

## **National climate policies across Europe and their impacts on cities strategies**

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### **ABSTRACT**

Globally, efforts are underway to reduce anthropogenic greenhouse gas emissions and to adapt to climate change impacts at the local level. However, there is a poor understanding of the relationship between city strategies on climate change mitigation and adaptation and the relevant policies at national and European level. This paper describes a comparative study and evaluation of cross-national policy. It reports the findings of studying the climate change strategies or plans from 200 European cities from Austria, Belgium, Estonia, Finland, France, Germany, Ireland, Italy, Netherlands, Spain and the United Kingdom. The study highlights the shared responsibility of global, European, national, regional and city policies. An interpretation and illustration of the influences from international and national networks and policy makers in stimulating the development of local strategies and actions is proposed. It was found that there is no archetypical way of planning for climate change, and multiple interests and motivations are inevitable. Our research warrants the need for a multi-scalar approach to climate policy in the future, mainly ensuring sufficient capacity and resource to enable local authorities to plan and respond to their specific climate change agenda for maximising the management potentials for translating environmental challenges into opportunities

**KEY WORDS:** *Adaptation; Climate change; Mitigation; Local policy; National climate policy*

### **RESEARCH HIGHLIGHTS:**

- The paper reports on international agreements, alliances and EU policies to tackle climate change and describes climate change policies across 11 European countries (71.4% of the EU-28 population).
- The published strategies or plans from 200 European cities (16.7% of EU-28 population) are reported.
- The paper shows the links of global, EU and national policies and networks on urban/city strategies.
- The analysis shows that many cities tackle the causes (64%) and consequence (23%) of climate change.
- The influence of national climate change policies on local climate strategies or plans are discussed

# **1. Introduction**

## ***1.1. Background to climate change policies***

Dealing with climate change is one of the many challenges for the European Union (EU), which has set ambitious short and long-term emissions reduction targets (see Section 1.2). Cities are crucial actors of climate change mitigation and adaptation efforts (Kousky and Schneider, 2003; Rosenzweig et al., 2010). However, how and why cities engage in climate policy remains largely unclear and the effect of (binding or non-binding) policies from higher levels of government is hardly understood (Kelemen, 2010). Whilst scholars note a supporting effect (Biesbroek et al., 2010; Leck and Simon, 2013), the mere existence of international or indeed national climate policies is no guarantee for local plans and action (Feliciano et al., 2013; Villarroel Walker et al., 2014). There is a need to provide cross country empirical evidence on climate change policy. Our investigation of climate change strategies at the city level and its relation to EU and national policies will provide empirical evidence and advances this field of research. Specifically we address two main questions in this paper (i) how is climate change mitigation and adaptation incorporated into national and urban policies, and (ii) what implications can be drawn from the EU and national policies for climate change strategies across European and global cities.

## ***1.2. International agreements, alliances and EU policies on climate change and cities***

The United Nations Framework Convention on Climate Change (UNFCCC), adopted in 1992 (United Nations, 1992), is the leading international treaty to negotiate a stabilization of greenhouse gas concentrations in the atmosphere. Its' first international agreement—the Kyoto Protocol—sets legally binding reduction targets for each of its signatories and provides important flexibility in how national policies achieve these (European Commission, 2010a). The EU plays a leading role in global mitigation efforts (Bäckstrand and Elgström, 2013; Rayner and Jordan, 2013), establishing ambitious environmental policies (Kelemen, 2010) and pushing for internationally binding emission reduction targets (Bäckstrand and Elgström, 2013). As a “champion of environmental protection” (Kelemen, 2010, p.12), the European Parliament set the 20-20-20 target in 2009 (European Parliament, 2009). It

comprises the aim of a 20% reduction of GHG emissions, a 20% increase in energy produced from renewables and a 20% increase in energy efficiency by 2020 (1990 baseline). Moreover, in 2011 the European Commission (2011b) committed to 80% GHG emission reductions by 2050. Achieving such ambitious targets requires major interventions across scales e.g. local, catchment or regional scales; and across sectors e.g. private and public sectors (Villarroel Walker et al., 2014). It is assumed that the EU significantly influences the Member States' spatial planning policies through environmental law (European Commission, 1997; Kelemen, 2010), so potentially also through European directives on climate change (20-20-20; EU white paper on adaptation, etc.). Besides climate change being a relatively new area of policy-making in rural as well as urban areas (Feliciano et al., 2013), the EU is influencing the action of the most reactive countries by setting the path to be followed (De Gregorio Hurtado et al., 2014).

Another factor increasingly recognized as being relevant for climate protection is the capacity of Member States to engage municipalities (i.e. cities) in their national climate change policy (European Commission, 2011a; Stecker et al., 2012). The EU supports this view with initiatives such as the Energy Strategy 2020 (European Commission, 2010b), the Covenant of Mayors (2013) and the Mayors Adapt (2014), Strategic Energy Technology (SET) Plan and Smart Cities Initiative (European Commission, 2009). The foundation and actions of numerous climate change networks are a witness of this credo (Archie et al., 2014). They support, coordinate and bundle city actions, offer financial support and transfer knowledge and expertise.

### ***1.3. Policies and strategies: from national to local levels***

Across Europe, governmental, institutional and legal structures and its influence on city plans differ in relation to climate policy. For example, Albrecht and Arts (2005) found that state-centric countries (e.g. France) and transition economies (e.g. Estonia) seem to have less precise implementation plans and time frames in tackling climate change. Local climate action plans in France help to raise awareness about climate and energy issues and bring local stakeholders together to develop shared solutions suited to local specificities. However, they do not seem to launch ambitious operations conducted in a cross-

cutting manner (Yalçın and Lefèvre, 2012). Therefore, cultural, historical and planning traditions should be considered in assessing climate change efforts (Getimis, 2012; Leck and Simon, 2013). Scholars note the positive influence of national frameworks (Stecker et al., 2012) and climate networks for climate change mitigation, the latter particularly in larger cities (Cerutti et al., 2013; Rosenzweig et al., 2010). However, not all cities develop climate policies in countries that provide national climate policies, or that support international targets or joined supporting networks (De Gregorio Hurtado et al., 2014; Sharp et al., 2011).

Mitigation often seems more advanced than adaptation as it can complement or integrate sector specific policies for example transport or waste management or even master plans. Integrating adaptation issues into urban fabrics is still a challenge and national strategies identify policies and planning instruments pivotal to its integration (Biesbroek et al., 2009; Reckien et al., 2014a). The recently published European Adaptation Strategy (European Commission, 2013) provides evidence that there was a scarcity of EU initiatives for local adaptation which resulted in the current sparseness of cities considering adaptation issues (Olazabal et al., 2014). This is contrary to other parts of the world as outlined by a global survey of 468 cities, conducted by the Massachusetts Institute of Technology (Carmin et al., 2012), which found membership to organizations linking and working with local governments to sustainable practices (such as ICLEI) boosting action to adapt to climate change. Further, examining 40 local climate change action plans in the US points out that these plans have typically “a high level of awareness”, moderate “analysis capabilities” for climate change, and relatively limited “action approaches” for climate change mitigation” (Tang et al., 2010). This is also supported by an assessment of the available best practices in both mitigation and adaptation for North American cities, highlighting the need for increased attention to adaptation at the local level (Zimmerman and Faris, 2011). In Australia on the other hand, adaptation seems to be taking the lead on the climate change strategies where geographically specific action through local adaptation strategies are being prioritised (Baker et al., 2012). Along these lines, recommendations have been made towards embedding adaptation and mitigation efforts in Europe within the urban planning framework, involving appropriately all the “organisations responsible for delivering local infrastructure and services” (Heidrich et al., 2013). To this end the European

Commission has set up a new initiative to engage cities more on climate change adaptation called Mayors Adapt (2014).

