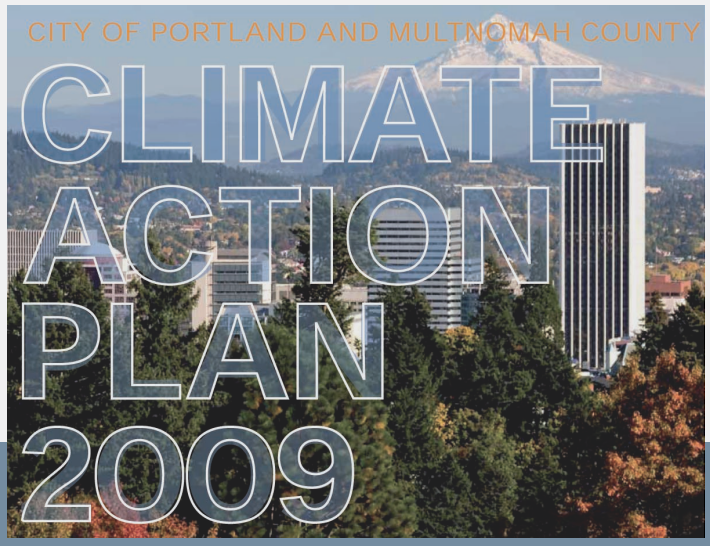
CLIMATE CHANGE MITIGATION, ADAPTATION AND SUSTAINABLE URBAN DEVELOPMENT

A Case Study of Copenhagen and Portland



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Abstract

Urban planning strategies for climate change are moving beyond mitigation and beginning to encompass adaptation as well. As adaptation concerns move higher up the policy agenda, planners and policy makers will be faced with difficult choices about how to effectively craft responses that take into account a wide range of societal concerns spanning the spectrum of sustainable development, including issues relating to intra- and intergenerational equity, environmental health and economic stability (Adger W. N., 2009). Moreover, it is becoming increasingly clear that climate change is intimately bound up with development paths (IPCC, 2007; Sathaye, et al., 2007), implying that the traditional focus on energy and environmental planning may be misplaced. Planning literature has only recently begun to attend to these issues (Howard, 2009) and there are a number of potential synergies, conflicts and trade-offs that will have to be made between mitigation, adaptation and development goals, sustainable or otherwise.

The following study is an exploratory, comparative case study of Copenhagen Metropolitan region, and Portland, Oregon, Metropolitan region that was conducted with the intention of mapping out and describing the main intersecting and diverging lines between: 1) climate mitigation and adaptation goals and 2) climate goals and other urban and socio-economic development goals. The main findings suggest that planners in the main treat mitigation and adaptation as distinct policy issues and while there is some evidence that cities attempt to link climate change strategies to other, pre-existing planning goals for denser, more sustainable development and mobility patterns, there are still substantial policy conflicts left unresolved.

Preface

This report has been written in connection to the 10th semester thesis requirements for the elite study in Sustainable Planning within the Master's in Urban Planning and Management program, at the School of Engineering, Natural and Health Sciences at Aalborg University. The research and writing was conducted from 1 February until 10 June 2010. The report is structured as follows: 1) the main body of the research report, including an introduction, problem formulation, literature review, methods, the Portland Metro region case analysis, the Copenhagen Metro region case analysis, a cross-case analysis, conclusions and theoretical reflections and 2) appendices, including an article intended for submission to a peer-reviewed scientific journal that addresses the synergies, conflicts and trade-offs between mitigation and adaptation strategies and a research diary.

The literature references are cited according to the APA style (author, date) within the text, with a full bibliography found at the end of the report. For sources with the same author and year of publication, the sources are distinguished within the text. The Danish references have been converted to English within the text, but are listed in both languages in the bibliography. Unless otherwise noted all translations from Danish to English have been undertaken by the author, therefore any errors and omissions are entirely my own. Sources with no date of publication are listed as (n.d.).

I would like to extend a heart-felt thanks to my supervisor, Petter Næss, who has unfailingly provided constructive and incisive critical feedback and suggestions without which this report would have suffered greatly. I am also indebted to Anna Wust, who gave me not only much needed assistance with the layout and design of the report, but, more importantly, support and love along the way. Any remaining errors or omissions are entirely my own.

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List of Acronyms

AAGR	Average Annual Growth Rate
AMSD	Adaptation/Mitigation/Sustainable Development
CCP	Cities for Climate Protection
COP	Conference of the Parties
CO2	Carbon Dioxide
DKK	Danish Kroner
ESDP	European Spatial Development Perspective
EU	European Union
FAR	Floor Area Ratios
FAR	Fourth Assessment Report
GHG	Greenhouse Gas
ICLEI	International Council for Local Environmental Initiatives
IPCC	Intergovernmental Panel on Climate Change
MSA	Metropolitan Statistical Area
NOX	Nitrous Oxide
OECD	Organization for Economic Co-operation and Development
RTP	Regional Transportation Plan
UGB	Urban Growth Boundary
UGR	Urban Growth Report
UNCED	United Nations Conference on Environment and Development
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar
VKT	Vehicle Kilometers Traveled
VMT	Vehicle Miles Traveled

1 Introduction

The starting point for this research project was a puzzling question that has intrigued me for nearly two decades: Why would cities and regions choose to devote planning attention to climate mitigation strategies given the global scale of the climate problem and the infinitesimal reduction that would result from any one city reducing their emission profile alone? Adaptation to coming climatic changes seemed to be much more in line with the existing competences of cities, encompassing land use and transport planning, critical infrastructure planning, flood plain hazard assessment and disaster readiness planning, health and social welfare provision and environmental protection planning. This question is not answered within this research project, but there are some tantalizing clues present about what may possibly explain this phenomenon. I found in the initial scoping stages of this project that the planning literature was relatively sparse in the empirical analysis of municipal mitigation and adaptation strategies, and what was required was further empirical study of the nature of the different aspects of the climate change planning problematique. How do planners and policy makers treat the relationship between mitigation and adaptation, and how do they further negotiate the complicated relationship between breaking the GHG emission curve, adapting to inevitable warming trends and ensuring that other development goals such as social equity, environmental protection and economic development are balanced out and traded off? Therefore the purpose of this research project is to offer a small contribution to the body of knowledge regarding the kinds of issues present within the policy and planning intersection of climate change strategies and sustainable urban development goals.

This research report is the culmination of a four-month qualitative, comparative case study based primarily on document analysis for data collection. The primary analytic purpose is descriptive, rather than explanatory; a search of relatively unexplored planning territory (the who, what, where and how) rather than a search for causal connections and explanations (the why). The “why” portion is reserved for further doctoral study of the role of that uncertainty plays in decision-making, with a research focus on the intersection between climate change strategies and development strategies.

Background

In recent years, there is a growing awareness of the need to develop climate adaptation strategies concurrently with mitigation strategies. However, there are potentially large differences between mitigation and adaptation. Additionally, there has been scant academic or practical attention paid to the connections between climate goals and sustainable urban development goals. Climate change presents a complex set of challenges globally, nationally, regionally, and locally. According to the most recent Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (FAR), the observable changes in the earth's climate are due in large part to rapid increases in atmospheric concentrations of carbon dioxide and other greenhouse gases, such as methane and nitrous oxide (IPCC, 2007). Due to primarily anthropogenic causes since 1750, concentrations of greenhouse gasses now far surpass pre-industrial values. Global emissions of greenhouse gases are continuing to rise, resulting in increased atmospheric and oceanic temperatures.

Since the signing of the United Nations Framework Convention on Climate Change (UNFCCC) in 1992, cities around the world have been addressing the challenges posed climate change by primarily pursing a path of mitigating greenhouse gas (GHG) emissions. Many cities around the world have had

some measure of success in lowering local greenhouse gas emissions (Granberg & Elander, 2007; OECD, 2009). On the global scale, however, emissions of GHG have continued to climb worldwide at an accelerating rate. The increase in emissions has led to rising atmospheric temperatures, warming oceans and rising sea levels. These trends are projected to continue well into the 21st and 22nd centuries, even if anthropogenic carbon emissions are brought down to a sustainable level.

Cities account for 60-80% of all global GHG emissions and rising levels of affluence, urbanization and mobility all point to a continuing growth trend in emissions unless significant actions are taken in the next decade (OECD, 2009; Bernstein, et al., 2007). For planners, responding to climate change presents a complex suite of challenges spanning social, environmental, political, economic, cultural and technical dimensions. As evidenced by the recent failure of the UN-led climate conference in Copenhagen in December 2009, there continues to be a decided lack of leadership from the national governments on this issue. Cities around the world, by contrast, have been actively using urban planning strategies and tools to mitigate current and future carbon emissions as well as to begin to adapt to future changes in the climate.

The planning literature has been rather thin to date, however, in identifying and critically examining the potential conflicts and synergies between climate mitigation strategies and climate adaptation strategies (Howard, 2009). Moreover, as it becomes clearer that GHG emissions are intimately tied to specific development pathways (Sathaye, et al., 2007; IPCC, 2007), planners are faced with the challenge of integrating climate change strategies into sustainable development goals. The structure of this research project, then, is two-fold. The first main area of study is to analyze the intersections and divergences between mitigation strategies and adaptation strategies and the second is to investigate the relationship between climate changes goals and other social, economic or environmental development goals.

The Research Focus

The primary locus of research interest at the mitigation/adaptation interface is at the scale of the municipality. I set out to explore the relationship between mitigation and adaptation through four particular theoretical lenses: 1) urban morphology, including issues relating to land use, transportation, energy and natural systems, 2) path dependencies, taking in physical, socio-technical, economic, cultural and behavioral dependencies, 3) synergies, conflicts and trade-offs, examining the ways in which climate mitigation and adaptation strategies support or weaken each other as well as the types of policy compromises and trade-offs that need to be made between climate goals and other development goals, such as social equity or economic development and 4) governance issues, looking at the level of policy *inclusion*, *consistency* between various planning measures, the types of *qualitative weightings* for differing policy priorities, the extent of *reporting* and monitoring requirements and finally the *resources* attached to the implementation of the proposed measures.

The research focus at the climate goals/development goals interface broadens to encompass the dynamic relationship between the municipalities of Copenhagen and Portland and regional and national planning policies and other relevant dominant societal trends. The analytic categories mirror those of the mitigation and adaptation interface: 1) urban morphology, path dependency, synergies/conflicts/trade-offs and governance. The analytic technique was built around pattern matching in a search for converging and diverging lines of policy, goals and trends. This should not be

construed as a Humean search for causal conjunction, but rather a heuristic to help map and understand complex, tangled and often conflicted policy and strategy lines.

The choice of case cities was driven by a few factors. Firstly, both Copenhagen and Portland have similar demographic and economic profiles, both at the municipal level and regional level and have high levels of mobility, high levels of affluence and strong growth promotion goals. They are also exposed to significant competitive pressures intra-regionally, inter-regionally and internationally. The hypothetical position prior to starting the empirical phase was that cities would seek to maximize their competitive position with any possible edge and that climate strategies would likely figure prominently in the economic growth agendas. Secondly, both cities have had long-standing CO2 reduction strategies through either Local Agenda 21 policies or stand-alone climate strategies. The initial hypothesis was that the longer experience with planning for climate change would lead to a more complete and integrated framework between mitigation and adaptation measures and goals. Thirdly, both cities also have strong planning controls in place to concentrate denser development patterns close to public transport; the underlying research hypothesis here was that cities with stronger planning focus on generating more sustainable development and mobility patterns would be more likely to integrate climate policies into the other planning policies and strategies to maximize their effectiveness. It was expected that climate mitigation and adaptation strategies would be put to good effect to strengthen and support densification and sustainable mobility efforts already underway. Finally, I have had some past experience serving on the City of Portland's Sustainable Development Commission in 1999-2001 and have spent a previous semester project analyzing the barriers to municipal climate strategies, using Copenhagen as a case study site. The operative hypothesis here was that personal insights gained from experience would help to inform a deeper understanding of the main planning and policy issues related to climate change and urban development strategies.

Research Questions

Research Question 1:

> How do municipal climate mitigation strategies reinforce or undermine climate adaptation strategies?

Research Question 1 sub-question:

> How have planners and policy makers accounted for possible reinforcements and/or conflicts between climate change mitigation and adaptation strategies?

Research Question 2:

> How do municipal climate strategies reinforce or undermine existing sustainable urban development goals (or other development goals)?

Research Question 2 sub-question:

> What are the planning implications of the reinforcements/conflicts present in climate change strategies in relation to sustainable development goals (or other development goals)?

Main Findings

1. Mitigation and adaptation measures are mostly treated as separate policy areas. There is little evidence that planners and policy makers address the two issues holistically. This could likely result in

the following conditions: 1) planners miss opportunities to create synergies between mitigation measures and adaptation measures, and vice versa, 2) planners potentially create unnecessary policy conflicts between mitigation and adaptation measures, creating sub-optimal or even counter-productive strategies and 3) trade-offs between climate goals and other societal values and aims, such as social equity, environmental protection and economic growth will be difficult to negotiate absent a comprehensive treatment of mitigation and adaptation.

2. Climate mitigation and adaptation strategies present significant governance challenges to existing spatial planning strategy and policymaking. The close connection between GHG emissions and development pathways requires more holistic thinking and acting. Mitigation strategies have typically adopted a point-source pollution approach to managing emissions: identify the problem, calculate the scale, identify the source(s) and enact policies and strategies to eliminate or reduce the problem. GHG emissions are a function of population growth, rising levels of affluence and a given technological base. Perhaps it is not then surprising that the resounding majority of policy attention in both Copenhagen and Portland is focus on what could be roughly characterized as eco-efficiency measures with little attention paid to social and economic drivers. The treatment of mitigation and adaptation as separate policy issues is in some measure a reflection of the siloed nature of the planning and governance structures rather than a result of the two being entirely distinct from one another. Planning for such highly complex problems with multiple levels of uncertainty over long time horizons will require a multiplicity of approaches and a flexible planning architecture. Careful consideration will likely have to be given to establishing a shared set of societal values and goals. Policy consistency and qualitative weightings of non-economic goals appear to be particularly difficult for cities and regions to come to grips with.

3. There are strong indications that densification and compact city strategies may be counteracted by adaptation strategies, particularly in addressing rising sea levels and increased frequency and intensity of storm events. Both Copenhagen and Portland identify the need to, for example, expand green areas, increase the coverage of permeable surfaces and help to make natural systems more resilient. The space requirements for these types of measures are not specified, but it is clear that it will be a difficult and expensive task to integrate such structures into the urban fabric. Many of the mitigation measures, such as the conversion of the energy system from fossil fuels to renewable energy supply, have the potential to either support or work against adaptation measures but depend heavily on the manner in which the policies are implemented. Should planners prioritize roof space for solar thermal and photovoltaic generation, or green roofs to handle storm water runoff and better insulation function? What is the optimum mix between policies that encourage high buildings to minimize land usage and ensuring solar or wind access rights? Neither Portland nor Copenhagen has begun to address such questions in any significant detail as of yet.

4. The existing development pathways in both Portland and Copenhagen create significant pressures on efforts to lower future GHG emissions. Despite the presence of strong planning policies to concentrate development along public transportation corridors, regional development patterns have led to both increased commuting distances and high modal share of private automobiles. Regional transportation and land use planning investments are still heavily geared toward the maintenance and expansion of road capacity at the expense of rail and bus service. Demographic and employment growth projections generate expansionistic planning measures that have resulted in two countervailing trends: a small increase in population and densities within the cities of Copenhagen and Portland and a bigger increase

in population and lower densities in surrounding municipalities and urbanized areas within the Portland region, while there are slight increases in density within the greater Copenhagen region. While there is significant policy attention paid to technological fixes ("clean" cars, "clean" power, etc.), very little is said regarding the other two driving forces of climate change: population growth and levels of affluence. The underlying premises of eternal economic growth and ever-rising levels of consumption remain unquestioned and tacitly assumed to be a given condition.

Structure of the Research Report

The report is structured into eight chapters from the Introduction to theoretical reflections. There are two appendices attached, a draft article for journal submission and the research diary covering the period from 1 February to 8 June 2010. Chapter 2, Literature Review, will explore the chosen lines of theoretical inquiry, examining first the main outlines of sustainable urban development strategies from urban morphology through transport, energy and natural systems. The reason for limiting the focus to these aspects is that these are the areas most impacted by climate mitigation and adaptation strategies. Next the outlines of the more relevant issues pertaining to spatial planning and climate change will be presented and discussed focusing particularly on the relationship between mitigation and adaptation. A more detailed description of municipal climate strategies will follow. Finally, the main outlines of the issues pertaining to the mainstreaming of climate change strategies into development goals (sustainable and otherwise) will be examined. The development of the main theoretical frames of urban morphology, path dependency, synergy/conflict/trade-offs and governance will be discussed in relation to the cross-cutting nature of mitigation, adaptation and development strategies that require broader analytic and policy perspective that traditional sectoral arrangements often miss.

Chapter 3, Methodology, has two main sections, one discussing the theoretical considerations governing case study research methods including validity, reliability and generalization. The second section will present the applied research methods pursued in this project, including the limitations of the study.

Chapters 4 and 5 present the empirical data collected from the two case study sites, Portland and Copenhagen. The structure of the two chapters follows the same structure: 1) background and introductory material, 2) an analysis of the mitigation/adaptation interface using the four analytic categories (urban morphology, path dependency, synergy/conflict/trade-offs and governance) and 3) an analysis of the climate change/development interface using the same analytic categories. There are a series of key questions that are put to the data as a device to draw out findings and these questions are used in the same fashion in both individual case reports.

Chapter 6 consists of the cross-case analysis, where the findings from the individual cases are combined and discussed. The structure of analysis is carried over from the Portland and Copenhagen cases. In this section the findings will be discussed in comparative relation to the two cases and also will also connect the specific findings to the general conditions of climate mitigation/adaptation concerns and climate/development concerns.

Chapter 7 presents the conclusions, drawn from a synthesis of the findings from the cross-case analysis and Chapter 8 contains two main theoretical reflections drawn from the empirical findings and re-assesses some unanswered questions. Finally, the Appendix contains a draft article based on the

findings related to the synergy/conflict/trade-offs issue and a research diary that offers the reader a more detailed look at the development and progress of the research.

2 Literature Review

Since the publication of the Brundtland Commission report in 1987 (United Nations World Commission on Environment and Development, 1987), sustainable urban development has moved into the mainstream of urban planning practice across the globe (Jenks, Burton, & Williams, 1996). Similarly, climate change mitigation and, to a lesser extent, adaptation strategies have been developing along parallel strategic and policy lines since before the Rio declaration in 1992. By now, both are firmly entrenched, at least at the level of rhetoric, in planning practice. There is a well-developed body of planning research into the various strategic and operational issues related to implementing sustainable development strategies and policies. By contrast, the body of literature surrounding the strategic and operational issues relating to municipal or regional efforts to implement climate change mitigation and adaptation measures is far less developed (Howard, 2009).

The purpose of this chapter is to identify and explore the relationships between sustainable urban development goals and climate change goals in order to establish the main lines of inquiry of integrating climate change within the field of sustainability. This chapter is structured into four sections. In Section 2.1, the main outlines of sustainable urban development are reviewed through four main aspects: urban morphology, transportation, energy and natural systems. In Section 2.2, the literature pertaining to climate change and spatial planning is discussed with an eye toward examining, among others, issues of complexity, mitigation actions, adaptation actions and the problematic of climate change. In Section 2.3, the broad outlines of municipal climate change strategies are traced by examining specific strategies and policies that cities have implemented to date and finally, in Section 2.4 the linkages between sustainable urban development strategies and climate change strategies will be explored through the categories of urban morphology, path dependency, synergies and conflicts, and governance.

2.1 Sustainable Urban Development

Sustainable development is broadly understood to describe development patterns that meet the needs of current generations without comprising the ability of future generations to do the same. The Brundtland Commission report identifies these needs as, for example, food, shelter, water, clothing, work, energy and sanitation. In the richer parts of the world, most of these needs are already met (United Nations World Commission on Environment and Development, 1987). Therefore sustainable development patterns in the developed world primarily pertain to lowering the existing levels of production and consumption to match the carrying capacity of the Earth's natural systems. The implications of altering existing patterns of production and consumption in response to environmental and social considerations are two-fold: 1) present-day encroachment on natural systems and use of non-renewable resources need to be limited in order to provide a basis for future generations and 2) present-day consumption levels in the rich world need to fall in order to allow more resource allocation to developing countries while still staying within the global sustainable limits of resource use (Næss, 2001).

2.1.1 Urban Morphology

There are three primary constituents of urban morphology: form, resolution and time (Moudon, 1997). Firstly, the particular shape and form of a city is the result of the dynamic relationship between the street, the building and the spaces in between. Secondly, the form can generally be understood at four different resolutions-the building/lot, the street/block, the city and the region, but for the purposes of this study only the latter two scales will be discussed in detail. Thirdly, understanding the past development of the city is crucial to comprehending the present and future of the city. Once streets and utilities are installed, the building lots platted and the transport infrastructure in place, path dependencies tend to constrain, shape and control possible future outcomes (Arthur, 1994). The causal relationships between the street, the building and the spaces in between are difficult to comprehensively map. However, it could be safely said that the development of the urban form in the last century has been heavily influenced by the mode of transportation.

In North America, the development of urban street grid in the 20th Century and into the 21st can be closely tied to the type of transportation available, ranging from the streetcar grid, to early garden suburbs (pre-WWII), Modernist suburban cul-de-sacs built for the car, late-20th Century exurban edge cities and the New Town/New Urbanist return to orthogonal grids, albeit primarily in the suburban fringe and built around public transport (Wheeler, 2003). In Europe, the situation is more nuanced due to the existence of medieval and ancient quarters within modern cities. Nonetheless, the post-war greenfield expansions of European cities generally follow the North American pattern. Broadly speaking, the general trend line into the late-20th Century has been a steady decrease in densities, discontinuous development patterns, lower street connectivity and a massive expansion of the road network to facilitate the use of the private automobile.

When it comes to sustainable urban development, the past is to some extent prologue. In order to create more sustainable cities, planners must contend with the existing morphology of the city or region. The existing structural conditions of the city both offer possibilities and constraints on the freedom of action and have effects well beyond the life span of those who created the structures in the first place (Næss, 2005). This sub-section will review the outlines of possible sustainable urban morphologies by exploring the dynamic relationship between compaction/dispersal on the one hand and mono-centric/polycentric development patterns on the other.

Compaction versus Dispersal

The contemporary discussion of the compact city versus the dispersed city (or some variation thereof) is one that has roots deep in the history of cities. In light of the current debate within the planning community as to what is the preferable sustainable urban form it should be understood that these debates, while the language may have shifted over the generations, are variations on a common theme. The Garden City movement was motivated by the need to create more sanitary conditions for a city's inhabitants. Overly dense and crowded cities were widely considered to be breeding grounds for physical and social contagions (Riis, 1890; Hall P., 1988). Many of the renowned planning theorists of the 20th Century, such as Howard, Unwin, Geddes, and Mumford, reacted to the social and environmental ills of the late 19th and early 20th Century industrial city by advocating more regionalized developments in a push against centralization (Breheny, 1996). In the post-WW II period, rapid suburbanization first in North America and then the rest of the world resulted in ever-growing

waves of expansion of the built-up areas of metropolitan areas. The push back toward increased densities and more centralized urban development came in fits and starts, reaching an apotheosis in the writings of Jane Jacobs in the early 60's in which she inveighed against the forces of dispersal (Jacobs, 1962). Throughout the 70's and 80's there were episodic swings back and forth between those advocating centrality and those advocating dispersion.

The emergence of the sustainable development discourse in the 80's and 90's re-energized the centralists after many decades of successive waves of suburbanization, ex-urbanization and the hollowing out of the metropolitan core. According to Breheny (1996), two guiding principles behind the renewed push for more compact cities came from: 1) the desire to address global warming and 2) the desire to restrict the growth of the built-up urban environment in order to protect natural areas (Breheny, 1996). Advocates for more compact urban forms also tout the increased social health and physical health benefits that result from compact cities (Krier, 1998). Compact cities also yield lower energy usage as well, both in the built environment and transportation sectors. Opportunities for the provision of public transport, walking and biking are significantly enhanced in a compact urban form (UN Habitat, 2009).

One criticism of the way in which the compact city model is put into operation is that there has developed a strong bias towards densification measures, leaving aside differences between cities in land use patterns, socio-economic conditions, political differences and fundamental differences in the ecological and geographic conditions (Burton, Williams, & Jenks, 1996; Neuman, 2005). Conceptualizing the compact city only in terms of density may lead to reductive planning measures that have difficulty addressing more than one causal relationship at a time. Table 1 below illustrates some of the other important categories of compactness, through a side-by-side comparison of urban sprawl and compact cities.

Table 1: Comparison of Compact City and Urban Sprawl Characteristics

Compact City Characteristics	**Urban Sprawl**
High residential and employment densities	Low residential and employment densities
Mixture of land uses	Single-use land use
Spatial integration of different activities	Spatial segregation of different activities
Diverse social and economic conditions	High levels of social and economic stratification
Contiguous urban development	Leapfrog development
Well-defined urban growth limits	Unrestrained urban expansion
Multiple modes of transport	Reliance on the private car
High degree of (non-motorized) accessibility to services/jobs	Emphasis upon mobility
High levels of street connectivity	Fragmented street network
Well-coordinated planning strategies and controls across governance levels	Fragmented planning strategies/little or no coordination
Low open space ratio	High open space ratio

Source: Adapted from Neumann (2005)

The sustainable urban form does not possess an ideal shape or character. Heterogeneous development patterns, in both activity and in form, have shaped and will continue to shape the future development of cities. Moreover, the conflicting pressures and demands between social, economic and ecological concerns imply a less strict orthodoxy concerning compactness and sustainability. Planning measures designed to create more compact settlement patterns are often met with fierce resistance from large segments of the citizenry, particularly among wealthy sub-urbanites (Burton, Williams, & Jenks, 1996). In addition, many older European cities are already quite dense and are hard pressed to intensify development in a compact area without sacrificing open space. De-industrialization within the last few decades has created many opportunities to direct new development inward but there remains a persistent demand for new development possibilities on the outskirts of the built-up urban area. Moreover, there have been significant alterations in the fundamental relationship between the center and the periphery. The dispersal and de-concentration of employment and residences through both the intra-urban area and the inter-urban conurbations has led to a fundamental reassessment of the applicability of the mono-centric urban form to new urban configurations (Kloosterman & Musterd, 2001).

Mono-centric versus Polycentric Forms

Intra-urban polycentric development patterns are not necessarily a new phenomenon, in that the relationship between the center and the periphery is as old as cities themselves. What has changed in recent decades is that a relatively stable pattern of relationships between the core and the periphery has become destabilized and more complex and the scale has shifted from the intra-urban to the inter-urban and inter-regional scales (Davoudi, 2003). As a result of systemic shifts in employment patterns, de-industrialization, residential location choices and large increases in both availability and affordability of faster modes of transportation and communication, the traditional hub-and-spoke system of land usage and commuting patterns has changed significantly. The physical borders that traditionally separated one city from another have been supplanted to some extent by a functional border that defines a given catchment area of employment and residence (Hall P., 2009).

According to Kloosterman and Musterd (2001), inter-urban polycentric development differs from intra-urban polycentric development in four main dimensions: the physical form, the political entity, the functional relationships and the identification and representation (Kloosterman & Musterd, 2001). The physical form of the inter-urban polycentric developments is characterized by irregular gradients of density and development that can encompass large tracts of agriculture, open space, natural areas and other rural land uses in addition to built-up areas. Movement between the different nodes of the polycentric development is also typically heavily skewed towards the use of the private automobile, due to fragmented and incomplete networks of public transport as well as the large distances between the nodes that make non-motorized forms of transport difficult if not impossible. The fragmentation of land uses and transport networks is mirrored in the political fragmentation present in inter-urban polycentric agglomerations. In a typical mono-centric city, the relationship between the core and the periphery is complex but manageable. In the absence of coordinated political regimes that match the scale of the conurbation, relationships between periphery and periphery within polycentric urban areas are difficult to negotiate.

The functional relationships between cities within a polycentric development are also marked by significant changes in the division of economic and social activity. The catchment area for both

employment, residential, administrative and retail opportunities is substantially larger. The pre-existing patterns of functional differentiation between cities can become blurred in response to the increasing use of the polycentric urban area as a single urban entity. Finally, the identity and representation of a traditional city is undergoing some shifts in the way that people interact with the symbolic and cultural artifacts. Different forms of media and representative arts are adjusting to the new terrain as well. Polycentric urban developments are taking on new identities that transcend the individual cities within them, for example Silicon Valley in the US and the Randstad in the Netherlands to name but a few.

The theoretical formulations underpinning polycentric development patterns are quite distinct between the American and European planning contexts. A more market-oriented planning regime as articulated by many in North America posits that the removal of centrally guiding planning restrictions will lead to market-optimal polycentric development patterns (Richardson & Gordon, 1993). With a few notable exceptions (Portland, Oregon being one of them), many American cities tend to equate controls on the expansion of the urban form as an unwarranted intervention in the healthy operation of the market and individual freedom. As a result, the polycentric development patterns that have evolved in the US are driven by a hybrid of strong planning interventions by the federal government (e.g. interstate highways, heavy subsidies for home ownership, cheap land) and by a more market-driven approach at the regional and local level with intense competition between cities within a functional urban region for employment and housing opportunities. By contrast, polycentric development in Europe is of a rather different character. While the economic and social driving forces are similar (deindustrialization, faster and cheaper means of communication and transportation, economic competition), the policy response at the regional, national and supra-national levels has been one that places significantly more responsibility on planning to address the manifold issues that arise from polycentric development patterns.

The publication of the European Spatial Development Perspective (ESDP) in 1999 expanded the conception of polycentric development to encompass not just the spatial and temporal dimensions of the inter-urban, intra-regional and inter-regional agglomerations. Spatial development as articulated in the policy document and subsequent re-ordering of regional development priorities embraced the conception of Europe as a space of flows and mobility (Jensen & Richardson, 2001). The policy was built around three main principles: 1) economic and social cohesion, 2) sustainable development and 3) balanced competitiveness (European Commission, 1999). According to Davoudi (2003), "…the concept of polycentricity is used not to explain or analyse an existing or emerging phenomenon, but as a guiding principle for achieving two arguably conflicting goals of: on the one hand, making the EU's economy more competitive in the world market; and on the other hand, reshaping its map of regional growth and decline into a more socially and spatially cohesive form" (Davoudi, 2003, p. 989). The inherent tensions between maintaining economic competitiveness in a globalized market and the desire to foster sustainable development between the "core" and the "periphery" are fundamentally at odds with one another regardless of the scale.

Pluralistic Approaches (A Return to Regionalism or Neo-Metropolitanism?)

As the preceding sub-sections indicate, there is a multiplicity of possible urban forms that are a result of many complementary and competing interests. The relationship between the compact city model and the polycentric development patterns visible in many cities around the world is complex and dynamic.

What then are the primary constituents of a sustainable urban form? Firstly, there is no ideal sustainable urban form. Every city is a complex network and intersection of a multitude of social, environmental, economic, political, institutional and cultural forces. This implies a pluralistic, multi-causal appreciation of the competing and complementary actions within the planning framework. Holding one variable, such as "compaction" or "density", constant is unlikely to be very successful in the face of such dynamics. The sustainable urban form is also intimately bound up in the provision of energy and mobility services and, perhaps most importantly, the relationship between the natural systems that sustain our social and economic systems. This would suggest that low-density, car-intensive patterns of urban sprawl are far less likely to generate sustainable outcomes than cities of a more compact nature.

A notable development in the last decades has been the accelerating re-centralization of many northern European cites (and to a lesser extent in the US) fuelled by attitudinal changes toward both environmental issues and commuting as well as strong governmental policies to reverse the outward expansion of the city (Davoudi, 2003; Næss, Næss, & Strand, 2010). It is too early to assess the full effects of this demographic, social and economic shift but the trend lines clearly indicate that there is a significant strategic push towards more compact urban forms. How successful these strategies are depends to a large extent upon the strategic and policy direction of transportation planning.

2.1.2 Transportation

There are a number of key components of a sustainable transportation system, many of them closely linked to questions of urban form. In the broadest sense, the main strategic goals of sustainable transport planning are: 1) reductions in the use of the private automobile combined with more eco-efficient fuels, 2) prioritization of non-motorized forms of transportation, such as walking and bicycling and 3) expansion and improvements in public transport. However, even in the best circumstances, sustainable transport systems by themselves are not sufficient to counter the growth of the use of private automobile usage or the expansion of the built-up urban area. Take for example the cities of Oslo and Copenhagen, two cities generally seen to have strong policies favoring both public transport and non-motorized transport. Between 1996 and 2007, car traffic in both cities increased faster than population growth, albeit at a much lower rate in Oslo (Næss, Næss, & Strand, 2010). Strong land use barriers to outward urban expansion, intensification of development within the existing built-up area, shifts in attitudes among commuters and most importantly significant revisions of existing policies favoring continued development of inter-urban and intra-urban road networks are also necessary to facilitate more sustainable modes of transport.

Reducing Auto Dependency

There are a number of planning interventions and strategies designed to reduce the use of the private automobile, ranging from land use measures (sprawl containment, increased densities, mixed use zoning, transit-oriented development), establishment and extension of car-free zones within the urban core, removal of parking spaces and road pricing schemes. It is widely accepted that more compact urban forms can lead to reductions in car use (Newman & Kenworthy, 1999). Compaction of the urban form alone, however, is a necessary but insufficient condition for reducing automobile dependency. Improvements in provision of public transport and pedestrian/bicycle networks are also crucial. A key

tenet of the New Urbanist, Smart Growth and Transit-Oriented Development (Calthorpe, 1993) movements is that compact developments built around public transport systems will lead to reduced travel distances and lower car use. More recent studies indicate that the location of residences relative to the metropolitan core may be a more powerful driver of both mode choice and distances traveled (Næss, 2005). The same is true for workplace location, especially offices, and for specialized service facilities.

Another way of reducing car usage is the imposition of different charges, including variable peak-period congestion charges, per-kilometer charges and increases in parking fees. The effective implementation of such measures is politically contentious and subject to substantial economic and institutional barriers (Nijkamp & Rienstra, 1996). There is a strong web of interconnections between the state, the market and individuals that reinforces the dominance of the private automobile within the transport hierarchy. Not only does the physical infrastructure create path dependencies that are difficult to alter, but the psychosocial infrastructure does as well. One way around the dominance of the privately owned automobile is the development of car-sharing networks that are integrated into the urban transport system. Car sharing networks allow for greater flexibility in the transport system while reducing financial, spatial and social demands that exclusive reliance on private car ownership brings (e.g., large dedicated spaces for parking at work and non-workplace locations, larger road networks to accommodate car traffic, etc.)

An important element of the existing path dependencies of auto travel that is often overlooked is that the expansion of the road network (typically undertaken to relieve congestion) typically leads to greater use of the car as the primary mode of transport (Næss, 2001; UN Habitat, 2009). Therefore sustainable urban transport policies should seek to avoid road extensions and expansions where possible to avoid creating demand-inducing travel infrastructure.

Prioritization of Non-motorized Transport

There are a number of strategies and policies that have been enacted to prioritize non-motorized transport over motorized transport: 1) controlling the car, 2) distance reduction, 3) infrastructure provision and integration, 4) physical safety provision and 5) behavioral and cultural shifts. While the use of various types of road charges and distance reduction measures are important in order to stimulate greater use of non-motorized transport, (Banister & Anable, 2009; Næss, 2005) these are not the only determining factors in the use of the private car. Other factors include age, sex, workforce participation, disposable income, daily obligations and interests, locations of specialty services and the rates of car ownership (Næss, 2005). Many of the policies and strategies to control the use of the car within the city, such as car-free streets, eliminating parking provision and lowering speed limits within the city, also improve opportunities for biking and walking.

Morphology also plays a role in that the gridded streets of the streetcar-era city (and older) are far easier to navigate on foot or by bike than the post-war suburban streets dominated by wide roadways, sinuous curves and cul-de-sacs (Wheeler, 2003). Older portions of the city are easier to navigate by foot or bike due to the smaller block and street sizes and shorter distances between services. A reconfiguration of the street itself is also advisable, in order to move away from the concept of the street-as-a-road where the car is clearly prioritized toward the idea of the street-as-a-space, where humans have primacy (or at least equality) of place (Banister, 2008). Numerous examples of such

strategies can be found throughout Europe and North America, but Copenhagen is often cited as one of the premier cities for cycling due to the high numbers of both commuters and non-commuters that use bikes as their main mode of transport. A combination of strategies and policies have encouraged high take up of bicycling within the city, including the construction of dedicated cycle ways, signal prioritization, provision of bicycle parking and extensions of existing commuter infrastructure to areas outside the city limits (Københavns Kommune, 2010). Additionally, personal safety is an important determining factor in where and how people choose to walk or bike, either for work or non-work purposes. Urban transport structures that prioritize motorized transport often create a hostile and insecure environment for non-drivers. Therefore a main policy goal of a sustainable transport system should be to prioritize human safety over travel speeds and the needs of automobiles. Many of the system improvements to prioritize non-motorized forms of transportation also serve to support the improvement and expansion of collective forms of motorized transport as well. While walking and biking modes can serve as the primary mode choice at smaller urban scales, intra-urban and inter-urban transport needs over longer distances can be met by various forms of public transport.

Expansion and Improvements in Public Transport

The third primary strategic goal of a sustainable transport system is improvements in the provision of public transport. Public transport can include high-speed intercity heavy rail, commuter rail, underground metro, light rail, tram, tram/commuter rail hybrids, bus rapid transit systems, electric or diesel buses, jitneys, car sharing, ferries, city bikes, and taxis. Heavy rail (such as regional commuter lines and subways), light rail and trams are the preferred option for motorized public transport for a number of reasons, chief among them speed, efficiency, capacity, comfort and a better environmental profile (UN Habitat, 2009). Heavy rail and light rail, unlike many buses, run on electric power and therefore have greater possibility to operate on renewable sources of power.

Improvements in frequency, system inter-connectivity, expansion of the various systems both extensively (covering a wider area) and intensively (using above-grade, under-grade and at-grade space) and more flexible connections are all necessary in order to make public transport a more viable option compared to the private automobile. Many German, Austrian and Swiss cities have successfully created regional systems of integrated transit that compare favorably in both speed and flexibility to the private automobile. In their case study of five urbanized regions (Hamburg, Munich, Dortmund-Essen-Dusseldorf-Duisburg, Vienna and Zurich), Pucher and Kurth (1996) found that there were some key similarities between the systems that created the conditions for maintaining or expanding the mode share of public transport. Among the measures were: 1) service expansion, 2) improved service quality, 3) attractive fare pricing, 4) extensive marketing campaigns and 5) sustained public subsidies from the national, regional and municipal governments (Pucher & Kurth, 1996). Further, the regional authorities integrated the disparate system components into one network, with a single fare structure, single timetable, high-frequency service day and night, easier access to route and timetable information and closely coordinated scheduling. But the financial support from governments is crucial to fund the system improvements. In order for public transport to compete effectively with cars as a preferred mode of transport, governments also need to provide sustained levels of public subsidy to support public transport.

In addition to the persistent and extensive social and environmental benefits that public transport delivers, there are significant economic ones as well. According to a 2008 report from the Organization for Economic Co-operation and Development (OECD), the authors note that:

> Moreover, in a mirror image of the external cost of congestion, there is also an external benefit created by new users that is most pronounced in urban public transport – rail, metro and buses – known as the Mohring effect, following Mohring (1972). When the frequency of scheduled public transport services is increased in response to an increase in demand, waiting times fall for existing users. As Glaister (1994) describes it – "the new users thereby create a benefit external to themselves but internal to the system." Hence, a subsidy to price in this element of welfare-increasing consumption is appropriate (Organization for Economic Co-operation and Development, 2008).

Such considerations ought be given greater weighting when cost-benefit analyses are conducted for transport infrastructure investment. Many of the externalized positive benefits of public transport, such as more efficient land uses, better opportunities for dense, mixed-use neighborhoods, lower air and noise pollution, lower GHG emissions, more equal access to jobs and services for citizens and lower energy and material consumption profiles compared to cars, are seldom assigned economic value or factored in to planning decisions. One way that cities and regions can help to rebalance existing transportation priorities is to push for more accurate assignation of costs and benefits at the national and state levels where much of the infrastructure investment decisions are made.

2.1.3 Energy

The main lines of sustainable urban energy policy are as follows: 1) reductions of energy usage, both aggregate and per capita, 2) shift from non-renewable to renewable sources of energy, 3) move toward closed-loop processes, such as combined heat/power systems fuel by methane from biological waste, where the waste stock from one process becomes feed stock for another, 4) creating distributed networks of energy production, moving the generation capacity closer to end-users and 5) implementing demand-side policies that incorporate environmental and social externalities into the pricing mechanism (Næss, 2001; UN Habitat, 2009; OECD, 2009).

Large-scale shifts toward renewable sources of energy are underway around the world, drawing from wind, tidal, solar, biomass, geo-thermal and hydroelectric sources of power. However, given the existing base load requirements and the lack of effective storage mechanisms to capture the fluctuations in supply from renewables, cities will have to pursue a multi-prong strategy that relies on a combination of higher feed-in tariffs for renewable sources of energy, reducing energy demand by a factor of 4 (or possibly higher), establishing more energy and material efficient building codes and distributing generating capacity throughout the city through facilitating, for example, solar thermal and photo-voltaic arrays on commercial, industrial and residential structures (UN Habitat, 2009).

Within built-up urban areas, the primary users of both embodied and operational energy are commercial/industrial/residential structures and transportation. There are numerous linkages between urban form, the built environment, transportation and energy usage. Low-density suburban and exurban developments characterized by single-family detached dwellings typically result in higher energy consumption for both space heating and power requirements (Newton, Tucker, & Ambrose, 2000). Many studies have also found a strong correlation between the energy requirements for

transport and the size of the urban area. In a study of 22 Nordic cities, the authors found that the density of settlement patterns had a significant influence on the energy demands from transport (Næss, Sandberg, & Røe, 1996). Cities and towns with lower population densities tended to use more energy than those with higher densities. The larger built-up land areas that result from urban sprawl also significantly increase the capital, operations and maintenance costs of the provision of water, sewerage, power, heating and telecoms infrastructure. In cities that utilize combined heat/power plants, low-density development patterns also increase the expense and decrease the efficiency of such district heating measures. Finally, dispersed settlement patterns combined with segregated zoning and land usages generate a higher dependency on private automobiles for transportation.

2.1.4 Natural Systems

Traditional approaches to urban planning and natural systems have been governed by an effect-oriented problem-solving approach where varying individual environmental targets have been identified then treated as independent entities (Beatley, 2000). Prioritization of one environmental target is often comes at the expense of others (Næss, 1993). Successful sustainable urban development strategies should attempt to holistically plan for integrative policies that operate at the biome level. For example, water issues, from provision of drinking water, treatment of sewage, rainfall run-off, riparian health, wetlands protection, flood control measures, wildlife protection, farmland and forest preservation and overall watershed health are all intimately connected to one another and therefore the strategies and policies need to take this into account. Normative considerations should also be brought into the planning considerations since there a number of different (sometimes complementary, sometimes competing) values that are attached to nature. Three key values identified by Thorén (2000) are: 1) the landscape (aesthetic) values, 2) the recreational (play) values and 3) the natural (biodiversity) values (Thorén, 2000). The ability to distinguish between these different normative systems allows for a more comprehensive planning approach that can facilitate trade-offs between different types of natural systems and their functional manifestations within the city.

There are numerous differing opinions and positions surrounding the most effective means to simultaneously pursue urban development and ensure natural system health. For instance Næss (1993) suggests that there are three common denominators for ensuring environmentally sound urban development: 1) Concentrating development to minimize encroachments on nature, 2) economizing on building sites and 3) restructuring the transport system. The application of these principles would imply restricting the outward expansion of the existing urban core coupled with a concentration of new development along public transportation corridors (Næss, 1993). Further, the densification of the building site itself would imply a smaller average dwelling unit. Smaller dwelling units also lead to lower average energy and heating consumption levels, feeding back into lower emissions of local and global air pollution. Attached dwelling units will also, other things being equal, have significantly less heat leakage in the winter and solar gain in the summer, leading to lower per-square meter energy needs. Finally, the restructuring of the transport system implies a reduced reliance on the private automobile with a consequent increase in the use of non-motorized transportation modes. Reducing vehicle kilometers traveled has positive impacts on human safety, noise and air pollution as well as significant economic benefits in the form of lower capital and maintenance costs for the road network.

Restrictions of urban encroachment, or greenfield (as opposed to brownfield) development, also feed into closer proximity of humans to outdoor recreation and interaction with nature. Establishing and expanding green corridors for walking, biking, horseback riding, skating, skiing, etc. also allows for a reversal of sorts in the dominant pattern of urban development, where human encroachment on green spaces at the periphery are countered by natural encroachments toward the core of the city (Beatley, 2000). These strategies allow for a shift from the built environment to the un-built environment, reducing the amount of tamed, structured space and increasing the area of "wilderness" in the city. These issues are intensely contested in the political sphere, however. Across the developed world there is a well-established divide between the real or perceived willingness to trade off environmental protection against growth (both spatially and economically) and between those who accept increased governmental and societal regulation and those who argue for less restriction on personal freedom of action and choice (Næss, 1993).

The Netherlands has demonstrated one possible way out of such policy binds with the implementation of a national-level integrated ecological network that identifies core natural areas, nature development areas and ecological corridors to provide migration routes between the cores (Beatley, 2000). Most development of the core and natural development areas is prohibited, while the eventual outlines of the Main Ecological Structures (MES) is decided in collaboration with regional and municipal planning bodies, landowners, farmers and other interest groups. The implementation of the policy was not entirely smooth, however, in that there was initially substantial opposition to the nature development projects (Hajer & Wagenaar, 2003), primarily in the form of resistance to top-down policy making measures that local governments and citizens fundamentally disagreed with. One of the lasting policy lessons that can be drawn from the above example, and many others like it, is that while it is possible to build consensus around the desirability of nature conservation (or expansion of nature), conflicts are nevertheless unavoidable. Therefore effective means of conflict-resolution and negotiating trade-offs are necessary in order to deal with the inevitable clash between competing interest groups.

