed above – most notably the large number of small firms their decentralized organizational structure, and the importance of experience-based knowledge – imply that while drivers and enablers can be conceived at regional, national or European scales, they will inevitably have to be implemented by locally engaging, policy-led initiatives. • The aforementioned developments regarding firm structure, product industrialization and process industrialization will drive the prominence of green buildings and construction in the market.

iii.	Are development and innovation based on well-defined territorial conditions or on open access?	***N***	Not beyond the territorial conditions mentioned throughout this document.
7.	Accessibility and mobility	***y/n***	***Why? Why Not?***
i.	Transport connections (transport of materials; transport of labor)	***N***	By nature, buildings are fixed in space and are based on a very local demand. With that being said, the linkage between green building, sustainable urban planning, and more resource efficient mobility in urban areas had been emphasized (with examples) throughout this document.
ii.	Regional Accessibility (access to markets; access to supply of materials; access to public services)	***N***	Due to the fact that, by nature, building are fixed in space and are based on a very local demand. With that being said, it was already highlighted that improving intra-regional accessibility (through infrastructure projects) has an important role in determining where the built environment will expand. Furthermore, given that the tourism sector is such an important consumer of buildings, there is a clear connection between tourism growth, the demand for buildings, and thus the opportunity to make them greener. As such, regional accessibility is a driver of tourism, which is in turn a driver of the potential for creating green buildings.
iii.	Information connections (use of communication and information services; need of interaction; questions of consumer and producer cultures)	***Y***	***What is the current situation?*** • It was outlined that a main driver of resource efficiency in the sector will be the improved behavior of investors. But this is driven by the degree in which investors are informed and thereby motivated about the economic and social potentials tied to green building investment. This emphasizes an undeniable link between green building investment and an overall shift toward more resource efficient resource consumption behavior. As such, the role of 'environmental consciousness' in greening the sector is absolutely undeniable. ***What can be expected with a greening of the sector?*** • Given the connection between environmental behavior and tendency for making green building investments, it is assumed that the culture of consumption has undergone a significant greening process. Not least this will be driven by awareness and educational campaigns, especially targeted at the 'next generation' – those currently enrolled in basic education programs.

8. Policy and governance by territorial level	***y/n***	***Why? Why Not?***
i. Scale of sector-based policy support		
• From the EU Level	***Y***	***What is the current situation?*** • Mainly in the form of thematic strategies, as well as directives and guidelines that govern national legislation. For instance, the Energy Roadmap 2050 was released in December 2012 as a scenario analysis of policies packages that extend the horizon of the EC's energy strategy to 2050. It states that nearly zero-energy buildings will be the norm in 2050 and that a key driver will be the much greater access to capital for consumers and new, innovative business models that will help transition investment behaviors. But again, it reiterates that the role of local organizations and cities will be much greater in the energy systems of the future. • Economic support for green building is offered via the European Investment Banks, which are directed mainly at regional and local governments Examples include: ELENA, JESSICA and the EEEF. • Multiple transnational governance networks supporting knowledge development in terms of green building are administered by the EU. In particular, this includes the EU Convenant of Mayors. ***What can be expected with a greening of the sector?*** • It is suggested that approximately EUR 120 billion in EU funding will be required for high voltage electricity transmission systems up to 2020, and in total, between 1.5 and 2.2 trillion Euros between 2011 and 2050 will be needed to transition Europe's energy system to support a decarbonized supply. This especially includes the proliferation of smart grids – from a one-way flow between centralized production and decentralized consumption – toward a two-way network that prioritizes energy savings and decentralized energy production from renewables. • A common European green building certification scheme would reduce implementation costs of building certification and would support a common and comparable European discourse on green building performance and potentials in EU regions. • EU regional policy support further acknowledges the importance of green building and mandates a certain share of structural funds to be allocated to the greening of existing buildings.
• From the national level	***Y***	***What is the current situation?***