It is assumed that adaptation has to be, and mostly is, undertaken by local authorities, as this is where impacts are experienced and interdependencies are more easily recognised (Biesbroek et al., 2009; European Commission, 2014; Measham et al., 2011). However, adaptation is not limited to local action (Archie et al., 2014): the regional extent of climate impacts and cross-sectoral (i.e. across various sectors such as public, industrial and private sector) nature of policies and planning often demands the coordination on larger scales (e.g. forest management, nature conservation, river basin management, water management, flood management, spatial planning).

Overall, integration of climate change into city policies remains a challenge (Heidrich et al., 2013; Zanon and Verones, 2013). However, Rayner and Jordan (2013) appreciated that the experiences gained at EU level can be of great importance to those seeking to understand climate policy, both within and between countries. It is therefore important to understand the implications of national frameworks to climate change policies, planning and performance by European cities (Albrecht and Arts, 2005). Our study responds to this need, presenting a pan-European comparative evaluation of the cross-national policies and their implications for the city/local level climate adaptation and mitigation strategies. In addition our study is, to our knowledge, the first study that investigates published and authorised mitigation and adaptation strategies rather than relying on questionnaires or responses by local authorities and their representatives as outlined in the method section below.

## **2. Research methodology**

A sample of 200 cities (defined by administrative and/or political boundaries) from 11 countries (Austria, Belgium, Estonia, Finland, France, Germany, Ireland, Italy, Netherlands, Spain and United Kingdom) were used to investigate the relation of climate change strategies at urban level to EU and national climate policies. The selection of the countries and subsequent the cities investigated are largely determined by considering the origin and research experiences of the authors. The 11 countries include

71.4% of the EU-28 population and the 200 cities approx. represent 16.7% of all EU-28 inhabitants. We gathered the required information from the Urban Audit (UA) database. This process is described in more detail in the Supplementary Information (SI-1). We then compiled a database of climate change mitigation and adaptation policy and strategy documents (see SI-2) and investigated the strategies, plans and actions by the cities in light of their national policies and plans. In particular, we focused our analysis of the documents on the following elements: Emission reduction targets; Level of achievement of such targets; Sharing of responsibility for climate change policy between different administrative tiers and the Membership to international initiatives, such as the Covenant of Mayors.

Only climate change mitigation and adaptation strategies, plans and policies that were officially adopted, published or in development by cities (if a draft was made available) were included in this analysis. The documents were obtained by either contacting city representatives or policy makers directly or by retrieving published information from the local authorities' websites, with the latest entry of policies being made in January 2013. Information on membership in the international climate network CoM was retrieved from its website. The data and national and local climate change mitigation and adaptation strategies were translated and interpreted by native speaking authors. More details on the methodology and selection criteria for the analysis is provided in SI-1 and the results of the meta-data that was generated from the 200 cities is provided in Table SI-2.

### **3. Results of the national climate policies and local climate change strategies**

The 15 countries that were part of the European Union when the Kyoto Protocol was adopted in 1997 (the 'EU-15') committed to reduce their collective emissions of six GHGs in the Protocol's first period (2008-2012) to 8% below 1990 levels. This target was then translated into country-specific targets for the EU Member States (European Commission, 2010a; UNFCCC, 2012), which are characterized by different national policies, legal systems and institutional settings (Table 1). We illustrate below how national climate policies are being translated to the urban i.e. city level by reporting on individual climate change plans and/or strategies published from the 200 cities in 11 countries that we surveyed. At national level, 10 out of the 11 countries have strategies to reduce emissions 10-20% between 2005

and 2020 and only Estonia is allowed to increase emissions during that time, because of a development concession after collapse of Soviet Union (the baseline year has been set 1990) – although their emissions actually reduced. At the end of 2011, only seven countries out of the 10 investigated reduced their emissions; Austria, Ireland and Spain, increased their emissions. Belgium, Finland, France, Germany, and the UK either met or over-achieved their targets. Italy and the Netherlands were able to reduce their emissions, but insufficiently to meet their targets.

From the 200 cities surveyed, whose details are provided in the Supplementary Table SI-2, 130 cities (64% of our sample) have dedicated climate change mitigation and 56 cities (23%) have adaptation strategies (Table 1). The United Kingdom (UK) clearly dominates the sample with 93% of the cities having a mitigation strategy. The Netherlands and Germany follow second, where 80% of the urban areas have a mitigation strategy. Belgian cities are not (yet) very active in the development of climate mitigation strategies/plans, and are being less effective in translating national policy into local action. The ratio of French cities with plans should have increased as deadlines in the National law (LOI, 2010) demanding cities to provide plans have passed since preparing this paper. The fewer number of cities with adaptation strategies could lead to the assumption that mitigation strategies are a precursor for adaptation strategies. This assumption holds true for many local strategies, but only partly for national policies (Table 1) as mitigation policies are more updated. Where there is a long history of mitigation activity, e.g. in Germany, adaptation strategies are more likely. Many cities review and update their mitigation strategies but this is rarely the case for adaptation.

**Table 1: National climate targets and policies, UA cities and membership of Covenant of Mayors (CoM) across 11 countries**

	UA Cities	EU target <sup>a</sup> 2005-2020 of GHG	Change of GHG <sup>b</sup> 1990-2011	National Mitigation Policy <sup>c</sup>	Cities with Mitigation Strategy	National Adaptation Policy <sup>d</sup>	Cities with Adaptation Strategy	CoM of UA cities	CoM Cities in Country
Country	N	%	%	Year	N	Year	N	N	N
Austria	5	-16	+16.3	2001	3	2012	0	0	14
Belgium	7	-15	-16.4	2008	3	2010	0	4	65
Estonia	2	+11	-47.3	2004	1	-	0	1	3
Finland	4	-16	-23.2	2008	3	2005	2	4	7
France	35	-14	-16.7	2011	15	2011	8	18	151
Germany	40	-14	-23.8	2000	32	2008	13	17	66
Ireland	4	-20	+2.3	2000	2	2012	0	2	9
Italy	32	-13	-9.6	2002	18	-	1	17	2,582
Netherlands	15	-16	-8.0	2007	12	2007	3	7	20
Spain	26	-10	+21.9	2007	13	2006	5	17	1,323
UK	30	-16	-28.6	2008	28	2008	24	13	44
Total	200				130		56	100	4,871

<sup>a</sup> GHG limits in 2020 compared to 2005 as agreed by European Commission, 2009a. Decision No 406/2009/EC 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, in: European Parliament and of the Council (Ed.), L 140/136. Official Journal of the European Union, Brussels, Belgium.

<sup>b</sup> GHGs including LULUCF, in Gg CO<sub>2</sub>e Change from base year (1990) to latest reported year (2011) in % as described in UNFCCC, 2013. Total CO<sub>2</sub> Equivalent Emissions with Land Use, Land-Use Change and Forestry in: United Nations Framework Convention on Climate Change (UNFCCC) (Ed.), Time series - Annex I. UNFCCC, Bonn, Germany.