2.1.5 Summary

The interconnections between urban morphology, transport, energy and natural systems are, as the preceding sub-sections have indicated, complex and deeply enmeshed in one another. Sustainable urban development strategies need take into account that the relationships are not static, but rather dynamic, emergent and unpredictable, with numerous uncertain or unstable relationships between the environmental, social, political and economic systems. It is possible, however, to identify some key structural principles that underpins and informs sustainable urban development strategies: 1) morphology, 2) path dependency 3) synergy/conflict and 4) governance. Morphology matters for a number of reasons, but chief among them is that the more compact and accessible the existing and future urban form is, the easier it is to create denser transport links based on non-motorized and collective forms transport, lower energy, water, material and waste demands and minimize encroachments on farmland and natural areas.

The urban form is also intimately linked to path dependency, for two reasons. Firstly, once infrastructure, streets and building plot lines are established they persist for centuries if not millennia. This implies that sustainable development strategies should plan for new expansion of urban areas by carefully considering the pathways that are embedded in the proposed developments. Retrofitting

existing low-density urban sprawl patterns towards more sustainable patterns is extremely expensive, time-consuming and complicated due to the established patterns of land use, transport and energy. Secondly, path dependencies matter not only in the physical form, but also in the psychosocial infrastructure as well. Dominant patterns of working, living and moving within a city have reinforcing effects so that once people become accustomed to, for example, commuting in private cars it is more difficult to change those patterns than if they are accustomed to commuting by bike or tram.

Synergistic strategies are bound up with the urban form and path dependencies in two key ways. One, sustainable urban development strategies often push against dominant trends in existing patterns of production and consumption. Therefore, policy frameworks should seek to maximize the positive spillover effects from different sectors in order to build legitimacy and acceptability for sustainable development measures. For example, the goal of creating carbon-neutral cities requires lowering base energy demands along with increasing the share of renewable sources of energy while simultaneously looking to substitute active systems of water and waste management for passive ones. The establishment of greenways, bio-swales, green roofs (both for insulation and storm water management) and permeable road surfaces also serve to introduce more green spaces into the urban areas, lower ambient temperatures, air pollution and noise pollution and offer greater possibilities for recreation close to where people live. More passive, decentralized systems of energy generation and waste disposal also happen to have significantly lower operations and maintenance costs. Two, synergistic policies build momentum for more progressive social and economic policy measures by reducing zero-sum outcomes where win-lose situations are the norm. Social justice and equity issues are central to sustainability and actively seeking synergies between policy sectors helps to open up greater possibilities for win-win outcomes that work to fairly and efficiently re-distribute social and economic capital. Not all strategies and policies can create synergies, however. Sustainable urban development strategies are fraught with trade-offs that need to be made between imperatives of economic growth and job creation, social equity and distributional fairness and environmental health (and not just human health, but natural systems health) therefore the identification of conflicts between different policy directions is an important first step toward resolving such conflicts fairly and efficiently.

Finally, the issue of governance is central to sustainable urban development (as well as climate change strategies, as is discussed below in Sections 2.2 and 2.3). The complex nature of the interlocked relationships in the nexus of land use/transport/energy/natural systems requires the various institutional actors to work in a coordinated fashion across both spatial scales and temporal scales. For example, in most countries mega-projects are planned at the national and supranational levels with little policy coordination between the municipal, regional and the national governance scales. Road policy is a case in point, in that the decisions for capacity expansion are typically taken at the national level often in direct opposition to the stated aims of many municipalities to lessen dependence on car travel in order to create more compact cities with less pollution, lower energy (and greenhouse gas emissions) and to create more opportunities to expand collective and non-motorized forms of transport. In order to avoid these types of conflicts, the institutional and policy frameworks should ideally be guided by shared goals and values that inform and govern strategic planning for sustainable urban development. These issues (morphology, path dependency, synergy and governance) are present not only in sustainable urban development, but also in relation to climate change strategies, as we shall see in the following section.

2.2 Climate Change and Spatial Planning

Spatial planning has an important role to play in successfully implementing climate change strategies. Like many of the issues identified in Section 2.1 regarding sustainable urban development, climate change strategies require planners to grapple with large uncertainties, operate in complex policy making environments that cross regional, national and international boundaries, address large-scale market failures in the form of pervasive externalities and prisoner's dilemma conditions and to resolve contradictory social, political and economic goals across generational time scales. Most critically, the decisions that are made for land use, the built environment, transportation and energy infrastructure and natural systems protection will have long-standing consequences for current and future generations. Through both compulsory national greenhouse gas reduction targets and voluntary alliances and strategic partnerships, such as ICLEI Cities for Climate Protection, C40 Climate Leadership Group and Local Agenda 21, cities around the world have been, with varying degrees of success, attempting to first halt then reverse growth of greenhouse gas emissions.

The scale of the challenge is significant. The current scientific consensus is that in order to hold atmospheric concentrations of greenhouse gases within "safe" (that is, within the accepted capacity of human and natural systems to adapt to the coming climactic changes) limits, world wide emissions will need to peak by 2015 and begin to fall 3-5% per year thereafter (Richardson, et al., 2009). Compare this with the trend line of 2% growth of greenhouse gas emissions per year and it becomes clear that climate change policies will need to be more aggressive and far-reaching than previously anticipated. The following sub-sections will examine the complex nature of climate change, the mitigation/adaptation policy divide and the framing of climate change as an environmental or development problem with an eye toward identifying the key challenges that climate change poses to the planning profession.

2.2.1 Complexity and Climate Change

Successfully reducing GHG emissions requires coordinated responses from a broad range of actors and institutions. There are a number of areas of concern for planners when attempting to articulate strategy and policy responses to climate change such as: 1) complexity of interactions, 2) path dependencies, 3) varying timescales of action, 4) changing policy contexts, 5) different spatial scales of action, 6) systemic uncertainties and 7) different portfolios of responses (Hall J., 2009). The *complexity of interactions* between land use, transportation, energy and natural systems is difficult to map and understand and therefore requires planners to make decisions with large areas of unresolved (and possibly fundamentally irreducible) uncertainty. Existing *path dependencies*, in the form of the built environment, transport networks, water/energy/waste infrastructure and psychosocial networks (in the form of political, social, behavioral and cultural structures) make it difficult to effect near-term alterations to the urban, socio-economic and cultural forms. Addressing climate change will also require a strategic approach that can handle *varying timescales of action*. For example, mitigation strategies operate on global scales over centuries while adaptation strategies are more concerned with responding to climactic changes in the coming decades.

Policy contexts are also rapidly changing, driven by changing scientific knowledge, on-going technological shifts and socio-political changes that drive alterations in the societal priorities and goals.

Differing spatial scales of action present a number of challenges regarding climate change. Planners need to respond locally to an aggregate international issue, all the while engaging actors from the national and regional level governments, non-governmental organizations and business interests. There are also significant *systemic uncertainties* that affect planning responses to climate change. There is range of scientific uncertainties, from the underlying uncertainties concerning complex climatic interactions to the lack of information to support local- and regional level adaptation decisions to the uncertainties of demography, economics and socio-political structures. Finally, planners need to draw from a *portfolio of responses*. Mitigation and adaptation strategies often require different policy responses guided by differing temporal and spatial scales of action. There is no one set of strategies and policies that will function successfully in every locale. Planners will need to adopt a methodologically diverse approach to addressing climate change.

2.2.2 Mitigation First

Mitigation is any action designed to either reduce future emissions of greenhouse gases or to enhance existing capacity of carbon sinks (IPCC, 2007). Since the release of the Intergovernmental Panel on Climate Change's First Assessment Report, the primary scientific focus has been on mitigating greenhouse gas emissions. The United Nations Framework Convention on Climate Change (and the legally binding Kyoto Protocol) also has, until recently, prioritized mitigation in its strategic and policy framework. The main outlines of the emissions reduction strategy articulated in the Kyoto Protocol (ratified in 1997) is a combination of signatory national governments choosing their own respective policies to meet their designated emissions reduction targets and market-based mechanisms to facilitate global trading of emissions certificates and technology transfer between the developed and developing worlds (for example through the Clean Development Mechanism, Emissions Trading and Joint Implementation measures) (UNFCCC, 2010). The main policy outlines of mitigation strategies have been closely linked to energy policy, with an eye toward increasing the share of renewable sources of power, adopting efficiency goals with respect to power and heating needs, restructuring freight and passenger transport systems to lower the greenhouse gas emissions profile and attempting to decouple increases in economic wealth and activity from increases in greenhouse gas emissions.

More recent studies indicate that despite the efforts to control GHG emissions that have been made to date, far more radical policy interventions will be necessary in order to hold future rises in temperature to a level that does not endanger either human society or natural eco-systems integrity (Richardson, et al., 2009). Global emissions of greenhouse gases would have to peak by 2015 and fall by an average of 5% per year well into the middle of the 21st Century in order to avoid "dangerous" climate change. In order for such a policy to have a chance of succeeding will require: 1) a legally binding treaty with real enforcement capabilities and sanctions for countries that do not meet their agreed-upon targets, 2) a policy framework that places social justice and equity questions at the center of any global climate policy (both for mitigation and adaptation), 3) a global carbon tax combined with cap-and-trade policies designed to facilitate the exchange of carbon credits, 4) significant transfers of financial and technical resources from the US, Japan and the EU to developing countries, 5) full-cost pricing to shift the costs of social and environmental damage to the producer (OECD, 2008; Richardson, et al., 2009). It is extremely likely that no matter how successful any future international climate treaty may be, governments will need to plan for not only reductions in future emissions but also to proactively plan for adaptation to coming changes in the climate.

2.2.3 Adaptation

Adaptation, in the context of a climate change strategy, can be understood to be the process of response, in the physical or social systems, to real changes in the climate system. In the social world, there is also the possibility of anticipatory adaptive response to actual or predicted changes in the climate (Adger, et al., 2008). However, the IPCC notes that adaptive capacity is closely connected to social and economic development, but that capacity not evenly distributed across and within societies (IPCC, 2007). The effects (rising ocean levels, increasing droughts, changes in rainfall patterns) of climate change will fall particularly hard on the poorest members of the global community who possess the least amount of capital (economic, social, political and institutional) needed to adapt to these changes. According to some recent studies (Richardson, et al., 2009; Tyndall Centre for Climate Change Research, 2009), it is not just the cities in the developing world that should be concerned about adaptive capacity. Developed countries in the north are also beginning to pay more attention to the issues of adaptation, although with less alacrity and seriousness than the situation may require. Many countries, including the United States and many members of the EU, have adopted a relaxed approach to climate change adaptation that is premised on the belief that no matter what happens in the coming decades and centuries, their societies will be able to muster the financial and technical wherewithal to address the problem (Adger W. N., 2009). There are a few reasons to question this strategic direction: 1) the pace and magnitude of warming is increasing and it is unlikely that ecosystems and social systems will be able to adapt quickly enough to the changes, 2) adaptive *capacity* does not equal adaptive *action*, 3) maladaptive strategies abound and 4) adaptive planning goals cannot be measured strictly by numbers and targets-social concerns are central to adaptation and therefore may require a radically different policy framework to account for those differences (Adger W. N., 2009). Conventional risk assessment strategies may be found wanting when it comes to providing planners and policy makers with sufficiently robust decision-support due to the complexity and uncertainty of future changes in climate, demography, economy, technology, land uses and behavior.

Risk Management/Vulnerability Assessment

Risk= Probability * Climate Hazard* Vulnerability.

Traditional climate-related risk management and impact assessment strategies tend to utilize a hazards-based approach, whereby a hazard is defined as a climate-related event that causes an impact on a given system (geo-physical, social, economic, biome). (Kleven, 2005) This approach tends to rely on a more quantitative methodology built on extensive modeling, which has proven to be effective in developing reasonably accurate near-term predictions of climate change at global scales. However there are limitations to the accuracy of these predictions due to the coarse spatial resolution of the existing models and the underlying model uncertainties. As a decision-support tool, the hazards-based approach may be insufficient for impact-assessments at regional (and local) scales (Klein, Schipper, & Dessai, 2005). Additionally, attitudes to risk vary significantly across the world depending on the real or perceived capacity to adapt (Tomkins & Adger, 2005). Small island nations and poorer countries in low-lying deltas (such as Bangladesh) are far less sanguine about adapting to rising sea levels than wealthier countries in Europe (such as Holland and Denmark) and in the US. The risk-management approach is a necessary but insufficient condition for climate adaptation, due to the inability to account

for the unequal distribution of technological, socio-economic and political factors that comprise effective adaptation strategies.

Vulnerability= Exposure * Sensitivity * Capacity

Vulnerability assessments, on the other hand, give stronger consideration to the social factors that comprise the ability of a given system to respond and withstand a given climate-driven event. According to Kleven, there are two inter-related aspects to the vulnerability of a system: 1) its relative sensitivity to climate hazards, or its physical vulnerability and 2) the adaptive capacity of the system, or the social vulnerability (Kleven, 2005). Social vulnerability (or coping capacity) is determined, in part, by the different social, institutional, political and economic resources that may be available (Wilbanks, Leiby, Perlack, Ensminger, & Wright, 2007). Because of the explicit inclusion of a wider range of specific social conditions, vulnerability assessments may be able to provide better decision-support at regional and local levels in the development of adaptation strategies. It is important to note that these two approaches should be viewed are complementary, rather than mutually exclusive (Füssel, 2007). Getting the balance right between the two is a tricky task for planners and policy makers, but will be crucial to ensure the legitimacy and viability of adaptive strategies.

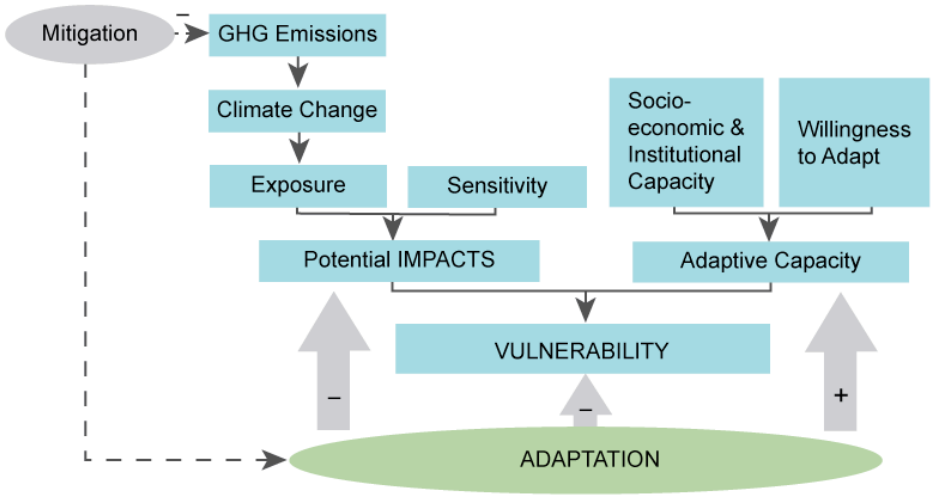
In the main, municipal climate strategies have treated adaptation and mitigation strategies as separate issues and have given little attention to the possible overlaps and conflicts that the two strategies may contain (Howard, 2009). Many theorists and practitioners have been only recently begun to respond to the challenges presented by the lack of an integrative approach. There are three noticeable shifts that are happening within the planning world regarding climate change mitigation and adaptation strategies. The first is that adaptation is rapidly rising on the planning and policy agenda due to the recognition of the need to proactively adapt to the unavoidable changes in the climate (Richardson, et al., 2009). The second is that mitigation and adaptation strategies need to be better coordinated in order to avoid maladaptive strategies that work against one another (Wilbanks, Leiby, Perlack, Ensminger, & Wright, 2007). The third is that climate change strategies and sustainable development strategies should be more closely integrated with one another since they share many common goals (Robinson, et al., 2006) and are driven by the same underlying structural forces.

2.2.4 Mitigation and Adaptation: Two Sides of a Similar Coin

There is a shared strategic framework underpinning both mitigation and adaptation policy that stems from a mutual reliance on both technological innovation and social change as critical components of a successful policy response to climate change (Tomkins & Adger, 2005). Mitigation is a form of future adaptation, in that absent efforts to reduce current and future emissions of GHG, there is a strong likelihood that the resultant climactic changes will be so great as to overwhelm the adaptive capacity of social and natural systems. Therefore the most effective form of an adaptation strategy is an effective mitigation strategy since that would obviate the need for adaptation in the first place (Howard, 2009; Swart & Raes, 2007; Wilbanks, Leiby, Perlack, Ensminger, & Wright, 2007).

As shown in Figure 1 on the following page, mitigation measures impact adaptation measures by yielding future reductions in exposure and sensitivity that reduce the extent of necessary adaptation and lowers systemic vulnerability (Swart, et al., 2009).

Figure 1: Relationship between Vulnerability, Capacity and Impact



Source: Swart, et al., (2009)

According to the IPCC,

> [e]ven though benefits of mitigation measures in terms of avoided climate change would take several decades to materialize, mitigation actions begun in the short term would avoid locking in both long-lived carbon intensive infrastructure and development pathways, reduce the rate of climate change and reduce the adaptation needs associated with higher levels of warming (IPCC, 2007).

Mitigation and adaptation need to be pursued as complementary strategy pathways, ideally within a policy framework that can attempt to resolve potentially conflicting goals while actively seeking synergistic opportunities that reinforce each other. Some researchers however, caution against an over-reliance on finding such synergies, since the differences between strategy of mitigation and the strategy of adaptation are significant (Kleven, 2005) for example the differing spatial and temporal scales of action, the impediments of free rider and prisoner's dilemma conditions and levels of scientific uncertainty that hinder policy formation and implementation.

The stabilization of atmospheric concentrations of GHG emissions occurs over a centennial or millennial time frames at a global scale. Adaptation to the changing climactic conditions happens over decadal time frames on a local or regional scale. The significant free rider and prisoner's dilemma conditions that are present within the mitigation context are weak or non-existent with adaptation (Swart & Raes, 2007). The level of uncertainty is also quite distinct between mitigation and adaptation. While the coarse spatial resolutions of the existing climate models are accurate enough to inform the global mitigation response, local adaptation decisions are still undertaken with extremely limited and inaccurate forecasts of potential changes in rainfall patterns, incidences of drought, frequency of extreme weather events and sea level rise (Wilbanks, Leiby, Perlack, Ensminger, & Wright, 2007). What both mitigation and adaptation strategies share, along with sustainable development strategies, is

a need to consider not just single-system management perspectives but rather to balance social, economic and environmental goals within a dynamic policy framework (Burch, 2009).

Defining the Policy Response Space

How then should policy makers and planners proceed? Tompkins and Adger (2005) propose that: "[A]ny response to climate change must be cognisant of wider development pressures as well as goals such as increasing economic, environmental and social well-being instead of focussing solely on single system management." (Tomkins & Adger, 2005). The authors suggest that policy responses to climate change should be guided by two interconnected factors, availability and take-up of technological change and the willingness and capacity of society to change. Both mitigation and adaptation decision-making is enabled and constrained by trade-offs between legitimacy, fairness, equity and efficiency in all societies. One possible approach to ensure that governing institutions are capable of handling these complex trade-offs is to build adaptive response capacity into the institutions themselves. This implies a re-orientation toward social learning, reflexive problem-solving and continuous evaluation and refinement of policy. Climate change strategies cut across sectors (transport, land use, energy), cut across disciplines (climatology, hydrology, sociology, planning, economics) and cut across broad scales and timeframes of actions (global/regional/local and past/present/future). In policy areas where significant barriers to action and implementation are present due to information asymmetries and irresolvable uncertainties, an 'act then learn' approach may offer a more flexible and iterative strategic framework that avoids locking into mal-adaptive development pathways.

The results from a four-year study conducted by the Oak Ridge National Laboratory in the United States that investigated the possibility for an integrated mitigation and adaptation framework also came to similar preliminary conclusions. In addition to the information asymmetries, numerous uncertainties, difficulties in measuring hazards and sensitivities and establishing adequate criteria for establishing the valuation measures of non-economic factors (such as biodiversity, cultural heritage, social equity, etc.), the authors found that:

> [O]ur results were affected by input assumptions, scale, the assumed value of time, uncertainty in a wide variety of ways (including what actions would reduce uncertainties and what difference would that make?), and the balance between exogenous learning (external to response systems, such as research and development) and endogenous learning (within response systems, such as learning by doing) (Wilbanks, Leiby, Perlack, Ensminger, & Wright, 2007).

Striking the proper balance between mitigation and adaptation decisions will more than likely resemble the manner in which epidemics, terrorists incidents or forest fires are addressed. Despite significant gaps in knowledge (e.g., frequency, severity, impact), planners can build resiliency and responsiveness into the system architecture to ensure that under most conditions most of the infrastructure will survive. The process by which these policies and strategies have developed over time have been a pendulum movement practical experience to theoretical knowledge to practical experience and back again to new, better theories and outcomes.

2.2.5 Changes in the Frame: From Environmental Problem to Consumption Problem

GHG reduction strategies have, in the main, been framed around the apprehension of climate change as primarily an energy and environmental problem. The focus made sense in the context of the emerging science of climate change that identified fossil fuels as the primary source of greenhouse gas emissions (Klein, Schipper, & Dessai, 2005). This scientific and policy frame has led to an approach of targeted reductions of greenhouse gas emissions negotiated through a consensus-driven framework established by the United Nations. This approach is based upon previously negotiated treaties (for example the 1987 Montreal Protocol) addressing the phase-out and elimination of environmental pollutants, such as chlorofluorocarbons and dangerous organophosphate pesticides. The institutionalization of climate issues within the energy and environment portfolios has strengthened this perception, leading to policy decisions that are effect-oriented in nature. The underlying rationality of the UNFCCC framework is one that treats GHG emissions like any other environmental pollutant that can be reduced through targeted cuts in emission levels, cap-and-trade mechanisms and offsets. Over the years, however, it has become increasingly accepted that GHG emissions are intimately linked to patterns of production and consumption, in both developed and developing countries (Swart & Raes, 2007; Sathaye, et al., 2007). The strategic and policy implications of this shift are significant. If GHG emissions are driven by specific development pathways then the type of pathway that is chosen (e.g. high energy intensiveness/ high material consumption levels versus low energy intensiveness/low material consumption levels) has significant implications for climate change policies as well as socio-technological development.

Examples of how development pathways influence climate policy can be found in many different instances. For example, many countries in Eastern Europe and Russia saw carbon emissions fall dramatically after the rapid de-industrialization and economic collapse post-1989. Across Europe, with the notable exceptions of Sweden, the UK and Belgium, the only countries that have registered a drop in CO2 emissions since 1990 have been those of the former Eastern Bloc countries and the remnants of the former Soviet Union(International Energy Agency, 2009). At the same time countries that have been rapidly industrializing over the past 20 years, such as Brazil, China and India, have registered double-digit annual growth in CO2 emissions during the same period. One of the major stumbling blocks in negotiations to construct a successor to the Kyoto Protocol is bound up in the development pathway implications of binding emissions reduction targets. While the EU has been pushing for a 30% reduction in CO2 emissions, many countries in the developing world (as well as the United States and Australia) argue that such targets will cripple economic growth prospects.

The existing climate policy architecture is ill equipped to handle these kinds of trade-offs. As Klein, Shipper and Dessai note, “[c]limate change is largely the result of human-induced greenhouse gas emissions that are driven by socio-economic development patterns characterized by economic growth, technology, population and governance.” (Klein, Schipper, & Dessai, 2005, p. 584). The framework of sustainable development is better able to address competing policy considerations such as equitable distribution of resources, financial burden sharing, institutional development and balancing environmental protection, social equality and economic development in a more comprehensive fashion (Sathaye, et al., 2007).

The shift in the frame from strictly environmental concerns to larger development concerns also opens up space for policy makers and planners to reconsider levels of affluence and population, topics that

are mostly taboo even today. In addition, most existing climate change policies are heavily focused on the production side of the equation, giving little or no attention to the consumption side. Globalized production and consumption chains make a hash of national emissions reporting as mandated by the Kyoto Protocol, since a significant amount of present and future emissions result from embodied emissions in the transport and production networks between the rich world and countries such as Brazil, India, China and Russia (Aall & Hille, 2010). The policy implications of these changes in the frame will be explored in further detail below in Section 2.4, on integrating sustainable development and climate change goals. The next section will outline the various strategic goals and policy initiatives that cities have adopted in order reduce their GHG emissions and adapt to the changing climate.

2.3 Municipal Climate Change Strategies

There is a dizzying array of voluntary municipal climate change alliances that have sprung up at the international, national, regional and local levels in the past few decades. Starting from roughly the same time as the United Nations Conference on Environment and Development (UNCED) in 1992, a number of voluntary transnational municipal networks were formed linking cities and regions together working towards a common goal of reducing greenhouse gas emissions. The main alliances in terms of both number of members and political influence are: 1) the International Council for Local Environmental Initiatives (ICLEI) [which has since been renamed ICLEI-Local Governments for Sustainability] Cities for Climate Protection (CCP), 2) the C40 Cities Climate Leadership Group, 3) the Climate Alliance and 4) Energie-Cites. The latter two alliances are drawn mainly from European cities, while the former two are international in scope.

The general goals of all the organizations are broadly similar: seeking voluntary commitments from member cities to reduce greenhouse gas emissions, building local capacity to implement GHG reduction measures, identifying and disseminating best practices among the networks and representing the interests of the membership at national, supra-national and international levels (Kern & Bulkeley, 2009). This section will concentrate on the two international organizations, the CCP campaign and the C40 climate group, in order to draw out the main outlines of the strategy and policy guidelines governing municipal climate strategies.

ICLEI comprises over 1000 cities, towns, counties and associations worldwide and has had a significant influence in the diffusion and adoption of both Local Agenda 21 sustainable development strategies and climate change mitigation strategies. There are three main strategic priorities: 1) building sustainable communities and cities, 2) protecting common goods and 3) participatory governance and sustainability management (ICLEI-Local Governments for Sustainability, 2006). Under the banner of protecting common goods are three areas of focus: 1) the Cities for Climate Protection Campaign, 2) water and 3) bio-diversity.

The Cities for Climate Protection Campaign began in 1993 and has now grown to encompass over 2800 communities worldwide (ICLEI-Local Governments for Sustainability, 2008-2009). There are three main program areas, mitigation, adaptation and advocacy, with the majority of effort to date concentrated on mitigating municipal greenhouse gas emissions and representing the interests of its members at the national and international level, such as the Conference of the Parties (COP) summits. There are five main milestones of a CCP climate strategy: 1) calculating emissions, 2) adopting targets,

3) developing policies, 4) implementing measures and 5) monitoring and verifying results (ICLEI-Local Governments for Sustainability, 2008). The strategy is designed to be adaptable to any size of community regardless of geography, economy and social and political structure.

In the United States, the adoption of municipal climate strategies is driven by many factors. Firstly, the lack of federal government action has impelled many cities and states to establish their own greenhouse gas reduction strategies. Secondly, many mayors and governors have felt political pressure from voters to respond to the challenges posed by global climate change. Thirdly, planners and politicians have seen municipal climate change strategies as a way to influence policy at the state and national levels (Wheeler, 2008; Schreurs, 2008). In Europe, although the EU member states have committed themselves to the Kyoto Protocol, over 1400 cities have joined one or more of the trans-municipal networks dealing with climate change, such as CCP-Europe, the Climate Alliance or Energie-Cités (Kern & Bulkeley, 2009). The underlying rationales motivating European cities to participate in these networks are similar in some ways to the American example, for instance a desire to influence policy at the national and supra-national level and as a response from political pressure to address a wide spread societal concern (Schreurs, 2008). One important difference between the European and American contexts is that a significant amount of effort is made by European cities within the climate networks to bypass national level governance in order to access financial support made available through EU initiatives (Granberg & Elander, 2007).

To date, the broad strategic outlines of municipal climate strategies in both North America and Europe are firmly rooted in well-established policy pathways of energy efficiency targets, promotion of renewable energy, tree planting programs and promotion of both public transport and non-motorized forms of transportation (Betsill & Bulkeley, 2007; Schreurs, 2008; Wheeler, 2008). For example, the C40 Climate Cities Initiative, encompassing many of the world's largest urban centers, lists the following examples (notably excluding land use measures such as densification/compaction) of what cities can do to lower greenhouse gas emissions:

- Creating building codes and standards that include practical, affordable changes that make buildings cleaner and more energy efficient.
- Conducting energy audits and implementing retrofit programs to improve energy efficiency in municipal and private buildings.
- Installing more energy efficient street and traffic lighting.
- Implementing schemes to reduce traffic and developing bus rapid transit and non-motorized transport systems.
- Establish the infrastructure and incentives to promote the use of low-carbon vehicles.
- Developing sustainable waste management solutions, reducing reliance on landfill disposal, and creating waste-to-energy systems (C40 Climate Cities Initiative, 2010)

Similarly, the main focus of the greenhouse gas emissions strategies articulated by ICLEI, Energie-Cites and the Climate Alliance follows similar outlines that roughly follow an ecological modernization model: more energy-efficient infrastructure, more renewable sources of energy, creating more sustainable mobility networks and improving waste management (ICLEI-Local Governments for Sustainability, 2009; Energie-Cites, 2010; Climate Alliance, 2010) The cross cutting relationship between emissions, population and affluence is rarely recognized and seldom taken into consideration when making policy (Giddens, 2009).

While the many of these transnational municipal networks have succeeded in raising the profile of urban areas as primary loci of action when it comes to GHG reduction strategies, there remain significant barriers to effective policy implementation. Firstly, the reliance on best practices to guide policy decisions creates some notable stumbling blocks. The lack of clearly defined criteria allows for a riot of competing notions of what "best practice" means. There is little guarantee of the quality, replicability, transferability or veracity of the practices and policies in question. According to some researchers, many planners and politicians have frequently articulated the need and desire to get behind the official version of the policies and into the actual implementation of the strategies themselves (Kern & Bulkeley, 2009). Secondly, the voluntary nature of the municipal climate strategies often impedes effective implementation due to the lack of structural support from the state. Even in Sweden, counted among the most progressive actors in addressing climate change, significant greenhouse gas reductions achieved through district heating and aggressive renewable energy strategies at the municipal level have been undercut by the growth of emissions from the transport sector (Granberg & Elander, 2007). This is also the case in the United States, where many cities have faced significant barriers to implementation due to the lack of integration between large infrastructure projects (with funding and implementation decisions taken at the federal level) and the local climate change strategies at the municipal level (Wheeler, 2008). Finally, there are significant scale issues to attend to, in that the benefits of successful mitigation efforts accrue at a global level while the costs are borne at the local level.

2.3.1 Urban Morphology

In the main, there has been only intermittent focus in the literature on the larger strategic planning issues related to climate change mitigation strategies and urban morphology, such as compaction and polycentrism. This is starting to change in response to increased awareness and concern for addressing adaptation to unavoidable changes in the climate but it is still in the early stages of development. As noted above, most climate change mitigation strategies are heavily focused on energy efficiency gains and shifts toward renewable sources of energy. In the built environment, this has mostly manifested in various forms of "green" building policies for new and existing residential, commercial and industrial buildings (ICLEI-Local Governments for Sustainability, 2009; C40 Climate Cities Initiative, 2010). These types of strategies (better insulation, lower energy usage, on-site renewable power generation, biological filtration and re-use of water) are often twinned with efforts to increase the densities of the building relative to the lot size.

Some countries, notable Sweden and the UK, are beginning to integrate climate change considerations within the local land use planning systems by providing local governments with both financial resources and technical assistance in planning carbon-neutral new towns or retro-fitting existing urban areas (Granberg & Elander, 2007; OECD, 2009). Examples of neighborhood scale developments designed to create more sustainable development patterns can also be found in Germany (Vauban and Freiburg) and Sweden (Malmö and Stockholm), among others. What these strategies share in common is an integrative approach that combines land use, transportation, energy and natural system protection concerns into a coherent framework. One common trait that most of the existing municipal mitigation strategies share around the world is that they do not take into account the GHG emissions from aviation, logistics (ships, railroads, trucks) or the embedded emissions from the goods and services produced elsewhere but consumed within the city.

2.3.2 Transportation

Transport policy is a key determinant of any successful climate change reduction strategies. CO2 emissions from this sector account for 30% of the total annual in OECD countries and are growing at nearly twice the rate of emissions from stationary power generation (OECD, 2009). Transportation infrastructure is also vulnerable to flooding and higher temperatures associated with climactic changes. The policy goals of current municipal mitigation strategies are broadly similar to those of sustainable urban development goals: 1) reductions in the use of the private automobile, 2) prioritization of non-motorized forms of transport such as biking and walking and 3) improvements in the provision of public transport (ICLEI-Local Governments for Sustainability, 2009; C40 Climate Cities Initiative, 2010). One of the most intractable problems in many cities is the increasing distances between residences and workplaces that are far larger than many public transport systems were built to service. In the absence of suitable alternatives, many commuters resort to car usage to make daily trips to work, school, retail excursions or leisure activities. Many cities in Germany, Austria and Switzerland have adopted a regional public transport system that is integrated across the region, allowing for users to buy one ticket that is good for an entire trip length, regardless of the mode of travel. While the backbone of the systems are trains (either U-bahn metro or S-bahn surface), bus (both diesel and electric), tram and ferry trips are well integrated into the network. Zurich's public transport system manages to maintain a modal share in excess of 50%, despite operating in one of the richest cities in Europe (Pucher & Kurth, 1996). The Zurich region has also closely linked land use decisions to the public transport infrastructure investment, stimulating more dense settlement patterns clustered around train and bus systems. Zurich's per capita carbon emissions in the transport sector are among the lowest of any European city (International Energy Agency, 2009). It is possible to decouple rising incomes and increased spatial dispersion of regional activity from increased usage of the private automobile, but the strategies and policies need to be implemented in a coherent, long-term planning framework that treats the regional land use and transport policies as one.

One important dimension that is missing from most sustainable transport strategies is the inclusion of climate adaptation needs. Much of the transport infrastructure is highly vulnerable to systemic or episodic disruptions in service due to extended periods of high temperatures or heavy rainfall. Rail buckling, signal failure, flooding of railways or streets or disruptions in the power supply can all lead to breakdowns in the functioning of both motorized and non-motorized forms of transport. It will be necessary in the coming decades for spatial planners to systematically analyze the vulnerability of each portion of the transportation system and attempt to build in resiliency and operational robustness. Location decisions for new and existing infrastructure should therefore be decided in light of not only cost-benefit analysis, land use changes and traffic models but also future carbon emission profiles and resiliency to climactic changes.

2.3.3 Energy

Waste-to-energy systems, district heating/cooling systems, implementation of feed-in tariffs for renewable power, subsidies, low-interest loans and grants for installation of solar, wind (among other sources of renewable power), research and development money allocated to low- or zero-carbon sources of power, improvements in the energy efficiency of the residential, commercial and industrial sectors are all part of the portfolio of responses for municipalities seeking to lower GHG emissions.

Växjö, Sweden has made significant progress towards the goal of halving per capita emissions by 2010 and severing the reliance on fossil fuels by pursuing a two-prong strategy of: 1) expansion of district heating (and later cooling) systems and 2) substituted biomass for fossil fuels in the stationary power and heating sectors (Växjö Kommune, 2007). The city has used a combination of leading by example, subsidies and changes in the building codes to spur moves toward more sustainable and carbon-free sources of power and heat. In the transportation sector, progress has been more fitful, but the main policy outlines are clear: increase the share of both public transport and non-motorized forms of transport, promotion of car-sharing schemes and shift the fuel source of motorized vehicles to ethanol or other biogas (Växjö Kommune, 2007). Interestingly, land use changes to generate more compact urban development or urban growth controls are not mentioned in the strategy, nor are active measures to discourage automobile use, such as road pricing, parking restrictions or the creation of car-free zones within the existing urban core.

2.3.4 Natural Systems

When it comes to natural systems and climate change goals, many of the same strategy and policy initiatives that are found in sustainable development strategies are synergistic to climate change strategies. For example, the integration of natural areas within the urban core, expanding tree cover, using natural forms of waste water and storm water management and establishing goals to increase the resiliency of natural systems within the city all serve to lower GHG emissions, create carbon sinks or to enhance the resiliency of the infrastructure to urban heat island effects, increased flooding or rising sea levels. An example of how natural systems management can be integrated into the spatial planning framework can be found in London. The Greater London Authority has adopted a climate adaptation strategy that, among other things, calls for the creation of a "Green Grid" in East London. The intention is that by establishing a connected web of protected open spaces, the region will be able to lower urban temperature, improve storm water and flood water management, provide urban refuges for wildlife and connect people to nature. Moreover, these natural systems enhancement policies form the backbone of a large-scale regeneration scheme that will eventually link up across the entire region of London (Greater London Authority, 2010).

2.3.5 Mapping the Synergies and Conflicts

Table 2 on the following pages illustrates some of the possible complementary policy areas, reinforcements and conflicts between selected sustainable urban development goals and climate change goals. The following sub-section will summarize the municipal climate change strategies discussed in this section. After that, the subsequent Section (2.4) will address in greater detail the strategic and policy implications of mainstreaming climate change.

Table 2: Integrated Assessment of Different Climate Change Policy Goals

Policy Goal	Policy Tool	Policy Sector	Purpose	Synergistic to:	Conflicting with:
Compact urban cores	Growth management, regional planning systems	Land Use, Transport	Mitigation	Shorter travel distances. More efficient use of energy and land. Better opportunities for collective and non-motorized transport. Lower capital and maintenance costs for infrastructure. More economies of scale for district energy, heating and cooling systems.	Sea level rises Increased flooding Rising temperatures
Increasing energy and material efficiency in buildings	Zoning regulations to promote smaller homes and multi-family dwellings.	Land Use zoning	Mitigation	Compact Urban Cores Improvements in linkages between population densities and public transport Increases in shared open space provision	Solar rights
	Improving efficiency requirements in the building codes.	Building	Mitigation w/ possible adaptation benefits (for example green roofs for insulation and rainwater catchment	Compact urban areas (smaller buildings on smaller lots).	
	Coordinating public-private partnerships to retro-fit existing building stock	Building	Mitigation	Economic development Social equity Lower energy usage	
	Creating financial incentives to overcome higher initial costs for more efficient technologies	Finance	Mitigation	Economic Development	

Policy Goal	Policy Tool	Policy Sector	Purpose	Synergistic to:	Conflicting with:
Increase provision of on-site renewable generation and district heating, cooling and power generation	Building codes to encourage on-site renewable power	Building	Mitigation	Improvements in resiliency of infra-structure	Possible conflicts with compaction if such sources have large space requirements
	District heating and cooling	Building	Mitigation and Adap-tation	Compact Urban Cores Higher material and energy efficiencies in buildings Lower operations and maintenance costs Economic development	Increased vulnerability of critical infrastructure
Increasing passive infrastructure systems	Passive systems of waste water and storm water management	Infrastructure	Mitigation and adaptation	Reductions in energy use. Increases natural systems health Increase open spaces within the city	
	Increase use of gray-water recycling and rainfall catchment for fresh water	Infrastructure, Building	Mitigation and adaptation	Lower energy usage. Increased watershed health Better air quality	
	Increase permeability of road, bike and walking surfaces	Infrastructure, Transport	Mitigation and adaptation	More green areas Increased health of urban watersheds Safer streets	

Policy Goal	Policy Tool	Policy Sector	Purpose	Synergistic to:	Conflicting with:
Reductions in trip lengths and frequency of trips	Mixed use zoning	Land Use	Mitigation	Transport improve-ments	
	Alterations in existing tax regimes to encourage denser development patterns	Land Use	Mitigation	Discourage auto use Higher share for non-motorized modes of transport	Could force poorer residents to outer suburbs with poor transit connections
Increase use of public transport	Transit oriented development	Land Use	Mitigation	Compact urban core Social equity	
	Use tax and fiscal policy to increase value of land close to transit lines	Land Use, Finance	Mitigation	Compact urban core Social equity	
	Improve system frequency and connection Improve linkages between different modes for different needs (e.g. bike-tram-commuter rail-carshare)	Transportation	Mitigation	Reductions of car usage Higher energy efficiency Improves opportunities to shift from fossil fuel to renewable sources of electricity	
Discourage use of the private car	Traffic calming measures	Transportation, Land Use	Mitigation (with possible adaptation benefits)	Improvements in public transport Public health Improve opportunities for non-motorized transport	
	Zoned restrictions on private car usage (e.g., car-free areas, restrictions on parking)	Transportation, Land use	Mitigation	Improvements in public transport Reductions in local air and noise pollution Compact urban areas	

Policy Goal	Policy Tool	Policy Sector	Purpose	Synergistic to:	Conflicting with:
Reduce vulnerability to extreme storm events	Zoning regulations to create more open space and buffer zones	Land use	Adaptation, Mitigation	Better recreational opportunities	Compact urban cores
Reduce vulnerability to sea level rises	Designation of open space as buffer zones	Land Use	Adaptation	More open space provision Better opportunities for multi-family dwellings	Compact urban cores
Reduce urban heat island effect	Improve transport and energy infrastructure to withstand extreme temperatures	Transport, Infrastructure	Adaptation		
	Tree planting programs	Natural systems	Adaptation, Mitigation	Lower urban heat island Improvements in local air quality	
	Building codes that require roofing and paving materials that reduce heat island effects (e.g., green roofs, pervious paving systems)	Building	Adaptation, Mitigation	Improvements in energy efficiency	

2.3.6 Summary

As the preceding sub-sections indicate, there are a number of strategic and policy intersections between sustainable development and climate change goals. Many of the issues (if not all) cut across traditional sectoral divisions of planning and governance as well as push against prevailing trends in society and economic development (e.g. increasing levels of mobility, affluence and consumption). In recognition of this, many planners and policy makers around the world are working toward an integrated planning regime that seeks to mainstream climate change concerns into the larger sustainable development framework. Careful consideration should be given to such efforts, since there are potentially large differences between both mitigation and adaptation on the one hand and climate change goals and sustainable development goals on the other (Swart & Raes, 2007). For example, efforts to "climate-proof" urban infrastructure in rich European cities often entail massive consumption of concrete and steel to build dikes and raised platforms, generating large amounts of GHG in the production process. While cities in the wealthier parts of the world have significantly more institutional, technical and financial resources to cope with rising sea levels, there is a marked disparity and unequal distribution of those resources in the developing world. Also, while humans possess (hopefully) the ability to proactively adapt to coming changes in the climate, what will happen to the rest of the plant and animal species on Earth that do not. Sustainable development concerns need to address the economic, social and environmental inequalities, something that the current discourse on climate change policy does not systematically engage with. The next section will attempt to sketch out the broad outlines of what an integrated framework would look like for sustainable, low carbon urban development pathways.

2.4 Mainstreaming Climate Change Strategies into Development Goals

> By framing the debate [of climate change] as a sustainable development problem rather than only a climate mitigation, the priority goals of all countries and particularly developing countries are better addressed, while acknowledging that the driving forces for emissions are linked to the underlying development path (IPCC Fourth Assessment Report, (Sathaye, et al., 2007, p. 696)).

There is increasing recognition that sustainable development goals and climate change goals should be assessed and analyzed within a common framework to maximize the reinforcing mechanisms and minimize conflicts between the two areas. Moreover, there are a number of structural, social, environmental, political barriers to action that require a larger, more adaptive policy framework than currently exists. Climate change mitigation and adaptation strategies cannot be implemented outside of existing social and economic and technological conditions (Burch, 2009) and yet these conditions remain on the margins of traditional perceptions of climate change as primarily an environmental problem. One of the key positions of sustainable development is that the social and economic conditions themselves must be transformed in order to generate equitable outcomes for current and future generations (United Nations World Commission on Environment and Development, 1987)

The chosen development pathway of a given city or society has an enormous influence on the future emissions profile. Therefore, the pursuit of a sustainable development pathway constructed around low material and energy intensiveness, lower rates of population growth and lower rates of consumption

should yield considerable reductions in GHG emissions (Robinson, et al., 2006). A related question is whether or not climate change mitigation and adaptation strategies can be thoroughly integrated into sustainable development strategies. The answer is, in theory, yes (Swart & Raes, 2007; Sathaye, et al., 2007; Dawson, et al., 2009). In practice, as discussed below, it is more difficult to say exactly how that can happen. A second question is if the two can be integrated, ought they be? This section will address the broad outlines of these questions by examining the synergies and trade-offs between climate change mitigation and adaptation strategies on the one hand and sustainable urban development goals on the other. In light of the fact that both climate change and sustainable development goals and strategies transcend sectoral policies and disciplinary boundaries, the following sub-sections will be arranged according to the main principles identified in Sub-section 2.1.5: morphology, path dependency, synergy/conflict and governance.

2.4.1 Morphology

One clear line of convergence between sustainable development goals and climate mitigation/adaptation goals is that land use and transportation are central nodes of climate policy conflict (and potential resolution) regardless of the sectoral divisions between transport, water, agriculture, energy and the like (Mickwitz, et al., 2009). Spatial planning will therefore be central to the successful implementation of climate strategies and sustainable development strategies. It will be important to open up space within both the expert community and the society at large for wide discussions concerning the appropriate portfolio of planning measures that can adequately balance mitigation, adaptation and sustainable development strategies. Development of such strategies will also require close attention to implementation, monitoring and feedback into future development goals in order to create responsive policies that seek to avoid mal-adaptive strategies (Klein, Schipper, & Dessai, 2005). Preventative planning for climate-adapted, sustainable cities will place also large demands on the socio-economic, technical and institutional resource base for cities and regions.