		• National policy is crucial because a vast majority of economic incentives for private investment in green building (subsidies, tax incentives) are developed at this level. • All EU Member States have at least one (and up to eleven) financial instruments in place to support energy efficiency in green building. ***What can be expected with a greening of the sector?*** • In the short term, more of a balance in terms of the national standards relating to the support for green building and construction (both in terms of the number of financial instruments and the relative benefit of each instrument for reducing costs of green building). • In the longer term, national financial support is reduced in favour of stronger regulations governing all building investments.
• From the regional level	***Y***	***What is the current situation?*** • There is insufficient regional data in Europe relating to issues of energy consumption, particularly in the building sector. While this data is available in some countries from national statistics institutions, it is far from a complete dataset. As such, it comes as no surprise that there is still no comprehensive understanding of regional variations in energy performance of the building sector in Europe. • Regional bodies are often responsible for the implementation of projects benefitting from EU funds supporting regional development. ***What can be expected with a greening of the sector?*** • Generally speaking, regional bodies are not directly responsible for land use planning and development, especially not in term of building development.
• From the local/municipal level	***Y***	***What is the current situation?*** • Again, one of the novelties of the building sector is that such a large share of responsibility for improving building performance ultimately comes down to planning and investment decisions by an extremely decentralized network of investors. One of the most important in this connection are municipal administrations, which are typically responsible for land use and development planning in their jurisdictions. This means they are also responsible for liaising with other importance actors – construction sector firms and building owners making investments in buildings. For example, they are likely involved in the decision making process for all land use issues; and while regional or national authorities may have central roles in the development of infrastructure, municipal administrations are generally control

			housing and non-residential building development. • Municipal governments quite often have building standards that promote energy efficiency beyond what would be otherwise transposed via national legislation. ***What can be expected with a greening of the sector?*** • Green building and construction in a greener economy will continue to rely on local, place-based development strategies for sustained growth of functional regions. • Local governments must continue to set a positive example by investing in green building and advertising their accomplishments. • From a policy perspective, urban regions facing growth have special opportunities for comprehensively linking green building within wider notions of sustainable urban development. But these possibilities are greatly supported by the appropriate institutional arrangements – both across sectors (i.e. between municipal departments) and among the range of important actors (i.e. urban planning, construction and utility companies, citizen groups, etc.). This means that integrated planning of urban areas with a heightened focus on urban design (between issues of land use, economy, transport and leisure and recreation) is crucial for providing people with the opportunity to choose a more desirable and sustainable urban living situation. • Municipalities can only pursue green building once they are informed of what they can actually achieve through their own efforts. From a top-down perspective, this reflects on the importance European and global networks such as the EU Covenant of Mayors, Build up, and the Smart Cities and Communities, among others, which are crucial for promoting local green governance through information sharing, communication of best practices and logistical and technical support.
ii.	Role of other EU policies with territorial dimension	***Y***	***What is the current situation?*** • Funding for development projects with a green building dimension is made through European regional policy. In particular, Cohesion Policy and the ERDF, where direct investment schemes are provided by the European Investment Bank. • The analysis on regional performance of the construction sector showed that seven of the eight countries with the highest relative size of their construction sector are New Member States (since the last two expansions in 2005 and 2007). This appears to indicate that the jolt national investment in the immediate years leading up to ascension, as well as the additional availability of European funds directly following membership to the EU are used to support the development of the built environment.

- Similarly, GVA from the building and construction sector in more established Member States is neutralized in the 8-10% range. This implies that the availability of European funds – for instance, through Cohesion Fund or the ESF can and could act as a formidable driver of greening the building and construction sector.

What can be expected with a greening of the sector?

- The importance of development of the built environment vis-à-vis EU ascension indicates that green building standards ought to be more directly emphasized within the distribution of structural funds. Just as the notion of municipalities leading by example through greening their public buildings was made, the EU can lead by example by enforcing that certain building standards become a conditionality of receiving investment.

iii. Private versus public sector – led development.