<sup>c</sup> See Table SI-2 for the titles of the national mitigation policies/statutory documents that may form the legal basis.

<sup>d</sup> See Table SI-2 for the title of the national adaptation policies/statutory documents that may form the legal basis.

From Table 1 it can be seen that only 23% of the cities sampled (56 out of the 200) have an adaptation strategy or plan, though this differs substantially between countries across Europe. The United Kingdom (UK) appears to be the most active country, 80% of the cities (24 cities) have an adaptation strategy. The legal framework in the UK is similar to that in Ireland (see below), in part due to similar legal structures and historical ties. Legislation in the UK: the Climate Change Act (AoP, 2008) requests to establish climate adaptation and mitigation plans. The responsibility for climate change is divided between the national governments and its agencies of Northern Ireland, Wales and Scotland. All UK cities acknowledge climate change being a threat (Heidrich et al., 2013), although there is large variation in the detail of analysis, targets and timeframes as well as mitigation and adaptation measures under consideration and the degree of implementation across the country. Although no direct legal

requirement, climate change strategies are provided by cities, and London, Leicester and Manchester (who signed the Nottingham Declaration<sup>1</sup>) demonstrate a high level of integration of adaptation and mitigation within their planning processes. Also the three Scottish cities translated national policy into their strategies and all three signed the Scotland's Climate Change Declaration. Although most UK cities recognised that adaptation and mitigation is related, the larger emphasis tends to be placed upon mitigation. The UK achieved a 28% reduction of CO<sub>2</sub>e between 1990 to 2011 (UNFCCC, 2013). However, similar to Germany (see below), this is mainly attributable to political and economic circumstances, e.g. recession in the early 1990's and the large-scale switch from coal to gas fire plants (Darwall, 2013).

In Germany, the federal state shares responsibility for climate change policy with the Bundesländer (states). However, it has been more successful in meeting its target than Austria, achieving a reduction of CO<sub>2</sub>e of 24% between 1990 and 2011 (UNFCCC, 2013). Germany has a national climate protection strategy and targets for emissions reductions, which was adopted in 1990 by the Federal Environment Ministry (BMU) and a national climate change adaptation strategy (Bundeskabinett, 2008). Approximately 80% of GHG emissions in Germany relate to energy and a large proportion of its reduction has been attributed to the reunification of Germany and “clean up” of coal power stations and economic change in the former East Germany (Darwall, 2013). We found that 80% of the 40 cities analysed provide a mitigation plan with qualified GHG reduction targets, but only 32.5 % have an adaptation strategy. Only 12 cities have both an adaptation and a mitigation strategy, like the capital city of Berlin as well as some larger cities like Stuttgart in the South, Hamburg in the North, Dresden in the East and Düsseldorf in the West. The most ambitious cities are Berlin and Hamburg both targeting a GHG emissions reduction of 40% in 2020 and 85% and 80%, respectively in 2050.

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<sup>1</sup> The Nottingham Declaration is a network initiative in England to tackle climate change and its signatories acknowledge for example, the risks of climate change, work to reduce emissions, monitor progress and publish results.

In the Netherlands (NL) the national “Climate Agenda: resilient, prosperous and green” (DMIE, 2013) outlines a combined approach to climate adaptation (by designing a resilient physical environment and preparing society for the consequences of climate change) and mitigation (by reducing greenhouse gas emissions). For supporting climate change mitigation on the national level the Central government and the provincial authorities reserve space for more onshore wind farms for about 6,000 MW until 2020 (DMIE, 2011). While the regions are mainly in charge for balancing urban and green space development, the municipalities have a relative freedom to decide about the urbanization policies and development plans. Therefore, the municipalities are the main actors in the Dutch climate change policy development. The cities are very active and ambitious, e.g. many aim to become carbon-neutral within 40 years (Reckien et al., 2014b). On the contrary, climate change adaptation is hardly practiced by Dutch municipalities, despite some interesting research initiatives like the Climate Proof Cities programme. The city of Rotterdam is the only Dutch city that has an explicit and detailed climate change adaptation plan. The main reason for the lack of adaptation programmes in the NL is the so-called Delta Programme (<http://www.deltacommissaris.nl/>), which is a national programme that handles strategic adaptation planning and implementation to address rising sea levels and other water supply and water quality issues. Based on the awareness of these national instruments, Dutch cities may perceive no need to provide local plans. In addition, Biesbroek et al. (2011) identified conflicting timescales and interests, lack of financial resources, unclear division of tasks and responsibilities, uncertain societal costs and future benefits, and a fragmentation within and between scales as the main barriers for the development and implementation of climate change adaptation strategies.

The implementation of Finland’s climate change policy is carried out by several institutions at the national, regional and local levels. Unlike Austria and Belgium, the implementation of climate planning occurs in the regions and municipalities. Of the four UA Finish cities in our sample (Helsinki, Oulu, Tampere and Turku) only Turku does not have adaptation strategy and local mitigation strategy covered only the years 2009-2013 (currently included in regional climate strategy). The mitigation plans stipulate targets in line with the UNFCCC and the local adaptation plans highlight the importance for

Finish cities of assessing the risks due to climate change. This provides some evidence that the national policy has been translated well into regional and urban policies resulting in coherent local action.

In France the responsibility for climate change is also divided between national, regional and local levels, but the national level has a strong guiding and directing function for cities — which is different from Austria, Belgium, Germany, Estonia and Finland, and can only be compared with the Climate Change Act (AoP, 2008) in the UK and the Climate Change Bill (2013) in Ireland. Guidance documents are provided by the national government and government agencies, e.g. through the 2004 National Climate Plan that encouraged cities to develop Climate-Energy Plans (PCETs). The 2010 Grenelle II Law made it legally binding for regions, departments (sub-regional administrative entities) and cities or group of cities of more than 50,000 inhabitants to release a PCET. The implementation of local climate policies can lead to the creation of dedicated agencies like the Parisian Climate Agency (APC). Out of the 35 French UA cities surveyed, 21 published mitigation and 12 published adaptation strategies. Whereas most plans reflect the national 2020 or 2050 targets, a few cities are more ambitious, either by setting higher reduction targets for 2020 (e.g. Paris, Bordeaux and Strasbourg) or by choosing a more recent baseline (e.g. Grenoble). Some cities set different mitigation targets for activities linked to public service and the city as a whole: for example, the city of Paris sets a 30% mitigation target in 2020 using a 2004 baseline for all municipal activities while it only aims at 25% reduction for the territory, including private activities and households. The adaptation aspect is not always dealt with or elaborated by the cities surveyed, although this was aimed for in the Grenelle II Law. Adaptation strategies are more detailed at the regional level as parts of the Regional Climate, Air and Energy Schemes. However climate change planning seemed dominated by mitigation policy, whereas regions deal with larger spatial units and tackle adaptation.

Estonia has reduced its CO<sub>2</sub>e by 47% (Table 1), but this is mainly due to a decrease in energy exports, whilst energy production still accounting for 89% of the total GHG emissions in 2011 (UNFCCC, 2013). The government is centrally responsible for climate planning and coordinates regional and local actions. However, some local governments instigated their own adaptation strategies to respond to floods and storms since an extreme storm in January 2005. But the completion of local strategy is a

long process (mainly due to limited capacity and low climate risks). From the two Estonian UA cities analysed (Tallinn and Tartu) it is only the capital city (Tallinn) that has a mitigation strategy; none of them has an adaptation strategy.