For example, the relationship between a sustainable city form and the climate-adapted city form is neither clearly demarcated nor simple. Some theorists posit that, in a given geographic region such as sub-tropical and tropical areas, the low-rise, decentralized, sprawling city may in fact be more resistant to climate-driven hazards than the compact, mixed-use, densely populated form (Pizarro, 2009), even though the built environment and infrastructure of the low-density city performs poorly in relation to mitigating GHG emissions. There are numerous critical variables that will have to be taken into account when planning for adaptive cities, for example the physical location, prevailing wind patterns, proximity and availability of water, amount of tree coverage, types of open space and natural areas, building densities, types and material. In addition, planners will have to respond and anticipate future changes in climate patterns, such as changes in the frequency and intensity of rainfall, large changes in average temperatures, potential rise of sea levels and prolonged periods of drought. Adaptive planning strategies for hot-humid climates will be, of necessity, quite different from those found in temperate climes. This implies that strategies for integrated frameworks of climate change and sustainable development goals will be context-sensitive and highly contingent due to the many physical, socio-economic, political and technological differences between cities.

A recent study conducted by the Greater London Authority (GLA) in cooperation with the Tyndall Centre for Climate Change Research illustrates the complicated policy intersections that result from the

incorporation of mitigation and adaptation goals into the spatial planning framework. Land use development scenarios indicated that projected growth by 2100 in population within the GLA boundary would necessitate difficult trade-offs to be made in terms of site selection. Calculated exposure to flood risks from the Thames River will have to be set against further loss of open space or increased densities of existing built-up areas. For example, losses from flooding by 2100 could range from £33m per annum (for the Suburban development scenario) to £89m per annum (for the Eastern Axis development scenario). These assessments do not include lost time due to travel or economic disruptions. Transport policy will have to be closely connected to not only to land use development, but also to large shifts in infrastructure investment (particularly rail), behaviors and lifestyles (Tyndall Centre for Climate Change Research, 2009). If the region is to meet its goal of an 80% reduction in carbon emissions by 2050, only a combination of technology shifts + carbon pricing+ lifestyle policies can deliver the desired outcomes. The authors also found that even with significant market penetration of low-carbon vehicles, growth in both personal and freight mobility will still lead to rising emissions (Tyndall Centre for Climate Change Research, 2009).

The analytic morphology measure will be: the extent to which climate policies are connected to and cross-referenced in other local, regional and national land use, transport, energy, and natural systems/environmental planning documents.

2.4.2 Path Dependency

Climate policies alone cannot deliver the necessary reductions in GHG emissions; the specific development trajectories are just as important, if not more so, in order to create a low-carbon society (Sathaye, et al., 2007). The path dependencies of a particular development trajectory can manifest in many different forms, for example innovation pathways, behavioral pathways, economic pathways, institutional pathways and environmental pathways. What these aspects share in common is that once a society commits to a particular development path, the costs of reversal are typically high (Pierson, 2000). There are points of inflection that allow for shifts in policy and direction, but due to high structural and institutional barriers that get reinforced through time and practice it is extremely difficult to effect systemic change. In other words, the law of increasing returns forms a positive feedback loop where each step along a given path increases the *probability* that future decisions will be oriented in a similar direction. According to Arthur (1994), there are four features of the relationship between technology and society that are likely to generate increasing returns: 1) the presence of large set-up or fixed costs, 2) learning effects, 3) coordination effects and 4) adaptive expectations (Arthur, 1994).

The majority of point-source GHG emissions arise from stationary and mobile power generation (for heating, cooling, electricity and fuel for transport). The path dependencies of the existing system of power generation and distribution illustrate the principle of increasing returns (even at the point of lowering the long-range viability of economic, social and ecological systems) and have important implications for planning decisions taken to both mitigate and adapt to climate change. The existing system architecture of power distribution is the result of a number of complex interactions between technological, socio-economic and political forces that has resulted in a specific arrangement that has persisted for over a hundred years. The *large fixed costs* of operations, maintenance and capital requirements of the generation and distribution network creates a strong incentive to maximize output (and profit) over a long period of time to lower the unit costs of production. The complexity of the

network yields a similar logic of maximizing returns due to the high initial *learning* curve. Modern, centralized production of power is very technically demanding and requires its operators to spend many years becoming proficient which in turn leads to focusing innovation on optimizing the existing architecture rather than seeking out disruptive new ways of doing things. The associated eco-system of suppliers and consumers of electricity also creates powerful *coordination effects*. The infrastructure of power generation has strong positive externalities that draw in many other sectors creating an inter-linked network of dependency. Fundamental changes in the underlying architecture of power generation would be extremely disruptive to the entire technological, social-economic and political architecture of modern society, creating a strong disincentive to change. Wind power provides an interesting illustration of how coordination effects play a role in conditioning and disciplining potentially disruptive technologies. After 30 years of fluid movement between radically different socio-technical configurations, there has been a coalescence around a fixed regime; clusters of grid-connected, horizontal, 3-bladed, megawatt scale turbines that are progressively moving offshore (Berkhout, Angel, & Wieczorek, 2009). Finally, *adaptive expectations* play an important role in maintaining the existing technological path, in that the aggregate expectations of future developments can establish self-fulfilling prophecies. Electricity is an integral part of our collective existence and the expectations of uninterrupted supply at low cost conditions and constrains possible futures in that renewable sources of power are intermittent and prone to large swings in availability.

Similarly, in the modern world, on-demand mobility has become the sine qua non of human desire. Car-dependent mobility is constituted from a (now) relatively stable regime of institutional, cultural, technical, economic, cognitive and behavioral changes and practices that have co-evolved into a functionally integrated system. The logic of this form of mobility has some basic predicates: 1) roads on which to travel, 2) fuel on which to run and 3) services that keep both car and driver running. As above, the systems that support automobiles have large fixed costs, significant learning effects, strong coordination effects and prevalent adaptation expectations. Therefore it could be expected that at this stage of development (over 100 years since the emergence of the car) that the pursuit of increasing returns dictates a particular set of policies and priorities-namely the maintenance and extension of the dominant mode of mobility in spite of significant societal resistance. Again, this is not to suggest that the path dependencies within this system make it impossible for change to happen, only that the *probability* of any significant shift is lower absent major disjunctive systemic shocks.

An interesting case of the convergence of these two mutually reinforcing path dependencies can be seen in the push to electrify the automobile. Battery-powered cars are an even older technology than the internal combustion engine, but have been hampered by weight, range and recharging time limitations. Many countries are dedicating extensive resources to research, development and production of electric vehicles despite the persistent lack of market demand. The overriding logic of this particular development path is driven in large part by the high fixed costs of the existing system of both automobile use and electricity infrastructure (highways, power plants, transmission lines, fueling, repair and service stations, the complexity of the system architecture that represents billions of man-years of education and skill development, the coordination effects of the overlapping and interlink networks of mobility and power generation and the adaptive expectations of the aggregate societal goals. The logic of increasing returns does not dictate some predestined future, but it does increase the *probability* that future steps will be in a similar direction.

An important planning implication for the mainstreaming of climate change of into the sustainable development discourse is that future projections matter far more than policies currently consider. Projected demographic expansions, areal expansions, mobility expansions and economic expansions are a fundamental part of long-range planning around the world. These projected futures are intimately bound up in the current development pathway of a society and making commitments to future expansions of the road network or built-up urban areas carry the high *probability* that increased energy and resource usage will follow. There is a strong bias towards the status quo in political and social institutions (Pierson, 2000) that is coupled with a strong ideological attachment to techno-rational solutions and economic reductionism of environmental and social issues(Næss P., 2010). One way to counter such tendencies is to use one of the most powerful tools that planning possesses-the ability to consciously create the future. Long-range planning strategies that started with the assumptions of a low-carbon energy base and rapidly changing climactic conditions would likely posit futures that are far less expansionistic than current strategies are. Another possible policy initiative is to consciously create and nurture niches within the dominant socio-technical regime. Organic agriculture, chemically-free consumer products and renewable energy generation are all examples of niches that developed within a dominant socio-technical regime that have grown to a significant presence within the landscape over multiple generations (Berkhout, Angel, & Wieczorek, 2009). Additionally, a common characteristic of path dependencies is that in periods of uncertainty and disruptive change in either the technological and/or socio-economic orders there is a large window of influence that closes rapidly once a clear set of goals and policies emerge. There is exactly such a moment emerging in the discourse of climate change. The specific strategies and policies for adaptation and mitigation are still fluid with many unresolved uncertainties about the "right" course of action. The strategic priorities are still at a contestable stage, but it is possible to witness the formative outlines of two radically different pathways. One is essentially a continuation of existing patterns of development with a substitution of fossil fuels with renewable sources of energy and technological fixes to address climate changes, leaving the existing economic and social system substantially intact. A divergent pathway is one where the underlying logic of production and consumption is altered to fit a "soft" development path of lower energy use, lower mobility flow, lower consumption levels and more equitable patterns of distribution (both intra-generationally and inter-generationally). By consciously illuminating the benefits and costs of different development pathways, planners can, at worst, make the consequences of the aggregate societal choices more transparent and at best help to realign the institutional and societal goals in a more sustainable direction.

The analytic path dependency measures will be: 1) a descriptive analysis of the extent to which path dependencies are addressed within the climate strategies, land use, transportation, energy and natural systems/environmental plans and 2) the extent to which plans assess the linkages between socio-technical, innovation, behavioral, cultural, institutional pathways.

2.4.3 Synergies, Conflicts and Trade-offs

There are two primary reasons for planners to engage in a search for both strategic synergies and conflicts: 1) many sustainable development and climate change strategies push against prevailing patterns of development and an important way to generate political, social and economic support is to actively create policies and strategies that support one another and 2) synergies help to identify policies that maximize gains for a variety of actors and institutions in order to avoid zero-sum outcomes with

clearly defined winners and losers. Many climate strategies have significant potential synergies and conflicts between mitigation and adaptation measures and sustainable development goals, but require the development of adequate methods to identify and act upon the synergies, try to minimize the conflicts where possible and provide a just and equitable framework for resolving conflicts that are unavoidable. A critical component of sustainability is the concept of intra- and inter-generational equity. Distribution of resources, whether financial, institutional, technical or political, is uneven throughout society and planners can be instrumental in identifying and rectifying such imbalances. The use of a Adaptation/Mitigation/Sustainable Development (AMSD) approach can help to broaden the reach of climate policy at the local and regional level, expanding from energy and environment concerns into budget planning, land use regulations, infrastructure investment and taxation policy (Bizikova, Robinson, & Cohen, 2007).

An example of synergistic policies between climate goals and sustainable development goals can be found in the area of energy efficiency. Energy efficiency improvements typically yield both significant reductions in GHG emissions and strengthen sustainable development goals by, for example, generating employment in new sectors, lowering heating and power costs, lowering emissions of other forms of air and water pollution, and lowering demand for primary resource extraction (Sathaye, et al., 2007). Improved building efficiencies have numerous positive externalities as well, obviating the need to expand power and heat generation facilities (whether renewable or fossil-fuel), improving indoor air quality and providing financial savings for building occupants (especially important for lower-income residents who pay a higher percentage of income for utilities). However, many mitigation and adaptation measures currently under consideration may push in the opposite direction. In Australia, for example, many cities are responding to water shortages by building fossil-fuel burning desalination plants that feed more GHG emissions into the atmosphere. In many places in Europe (such as the Netherlands, the UK and Denmark) governments are contemplating mega-projects such as dikes and tidal barriers to address rising sea levels. Such measures are heavily reliant on energy-intensive materials such as steel and concrete that result in large increase in GHG emissions and still leave significant sections of natural ecosystems and wildlife exposed to the dangers. Similarly, increased use of air conditioning to adapt to warming climates works against mitigation policies by increasing the intermittent base load requirements on the electricity grid that is typically met through fossil fuel power plants. Reliance on shifts from fossil fuel to biomass may cause long-term damage to forestry and food production in the world, having negative effects on environmental, social and economic sustainability.

There is also the possibility that mitigation measures will work against sustainable development goals of social equity. For example, many national governments are implementing or planning to implement road-pricing schemes to control congestion and lower GHG emissions from the transport sector. These types of policies will have to be carefully designed in order to avoid creating two-tier mobility systems, where the wealthy can continue driving solo while those with less means have more constrained mobility options. Adaptation policies also risk sacrificing natural areas by focusing measures to adapt to sea level rises on high-value (for humans) urban areas and leaving

The analytic measure for synergies, conflicts and trade-offs will be: a descriptive analysis of the presence or absence of actions/policies to create an Adaptation/Mitigation/Sustainable Development (AMSD) framework.

2.4.4 Governance

Multi-level governance issues pervade both climate change and sustainable urban development. Issues of scale, policy integration and the role of non-state actors need to be addressed in order to successfully bridge the inherent gap between the international scope and scale of the problem generation and building up local response capacity.

Issues of Scale

Climate mitigation and adaptation strategies share many similarities to sustainable development strategies in that while the nature of the problem is global, the particular suite of policy measures to address the issue are resolutely local. Recognition of the scalar and temporal differences between mitigation and adaptation are essential in order to create a balanced, sustainable development framework (Swart & Raes, 2007). Mitigation measures are necessary to stem future growth of GHG concentrations, but at the municipal or regional level the legal, policy and financial resources to effectively reduce emissions by 80% or more are beyond the reach of cities. Adaptation measures are more closely linked to the existing competences of planning authorities such as trading off land use, economic development, social equity, disaster readiness and natural resource protection goals. Moreover, even though many of the driving forces of unsustainable development patterns (e.g. demographic, social or technical) lie beyond the direct influence of municipal and regional planning authorities to control or change in the near term, cities and regions still possess considerable power to consciously shape the current and future resource and energy intensiveness of the urban form. Effective integration of climate goals into the sustainable development agenda will also require close policy coordination between municipal, regional, national and supra-national governments. For example, environmental and regulatory impact assessment measures incorporating mitigation and adaptation goals will have to be developed at the national or EU level in order to ensure harmonized implementation (Mickwitz, et al., 2009). New infrastructure investment, whether transport, environmental services, energy or the like, will also have to take into financial considerations for both GHG reduction goals and climate adaptation goals.

Integrated Policy

In order to integrate both mitigation and adaptation concerns into a sustainable development framework, five main criteria will need to be met: 1) inclusion, 2) consistency, 3) weighting, 4) reporting and 5) resources (Mickwitz, et al., 2009). *Inclusion* refers to the extent to which direct as well as indirect climate change mitigation and adaptation impacts are accounted for, including distributive fairness and social justice questions. There should also be efforts to ensure *consistency* between the various policy aims and objectives. Mitigation and adaptation strategies often contain contradictory policy aims (such as the desire for more compact harbor front developments despite rising sea levels) and it is important that planners attempt to minimize such conflicts where possible. Where such conflicts are unavoidable, it will be crucial to have a decision-making process in place to fairly and justly decide how to negotiate the inevitable trade-offs to be made. Such *weightings* (qualitative) will need to take into account the different goals and aims of climate policies compared to societal goals. Once the policies are formulated, *reporting* requirements should be in place to gather feedback and to measure the degree of correspondence between the stated goals and the actual outcomes. Finally,

knowledge, fiscal and institutional *resources* need to be allocated in order to ensure that the good intentions informing the climate and sustainable development goals are put into action. Many of the difficult climate change policy decisions have yet to be addressed in a substantial way and despite the appearance of widespread consensus about the need to act, conflicts between the market, the state and various sectors of civil society are inevitable.

The analytic measure for governance will be: a descriptive analysis of the presence and extent to which plans meet the criteria of inclusion, consistency, weighting, reporting, and resource allocation.

3 Methodology

This study was an exploratory, qualitative, multiple-case study, with primary data gathered from planning and policy documents, relevant planning journal articles and books. This chapter is divided into two sections. Section 3.1 addresses the theoretical considerations of case study research methods, including issues of validity, reliability and generalization, data collection principles, analytic methods and case composition. Section 3.2 is a descriptive account of the applied methods used to conduct this research as well as the limitations of the study.

3.1 The Case Study as a Research Method

A case study method is appropriate in a research environment where primarily "how" and "why" questions are being asked regarding a contemporary set of events where the researcher has little or no behavioral control over the actors or events. (Yin, 2009) Cases can be constructed from a wide variety of differing sources of data of either a qualitative or a quantitative nature, or some combination thereof. Social science theory and practice is heavily context-dependent and therefore requires a deep understanding of not just the documentary material but also the look, texture and feel of the environment. The case study allows the researcher to get close and stay close to the primary sources of data throughout the research process, including the phases of data analysis, feedback and publication (Flyvbjerg, 2004).

A two-fold technical description of a case study is, according to Yin, as follows:

> A case study is an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident.

And

> The case study inquiry copes with the technically distinctive situation in which there will be many more variables of interest than data points and, as a result, relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another result, benefits from the prior development of theoretical propositions to guide data collection and analysis (Yin, 2009, p. 18).

Single versus Multiple Case Studies

Yin articulates five types of single-case studies: the critical case, the extreme case, the typical case, the revelatory case and the longitudinal case (Yin, 2009). The critical case is one in which the researcher chooses in order to take a well-developed theory and bring in to ground in order to understand better which hypotheses hold and which do not. The extreme case is one in which the subject of study is understood to represent something of an outlier among a group or a category. The representative case is one in which the situation on the ground could be considered typical or commonplace, in that the conditions encountered in the specific case could be said to be found widely across any given range. The revelatory case is one that the researcher would choose if they wanted to explore a new

phenomenon previously inaccessible to research inquiry. Finally, there is the longitudinal case that enables the researcher to study cases at multiple junctures in time and/or space.

Multiple case studies can strengthen the validity and reliability of the data by drawing from a wider variety of sources and providing another form of triangulation. The logic of multiple case studies is analogous to the replication logic of quantitative research-the findings become more robust the more times they are tested (Yin, 2009). Therefore, expanding the site of study from one case to multiple comparative cases offers the researcher the opportunity to establish a higher degree of robustness of the findings. There is an important caveat here, however. The underlying logic that the replication of repeatable patterns is sufficient to establish causal connections is subject to both ontological and epistemic debate.

Abstracting by generalization, or the search for event regularities across cases, is often based on the inductive logic that if a known set of samples demonstrate a set of conditions then these observable phenomena can be understood to persist outside of the specific context of the object or event of study (Bergene, 2007). A critical realist approach to comparative case study, in contrast to that articulated by Yin and others, would seek to distinguish between empirical generalizations and realist generalizations. Empirical generalizations rely mainly on inductive logic to extrapolate from a limited set of observable phenomena/events to universally applicable conclusions. Realist generalizations rely on abductive/retroductive inference to uncover the deeper mechanisms and structures that underlie the phenomena/events (Danemark, Ekström, Jakobsen, & Karlsson, 1997). According to this conception, "causes are not regularities, but powers and liabilities, and they may be possessed exercised, exercised unrealized and realised unperceived (or undetected); they may also be transformed" (Bergene, 2007, p. 13). Therefore event regularities (and their replication) will not yield explanatory causes of the underlying structures and mechanisms. In order to apprehend the deep structures, abductive and retroductive inferences allow the researcher to move from the concrete to the abstract and then back again in order to re-contextualize the analysis and theorization. Comparative case studies undertaken from critical realist perspective will seek to establish a dynamic relationship between theory, observed events, underlying structures and mechanisms and back to a re-interpreted theory that creates a richer understanding of the process or object of study that accounts for the contingent and context-sensitive nature of social relationships (Bergene, 2007).

3.1.1 Understanding Validity, Reliability and Generalization

Within the social sciences, there remains in many disciplines an almost fetishistic impulse to prove itself worthy of the name "science". The concern for credibility, validity and reliability is, to some extent, indicative of the continuing influence of positivistic modes of conceptualizing the world. The idea that there are operational laws governing the social world has been subject to numerous revanchist attacks over the years, most recently from constructivist, post-modernist and feminist theories (Silverman, 2006). Like the Hydra, though, empiricist and positivist ideas continue to regenerate and multiply. In this sub-section, rather than engaging with a debate that has been ably conducted by persons more qualified than myself, I will review the four research design tests drawn from Yin (2009) in order to explore the ways in which qualitative social research can address issues of validity, reliability and generalizations. The following table, Table 3, sets out four research design tests for

construct validity, internal validity, external validity and reliability along with various ways that the case study researcher can address each of the four tests.

Table 3: Case Study Tactics for Four Design Tests

Tests	Case Study Tactic	Phase of research in which tactic occurs
Construct Validity	Use multiple sources of evidence Establish chain of evidence Have key informants review draft case study report	Data Collection Data Collection Composition
Internal Validity	Do pattern matching Do explanation building Address rival explanations Use logic models	Data analysis Data analysis Data analysis Data analysis
External validity	Use theory in single-case studies Use replication logic + theory in multiple-case studies	Research design Research design
Reliability	Use case study protocol Develop case study database	Data collection Data collection

Source: (Yin, 2009, p. 41)

Construct validity can be established through triangulation of differing data sources and methods, such as interviews, surveys, documents, archival records, direct observation or participant-observation. The underlying logic of triangulation is that by combining different sources of data and different methods, a more comprehensive picture can emerge of the subject under study (Silverman, 2006; Bryman, 2008). Additionally, triangulation can reveal possible misinformation from single sources, which may have an interest in presenting data in a particular light.

Internal validity concerns the establishment of causal relationships in an attempt to make a case for a particular cause (or causes) out of the universe of possible explanations. There are many strategies the researcher may adopt in order to minimize threats to the internal validity of the findings such as searching for anomalous data and patterns that do not conform to the posited explanation (Maxwell, 2009). In social research of a descriptive or exploratory nature, these types of concerns are negligible in that such studies are not primarily concerned with establishing causal connections (Yin, 2009).

External validity is the degree to which the findings can be generalized from the sampled population to the general population. Many critics of case studies cite the inability to statistically generalize from the sample to the whole as a weakness of the methodology. Yin argues that case studies rely instead attempt to link generalize findings to theory, rather than generalizing to other cases. The use of abductive and retroductive methods of inference also can potentially decrease non-systematic errors on the part of the researcher by establishing multiple sites of possible discrepancies between theorized and recorded outcomes.

Reliability is established by ensuring that the operations of the study are repeatable, with the same (or similar) findings. Another researcher should, by following the same procedures and using the same

data set from the case, come to similar conclusions. A crucial prerequisite for this to happen is that case study researchers should make every effort possible to document the various steps taken during the research project. Therefore a case study protocol and database is recommended to allow for another researcher to have access to the both the documentation and the processes by which the data was collected.

3.1.2 Three Principles of Data Collection

The collection of data in a case study is built around three main principles: 1) use multiple sources of evidence, 2) create a case study database and 3) maintain a chain of evidence (Yin, 2009). Multiple sources should be triangulated around a given set of study questions in order to create a converging line of evidence (Silverman, 2006).

There are six main sources of evidence: 1) documentation, 2) archival records, 3) interviews, 4) direct observation, 5) participant-observation and 6) physical artifacts (Bickman & Rog, 2009). Each source has its own strengths and weaknesses that need to be taken into account. The primary focus on the strengths and weaknesses of documentation is due to the reliance of this study on documents alone, not supplemented by survey data or interview data. For example, documentation and archival records are stable, can be viewed repeatedly, are highly detailed and exact and can span a broad range of time-scales and event horizons. The drawbacks include 1) difficulties in document retrieval, 2) selectivity bias on the part of the researcher, whether accidental or intentional, 3) reporting bias on the part of the author(s) of a particular document, 4) the potential for deliberate falsification of the material and 5) difficulties in gaining access to sensitive, embarrassing or classified material (Yin, 2009; Bernard & Ryan, 2010). Moreover, documents also tend to present a more structured and coherent finished product, obscuring the complex and messy processes that generated the document. The other sources of evidence also have their respective strengths and weaknesses, so it is important for the researcher to choose complementary approaches that attempt to counter the reliance on single sources of evidence.

The case study protocol is both an instrumental and procedural tool that contributes to the reliability of the study's findings. In it, the research team should provide an overview of the case study project, including the objectives, study issues and relevant literature, detailed field procedures setting out the chosen sources of information and how to gather them, the specific case study questions and a draft outline for the eventual report (Yin, 2009).

The third principle links the first two, in that the reader of a case study report should be able to trace the findings of the study backward, through the case study database, to the original source material. It is therefore important that the collection of the data should indicate the time, place and circumstances under which it was collected and also link the circumstance back to the case study protocol to demonstrate that essentially the same procedures were followed in each circumstance. For my own research project, I tend to view these procedures as useful less for the ability to demonstrate validity and reliability and more to maximize transparency.

3.1.3 Establishing the Analytic Frame

Analysis of case study data can be one of the most difficult portions of the research project, primarily because there are few off-the-shelf strategies. In addition, data analysis is often treated as a conceptually distinct action from the research design process (Maxwell, 2009). It is, in large measure, up to the researcher to decide how to analyze the gathered data. One of the first steps is to manipulate the data in different ways, through, for example, the creation of chronologies, matrices of categories, event frequencies or creating data arrays, charts or graphs. This process is a preliminary step that allows the researcher to experiment with different conceptual orientations of the data. It is important to allow space for the data to tell part of the story as well and not let the researcher's biases shape the final outcome. From this first step, the researcher should then decide on an overall strategy of analysis. Yin posits four general strategies of analysis: 1) theoretical propositions developed at the inception of the study, 2) case description, 3) use of both qualitative and quantitative data, and 4) examining rival explanations (Yin, 2009).

No matter which strategy is chosen (or a combination of strategies), there are at least five specific techniques that can be employed: pattern matching, explanation building, time-series analysis, logic models and cross-case synthesis. Pattern matching can consist of a series of actions, events or outcomes. Explanation building is a form of analysis drawn from the collected case study data that attempts to isolate and describe an explanation for some set of conditions or events. Time-series models are built around the chronologically ordering of a set of events, predicated on the logic of a causal chain where Event 1 MUST under all circumstances precede Event 2. Logic models can be used to model multivariate complex causal chains. The researcher can model the operational phases of a given process, event or chain of events, comparing expected outcomes to actual outcomes and weighing rival hypothesis against the gathered data. Finally, cross-case synthesis allows for comparison across different case studies in order to analyze patterns and findings drawn from divergent contexts (Yin, 2009).

3.1.4 Composing the Case Study

The composition of the case study report should commence as early as possible in the research project. The need to maintain as much openness and detail regarding the data collection and analysis argues for early and sustained writing. Many decisions that are taken, whether as a researcher working alone or in a group, and choices made in the course of developing theories, establishing research questions, scoping data sources and collecting, analyzing and interpreting the data often become hazy in hindsight. Therefore it is crucial to, as much as possible, document either in the case study report itself or within a supplementary research diary the decisions and choices made during the course of the project. Additionally, it is more difficult to make sense of the gathered data if one waits until near the end of the data collection and analysis phase to begin writing.

Not only is it important to begin the composition of the report as early as possible, but also it is crucial to determine the target audience. A case study report intended for an academic readership will be constructed and argued differently than if the report is intended for policy makers or the general public. This report is intended for an academic audience, therefore the structure follows a typical format of introduction, literature review, methods, analysis of individual cases followed by cross-case analysis,

conclusions, policy implications and areas of further research. The next section addresses the specific applied methods that were used to during the conduct of the research project in detail.

3.2 Applied Methods

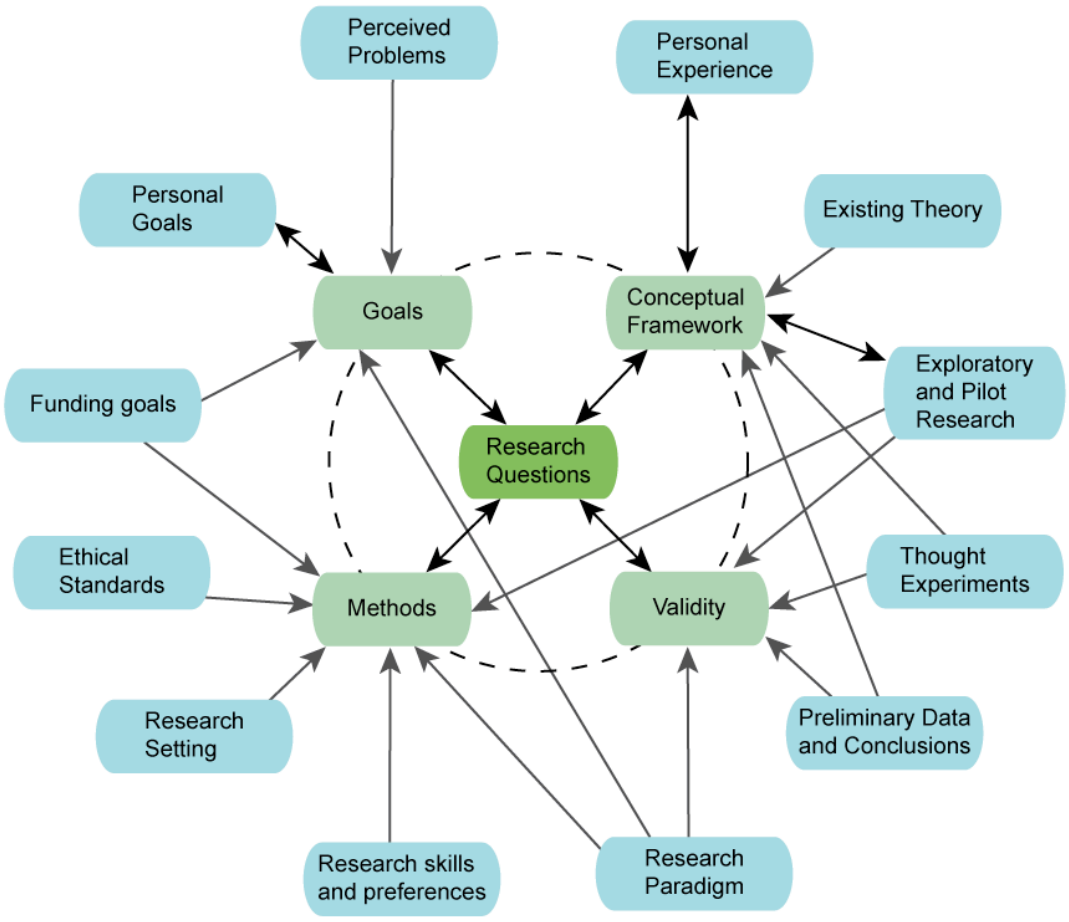
In this section, the actual methods employed during the course of the research will be discussed. First, the research design process will be described, followed by the research questions, study propositions, the unit of analysis and an analytic table linking the research questions to theoretical knowledge and data collection sources. The criteria for interpretation of the finding will also be briefly discussed, along with the data collection protocol and the research diary [See Appendix 2]. Finally, the limitations of this study will be outlined.

3.2.1 Research Design

A qualitative social research design, rather than being a linear progression from inception to conclusion, should be iterative and reflexive, open to possible re-configurations of the research project based upon new information and new discoveries along the way (Maxwell, 2009). By analogy, the construction of a building begins with an idea. From design and development drawings to as-built construction, there are often many changes that result from the often unpredictable interactions between design criteria, cost, time schedules, engineering issues and human error. Throughout the process, however, certain key parameters govern and shape the possible outcomes. Similarly, in social research, the careful consideration of the research design and research questions form the parameters of the project, not the actual outcome. The research project needs to be given space for accidental emergence of surprising or unexpected results. The conscious creation of that space also serves as a reflexive hedge against normative considerations occluding the results. The figure, Figure 2, on the next page represents some of the considerations that enter into the frame when developing the guiding research questions. For this project, many of the external considerations, such as funding priorities, ethical standards and participant concerns, did not come into play.

The starting place for my personal interest in the subject of the intersection of climate change strategies and sustainable development goals dates to sometime in 1992, when the twin issues of global warming and sustainable development were still struggling to gain policy traction. In the intervening decades, the discourse surrounding sustainable urban development broadened, deepened and has become firmly rooted into the spatial planning and policy frameworks. Until recently, the same could not be said for climate change strategies that mostly existed on the margins of planning concern. In light of new knowledge concerning both the need to radically reduce future emissions while simultaneously addressing the need to adapt to a changing climate, planners are beginning to take climate concerns more seriously. There remains a significant gap in the literature, however, concerning the policy ramifications of on the one hand, similarities and differences between mitigation and adaptation strategies and on the other, similarities and differences between climate strategies and sustainable urban development strategies.

Figure 2: Research Design Considerations



Source: Adapted from Maxwell (2009)

The overall aim of the research project from the outset, then, was two-fold: 1) to describe and map the connections between various aspects of the climate goals (mitigation/adaptation) and 2) describe and map the connections between the climate goals and sustainable urban development goals. The choice to confine the data collection to document study was primarily driven by time and financial constraints. This report is intended to provide the foundation for a doctoral study that will analyze in greater detail the main issues surrounding efforts to mainstream climate considerations in the sustainable development framework.

Research Questions

Research Question 1:

How do municipal climate mitigation strategies reinforce or undermine climate adaptation strategies?

Research Question 1 sub-question:

How have planners and policy makers accounted for possible reinforcements and/or conflicts between climate change mitigation and adaptation strategies?

Research Question 2:

> How do municipal climate strategies reinforce or undermine existing urban development goals (sustainable or otherwise)?

Research Question 2 sub-question:

> What are the planning implications of the reinforcements/conflicts present in climate change strategies in relation to development goals (sustainable or otherwise)?

Propositions

Regarding the relationship between the goals of sustainable urban development and climate change strategies, I would expect that planners have made some attempts to integrate climate change mitigation strategies into the existing sustainable development goals. Nevertheless, I anticipate finding significant strategic conflicts between the plans for transport infrastructure and compact urban form, and between densification and natural resource protection. For instance, large infrastructure projects such as roadway expansions, bridge construction, tunnels and the like generally serve to increase usage of both private automobiles and heavy-goods vehicles as well as lead to increased dispersion of the urban form. In-fill development and densification of the existing urban core may also conflict with adaptation strategies designed to handle increased rainwater run-off and more frequent flood events.

I would expect to find that planners have taken some account of the potential strategic overlaps between mitigation and adaptation, but would also anticipate that mitigation efforts are significantly more developed than adaptation measures. Also, based upon a review of the existing literature, I would assume that there has been very little done to systematically identify and address the potential and actual synergies and conflicts between mitigation and adaptation strategies.

Unit of Analysis

The primary unit of analysis for this study is the Greater Metropolitan Areas of Copenhagen, Denmark and Portland, Oregon. For Copenhagen, the urban area contained within the most recent Finger Plan demarcates the boundary of the study. For Portland that of the Metro 2040 Plan encompassing Multnomah, Washington and Clackamas Counties defines the boundary of the study.

The choice of these two urban regions for the case study is driven by three factors. Firstly, both cities are acknowledged environmental leaders and have been addressing both climate change issues and sustainable development issues for well over a generation. In Portland, the Office of Sustainable Development recently was incorporated into the Planning Department, indicating the level of institutionalization that is taking place regarding sustainability concerns. In Copenhagen, the sustainable development discourse is similarly well established within the planning system. Secondly, both cities have planning systems that have clear growth containment and densification strategies along with a regional level coordinating body. Since most of policy concerns for both sustainability and climate change transcend municipal borders, I wanted to study city regions that had established governmental bodies and policies with a history of addressing problems that manifest at multiple scales of governance. Finally, I have some measure of personal and professional experience with both cities, having served on the sustainable development commission in Portland while living there for over 8 years. I was able to familiarize myself with climate change strategies and spatial planning in Copenhagen through a research project conducted in 2008 that analyzed the various types of

limitations to municipal climate strategies. Table 4 below provides an overview of the research questions, theoretical knowledge required and the data sources that were used to help inform the study..

Table 4: Research Questions, Theoretical Knowledge and Data Sources

Research questions	**Theoretical knowledge**	**Sources for acquiring the empirical data**
How do municipal climate strategies reinforce or undermine existing sustainable urban development goals?	What are the main principles of sustainable urban morphology?	(Breheny, 1996), (Burton, Williams, & Jenks, 1996), (Calthorpe, 1993), (Davoudi, 2003), (European Commission, 1999), (Hall P. , 1988), (Hall P. , 2009), (Jacobs, 1962), (Jensen & Richardson, 2001), (Kloosterman & Musterd, 2001), (Krier, 1998), (Moudon, 1997), (Neuman, 2005), (Newton, 2000), (Richardson & Gordon, 1993), (Riis, 1890)
	What are the main outlines and considerations of sustainable urban transport?	(Banister, 2008), (Banister & Anable, 2009), (Næss, 2005), (Næss, Næss, & Strand, 2010), (Newman & Kenworthy, 1999), (Nijkamp & Rienstra, 1996)
	What are the main outlines and considerations of sustainable energy systems?	(Næss, 2001), (Næss, Sandberg, & Røe, 1996) (Newton, Tucker, & Ambrose, 2000), (UN Habitat, 2009)
	What are the main outlines and considerations of sustainable natural systems?	(Næss, 1993), (Næss, 2001) (Beatley, 2000), (Thorén, 2000)
	How do development pathways affect sustainability and climate change?	(Aall & Hille, 2010), (Sathaye, et al., 2007), (UN Habitat, 2009)
	What is the relationship between economic growth strategies and climate change strategies?	(Sathaye, et al., 2007), (OECD, 2009), (Tyndall Centre for Climate Change Research, 2009)
What are the planning implications of the reinforcements/conflicts present in climate change strategies in relation to sustainable develop-ment goals?	What is the relationship between sustainable urban development and climate change strategies?	(Klein, Schipper, & Dessai, 2005), (Robinson, et al., 2006), (Swart & Raes, 2007)
	What are the main areas of overlap between sustainable development goals and climate change goals?	(Klein, Schipper, & Dessai, 2005), (Sathaye, et al., 2007)
	What are planners doing to address the potential and actual synergies and conflicts between climate strategies and sustainable development strategies?	(OECD, 2009), (Mickwitz, et al., 2009)
	How is spatial planning responding to climate change issues?	(Giddens, 2009), (Kern & Bulkeley, 2009)

Research questions	Theoretical knowledge	Sources for acquiring the empirical data
How do municipal climate mitigation strategies reinforce or undermine climate adaptation strategies?	What are the reasons for cities to adopt and implement climate change strategies?	(Climate Alliance, 2010), (ICLEI-Local Governments for Sustainability, 2009), (ICLEI-Local Governments for Sustainability, 2006), (Kern & Bulkeley, 2009), (Richardson, et al., 2009), (Schreurs, 2008)
	What is the scientific and policy basis for developing and implementing municipal climate strategies?	(European Environment Agency, 2008), (OECD, 2008), (Richardson, et al., 2009), (UNFCCC, 2010)
	What are the main outlines and considerations of a climate mitigation strategy?	(Betsill & Bulkeley, 2007), (C40 Climate Cities Initiative, 2010), (Climate Alliance, 2010), (Energie-Cites, 2010), (ICLEI-Local Governments for Sustainability, 2008), (Wheeler, 2008)
	What are the main outlines and considerations of a climate adaptation strategy?	(Adger W. N., 2009), (Adger, et al., 2008), (Füssel, 2007), (Tomkins & Adger, 2005)
	What are the similarities and differences between mitigation and adaptation strategies?	(Adger W. N., 2009), (Howard, 2009), (Kleven, 2005)
	How should policy responses be developed based on the different goals of mitigation and adaptation?	(Dawson, et al., 2009), (Granberg & Elander, 2007), (Mickwitz, et al., 2009), (OECD, 2009)
How have planners and policy makers accounted for possible reinforcements and/or conflicts between climate change mitigation and adaptation strategies?	What are the main similarities and differences between municipal mitigation and adaptation strategies?	(Davoudi, 2009), (Granberg & Elander, 2007), (Pizarro, 2009), (Swart & Raes, 2007)
	What are the policy considerations that need to be taken into account in order to minimize conflict between mitigation and adaptation measures?	(Granberg & Elander, 2007), (Hall J., 2009), (Mickwitz, et al., 2009), (Swart & Raes, 2007), (Tyndall Centre for Climate Change Research, 2009)
	Is there a theoretically optimal mix between mitigation and adaptation strategies?	(Hall J., 2009), (Mickwitz, et al., 2009), (Pizarro, 2009), (Swart & Raes, 2007)
	What is the current status of municipal climate change strategies?	(City of Copenhagen, 2009), (City of Portland; Multnomah County, 2009), (ICLEI-Local Governments for Sustainability, 2008-2009), (OECD, 2009), (Kern & Bulkeley, 2009)

Criteria for Interpreting Findings

I analyzed the internal logic of the plans and strategies, linking the stated aims and goals of the various strategies to one another first within the individual cases then between the cases. I use the respective climate change strategies as starting point of an outward spiraling line of analysis and interpretation drawing in planning documents concerning the urban form/built environment, transportation, energy and natural resources. I looked for patterns of intersecting and diverging nodes between these various strategies to determine if they are in strategic alignment or misalignment with the existing aims of the development goals.

Data Collection Protocol

For the literature review portion, I collected data from relevant books and peer-reviewed journal articles that address: 1) primary strategic goals of sustainable urban development, 2) existing studies of climate change mitigation and adaptation strategies and 3) studies concerning the strategic overlaps/conflicts present between sustainable development strategies and climate change strategies.

The case study sites, Copenhagen and Portland Metropolitan Regions, are in similar stages of planning and implementation of their climate change strategies as well as their respective general plans. The planning documents, including relevant municipal, regional and national plans covering land use, transportation, energy, housing, environmental and infrastructure planning, collected are therefore mainly gathered from 2007 forward. The relevance of the documents is determined by their relationship to the four main areas of analytic concern: 1) urban morphology, 2) path dependency, 3) synergy/conflict and 4) governance. The astute reader will notice that in the Portland case, there are more planning documents analyzed than in the Copenhagen case. The primary reason for this is that the City of Portland is still in the formative phase of the general plan and therefore only the background reports were available at the time of data collection.

Research Diary

The inclusion of a research diary [see Appendix 2] is intended to make the research process as transparent as possible. Moreover, the writing of the diary served as another means to open up space to reflect and adjust the scope and direction of the research and should be seen as contributory element to buttress construct validity by helping to maintain the evidentiary chain.

Supervision

Another key process in the research has been the close cooperation with my supervisor, Petter Næss. From the initial scoping stages of the research project to the completion the final draft, this project has been vetted and reviewed for the overall aims of the project, the structure, the research goals and the written report. This process serves as one more mechanism to help maintain validity and reliability of the findings through sustained exposure to outside criticism and assistance, and constitutes another bulwark against conscious or unconscious biases leaking into the research. It is not possible to completely eliminate such biases, but repeated and sustained exposure to peer review helps to catch more obvious logical or methodological fallacies.

3.2.2 Limitations of the Study

Absent other forms of collected data, such as interviews, document analysis is not always sufficient by itself to form the basis for a complete research project (Bryman, 2008). Documents themselves are not capable of reflecting the struggles, dissensions, dissimulations or other forms of distortion or error that are often involved in their creation. Moreover, the documents are only a contributory piece of the research puzzle when it comes to understanding the deeper causal mechanisms at work. A further limitation of this study has been the lack of historical context from previous generations of plans and strategies. It was difficult to determine with any confidence such issues the extent of political and institutional support for the climate goals, to what extent the climate strategies represented a significant planning turn toward a more low-carbon sustainable pathway or whether they represented a form of planning green washing or some other measure to enhance the competitive profile of the city or region. Another issue that was difficult to address was attempting to understand the causal connections between the various forces at work and distinguishing drivers from responses. For instance, casual connections within path dependencies are tricky to establish with any degree of certainty. Do people drive because motorways are constructed or are motorways constructed because people drive? Another example is the inability to determine why climate issues are mostly still framed and understood to be environmental and energy issues, even in light of revised knowledge that strongly suggests a much stronger connection to levels of population, affluence as well as technology. These kinds of questions are important to pose and even more important to understand, particularly with an issue such as climate change that is intricately bound up with the development pathways of a particular society. The next stage of this research will build on the accumulated data here that provide the groundwork for doctoral research that will extend the critical approach beyond the observable phenomena and attempt to uncover deeper structures and mechanisms that shape the relationships between climate change strategies and development goals.

4 The Portland Metropolitan Region

In Chapters 4 and 5, the individual case analyses of the Portland and Copenhagen Metropolitan regions are presented. Chapter 4 is composed of three sections. Section 4.1 presents background information concerning the Portland Metropolitan region, including a description of the political, planning and demographic profile of the city and region as well as a brief historical description of climate policies. Section 4.2 analyzes the mitigation and adaptation interface present in the Portland/Multnomah County Climate Action Plan, using the analytic categories of urban morphology, path dependency, synergy/conflict/trade-offs and governance. Finally, Section 4.3 presents an analysis of the strategic synergies and conflicts between the stated climate goals and other development goals using the same analytic categories of urban morphology, path dependency, synergy/conflict/trade-offs and governance.