Y

What is the current situation?

- Are consumer organizations advocating for developing the green economy. At what political scale are they located?

- Various countries receive the benefit of having national green building councils. As an excellent example of this, the Swedish Green Building Council was initiated in 2009 by 13 public, private and public-private companies/organizations, including the City of Stockholm and Europe's largest construction firm, Skanska. Operating throughout Sweden, it now has 186 paying members. Open to all organizations within the Swedish construction and real estate sector, it strives to create common set of green building values to accelerate development, to provide clear and concise information to the public, and not least, help increase the competitiveness of Swedish technology and Swedish expertise.

What can be expected with a greening of the sector?

- Continued strengthening of national councils for green building, which bring together the range of economic actors involved in the sector. In particular, to strengthen the use of building certification schemes such as BREEAM, LEED, or preferably a common European scheme, for all EU regions.

Table 8 Territorial outcomes of green building

	Territorial outcomes of greening the sector:
• Inter- and intra-territorial relations	In terms of intra-territorial relations, the role of comprehensive land use planning is accentuated further as a means to bridge the multiple demands (desires) of local people and business. While the discussion under settlement types alludes to the correlation between a green building sector and higher population densities, it must be understood that: a) even though there is an overall trend towards urbanization, there are many people who simply wish not to live in dense urban areas (thus preferring rural environments); b) many regions of Europe already have an extensively developed peri-urban settlement pattern and it is certainly not resource efficient to assume that this should be uprooted and re-developed; and c) other sectors of a green economy (i.e. agriculture, forestry, tourism) require less-concentrated settlements. Each of these requires that the multiple demands, cultures and histories within territories are considered when coordinating plans for greening the building sector. Put together, the environmental benefits of urban living should be promoted to local populations and drivers of these benefits (mixed use communities, high quality recreation and natural areas, etc.) should be especially emphasized within urban development strategies as a means of attracting demand. In terms of inter territorial relations, the cross-sector link to energy is absolutely emphasized for its role in conditioning the greening of the building sector. This is primarily due to the fact that if a European energy market becomes a reality, the traditional barriers of space, time and isolated energy markets are eliminated. Consequently, even nations and regions with an ample supply of clean, cheap energy will then have an incentive to invest in demand-side initiatives (such as the greening of buildings) because saved energy can be sold, on a European market, to regions that are not able to produce as much energy.
• Settlement types	Higher building densities are a prerequisite for a plausible future of green building and the compact city perspective is viewed as a standard practice of urban development in Europe. This is not only due to the potential increased resource efficiency of multi-family dwellings (compared to larger, detached homes), but especially due to the cross sector implications of higher densities of scale and mixed land uses of more compact urban development. In particular, denser built environments improve the efficiency and feasibility of non-car transport schemes, innovative solutions for waste and sewage disposal/recycling/reuse, as well as innovative energy systems operating at the community or district level. In speaking of the need to reduce GHG emissions, this is exemplified in the ESPON project SIESTA, which comments: “And, taking into account that it is clear that metropolitan areas concentrate GHG emissions, it is also clear that particular urban strategies for each individual city seem to be

suitable. All this has direct implications in spatial and urban planning, for instance the need to reduce sprawl and to favour a *compact urban model* (emphasis added). As it has been suggested by several scholars, the world needs a double revolution: achieving a reduction of GHG emissions and building better urban environment, given that people are concentrated in cities. They are both absolutely inter-related. However, much the discussion around these issues is placed in the context of new buildings and developments, rather than the existing stock of ever-aging buildings." (Compostela, 2012, pp.37).

In terms of the current situation of settlement types, it was also mentioned that many existing urban areas likely have a great potential for greening the building sector due to the number of old or poorly constructed buildings with relatively poor thermal performance. These buildings will be a first and foremost target for retrofitting.