In Italy the Inter-Ministerial Committee for Economic Planning (CIPE, 2002) approved the National Climate Change Strategy in 2002 and established a cross-ministerial body responsible for monitoring and evaluating the policies in the national strategy (Hogan et al., 2012). Currently, the Ministry for the Environment, Land and Sea (IMELS) administers the implementation process of a National Adaptation Strategy (NAS), which is expected to be completed in 2014. Similarly to France, Ireland, Estonia and Finland, guidance and national strategy are provided by the national government and its agencies, which direct regional and local climate strategy. No specific examples could be found by Italian cities that would illustrate comprehensive mitigation plans, though most cities are active on mitigation issues, mainly through Municipal Energy Plans and, in recent years, Sustainable Energy Action Plans (SEAPs) as members of the CoM (e.g. Genova, Bologna, Modena and Bari). There is little climate change adaptation, which in part is due to the lack of guidelines given at the national or regional level. Adaptation initiatives are often carried out at a higher administrative level of Provinces or Regions (e.g. the Province of Genoa).

In Austria, where national emission reduction targets were not met, and Germany, where emission targets were surpassed, responsibilities are shared between the federal states<sup>2</sup> (i.e. Länder) and local authorities. The focus of climate planning in Austria appears to be at the national level with its Climate Protection Act (Klimaschutzgesetz) rather than at a city level, although a number of its 'Länder' (Vienna, Upper Austria, Lower Austria, Salzburg) also have their own regional climate change programmes (Kriech et al., 2009). In 2002, Linz set an ambitious target of 50% reduction by the year 2030, whilst Vienna and Graz have set CO<sub>2</sub>e reduction targets of 21% and 30% by 2020 (with a 1990

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<sup>2</sup> The Federal State is a political entity characterized by a union of partially self-governing states or regions under a central (federal) government.

baseline). It is interesting to note that there is not one Austrian city that published an adaptation plan.

In Ireland guidance documents and plans are provided by the national government and agencies. As in France, adaptation strategies are prepared regionally using the national guidance. The Framework for Climate Change Bill provides for a statutory obligation on the Minister to propose to the Government a National Climate Change Strategy on a 5 year cycle and to review the previous Strategy at the end of this time (DEHLG, 2010). The Climate Change Act is now at a Bill phase in the Houses (i.e. Seanad and Dáil) of Parliament in Ireland (Oireachtas, 2013 ). So far, Irish cities have not published binding mitigation targets or adaptation policies and Dublin has a rather descriptive strategy. In early 2012 two cities, Cork and Dublin, prepared initial drafts of climate change strategies. In addition, a number of Regional Authorities had developed draft climate change strategies. However, the process is underway via the Climate Change Bill 2013 and the ‘National Climate Change Adaptation Framework, Building Resilience to Climate Change (DECLG, 2012)’ and Irish cities now should develop strategies. This will be facilitated through the County and City Development Plans in Ireland and all Irish UA cities i.e. Galway, Limerick, Cork city and Dublin are currently developing and approving climate change strategies.

In Belgium, the National Commission introduced the first National Climate Plan in 2009 (Commission Nationale Climat, 2009) and a National Adaptation Strategy in 2010 (Hoyaux et al., 2010). Similar to Austria, the focus of climate planning is centred at the regional and federal government level. Among the seven Belgium UA cities, we could only identify a few initiatives in the Brussels region and in a number of cities in Flanders. Brussels’ mitigation strategy was published in 2002 and (only) refers to a 7.5% CO<sub>2</sub>e reduction target to be achieved in 2010 (1990 baseline). Consecutive to joining the CoM initiative, Brussels published another mitigation strategy in March 2010 describing measures that are adopted to reach the 20% emissions reduction target of the EU by 2020 and to decrease this further to 30% by 2025 (1990 baseline). However, Brussels does not depict the situation in Belgium as it has not

only city, but also a regional status. Some examples such as Antwerp and Gent show that a few cities are nonetheless active in Flanders, the former even aiming at being carbon neutral by 2050.

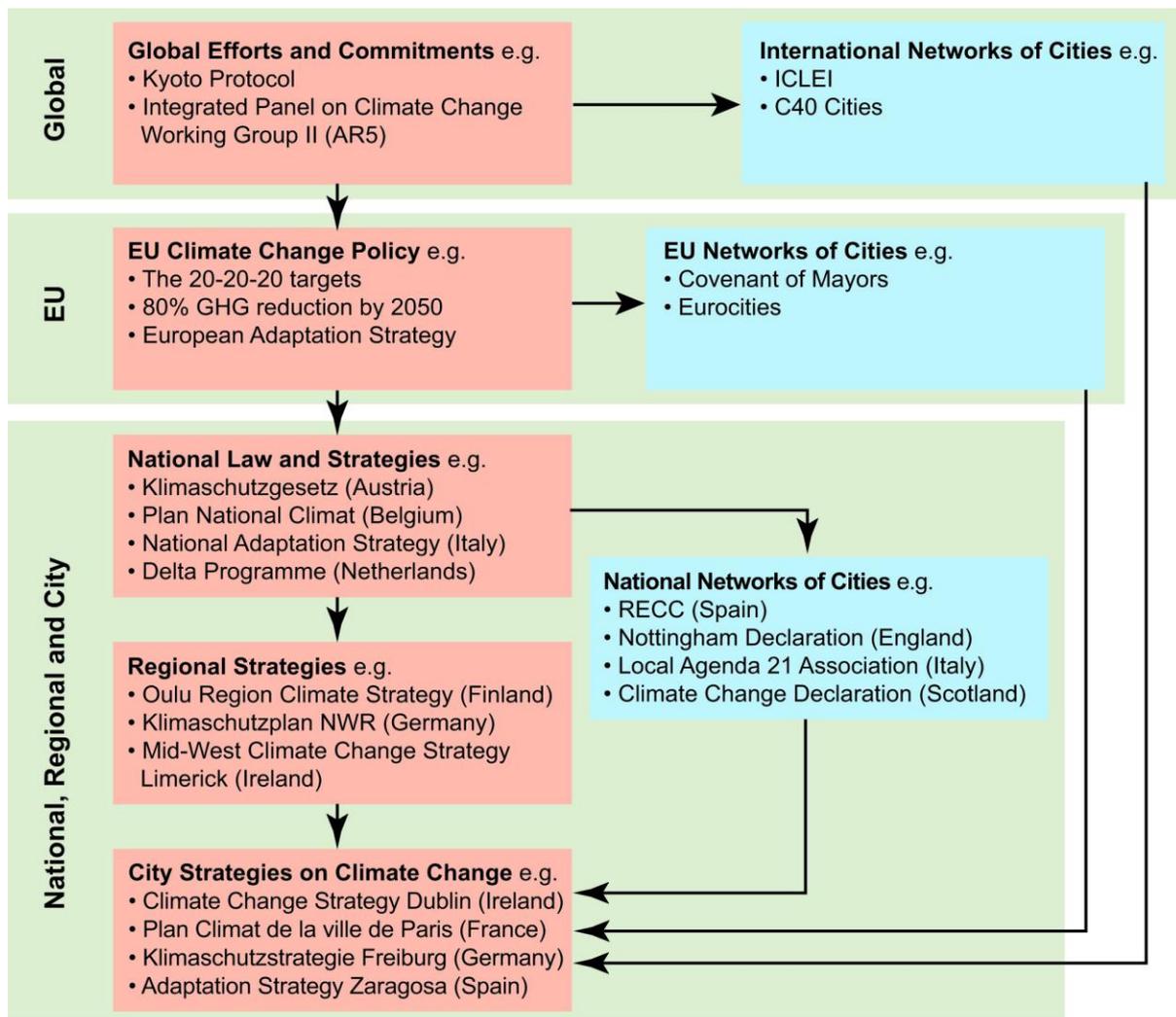
In 2007, the Spanish Strategy on Climate Change and Clean Energy (*EECCCEL*) (Gobierno de España, 2007) was published setting the framework to national, regional and local policies on climate change. The National Plan for Adaptation to Climate Change (MARM, 2006) provides adaptation guidelines, but until the publication of its 3<sup>rd</sup> Work Programme in 2013 there was no explicit mention to the importance of urban adaptation.. The country is governed under a parliamentary monarchy with a high level of decentralization and devolution to the governments of the 17 regions (Autonomous Communities), with important competences for climate change policies like spatial planning, housing or internal water basins management, as well as to the municipalities, having as in many other countries competences among others related to land use, mobility, water supply or waste treatment, also crucial for climate action and that require considerable coordination with upper administrative levels. As a result the regions and local authorities share administrative and regulatory competences in many policy areas. Sixteen of the 17 regions have developed and approved their climate change strategies (the 17<sup>th</sup> is under development). These are usually mitigation strategies that include some testimonial adaptation measures, in most cases not related to a proper climate vulnerability assessment, which is also the case at local level. In 2004 the Ministry of Environment created the Spanish Network of Cities for Climate Protection (RECC), which incorporates all the cities we reviewed. Almost all are members of the CoM. Madrid, Murcia and Zaragoza have some of the most ambitious targets in terms of both overall emissions reduction and the timeframe to deliver. Few cities have included adaptation in their climate strategies. Zaragoza is the only city where a strategy exclusively for adaptation has been developed, also setting ambitious targets with a 30% reduction of GHG emissions by 2015. Among the 13 cities having a mitigation strategy, 6 of them belong to 3 regions that have developed initiatives for supporting local climate action from the regional or provincial governments, i.e. Andalucía, Catalonia and Basque Country, being the rest of cities spread among other 7 regions.