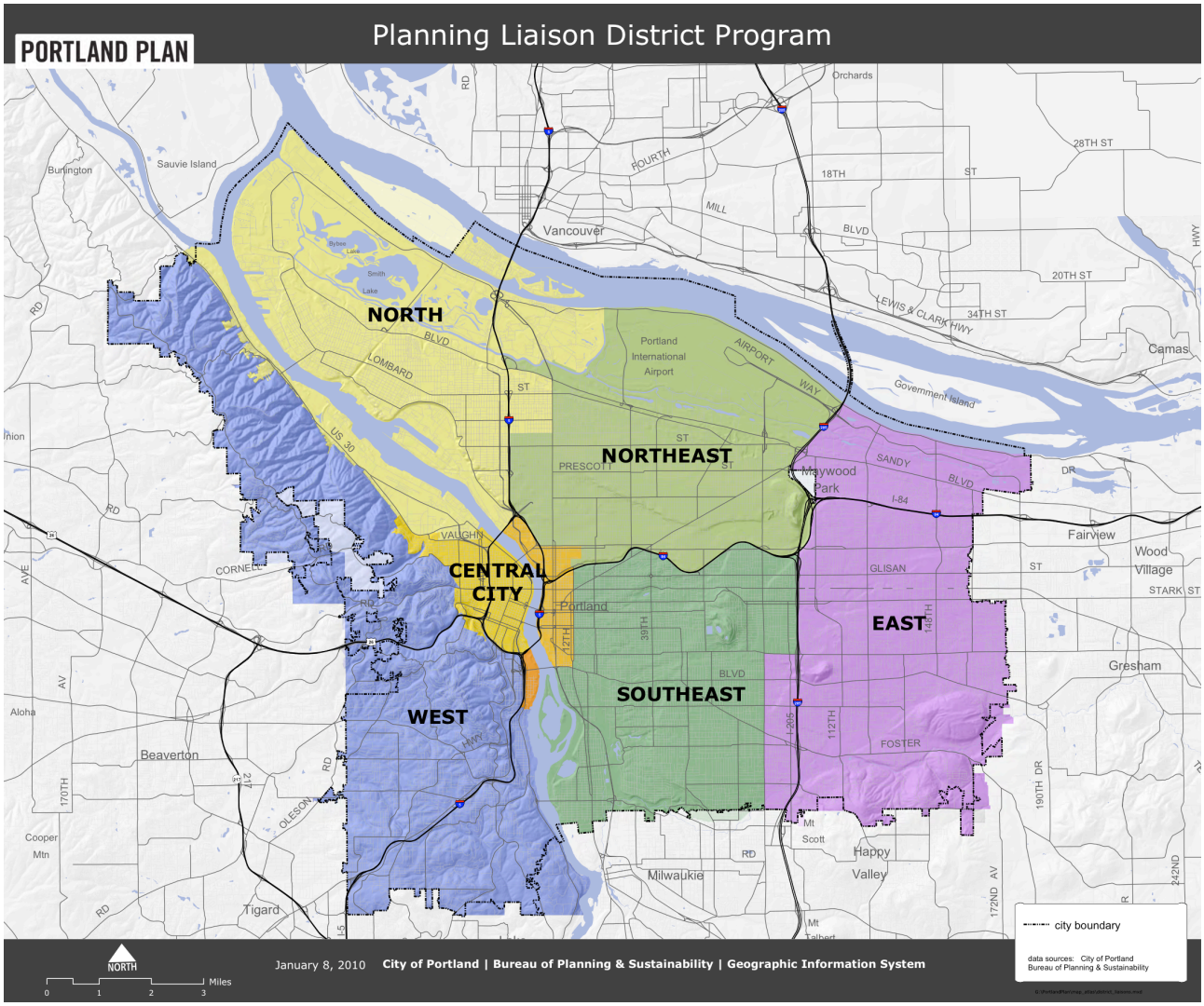
4.1 Background

The metropolitan region of Portland, Oregon has steadily grown from a small clearing at the confluence of the Willamette and Columbia rivers in 1845 to the 23rd largest metropolitan area in the United States (United States Census Bureau, 2010). The greater consolidated metropolitan area now spans 7 counties in two states (Oregon and Washington) with a combined population of over 2.2 million. The city of Portland (pop. 582,000, area 376.5 km^2) is the largest in Oregon and is a central hub of service, manufacturing and logistics in the region. Portland's planning system is well known for its embrace of urban growth controls, densification efforts and coordinated development policies that closely link land use development and transportation planning decisions. In 1993, Portland was the first major city in the United States to adopt a carbon dioxide mitigation strategy; Multnomah County joined Portland to create a shared strategy in 2001 (City of Portland; Multnomah County, 2009). To date, Multnomah County's per capita greenhouse emissions have declined 1% while the trend line for the US a whole has seen a 13% increase in emissions (from a 1990 baseline) [it is not sufficiently established that this reduction was a direct result of the climate policies themselves or a result of other socio-economic shifts such as de-industrialization or rising fuel prices]. The most recent joint Climate Action Plan adopted by both the City of Portland and Multnomah County in 2009 recognizes that much more radical reductions in future greenhouse gas emissions will be necessary. The city and county have committed themselves to a goal of 40% reduction in GHG emissions by 2030 and an 80% reduction by 2050 (City of Portland; Multnomah County, 2009).

In the United States, the lack of national GHG reduction strategies that followed from the decision to withdraw from the Kyoto Protocol has meant that cities, regions and states have taken the lead when it comes to establishing GHG reduction strategies (Wheeler, 2008). In the case of the Portland Metropolitan Region, there are four main governmental actors involved in the development and implementation of climate change strategies: 1) the City of Portland, 2) Multnomah County, 3) Metro (a regionally elected government) and 4) the state of Oregon.

The City of Portland governance structure is composed of four city commissioners and a mayor, with individual bureaus responsible for various sectors (e.g., environmental services, transportation, fire, police, planning). The Bureau of Planning and Sustainability (BPS) has primary responsibility for the creation and implementation of the climate strategy but has coordinated with the bureaus of environmental services, housing, transportation, parks and recreation, development services (building codes and zoning), and the Portland Development Commission. Additionally, representatives from Multnomah County, Metro, Tri-Met (the regional provider of public transport), and local environmental groups took part in the development of the strategy (City of Portland; Multnomah County, 2009). Map 1 below provides a view of Portland by district.

Map 1: The City of Portland by District



Source: City of Portland (2009)

Multnomah County encompasses the city of Portland, in addition to smaller surrounding municipalities and unincorporated rural areas, covering an area approximately 1127 km^2. The County is responsible for, among other things, provision of social and health services, libraries, public safety and land use and transportation planning. The Comprehensive Framework Plan in Multnomah County covers

housing, transportation, open space/recreation, water and sewer infrastructure, energy and economic development for a wide range of land uses (Multnomah County, 2007). Much of the county is composed of rural and semi-rural agriculture and forests, major river basins, including a federally protected section of the Columbia River Gorge, as well as smaller municipalities that are a part of the Portland/Vancouver Metropolitan region.

Metro is a regional authority that has primary responsibility for coordinating land use, transport, waste management, open space and natural systems preservation and enhancement policies. The governing remit of Metro extends to three counties (Multnomah, Clackamas and Washington) spanning 1,119 km^2 and 24 cities encompassing approximately 1.3 million people (Metro, 2010c). Metro has a democratically elected council of seven members elected by districts and one executive officer elected region-wide. Since the passage of a comprehensive land use law (SB 100) in 1973, the Oregon Legislature has required all cities in Oregon to establish an Urban Growth Boundary while maintaining a 20-year supply of land for future development. In 1979 Metro was created by voter initiative to coordinate land use, transport and waste management strategies for cities and counties across the Portland Metropolitan Region.

The 2040 Growth Concept Plan is a vision statement informing the Regional Framework Plan with the following main policy goals: 1) a polycentric development pattern of mixed-use, pedestrian friendly centers that are well connected by high capacity transit and corridors, 2) a multi-modal transportation system that ensures continued mobility of more people and goods throughout the region, consistent with transportation policies, 3) coordination of land uses and the transportation system, to embrace the region's existing locational advantage as a relatively uncongested hub for trade, 4) a jobs-housing balance in municipal and regional centers and a jobs-housing balance by regional sub areas to account for the housing and employment outside of the centers, 5) an urban to rural transition to reduce sprawl, keeping a clear distinction between urban and rural lands and balancing re-development, 6) separation of urbanizable land from rural land by the UGB for the region's 20-year projected need for urban land and 7) rural reserves that are intended to assure that Metro and neighboring cities remain separate (Metro, 2005).

At the State level, climate protection efforts date back to 1989, when the legislature adopted explicit [albeit non-binding] carbon reduction goals. In 2005, a governor's advisory board for the State of Oregon published an advisory strategy on GHG emissions in 2005 that outlines seven key policy areas to achieve an intended 75% reduction in emissions from a 1990 baseline: 1) integrating actions, 2) energy efficiency, 3) electric generation and supply, 4) transportation, 5) biological sequestration, 6) materials use, recovery and waste disposal and 7) state government operations (State of Oregon, 2005). In 2007, the legislature adopted a bill calling for statewide GHG emissions to peak in 2010, decline 10% by 2020 and 75% by 2050 (Metro, 2010d). More recently, the Oregon Legislature passed a bill that will require cities in Oregon to develop coordinated land use and transportation measures to control greenhouse gas emissions from the transport sector, commencing in 2011 (Metro, 2010d). The state of Oregon is also in the process of passing enabling legislation to participate in a regional cap-and-trade emission framework. The Western Climate Initiative is an inter-regional/trans-national cooperation between seven western states in the US and three Canadian provinces.

4.2 Mitigation/Adaptation Interface

This section will analyze the interface between mitigation and adaptation strategies, drawing primarily on the internal logic the Climate Action Plan. The main strategic goals of the Climate Action Plan are as follows: 1) a 40% reduction (from a 1990 baseline) in GHG emissions by 2030 and 2) an 80% reduction (from a 1990 baseline) in GHG emissions by 2050. This section will take a closer look at the policies and actions that are proposed to meet these targets. The Climate Action Plan objectives and near-term measures are broken down into eight categories: 1) buildings and energy, 2) urban form and mobility, 3) consumption and solid waste, 4) urban forestry and natural systems, 5) food and agriculture, 6) community engagement, 7) climate change preparation and 8) local government Operations (City of Portland; Multnomah County, 2009). This analysis will focus on four of the eight categories: buildings and energy, urban form and mobility, urban forestry and natural systems and climate change preparation. The reason for this is two-fold. One, the majority of emissions reductions in the Climate Action Plan are intended to come from the building, energy and transport sectors. Two, the theoretical frame of this inquiry is built around the investigation of the strategic intersection of mitigation and adaptation in urban morphology, transport, energy and natural systems.

It should be noted that throughout this section, the figures quoted are taken directly from the published reports and have not been independently verified or audited. To date there has been no formalized system of climate audits that have ensured the accuracy of either the emissions inventory or the effects of various measures in reducing emissions. There are a number of complicating factors that inhibited the development of such a framework. Firstly, boundary issues are complex. Established methods of creating emissions inventories are based on sectoral allocations (e.g., transport, energy, agriculture, forestry) that focus on production and therefore do not account for embedded emissions in goods and services. In response to this, the State of Oregon Department of Environmental Quality is, in partnership with the federal Environmental Protection Agency, in the process of developing a complementary method of emissions inventory constructed around the entire system of production and consumption (City of Portland; Multnomah County, 2009). Secondly, many important GHG emissions other than CO2 are not included in the inventory including but not limited to: perfluorocarbons (from aluminum and semi-conductor manufacturing), agriculture and forestry, shipping and aviation (City of Portland; Multnomah County, 2009, p. 66). Additionally, the impact of carbon offsets or sequestration from forestry or other sectors is not included in the inventory. Thirdly, spillover effects of emissions from neighboring cities, counties, regions, states and nations are not accounted for.

4.2.1 Urban Morphology

Key Question: *What is the level of integration of the mitigation and adaptation goals in relation to land use, transport, energy and natural systems planning goals?*

Finding: the plan makes a notable effort to integrate land use, transport and energy sectors into the strategy within the 20-minute complete neighborhood concept. This is probably the most (potentially) powerful element of the strategy and one where the city and county have the most resources (technical, financial, legal) to implement the policies successfully. There are three main weaknesses of the 20-minute complete neighborhood concept: 1) the exclusion of commuting trips from the criteria, 2) the lack of attention to adaptation requirements and 3) the lack of revisions to zoning regulations to

stimulate the desired development pattern. Many of the measures identified elsewhere in the plan (for example green infrastructure projects like bio-swales and wetlands expansion) could push against efforts to create more a compact urban form. Adaptation strategies are treated as subordinate to, and to a large extent separate from, mitigation strategies.

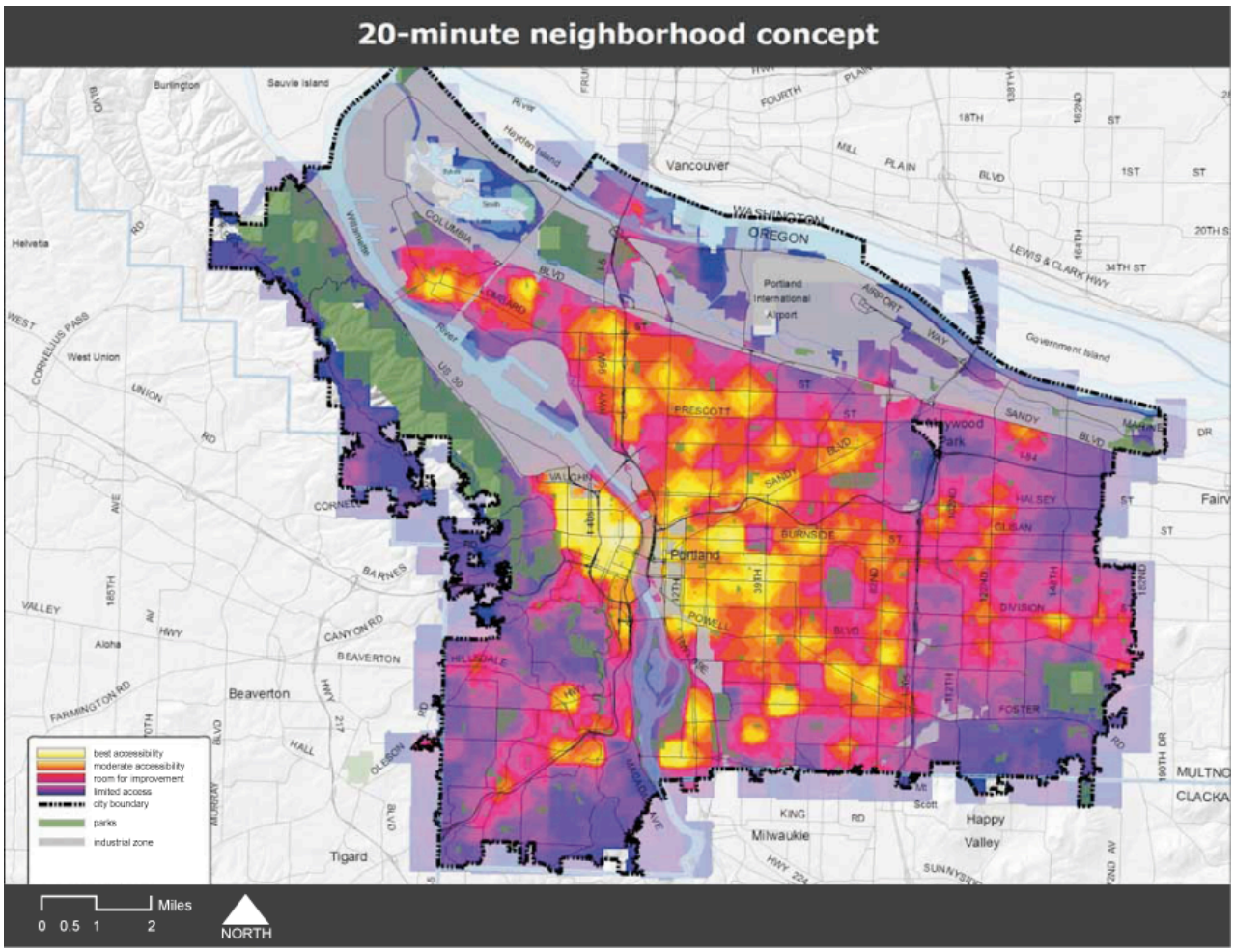
Discussion: The Climate Action Plan recognizes and attempts to create policy convergences around the land use/transport/energy/natural systems nexus. The identification of the 20-minute complete neighborhood concept (Objective 5) is a case in point. The plan states "[a] critical and basic step to reduce automobile dependence is to ensure that residents live in 20-minute neighborhoods, meaning that they can comfortably fulfill their daily needs within a 20-minute walk from home." (City of Portland; Multnomah County, 2009, p. 39). The objective is that 90% of Portland residents and 80% of Multnomah County residents can meet their daily (non-work) needs by walking or biking. The actions to realize the objective include: 1) the city and county will push for accommodation of future urban expansion within the existing Urban Growth Boundary, 2) the city will make the 20-minute concept a core feature of the new general plan that is currently being revised, 3) the city will identify the land use and infrastructure investments that are needed to create the necessary structures to support higher levels of walking and biking, 4) the city will, with other municipalities in the region and Metro, work towards including both mitigation and adaptation impacts into the funding criteria for the Metro Policy Advisory Committee and the Joint Policy Advisory Committee on Transportation and 5) requiring that evaluations of scenarios and models used as decision-support tools for the comprehensive plan and the transportation system plan include future carbon emissions.

An additional objective to reinforce the shift towards non-motorized modes of transport is that of reducing vehicle miles traveled (VMT) by 30% (Objective 6). The actions to realize this objective include: 1) accounting for GHG emissions in transport planning through life cycle carbon footprints and GHG tracking and reporting mechanisms, 2) working with Metro and the state Department of Transportation in order to coordinate transportation investments that result in lower VMT numbers and 3) coordinating with Metro and Tri-Met (the regional provider of public transport) to revise the service plan to assist in shifting commuting patterns away from single-occupancy vehicles toward walking, biking and public transport (City of Portland; Multnomah County, 2009). Notably absent from the list of actions to be taken is any indication of active demand-management policies, such as congestion pricing, removal of parking spaces, creation of car-free streets or a blanket restriction on new road construction.

The 20-minute complete neighborhood map, Map 2 on the following page, shows the gradients between best opportunities for walking and biking (yellow) and the worst (purple). The relationship between morphology, path dependency and the resultant possibilities for more sustainable forms of mobility is neatly on display. The historical development of the urban form of Portland was heavily conditioned by the dominant mode of transportation. The streetcar suburbs of downtown, the central eastside and the main east-west corridors and north-south corridors resulted in a regular grid of compact blocks that, in the present day, support the most diverse land uses and allow for more non-motorized forms of transport (Wheeler, 2003). The further one moves away from the city center, the more that the morphology of the city shifts to accommodate the increasing dominance of the private car. The planning implications for sustainable urban development are considerable in light of the strong structuring effects on the urban form that results from vestigial remnants of transport and other infrastructure decisions made decades or centuries before. The lack of a systematic appraisal and

inclusion of the implications for long-term strategic planning will likely set up further policy conflicts in the future.

Map 2: Portland 20-Minute Complete Neighborhood Map



Source: (City of Portland; Multnomah County, 2009)

While there is significant attention paid to the land use/transport connections within the Climate Action Plan, comparatively little is said about other infrastructure planning decisions such as water and sewerage, nor is there much mention of the possible trade-offs between mitigation and adaptation decisions (e.g., the desire for compaction within the existing urban growth boundary against the need to restrict development in areas where flooding risks will be highest). One other significant omission from the 20-minute concept is the trips taken to commute from residence to workplace. The structure of the city and the distance from workplace to residence has a very strong influence on mode choice (Næss, 2005). In the Portland metro region, there are strong drivers for car-dependent commuting given the long distances between areas of significant employment growth and residential development (Metro, 2010e). The mayor of Portland, Sam Adams, also notes that: "I think the other big challenge, on the federal level especially, has been the lack of valuation of the trip not taken. The 20-minute complete neighborhood concept puts a very high value on the trip not taken, the mile not driven. It's changing now, because this [Obama] administration gets it. But the biggest challenge has been getting

federal funding for investments that prevent trips" (Camner, 2010). Additionally, local tax arbitrage plays a role in trip generation. Oregon has no sales tax, while Washington has lower property taxes than Oregon. As a result, many people choose to live in Clark County, Washington, while working and shopping in Oregon. These location decisions have a large impact on car usage and GHG emissions that the current Climate Action Plan does not address.

4.2.2 Path Dependencies

Key Question: *How do planners account for path dependencies of the built environment, transport networks and socio-economic development pathways that make it difficult to effect near-term alterations to the municipal or regional urban form?*

Finding: Despite some attempts to address the path dependencies of the built environment and energy systems, the plan notably fails to include an integrated strategy to address the socio-economic and technological path dependencies that have significant influence on climate policy. The underlying rationality of the climate strategy is one of a reliance on technological improvements to continue to deliver economic growth while reducing carbon intensity. The existing systems of energy production and transportation are mainly left intact. Additionally, rising levels of affluence and consequent increase in consumption are not addressed.

Discussion: The Climate Action Plan does recognize that some path dependencies have an impact on future emissions profiles. For example, in the building sector the plan notes that "b]ecause buildings last for decades, efforts to reduce emissions from buildings need to address both existing structures and new construction." (City of Portland; Multnomah County, 2009, p. 30). At the nexus of land use and transportation, the plan states "…transportation emissions reduction depends critically on coordinated land use policies and the development of infrastructure for low-carbon modes of transportation." (City of Portland; Multnomah County, 2009, pp. 29-30). Finally, regarding the psychosocial aspects of path dependency, the plan acknowledges "a]s consumers, our decisions to acquire goods, including certain foods, result in nearly half of all carbon emissions. As producers, our decisions about the entire supply chain-extraction, production, packaging, distribution, retail and disposal-affect carbon emissions." (City of Portland; Multnomah County, 2009, p. 22).

However, these indications tend to reside at the level of generality with little indication of a systematic effort to integrate climate considerations into the core of the economic and social development pathway. The 20-minute neighborhood concept is a good start toward remediation of the past development pathways, but the lack of a complementary strategy to restructure persistent infrastructure (energy, transport, water, etc.) and development pathways makes it unlikely that such a policy can be effective on its own. Further, the omission of commuting trips from the 20-minute neighborhood considerations seriously impedes the ability to lower GHG emissions from the transport sector since commuting distances have a significant impact on mode choice (Næss, 2005). The further away one's residential location is from the place of employment, the more likely it is that people will choose to drive rather than walk or bike. For public transport, absolute distance between residence and workplace matters to a lesser degree, but station proximity still has a marked influence on public transport mode choice. Rather, the main variables are distance from home to station and distance from station to workplace. The higher concentrations of both workplaces and residences around station stops, the more likely it is that people will choose to travel by public transport. In areas that have low concentrations of

public transport provision and long distances from residence-station and workplace-station will likely have far greater car usage.

Finally, the Climate Action Plan does not factor in the GHG contributions from the Port of Portland (responsible for harbor/freight/airport infrastructure and operation), the freight haulage sector nor the main sources of power supply to the city. As noted above, embedded emissions from products and services produced elsewhere but consumed in Multnomah County are not taken into consideration either. In order to achieve the stated GHG reduction goals of 80% by 2050, significant alterations to the existing development pathway will be necessary. Population growth and levels of affluence will need to be integrated into the planning and decision-making framework; technological shifts alone will not be able to deliver the desired policy outcomes.

4.2.3 Synergies, Conflicts and Trade-offs

Key Questions: *To what extent do planners seek to create synergistic policies that support both mitigation and adaptation efforts? How do planners avoid conflicts between mitigation and adaptation efforts? What means do planners employ to negotiate trade-offs between mitigation and adaptation goals?*

Finding: The plan does not systematically analyze the possibilities for creating synergies and avoiding conflicts between mitigation and adaptation strategies. Portland/Multnomah County is in the process of creating a separate adaptation strategy in 2010, but the broad outlines of the adaptation strategy as it now stands suggest that there are significant information and policy gaps that will need to be filled in order to create a more comprehensive matrix of the synergies and conflicts. Furthermore, there is little indication that there is a policy framework in place capable of handling the trade-offs between mitigation and adaptation measures.

Discussion: The Climate Action Plan does not contain a systematic appraisal of the potential or actual synergies and conflicts between mitigation and adaptation strategies. There are a few areas, urban forestry for example, where the plan indicates synergistic relationships between expansion of the urban forest canopy and reductions in the urban heat island effect. One of the actions to be taken is to "a]cquire, restore and protect natural resources to promote functional watersheds and forest ecosystems, reduce the urban heat island effect, improve air and water quality, connect habitats and contribute to regional health, biodiversity, and resiliency." (City of Portland; Multnomah County, 2009, p. 51). In Table 5 [below], some of the other main mitigation policy goals are compared to stated adaptation goals to illustrate some of the possible intersections of synergy and conflict between the two aims. The majority of the specific actions identified create synergies between mitigation and adaptation strategies, save for the prominent exception of the 20-minute complete neighborhood concept.

Objective 17 (Climate Change Preparation) sets out the following goals for adaptation: 1) conduct an assessment of vulnerabilities and resiliencies of impacted areas (infrastructure, energy, economy, transportation, water, food, storm water management, social and health services, public safety, environment and biodiversity, population migrations and emergency preparedness), 2) create a framework for the prioritization and risk management of the projected impacts with a focus on ensuring that more vulnerable populations are protected from disproportionate impacts, 3) protect and restore natural watersheds to cope with flooding and severe storm events, 4) integrate adaptation concerns into major planning efforts, including collaboration with Metro to update land hazard

mapping and inventories at the regional level and 5) integrate considerations of physical, social, environmental, economic and regulatory impact of both mitigation and adaptation into the planning process for public infrastructure investment projects (City of Portland; Multnomah County, 2009).

One key omission from this list is the appraisal and incorporation of the range of informational and developmental uncertainties that are associated with adaptation planning, such as the lack of fine-grained regional data for predicting local climactic changes, the information asymmetries present due to unforeseen social, political, economic and technological shift and the difficulties inherent in creating (and using) adaptive capacity within the existing socio-economic structure. Additionally, the cross-sectoral nature of climate change mitigation and adaptation strategies will put pressure on the existing institutional structure of the city-region since successful adaptation strategies draws from a wider range of disciplines and expertise.

Table 5: Portland Mitigation and Adaptation Synergy/Conflict

Mitigation Objective	**Primary Policy Sector**	**Secondary Policy Sector**	**Adaptation Objective**	**Adaptation Action**	**Synergy, Conflict or Neutral**
20-minute complete neighborhood concept	Urban Morphology	Transport, Energy	Successful Adaptation	Green Infra-structure	Potential Conflict due to space requirements
Reduce daily vehicle miles traveled (VMT) by 30%	Transport	Urban Morphology, Energy	N/A	N/A	N/A
Reduce energy usage of pre-2010 building stock by 25%	Built Environment, Energy	Urban Morphology	Buildings that can adapt to changing climates	Influence statewide building codes	Synergy
10% of energy produced by on-site renewable sources	Built Environment, Energy	Urban Morphology	Buildings that can adapt to changing climates	Influence statewide building codes	Potential Synergy Potential Conflict (for example densification efforts and solar rights)
Zero net GHG emissions from new homes	Built Environment, Energy	Urban Morphology	Adaptive buildings	Alter building codes	Synergy
Expand urban forest coverage to 1/3 of overall urban area	Natural Systems	Built Environment	Lower urban heat island effect	Expand tree preservation and planting programs	Synergy

4.2.4 Governance

Key Question: *What is the extent of policy integration between mitigation and adaptation goals, measured by the criteria of inclusion, consistency, qualitative weighting, reporting and resources?*

Finding: Overall level of policy integration is low. Incomplete or non-existent climate change impact assessment measures make it difficult to determine the level of inclusion and policy consistency is fragmented. To date, there has been no systematic weighting given to climate goals in relation to other socio-economic goals. The plan has an established system of reporting and monitoring, setting out a process of annual reports on emission trends and progress, three-year review cycles and a revision of the entire plan by 2020. The financial and institutional resources attached to meeting the objectives are, for the most part, not specified. It is likely that absent consistent, year-to-year budgetary allocations, many of the measures will be implemented on an ad hoc basis.

Discussion: Inclusion (direct and indirect climate change impact assessment, including distributive fairness and social justice issues): Incomplete. The current climate strategy is mostly geared toward mitigation, with relatively little emphasis upon adaptation measures. The city has not yet undertaken a comprehensive review of potential climate change impacts therefore it is difficult to ascertain how inclusive the assessment will be.

Consistency (between various policy measures): Mixed. Some measure of consistency in the 20-minute complete neighborhood concept that link land use, transport, retail and leisure activities together toward the goal of reducing GHG emissions, but the omission of employment (and the transport-related emissions that arise from auto-dependent commuting patterns) is significant. As noted in the previous sub-section, adaptation measures (e.g., green infrastructure) may conflict with densification measures. Higher building densities may also conflict with solar energy potential due to shading. Finally, the lack of integration of the climate goals into the land use zoning regulations creates the possibility that existing, legally binding land use designations will override what are essentially voluntary planning goals.

Qualitative Weighting (of climate goals in relation to other societal goals such as growth, sustainability, fairness, equity): No established measures to rank the relative importance of climate change goals in relation to, for example, distributive justice or social equity goals. Many mitigation measures, such as higher housing costs due to higher efficiency requirements, have the potential to disproportionately impact poorer and more socially marginalized citizens. Similarly, adaptation goals can negatively impact more vulnerable segments of society if, for example, areas of higher real estate value are afforded greater priority protection from rising sea levels or increased flooding events.

Reporting: The Climate Action Plan calls for an annual review by the city and county planning department to the political leadership to report local carbon emission trends, fossil fuel use and progress reports on the implementation of the actions listed in the plan. Every three years the city and county councils will revise existing actions and identify new ones. The effectiveness of the previous actions will also be assessed and altered as necessary. In 2020, the entire climate plan will be revised based upon both new information and experience gathered from implementing the 2009 plan (City of Portland; Multnomah County, 2009).

Resources (fiscal, institutional and technical necessary to enact policy): As for financing mechanisms, the majority of the actions listed have no cost benefit analysis or identified source of funding. The

notable exception is Objective 1, to lower the energy usage of the existing building stock by 25%. The plan calls for the establishment of a $50 million USD public/private capital fund to provide low-cost financing for residents and businesses to make capital improvements that reduce energy consumption.

4.2.5 Summary

Urban morphology: The plan makes a significant effort to integrate land use, transport and energy sectors into the strategy within the 20-minute complete neighborhood concept. This is probably the most powerful element of the strategy and one where the city and county have the most resources (technical, financial, legal) to implement the policies successfully. There are three main weakness of the 20-minute complete neighborhood concept: 1) the exclusion of commuting trips from the criteria, 2) the lack of attention to adaptation requirements and 3) the lack of revisions to zoning regulations to stimulate the desired development pattern. Many of the measures indicated elsewhere in the plan (for example green infrastructure projects like bio-swales and wetlands expansion) could push against efforts to create more a compact urban form.

Path Dependency: Despite some attempts to address the path dependencies of the built environment, the plan notably fails to include an integrated strategy to address the socio-economic and technological path dependencies that have significant influence on climate policy. The underlying rationality of the climate strategy is one of a reliance on technological improvements to continue to deliver economic growth while reducing carbon intensity. The existing systems of energy production and transportation are mainly left intact. Additionally, rising levels of affluence and consequent increase in consumption are not addressed.

Synergies, Conflicts and Trade-offs: The plan does not systematically analyze the possibilities for creating synergies and avoiding conflicts between mitigation and adaptation strategies. The broad outlines of the adaptation strategy as it now stands suggest that there are significant information and policy gaps that will need to be filled in order to create a more comprehensive matrix of the synergies and conflicts. There are numerous uncertainties as well, including but not limited to the lack of down-scaled regional climate projections, the effects of future development pathways, the lack of both adaptive capacity and resiliency in the physical infrastructure as well as the institutional and socio-economic structures.

Governance: Overall level of policy integration is low. Incomplete or non-existent climate change impact assessment measures make it difficult to determine the level of inclusion and policy consistency is fragmented. To date, there has been no systematic weighting given to climate goals in relation to other socio-economic goals. The plan has an established system of reporting and monitoring, setting out a process of annual reports on emission trends and progress, three-year review cycles and a revision of the entire plan by 2020. The financial and institutional resources attached to meeting the objectives are, for the most part, not specified. It is likely that absent consistent, year-to-year budgetary allocations, many of the measures will be implemented on an ad hoc basis. While the lack of federal policy guidance does not seem to be a hindrance to local climate policy formation, the realization of significant reductions in GHG emissions is unlikely to be possible without the legal and financial leverage of the federal government. Cap and trade policies, carbon taxes, emissions trading and a more radical regulatory framework cannot be achieved through city-to-city or inter-regional initiatives. The scalar and temporal dimensions of mitigation are too large to be contained within the urban or regional

policy frame. Cities and regions do not posses the necessary legislative, financial, technical and enforcement powers to guarantee that GHG reduction measures are adequately policed. Even at the supra-national level in the European Union, the European Trading Scheme has been beset by a host of problems, from rigged auctions of trading permits, price fixing between large energy companies, fraud and national interests struggling for control over proprietary carbon market trading platforms (particularly the UK and Germany) (EurActiv, 2010). Adaptation strategies are more in line with cities and regions primary competences, such as land use planning and zoning, transportation planning, long-range strategic planning, social equity, environmental protection and economic development.

4.3 Mainstreaming Climate Change Strategies into Development Goals

This section will examine the main elements of the climate strategy in relationship to other development goals to find areas of complementary and contradictory policy convergences. The documents analyzed in this section include, but are not limited to: 1) City of Portland Background Reports on Energy, Natural Resource Inventory, Urban Form, Housing and Transportation Cost Study, Infrastructure/Capacity for Water and Transport and Watershed Health and 2) Metro Infrastructure Analysis, 2035 Regional Transportation Plan and the 2040 Growth Concept Plan.

4.3.1 Urban Morphology

Key Question: *To what extent are the climate goals supported by other municipal and regional planning goals (land use, transportation, economic development, environmental, etc.)?*

Finding: The strongest correlations can be found between the goals of the climate strategy and energy/environmental strategies. This finding is not particularly surprising since planners have traditionally addressed climate issues as primarily energy/environmental problems. At the city level, there is some evidence of strategies that support the climate goals in, for example, wastewater management and transportation, but neither the economic development plan nor the urban form plan have strong correlations to the expressed climate goals. At the regional level, there is very little strategic alignment between the land use, transportation and economic development goals and the city's climate goals. The legislative mandate from the state, combined with the high socio-economic and institutional prioritization of growth and economic development, leads to regional and municipal development strategies and policies that push against strategies to lower GHG emissions.

Discussion: The over-arching regional and municipal planning goals are shaped by the legal requirements of the Oregon State Legislature. Oregon statewide planning goal 9 (economic development) states that:

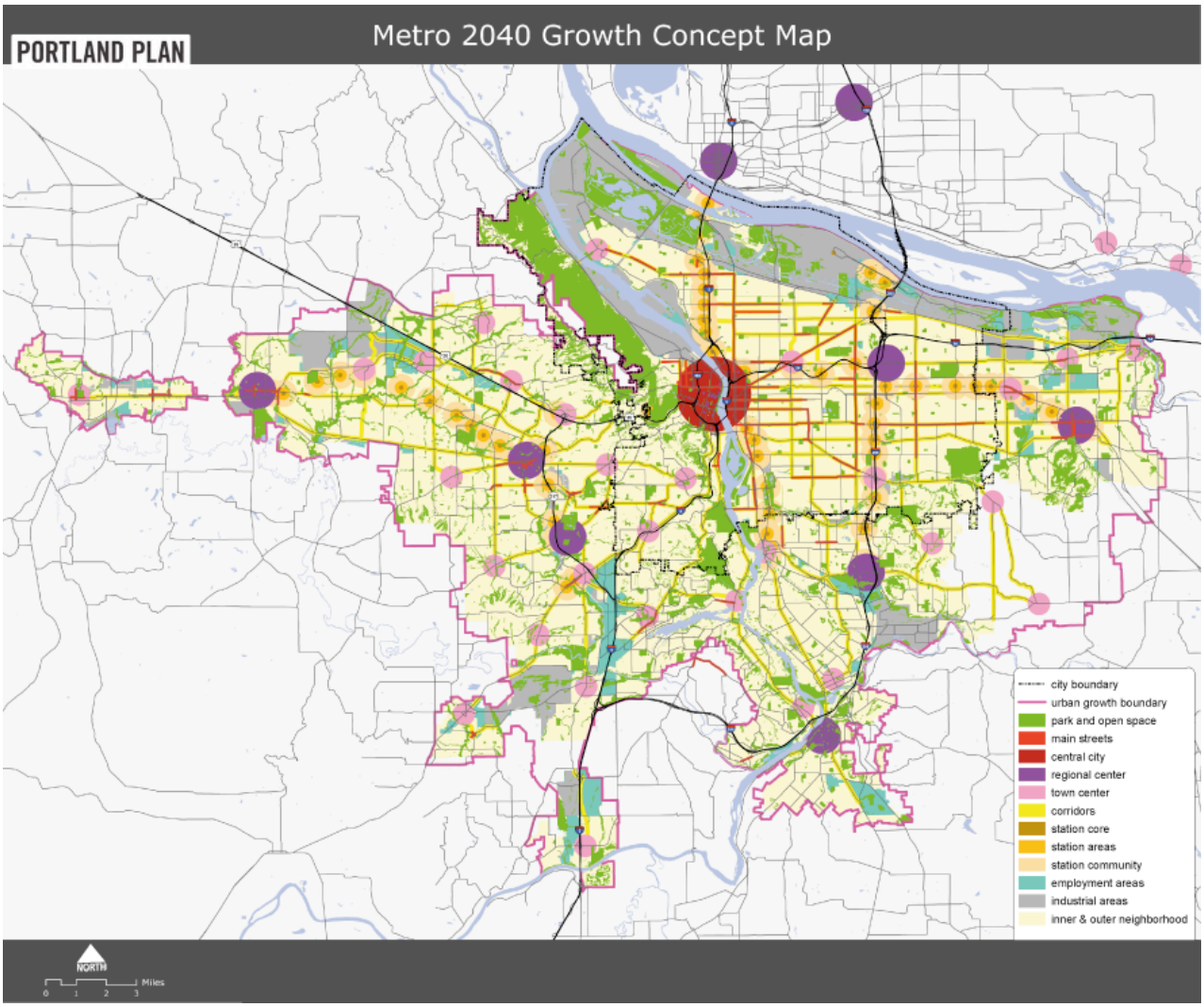
> Comprehensive plans and policies shall contribute to a stable and healthy economy in all regions of the state. Such plans shall be based on inventories of areas suitable for increased economic growth and activity after taking into consideration the health of the current economic base; materials and energy availability and cost; labor market factors; educational and technical training programs; availability of key public facilities; necessary support facilities; current market forces; location relative to markets; availability of renewable and

non-renewable resources; availability of land; and pollution control requirements (Metro, 2010e).

Oregon statewide planning goal 14 (Urbanization) states that:

> Urban growth boundaries shall be established and maintained by cities, counties and regional governments to provide land for urban development needs and to identify and separate urban and urbanizable land from rural land. Establishment and change of urban growth boundaries shall be a cooperative process among cities, counties and, where applicable, regional governments. Prior to expanding an urban growth boundary, local governments shall demonstrate that needs cannot reasonably be accommodated on land already inside the urban growth boundary (Metro, 2010e).

Map 3: Growth Concept Map



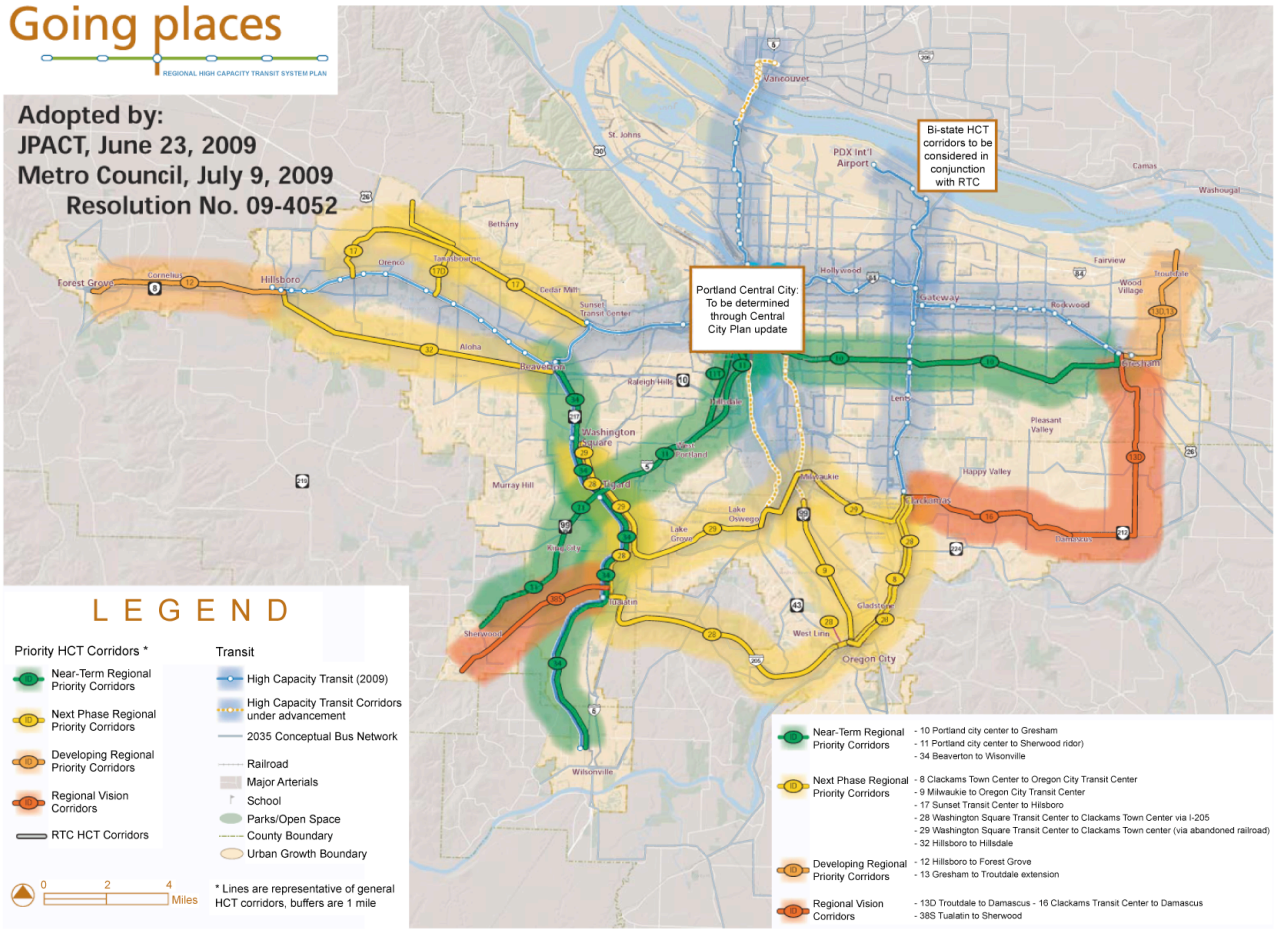
Source: City of Portland (2009)

The two driving legislative forces of land use planning and transportation planning in the region are geared toward growth both of the economic base and the demographic base. At the regional and municipal levels, land use and transportation plans are also oriented toward the strengthening of

polycentric development patterns and a regional-level housing balance (Metro, 2010e). The preceeding map, Map 3, illustrates the preferred loci of development-the central city of Portland is to serve as the regional provider of financial, professional and information services as well as specialized retail and leisure opportunities while the surrounding regional centers provide opportunities for denser residential, commercial and office development and serve as major multi-modal transportation nodes. Town centers provide more local shopping, employment, recreation and cultural activities (Metro, 2005).

One of the major factors that push against the expressed desire for concentration and compaction is the lack of availability of large tracts of land for industrial, warehousing and manufacturing. The vast majority of these plots lie at the outer edges of the urban growth boundary far from the established concentrations of residential and retail centers, particularly the city of Portland. Metro has a policy of attempting to create a balance distribution of housing throughout the region, but does not have a similar policy for employment (Metro, 2010e). One of the ways that planners and politicians have attempted to counter the imbalance between regional job growth and regional housing growth is to use transit projects (such as the light rail and tram systems) to create concentrated nodes of mixed-use development.

Map 4: Portland Metro Region Transportation Priority Corridors



Source: Metro (2010a)

While there has been a small drop in Vehicle Miles Traveled (VMT) per person between 1996 and 2007 (Metro, 2010a), overall travel time and distances have increased, as have GHG emissions from transport that comprise over 25% (and rising) share of regional emissions (Metro, 2010a).

The continued outward expansion of the urbanized areas, with large concentrations of job growth in the western and northern peripheries of the region disconnected from public transport lines makes it difficult to either concentrate development at the regional scale or to effect a significant shift in the transportation modal split. The Regional Transportation Plan (RTP) of 2035 sets out the priorities for transportation system investments in the next few decades. The vast majority of the proposed transit improvements are to be bolted on to the existing freeway network, while the new development corridors in the western part of the region (an area with a much higher percentage of job growth than the city of Portland itself) will be developed almost exclusively based on the use of the private automobile. While the RTP has also identified GHG reduction goals as an important component of the transportation strategy, the infrastructure investment priorities continue to reflect a higher priority on economic growth and job creation over emissions reductions. Map 4 on the previous page shows the Portland Metro Region Transportation Priorities Corridors.

At the city level, there is a similar tension between the desire to reduce GHG emissions and to generate economic growth. Portland's economic position relative to the rest of the region has taken a beating in the last decade and the city is hard pressed to increase both economic growth rates and rates of job creation. However, the Economic Development background report for the city notes that: "Portland's 40-percent share of the total jobs in the 7-county metropolitan area (MSA) in 2006 is declining, sharply since 2000, eroding the city's position as a regional economic center. Portland's capture rate of regional job growth fell to 11 percent in the 2000-2006 period, down from about 27 percent in the 1980-2000 period. Central Portland has been an exception to this trend, adding about 12,000 jobs from 2000 to 2006, while the rest of the city altogether lost 7,000 jobs" (Portland Bureau of Planning and Sustainability, 2009a, p. 5). What these trends indicate is that job creation in the inner core of Portland (mostly for those with higher education) is increasing while the remainder of the city is losing jobs to outlying suburbs and exurbs. The city of Portland already has significant income, education and social imbalances between the close-in and southwest neighborhoods and those in the North and East sections of the city (Portland Bureau of Planning and Sustainability, 2009b) and these imbalances will be exacerbated by the job growth and housing trends. In the absence of regional affordable housing policies and a regional policy on shared employment growth, the city, county and the region will be find it difficult to realize the necessary reductions in energy use and transportation to achieve their GHG emission goals.