- Land and land based resources

As mentioned in terms of settlement types, there will be a crucial goal to end urban sprawl so that land take is limited as much as possible. Mandated investigations seeking for opportunities for brownfield (rather than greenfield) development are now preconditions to obtaining EU funds in support of development projects. Furthermore, coordinated EU policy on land use and landscape has been developed to create conditions that Member States' shall adhere to when developing their built environment and it especially focusses on restricting development to already developed areas.

In part through increased preference for brownfields, processes of urban mining (recycling of the materials comprising existing building and infrastructure) are now economically viable.

- Market relations (Production; consumption; export, import) and innovation

The construction sector has gone through a certain level of industrialization in order to reduce resource waste during the construction process (embodied emissions) construction process are now more coordinated because larger construction firms (operating on the national and international scales) are now commonplace.

The demand for green building products has been conditioned by policy support at a range of scales, especially in terms of financial support from national and regional administrations, coupled with knowledge and awareness support from local levels of government.

- Place-based factors

As mentioned, the importance of creating a sense of place in urban areas - where citizens can feel at home - is essential for creating competitive and robust built environments. As mentioned, this includes the acceptance of the existing built environment as a point of departure, thus accentuating the role of retrofitting for achieving Europe's resource efficiency goals. It also means that consideration of existing

building types is important for creating new buildings that are accepted by consumers, just as it implies the importance of considering local architecture and design within building development.

Not least, the responsibility of local governments – as those general responsible for land use development and the political scale most in touch with consumers of buildings – is universally understood. As such municipalities now have staff with expert knowledge in practices and processes of sustainable land use planning.

- Accessibility and mobility

As above, relating to the connection between compact city development, cities of short distances and the fact that car transport is now not the most efficient means of transport in many urban areas of Europe.

- Policy and governance by territorial level

We must set better goals, but this can only start with measuring the RIGHT successes – particularly energy consumption patterns at scales that can reflect territorial trends in population densities and building age. The key is to produce data that is clear and that does not hide places with poor performance and high potential. As such, regional and local green building action plans are tailored to regional specificities of planned growth and development. Depending on such factors, the greening of existing buildings and new development opportunities is now facilitated through policies that promote:

- Systematic audit of the energy performance of buildings.
- Local and regional incentives that are now provided and they are directly based on knowledge of the performance of the existing building stock.
- Creating official networks (green building councils, associations, etc.) at the local level to bring together key actors responsible for planning land use and construction development. This includes urban and regional administrations, local construction enterprises and those making building investments (all sorts of locally-embedded public and private sector actors, including individuals)
- Green building plans are place in a multi-sector dimension of green growth for urban regions. This especially includes consideration of mobility issues and providing incentives for existing jobs related to the development of buildings and infrastructure to be made greener. It means that municipal and regional planning now requires increased communication between existing city departments.
- Use public funds to increase focus on greening buildings focusses on social and publically owned housing.
- Local information and awareness campaigns that target the investment and consumption behaviours of building owners, including individual citizens and particularly youth are universal in European municipalities.

Perhaps most importantly, the necessary link between green building and sustainable urban planning has meant that traditional administrative constructs that have guided development since industrialization

are being rethought. As a result, the profound importance of administrative-based territorial distinctions (between municipal, regional and national levels of planning and government) are being replaced by new forms of municipal sharing and cooperation, which promotes planning that views urban regions as on complete metropolitan area.

The importance of planning and governance of the functional urban region – in other words, coordination and agreement among municipalities rather than strictly within municipalities – is important when planning for growth, but absolutely crucial when planning for resource efficient growth. This notion of “metropolitan governance” emphasizes the role of building a common vision among the range of institutions responsible planning an urban territory – notably, among the range of municipalities that comprise an urban region. As such, polycentric urban development through municipal cooperation is now a norm that replaces development of satellite communities in response to municipal competition.