We also analysed the influence of climate networks on local climate action (Table 1). As hypothesised, our study found that a large proportion of cities take part in global and European climate networks (e.g.

Eurocities, Energy Cities, Climate Alliance and CoM). Participating in these transnational networks and alliances supports the development of an explicit urban approach to climate change, providing cities with easy access to best practices and helping them to develop local capacity (Cerutti et al., 2013). We analysed the influence of the CoM in more detail, as a wide range of cities across Europe were part of this initiative. Signatories of the CoM go beyond the EU 2020 targets committing to reduce CO<sub>2</sub> emissions by at least 20% and promoting concrete measures and projects aimed at increasing energy efficiency and the use of renewable energy sources. Table 1 illustrates that countries with a high number of mitigation plans i.e. Germany, Netherlands, and UK, have relatively few cities that are members of CoM. On the other hand, Italy and Spain are the countries with the largest number of signatories of the CoM (respectively 2,582 and 1,323 municipalities), together representing more than 77% of the overall number of COM signatories (Cerutti et al., 2013; Reckien et al., 2014b).

It is noteworthy that the proportion of cities with adaptation strategies is much lower in countries without (Estonia and Italy) or recently produced (Austria and Ireland) national adaptation policies. Moreover, cities often develop strategies only for their own operations i.e. set specific goals and measures for their administration (e.g. Utrecht, NL; Aberdeen, UK). This is understandable as they fall within their control and do not require action from third parties such as citizens, businesses, utility owners, commerce or industry. For example, in the UK, of the 28 cities that had published climate change strategies, the majority (16 local authorities ~60%) had a strategy just for the authority own activities, i.e. for the provision of municipal services such as administrative services in public buildings, public sport centres operation or public areas maintenance. Strategies that require third party involvement were published after the local authority's own strategy.

Overall, our analysis highlights that European cities have large differences in terms of their degree of advance in climate change policy, and the different motivations that lie behind the development of mitigation and adaptation strategies. It seems that adaptation, although delayed, runs behind mitigation strategies (e.g. UK and Germany) and that, while national legislation might be instrumental for the development of local climate strategies (e.g. France), international networks and activities are able to act as a motivator in the approval of strategies (e.g. Italy).



**Figure 1. Links of global, EU and national policies and networks on urban/city climate change strategies/plans.**

Our findings highlight the shared responsibility that global, European, national, and regional policies and international networks have in stimulating the development of local climate strategies as illustrated in Figure 1. Global commitments may result in the creation of international networks similar as EU commitments have resulted in EU networks of cities. Within the countries we investigated there is clear evidence that national law, policies and networks, and sometimes even regional networks, do support cities in developing their strategies. Nevertheless as discussed previously, the existence of global policies or national legislation or similar structures do not guarantee the development of city strategies.

## **4. The influence of national climate change policies on local climate strategies and plans**

From the analysis above we reckon that the influence of national policy frameworks and guidelines seems inconclusive, as causal relationships cannot be established with any certainty. Whether a country is a late-comer or a forerunner in the development of national climate change policies had varying influences on the likelihood of developing local adaptation and mitigation policies. For example, Germany's first national mitigation strategy (2000) is rather old compared to the UK's Climate Change Act (AoP, 2008), but both countries rank high in mitigation strategies. The same holds true for adaptation. While Finland's adaptation strategy is the oldest in the sample (2005), they have besides this document recently introduced The National Climate Change Adaptation Plan 2022 of Finland, In total 75% of studied Finish cities have adaptation strategies, almost similar to UK, where 80% of cities have adaptation strategies.

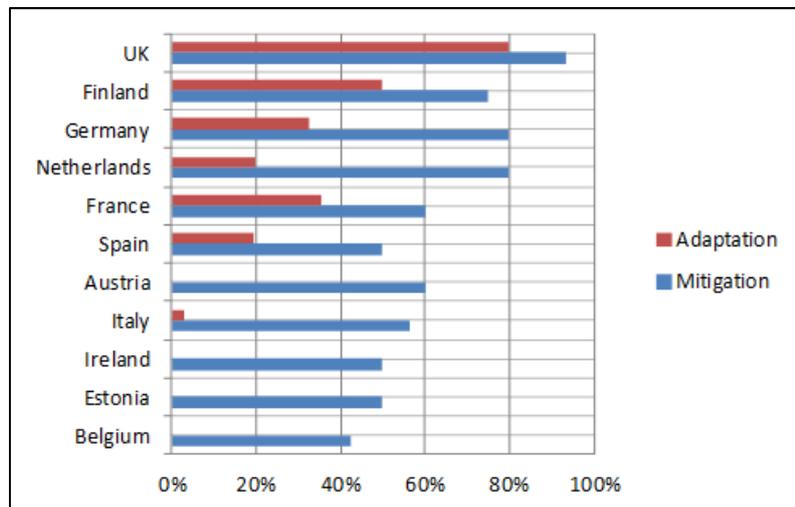
Countries that acted rather late in terms of national climate change policies have in the past followed EU policy rather than leading it in terms of influencing the agenda or implementing policies (Börzel, 2002; ESPON Climate, 2011), i.e. they have in the past followed EU policy rather than leading it in terms of influencing the agenda or implementing policies. Yet, Spain has been relatively late in adopting policies but has now developed and implemented a number of mitigation and adaptation policies (ESPO Climate, 2011). Countries that acted late in formulating a comprehensive national mitigation strategy have seen some of their cities develop disconnected climate change policies and measures. Others, e.g. Ireland and France try to "catch up" quickly and cities release many sectoral policies and set ambitious long-term targets but again there is limited cohesion in achieving the country's long-term targets.