4.3.2 Path Dependency

Key Question: *How do physical, socio-technical and institutional path dependencies work with or against the strategic climate goals?*

Finding: the climate goals of the city are significantly impacted by two main path dependencies, demographic and economic growth projections, that push against the desired policy goals of the climate strategy. Existing planning methodologies reinforce the spatial expansion of the city and the region (population growth driving employment growth driving building expansion driving transport infrastructure). There is a need for planners and policy makers to consciously create niches within the

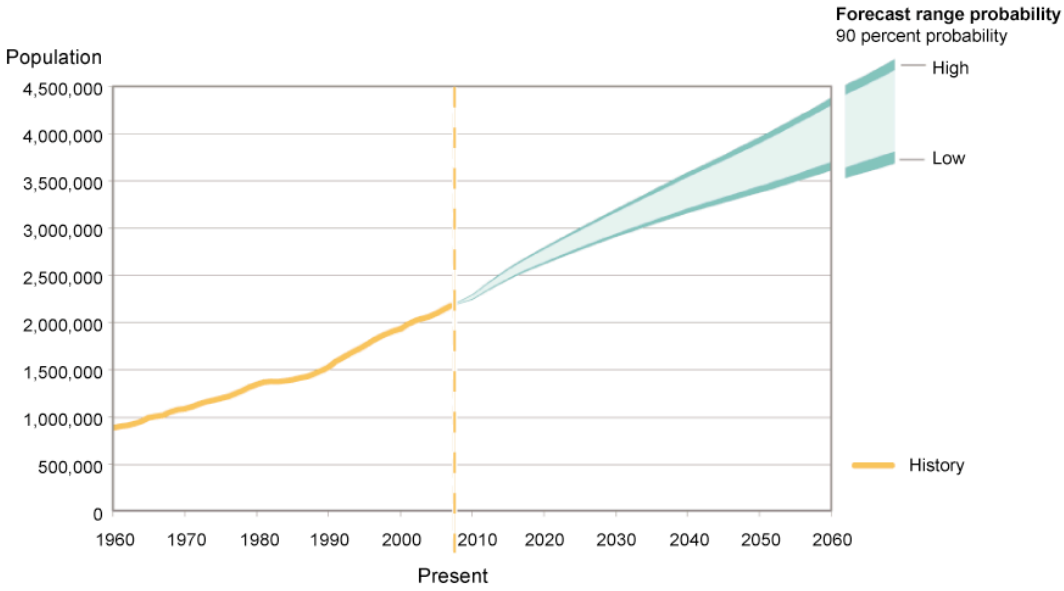
dominant socio-technical and institutional regime to allow for potentially disruptive forms of low-carbon development patterns to emerge.

Discussion: There are three primary drivers of GHG emissions: population, affluence and technology. As noted elsewhere, there is a marked tendency for planners and politicians to be affected by a "disciplinary tunnel vision" (Næss P., 2010) and to ignore the demographic and economic drivers of climate change. Metro is required by state law to produce long-range land use and transportation plans that will provide a 20-year supply of land for new development, based on projected growth in population and economic development. Metro's draft report concerning the 20 and 50-year regional population and employment range forecasts notes:

> Oregon land use laws require that Metro maintain a supply of buildable land inside the urban growth boundary to accommodate estimated housing needs for twenty years. Metro fulfills a similar role in determining whether or not there is adequate capacity for employment. This draft 2030 forecast is a necessary step towards Metro's compliance with these requirements and is the determination of how much growth is expected. A separate analysis of the region's capacity to accommodate growth is included in the urban growth report (Metro, 2009).

These forecasts themselves, however, are heavily reliant on past path dependencies, based on extensive use of fossil fuels and perpetual rises in affluence and material consumption. Therefore population and job growth projections contain an often unquestioned, skewed bias toward a high emissions future. Figure 3 below shows the projection for demographic growth from 2009-2060 (and beyond).

Figure 3: Metro Population Forecast (2009-2060) [90% forecast range probability beyond 2060]

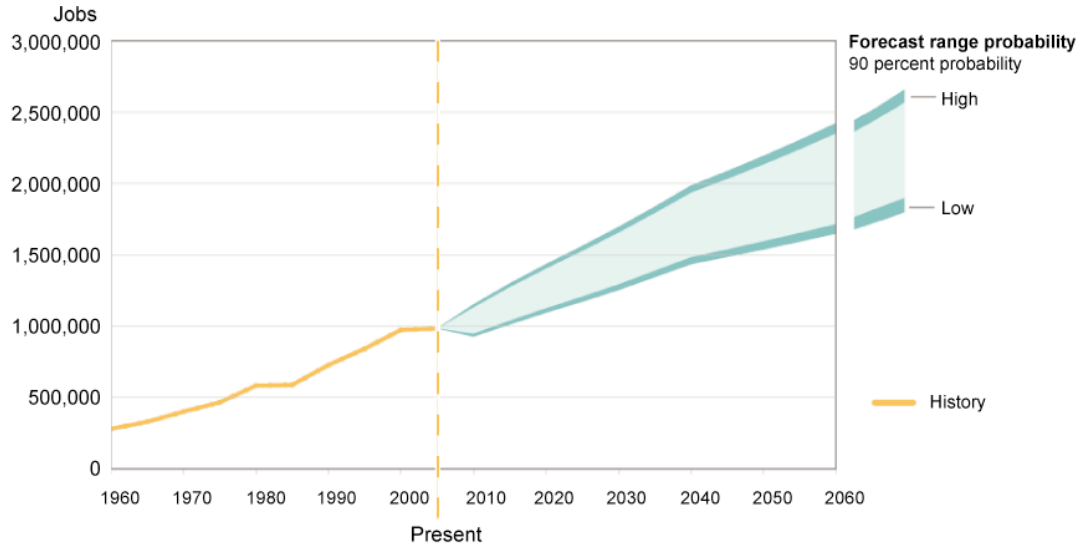


Source: Metro (2009)

The following figure, Figure 4, shows the projected regional growth of jobs from 2009-2060. The twin drivers of demography and economy lead to a series of land use and transportation strategies, policies and real-world outcomes that are embedded in an expansionistic paradigm, a paradigm that is predicated in turn on unsustainable levels of resource extraction, social inequalities and environmental depletion. A powerful positive feedback mechanism within path-dependent systems is the role of adaptive expectations. If the socio-economic and demographic projections demonstrate continuous

upward growth, it reinforces a particular set of strategies and policies to accommodate the projected growth.

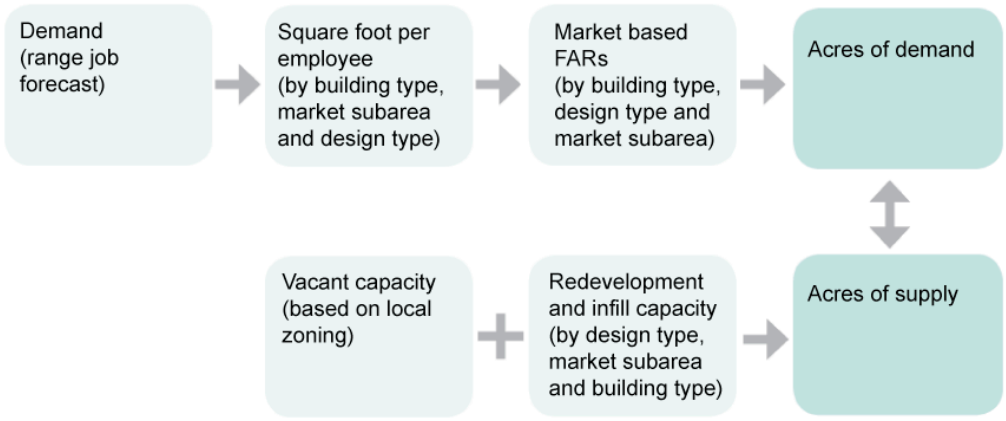
Figure 4: Metro Job Forecast (2009-2060) [90% forecast range probability beyond 2060]



Source: Metro (2009)

The most recent iteration of the Urban Growth Report (Metro, 2010) illustrates the manner in which projections of job growth feed into land usage, area-per-employee, floor-area ratios and the resultant land needs [see Figure 5]. Intimately tied to these projections are transport models that are based on both population growth projections, job growth projections and spatial growth projections, necessitating the construction and expansion of the transportation system to meet the projected demands.

Figure 5: Job Growth Projections Driving Spatial Expansion



The first step is to assign jobs to six building types, based on recent trends and professional expertise. The six building types used for purposes of the design paradigm are: office, institution, flex, general industrial, warehouse, and retail. Assumptions as to the building type in which jobs are located could change over time as the real estate market matures, land prices increase, and technology shifts.

Source: Metro (2009)

Scaling down from the regional to the municipal level, the economic development strategy of Portland reflects similar path dependencies of employment growth feeding into increased land consumption (and regional competition for employment opportunities).

> Portland's draft mid-range forecast from 2010 to 2035 is for recovery to a 27-percent capture rate of regional job growth, which would add about 150,000 new city jobs (1.3 percent Average Annual Growth Rate (AAGR)) and translate into demand for 3,200 acres of employment land absorption. (Land absorption is a measure of both the vacant land developed during the period and the sites redeveloped to higher density.) The high range forecast is for 200,000 new jobs (36 percent capture rate, 1.6 AAGR) and land absorption of 4,100 acres; the low range forecast is for 100,000 new jobs (18 percent capture rate, 0.9 AAGR) and land absorption of 3,200 acres at lower development densities (Portland Bureau of Planning and Sustainability, 2009a, p. 5).

The twin pressures of demographic and economic growth form a specific logic of spatial expansion that will likely lead to increases in GHG emissions from both the built environment and transport sectors. There are numerous planning interventions designed to counter these trends but they are weakly institutionalized and lack either legislative support or political will to be fully implemented.

One way possible way to break these path dependencies is for planners to actively create niches within the larger system that consciously carve out space for new and emergent planning interventions that prioritize low carbon development patterns. An example can be found in the way in which Portland's watershed health, natural resource conservation, wastewater management and recreational goals are built around a whole-systems management approach. In response to a number of pressures (legal, regulatory, environmental, financial), the city has created a framework for watershed management that has three main components: 1) integrated strategies with land use and storm water management to reduce hazards and build in greater resiliency to climactic changes 2) natural resource systems as the backbone of the urban infrastructure (e.g., pervious surfaces, green roofs, natural wastewater filtration and bioswales), 3) cumulative impacts (holistic planning) assessment that looks at system-level interactions rather than individual sections (Portland Bureau of Planning and Sustainability, 2009e). In response to the large costs of traditional engineering solutions, such as the $1.4 billion Combined Sewer Overflow project, the city has begun to shift focus away from large centralized projects toward a more decentralized approach that relies on natural system functions to handle storm water runoff closer to the source (Portland Bureau of Planning and Sustainability, 2009c). A key strategic system goal is to protect natural areas, especially those with high levels of biodiversity, while also expanding the connectivity of the natural areas so that humans have connections to nature and nature has connections to humans.

> Policies that address natural resource protection and habitat restoration along with innovative strategies starting with green buildings, green streets, and ecoroofs can be applied more broadly and strategically to protect and enhance watershed health while accommodating residential and job growth (Portland Bureau of Planning and Sustainability, 2009e, p. 13).

There is a remarkable consistency of approach when it comes to questions of levels of affluence, consumption and population growth. The dominant theme is that climate change strategies can successfully lower GHG emissions while simultaneously supporting the underlying rationality of perpetual economic growth. There is a strong bias toward mainstreaming climate concerns and

sustainable development concerns into the existing development pathway that sets growth as the highest goal. The contradiction between radically lowering consumption and production levels and keeping the existing economic development framework substantially intact is not explicitly acknowledged. In fact, it is quite the opposite. For example, the Climate Action Plan notes "[the] City Council has adopted an economic development strategy that prioritizes sustainability as the key economic engine of the Portland region" (City of Portland; Multnomah County, 2009, p. 8). Similarly, Metro's climate strategy, the Portland Metro Climate Prosperity Strategy, is an economic growth-promotion strategy first and foremost (Metro, 2010b).

4.3.3 Synergies, Conflicts and Trade-offs

Key Questions: *Have planners established an Adaptation/Mitigation/Sustainable Development (AMSD) framework to identify and capture synergies and avoid conflicts between climate goals and sustainable development goals? Do planners have a means to identify and resolve policy trade-offs? What mechanisms are in place to ensure fair and equitable policy outcomes?*

Finding: There is neither a formal AMSD framework, nor are there established mechanisms to address trade-offs between conflicting climate change planning goals and other development goals. Issues of fair distribution of financial, institutional, social and technical resources are not systematically addressed. However, there are policy fragments within the climate plan that demonstrate a way forward, showing how to combine issues of social equity, economic development and environmental benefit, such as the Clean Energy Works program.

Discussion: The capacity to realize the 20-minute complete neighborhood concept is unevenly distributed throughout the city. There are significant spatial and historic disparities of physical, social, economic, political, cultural and recreational resources and opportunities between the downtown, inner eastside and westside neighborhoods and the outer northeast and east neighborhoods (Portland Bureau of Planning and Sustainability, 2009b,c,d).

Economic development priorities are heavily geared toward maintaining the preeminence of the central city as the regional center for financial services, insurance, regional headquarters and the like.

> The city's office sectors are strongly concentrated in Central Portland. Office sectors made up 58 percent of Central Portland employment in 2006, compared to a range of 15 to 28 percent in other regional and town centers, 15 to 43 percent in industrial areas, and an average 30 percent along neighborhood commercial corridors. Policies for regional growth management, compact urban form, transit investment, and urban renewal support this office concentration in Central Portland as the region's high-density center and Oregon's largest concentration of office services (Portland Bureau of Planning and Sustainability, 2009a, p. 7).

It is not just the economic planning that tends to concentrate development close to the city center. Capital transport investments, such as the light rail and streetcar, tend to be concentrated around the areas close to downtown. The outer northeast and east neighborhoods have poorer transport connections, significantly less walking and biking infrastructure and are far more likely to rely on the car for transportation, increasing the financial burden on families with lower incomes (Portland Bureau of Planning and Sustainability, 2009b,d). There is a similar inequality of distribution of cultural facilities, educational opportunities, parks and recreation and retail services located within walking or

biking distance. Absent a clear articulation and policy integration of these types of concerns, it is quite possible that the promulgation of the 20-minute complete neighborhood concept will merely reinforce the existing economic, social, environmental and spatial inequalities between the central city and the periphery.

The Clean Energy Works program is a good example of what an integrated assessment of climate and sustainable development goals looks like. In order to stimulate energy-saving retrofits of existing homes, the city and county have, in partnership with the major energy suppliers and local non-profits, created a program to offer low-interest loans to private home owners that can be repaid through the homeowners utility bill over a 15-20 year period (City of Portland; Multnomah County, 2009). The program has strong emphasis on the linkages between employment creation, environmental benefits and targeted efforts toward helping socially disadvantaged groups gain a foothold in the job market. The lack of an integrated policy to capture such synergies and avoid (where possible) policy conflicts suggests that the region may end up both by-passing policy measures that reinforce one another and creating conflicting policy goals that lead to sub-optimal outcomes.

The types of trade-offs that are made between competing aims between climate goals and other development priorities are not difficult to locate but they are often difficult to negotiate. Two particular examples will be discussed below of the types of trade-offs that are present between climate goals and competing land use and transportation goals: 1) the north reach of the Willamette River and 2) the proposed replacement of the Interstate 5 bridge that spans the Columbia River and serves as a crucial transport link for the Portland Metropolitan Region and the west coast corridor stretching from Vancouver, British Columbia down to San Diego, California.

One recent, though by no means exceptional example of the difficult trade-offs that planners must address is exemplified by the conflict between environmental groups and business interests over the restoration plan of the northern reach of the Willamette River. The Willamette and the Columbia rivers, along with their main tributaries, have a significant influence on the economy, society and environment of the Portland region. Like rivers elsewhere, however, industrial pollution and man-made diversions and disruptions have taken their toll on the health of the rivers and the various dependent animal and plant species. Planners are attempting to create synergistic policies that simultaneously restore wetlands, allow rivers to flow more naturally, increase the bio-diversity in the city and provide both jobs and recreational opportunities to residents. The city is also working with Metro to coordinate a regional program (Nature in Neighborhoods) to protect and restore riparian corridors and wildlife habitat (Portland Bureau of Planning and Sustainability, 2009e). Additionally, the Climate Action Plan calls identifies healthy watersheds an important component of an adaptation strategy. While there is little voiced opposition to such measures in the abstract, conflicts often erupt when business interests collide with environmental protection measures.

There is a significant industrial presence on the Willamette River, including silicon wafer manufacturing, steel mills and Port of Portland harbor operations in the area. The Portland Harbor, situated on the Willamette River watershed within the city limits has been designated a Superfund clean up site, [meaning that the level of environmental contamination is high enough to warrant federal government intervention], necessitating the development of a comprehensive environmental remediation plan. The city has been developing such a plan over the past 10 years and the first portion of the plan is now close to being adopted by the city council. Businesses in the affected area, including

the quasi-public Port of Portland, are fighting two key measures: 1) the imposition of a fee that will pay for mitigation of environmental damage and 2) the ability of the city to regulate development activity that will impact watershed health (Giegerich, 2010). Many of the same businesses have been actively involved in the negotiation and shaping of the restoration plan but have come out in opposition to the more restrictive planning measures. An important lesson to draw from examples such as this is that planners can and do devote significant time and resources to carefully crafting consensual agreements with a variety of actors. These agreements, however, are still subject to political approval. Dogfights between institutions and interests are unavoidable, especially in situations where there is a power struggle between the desire to conduct business as usual (e.g. treating environmental damages as externalities) and a new regime that is attempting to regulate and incorporate such costs at the point of production. Similar battles will break out over land use regulations governing climate adaptation issues. Many of the low-lying areas of the Columbia and Willamette Rivers that are used for commercial and industrial purposes are vulnerable to rising sea levels and more extreme flooding events.

In the transportation sector, there is a similar series of trade-offs that are made between GHG emission reductions and transport/development concerns. Metro's Regional Transportation Plan has made GHG reduction a component of the decision-making process for funding decisions for different mobility corridors linking the various cities in the region together.

> In anticipation of future requirements, this RTP [Regional Transportation Plan] includes specific CO2 reduction targets, policies and actions to reduce the need to drive and improve operations of the transportation system-two primary strategies that have been identified for the transportation sector. However, more work is needed. Preliminary scenarios modeling conducted in 2008 looked at how vehicle emissions might change over time with different investment choices to illustrate the region's ability to continue to meet current state and federal air quality requirements and state targets to reduce greenhouse gas emissions. None of the scenarios, including the reference scenario, achieve the state targets by 2035. The region's growing population will make it difficult to achieve the targets without other strategies. The region must identify the land use and transportation strategies needed to meet them. The region will also need to support new technology and conservation measures. The scenario work in 2010 will evaluate a full array of land use and transportation strategies (Metro, 2010a, p. 11).

The plan notes that more aggressive actions will need to be taken to account for increased population growth and travel demand, mainly through better coordination of land use and transport decisions but also through conservation measures, cleaner forms of fuel and transportation demand strategies.

An interesting test case of how deeply committed the State, region and city are to developing a lower-carbon transport infrastructure is the Columbia River Crossing project that is currently in the final project design and development stages. The ageing lift-span bridge is a major regional lynchpin of the passenger and freight transportation system. In order to relieve congestion, the states of Oregon and Washington have proposed replace the current six lanes of travel with a 10-12 lane bridge at an estimated cost of $3.6 billion USD. The bridge would also be built to accommodate an expansion of the light rail system into Vancouver in addition to providing improved pedestrian and bike access.

Politicians on both the Washington and Oregon side of the river are pushing hard to get the design and the draft environmental impact assessment complete by autumn, 2010 in order to qualify for funding

from the federal government. Proponents of the bridge argue that the doubling of the travel lanes is necessary to relieve congestion and create smoother freight movement through the region. Despite the opposition from some local politicians, environmental and social advocacy groups and other interest groups, the preferred alignment and design that is going forward will lead to dramatic increases in both traffic volumes and GHG emissions. The expansion of the bridge will of course necessitate large re-alignments and consequent expansions of the interchanges and approaches. Most importantly, the persistence of the infrastructure will virtually guarantee the continued expansion of car-based travel for the next 50-100 years.

There is also an important symbolic dimension to planning decisions such as these. One of the underlying rationales for creating and implementing climate change strategies is that humanity needs to act quickly to dramatically lower GHG emissions within the next 10-15 years in order to begin to stabilize atmospheric GHG concentrations. The Columbia River Crossing, for example, undercuts that message and sends a message that efficient freight and automobile movement is a much higher societal priority than lowering GHG emissions.

4.3.4 Governance

Key Question: *What is the extent of policy integration between climate goals and development goals, measured by the criteria of inclusion, consistency, qualitative weighting, reporting and resources?*

Finding: At the city scale, there is a higher level of policy integration between the climate goals and other development goals, particularly in the energy, environmental (including "soft" infrastructure such as parks, recreation and watersheds) and economic development sectors. At the regional scale, despite sound land use and transportation policies to create compact, transit-oriented development patterns, the fundamental drivers of employment growth and demographic growth lead to policy conflicts between the climate change goals and the development priorities.

Discussion: The following table, Table 6, analyzes the extent of integration between the main policy goals of the climate plan to other development and planning goals at both the municipal level and regional level. For the city of Portland, the documents reviewed are background reports prepared for the revision of the 25-year Portland Plan that is currently under development. All were published in 2009, contemporaneously with the Climate Action Plan. Most of the Metro plans were also published in 2009 and 2010. It should stand to reason that if climate change goals were a priority for regional and municipal plans, then plans that establish other land use, transport and infrastructure priorities will reflect that. A plus (+) means that the overall planning goals serve to support the climate goals, a minus (-) means a weakening of the climate goals, a plus/minus (+/-) means that it could either support or undermine the climate goals, depending on the implementation and a zero (0) means that it either not applicable or that there are no clear linkages.

The highest level of policy linkage can be found in the energy and environmental sectors. For instance, the energy plan goals for both the built environment and transport sectors are drawn directly from the climate plan. Many of the watershed health goals also serve to support the climate goals and other development goals through an ecosystem services approach.

> When development intensity increases, it often contributes to declining water quality, altered hydrology (such as erosion and flooding), declining wildlife populations, and degraded

> habitat. Assessments of local conditions confirm that Portland watersheds are challenged in all of these areas. Although it would be easy to assume that further growth will inevitably lead to worsening watershed conditions, Portlanders have said that they expect more — that they envision communities that are greener and healthier than they are today. Policies that address natural resource protection and habitat restoration along with innovative strategies starting with green buildings, green streets, and ecoroofs can be applied more broadly and strategically to protect and enhance watershed health while accommodating residential and job growth (Portland Bureau of Planning and Sustainability, 2009e, p. 13).

The urban form background report is primarily concerned with mapping the places, patterns, public realm and private realm of the current built environment of the city of Portland. While it would be expected that climate goals such as the 20-minute complete neighborhood and high-efficiency buildings would figure prominently in this report, that expectation would be disappointed. There are fragments of such considerations found within the report, for example:

> What relationship is there between priorities for new development to continue existing characteristics and community interest in fostering sustainable development practices? Are there conflicts that need to be resolved or relative priorities that need to be discussed? (For example, a topic that has been raised is that past development practices and the urban patterns that have emerged have not been responsive to solar access needs, and that new development, as part of an emphasis on sustainable development practices, should be designed around solar access, departing from existing patterns if need be.) How should priorities for community-responsive design be balanced with priorities for housing affordability, accomplishment of density objectivities, design innovation, etc.? (Portland Bureau of Planning and Sustainability, 2009d, p. 80).

These types of considerations are, however, mostly on the margins of the main strategic direction of the report. Economic development goals are, in general, weakly tied to climate goals as well, although there are indications that this may be changing. The economic development priorities of the city are placed in the context of competition, not only regionally, but also nationally and internationally:

> Economic globalization since 1990 has put increasing pressure on cities to be competitive and adaptable in order to remain prosperous. Related trends include rapid growth of world trade, Asian-led economic growth, off-shoring of production and outsourcing of services to lower-cost locations, new decentralization technologies (such as the Internet), trade blocs such as NAFTA (North American Free Trade Agreement), and consolidation in international firms. Local responses to these phenomena have emphasized “traded sectors” (those firms that compete in markets outside the region) and competitive local strengths that attract and keep them (Portland Bureau of Planning and Sustainability, 2009a, p. 3).

One of the key traded sectors that Portland is developing is in clean technologies and sustainable industries.

> Portland is home to one of the most significant concentrations in the U.S. of firms in the renewable energy, environmental services, recycling, and green building sectors. In particular, the city boasts notable concentrations of green building and wind energy firms, including the North American headquarters of Vestas and Iberdrola. The metro region is benefitting from an influx of solar energy firms, which now number nearly 40. Equally important is a growing supply of experienced employees for clean tech firms: the region possesses talent clusters 84%

> greater than similar sized regions for renewable energy and 43% greater for environmental services and recycling. In short, when clean tech and other green firms are seeking a location to form or expand their businesses, Portland is usually at or near the top of the list. Portland has become the ultimate laboratory for innovations in alternative energy, green building and green living. An unwavering commitment over nearly 40 years to producing and enhancing a cleaner, more sustainable lifestyle has produced a city and region at the forefront of alternative transportation use, green and energy efficient building, and promotion and usage of non-carbon-based energy sources. In the race to be proclaimed the greenest city in America, Portland has the distinct advantage of actually doing more than just talking about sustainability - and businesses, entrepreneurs, and aspiring green sector talent know this. Investment and talent seeking a place in the emerging green economy now gravitate to Portland (Portland Development Commission, n.d., p. 3).

The rise of sustainability on the development policy agenda in Portland has significant positive feedback effect on the climate change goals, particularly in the areas of more efficient building practices and renewable power generation. These types of measures, if fully implemented, can lead to gradual changes in the development pathway given time, resources and consistency of policy direction.

Table 6: Level of Policy Integration between Climate Goals and other Development and Planning Goals

Note: + = supporting, - = weakening, +/- = ambiguous, depends on implementation and 0 = not present

Governance Scale	Plan Type	20-minute neighbor-hood	Reduce VMT by 30%	Reduce energy use of existing buildings by 25%	Zero-net GHG in new buildings	Grey to Green initiatives: tree plant-ing, natural infrastruc-ture
Portland	Urban Form	+	0	0	0	+/-
	Economic Development	-	-	+/-	+/-	+/-
	Energy	+	+	+	+	+
	Housing and Transportation Cost Study	+/-	+	0	0	0
	Infrastructure Condition and Capacity (ICC): Environmental Services	+/-	+/-	+	+/-	+
	(ICC) Parks and Recreation	+	0	+/-	+/-	+
	(ICC) Trans-portation	+/-	+/-	0	0	+/-
	(ICC) Water	0	0	0	0	+
	Natural Resources Inventory	+/-	0	0	0	+
	Watershed Health	+/-	0	+/-	0	+
Metro Regional Government	2040 Growth Concept	+/-	-	-	0	+/-
	Regional Trans-portation Plan	-	+/-	+/-	-	-
	Regional Popula-tion and Growth Forecast	-	-	-	-	-
	Urban Growth Report 2009 to 2030, Employment and Housing	-	-	-	-	-

At the regional scale, the main drivers of both land use and transportation planning decisions, population and job growth projections, both serve to work mostly against the climate goals. The

primary culprits are the twin forces of low-density development on the outer edges of the built-up urban areas and the growth of car-based travel patterns. The overall planning aims of both the 2040 Growth Concept and the 2035 Regional Transportation Plan are well aligned toward creating compact, polycentric development patterns, closely connecting denser developments close to transit stations that offer better opportunities for walking and biking. However, the state-mandated planning goals require both the municipalities and Metro to prioritize economic growth (and expansion of the urbanized areas) over environmental or social considerations. The result is that although Vehicle Miles Traveled (VMT) per capita has decreased, absolute VMT is projected to continue to grow well into the next few decades. Table 7 below shows the projected increases in total VMT out to 2035, comparing a no-build scenario, federal transport system priorities and the regional investment strategy for Metro (with a higher emphasis on transit capacity expansion than the federal priorities). The most important implication for climate change planning here is that no matter what options are taken, absolute VMT will increase and per capita reductions are minimal regardless of the policy choice. This implies that GHG emissions will continue to rise from the transport sector unless more significant interventions are made.

Table 7: Vehicle Miles Traveled Projections to 2035, with Three Scenarios

Vehicle miles traveled (VMT)	**2005**	**2035**	**2035 Regional Transportation Plan (RTP)**	**2035 Regional Transportation Plan (RTP)**
	Base Year	No Build	Federal Priorities System	Investment Strategy
Total	32,657,381	48,730,602	49,231,806	49,393,229
Per person	16.65	15.74	15.90	15.59

Source: Metro Regional Transportation Plan 2035 (2010a)

Residential location preferences are closely related to travel patterns. The Urban Growth on Employment and Residential sectors covering the period from 2009-2030 notes that:

> Housing preferences play a critical role in determining how much capacity is needed to accommodate future growth. For instance, preferences for larger lots could result in more land consumption. However, housing preferences are a product of a number of variables and are not static. As variables such as those listed below change, so too can housing preferences:
>
> - Property tax rates
> - Perception of personal safety in different locations (e.g. urban or suburban)
> - Transportation costs (e.g. gasoline and the value of time)
> - Income tax policy (e.g. ability to deduct mortgage interest)
> - Public investments in transportation
> - Public investments or disinvestments in different locations
> - Demographics (e.g. family size, number of workers and income or age of householder)
> - Lending practices
> - Policies and investments that address or fail to address negative externalities (e.g. air pollution)
> - Share of infrastructure cost burden that is borne by a household
> - Customs and norms (Metro, 2010e, p. 92)

Many of housing preference variables listed above have important implications for long-term climate change goals. For instance, many of the energy efficiency measures in the built environment are predicated on smaller dwellings located in dense proximity to one other, minimizing heat and power loads. Preferences for single-family homes on large lots leads to increased need for new land, necessitating expansions of the road network to accommodate car traffic. Once these lower-density development patterns have been established, the low population densities make it financially unviable to build effective public transport systems due to the lack of ridership. Having made mention of the dependent variables that make up the complex strata of residential location preferences, the authors go on to state that, nevertheless, the planning for new residences will be based on the assumption that past preferences will guide future planning.

> The future will not necessarily be like the past. However, in the absence of other information, this UGR and other estimates of future housing demand (Goodman, 1999) (Nelson, 2006) (Leinberger, 2008) assume that a particular household type (age, income, size, etc) will have the same housing preferences in the future as they have today. Clearly, this is an imperfect assumption that should be weighed by policy makers (Metro, 2010e, p. 92).

In essence, the plan indicates that both existing residential and workplace location decisions will not alter substantially in the coming decades. As discussed in Sub-section 4.3.2 [Path Dependency], demographic and employment expansion projections are fed into a model that yields an increased need for land and building, which is then compared to the existing availability of land for each zoned use. A significant problem at the root of this process is that there has historically been a large mismatch between zoned densities and built densities. Previous plans allocated too much space that was never filled by market demand.

> However, a shortcoming of using supply-side or regulatory FAR values is that many zoning ordinances are well ahead of building densities that the market can feasibly build in the next 5 to 20 years. In some instances, the FAR values were unrealistic given prevailing and expected market conditions. As a result, this revised employment analysis employs expected market-based FAR projections. This approach provides less potential capacity than the regulatory FARs but is more reflective of market conditions. These demand-side or market-based FAR values have been vetted with local governments and a variety of trade and business organizations as well as by the Hovee consultant team. The demand-side FARs are also consistent with MetroScope scenario results reflecting current policies and trends (Metro, 2010e, p. 45).

Despite the changes in the way in which the FARs are calculated, the net result for both residential and employment location decision planning is a bias toward expansion, leading to more single-family homes located in distant suburbs, generating more auto traffic to allow commutes between low-density homes and low-density workplaces.

5 The Copenhagen Metropolitan Region

In this chapter the analysis of the Copenhagen Metropolitan region will be presented. Chapter 5 is composed of three sections. Section 5.1 presents background information concerning the Copenhagen Metropolitan region, including a description of the political, planning and demographic profile of the city and region as well as a brief historical description of climate policies. Section 5.2 analyzes the mitigation and adaptation interface present in the Copenhagen Climate Plan, using the analytic categories of urban morphology, path dependency, synergy/conflict/trade-offs and governance. Finally, Section 5.3 presents an analysis of the strategic synergies and conflicts between the stated climate goals and other development goals using the same analytic categories of urban morphology, path dependency, synergy/conflict/trade-offs and governance.

5.1 Background

The city of Copenhagen, founded in the mid-11th Century, is situated on the islands of Amager and Sjælland at the intersection of the Baltic and North Seas. Commerce and trading has historically played a significant role in the development of the city, a role that continues into the present day. The functional urban region of Copenhagen encompasses today the cities of Copenhagen (pop. 518,000), Frederiksberg (pop. 83,000) and 34 surrounding municipalities. The total population of the functional urban region is approximately 1.86 million, accounting for 33% of the Danish population (Næss, Næss, Nicolaisen, & Clemens, 2009) while the City of Copenhagen is approximately 80 km^2 and that of the functional region approximately 629 km^2 (Næss, Næss, Nicolaisen, & Clemens, 2009). Although small by world city standards, the Copenhagen Metropolitan Area is the dominant presence in the region economically, politically and culturally.

The structure of post-war urban development in the region has been guided by the 1947 Finger Plan, which established 5 development corridors concentrated around the trunk lines of the regional train network. The intention was to create dense develop patterns centered around public transport and to minimize encroachment on green areas. Radial ring roads have been constructed over the years that facilitated more diffuse and extensive growth based on the use of the private car. Nevertheless, the most recent revision of the Finger Plan in 2007 reinforces and extends these principles of concentrating development along public transport corridors (Miljøministeret, 2007). One of the main drivers pushing against planning efforts to create denser development is the expansion of the use of motorized vehicles. Between 1999 and 2009 the road network in Denmark expanded by 10% while the rail network shrunk by 10%. Further, public investment in roads more than doubled during the same period while spending on rail saw only small increases (Statistics Denmark, 2010). The consequent expansion of both car ownership and vehicle kilometers traveled has created severe congestion on the motorways and surface streets in the region and led to large increases in GHG emissions from the transport sector (Statistics Denmark, 2009). However, although development patterns since the end of World War II have resulted in extensive expansions of urbanized areas outside the city limits, the cities of Copenhagen and

Frederiksberg still possess considerable residential and workplace location appeal (Næss, 2005). The following map, Map 5, shows the Copenhagen Metropolitan Region.

Map 5: Copenhagen Metropolitan Region

Infrastructure of the Capital Region

Source: Region Hovedstad (2008)

Similar to the case of the Portland Metropolitan region, there are a number of actors involved in the creation and implementation of climate strategies: 1) the city of Copenhagen, 2) the regional government (and the 34 constituent municipalities), 3) the national government and 4) various non-state actors such as environmental organizations and city-to-city networks such as ICLEI, the C40 Climate Cities and the Danish Society for Nature Conservation's climate city initiative. Additionally, the hosting of the 15th Conference of the Parties (COP 15), which was to draw up the post-Kyoto global climate strategy, by Copenhagen presented an added impetus to draft and implement the municipal climate strategy. The city of Copenhagen has an elected council of 55 members, with 7 mayors overseeing 7 administrative divisions. Each of the heads of the administrative divisions have significant political autonomy, with little institutional pressure to tightly coordinate decision-making

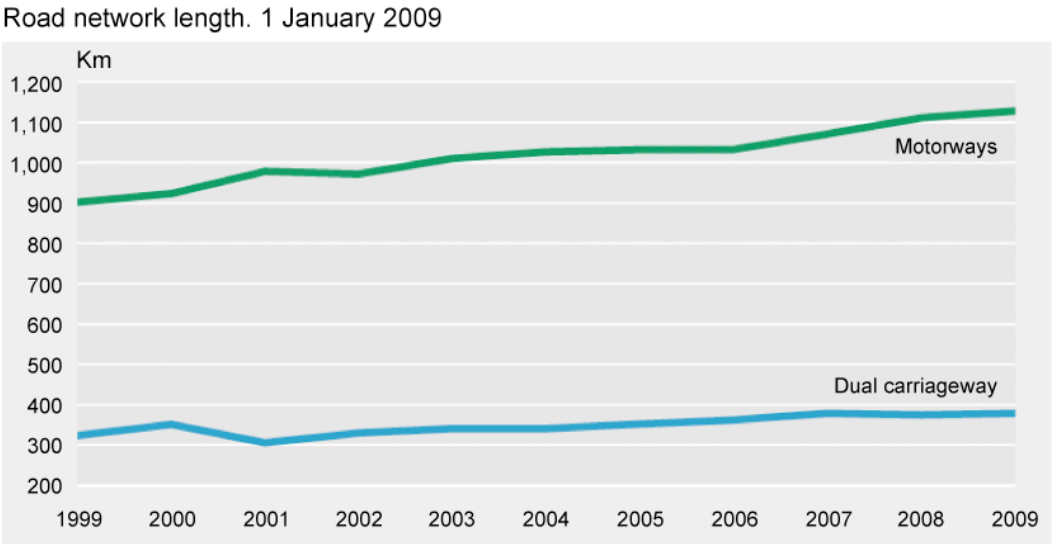
and strategic alignment between the divisions. The primary tasks of the municipality, in terms of staff and financial resources, is the administration of the welfare system including health care, education, job training/development and social work.

Development and planning constitute a relatively small percentage of the overall budgetary priorities. The Technical and Environmental department has, among other things, primary responsibility for urban planning and renewal, building the provision and maintenance of the road network, environmental planning and parks. While sustainable development principles have been a visible part of the planning process (for example Local Agenda 21 strategies have been in place since the 90's), the 2009 Copenhagen Climate Plan is the first time that an explicit GHG reduction strategy has been formulated for the city.

At the regional level, Region Hovedstaden (RH) has 41 elected political representatives that are responsible for health care, education, transport, regional development planning and environmental protection. After legislation passed by Parliament in 2007 abolished the old county administrative level, the newly constituted region overtook planning authority for the region, including plans for land use, transport (both road and rail), nature preservation, water planning and regional development (Miljøministeret, 2007). Additionally, the region is currently in the process of formulating a climate strategy that will be completed by mid-2011 (Region Hovedstad, 2010). The region will develop the strategy in coordination with the 34 municipalities within the region, the national government, planning consultancies, universities, business groups and other interest groups.

> Institutional fragmentation of the metropolitan region poses a significant challenge, making an integral vision on transport modes and their connection difficult. Currently, no integrated transportation infrastructure system exists; several actors within the transportation field need to co-operate with each other. National and municipal governments are responsible for roads, based on the Danish Roads Act. The national government is largely responsible for the commuter train (S train) and regional trains. The national government, City of Copenhagen and the City of Frederiksberg own the metro based on separate legislation (Organization for Economic Co-operation and Development, 2009, p. 157).

Figure 6: Road Network in Denmark (1999-2009)

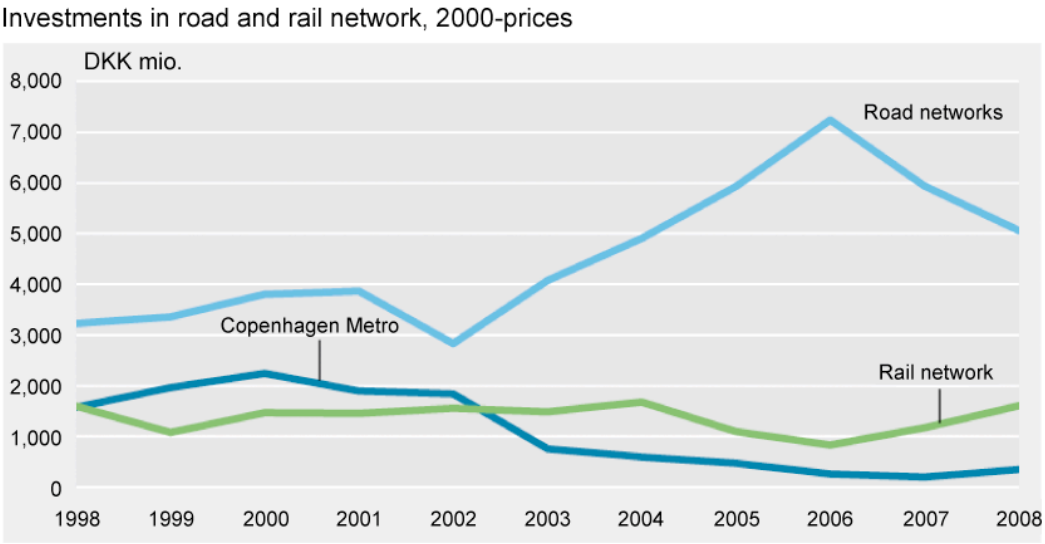


Source: Statistics Denmark (2009)

At the national level, the current government (in power since 2001) has adopted a rather relaxed attitude to reducing carbon emissions, not entirely dissimilar from the US government. Despite periodic statements to the contrary, the overall development strategy for Denmark continues to prioritize economic growth coupled with expansions of the motorway, airport and shipping infrastructure. Figure 6 on the previous page shows the trend line for increases in motorway length in Denmark from the period of 1999-2009.

Road capacity continues to expand with major projects such as the 19-kilometer long Fehmarn Belt bridge between Puttgarden in Germany and Rødby in Denmark and the 70-kilometer long Ring 5 project in the exurban Copenhagen region. Investments in rail have stagnated while those for roads have continued to grow. Figure 7 below shows the investment trends over the last decade.

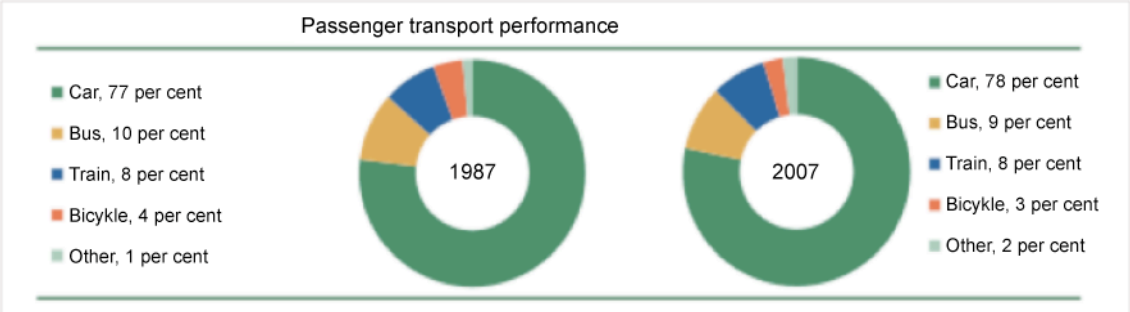
Figure 7: Investments in Road and Rail Network (1998-2008)



Source: Statistics Denmark (2009)

The modal split on the national level in Denmark has stayed fairly consistent for the last 20 years, with cars continuing to dominate public transport and bicycling. Within the city of Copenhagen, modal share of cycling is around 37% (City of Copenhagen, 2009b), but car ownership and rates of usage have climbed consistently over the last decades (Næss, Næss, Nicolaisen, & Clemens, 2009). The following figure, Figure 8, shows the modal share split between 1987 and 2007 indicating a continued high modal share for automobile travel.

Figure 8: Transport Modal Share (1987 and 2007)



Source: Statistics Denmark (2009)

5.2 Mitigation/Adaptation Interface

This section will analyze the interface between mitigation and adaptation strategies, drawing primarily on the internal logic of the Copenhagen Climate Plan. The city of Copenhagen has set itself the goal of reducing CO2 emissions by 20% in the year 2015, based on 2005 emission levels. This target is intended to be a stepping-stone toward creating a carbon-neutral city by 2025 (City of Copenhagen, 2009d). The climate plan is also intended to be an integral part Copenhagen's other planning goals as well as influencing the larger policy framework at the national and international levels:

> The climate plan's goals are an extension of the city's other goals in transport, housing and construction, health, education, social activities and culture. We also want to look beyond the city limits. We want to increase our influence on the national and international agenda (City of Copenhagen, 2009d, p. 4).

The breakdown of the targeted 20% emission reductions is as follows: 75% from the energy sector, 10 % from transport, 10% from buildings, 4% from "Copenhageners" [which could be roughly translated as behavioral change] and 1% from urban development (City of Copenhagen, 2009d). The energy sector is intended to carry the torch, as it were, for the climate policy overall. The City of Copenhagen currently has 98% of households connected to district heating systems and therefore a significant component of carbon emissions stem from the combined heat/power generating stations. Policy goals to lower emissions include: 1) replacing coal with wood chips as the primary feed stock, 2) adding wind power capacity, 3) expanding geothermal sources of heating and 4) efficiency gains from waste incineration plants and improved insulation in the distribution network for heating (City of Copenhagen, 2009d). In the transport sector, initiatives include mandated reductions from bus emissions, expansion of the bicycling network and parking facilities, service and infrastructure improvements for public transport, increased restrictions on the use of the private car (parking restrictions, establishing environmental zones that restrict car and truck traffic and measures to implement road pricing schemes) and conversion of the existing vehicle fleet to hydrogen or electric sources of power.

In the building sector, the plan calls for higher energy efficiency (for both power and heating) in new construction and renovation of existing building stock. The specific measures include: 1) requiring that

city-owned buildings to meet strict low-energy usage standards, 2) education and outreach for landlords, builders, businesses and consultants to disseminate information about energy conservation, 3) encouraging local energy production through piloting of solar photovoltaic systems and 4) establishing a fund to finance energy conservation programs (City of Copenhagen, 2009d).