While metropolitan governance requires a scaling down of territorial strategies from the national and EU levels, it also requires an up-scaling of urban land use and development planning beyond individual municipalities. But the challenge is that implementing such an approach means overcoming the underlying fact that many municipalities are in reality competing against each other rather than working together. Not only does this require innovative policy and governance solutions to bring them together, but it also accentuates a shift to the way we identify regions – from largely administrative-based structures toward ones based on the location and movement of people, materials and resources.

8.2. Synthesis of key EU policy relating to the building sector

Table 9 Analysis of sectoral policy Directive 2010/31/EU on the energy performance of buildings

Type of policy and hierarchy	**Binding framework Directive of the EU**
Name	**DIRECTIVE 2010/31/EU on the energy performance of buildings (recast)**
Description	• Provides the basis for how the building sector can respond to Decision No 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020, for which energy efficiency in the building sector will be crucial. • Lays down more concrete actions for realizing the great potential of energy efficiency in buildings, and reducing the large differences between Member States' in this area. • Member States set their own minimum requirements for energy performance. These should be set with a view to achieving the cost-optimal balance between the investments and the energy costs saved throughout the lifecycle of the building, but **without prejudice** to the right of Member States to set minimum requirements beyond those that are considered cost-optimal energy in the larger context of the EU. • States that Member States should use harmonised instruments, for testing and calculation methods and energy efficiency in relation to the Directives 2009/125/EC (on ecodesign labelling) and Directive 2010/30/EU (energy labelling) and their associated regulations mentioned below. • Encourages Member States to draw up national plans for increasing the number of nearly zero-energy buildings and regularly report such plans to the Commission. • Member States should draw up lists of existing and proposed measures, including those of a financial nature, other than those required by this Directive, which promote the objectives of this Directive. • That prospective buyers and tenants should be given correct information about the energy performance of the building and practical advice on improving such performance in a buildings' energy performance certificate. • Increased focus must be placed on optimizing thermal performance in warmer climates to reduce the energy demands of air conditioning. Measures include shading and passive cooling techniques that improve indoor climatic conditions and the microclimate surrounding buildings. • In each Member State there should be a common (an independent control mechanism) approach to certification of buildings as well as regular maintenance and inspection of heating and air- conditioning systems to ensure optimal performance. • Member States, through the activities under the Intelligent Energy

	Europe Programme, shall continue to ensure that builders and installers are being equipped with the necessary skills to integrate energy efficient and renewable energy technologies in buildings.	
Targets	• None, other than that improved energy efficiency in buildings directly relates to the ability for the EU to achieve a 20% reduction in $C0_2$ emissions.	
Territorial implication	**Characterisation**	***Strong***
	Description	• Local and regional authorities are critical for the successful implementation of green building and should be consulted and involved in the development of programmes to provide information, training and awareness-raising, and, in general, the implementation of this Directive at national or regional level. Such consultations also promote the adequate guidance to local planners and building inspectors to carry out the necessary tasks. • Municipal authorities because they are generally responsible for land use planning and development. • Public authorities should lead by example and endeavour to implement the recommendations included in energy performance certificates. Member States should include measures supporting public authorities (which, as mentioned, are general local and regional authorities that own public buildings) to become early adopters of energy efficiency improvements within their national plans. As such, buildings either occupied by public authorities or frequently visited by the public should set an example by showing that environmental and energy considerations are being taken into account. Information on energy performance should be enhanced by clearly displaying energy performance certificates and other relevant information to the public.
Indicators	Best available is change in energy consumption in the residential sector between 2000 and 2009, corrected to temperature variations between the years.	