France provides an interesting case where national policies make the development of local climate change action plans obligatory. Its scope of climate strategies usually cover the whole city territory and concern all shareholders and inhabitants but some cities like Paris set higher targets and more ambitious actions for local administration activities (for example for public buildings or municipal vehicle fleet).

Before the law made their development compulsory, only sectoral actions as parts of local Agenda 21 were undertaken by the cities (with the sole exception of the capital Paris that released a comprehensive independent plan in 2007). The 2010 Grenelle II law (LOI, 2010) led to the adoption of a flourishing number of local climate strategy between 2010 and 2013. In Spain, there is no legal requirement for cities to develop mitigation or adaptation strategy. However, the central government is providing a framework for climate mitigation and adaptation and a number of institutional initiatives support the involvement of the regions in order to achieve the national goals. In addition, specific regional governments like Andalucía are developing a binding approach similar to France or UK, with a new legal framework under discussion now, making compulsory climate strategies for cities over a certain population threshold. Regional advances are also supported by EU initiatives, for example in Italy, but there is no central obligation regarding the implementation of local climate strategy. In most of the cases the proactive role of cities in implementing climate strategy depends on their involvement in international associations (e.g. CoM, Local Agenda 21), and/or in European projects. For example, the adaptation plan of Padova (Italy) and more recently the one of Ancona have been developed following the cities' involvement in specific EU projects.

A comprehensive analysis of both mitigation and adaptation strategies in the UA cities allows to make a ranking of the 11 European countries in terms of climate change preparedness and planning at urban scale (Figure 2). UK is still at the top of this ranking list followed by Finland and Germany whereas Ireland, Estonia, and Belgium bring up the rear. It is interesting to cross the state-of-art of cities climate planning with their *compulsory* or *voluntary* nature according to their respective national laws (Table 1); it can be seen that in those countries where a national law requires municipalities to prepare urban climate strategies there is a large number of cities having mitigation and adaptation strategies (e.g. UK, France). Italy is one of the exception because a substantial number of mitigation strategies (namely SEAPs) have been implemented voluntarily by cities in the framework of the CoM commitments although there is no legal obligation on a national level. In Ireland the local authorities can implement strategies for all citizens, businesses, utility owners, commerce and industry to include climate change and mitigation requirements in any new developments within the framework of the county or city

‘development plan’. These requirements are usually underpinned by the regional planning authorities and government policies and statutory laws.



**Figure 2. Ranking of urban climate planning in the 11 countries analysed (as percentage of UA cities with climate plans).**

Policy integration often takes place at higher regional and national level and not at the local level. Regions might often be the more relevant scale for tackling and managing climate change issues, e.g. for urban sprawl and its relationship to mitigation, or for the catchment scale and corresponding flood risk management with respect to adaptation (Biesbroek et al., 2009; Leck and Simon, 2013). Furthermore, although an influence of national government frameworks on city strategies was documented in some countries (Stecker et al., 2012), a national framework is not always sufficient to trigger climate change action on the ground (De Gregorio Hurtado et al., 2014; Feliciano et al., 2013). Our study corroborates the findings of Baker et al. (2012), which call for common standards for local climate adaptation strategies which must be established in strict collaboration among different levels of governments (local, regional and national). For instance, the French experience of the Grenelle policy showed how strong national legislation can lead to a thriving number of comprehensive local climate strategies within only a few years. Although many French cities experience delays in the application of the national policy, mostly due to lack of local capacity and long consultative processes, detailed national guidance and support by the French environmental agency (ADEME) makes it easier for cities

to develop strategies. Also, the UK has a high number of city adaptation and mitigation strategies, high sectoral policies and a nationally agreed long-term target, indicating that national legislation and policies are effective. In turn, the example of Italy shows the contrary: a national framework might not be required to stimulate climate change strategy development. Overlaps of national, regional and city climate policies can exist as central government policies influence the selection of mitigation and adaptation measures within cities (Biesbroek et al., 2009; Bulkeley and Kern, 2006). However, we also provided evidence that the lack of national leadership can lead to a more active membership in climate change networks. Many other strategies such as transport, waste, energy policy can have significant impacts and relevance to climate change (Villaruel Walker et al., 2014). Those strategies can strengthen climate action-related areas such as: reduction of emissions from transport (e.g. transport plans); protection from hydrologic risks (e.g. flooding, drought) and hydro-geological risks (e.g. landslides, aquifer vulnerability); increasing carbon absorption (e.g. green urban areas); creation of fresh air corridors (e.g. urban parks); support and assistance during the summer months for disabled and elderly people (e.g. heat wave strategies, early warning systems). However, our study collected, investigated and analysed policy, strategy and planning documents published by the cities under the banner of 'climate change', 'mitigation' or 'adaptation'. This limits the conclusions of our study, as action in other sectors or at bigger administrative scales (e.g. those related to transport, national rail infrastructure, coastal floods) might have been developed, but were not included. For example, in Ital, Spain or the Netherlands, flood protection responsibilities pertain to regional and national levels and therefore, no such action or measures are exclusively implemented at local level. Cities are close to its citizens, which can positively influence emission reduction efforts at the local level and safeguard and manage the risks of extreme events and disasters. This leads to a shared responsibility between cities and its citizens and the potential costs and benefits of mitigation and adaptation will increase the planning and action on the ground. Beyond the influence of the upper levels of government and networks of cities (Leck and Simon, 2013), the local level seems to be acting on the basis of the experience gained in implementing environmental policies, as well as broader development policies allied to climate action(e.g. land use, mobility, entrepreneurship, social care, housing, etc.), over the years. This experience can provide cities with the skills necessary to cope with climate issues, even in countries that have not established an

explicit link between national and local climate action. In those cases, the experiences gained by cities on environmental matters have made them aware of the importance of being active in the climate change policy field (De Gregorio Hurtado et al., 2014). However, tackling global issues requires more than the planning and action from the most forward-looking cities (Leck and Simon, 2013). Stronger and coherent national and where applicable regional strategies are required. Our analysis confirms that a “multi scalar approach to provisioning of plans and strategies” (Bulkeley and Kern, 2006; Leck and Simon, 2013) from European, national to regional level is the most effective in ensuring that cities will plan for mitigation and adaptation. Cities can provide and deliver strategies without the wider support and guidance but they need to have the capacity, resource and political will to do so. Our analysis shows that, where such wider support is limited, only larger or capital cities have achieved this. This creates a considerable gap between smaller cities and larger cities, which should be addressed by providing support and clear climate change strategies for cities of any size. One potential solution seems the creation and employment of larger planning units for climate change mitigation and adaptation issues, e.g. grouping municipalities through the organisation of collective action of a number of smaller cities.