Urban development, as noted above, is expected to deliver a negligible share of expected reductions in GHG emissions. Considering the large emissions profile of the built environment plus associated transportation requirements, one would expect to find greater importance attached to urban morphology concerns. Many of the initiatives listed, such as creating denser developments, reducing travel needs and the reduction of parking provision within the city, are all sound policies that should serve to reduce the GHG emissions over the long term. However, the climate plan focuses mostly on new developments, not the existing stock of residential, commercial, retail and industrial buildings. The city of Copenhagen is already quite densely constructed with few large areas of buildable land left within the city proper and therefore the opportunities to build low-carbon infrastructure pathways mostly exist in the renovation sector, not new construction.

Adaptation policies are, like Portland, quite general and in a preliminary stage of development. Copenhagen is still in the early stages of forming a more comprehensive adaptation strategy but the main areas of policy concern expressed in the climate strategy are 1) addressing increases in sea level rise and storm water runoff, 2) lowering cooling requirements through adoption of passive ventilation and better insulation of buildings and 3) addressing the heat island effect by expanding green areas within the city. In the main, the adaptation policies are not tied to mitigation of GHG emissions. There does not seem to be any indication of a planning framework that seeks to create synergies and avoid tradeoffs between adaptation and mitigation strategies-they are rather treated as discrete policy entities.

5.2.1 Urban Morphology

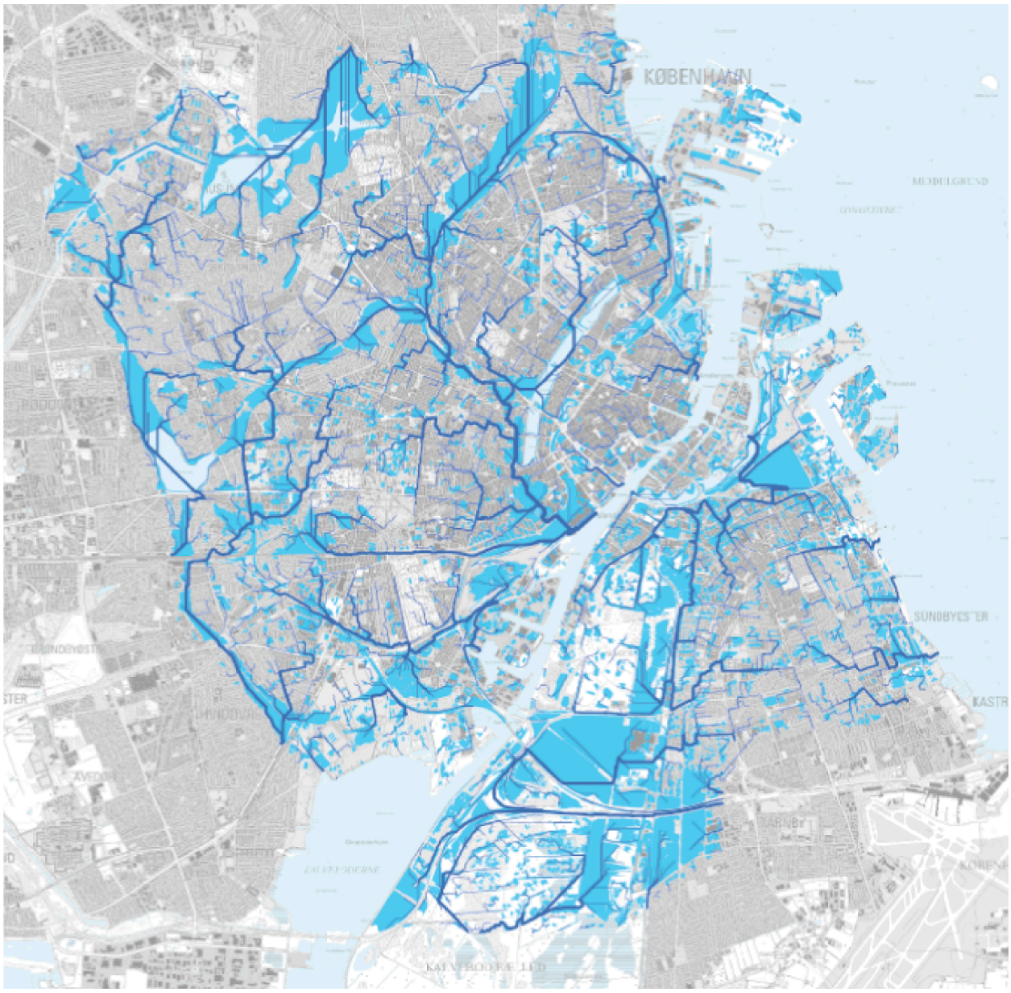
Key Question: *What is the level of integration of the mitigation and adaptation goals in relation to land use, transport, energy and natural systems planning goals?*

Finding: The Copenhagen Climate Plan has some degree of integration between proposed land use, transport and energy measures. The focus on concentration of development within 600 meters of public transport corridors, creating more energy efficient developments and switching to renewable sources of heat and power serve as positive feedback loops that could contribute to lower future GHG emissions within the built environment. Three notable omissions from the plan are: 1) the lack of an integrated approach to natural systems health and regeneration, 2) the lack of a comprehensive strategy to deal with rising emissions from private automobiles and 3) the absence of zoning revisions that would stimulate the desired development patterns. The plan implicitly treats adaptation and mitigation as independent planning processes with mostly separate goals, objectives and aims. There are a number of policy intersections and reinforcements that are noted within the climate strategy between land use, transportation and energy planning but very little in the way of recognizing key linkages between those sectors and natural system protection concerns such as watershed protection, biodiversity or wildlife preservation.

Discussion: The climate plan also seeks to integrate climate considerations within the wider development plans for both the existing built-up urban areas and new development project such as the North Harbor area and the Carlsberg brewery projects (City of Copenhagen, 2009b). According to the

climate plan, all new city development will meet the most aggressive low-energy standards for buildings. In addition, the city sets out densification as a main policy goal in order to reduce transportation needs. Additionally, the plan reinforces a policy to concentrate development within 600 meters of public transport nodes, whether metro, S-train, light rail or bus line (City of Copenhagen, 2009b). The stated intentions of these policies are: 1) distance reduction, in order to make walking and biking modes more attractive, 2) increasing access to jobs, services and housing and 3) increasing the attractiveness of using public transport, bicycles or foot to move around the city (City of Copenhagen, 2009b).

Figure 9: Potential Flooding from Extreme Storms in Copenhagen



Light blue areas show possible standing water and dark blue areas show stream paths where water will flow

Source: City of Copenhagen Climate Plan (2009d)

The adaptation portion of the plan seeks to coordinate a few of the adaptive measures with other planning goals, for example the use of pocket parks to control heavy storm water runoff that also serve to expand recreational opportunities for residents and lowering the heat island effect. For the most part, however, there is little systematic attention paid to the synergies and tradeoffs between mitigation and adaptation policies, such as concentration of development around the harbor and the need to guard both

future and existing development from sea level rises. Figure 9 on the previous page shows the areas in light blue that would be expected to have standing water in the event of extreme rainfall. Significant portions of both the older city core and areas slated for redevelopment will likely be affected by projected increases in the intensity and frequency of storm events. Copenhagen has a high degree of non-pervious surface cover that does not allow for local infiltration of storm water runoff (City of Copenhagen, 2009c). Given the size of the area in the city at risk, Copenhagen would benefit from a strategy of integrated watershed management that worked cross-sectorally to locally manage storm water.

A recent OECD territorial review of the Copenhagen region notes that:

> The use of an ecosystem-based planning approach would facilitate co-ordinated inter-municipal action. This is highly important given the urban land conversion of municipalities on the periphery of Copenhagen, along with prospective changes to the land and seascape resulting from climate change, particularly rising sea levels. Although Copenhagen‘s spatial planning is mandated to integrate respect for nature and the environment, the current planning approach does not fully incorporate the principles of integrated landscape or watershed planning, which are based on the need to preserve and enhance ecosystem functions (Organization for Economic Co-operation and Development, 2009, p. 186).

The adaptation portion of the climate plan has a preliminary section devoted to addressing water issues in the city, but it is not connected to either mitigation goals or other planning goals very well. Green roofs, green streets, green facades, extensive tree planting, and wetland development schemes are all part of a comprehensive strategy that create synergies between climate change goals, social equity goals (access to water, recreation, quiet spaces), transport goals (reduction of street space devoted to cars, pedestrian districts, better opportunities for cycling, and energy goals (higher building efficiency, lower energy usage, better insulation). While the city’s plan identifies greening the infrastructure as a possible policy measure there is no coordinated attempt to link these measures to other desirable planning goals.

Furthermore, the construction of the public transport system based on the Fingerplan has led to a dense concentration of nodal connections at the center of the city. A recent OECD report on Copenhagen notes that: “The current mono-centric structure of Copenhagen‘s transportation system could jeopardize the total transportation system in the case of an emergency” (Organization for Economic Co-operation and Development, 2009, p. 154). The climate plan does not have a comprehensive framework of identifying vulnerabilities within the city nor to identify the capacity to adapt within the institutions, infrastructure and the society. The provisions and suggested policy options for adaptation typically are built around an engineering solution approach, such as raising the elevation of new developments, building tidal barriers and raising the height of sewage outflow pipes (City of Copenhagen, 2009d). There does not seem to be a sustained focus on tying adaptation policies to other desirable outcomes, such as more permeable street surfaces, better water quality or improvements in biodiversity and wildlife health.

The plan states that “t]raffic is not the area where greatest CO2 emission reductions can be achieved, but it is the area where our initiatives do the most for our health” (City of Copenhagen, 2009d). This statement flies in the face of widespread acknowledgement that emissions from the transport sector are a large and growing segment of GHG emissions in the world (International Energy Agency, 2009). It is

also is contradicted by projections in the climate plan itself that CO2 emissions from the transport sector in Copenhagen will grow from 21% to 30% of total emissions by 2025 (City of Copenhagen, 2009d). In both Europe and North America, even significant reductions in the stationary power generation sector are often outweighed by the growth in vehicle kilometers traveled and large increases in the freight and air travel sectors. Notably, Copenhagen's climate plan does not address either embedded emissions generated by the consumption of goods and services nor the growth of air travel connected with Kastrup International Airport.

5.2.2 Path Dependencies

Key Question: *How do planners account for path dependencies of the built environment, transport networks and socio-economic development pathways that make it difficult to effect near-term alterations to the municipal or regional urban form?*

Finding: The energy pathway outlined in the climate plan focuses on energy efficiencies in the built environment, diversification of fuel sources and substitution of fossil fuels with renewable power. The underlying pathway, however, of centralized generation and distribution remains intact. Similarly, the transportation strategies go some way toward creating an alternative system of mobility built around public transport and non-motorized transport but fall short in addressing the underlying socio-technical and institutional forces that contribute to the expansion of the road network and automobile ownership. Rising levels of affluence and consumption are not addressed.

Discussion: There are three primary path dependencies that are particularly relevant to GHG reduction strategies-energy systems, transportation systems and overall development pathways. The Copenhagen Climate Plan addresses the energy pathway minimally, the transport pathway fitfully and the development pathway only marginally, if at all. Changes in the energy system in Copenhagen are intended to deliver 75% of the city's targeted 500,000 tons annual reductions of CO2 emissions by 2015 (City of Copenhagen, 2009a). Combined with the expected efficiencies in the built environment, energy savings and shifts to renewable sources of heat and power are projected to account for 85% of all targeted reductions. If the stated measures are achieved, this could be a step-change in the underlying supply infrastructure for the city if the policies eventually lead to a shift toward more renewable and sustainable sources of energy and heating. However, there remains the possibility that the existing system architecture will remain in place and the policies will only result in marginal shifts in fuel supply. An example of how different path dependencies could conflict is that in the case of Copenhagen's combined heat and power plants. Vattenfall is the large, incumbent monopoly provider of heat and power to the city and has significant sunk costs invested in the generation and distribution of district heating systems and electricity. Recalling the characteristics of path dependencies and the logic of increasing returns (high fixed costs, learning effects, coordination effects and adaptive expectations), we can see that the substitution of coal and oil with biomass does not represent a noticeable break from the existing pathway. The generating facilities remain in place, the learning effects reinforce the continued technical optimization of the existing system, the coordination effects of the associated hardware and software of district heating and power supply continue to be tightly networked around the existing system and the adaptive expectations are set so that the current socio-technical and institutional arrangements are expected to remain fundamentally intact.

Let's assume a counter-factual example of what a more sustainable pathway for energy and heating could look like for Copenhagen. If the city would mandate the widespread adoption of passive, energy + structures that are net-zero consumers of energy and heating in both new construction and retrofitting existing building stock in the city, there would be a radically different development pathway set in motion. Heating and electricity needs would decline dramatically, generation capacity would be decentralized across the city, making the network more robust and resistant to sporadic or systemic shocks and GHG emissions would all fall significantly, depending on the embedded emissions profiles of the construction materials. Such a policy would also contribute to better household economy through savings on heat and electricity and could lead to new job growth in construction technology, energy systems and technical fields.

The transportation goals in the climate plan demonstrate fitful efforts toward addressing the path dependency of the transport network. The continued expansion of bicycling/walking and the strengthening of public transport are key components of low-carbon mobility, but the plan does not address the projected growth of car traffic, car ownership and planned road expansions other than to complain about the lack of legislative authority to enact road pricing.

> Copenhagen has made considerable investments in a new Metro, but considerable road capacity increases have also taken place. Together with the low-density suburban development this has contributed to a steady and rapid growth in car traffic. During the period 1995-2007, car traffic within Copenhagen Metropolitan Area increased on average by 24 %, whereas public transport decreased by 7 % (Næss, Næss, Nicolaisen, & Clemens, 2009).

But as the plan itself points out, high levels of bicycling, walking and public transport mode usage is not sufficient to bring down GHG emissions within the transport sector. Capacity expansion of the road network, rising automobile ownership and rising vehicle kilometers traveled are not systematically dealt with. The result is that even if Copenhagen achieves its goals vis-à-vis cycling and public transport, increases in automobile travel will likely lead to net increases of GHG emissions. A path-breaking policy initiative would seek to integrate carbon emissions into the heart of policy assessment and infrastructure investment decisions and any transport investment that led to a rise in GHG emission would be prioritized the least. The plan also notably fails to address aviation and shipping emissions that have high emissions profiles.

Finally, the overall development pathway is assumed to be unchanged. The Copenhagen Climate Plan does not take into consideration levels of affluence, consumption levels or embedded emissions from imported goods and services. The omission of these considerations will make it difficult if not impossible to attain sustained annual reductions in GHG emissions (Sathaye, et al., 2007; Næss P., 2010). Furthermore, the existing supply chains of goods, services, transport, energy, and water are built around centralized production and distribution, making them extremely vulnerable to sporadic or systemic disruption from climactic changes.

5.2.3 Synergies, Conflicts and Trade-offs

Key Questions: *To what extent do planners seek to create synergistic policies that support both mitigation and adaptation efforts? How do planners avoid conflicts between mitigation and adaptation efforts? What means do planners employ to negotiate trade-offs between mitigation and adaptation goals?*

Finding: There is little indication of efforts to acknowledge, plan for and capture synergies between mitigation and adaptation policies. For example, the adaptation section identifies green roofs and facades as a desirable planning goal for, among other reasons, reductions in the urban heat island effect, better air quality, better insulation, lower energy usage, more area for wildlife and better storm water management. But these effects also serve to lower GHG emissions by reducing energy consumption, obviating the need for large expansions of the sewer system and flood control measures, reducing or eliminating the need for air conditioning, and reducing the reliance on traditional, energy-intensive roofing materials. The lack of integration of these types of mitigation and adaptation efforts is a missed opportunity for at least two reasons. Firstly, cities will need to build support for far more radical reductions in GHG emissions in the near future and a relatively easy way to garner that support is to focus attention on policies that can deliver multiple desirable outcomes. Secondly, there is a significant risk of implementing maladaptive strategies that may decrease GHG emissions in the short run but lead to higher emissions over the long run if active interventions are necessary to sustain them.

Discussion: There are neither identifiable efforts to link up mitigation and adaptation goals nor efforts to avoid policy conflicts between the two. For example, many of the adaptation measures listed, such as large flood control projects and elevating entire sections of the city (City of Copenhagen, 2009d), are extremely energy and material intensive, potentially leading to increases in both point source and embedded GHG emissions. Further, the goal of switching the fuel source for combined heat/power plants from coal to trees may lead to the loss of forested lands, destroying carbon sinks, releasing stored CO2, monoculture forestry (which are often heavily reliant on pesticides and herbicides) and disrupting plant and animal communities. Additionally, relying on a few centralized sources of heat and power exposes critical infrastructure to possible hazards from flooding or storm-related damage.

The uncertainties present in planning for both mitigation and adaptation are sporadically noted within the plan, but overall there is little space given over to the identification of significant areas of uncertainty. Where uncertainties are recognized they are typically epistemic uncertainties that result from a real or perceived information gap. An example is cited below:

> CO2 calculations and projections are based on forecasts and projected developments and therefore are subject to some uncertainties. Moreover, in some cases it has not been possible to obtain specific figures for Copenhagen, and therefore national figures are used. This presents certain imbalances. One example is transport, where CO2 calculations are based on a driving pattern of cities in general. But in Copenhagen, where there is more traffic and more congestion than in other cities, there will probably be higher CO2 emissions than the figures show [translation by author] (City of Copenhagen, 2009d, p. 133).

Similarly, the section on adaptation states:

> The forecast identifies the following issues for further clarification: the extent of the heat island effect in Copenhagen, changes in air quality due to climate change, detailed description of the means that may be taken in relation to permanent changed shoreline and intermittent flooding, climate change impact of water table and the secondary effects of sewers, buildings and other installations, assessment of drainage system capacity, climate change impact on groundwater quality and leaching of contamination from contaminated sites, climate change impact of underground drinking water in terms quality and quantity, detailed mapping of flood areas and flow paths and climate change impact on water use and quality of drinking water (City of Copenhagen, 2009d, p. 117).

The following table, Table 8, illustrates some of the possible synergies and conflicts between proposed mitigation actions and proposed adaptation actions in the Copenhagen Climate Plan. The lack of identified conflicts is not necessarily due to their absence, but is rather an indication of the lack of concrete adaptive measures in the plan itself.

Table 8: Copenhagen Mitigation and Adaptation Synergies and Conflicts

Mitigation Objective	Primary Policy Sector	Secondary Policy Sector	Adaptation Objective	Adaptation Action	Synergy, Conflict or Neutral
Renewable energy supply for combined heat/power plants	Energy	Urban Morphology, Built Environment	N/A	N/A	N/A
Increase cycling to 50% mode share	Transport	Urban Morphology, Energy	N/A	N/A	N/A
Reduce energy usage of building stock by 7.5%	Built Environment, Energy	Urban Morphology	Expand green roofs and facades	Demonstration projects in Copenhagen	Synergy
Traffic re-routing, lane reduction measures and parking restrictions	Transport	Urban Morphology Built Environment	Pocket parks and permeable surfaces to locally divert rainwater	Construct new parks and integrate green infrastructure into new developments	Synergy

5.2.4 Governance

Key Question: *What is the extent of policy integration between mitigation and adaptation goals, measured by the criteria of inclusion, consistency, qualitative weighting, reporting and resources?*

Finding: Overall, the level is policy integration is mixed. The mitigation objectives listed in the plan are, for the most part, assigned costs and responsible parties. Barriers to implementation and other planning synergies are noted, where relevant and there are established reporting requirements for monitoring and implementation of the plan objectives. However, there is relatively little policy consistency between adaptation measures and mitigation measures or is there evidence of qualitative weightings assigned to climate goals and other socially desirable planning goals such as affordable housing. The treatment of mitigation and adaptation as separate strategies sets up the possibility that synergies will be missed, conflicts between mitigation and adaptation measures may be more frequent and trade-offs between climate goals and other social, environmental and economic development goals will be more difficult to negotiate.

Discussion: Inclusion (direct and indirect impact assessment, including distributive fairness and social justice issues): Generally low levels of policy inclusion. The Copenhagen Climate Plan is primarily oriented toward mitigation actions, with adaptation measures discussed as a separate policy agenda. The city is in the midst of formulating an adaptation strategy in 2010. The treatment of the two as

separate policy questions can lead to significant mismatches between goals. For example, the imposition of road charging could negatively impact mobility options for middle and working class residents who rely on their cars to commute to work. One possible reason for the treatment of mitigation and adaptation as separate policy issues is the siloed nature of policy formulation and implementation in the city.

> "The [governance] system is not well adapted to integrated planning and policy execution. The number and subject area of the committees are mandated in law, and the organisation of the city executive reflects this committee structure, while the City Council determines the composition of the committees. This results in a bottleneck largely restricting the flow of information within the organisation to vertical lines of control and putting strains on cross-organisational communication, although many of the areas of local government responsibility are cross-sectoral in nature" (Organization for Economic Co-operation and Development, 2009, p. 228).

Where mitigation policy is mostly focused on energy and transport, adaptation policy cuts across multiple sectors, from health and welfare, infrastructure, economic development, recreation and parks, social integration, cultural and historical preservation and planning issues.

Consistency (between various policy measures): Mixed. On the one hand, many of the mitigation measures are well linked to other planning goals in the support of creating denser urban developments, more pedestrian and bicycling opportunities, improving public transport and improving air quality. On the other, many of the measures proposed have possible negative climate policy implications or outcomes. For instance, the decision to convert the main heating and power plants from coal to biomass could, depending on the direction that the policy is implemented, lead to an "off-shoring" effect where local GHG emissions are reduced at the city level while exporting the emissions elsewhere. Biomass in the form of methane captured from decaying organic material is very different from biomass derived from clear-cutting boreal forests and converting the trees to pellets. Many of the adaptation measures proposed, such as building a sea wall and raising dikes to protect the city from rising sea levels carry their own risks of countering either climate goals or other planning goals:

> The existing urban areas along the inner part of Copenhagen Harbor that cannot be secured against flood by raising the ground levels can be secured with sluice gates in the north and south of the port as well as elevated dikes at Amager. If a barrier is built to the Sound [Øresund], the city will be safe from high water changes during future storm surges. This prevents recurrent destruction, while the city can develop along the harbor - regardless of the increased flood risk [translation by author] (City of Copenhagen, 2009d, p. 115).

The types of measures proposed here are extremely expensive, risky and involve large-scale emissions of GHG emissions for concrete, steel and earthmoving. Further, the city already has a significant problem building adequate affordable housing (City of Copenhagen, 2009b). Measures to require elevating the ground level of new buildings will add a considerable price tag to housing that is already out of reach for many middle-class and working-class residents.

Qualitative Weighting (of climate goals in relation to other societal goals such as growth, sustainability, fairness, equity): No established measures to rank and prioritize climate goals in relation to other planning goals. The lack of a defined set of criteria will make it difficult to negotiate trade-offs between competing measures. For example, the Climate Plan states:

> Electrical and hydrogen-powered cars will dominate the future street scene. The benefits go beyond what can be seen with the naked eye. It is by reducing all the things we can't see – CO2, NOx, particulates, noise – that the changes will be most dramatic. That is why the new cars are a vital condition for our vision of a carbon neutral Copenhagen by 2025 [translation by author] (City of Copenhagen, 2009d, p. 12).

Many of the problems of traffic in Copenhagen are a result of congested roadways and competition for scare street space between public transport, pedestrians, cyclists, taxis, trucks and private automobiles and the city. Setting aside the question of whether or not an electric car is truly less polluting than an efficient petrol-fueled car, the main policy direction towards the electrification of the car does not change the underlying conflict between the various users of the road space.

Reporting: There are reporting requirements within the Climate Plan for annual review of objectives and targets which are to be incorporated into the environmental accounts published by the city. Additionally, the city will annually review the targets to establish priority objectives for the coming year, with a mid-point review set for 2012. Most of the objectives have designated responsibility to respective departments for implementation of the measures.

Resources (fiscal, institutional and technical necessary to enact policy): The Climate Plan has, where possible, a detailed set of objectives, resources, synergies between mitigation actions and other planning goals and regulatory barriers for a majority of the 50 listed objectives. Many of the identified measures, for example expansion of the bicycle network, elimination of parking spaces, and the switch from coal to biomass in the combined heat power plants, have been transplanted from other, older plans. For example, the Traffic and Environment plan of 2004 set out an even more ambitious goal for GHG emission reductions, using the same policy tools of increasing cycling, strengthening public transport and introducing road charges.

> The City Council adopted in autumn 2002 a plan for limitation of CO2 emissions in Copenhagen. The plan contains an overall reduction target of 35% from energy, transport and waste management and proposals for new initiatives to reduce emissions. The City Council decided further that efforts to reduce transport CO2 emissions should be determined in the preparation of the new Traffic and Environment Plan. The Traffic and Environment Plan deals with municipal policies such as: Improvements for bicycles and public transport, impacts of transport behavior, choice of transport, etc. These will all pull in the right direction, but all in all it will be necessary to restrict transportation choice by increasing tariffs and taxes on transport, for example introduction of road pricing [translation by author] (City of Copenhagen, 2005, p. 52).

Regarding transport policy, then, the Copenhagen Climate Plan is mostly an extension of pre-existing policy.

> All experience shows that it is not enough to change travel behavior with better cycling conditions and better collective traffic. It is also necessary to establish restrictions in the form of prohibitions on cars or road pricing, for example, if the municipality is to obtain the maximum benefit of investing in alternatives to the car. Possibilities include congestion charging, pedestrian areas, street redistribution, green zones and parking restrictions. The potential is greatest with the use of economic instruments. In addition, the limited space in the city means that more and wider bike lanes and more space for buses means less space for cars [translation by author] (City of Copenhagen, 2009d, p. 41).

5.2.5 Summary

Urban Morphology: the Copenhagen Climate Plan has a medium degree of integration between proposed land use, transport and energy measures. The focus on concentration of development within 600 meters of public transport corridors, creating more energy efficient developments and switching to renewable sources of heat and power serve as positive feedback loops that could contribute to lower future GHG emissions within the built environment. Three notable omissions from the plan are the lack of an integrated approach to natural systems health and regeneration, the lack of a comprehensive strategy to deal with rising emissions from private automobiles and the lack of an integrated framework to identify and implement strategies that generate synergies between adaptation measures and mitigation measures. The plan implicitly treats the two as independent planning processes with separate goals, objectives and aims.

Path Dependencies: the energy pathway outlined in the climate plan focuses on energy efficiencies in the built environment, diversification of fuel sources and substitution of fossil fuels with renewable power. The underlying pathway, however, of centralized generation and distribution remains intact. Similarly, the transportation strategies go some way toward creating an alternative system of mobility built around public transport and non-motorized transport but fall short in addressing the underlying socio-technical and institutional forces that contribute to the expansion of the road network and automobile ownership. Rising levels of affluence and consumption are not addressed.

Synergies/Conflicts: There is little indication of efforts to acknowledge, plan for and capture synergies between mitigation and adaptation policies. For example, the adaptation section identifies green roofs and facades as a desirable planning goal for, among other reasons, reductions in the urban heat island effect, better air quality, better insulation, lower energy usage, more area for wildlife and better storm water management. But these effects also serve to lower GHG emissions by reducing energy consumption, obviating the need for large expansions of the sewer system and flood control measures, reducing or eliminating the need for air conditioning, and reducing the reliance on traditional, energy-intensive roofing materials. The lack of integration of these types of mitigation and adaptation efforts is a missed opportunity for at least two reasons. Firstly, cities will need to build support for far more radical reductions in GHG emissions in the near future and a relatively easy way to garner that support is to focus attention on policies that can deliver multiple desirable outcomes. Secondly, there is a significant risk of implementing maladaptive strategies that may decrease GHG emissions in the short run but lead to higher emissions over the long run if active interventions are necessary to sustain them.

Governance: Overall, the level is policy integration is mixed. The mitigation objectives listed in the plan are, for the most part, assigned costs and responsible parties. Barriers to implementation and other planning synergies are noted, where relevant and there are established reporting requirements for monitoring and implementation of the plan objectives. However, there is relatively little policy consistency between adaptation measures and mitigation measures or is there evidence of qualitative weightings assigned to climate goals and other socially desirable planning goals such as affordable housing. The treatment of mitigation and adaptation as separate strategies sets up the possibility that synergies will be missed, conflicts between mitigation and adaptation measures may be more frequent

and trade-offs between climate goals and other social, environmental and economic development goals will be more difficult to negotiate.

5.3 Mainstreaming Climate Strategies into Development Goals

Where the previous section analyzed the relationship between mitigation and adaptation on the city scale, this section will examine the main elements of the climate strategy in relationship to other development goals to find areas of complementary and contradictory policy convergences at the city and regional scales. The documents analyzed in this section include, but are not limited to: the City of Copenhagen general plan, the City of Copenhagen traffic plan, the City of Copenhagen North Harbor Redevelopment Plan, the regional Fingerplan of 2007, the regional development plan, the Danish Infrastructure Commission report of 2030.

5.3.1 Urban Morphology

Key Question: *To what extent are the climate goals supported by other municipal and regional planning goals (land use, transportation, economic development, environmental, etc.)?*

Finding: While there are significant efforts to create denser development patterns within the city of Copenhagen, the regional and national policies supporting polycentric development patterns push in the direction of low-density suburban development patterns in the greater metropolitan area. The high cost of housing in the inner city, large increases in road traffic volumes, distances traveled and capacity expansion of the road network and inter-regional competition for business and employment opportunities all contribute toward a general expansion of the urbanized area. There is a strong alignment between the municipal, regional and state governments to support the principles of the Fingerplan (station proximity, green fingers, dense urban development) that are consistent with strategies and policies to reduce GHG emissions. However, the general pattern of dispersed, polycentric regional development continues to generate high levels of car use and low-density developments far from public transportation.

Discussion: One of the key drivers in both urban expansion and increased auto traffic is the high price of housing within the urban core of Copenhagen. In America, the typical response is the high cost of housing is to “drive until you qualify”-that is, to move away from the center of the city until it is possible to qualify for a mortgage on a house. In Copenhagen, the logic is not entirely dissimilar. Housing prices have risen by a factor of four between 1997-2007 and the city has lost almost 39,000 rental units in the past two decades (City of Copenhagen, 2009b). The high price of housing, combined with the near-standstill in the development of social housing schemes, has driven middle-class and working-class families to the outer suburbs of Copenhagen and even further to the far reaches of Sjælland, Falster and Lolland (The Capital Region of Denmark, 2008). Like most capital cities, high concentrations of job and leisure opportunities continue to draw people back to the central Copenhagen on a daily basis (Næss, 2005) resulting in a high proportion of trips in the Capital Region being taken by car.

The city of Copenhagen has identified 5 central challenges in the 2009 general plan: 1) growth of car traffic by 30-40% by the year 2025, 2) provision of affordable housing for up to 45,000 more residents within the city, 3) social exclusion, 4) loss of competiveness and lower growth rates than Oslo, Helsinki or Stockholm and 5) the combined provision of public transport and road connections to the areas of new development, such as the North Harbor (Nordhavnen) area, Carlsberg brewery redevelopment and the north-eastern part of Amager island (City of Copenhagen, 2009). The Copenhagen general plan is linked to the considerations of the Fingerplan of 2007 by, for example, an expressed desire to concentrate development of new housing, retail and employment within 600 meters of public transport stations. Copenhagen also attempts to coordinate planning strategies with the surrounding communities and the Capital Region's development plan of 2008 (City of Copenhagen, 2009b). One example of an attempt to integrate social, environmental and economic concerns into urban redevelopment can be found at the Carlsberg brewery project that is intended to provide 10,000 workplaces, 3000 residential units (10% of which are to be affordable housing) and 22,000 square meters of retail tightly knit into the existing urban area. The intention is to create a CO2-neutral neighborhood (City of Copenhagen, 2009b).

A larger project is the conversion of the North Harbor from industrial to residential/workplace uses. The finished project will house 40,000 people, 40,000 new workplaces, and 3-4 million square meters of new buildings with renewable sources of power and heating and high energy efficiency of the new building stock (The City of Copenhagen/Port of Copenhagen, 2009). There is a stated desire to create a diverse neighborhood with good cycling, walking and public transport connections (in 2018 upon the projected completion of the Metro Cityring project) and adequate green and blue spaces for recreation. The overall goals indicate that there are strong planning efforts made to integrate sustainable social, environmental and economic considerations into the project, including efforts to reduce car travel by locating more housing close to the city center. There are, however, some considerations that may make the more ambitious elements of the project difficult to achieve. First, the provision for social housing is abysmal. The city has, since 2006, had a policy (the 5x5 project) that was intended to supply 5000 units of housing at a monthly cost of 5000 DKK. To date, only a few hundred units have been built, far too few to meet even the modest goals set by the plan. As noted above, one of the primary drivers of increased car usage is middle-class and working class flight from the expensive inner city to the outer suburbs. Existing developments such as the Ørestaden and Kalvebod Brygge show that architecturally driven redevelopment schemes do not always result in liveable neighborhoods if social and environmental considerations are poorly attended to. Social exclusion and extensive racial discrimination are significant issues for the city and building environmentally sustainable neighborhoods that are too expensive for the majority of the population to afford is not going to alleviate those problems.

The second main challenge for the North Harbor project, and other redevelopment efforts throughout the region, is car traffic and the infrastructure that sustains it. There is a need to more closely coordinate the land use and transportation planning structures between Copenhagen, the 34 surrounding municipalities, the regional government and the national government. Many of the municipalities surrounding Copenhagen compete with each other for business development, housing and transportation investments often leading to sub-optimal outcomes for everyone. As noted by a recent OECD report:

> If rigid land use restrictions are kept in place and Copenhagen‘s economy continues to grow, it is inevitable that the area will evolve into a polynodal region. Commuting and land use data indicate a rapid development of peripheral areas, although job markets are still highly centralised in Copenhagen proper. If Copenhagen continues to develop in a centrifugal direction, additional regional policies are needed, particularly a regional affordable housing policy and improved regional public transit (Organization for Economic Co-operation and Development, 2009, p. 169).

5.3.2 Path Dependency

Key Question: *How do physical, socio-technical and institutional path dependencies work with or against the strategic climate goals?*

Finding: There are two countervailing trends evident. One, at the city level, there are indications of potentially significant shifts in the local transport path dependencies supported by increasing cycling, walking and public transport provision while simultaneous reductions in parking spaces and re-allocate street space from dedicated car space to more shared space. Pushing against these trends, however are rising levels of car ownership (Statistics Denmark, 2010), rising levels of cross-commuting and reverse commuting patterns (City of Copenhagen, 2005), high costs of housing within the existing urban areas and regional development policies that are biased toward expansion of the road network at the expense of rail and bus. The dominant development pathway in the region is towards low-density car-dependent sprawl that is nearly certain to generate higher GHG emissions from both the built environment and transport sectors.

Discussion: The capital region of Copenhagen has one of the lowest rates of public transport use and highest car modal share (82%) of any European capital city (The Capital Region of Denmark, 2008). Nowhere in the transportation section of the Regional Development Plan do planners address the connection between capacity expansion of roadways, airports and shipping facilities and increasing GHG emissions. The regional development plan notes that:

> The traffic-related development in the Capital Region has become increasingly complex and today is far more spread geographically than before. The relocation of workplaces from central Copenhagen and spread of residential areas further out the city fingers has resulted in an increasing need for traffic connections across the Region (The Capital Region of Denmark, 2008, p. 36).

The regional development plan pushes for on-going capacity expansion of the ring roads and motorways, noting that traffic volumes on the existing network have grown 25-30% in the last decade. The perceived need to relieve congestion creates a logic of road capacity expansion (such as the Ring 5 motorway) that will further embed physical, socio-technical and cultural/behavioral path dependencies at the regional level and have a lasting effect on residential and employment location decisions as well as modal choice for the region’s residents. Among the proposed investments in road and rail, notably absent is any discussion of distance reduction, mobility restrictions, or demand management policies. The Danish Infrastructure Commission, a national advisory body that was tasked in 2006 to analyze and advise the government on priority investments in transport infrastructure that would ensure good service levels of road and rail mobility toward 2030, also relies on both congestion-relief and economic rationales to outline the need to continue to strengthen the motorway network.

> For many years, the Danish infrastructure has been developed on the basis of the vision of "the large H", which connects north, east, south and west with effective road and rail connections and ensures connections to other countries. The large H has proved its robustness, and the H should continue to form the solid basis for the development of our infrastructure (The Danish Infrastructure Commission, 2008, p. 308).

There is an inherent, and perhaps irresolvable tension, between the strategic planning goals and outcomes of the Fingerplan and the large "H". Where the Fingerplan seeks to concentrate residential and economic development in close proximity to public transport nodes, the continued strengthening of the large "H" generates low-density, sprawling developments on the outskirts of the existing urbanized areas in the Copenhagen region. Each major capacity expansion of the roadway network, from the connection between Zealand and Fyn, the Øresund link between Malmo and Copenhagen and now the Fehmarn Belt between Germany and Denmark all create a logic of increasing returns and adaptive expectations of further capacity expansions. More road capacity leads to more drivers, more drivers lead to higher levels of congestion, necessitating more capacity expansions to the road network, which opens up new transport connections in previously rural areas with low land values and better connectivity to employment, residential and leisure activities. The resultant low-density sprawl and high automobile use result in rising GHG emissions and contribute to the continued outward expansion of the urbanized areas and simultaneously creates unfavorable conditions for public transport due to the large distances and low population densities of these areas.

The construction of the Fehmarn Belt between Puttgarden in Germany and Rødby in Denmark will have significant effects on the road network and urban development of both the city of Copenhagen and the entire Capital Region. The OECD notes that, as a result of the construction of the Fehmarn Belt:

> Through-traffic is highly likely to increase and cause more pressure in the city centre of Copenhagen. To assure smooth transportation of goods and people, establishment of Ring 5, connecting Sjaelland and Helsingør and the physical link between Helsingør and Helsingborg, will be necessary in the long run (Organization for Economic Co-operation and Development, 2009, p. 165).

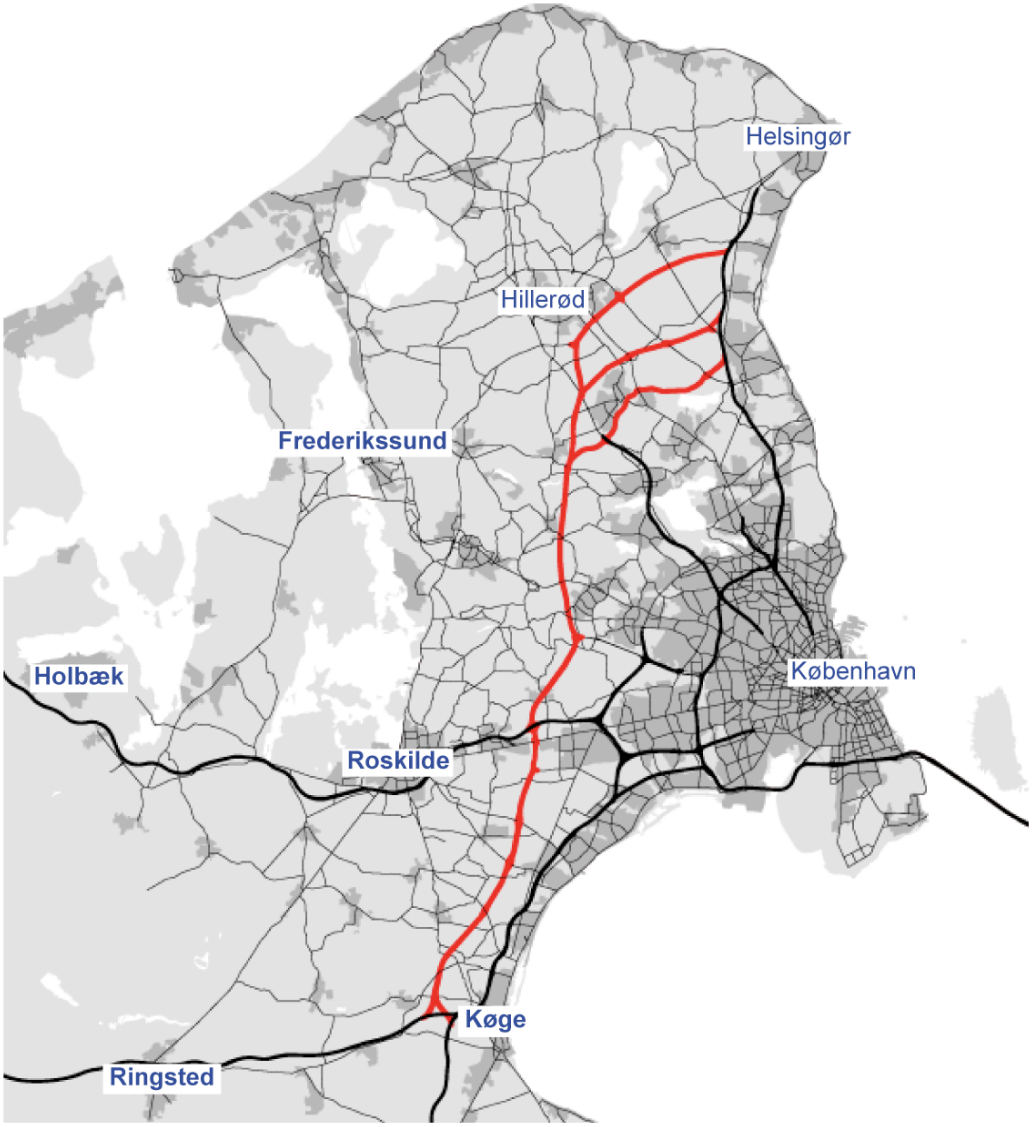
A key feature of path dependencies within the transport system (or any system for that matter) is that past decisions lay the ground work for future decisions in ways that constrain the possibilities for radically different physical, socio-economic, technical or institutional arrangements. As noted by the regional development plan:

> In the long term, there is a need for another fixed link across the Oresund. The fixed Femern Belt link will, in combination with the expected development in commuting across the Oresund, increase the traffic-related pressure and thereby create a need for a fixed link between Helsingør [in Denmark] and Helsingborg [in Sweden]. This will also call for establishment of a new railway and road link in Ring 5 (The Capital Region of Denmark, 2008, p. 40).

The traffic generated by the construction of the Fehmarn Belt creates a situation where the most viable and logical policy is to continue to build more and bigger connections to tie the road network together. The medium- to long-term planning implications of these decisions are not particularly difficult to divine. Despite the strong planning measures in place at both the municipal and regional scale to

concentrate development, the built-up urbanized areas will continue to expand, increasing the distances between the central city and the outer suburbs, draw more low-density development to the fringes of the region, all of which will likely lead to higher GHG emissions in the future. The map below [Map 6] shows the proposed alignment of the new Ring 5 road [in red]. The three diverging lines at the northern end are variations of possible alignments to connect to the existing motorway.

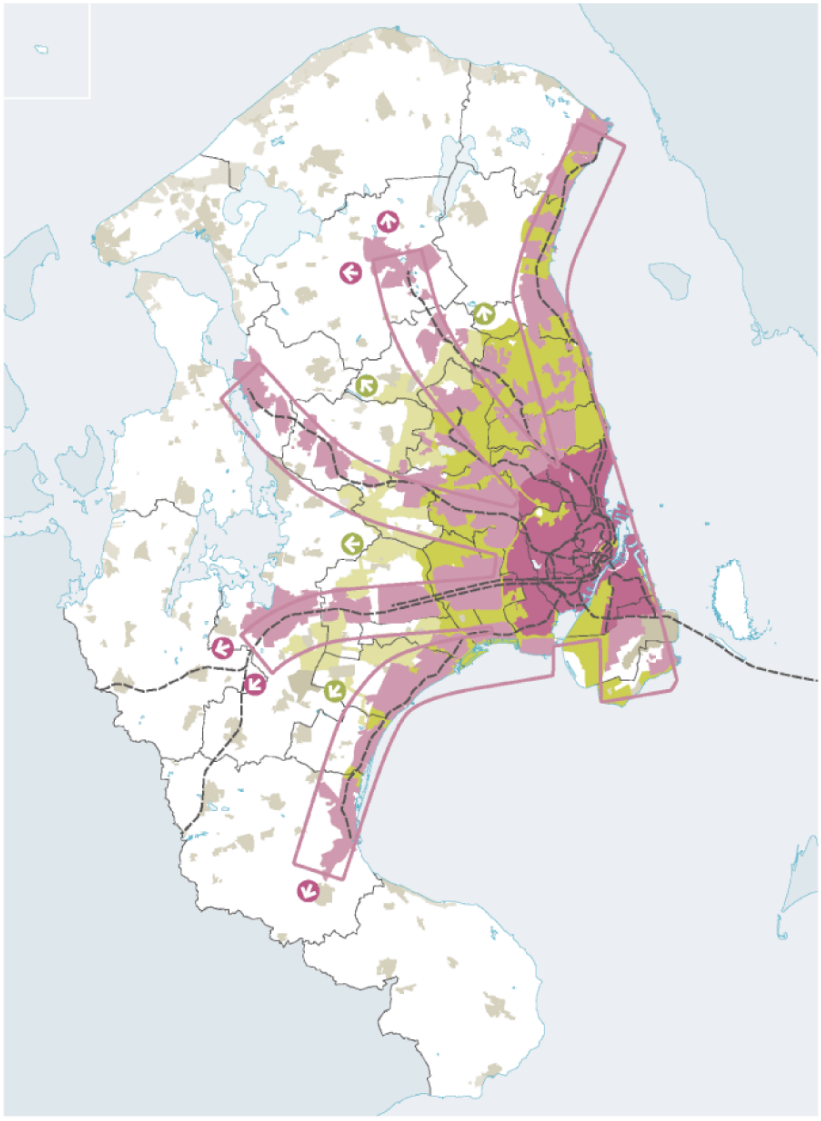
Map 6: Proposed Ring 5 Alignment



Source: Ministry of Transport (2010)

Compare Map 6 above to the one on the following page [Map 7] from the Fingerplan 2007. The Fingerplan is intended to guide development toward public transport corridors and to preserve the green areas surrounding the urbanized zones. Ring 5 will establish a development patterns that works directly opposite the Fingerplan, encouraging travel and location decisions that cut across the fingers, putting pressure on the green areas and surrounding farmland. Again, existing path dependencies based on increasing returns do not specifically exclude the likelihood of significant changes in future development pathways, but the *probabilities* for change are remote.