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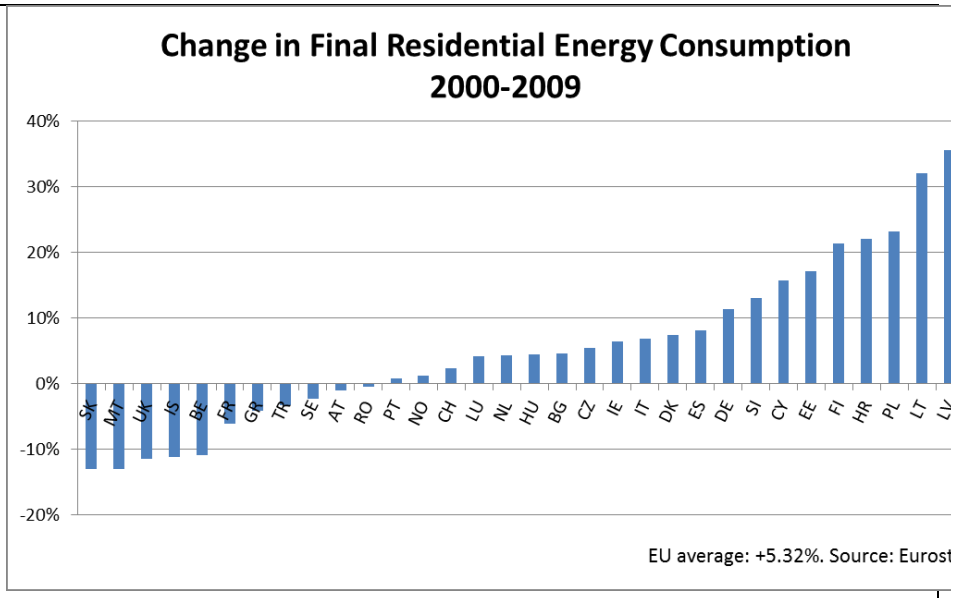
<tr><td></td><td colspan="2"> 
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<tr><td>Distance to target (Graph or map should be provided in support of the distance to target analysis)</td><td colspan="2">Based on the last ten years it quite simply shows that reductions in residential energy consumption are taking place only in a few countries. In contrast, many countries show significant increases.</td></tr>
<tr><td rowspan="2">Policy effectiveness</td><td>Characterisation</td><td>Weak</td></tr>
<tr><td>Description</td><td>The buildings directive has been effective in the sense that it provides a platform of understanding and expectations for how the sector can become greener. This is absolutely necessary due to the extremely decentralized nature of land use and built environment management in Europe, and therefore the wide number of political actors involved in the process. In this regard, it clearly highlights the role of local authorities, and how they are essential in leading investment through a greening of public buildings. However, the policy lacks binding legislation governing the overall energy performance of new buildings, and this is left up to individual MS’s (and the subsequent regional and local authorities) to decide. However, in communication with a number of local authorities with responsibility for the building and planning, we know that the directive acts as a guiding principle.

At the same time, we must say the policy is characterized as weak in effectiveness because we are still so far from achieving our 20/20/20 goals, and the overall energy consumption patterns shown in the figure above indicate that buildings are consuming much more energy than they were</td></tr>
</table>

		in 2000.
Transformative character of policy	**Characterisation**	***Incremental***
	Description	The policy lacks binding legislation governing the overall energy performance of new buildings, and this is left up to individual MS's (and the subsequent regional and local authorities) to decide. However, in communication with a number of local authorities with responsibility for the building and planning, we know that the directive acts as a guiding principle.
Green economy implication	**Characterisation**	***Positive strong (++++)***
	Description	• Due to the nature of the buildings sector, the implications of factors taken up in the buildings directive are positive strong. Achieving the goals put forth in the directive would mean that a huge share of the economy (jobs and gva) become green, that people will be living in more enjoyable and functional spaces (society) and both emissions and energy consumption will be reduced (environmental). • Achieving the policy goals will require that local growth potentials are acknowledged • All developments in the sector are largely internalized in the local economy and the local build environment. • Additional jobs are created to handle the share of buildings that need to undergo an energy retrofit. • It requires that local authorities are stimulated to create local action plans related to resource efficient land use and building development.

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