## **5. Conclusions**

The research showed a substantial commitment by European cities, albeit with a higher degree of emphasis on deployment of mitigation compared to adaptation so far. However, it is difficult to establish causal relationship between European and national policies and the climate change adaptation and mitigation strategies by the cities. This is at least in part due to scale, as mitigation and adaptation are cross-sectoral (ESPON Climate, 2011). In our analysis the UK sticks out in many respects, i.e. the number of adaptation and mitigation strategies, sectoral policies and its nationally agreed long-term targets. Their planning system is based on larger spatial units compared to other EU member states, such as Ireland, France, Germany, the Netherlands, and Spain (Oxley et al., 2009), which probably makes their adaptation and mitigation planning more effective and coherent. We found that the relevance of the size of spatial planning units for the suitability, or efficiency of mitigation and adaptation strategies at broader scales, might also address the vacuum currently noticed in smaller cities

with no climate change strategies. The CoM initiative is found to be popular in the Southern European countries, particularly those which either lack national mitigation strategies (e.g. Italy) or have implemented them relatively late (e.g. Spain). Moreover, cities in countries with no nationally agreed long-term targets often align GHG reduction levels at the EU20-20-20 targets, as seen in Spain, Italy and Estonia. This suggests that European climate policies have a large influence in countries without, or with weaker, national policies. Our analysis shows that many European cities are proactive on climate change. However climate change mitigation and adaptation often lies outside the administrative boundary of the city and clear guidance and collaboration across the city boundary is needed. Therefore, cities look for national guidance but if this is not available, the most proactive ones align themselves to international guidance and networks such as ICLEI (2008) and CoM. We conclude that, there is no archetypical way of planning for climate change, and multiple interests and motivations are inevitable. As a natural next step, our research warrants the need for a multi-scalar approach to climate policy, mainly ensuring sufficient capacity and resource to enable local authorities to plan and respond to their specific climate change agenda.

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## 7. References

Albrecht, J., Arts, B., 2005. Climate policy convergence in Europe: An assessment based on National Communications to the UNFCCC. *Journal of European Public Policy* 12, 885-902.

AoP, 2008. The Climate Change Act, in: (AoP), A.o.P. (Ed.). Her Majesty's Stationery Office (HMSO) and Queen's Printer of Acts of Parliament,, UK, p. 103.

Archie, K.M., Dilling, L., Milford, J.B., Pampel, F.C., 2014. Unpacking the 'information barrier': Comparing perspectives on information as a barrier to climate change adaptation in the interior mountain West. *Journal of Environmental Management* 133, 397-410.

Bäckstrand, K., Elgström, O., 2013. The EU's role in climate change negotiations: From leader to 'lead-actor'. *Journal of European Public Policy* 20, 1369-1386.

Baker, I., Peterson, A., Brown, G., McAlpine, C., 2012. Local government response to the impacts of climate change: An evaluation of local climate adaptation plans. *Landscape and Urban Planning* 107, 127-136.

Biesbroek, G.R., Swart, R.J., Carter, T.R., Cowan, C., Henrichs, T., Mela, H., Morecroft, M.D., Rey, D., 2010. Europe adapts to climate change: Comparing National Adaptation Strategies. *Global Environmental Change* 20, 440-450.

Biesbroek, G.R., Swart, R.J., van der Knaap, W.G.M., 2009. The mitigation-adaptation dichotomy and the role of spatial planning. *Habitat International* 33, 230-237.

Biesbroek, R., Klostermann, J., Termeer, C., Kabat, P., 2011. Barriers to climate change adaptation in the Netherlands. *Climate Law* 2, 181-199.

Börzel, T.A., 2002. Pace-setting, foot-dragging, and fence-sitting: Member State responses to Europeanization. *Journal of Common Market Studies* 40, 193-214.

Bulkeley, H., Kern, K., 2006. Local government and the governing of climate change in Germany and the UK. *Urban Studies* 43, 2237-2259.

Bundeskabinett, 2008. Deutsche Anpassungsstrategie an den Klimawandel, in: Bundesregierung, D. (Ed.). vom Bundeskabinett am 17. Dezember 2008 beschlossen, Berlin, Germany.

Carmin, J., Nadkarni, N., Rhie, C., 2012. Progress and Challenges in Urban Climate Adaptation Planning: Results of a Global Survey. MIT, Cambridge, MA: USA.

Cerutti, A.K., Iancu, A., Janssens-Maenhout, G., Melica, G., Paina, F., Bertoldi, P., 2013. The Covenant of Mayors in Figures 5-Year Assessment. Joint Research Centre- Institute for Environmental Sustainability, Luxembourg, p. 52.

CIPE, 2002. Approvazione del Piano nazionale per la riduzione delle emissioni di gas responsabili dell'effetto serra 2003 – 2010, in: Deliberation of the Inter-Ministerial

Committee for Economic Planning (CIPE) (Ed.), CIPE 123, Rome, Italy.

Commission Nationale Climat, 2009. Plan National Climat de la Belgique 2009 - 2012. Commission Nationale Climat.

Covenant of Mayors, 2013. Covenant of Mayors. Covenant of Mayors Office, Brussels Belgium.

Darwall, R., 2013. The age of global warming- A history. Quartet Book Ltd., London, UK.

De Gregorio Hurtado, S., Olazabal, M., Salvia, M., Pietrapertosa, F., Olazabal, E., Geneletti, D., D'Alonzo, V., Feliú, E., Di Leo, S., Reckien, D., 2014. Implications of Governance Structures in Urban Climate Action: Evidence from Italy and Spain, BC3 Working Paper Series 2014-2. Basque Centre for Climate Change (BC3), Bilbao, Spain.

DECLG, 2012. National Climate Change Adaptation Framework- Building Resilience to Climate Change, in: Department of the Environment Community and Local Government (DECLG) (Ed.), p. 72.

DEHLG, 2010. Framework for Climate Change Bill 2010. Department of Environment, Heritage and Local Government (DEHLG),, Dublin, Ireland.

DMIE, 2011. Summary National Policy Strategy for Infrastructure and Spatial Planning- Making the Netherlands competitive, accessible, liveable and safe. Dutch Ministry of Infrastructure and the Environment (DMIE), The Hague

DMIE, 2013. Climate Agenda: Resilient, prosperous and green (Summary). Dutch Ministry of Infrastructure and the Environment (DMIE), The Hague

ESPO Climate, 2011. Climate change and territorial effects on regions and local economies. ESPON & IRPUD, TU Dortmund University, Luxembourg, p. 302.

European Commission, 1997. The EU compendium of spatial planning systems and policies. Official Publications of the European Communities, Luxemburg, p. 192.

European Commission, 2009. Investing in the Development of Low Carbon Technologies (SET-Plan), Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. European Commission, Brussels, Belgium, p. 15.

European Commission, 2010a. Commission Decision of 15 December 2010 Amending Decision 2006/944/EC determining the respective emission levels allocated to the Community and each of its Member States under the Kyoto Protocol pursuant to Council Decision 2002/358/EC, in: European Commission (Ed.), L 332/41. Official Journal of the European Union, Brussels, Belgium,, p. 2.

European Commission, 2010b. Energy 2020- A strategy for competitive, sustainable and secure energy. Communication from the Commission to the European Parliament, the Council, The European Economic and Social Committee and the Committee of the Regions, Brussels, Belgium.

European Commission, 2011a. Energy Efficiency Plan 2011, Commission to the European

Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. European Commission, Brussels, Belgium, p. 16.