Map 7: Fingerplan (2007)



Source: Capital Region (2009)

Many of the strategies that the City of Copenhagen are proposing or have enacted demonstrate the principle of path dependency, but pushing in an opposite direction. The expansion of the city's cycle network is a good example of the type of path dependency that yields significant changes in the physical, socio-economic, behavioral and cultural path dependencies and has a positive effect on lowering GHG emissions. Larger capacity expansions of the cycle network draw more riders, yielding more congestion on the cycle lanes creating pressure for expansions of the network. Not only is cycling in many cases easier, it is faster than many modes of transport within the city over shorter distances. The city of Copenhagen has also identified a number of restrictions on private automobile use in the Climate Action Plan, for example: "We lobby the government for the right to establish environmental zones in dense downtown areas where only environmentally friendly cars and trucks are allowed. We lobby the government for the right to introduce congestion charges. (City of Copenhagen, 2009a, p. 11). The city also is eyeing reductions of public parking provisions.

At the regional level, however, the continued expansion of the road network, combined with stagnating levels of support for the expansion and operation of public transport as well as increasing regional mismatches between residential location preferences and employment opportunities has led to development pathways that have high future GHG emission profiles. Despite the efforts of the city, the regional level development patterns will likely overwhelm the municipal climate strategies. As noted by a recent Organization of Economic Co-operation and Development territorial review of Copenhagen:

> In the past decade, cross-traffic between fingers through ring roads has grown by as much as 40%. This increased cross-traffic puts a burden on the environment. However, the increase and expansion of the ring road infrastructure would lead to further development between fingers, and attract more activities and population in those areas, most likely conflicting with the design of the Finger Plan, which called for a clear demarcation of urban and rural land. The introduction of mass transport (railway and metro) between the fingers will be difficult to sustain financially, as the population density of the suburbs cannot ensure enough passengers. Even if the government could fund the expense of construction, the operational expense could not be sustainably covered. The cost of construction and operation would increase if ring railways are constructed far from the city centre, because the length of the arc would be longer (Organization for Economic Co-operation and Development, 2009, p. 154).

The path dependencies that have to date generated expansion of urbanized areas and led to increased car usage look likely to continue in the same direction for decades to come. The high levels of initial investment in the road network, the high levels of technical know-how necessary to plan and operate the complex system, the strong coordination effects tying economic and social drivers to road expansions and adaptive expectations that cars will continue to dominate the transport system and likely overwhelm planning efforts to reduce travel and create more compact urban forms.

5.3.3 Synergy, Conflict and Trade-offs

Key Questions: *Have planners established an Adaptation/Mitigation/Sustainable Development (AMSD) framework to identify and capture synergies and avoid conflicts between climate goals and development goals? Do planners have a means to identify and resolve policy trade-offs? What mechanisms are in place to ensure fair and equitable policy outcomes?*

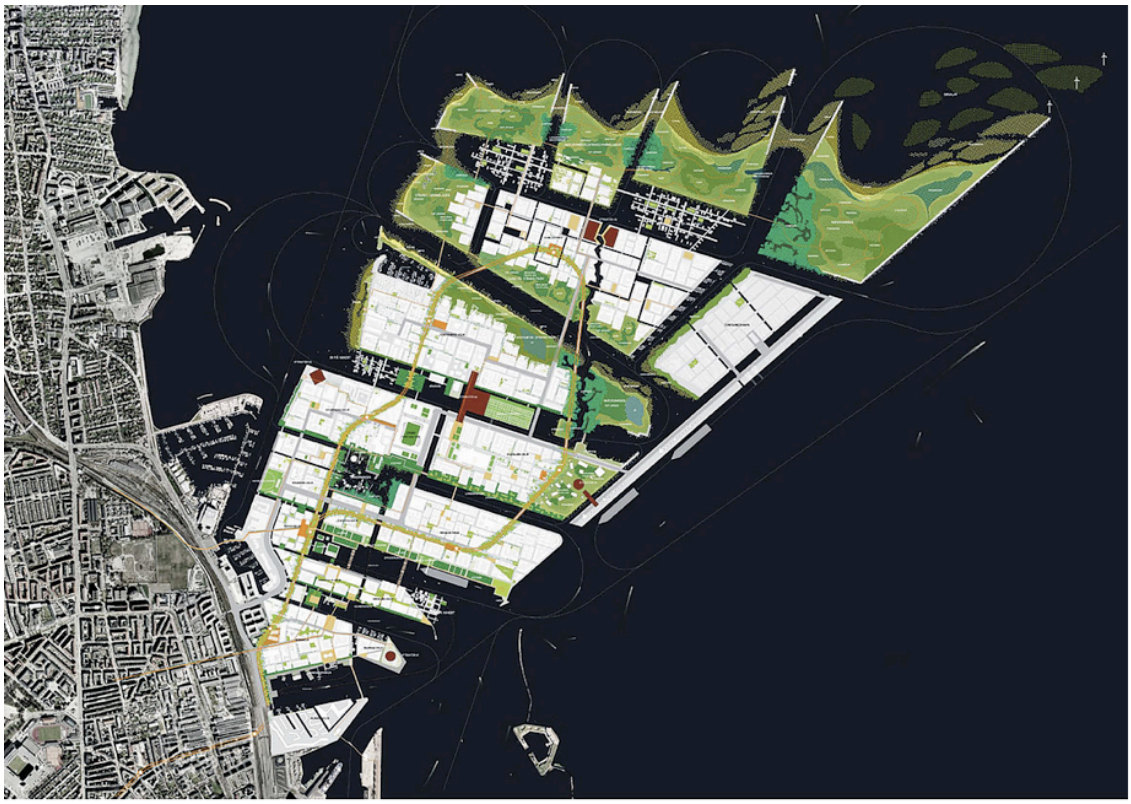
Finding: While there are indications of some measures to identify synergies between climate goals and other developmental priorities (social, environmental and economic), there is no comprehensive AMSD framework at either the municipal or regional level to analyze not only synergies but also to identify areas of policy conflict and negotiate trade-offs between competing goals. Policy conflicts between density requirements and solar access, the need for more affordable housing and more energy-efficient dwellings that add to the expense of construction and transportation mode conflicts between walking/biking/public transport and car travel all have implications for climate change strategies.

Discussion: There are many synergies identified within the Climate Plan between climate mitigation goals and other social, environmental and economic goals. For example, the cycling goals are linked to lower air pollution, improved human health due to more activity and lower health care expenditures that result from a healthier population (City of Copenhagen, 2009d). What is absent from the plan is a comprehensive assessment of not only the synergies, but also the conflicts and trade-offs that have to

be made between competing aims and goals. The North Harbor development represents a textbook example of the types of synergies, conflicts and trade-offs that have to be negotiated between climate goals, development goals, social goals and environmental goals. The development, 4 kilometers north of the city center, is intended to eventually house over 40,000 people and have employment for another 40,000 people, based on compact city principles, encouraging low energy and low resource consumption lifestyles centered around walking, biking and public transport (The City of Copenhagen/Port of Copenhagen, 2009). The development is planned be well integrated into the existing urban fabric.

> Nordhavnen should be an integral part of Copenhagen and based on Copenhagen's special identity, so it is vital that Nordhavnen is not developed as an isolated project. Instead, it must be ensured that its affinity and coherence with the rest of Copenhagen is very clear in the development of this new district. The development strategy is based on six themes dealing with aspects that are key to the further development of Nordhavnen. The six themes match the six headlines set out in the vision for the sustainable city of the future. Together, they provide a robust yet flexible framework for future sustainable urban development (The City of Copenhagen/Port of Copenhagen, 2009, p. 21).

Map 8: North Harbor Development Plan (2009)



Source: City of Copenhagen/Port of Copenhagen (2009)

The six themes are: 1) islets and canals, 2) identity and history, 3) five-minute city, 4) blue and green city, 5) CO2-friendly city and 6) intelligent grid. All of these principles are sound components of sustainable urban development strategies and, if fully implemented, should result in much lower GHG emission profiles than typical developments. The map above, Map 8, shows the master plan for the development, which will be a series of islands separated from one another by water with a road

connection tying the various islands together. There is to be a large area at the northern end of the development given over to recreation and natural wildlife habitat.

However, there are social and environmental costs that have to be considered and weighed as well. The Copenhagen draft environmental assessment in 2009 notes that:

> Urban development in North Harbor will cause negative environmental impacts of existing natural and buildings in the area. The development will, among other things, affect the rare endangered moths, chalk owl and green variegated toad, which is included in the EU Habitat list. At the same time developing the area offers good possibilities for improving the opportunities for recreation of that area to good public transport, bicycle and pedestrian connections, and to promote environmentally friendly construction. Since a large part of the North Harbor area is not station-proximate, it is essential to establish subway or rail-borne public transport. Environmental impacts of urban development of North Harbor depends on the gradient of density where a higher density, for example, offers better opportunities for collective transport solutions, but may enhance the negative environmental impacts resulting from increased energy construction operation and increased shading effects (City of Copenhagen, 2009c, p. 9).

The trade-offs between density and environmental protection are difficult for planners, policy makers and citizens to negotiate and understand absent a clear framework of priorities. The observation above captures another complicated trade-off, that of building heights in relation to solar rights. Many of the passive heating and cooling principles for low-energy homes rely on the solar access. Higher buildings closely constructed on a smaller footprint will typically decrease the opportunity for decentralized power and heat generation, requiring off-site, centralized sources of energy and heat. Additionally, as noted earlier, Copenhagen has a significant problem with social, racial and economic segregation, with many working-class and middle-class residents unable to find affordable housing within the city. The creation of the new district of North Harbor has the potential to reinforce these patterns, due to the high cost of housing and lack of employment opportunities for those with lower educational or vocational training. The 2009 city plan notes that:

> In social housing there is a clear over-representation of people from non western countries, cash benefits and early retirement, especially when compared to owner-occupied homes that are characterized by a high proportion of better paid and self-supporting people with children. As new buildings are characterized by relatively expensive home ownership and rental housing, this trend will continue unless the municipality of Copenhagen makes an active effort to reverse the trend [translation by author] (City of Copenhagen, 2009b, p. 130).

The city has attempted to encourage construction of affordable housing, for example through the 5 X 5 project and inclusion of affordable housing in the Carlsberg redevelopment project and at North Harbor (City of Copenhagen, 2009b). However, the pace of construction of new lower-end rental apartments is nowhere close to meeting the market demand (Organization for Economic Co-operation and Development, 2009) and adding a few hundred more affordable dwellings in the North Harbor development will also do little to provide relief.

Another example of the kind of policy trade-offs with potentially negative for climate goals implications in the North Harbor development is the relationship between the transport infrastructure and the land uses. While the city is hoping to build a high density, sustainable neighborhood, there are

also plans to build a motorway tunnel from Sjællandsbroen in the south, through North Harbor and linking up to the Helsingør motorway in the northern part of the city. Map 9 below shows the proposed alignment and potential development opportunities along the corridor.

The rationale for the development of the tunnel is tied to the City of Copenhagen's Traffic and Environment plan of 2004.

> The overall planning shall ensure the creation of a balance between economic and demographic developments. The Traffic and Environment Plan shall in particular ensure that we get a functioning transport system that can help to preserve the prosperity of the city. The vision for Traffic and Environment Plan must therefore be to "maintain and further develop a transportation system that ensures high mobility for all residents and users of the city. At the same time providing transportation consumption by automobiles and environmental problems are minimized [translation by author] from Trafik og Miljøplan 2004 as quoted in (Sund og Bælt A/S, n.d.).

Map 9: Proposed Alignment of the Harbor Tunnel in Copenhagen

Source: Sund & Bælt A/S (n.d.). The red circles represent the potential development opportunities for both residences and workplaces.

The tunnel is proposed both as a development tool and as a solution for air pollution and removal of car and truck traffic from the city streets. The road capacity expansion and consequent induced travel demand will have negative effects on GHG emission profiles for the city and region and will additionally put pressure on the stated aims of promoting walking, biking and public transport within North Harbor. Both work and non-work commuting patterns are shifting regionally, with reverse commuting patterns from the city of Copenhagen to surrounding municipalities rising 23% between the period of 1995-2004 (City of Copenhagen, 2005).

These kinds of trade-offs identified here, between urban development, compact cities, environmental protection, social equity, mobility and economic development are not new. What is different about the relationship between climate change mitigation and adaptation strategies and other environmental goals, is that successfully creating a low emission profile for past, present and future development requires re-examining the underlying development pathway. Point source pollution controls and technological fixes are necessary, but have a limited policy range when the real problem lies at the very heart of the way in which modern society is constructed.

5.4.4 Governance

Key Question: *What is the extent of policy integration between climate goals and development goals, measured by the criteria of inclusion, consistency, qualitative weighting, reporting and resources?*

Finding: At the municipal level, there is a relatively high degree of policy integration between climate goals and other development goals, especially in the energy and environment sectors. The continued segregation of the city between the wealthier residents and middle-class and poorer residents presents a significant, on-going challenge. The other primary difficulty faced by the city is the steady growth of car traffic, both commuting traffic within the city proper and inter-regional transport. At the regional level, there is evidence of both strong support for dense, station-proximate development as well as strong support for continued capacity expansion of the road network. Competing priorities between economic growth, mobility provision, social equity and distributive fairness are typically resolved in favor of continued economic growth and expansion of car-based mobility networks. The national-level priorities, while paying lip-service to expanding public transport and cycling networks, are mostly geared towards road capacity expansion, leading to further urban sprawl, lower regional densities and higher share of car travel.

Discussion: The municipal plans have a high degree of integration between many of the climate goals and other development goals. For example, the municipal plan of 2009 has designated the larger new developments in the city to be low-energy districts.

> All major urban areas are designated for low-energy buildings under the specific provisions in the plan and construction law. This implies that new construction would have to observe the requirements for low-energy class 1, but with the possibility to make exemptions for how the environmental and most economically advantageous energy and heat supply can happen in this particular area. The requirement for energy-class one must ensure that developers have focused on integrating renewable energy solutions for buildings, while the possibility of exemption to allow that there can be built in planned or existing dense urban areas where for example the installation of wind turbines for power generation is not possible [translation by author] (City of Copenhagen, 2009b, p. 60).

The CO2-neutral development in the Carlsberg redevelopment project, the North Harbor project and the Marmormolen project are all examples of the city's efforts to create urban developments that are dense and environmentally sustainable, using low energy and seeking to expand the use of renewable power and heat sources. Additionally, these projects are intended to support efforts to strengthen sustainable development objectives, such as social integration and environmental protections.

> Succession planning for urban development must contribute to sustainable development, where environmental, traffic and social considerations are balanced against the need for urban regeneration and the need for investment in infrastructure and service facilities. It sets out a number of criteria used for prioritization in sequence planning: 1) development of the station proximate areas and areas with large location value should be a priority, 2) development should promote dense urban neighborhoods with vibrant and diverse city life, 3) development should satisfy the desire for a diversified housing supply, 4) investment in major service facilities should be underpinned by rapid building development, 5) developing pace in an area should be high if the development requires large infrastructure investments and 6) development of potential development areas outside high class infrastructure should provisionally be postponed [translation by author] (City of Copenhagen, 2009b, p. 62).

Explicit prioritization of public transport station-proximate developments that are dense, mixed-use and socially diverse all help to support both the climate goals and sustainable development goals. There is a caveat here since the ban on development outside of areas with high-class infrastructure is temporary and subject to being overridden by other competing interests or priorities. The three main transport planning goals from the Traffic and Environment plan of 2004 also are connected to station proximity development goals, increasing opportunities for cycling and walking, expanding and improving public transport and restricting car traffic within the city (City of Copenhagen, 2005). The picture is more mixed at the regional level. While the Fingerplan 2007 and the Regional Development Plan of 2008 both highlight the need to reinforce station proximity and the protection of green space as priority planning goals, there is a counter trend of pushing for road capacity expansion throughout the region. The Fingerplan of 2007 has a strong focus on station proximity to public transportation:

> The principle of station proximate location aims to provide commuters good choices of transport means and thus to influence the traffic behavior. Location of jobs within acceptable walking distance from station has even significant effect on transport behavior and thus on both congestion and economies of collective transport. The traffic effects achieved only when the distance from the station to work is a maximum of 600 m. When it comes to housing, the distance is not quite as crucial, since many cycle between home and station [translation by author] (Miljøministeret, 2007, p. 89).

Similarly, the Regional Development Plan of 2008 expresses a similar, but on some level contradictory version of these principles.

> The challenge for the Capital Region will accordingly be to ensure mobility for all citizens, irrespective of where they come from and where they are going to, and irrespective of income, as well as to lower the strain on the environment. The way to handle this is on two tracks: Notable dedication to collective transportation where the need and the pressure on environment are higher, i.e. in the densely populated part of the Region and an expansion of the road network of main traffic veins where the need is higher, and where it is the best

> solution, i.e. the large circular roads and approach roads (The Capital Region of Denmark, 2008, p. 21).

Note that station proximity principle is primarily geared toward areas that are already densely populated. The rest of the region will be served by an expanding road network that has the effect of drawing more low-density development to the outer edges of the urbanized region. Another clear difference between the regional development priorities and those of the city of Copenhagen is that while the city is actively implementing measures to reduce and restrict certain forms of mobility, primarily the car, the regional planning goals are to actively support unrestricted freedom of mobility. It is the planning equivalent of "stepping on the accelerator and brake at the same time." (Næss, Næss, Nicolaisen, & Clemens, 2009) The Regional Plan of 2008 also notes that:

> The traffic-related development in the Capital Region has become increasingly complex and today is far more spread geographically than before. The relocation of workplaces from central Copenhagen and spread of residential areas further out the city fingers and outside the city fingers has resulted in an increasing need for traffic connections across the Region. The consequence is that the congestion problems of the capital area already today are notable on the overall road network and will increase materially in future. A special challenge will be to finish the "rings" around the capital (The Capital Region of Denmark, 2008, p. 36).

Despite the understanding that expansion of the urbanized areas, migration of both housing and employment possibilities to the outer edges of the region and the increasing cross traffic, the plan calls for continued expansion of the roadway network to solve the congestion problem. As noted in the sub-section on path dependency [5.3.2] a significant driver of future GHG emission profiles in the region come from increasing use of cars and low-density development patterns on the urban fringe. Ring road expansions will induce new travel by car and draw more development to green spaces that surround the built up areas. Finally, there is the issue of growth and development. The Regional Development plan has a strong component of growth promotion.

> The vision is based on growth and quality of life being preconditions for each other – and that the vision of lasting high growth and quality of life can only be realised if both are included as objectives…Good conditions for high quality of life accordingly create the basis for lasting growth. And growth is the precondition that ensures our ability to pay for quality of life, for the individual as well as for providing tax income to maintain public service, health, schools and investing in good housing, cultural and leisure offers, recreational areas, etc. (The Capital Region of Denmark, 2008, p. 9).

The implicit or explicit prioritization of extensive economic growth, spatial extensions of the transport network, regional employment development patterns that contribute to increased distances and more car usage will have strong negative implications for the city's (and eventually the region's) climate goals. The level of policy fragmentation between the city, the surrounding municipalities, the regional government and the national government will continue to hamper effective policies to lower GHG emissions. When it comes to adaptation planning, the stresses will be even greater. The following table, Table 9, shows the level of policy integration between the climate goals and other development goals in the Copenhagen Metropolitan region.

Table 9: Level of Policy Integration between Climate Goals and other Development and Planning Goals

Note: + = supporting, - = weakening, +/- = ambiguous, depends on implementation and 0 = not present

Governance Scale	**Plan Type**	**Renewable Energy Supply for CHP**	**Increase cycling to 50% modal share**	**Reduce energy use of building stock by 7.5%**	**Controls on private car usage (road pricing, parking re-strictions, travel lane reallocation)**
Copenhagen	Kommuneplan 2009	+	+	+	+
	Traffic and Environment Plan 2004	0	+	0	+
	Environment Plan	+	+	+	+
Regional	Fingerplan 2007	0	+	0	+/-
	Capital Region Development Plan 2008	0	+	0	+/-
National	Danish Transport Infrastructure, 2030	0	-	0	-

6 Cross-Case Analysis

This chapter, consisting of three sections, will integrate the findings from the previous two individual case studies along with a discussion that integrates the theoretical considerations and the knowledge from the previous analyses. Section 6.1 presents the combined findings of the mitigation and adaptation interfaces. Section 6.2 discusses the findings concerning the climate change/development interface and Section 6.3 touches upon the limitations of the analysis.

6.1 Findings on the Mitigation/Adaptation Interface

Portland: The plan makes an effort to integrate land use, transport and energy sectors into the strategy within the 20-minute complete neighborhood concept. This is probably the most (potentially) powerful element of the strategy and one where the city and county have the most resources (technical, financial, legal) to implement the policies successfully. There are three main weaknesses of the 20-minute complete neighborhood concept: 1) the exclusion of commuting trips from the criteria, 2) the lack of attention to adaptation requirements and 3) the lack of revisions to zoning regulations to stimulate the desired development pattern. Many of the measures identified elsewhere in the plan (for example green infrastructure projects like bio-swales and wetlands expansion to handle storm water run-off) could push against efforts to create a more compact urban form. Adaptation strategies are treated as subordinate to, and to a large extent separate from, mitigation strategies.

Copenhagen: The Copenhagen Climate Plan has a medium degree of integration between the climate goals and existing land use, transport and energy measures. The focus on concentration of development within 600 meters of public transport corridors, creating more energy efficient developments and switching to renewable sources of heat and power serve as positive feedback loops that could contribute to lower future GHG emissions within the built environment. Three notable omissions from the plan are: 1) the lack of an integrated approach to natural systems health and regeneration, 2) the lack of a comprehensive strategy to deal with rising emissions from private automobiles and 3) the absence of zoning revisions that would stimulate the desired development patterns. The plan implicitly treats mitigation and adaptation as independent planning processes with mostly separate goals, objectives and aims.

Discussion: The climate goals of both cities are much more closely aligned with the environmental and energy goals than with spatial development and transportation goals. In Portland, there is a stronger focus on concentration of development (20-minute neighborhood model) and more ambitious energy saving targets in the built environment in order to realize GHG reductions. In Copenhagen, the vast majority of the targeted reductions are to come from the energy sector, specifically from more windmills and a fuel source conversion at the three main combined heat/power plants from coal to wood and hay pellets. This could be read as each city playing to its particular strength. District heating in Copenhagen covers 98% of households (City of Copenhagen, 2009b) and national/EU legislation is pushing for the development of renewable sources of heat and electricity. In Portland, there are two privately owned monopoly providers of energy and they are under less pressure, both regulatory and

financial, to shift toward renewable sources of energy than is the case in Denmark. Portland, on the other hand, has a strong green building sector and is keen to expand what it perceives to be a comparative economic development advantage.

Even though both Portland and Copenhagen have strong planning policies of densification and support for development close to public transportation, those policies are overridden by the decentralized regional development patterns that create low-density development located far from public transport services. Both cities have in recent years seen two countervailing trends happening simultaneously, a re-population of the inner city combined with low-density, auto-dependent sprawl in the outlying areas. Regarding transportation, both cities have committed to increasing modal share of walking, bicycling and the use of public transport, but the role of the private car remains problematic for both Portland and Copenhagen. In Copenhagen, the city lacks the legislative authority to enact stricter environmental zones, congestion pricing and other regulatory measures to control automobile access to the city. In Portland, despite the stated goal of reducing Vehicle Miles Traveled (VMT) by 30%, the plan does not have a viable strategy to deal with the increasing distances traveled by commuters within the city and the region as a whole. On adaptation, both cities treat climate change mitigation and adaptation as two, mostly distinct, policy areas. This is perhaps a result of the rather recent emergence of adaptation on the policy agenda or it could reflect an underlying policy orientation that perceives the two not to have strong policy linkages. Both regions are still in the policy formulation stage of addressing adaptation and often there is a significant lag between recognition of an issue and the policy integration of that issue into the existing policy framework.

A notable absence from both plans is the lack of legally binding instruments to achieve the climate objectives, suggesting the real possibility that the climate plans are more symbolic than real. Land use plans and transportation plans in both regions, as discussed in the individual case analyses, often conflict with the stated goals of the climate plans and in these situations typically the voluntary climate goals will be overridden by other economic, institutional, juridical or political imperatives.

Path Dependency

Portland: Despite some attempts to address the path dependencies of the built environment and energy systems, the plan notably fails to include an integrated strategy to address the socio-economic and technological path dependencies that have significant influence on climate policy. The underlying rationality of the climate strategy is one of a reliance on technological improvements to continue to deliver economic growth while reducing carbon intensity. The existing systems of energy production and transportation are mainly left intact. Additionally, rising levels of affluence and consequent increase in consumption are not addressed.

Copenhagen: The energy pathway outlined in the climate plan focuses on energy efficiencies in the built environment, diversification of fuel sources and substitution of fossil fuels with renewable power. The underlying pathway, however, of centralized generation and distribution remains intact. Similarly, the transportation strategies go some way toward creating an alternative system of mobility built around public transport and non-motorized transport but fall short in addressing the underlying socio-technical and institutional forces that contribute to the expansion of the road network and automobile ownership. Rising levels of affluence and consumption are not addressed.

Discussion: Both plans partially address the socio-technical and physical path dependencies, for example in the energy systems and changes in the transportation infrastructure. Neither plan addresses the institutional path dependencies or the overall development path dependencies. GHG emission profiles are intimately connected to the development pathway and marginal changes in the existing technological regimes will be insufficient to achieve the desired reduction targets. The growth assumption, of both economic development and spatial expansion, is taken as a given in both cities. The demographic and employment projections drive similar path dependencies in both cities-a need for increased land, increased building area, increased transport connections (usually roads) that ultimately lead to greater urban sprawl and higher automobile modal share and usage.

Institutional path dependencies affect climate change strategies in a number of ways. The treatment of climate mitigation strategies as primarily an energy and environmental problem makes it difficult to understand and respond effectively to the development path dependencies driving GHG emissions. Climate adaptation strategies will entail a more diverse collection of competences and disciplines than current mitigation strategies, therefore the existing institutional arrangements within cities and regions, with the respective silos of oversight and responsibility will be stressed by the cross-cutting nature of adaptation. Both Portland and Copenhagen have similar institutional structures of planning, with separate divisions of land use, transportation, water, wastewater, energy, social services and environmental protection. There is some evidence that in Portland the policy shift toward holistic watershed health management may reflect an alteration in the way in which planning is done, working across sections and divisions to craft comprehensive strategies that encompass land use, transport, parks and recreation, infrastructure investment and environmental protection.

Synergies, Conflict and Trade-offs

Portland: The plan does not systematically analyze the possibilities for creating synergies and avoiding conflicts between mitigation and adaptation strategies. Portland/Multnomah County is in the process of creating a separate adaptation strategy in 2010, but the broad outlines of the adaptation strategy as it now stands suggest that there are significant information and policy gaps that will need to be filled in order to create a more comprehensive matrix of the synergies and conflicts. There are numerous uncertainties as well, including but not limited to the lack of down-scaled regional climate projections, the effects of future development pathways, the lack of both adaptive capacity and resiliency in the physical infrastructure as well as the institutional and socio-economic structures.

Copenhagen: There is scant identifiable effort to acknowledge, plan for and capture synergies between mitigation and adaptation policies. For example, the adaptation section identifies green roofs and facades as a desirable planning goal for, among other reasons, reductions in the urban heat island effect, better air quality, better insulation, lower energy usage, more area for wildlife and better storm water management. But these effects also serve to lower GHG emissions by reducing energy consumption, obviating the need for large expansions of the sewer system and flood control measures, reducing or eliminating the need for air conditioning, and reducing the reliance on traditional, energy-intensive roofing materials. The lack of integration of these types of mitigation and adaptation efforts is a missed opportunity for two reasons. Firstly, Copenhagen will need to build political support for far more radical reductions in GHG emissions in the near future and a relatively easy way to garner that support is to focus attention on policies that can deliver multiple desirable outcomes. Secondly, there is a significant risk of implementing maladaptive strategies that may decrease GHG emissions in the

short run but lead to higher emissions over the long run if active interventions are necessary to sustain them (for instance building pump stations to handle flood events).

Discussion: In both Copenhagen and Portland, there is an absence of informal or formal mechanisms for assessing the synergies, conflicts and trade-offs present between mitigation and adaptation strategies. This is perhaps the most significant weakness of both strategies. As detailed in Sub-sections 4.2.3 and 5.2.3, many of the proposed mitigation strategies can conflict with adaptation strategies and vice verse. Many mitigation strategies may, if properly designed and implemented, contribute to adaptation goals. A number of adaptation strategies may conflict with mitigation goals. Finally, there are many instances where mitigation and adaptation strategies are fundamentally at odds with one another and require planners and policy makers to make difficult choices as to what the strategic and policy priorities should be.

The potential synergies between mitigation and adaptation strategies are manifold, from green roofs, passive infrastructure systems that integrate natural processes to retain and filter storm water and wastewater, permeable transport surfaces that reduce local water and air pollution while lowering the urban heat island effect, distributed renewable power generation systems while creating buildings that are more adaptable to atmospheric and hydrologic changes and so on. It makes sense to capture what synergies there may be, since early successes can be built upon and enlarged if multiple goals can be met with the same or similar policies. If properly designed and implemented, many of the adaptation strategies can, in addition to lowering future GHG emission profiles, save money over the long run for cities and regions by using natural systems to perform services (water filtration, pollution remediation) that currently have substantial capital and operating costs.

Policy conflicts, potential or actual, between adaptation measures and mitigation measures are numerous. Many of the adaptation strategies to handle storm water and rising sea levels may lead to a more decentralized urban structure with lower densities and greater land consumption, increasing the spatial expansion of the urbanized areas. Many of the proposals being offered currently to address adaptation concerns, such as flood control barriers, elevating building sites, and “climate-proofing” the infrastructure are heavily energy and material intensive themselves, often resulting in increased GHG emissions over the life of the project. Similarly, cooling systems to counter rising temperatures are likely to increase the base load on the energy supply, leading to higher emissions.

Many of the mitigation measures proposed, road pricing for example, may have negative impacts on poorer and more vulnerable segments of the population. Climate policies that are enacted without adequate conditions established to determine how fair and just the policies are may serve to entrench existing inequalities. In both Portland and in Copenhagen, high housing prices in the inner city have driven many working-class and middle-class residents to more affordable outlying neighborhoods and to surrounding municipalities. Policies to restrict car usage may impact these groups harder than wealthier residents if compensatory measures are not embedded within the policy framework. More widespread use of innovative policies and practices, such as location-efficient or climate-efficient mortgages may help to allow for more compact settlement patterns closer to the city center that take into account the reduced transport and energy costs of car-less residential location decisions.

Governance

Portland: Overall level of policy integration is low. Incomplete or non-existent climate change impact assessment measures make it difficult to determine the level of inclusion and policy consistency is fragmented. There has been no systematic weighting given to climate goals in relation to other socio-economic goals. The kinds of qualitative weightings one could expect to find would be, for instance, an full appraisal of the existing social and economic imbalances within the city, spanning issues such as access to education, recreation, opportunities to move by foot, bike or public transport, access to affordable, energy-efficient housing and access to employment. Climate mitigation and adaptation strategies that worsened these imbalances would ideally be avoided or possibly neutralized by off-setting policies to ensure that the poorer and more vulnerable populations were given high policy priority than the more wealthy and powerful segments of society. The plan has an established system of reporting and monitoring, setting out a process of annual reports on emission trends and progress, three-year review cycles and a revision of the entire plan by 2020. The financial and institutional resources attached to meeting the objectives are, for the most part, not specified. It is likely that absent consistent, year-to-year budgetary allocations, many of the measures will be implemented on an ad hoc basis, if at all.

Copenhagen: The level of policy integration is mixed. The mitigation objectives listed in the plan are, for the most part, assigned costs and responsible parties. Barriers to implementation and other planning synergies are noted, where relevant and there are established reporting requirements for monitoring and implementation of the plan objectives. However, there is relatively little policy consistency between adaptation measures and mitigation measures or is there evidence of qualitative weightings assigned to climate goals and other socially desirable planning goals such as affordable housing.

Discussion: Reporting requirements and assignation of resources appeared to be the least problematic issues for both cities. Copenhagen's Climate Plan has a much higher level of detail when it comes to identifying the financial and institutional resources, identifying possible barriers to action and noting the party responsible for implementation. The level of policy consistency in Portland between mitigation and adaptation measures cannot be ascertained, due to the preliminary nature of the adaptation strategy outline. In Copenhagen, where the adaptation strategy is more detailed, there is little consistency between the two. Both cities treat mitigation and adaptation as separate policies. There are no consistent measures to establish qualitative weightings for non-economic costs and benefits. Many issues surrounding adaptation decisions are normative, such as values placed on historical and cultural resources or distributive fairness and planners will eventually have to figure out a way to accommodate such concerns. The following table, Table 10, summarizes the analytic findings for the mitigation and adaptation interface.

Table 10: Summary of Analytic Findings for the Mitigation and Adaptation Interface

Analytic Category	Analytic Questions	Portland	Copenhagen
Urban Morphology	To what extent have municipal land use plans been integrated into climate mitigation and adaptation goals?	Mixed. 20-minute complete neighborhood strategy is promising, but employment location preferences omitted.	High. Relatively strong connections between climate mitigation goals and land use measures for building efficiency, compact development patterns and transport reduction strategies.
	Transportation plans?	Mixed. Strong planning coordination between goals for walking, biking and public transport, but little in the way of significant reductions in car and truck travel.	Mixed. Strong integration between biking, pedestrian and public transport goals. Lack of effective strategy to reduce car usage.
	Energy plans?	High degree of integration between energy plans and climate mitigation plan.	High degree of integration between energy plans and climate mitigation plan.
	Environmental plans?	High degree of integration between environmental plans and climate plans.	Medium degree of integration. Major omissions of natural systems and environmental protection plans within the climate strategy
Path Dependency	Extent to which the climate plans address physical path dependencies?	Attempts to alter energy path dependencies (e.g. renewable, distributed systems) and some infrastructure path dependencies, particularly in water management. Transport pathways mostly unchanged.	Clear efforts to alter both transport and energy pathways, through promotion of renewable energy and continuing support for bicycle policies.
	Socio-technical path dependencies?	Some efforts to alter behavior and cultural norms through promotion of 20-minute complete neighborhood. Overall economic growth pathways not addressed.	Strong evidence of policies to shift behaviors (e.g. cycling, lower energy usage). No significant effort to address underlying economic growth pathway.
	Institutional path dependencies?	Some evidence of a change within the watershed management approach.	Not addressed
Synergy/ Conflict	Is there a systematic effort to identify and respond to synergies and conflicts between mitigation and adaptation?	A few indications, for example promotion of green infrastructure, but overall no comprehensive framework in place.	No evidence found. Mitigation and adaptation treated as mostly distinct policy areas.

Analytic Category	Analytic Questions	Portland	Copenhagen
	Are there policies in place to identify and respond to trade-offs between mitigation and adaptation strategies?	No evidence found.	No evidence found.
	Are there mechanisms to ensure fair and equitable policy outcomes?	No evidence found.	No evidence found.
Governance	Inclusion-direct and indirect mitigation and adaptation impacts, including distributive fairness and social justice	Inconclusive-the lack of clear adaptation policy makes it difficult to assess.	Low levels of inclusion, especially in the realm of distributive fairness and social justice.
	Consistency-between the various policy measures	Fragmented.	Low, primarily due to the treatment of mitigation and adaptation as separate policy areas.
	Qualitative Weighting-valuation of climate change goals in relation to other societal goals (e.g. growth, sustainability, equity, fairness)	No mechanisms to establish qualitative weightings.	No mechanisms to establish qualitative weightings.
	Reporting	Established system of reporting, monitoring and evaluating.	Established system of reporting, monitoring and evaluating.
	Resources	Mixed. Few measures have established funding mechanisms.	Most measures have assigned funding and institutional responsibility.

6.2 Findings for Climate Change/Development Interface

Urban Morphology

Portland: The strongest correlations can be found between the goals of the climate strategy and energy/environmental strategies. This finding is not particularly surprising since planners have traditionally addressed climate issues as primarily energy/environmental problems. At the city level, there is some evidence of strategies that support the climate goals in, for example, wastewater management and transportation, but neither the economic development plan nor the urban form plan have strong linkages to the climate goals. At the regional level, there is very little strategic alignment between the land use, transportation and economic development goals and the city's climate goals. Despite the strong planning doctrine of the Urban Growth Boundary (UGB), with a clear policy goal of creating dense development patterns in conjunction with public transport systems, the overall travel patterns of the region will lead to increases in GHG emissions The legislative mandate from the state, combined with the high socio-economic and institutional prioritization of growth and economic development, leads to regional and municipal development strategies and policies that strongly push against strategies to lower GHG emissions.

Copenhagen: While there are significant efforts to create denser development patterns within the city of Copenhagen, the regional and national policies supporting polycentric development patterns tend to push in the direction of low-density suburban development patterns in the greater metropolitan area. The high cost of housing in the inner city, large increases in road traffic volumes, distances traveled and capacity expansion of the road network and inter-regional competition for business and employment opportunities all contribute toward a general expansion of the urbanized area. There is a strong alignment between the municipal, regional and state governments to support the principles of the Fingerplan (station proximity, green fingers, dense urban development) that are consistent with strategies and policies to reduce GHG emissions. However, the general pattern of dispersed, polycentric regional development continues to generate high levels of car use and low-density developments far from public transportation. Additionally, land use and transportation policies pursued by the municipalities surrounding Copenhagen have also been oriented more toward car-based, low-density development patterns for residential, commercial and industrial uses.

Discussion: Both regions have long-standing growth policies of encouraging compact, dense urban developments close to public transport lines, combined with legally binding restrictions on the conversion of rural land to urbanized areas. At the municipal level, there is a high degree of correlation between the climate goals and various land use, transport and environmental goals. Within the municipal boundaries of Copenhagen and Portland, there is a stronger emphasis on pushing for low-energy buildings, non-motorized forms of transport and better natural and recreational environments, all of which can positively impact GHG emission profiles. Once the scale of inquiry expands to the regional level, a more complicated and ambiguous picture emerges. While regional-level planning policies are in place to, for example, concentrate development close to public transport lines and encourage higher density developments, there are contrary development policies that encourage low density, auto-dependent travel patterns within the regions. The prioritization of economic development

and high levels of mobility in both regions leads to similar patterns of development. The older, more compact city centers are drawing more people back to live and work, but much larger numbers of people are either choosing or are being compelled (due to high housing prices) to reside and work far from densely urbanized areas. Intra-regional competition between municipalities for residential and employment development also pull development in a centrifugal pattern away from the city centers, a process made much easier by the continued expansion of the road network. Despite large increases in investment in public transport in both the Portland region and Copenhagen region, transit modal share has remained stagnant or fallen over the past 20 years (Statistics Denmark, 2010; Metro, 2009). The planning implications for climate change strategies are clear. In order to create sufficient conditions for a low-carbon society, transportation and land use priorities will have to shift. As long as economic growth measures and maximizing mobility remain at the peak of the policy pyramid, it will be nearly impossible to break the trend line of rising GHG emissions.

Path Dependency

Portland: There is evidence of attempts to alter the path dependencies of the energy system, through decentralized generation and low-energy built environment. Similarly, in the case of watershed management, there are indications that there is a shift away from a traditional engineering solution to handling hydrology to one that uses natural systems to perform many functions, such as rainwater detention, groundwater replenishment, waste water filtration and the like. Many of these policies have positive effects on both lowering future GHG emissions profiles and helping to build resiliency and adaptive capacity into the urban structure. The climate goals of the city are, however, significantly impacted by two main path dependencies, demographic and economic growth projections, that push against the desired policy goals of the climate strategy. Existing planning methods reinforce the spatial expansion of the city and the region (population growth driving employment growth driving building expansion driving transport infrastructure). There is a need for planners and policy makers to consciously create niches within the dominant socio-technical and institutional regime to allow for potentially disruptive forms of low-carbon development patterns to emerge.

Copenhagen: There are two countervailing trends evident. One, at the city level, there are indications of potentially significant shifts in the local transport path dependencies supported by increasing cycling, walking and public transport provision while simultaneous reductions in parking spaces and re-allocate street space from dedicated car space to more shared space. Pushing against these trends, however are rising levels of car ownership (Statistics Denmark, 2010), rising levels of cross-commuting and reverse commuting patterns (City of Copenhagen, 2005), high costs of housing within the existing urban areas and regional development policies that are biased toward expansion of the road network at the expense of rail and bus. The dominant development pathway in the region is towards low-density car-dependent sprawl that is nearly certain to generate higher GHG emissions from both the built environment and transport sectors.

Discussion: Similar to the observable conditions regarding the relationship between urban morphology and climate change goals, there is a scalar dimension evident in both the Copenhagen and Portland Metropolitan regions. At the city level, there are indications of shifts or partial breaks in the existing energy and environmental management path dependencies. However, the underlying socio-technical and economic path dependencies tend to overwhelm these efforts. The regional development policies are heavily influenced by demographic and economic path dependencies. Metro in the Portland region

is bound by state law to provide an ample supply of land to meet projected demand 20 years out in the future (Metro, 2009). The growth projections of both population and employment drive a planning process that results in projected expansions of buildings, land and associated infrastructure. A similar process plays out in the Copenhagen Metropolitan region, where path dependent economic and socio-technical patterns also create decentralized development patterns characterized by dense development in the city center awash in a sea of low-density, auto-dependent sprawl on the periphery (Næss, Næss, Nicolaisen, & Clemens, 2009).

Synergies, Conflicts and Trade-offs

Portland: There is neither a formal Adaptation/Mitigation/Sustainable Development (AMSD) framework, nor are there established mechanisms to address trade-offs between conflicting climate change planning goals and other development goals. Issues of fair distribution of financial, institutional, social and technical resources are not systematically addressed. However, there are policy fragments within the climate plan that demonstrate a way forward, showing how to combine issues of social equity, economic development and environmental benefit, such as the Clean Energy Works program.

Copenhagen: While there are indications of some measures to identify synergies between climate goals and other developmental priorities (social, environmental and economic), there is no comprehensive AMSD framework at either the municipal or regional level to analyze not only synergies but also to identify areas of policy conflict and negotiate trade-offs between competing goals. Policy conflicts between density requirements and solar access, the need for more affordable housing and more energy-efficient dwellings that add to the expense of construction and transportation mode conflicts between walking/biking/public transport and car travel all have implications for climate change strategies.

Discussion: The lack of any systematic effort to account for and respond to the complex policy interactions between mitigation, adaptation and sustainable development goals is perhaps one of the most surprising findings. Both the city and regional-level governments have a strong planning orientation toward sustainable development policies, incorporating social equity and environmental protections as much as possible into the urban development framework. Many of the measures that are proposed, such as road pricing and increasing energy efficiency requirements, have the potential to impact poorer and more vulnerable sections of the population. Many of the land use and urban development plans designed to lower GHG emissions do not have mechanisms in place to account for non-economic costs and benefits, such as distributive fairness questions and social equity concerns.

Governance

Portland: At the city scale, there is a higher level of policy integration between the climate goals and other development goals, particularly in the energy, environmental (including “soft” infrastructure such as parks, recreation and watersheds) and economic development sectors. At the regional scale, despite sound land use and transportation policies to create compact, transit-oriented development patterns, the fundamental drivers of employment growth and demographic growth lead to policy conflicts between the climate change goals and the development priorities.

Copenhagen: At the municipal level, there is a relatively high degree of policy integration between climate goals and other development goals, especially in the energy and environment sectors. The continued segregation of the city between the wealthier residents and middle-class and poorer residents presents a significant, on-going challenge. The other primary difficulty faced by the city is the steady growth of car traffic, both commuting traffic within the city proper and inter-regional transport. At the regional level, there is evidence of both strong support for dense, station-proximate development as well as strong support for continued capacity expansion of the road network. Competing priorities between economic growth, mobility provision, social equity and distributive fairness are typically resolved in favor of continued economic growth and expansion of car-based mobility networks. The national-level priorities, while paying lip-service to expanding public transport and cycling networks, are mostly geared towards road capacity expansion, leading to further urban sprawl, lower regional densities and higher share of car travel.

Discussion: Overall, there is a fairly low degree of policy integration between climate goals and other development goals, with some notable exceptions. At the municipal level, energy and environment goals have a high degree of integration with the climate goals, while transport and economic development goals are more mixed. At the regional level, due to the combined pressures of continued roadway capacity expansions and consequent low-density development patterns, there are contradictory planning aims that hamper effective strategies to reduce emissions.

6.3 Limitations of the Analysis

As discussed in Sub-section 3.2.2, document analysis as a data source has many limitations. Some of the more relevant limitations for this study are the lack of ability to adduce: 1) the extent of political and institutional support for the climate goals, 2) the intersection and overlap of the climate goals with other land use and transportation goals, particularly funding levels and extent of political will and 3) the intentions of the multiple actors and institutions that shaped the climate strategies. The documents analyzed in this research project are by no means exhaustive and it is likely that there are other relevant plans, policies and guidelines that could shed more light on the relationship between mitigation, adaptation and urban development. The recent emergence of climate change strategies in both regions may indicate a real change in planning priorities, a change that would not necessarily be evident in older plans. Another possibility is that the climate plans are a symbolic measure to demonstrate that planners and politicians are "doing something" about climate change without significantly altering the underlying development trajectory in any significant way. Either way, document collection would need to be supplemented by, for example, expert interviews with planners, policy-makers, politicians and other relevant non-state actors in order to uncover some of the deeper underlying mechanisms that inform and impel climate strategies and their relationship to other development goals.