European Commission, 2011b. A Roadmap for moving to a competitive low carbon economy in 2050, Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. European Commission, Brussels, Belgium, p. 15.

European Commission, 2013. An EU Strategy on adaptation to climate change. EC, Brussels, Belgium, p. 11.

European Commission, 2014. Adaptation Strategies for European Cities, in: European Commission DG Climate Action (Ed.).

European Parliament, 2009. Decision No 406/2009/EC 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, in: European Parliament and the Council of the European Union (Ed.), L 140/136. Official Journal of the European Union, Strasbourg, France.

Feliciano, D., Hunter, C., Slee, B., Smith, P., 2013. Selecting land-based mitigation practices to reduce GHG emissions from the rural land use sector: A case study of North East Scotland. *Journal of Environmental Management* 120, 93-104.

Getimis, P., 2012. Comparing Spatial Planning Systems and Planning Cultures in Europe. The Need for a Multi-scalar Approach. *Planning Practice and Research* 27, 25-40.

Gobierno de España, 2007. Estrategia Española de Cambio Climático y Energía Limpia (Spanish climate change and clean energy strategy), Horizon 2007-2012-2020. .

Heidrich, O., Dawson, R.J., Reckien, D., Walsh, C.L., 2013. Assessment of the climate preparedness of 30 urban areas in the UK. *Climatic Change* 120, 771-784.

Hogan, P., Falconer, A., Micale, V., Vasa, A., Yu, Y., Zhao, X., 2012. Tracking Emissions and Mitigation Actions: Current Practice in China, Germany, Italy and the United States, CPI Working Paper. Climate Policy Initiative, San Francisco, USA.

Hoyaux, J., Verheyden, S., Bogaert, J., Ghelen, Y., Leest, M.v., Avort, A.v.d., Squilbin, M., 2010. Belgian national climate change adaptation strategy, in: Commission, N.C. (Ed.). Flemish Environment, Nature and Energy Department, Brussels, Belgium.

ICLEI, 2008. The Five Milestone Process. International Council for Local Environmental Initiatives (ICLEI).

Kelemen, R.D., 2010. Globalizing European Union environmental policy. *Journal of European Public Policy* 17, 335-349.

Kousky, C., Schneider, S.H., 2003. Global climate policy: Will cities lead the way? *Climate Policy* 3, 359-372.

Kriech, M., Lamport, C., Friedrich, A., 2009. Fifth National Communication of Austria under the Framework Convention on Climate Change. Federal Ministry of Agriculture, Forestry, Environment and Water Management Vienna, Austria.

Leck, H., Simon, D., 2013. Fostering Multiscalar Collaboration and Co-operation for Effective Governance of Climate Change Adaptation. *Urban Studies* 50, 1221-1238.

LOI, 2010. LOI n° 2010-788 du 12 juillet 2010 portant engagement national pour l'environnement.

MARM, 2006. Plan Nacional de Adaptación al cambio climático (National Plan for Adaptation to Climate Change Spanish Ministry of Environment).

Mayors Adapt, 2014. Mayors Adapt- Promoting urban leadership in adaptation to climate change, in: Action, E.C.s.D.G.C. (Ed.). *Covenant of Mayors*.

Measham, T.G., Preston, B.L., Smith, T.F., Brooke, C., Gorrdard, R., Withycombe, G., Morrison, C., 2011. Adapting to climate change through local municipal planning: Barriers and challenges. *Mitigation and Adaptation Strategies for Global Change* 16, 889-909.

Oireachtas, 2013 Climate Change Act 2013.

Olazabal, M., De Gregorio Hurtado, S., Olazabal, E., Pietrapertosa, F., Salvia, M., Geneletti, D., D'Alonzo, V., Feliú, E., Di Leo, S., Reckien, D., 2014. How Italian and Spanish Cities are tackling climate change? A local comparative study, BC3 Working Paper Series 2014-3. Basque Centre for Climate Change (BC3), Bilbao, Spain.

Oxley, M., Brown, T., Nadin, V., Qu, L., Tummers, L., 2009. Review of European Planning Systems, Centre for Comparative Housing Research. Leicester Business School De Montfort University, Leicester, UK.

Rayner, T., Jordan, A., 2013. The European Union: The polycentric climate policy leader? *Wiley Interdisciplinary Reviews: Climate Change* 4, 75-90.

Reckien, D., Flacke, J., Dawson, R.J., Heidrich, O., Olazabal, M., Foley, A., Hamann, J.J.P., Orru, H., Salvia, M., De Gregorio Hurtado, S., Geneletti, D., Pietrapertosa, F., 2014a. Climate change response in Europe: What's the reality? Analysis of adaptation and mitigation plans from 200 urban areas in 11 countries. *Climatic Change* 122, 331-340.

Reckien, D., Flacke, J., De Gregorio Hurtado, S., Salvia, M., Heidrich, O., Dawson, R., Olazabal, M., Foley, A., Orru, H., Geneletti, D., Pietrapertosa, F., 2014b. Urban climate change response and the impact of climate networks in Europe, in: Dawson, R., Wyckmans, A., Heidrich, O., Köhler, J., Dobson, S., Feliu, E. (Eds.), *Understanding Cities: Advances in integrated assessment of urban sustainability*, Final Report of COST Action TU0902. Centre for Earth Systems Engineering Research (CESER), Newcastle, UK.

Rosenzweig, C., Solecki, W., Hammer, S.A., Mehrotra, S., 2010. Cities lead the way in climate-change action. *Nature* 467, 909-911.

Sharp, E.B., Daley, D.M., Lynch, M.S., 2011. Understanding local adoption and implementation of climate change mitigation policy. *Urban Affairs Review* 47, 433-457.

Stecker, R., Mohns, T., Eisenack, K., 2012. Anpassung an den Klimawandel - Agenda Setting und Politikintegration in Deutschland, *Zeitschrift für Umweltpolitik und Umweltrecht* Deutscher Fachverlag, Frankfurt Oder, Germany, pp. 179-208.

Tang, Z., Brody, S.D., Quinn, C., Chang, L., Wei, T., 2010. Moving from agenda to action: Evaluating local climate change action plans. *Journal of Environmental Planning and Management* 53, 41-62.

UNFCCC, 2012. Decisions adopted by the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol. United Nations Framework Convention on Climate Change (UNFCCC).

UNFCCC, 2013. Total CO2 Equivalent Emissions with Land Use, Land-Use Change and Forestry in: United Nations Framework Convention on Climate Change (UNFCCC) (Ed.), Time series - Annex I. UNFCCC, Bonn, Germany.

United Nations, 1992. The United Nations Framework Convention on Climate Change, in: Nations, U. (Ed.). United Nations, New York, USA.

Villarroel Walker, R., Beck, M.B., Hall, J.W., Dawson, R.J., Heidrich, O., 2014. The energy-water-food nexus: Strategic analysis of technologies for transforming the urban metabolism. *Journal of Environmental Management* 141, 104-115.

Yalçın, M., Lefèvre, B., 2012. Local Climate Action Plans in France: Emergence, Limitations and Conditions for Success. *Environmental Policy and Governance* 22, 104-115.

Zanon, B., Verones, S., 2013. Climate change, urban energy and planning practices: Italian experiences of innovation in land management tools. *Land Use Policy* 32, 343-355.

Zimmerman, R., Faris, C., 2011. Climate change mitigation and adaptation in North American cities. *Current Opinion in Environmental Sustainability* 3, 181-187.