7 Conclusions

This exploratory, comparative case study of climate change strategies was undertaken to map out and identify some of the relevant policy intersections and conflicts between: 1) mitigation strategies and adaptation strategies and 2) climate change goals and other urban development and socio-economic development goals. Climate change is no longer perceived to be only an environmental issue, but rather one that is intimately bound up with a particular development pathway (Sathaye, et al., 2007; Richardson, et al., 2009; IPCC, 2007). Additionally, the need to address climate change adaptation is rising higher on the planning and policy-making agendas worldwide, raising many issues and questions as to how to plan for, accommodate and respond effectively to existing demographic, economic and technological growth pressures while ensuring the safety and quality of life in light of potentially vast changes in the underlying physical conditions in which we live. Regardless of how effective future mitigation efforts are at a global scale, the inertial atmospheric loading of greenhouse gases will continue to drive global mean average temperatures higher well into the next century (IPCC, 2007). Effective planning strategies for addressing both the need to stop future emissions and adapt to unavoidable changes in the climate over the coming decades will require new ways of thinking, acting, planning and learning (Howard, 2009; Mickwitz, et al., 2009).

Mitigation and adaptation are mainly treated as separate policy areas with minimal overlap. Where there is generally a high degree of policy coordination and synergy between climate goals on the one hand and energy/environment goals on the other, there is a much lower level of coordination between land use and transportation goals. Neither city has developed any formal mechanisms to identify synergies and avoid conflicts between mitigation and adaptation measures. The result is that there are numerous potential policy reinforcements left on the table while simultaneously setting up possible conflicts between competing aims down the road. Furthermore, there are and will be many trade-offs that planners will have to negotiate between climate change goals, social justice issues and economic growth policies. Many proposed GHG mitigation measures, such as road pricing and higher energy prices may disproportionately impact poorer and more vulnerable populations. When establishing priorities for adaptation measures there are inherent systemic biases toward weighting economic variables higher than cultural or social variables. These biases could, for example, lead to plans to create defensible flood control barriers around expensive land in the Central Business Districts while letting older, less economically valuable urban areas be flooded.

Climate mitigation and adaptation strategies present significant governance challenges to existing spatial planning strategy and policymaking. The close connection between GHG emissions and development pathways requires more holistic thinking and acting. Mitigation strategies have typically adopted a point-source pollution approach to managing emissions: identify the problem, calculate the scale, identify the source(s) and enact policies and strategies to eliminate or reduce the problem. GHG emissions are a function of population growth, rising levels of affluence and a given technological base. Perhaps it is not then surprising that the resounding majority of policy attention in both Copenhagen and Portland is focus on what could be roughly characterized as a perceived need to merely alter the fuel source for energy and everything will be fine. The treatment of mitigation and adaptation as separate policy issues is in some measure a reflection of the siloed nature of the planning and governance structures rather than a result of the two being entirely distinct from one another.

Planning for such highly complex problems with multiple levels of uncertainty over long time horizons will require a multiplicity of approaches and a flexible planning architecture. Careful consideration will have to be given to establishing a shared set of societal values and goals. Policy consistency and qualitative weightings of non-economic goals appear to be particularly difficult for cities and regions to come to grips with.

There are strong indications that densification and compact city strategies may be counteracted by adaptation strategies, particularly in addressing rising sea levels and increased frequency and intensity of storm events. Both Copenhagen and Portland identify the need to, for example, expand green areas, increase the coverage of permeable surfaces and help to make natural systems more resilient. The space requirements for these types of measures are not specified, but it is clear that it will be a difficult and expensive task to integrate such structures into the urban fabric. Many of the mitigation measures, such as the conversion of the energy system from fossil fuels to renewable energy supply, have the potential to either support or work against adaptation measures but depend heavily on the manner in which the policies are implemented. Should planners prioritize roof space for solar thermal and photovoltaic generation, or green roofs to handle storm water runoff and better insulation function? What is the optimum mix between policies that encourage high buildings to minimize land usage and ensuring solar or wind access rights? Neither Portland nor Copenhagen has begun to address such questions in any significant detail as of yet.

The existing development pathways in both Portland and Copenhagen create significant pressures on efforts to lower future GHG emissions. Despite the presence of strong planning policies to concentrate development along public transportation corridors, regional development patterns have led to both increased commuting distances and high modal share of private automobiles. Regional transportation and land use planning investments are still heavily geared toward the maintenance and expansion of road capacity at the expense of rail and bus service. Demographic and employment growth projections generate expansionistic planning measures that have resulted in two countervailing trends: a small increase in population and densities within the cities of Copenhagen and Portland and a bigger increase in population and lower densities in surrounding municipalities and urbanized areas within the Portland region, while there are slight increases in density within the greater Copenhagen region. While there is significant policy attention paid to technological fixes (“clean” cars, “clean” power, etc.), very little is said regarding the other two driving forces of climate change: population growth and levels of affluence. The underlying premises of eternal economic growth and ever-rising levels of consumption remain unquestioned and tacitly assumed to be a given condition.

8 Reflections

This chapter will present some theoretical reflections based upon the results of the study. There are more than a few questions that continue to puzzle and confound, two of which will be discussed here. Section 8.1 concerns the way in which climate change strategies are still primarily addressed as an extension of environmental and energy policy. Section 8.2 discusses some possible reasons for the continued separation of mitigation and adaptation strategies.

8.1 Climate Change as Development Issue

There is a growing body of evidence that climate change issues are firmly rooted in the development pathway of a society (IPCC, 2007; Sathaye, et al., 2007; OECD, 2009; Wilbanks, Leiby, Perlack, Ensminger, & Wright, 2007). In both the Copenhagen and Portland Metropolitan region there is a much higher degree of consistency between the climate change policies and energy/environment policy nexus than with the economic and social development nexus. Furthermore, there is a strong focus on the production side of the climate mitigation policy, with both regions employing a very similar model (used by, among other, the United Nations Framework Convention on Climate Change, ICLEI, the EU, etc.) of calculating point-source emissions, setting reduction targets and implementing strategies to reduce the targeted emissions. Aall and Hill note that in studies conducted in the UK, Sweden and Denmark, there is often a marked difference between GHG emission calculations from the production side and the consumption side of the equation (Aall & Hille, 2010). The Portland/Multnomah County Climate strategy makes mention of this discrepancy and notes the need to create a more comprehensive methodology to capture the impact of consumption on GHG emissions.

> This inventory method allocates carbon emissions among the residential, commercial, industrial and transportation sectors according to how much energy is used in each, and among waste disposal activities according to methane emissions. This method, referred to here as the "sector method" of inventorying emissions, has been widely used by state and local governments throughout the United States, including Oregon and Portland. Because this approach does not explicitly capture emissions associated with the consumption of goods, the Oregon Department of Environmental Quality (DEQ) is developing a complementary method, the "systems method," to consolidate carbon emissions from the full life cycle of a product, including manufacturing, distribution and disposal. Whereas the sector method allocates emissions based on the production of goods — the supply side of the economy — the systems method seeks to attribute emissions to the consumption of goods — the demand side of the economy (City of Portland; Multnomah County, 2009, p. 21).

The Copenhagen Climate Plan also notes that production and consumption GHG emission numbers are different.

> CO2 emissions from product use are not included in the total baseline scenario, as it is a different calculation from that which is based on CO2 emissions from the product life cycle. If product consumption were taken into the baseline, this would yield a double accounting in CO2 emissions from the goods produced in Copenhagen. Although consumption of goods is

> not included in the inventory, it is an area the municipality has focused on…The graph of CO2 emissions from Copenhageners annual consumption of goods shows that each Copenhagener in 2005 emitted 1.55 tons of CO2 from the consumption of goods and that by 2025 this figure will have risen to 2.14 tons per capita per year. This is an increase of 39% over 20 years [translation by author] (City of Copenhagen, 2009, p. 130).

Perhaps the numbers above suggest why it is that most climate strategies tend to focus on production rather than consumption. Production-side policies keep focus on technological efficiency gains, such as electric vehicles and more renewable sources of power, and keep policy attention away from the consumption side of the equation. If explicit connections are made between increasing levels of consumption and increasing levels of GHG emissions, it becomes more difficult to formulate and implement climate strategies absent a re-think of economic and development policy. Policies that cut to the heart of profit-driven capitalism and consumer culture are often avoided due to a form of "disciplinary tunnel vision" (Næss P., 2010) where for a variety of political, ideological and ontological reasons people tend not to see what lies in front of them.

In both the Copenhagen and Portland Metro regions, there are strong indications of two competing visions. One vision sets out a future of cities and regions that are compactly developed with excellent public transport connections, good opportunities for walking and biking, low energy consuming buildings, a solid low-carbon economic base with good jobs and high degree of equality and healthy natural environments. Many policies in both cities are solidly grounded in that vision. The other vision is a radically different one. This vision prioritizes smooth movement of goods, services and people in the continued pursuit of eternal economic growth and boundless levels of affluence. This is the vision of perpetual capacity expansion, increasing population driving increasing building needs driving increased spatial expansion of the urban areas driving capacity expansions of the transport and utility networks. While planners and policy makers have strongly established plans to control the expansionary impulses (the Fingerplan and Urban Growth Boundary, respectively), the evidence to date is that the underlying drivers of economic expansion will continue to overwhelm planning efforts designed to counter the worst effects of the system.

Which returns the focus back to the development pathway. The vision articulated by the Brundtland Commission (United Nations World Commission on Environment and Development, 1987) was one focused on satisfaction of needs, not wants. Sustainable development requires not just ecological efficiency, but rather must encompass a fair and equitable distribution of benefits and burdens both in the global sense of the here-and-now and temporally, with an eye towards the needs of future generations (United Nations World Commission on Environment and Development, 1987). Nature as an instrumental appendage of the human world is not a sustainable concept; there needs to be an appreciation for the natural world outside of reductive anthropogenic requirements. Climate change strategies will eventually have to address these issues, preferably sooner rather than later.

The challenge for planners will be to find politically acceptable methods and strategies for anchoring climate change strategies within the development agenda. As long as climate change issues are treated as extensions of energy and environmental policy it will be difficult if not impossible to integrate the two. Going forward, it is clear that many of the possible mitigation and adaptation policies have the potential to impact the poorest and most vulnerable members of society, from rising home prices, higher energy prices, road pricing and the like. Moreover, adaptive capacity and vulnerability to changing climates is unevenly distributed across cities and regions. Adaptation strategies will fail

miserably if plans are made to focus protection efforts only on high economic value land uses. It is not difficult to imagine that in societies that value economic growth above other concerns, planning interventions to address climate change adaptation will be oriented toward protecting the mechanisms that sustain the growth machine first and assign other considerations to a secondary or tertiary policy priority.

8.2 Mitigation and Adaptation as One Strategy

Recalling Tomkins and Adger,

> [A]ny response to climate change must be cognisant of wider development pressures as well as goals such as increasing economic, environmental and social well-being instead of focusing solely on single system management (Tomkins & Adger, 2005).

Building adaptive capacity relies not only on technology to achieve policy goals. Social action is a more important factor than technology, action that is the combination of capacity, collective will and an overarching strategy that embraces sustainable development in all aspects, especially distributive fairness and equity dimensions. The climate strategies of both Copenhagen and Portland have relatively underdeveloped adaptation goals, but the policy outlines for both regions are already perceivable. Risk management and knowledge collection dominate the policy framework. In Denmark, the national climate adaptation planning agenda is set around the following cross cutting research agenda:

> The trans-disciplinary knowledge needs cover a series of tools that can be essential prerequisites for research and other knowledge building in both sectoral and intersectoral disciplines. The trans-disciplinary knowledge needed includes, for example provision of a stronger knowledge of 1) climate change (climate models, sea level rise, CO2 levels); 2) other scientific modeling tools (height model, hydrological model, etc.) 3) decision tools (economics, management of risk and uncertainty in decision making, etc.) and 4) funding models / methods (including insurance, funds, responsibilities and distribution). These are examples of tools that also are required by the [National] government and the EU climate adaptation strategies [translation by author] (Andersen, et al., 2009).

At the national level, the primary research focus is on reducing epistemic uncertainties, based on a standard framework of economic cost-benefit analysis and risk assessment. This type of techno-rationalist approach does not create room for questions of fairness and equity, inter-generational or otherwise since there is no economic value attached to them. This does not imply that such research should not be undertaken, but rather to argue for a broader approach that recognizes the limits of our ability to forecast and predict future events. A more balanced policy framework would be drawn from a wider sustainable development perspective that is non-reductionistic and actively seeks to go beyond the disciplinary tunnel vision of seeing the solution to every problem in a technological fashion.

The Copenhagen Climate Plan notes that:

> We do not yet know all the effects, risks or economic consequences of the tools we can use in the fight to climate-proof our city. It requires a number of studies and surveys, as it has been impossible to implement in the context of preparation of climate plan. Therefore, we must

> develop a proper climate adaptation plan, detailing the possible actions that affect this section. The plan must ensure that climate adaptation is in the best and most cost effective way. Long-term investments and good planning should ensure that the costs of climate proofing in the long run would be significantly reduced. It will also create synergy between all environmental initiatives and a continued development of the city's recreational opportunities. In this way the desire for a climatic secured city go hand in hand with the desire to make Copenhagen a better place to live (City of Copenhagen, 2009, p. 101).

The main policy focus is on two primary issues, economy and reductions of epistemic uncertainty. Social equity concerns, distributive fairness and the unequal distribution of adaptive capacity do not figure prominently in the proposed policy goals. In Portland the picture is similar, but there seems to be some indications of at least awareness of wider social and environmental concerns.

> Develop a climate change preparation plan that analyzes and prioritizes preparation actions to manage risks and increase overall flexibility and resiliency, assigns responsibility to appropriate bureaus or departments and ensures that disproportionate impacts on vulnerable populations are addressed…When planning public infrastructure investments and service delivery strategies, consider the physical, social, environmental, economic, and regulatory impacts of mitigating and adapting to climate change. This may necessitate developing and using forecasts and models that account for potential climate changes and evaluating investment alternatives based on triple bottom line and climate change impacts over the lifespan of the infrastructure (City of Portland; Multnomah County, 2009, p. 57).

Neither city as of yet has developed a method to be able to negotiate the trade-offs that will be necessary between economic growth, social equity and environmental protection. Such trade-offs are unavoidable, however, and it would be prudent to start working on an acceptable and fair process of deliberation and planning sooner rather than later.

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Appendix 1 Draft Article

This appendix presents a draft article for publication based on one of the main findings from the research report, namely the lack of an integrated assessment framework to analyze the synergies, conflicts and trade-offs between mitigation and adaptation measures and competing development goals. An important study goal for the elite student is to produce an article that is of sufficient quality to be published in a peer-reviewed journal. This article is in the early draft stages, so apologies are owed to the reader for any inconsistencies or lack of analytic clarity. It should also be noted that, vis-à-vis the elite study requirements, another paper has been completed for the upcoming Association of European Schools of Planning (AESOP) conference 6-11 July 2010. While much of the analytic portion of this article is drawn from the main report, there has been some attempt to sharpen the focus on the practical implications for climate change planning.

Draft title:

"Synergies, conflicts and trade-offs in climate change planning: Some preliminary findings from a comparative case study of Copenhagen, Denmark and Portland, Oregon"

Author: Patrick Arthur Driscoll, Aalborg University

Introduction

The need to adapt to a changing climate presents a tangle of opportunities and challenges for spatial planners, not least how to effectively create and implement strategies that to both reduce future emission profiles and adapt to inevitable climatic changes (Wilbanks, Leiby, Perlack, Ensminger, & Wright, 2007; Swart & Raes, 2007). Moreover, as it becomes clearer that GHG emissions are intimately tied to specific development pathways (Sathaye, et al., 2007; IPCC, 2007), planners are faced with the challenge of integrating climate change strategies into sustainable development goals. Many mitigation and strategies may fall harder on poorer and more vulnerable segments of the population and care should be taken to address the potential imbalances. This paper examines the synergies, conflicts and trade-offs present within the municipal climate strategies of Copenhagen, Denmark and Portland, Oregon in relation to existing urban development goals. The findings of the research suggest that effective policy integration will require broadening the criteria beyond the current focus on environmental and energy policy. Social equity goals, economic development priorities will have to be given more attention in the decision-making process when formulating and implementing climate strategies.

Research design

This paper is based on one of the findings from a larger research project, a comparative case study of Copenhagen and Portland, Oregon's climate strategies. Primary data collection was conducted through the document study of relevant municipal, regional and national plans that included, among others, municipal, land use, transport, energy, environmental, economic development, regional development and infrastructure plans primarily covering the period from 2007 to 2010.

Background

Since the signing of the United Nations Framework Convention on Climate Change (UNFCCC) in 1992, cities around the world have been addressing the challenges posed climate change by primarily pursing a path of mitigating greenhouse gas (GHG) emissions. Many cities around the world have had some measure of success in lowering local greenhouse gas emissions (Granberg & Elander, 2007; Organization for Economic Co-operation and Development, 2009a). On the global scale, however, emissions of GHGs have continued to climb worldwide at an accelerating rate. The increase in emissions has led to rising atmospheric temperatures, warming oceans and rising sea levels. These trends are projected to continue well into the 21st and 22nd centuries, even if anthropogenic carbon emissions are brought down to a sustainable level (IPCC, 2007).

Cities account for between 60-80% of all global GHG emissions and rising levels of affluence, urbanization and mobility all point to a continuing growth trend in emissions unless significant actions are taken in the next decades (Organization for Economic Co-operation and Development, 2009a). Regardless of how effective any eventual efforts may ultimately be in lowering emissions to a sustainable level, urban areas will still need to craft effective adaptation strategies. Moreover, as it becomes clearer that GHG emissions are intimately tied to specific development pathways (Sathaye, et al., 2007; IPCC, 2007), planners are faced with the challenge of integrating climate change strategies into sustainable development goals.

The planning literature has been rather thin to date, however, in identifying and critically examining the potential conflicts, synergies and trade-offs between climate mitigation strategies and climate adaptation strategies (Howard, 2009). Some earlier studies have suggested that one of the key differences between mitigation and adaptation strategies is scalar since "mitigation pathways show higher net benefits at a global scale than a local scale, because so many benefits from mitigation investments are external to a local area. By contrast, adaptation pathways show higher net benefits at a local scale, at least in industrialized countries…" (Wilbanks, Leiby, Perlack, Ensminger, & Wright, 2007, p. 723). The type of benefits that adaptation strategies can deliver are heavily context-dependent and are shaped by radically different valuations placed on a combination of social, environmental and economic goals (Klein, Schipper, & Dessai, 2005). This suggests that efforts to establish an optimal mix between mitigation and adaptation measures may be ultimately impossible and that it is perhaps more important for planners and policy makers to focus on establishing a shared framework of societal priorities.

The re-framing of climate change as a development issue rather than an environmental issue requires more attention be paid to issues of class, race, social exclusion, fairness and equality of opportunity. Moreover, the chosen development pathway will have significant impacts on the future emissions profile and the adaptive capacity of a society (Robinson, et al., 2006). Planners and policy makers will also be forced to make difficult trade-offs not only between the appropriate balance between mitigation and adaptation options, but also more contentious issues such as rates of economic growth, levels of social equality and allowable limits of environmental degradation.

The findings from my research indicates that in Portland, Oregon and Copenhagen, Denmark, climate issues are still primarily framed as an environmental and energy problem, adaptation measures are relatively undeveloped in relation to the mitigation strategies and there is little evidence to suggest that policies are in place to integrate mitigation, adaptation and development goals into a comprehensive

planning framework. The following sections present first an outline of the specific conditions found in Portland, then Copenhagen, followed by a discussion of what the wider implications are for integrating climate change policies into the development framework.

Portland Metropolitan Region

The metropolitan region of Portland, Oregon has steadily grown from a small clearing at the confluence of the Willamette and Columbia rivers in 1845 to the 23rd largest metropolitan area in the United States (United States Census Bureau, 2010). The greater consolidated metropolitan area now spans 7 counties in two states (Oregon and Washington) with a combined population of over 2.2 million. The city of Portland (pop. 582,000) is the largest in Oregon and is a central hub of service, manufacturing and logistics in the region. Portland's planning system is well known for its embrace of urban growth controls, densification efforts and coordinated development policies that closely link land use development and transportation planning decisions. In 1993, Portland was the first major city in the United States to adopt a carbon dioxide mitigation strategy; Multnomah County joined Portland to create a shared strategy in 2001. To date, Multnomah County's per capita greenhouse emissions have declined 1% while the trend line for the US a whole has seen a 13% increase in emissions (from a 1990 baseline) (City of Portland; Multnomah County, 2009).

The most recent joint Climate Action Plan adopted by both the City of Portland and Multnomah County in 2009 recognizes that much more radical reductions in future greenhouse gas emissions will be necessary. The city and county have committed themselves to a goal of 40% reduction in GHG emissions by 2030 and an 80% reduction by 2050 (City of Portland; Multnomah County, 2009). The Climate Action Plan objectives and near-term measures are broken down into eight categories: 1) buildings and energy, 2) urban form and mobility, 3) consumption and solid waste, 4) urban forestry and natural systems, 5) food and agriculture, 6) community engagement, 7) climate change preparation and 8) local government Operations (City of Portland; Multnomah County, 2009). For the purposes of this article, only objectives 1, 2, 4 and 7 will be considered. The Climate Plan states that 99% of the combined GHG emissions from Portland and Multnomah County arise from two sectors, building energy and transport (City of Portland; Multnomah County, 2009) so

Objective 17 (Climate Change Preparation) sets out the following goals for adaptation: 1) conduct an assessment of vulnerabilities and resiliencies of impacted areas (infrastructure, energy, economy, transportation, water, food, storm water management, social and health services, public safety, environment and biodiversity, population migrations and emergency preparedness), 2) create a framework for the prioritization and risk management of the projected impacts with a focus on ensuring that more vulnerable populations are protected from disproportionate impacts, 3) protect and restore natural watersheds to cope with flooding and severe storm events, 4) integrate adaptation concerns into major planning efforts, including collaboration with Metro to update land hazard mapping and inventories at the regional level and 5) integrate considerations of physical, social, environmental, economic and regulatory impact of both mitigation and adaptation into the planning process for public infrastructure investment projects(City of Portland; Multnomah County, 2009).

A key omission from the adaptation goals is the appraisal and incorporation of the range of informational and developmental uncertainties that are associated with adaptation planning, such as the lack of fine-grained regional data for predicting local climactic changes, the information asymmetries

present due to unforeseen social, political, economic and technological shifts and the difficulties inherent in creating (and using) adaptive capacity within the existing socio-economic structure.

The Climate Action Plan does not contain a systematic appraisal of the potential or actual synergies and conflicts between mitigation and adaptation strategies. There are a few areas, urban forestry for example, where the plan identifies possible synergistic relationships between expansion of the urban forest canopy and reductions in the urban heat island effect. One of the actions to be taken is to "a]cquire, restore and protect natural resources to promote functional watersheds and forest ecosystems, reduce the urban heat island effect, improve air and water quality, connect habitats and contribute to regional health, biodiversity, and resiliency." (City of Portland; Multnomah County, 2009, p. 51). In Table 1 (below), some of the other main mitigation policy goals are compared to selected adaptation goals to illustrate some of the possible synergies, conflicts and trade-offs between selected climate change goals and other development and planning goals.

Table 1: Synergies, Conflicts and Trade-offs Between Selected Climate Change Goals in Portland

Mitigation Objective	Primary Policy Sector	Secondary Policy Sector	Adaptive Objective	Adaptive Action	Synergy or Conflict	Trade-offs
20-minute complete neighborhood concept	Urban Morphology	Transport, Energy	Successful Adaptation	Green Infra-structure	Potential Conflict due to space requirements	Mal-distributed infrastructure and opportunities Residence and employment location freedom Bias toward central city More vulnerable critical infrastructure
Reduce daily vehicle miles traveled (VMT) by 30%	Transport	Urban Morphology, Energy	N/A	N/A	N/A	Potential harm to poorer citizens in areas poorly served by transit Loss of access to employment Lower mobility leading to lower economic growth rates
Reduce energy usage of pre-2010 building stock by 25%	Built Environment, Energy	Urban Morphology	Buildings that can adapt to changing climates	Influence statewide building codes	Synergy	Higher up-front housing costs Occupancy behavior of buildings restricted
10% of energy produced by on-site renewable sources	Built Environment, Energy	Urban Morphology	Buildings that can adapt to changing climates	Influence statewide building codes	Potential Synergy Potential Conflict (for example densification efforts and solar rights)	Denser developments, Solar rights conflicts Land use/siting conflicts over wind or solar

Mitigation Objective	Primary Policy Sector	Secondary Policy Sector	Adaptive Objective	Adaptive Action	Synergy or Conflict	Trade-offs
Zero net GHG emissions from new homes	Built Environment, Energy	Urban Morphology	Adaptive buildings	Alter building codes	Synergy	Higher up-front building costs
Expand urban forest coverage to 1/3 of overall urban area	Natural Systems	Built Environment	Lower urban heat island effect	Expand tree preservation and planting programs	Synergy	Higher space requirements

The capacity to realize the 20-minute complete neighborhood concept is unevenly distributed throughout the city. There are significant spatial and historic disparities of physical, social, economic, political, cultural and recreational resources and opportunities between the downtown, inner eastside and westside neighborhoods and the outer northeast and east neighborhoods (Portland Bureau of Planning and Sustainability, 2009b,c).

Economic development priorities are heavily geared toward maintaining the preeminence of the central city as the regional center for financial services, insurance, regional headquarters and the like.

> The city's office sectors are strongly concentrated in Central Portland. Office sectors made up 58 percent of Central Portland employment in 2006, compared to a range of 15 to 28 percent in other regional and town centers, 15 to 43 percent in industrial areas, and an average 30 percent along neighborhood commercial corridors. Policies for regional growth management, compact urban form, transit investment, and urban renewal support this office concentration in Central Portland as the region's high-density center and Oregon's largest concentration of office services (Portland Bureau of Planning and Sustainability, 2009a, p. 7).

It is not just economic planning that tends to concentrate development close to the city center. Capital transport investments, such as the light rail and streetcar, tend to be concentrated around the areas close to downtown. The outer northeast and east neighborhoods have poorer transport connections, significantly less walking and biking infrastructure and are far more likely to rely on the car for transportation, increasing the financial burden on families with lower incomes (Portland Bureau of Planning and Sustainability, 2009b,c). There is a similar inequality of distribution of cultural facilities, educational opportunities, parks and recreation and retail services located within walking or biking distance. Absent a clear articulation and policy integration of these types of concerns, it is quite possible that the promulgation of the 20-minute complete neighborhood concept will merely reinforce the existing economic, social, environmental and spatial inequalities between the central city and the periphery.

However, there are fragments of policy within the climate plan that demonstrate a possible way forward, showing how to combine issues of social equity, economic development and environmental benefit, such as the Clean Energy Works program. The Clean Energy Works program is a good example of what an integrated assessment of climate and sustainable development goals looks like. In order to stimulate energy-saving retrofits of existing homes, the city and county have, in partnership with the major energy suppliers and local non-profits, created a program to offer low-interest loans to private home owners that can be repaid through the homeowners utility bill over a 15-20 year period (City of Portland; Multnomah County, 2009). The program has a strong emphasis on the linkages between employment creation, environmental benefits and targeted efforts toward helping socially

disadvantaged groups gain a foothold in the job market. The lack of an integrated policy to capture such synergies and avoid (where possible) policy conflicts suggests that the region may end up both by-passing policy measures that reinforce one another and creating conflicting policy goals that lead to sub-optimal or counter-productive policies and measures.

The types of trade-offs that are made between competing aims between climate goals and other development priorities are not difficult to locate but they are often difficult to negotiate. Two particular examples will be discussed below of the types of trade-offs that are present between climate goals and competing land use and transportation goals: 1) the north reach of the Willamette River and 2) the proposed replacement of the Interstate 5 bridge that spans the Columbia River and serves as a crucial transport link for the Portland Metropolitan Region and the west coast corridor stretching from Vancouver, British Columbia down to San Diego, California.

One recent trade-offs that planners must address is exemplified by the conflict between environmental groups and business interests over the restoration plan of the northern reach of the Willamette River. The Willamette and the Columbia rivers, along with their main tributaries, have a significant influence on the economy, society and environment of the Portland region. Like rivers elsewhere, however, industrial pollution and man-made diversions and disruptions have taken their toll on the health of the rivers and the various dependent animal and plant species. Planners are attempting to create synergistic policies that simultaneously restore wetlands, allow rivers to flow more naturally, increase the bio-diversity in the city and provide both jobs and recreational opportunities to residents. The city is also working with Metro to coordinate a regional program (Nature in Neighborhoods) to protect and restore riparian corridors and wildlife habitat (Portland Bureau of Planning and Sustainability, 2009d). Additionally, the Climate Action Plan calls identifies healthy watersheds an important component of an adaptation strategy. While there is little voiced opposition to such measures in the abstract, conflicts often erupt when business interests collide with environmental protection measures.

There is a significant industrial presence on the Willamette River, including silicon wafer manufacturing, steel mills and Port of Portland harbor operations in the area. The Portland Harbor, situated on the Willamette River watershed within the city limits has been designated a Superfund clean up site, [meaning that the level of environmental contamination is high enough to warrant federal government intervention], necessitating the development of a comprehensive environmental remediation plan. The city has been developing such a plan over the past 10 years and the first portion of the plan is now close to being adopted by the city council. Businesses in the affected area, including the quasi-public Port of Portland, are fighting two key measures: 1) the imposition of a fee that will pay for mitigation of environmental damage and 2) the ability of the city to regulate development activity that will impact watershed health (Giegerich, 2010). Many of the same businesses have been actively involved in the negotiation and shaping of the restoration plan but have come out in opposition to the more restrictive planning measures. An important lesson to draw from examples such as this is that planners can and do devote significant time and resources to carefully crafting consensual agreements with a variety of actors. These agreements, however, are still subject to political approval. Dogfights between institutions and interests are unavoidable, especially in situations where there is a power struggle between the desire to conduct business as usual (e.g. treating environmental damages as externalities) and a new regime that is attempting to regulate and incorporate such costs at the point of production. Similar battles will break out over land use regulations governing climate adaptation issues. Many of the low-lying areas of the Columbia and Willamette Rivers that are used for

commercial and industrial purposes are vulnerable to rising sea levels and more extreme flooding events.

In the transportation sector, there is a similar series of trade-offs that are made between GHG emission reductions and transport/development concerns. Metro's Regional Transportation Plan has made GHG reduction a component of the decision-making process for funding decisions for different mobility corridors linking the various cities in the region together. However, the report notes that, due to increasing population, meeting the state GHG reduction targets will be difficult.

> In anticipation of future requirements, this RTP [Regional Transportation Plan] includes specific CO2 reduction targets, policies and actions to reduce the need to drive and improve operations of the transportation system-two primary strategies that have been identified for the transportation sector. However, more work is needed. Preliminary scenarios modeling conducted in 2008 looked at how vehicle emissions might change over time with different investment choices to illustrate the region's ability to continue to meet current state and federal air quality requirements and state targets to reduce greenhouse gas emissions. None of the scenarios, including the reference scenario, achieve the state targets by 2035. The region's growing population will make it difficult to achieve the targets without other strategies. The region must identify the land use and transportation strategies needed to meet them. The region will also need to support new technology and conservation measures. The scenario work in 2010 will evaluate a full array of land use and transportation strategies (Metro, 2010, p. 11).

The plan notes that more aggressive actions will need to be taken to account for increased population growth and travel demand, mainly through better coordination of land use and transport decisions but also through conservation measures, cleaner forms of fuel and transportation demand strategies.

An interesting test case of how deeply committed the State, region and city are to developing a lower-carbon transport infrastructure is the Columbia River Crossing project that is currently in the final project design and development stages. The ageing lift-span bridge is a major regional lynchpin of the passenger and freight transportation system. In order to relieve congestion, the states of Oregon and Washington have proposed replace the current six lanes of travel with a 10-12 lane bridge at an estimated cost of $3.6 billion USD. The bridge would also be built to accommodate an expansion of the light rail system into Vancouver in addition to providing improved pedestrian and bike access.

Politicians on both the Washington and Oregon side of the river are pushing hard to get the design and the draft environmental impact assessment complete by autumn, 2010 in order to qualify for funding from the federal government. Proponents of the bridge argue that the doubling of the travel lanes is necessary to relieve congestion and create smoother freight movement through the region. Despite the opposition from some local politicians, environmental and social advocacy groups and other interest groups, the preferred alignment and design that is going forward will lead to dramatic increases in both traffic volumes and GHG emissions. The expansion of the bridge will of course necessitate large re-alignments and consequent expansions of the interchanges and approaches. Most importantly, the persistence of the infrastructure will virtually guarantee the continued expansion of car-based travel for the next 50-100 years.

There is also an important symbolic dimension to planning decisions such as these. One of the underlying rationales for creating and implementing climate change strategies is that humanity needs to

act quickly to dramatically lower GHG emissions within the next 10-15 years in order to begin to stabilize atmospheric GHG concentrations. The Columbia River Crossing, for example, undercuts that message and sends a message that efficient freight and automobile movement is a much higher societal priority than lowering GHG emissions.

Copenhagen

The city of Copenhagen, founded in the mid-11th Century, is situated on the islands of Amager and Sjælland at the intersection of the Baltic and North Seas. Commerce and trading has historically played a significant role in the development of the city, a role that continues into the present day. The functional urban region of Copenhagen encompasses today the cities of Copenhagen (pop. 518,000), Frederiksberg (pop. 83,000) and 34 surrounding municipalities. The total population of the functional urban region is approximately 1.86 million, accounting for slightly over 33% of the Danish population (Næss, Næss, Nicolaisen, & Clemens, 2009) while the area of the City of Copenhagen is approximately 80 km^2 and that of the functional region approximately 629 km^2 (Næss, Næss, Nicolaisen, & Clemens, 2009). Although small by world city standards, the Copenhagen Metropolitan Area is the dominant presence in the region economically, politically and culturally.

The structure of post-war urban development in the region has been guided by the 1947 Finger Plan, which established 5 development corridors concentrated around the trunk lines of the regional train network. The intention was to create dense develop patterns centered around public transport and to minimize encroachment on green areas. Radial ring roads have been constructed over the years that facilitated more diffuse and extensive growth based on the use of the private car. Nevertheless, the most recent revision of the Finger Plan in 2007 reinforces and extends these principles of concentrating development along public transport corridors (Miljøministeret, 2007). One of the main drivers pushing against planning efforts to create denser development is the expansion of the use of motorized vehicles. Between 1999 and 2009 the road network in Denmark expanded by 10% while the rail network shrunk by 10%. Further, public investment in roads more than doubled during the same period while spending on rail saw only small increases (Statistics Denmark, 2010). The consequent expansion of both car ownership and vehicle kilometers traveled has created severe congestion on the motorways and surface streets in the region and led to large increases in GHG emissions from the transport sector (Statistics Denmark, 2009). However, although development patterns since the end of World War II have resulted in extensive expansions of urbanized areas outside the city limits, the cities of Copenhagen and Frederiksberg still possess considerable residential and workplace location appeal (Næss, 2005).

The city of Copenhagen has set itself the goal of reducing CO2 emissions by 20% in the year 2015, based on 2005 emission levels. This target is intended to be a stepping-stone toward creating a carbon-neutral city by 2025 (City of Copenhagen, 2009a). The climate plan is also intended to be an integral part Copenhagen's other planning goals as well as influencing the larger policy framework at the national and international levels:

> The climate plan's goals are an extension of the city's other goals in transport, housing and construction, health, education, social activities and culture. We also want to look beyond the city limits. We want to increase our influence on the national and international agenda (City of Copenhagen, 2009a, p.4).

The breakdown of the targeted 20% emission reductions is as follows: 75% from the energy sector, 10 % from transport, 10% from buildings, 4% from "Copenhageners" [which could be roughly translated as behavioral change] and 1% from urban development (City of Copenhagen, 2009a). The energy sector is intended to carry the torch, as it were, for the climate policy overall. The city of Copenhagen currently has 98% of households connected to district heating systems and therefore a significant component of carbon emissions stem from the combined heat/power generating stations. Policy goals to lower emissions include: 1) replacing coal with wood chips as the primary feed stock, 2) adding wind power capacity, 3) expanding geothermal sources of heating and 4) efficiency gains from waste incineration plants and improved insulation in the distribution network for heating (City of Copenhagen, 2009a). In the transport sector, initiatives include mandated reductions from bus emissions, expansion of the bicycling network and parking facilities, service and infrastructure improvements for public transport, increased restrictions on the use of the private car (parking restrictions, establishing environmental zones that restrict car and truck traffic and measures to implement road pricing schemes) and conversion of the existing vehicle fleet to hydrogen or electric sources of power.

There is little indication of efforts to acknowledge, plan for and capture synergies between mitigation and adaptation policies. For example, the adaptation section identifies green roofs and facades as a desirable planning goal for, among other reasons, reductions in the urban heat island effect, better air quality, better insulation, lower energy usage, more area for wildlife and better storm water management. But these effects also serve to lower GHG emissions by reducing energy consumption, obviating the need for large expansions of the sewer system and flood control measures, reducing or eliminating the need for air conditioning, and reducing the reliance on traditional, energy-intensive roofing materials. The lack of integration of these types of mitigation and adaptation efforts is a missed opportunity for at least two reasons. Firstly, cities will need to build support for far more radical reductions in GHG emissions in the near future and a relatively easy way to garner that support is to focus attention on policies that can deliver multiple desirable outcomes. Secondly, there is a significant risk of implementing maladaptive strategies that may decrease GHG emissions in the short run but lead to higher emissions over the long run if active interventions are necessary to sustain them.

Table 2, below, illustrates some of the possible synergies, conflicts and policy trade-offs that may be present in the selected climate change measures. An important consideration for climate change planning is that many of the mitigation measures will have impacts, both positive and negative, not only on adaptation measures, but also will impact social, economic and environmental goals.

Table 2: Copenhagen Mitigation and Adaptation Synergies and Conflicts

Mitigation Objective	Primary Policy Sector	Secondary Policy Sector	Adaptive Objective	Adaptive Action	Synergy or Conflict	Trade-offs
Renewable energy supply for combined heat/power plants	Energy	Urban Morphology, Built Environment	N/A	N/A	N/A	Increased vulnerability of critical infrastructure Possible "exporting" of GHG emissions via use of forestry products for fuel Could counter strategies to create more distributed systems of power generation
Increase cycling to 50% mode share	Transport	Urban Morphology, Energy	N/A	N/A	N/A	
Reduce energy usage of building stock by 7.5%	Built Environment, Energy	Urban Morphology	Expand green roofs and facades	Demonstration projects in Copenhagen	Synergy	Possible increase in housing prices, driving more working and middle class residents to the outer suburbs Over the long term, may conflict with monopoly profits from centralized heat and power plants
Traffic re-routing, lane reduction measures and parking restrictions	Transport	Urban Morphology Built Environment	Pocket parks and permeable surfaces to locally divert rainwater	Construct new parks and integrate green infrastructure into new developments	Synergy	May impact poorer residents harder than wealthier ones. May increase congestion and pollution if continued road capacity expansion continues regionally.

There are many synergies identified within the Climate Plan between climate mitigation goals and other social, environmental and economic goals. For example, the cycling goals are linked to lower air pollution, improved human health due to more activity and lower health care expenditures that result from a healthier population (City of Copenhagen, 2009a). What is absent from the plan is a comprehensive assessment of not only the synergies, but also the conflicts and trade-offs that have to be made between competing aims and goals. The North Harbor development represents a textbook example of the types of synergies, conflicts and trade-offs that have to be negotiated between climate

goals, development goals, social goals and environmental goals. The development, 4 kilometers north of the city center, is intended to eventually house over 40,000 people and have employment for another 40,000 people, based on compact city principles, encouraging low energy and low resource consumption lifestyles centered around walking, biking and public transport (The City of Copenhagen/Port of Copenhagen, 2009). The development is planned be well integrated into the existing urban fabric.

> Nordhavnen should be an integral part of Copenhagen and based on Copenhagen's special identity, so it is vital that Nordhavnen is not developed as an isolated project. Instead, it must be ensured that its affinity and coherence with the rest of Copenhagen is very clear in the development of this new district. The development strategy is based on six themes dealing with aspects that are key to the further development of Nordhavnen. The six themes match the six headlines set out in the vision for the sustainable city of the future. Together, they provide a robust yet flexible framework for future sustainable urban development (The City of Copenhagen/Port of Copenhagen, 2009, p. 21).

The six themes are: 1) islets and canals, 2) identity and history, 3) five-minute city, 4) blue and green city, 5) CO2-friendly city and 6) intelligent grid. All of these principles are sound components of sustainable urban development strategies and, if fully implemented, should result in much lower GHG emission profiles than typical developments. The map below, Map 8, shows the master plan for the development, which will be a series of islands separated from one another by water with a road connection tying the various islands together. There is to be a large area at the northern end of the development given over to recreation and natural wildlife habitat.

However, there are social and environmental costs that have to be considered and weighed as well. The Copenhagen draft environmental assessment in 2009 notes that:

> Urban development in North Harbor will cause negative environmental impacts of existing natural and buildings in the area. The development will, among other things, affect the rare endangered moths, chalk owl and green variegated toad, which is included in the EU Habitat list. At the same time developing the area offers good possibilities for improving the opportunities for recreation of that area to good public transport, bicycle and pedestrian connections, and to promote environmentally friendly construction. Since a large part of the North Harbor area is not station-proximate, it is essential to establish subway or rail-borne public transport. Environmental impacts of urban development of North Harbor depends on the gradient of density where a higher density, for example, offers better opportunities for collective transport solutions, but may enhance the negative environmental impacts resulting from increased energy construction operation and increased shading effects (City of Copenhagen, 2009c, p. 9).

The trade-offs between density and environmental protection are difficult for planners, policy makers and citizens to negotiate and understand absent a clear framework of priorities. The observation above captures another complicated trade-off, that of building heights in relation to solar rights. Many of the passive heating and cooling principles for low-energy homes rely on the solar access. Higher buildings closely constructed on a smaller footprint will typically decrease the opportunity for decentralized power and heat generation, requiring off-site, centralized sources of energy and heat. Additionally, as noted earlier, Copenhagen has a significant problem with social, racial and economic segregation, with many working-class and middle-class residents unable to find affordable housing within the city. The

creation of the new district of North Harbor has the potential to reinforce these patterns, due to the high cost of housing and lack of employment opportunities for those with lower educational or vocational training. The 2009 city plan notes that:

> In social housing there is a clear over-representation of people from non western countries, cash benefits and early retirement, especially when compared to owner-occupied homes that are characterized by a high proportion of better paid and self-supporting people with children. As new buildings are characterized by relatively expensive home ownership and rental housing, this trend will continue unless the municipality of Copenhagen makes an active effort to reverse the trend [translation by author](City of Copenhagen, 2009b, p. 130).

The city has attempted to encourage construction of affordable housing, for example through the 5 X 5 project and inclusion of affordable housing in the Carlsberg redevelopment project and at North Harbor (City of Copenhagen, 2009b). However, the pace of construction of new lower-end rental apartments is nowhere close to meeting the market demand (Organization for Economic Co-operation and Development, 2009) and adding a few hundred more affordable dwellings in the North Harbor development will also do little to provide relief.

Another example of the kind of policy trade-offs with potentially negative for climate goals implications in the North Harbor development is the relationship between the transport infrastructure and the land uses. While the city is hoping to build a high density, sustainable neighborhood, there are also plans to build a motorway tunnel from Sjællandsbroen in the south, through North Harbor and linking up to the Helsingør motorway in the northern part of the city.

The rationale for the development of the tunnel is tied to the City of Copenhagen's Traffic and Environment plan of 2004.

> The overall planning shall ensure the creation of a balance between economic and demographic developments. The Traffic and Environment Plan shall in particular ensure that we get a functioning transport system that can help to preserve the prosperity of the city. The vision for Traffic and Environment Plan must therefore be to "maintain and further develop a transportation system that ensures high mobility for all residents and users of the city. At the same time providing transportation consumption by automobiles and environmental problems are minimized [translation by author] from Trafik og Miljøplan 2004 as quoted in (Sund og Bælt A/S, n.d.).

The tunnel is proposed both as a development tool and as a solution for air pollution and removal of car and truck traffic from the city streets. The road capacity expansion and consequent induced travel demand will have negative effects on GHG emission profiles for the city and region and will additionally put pressure on the stated aims of promoting walking, biking and public transport within North Harbor. Both work and non-work commuting patterns are shifting regionally, with reverse commuting patterns from the city of Copenhagen to surrounding municipalities rising 23% between the period of 1995-2004 (City of Copenhagen, 2005).

These kinds of trade-offs identified here, between urban development, compact cities, environmental protection, social equity, mobility and economic development are not new. What is different about the relationship between climate change mitigation and adaptation strategies and other environmental goals, is that successfully creating a low emission profile for past, present and future development requires re-examining the underlying development pathway. Point source pollution controls and

technological fixes are necessary, but have a limited policy range when the real problem lies at the very heart of the way in which modern society is constructed.

Conclusions

There are two main conclusions to draw from the above discussion. Firstly, mitigation and adaptation measures are mostly treated as separate policy areas. There is little evidence that planners and policy makers address the two issues holistically. This could likely result in the following conditions: 1) planners miss opportunities to create synergies between mitigation measures and adaptation measures, and vice versa, 2) planners potentially create unnecessary policy conflicts between mitigation and adaptation measures, creating sub-optimal or even counter-productive strategies and 3) trade-offs between climate goals and other societal values and aims, such as social equity, environmental protection and economic growth will be difficult to negotiate absent a comprehensive treatment of mitigation and adaptation.

Secondly, there are strong indications that densification and compact city strategies may be counteracted by adaptation strategies, particularly in addressing rising sea levels and increased frequency and intensity of storm events. Both Copenhagen and Portland identify the need to, for example, expand green areas, increase the coverage of permeable surfaces and help to make natural systems more resilient. The space requirements for these types of measures are not specified, but it is clear that it will be a difficult and expensive task to integrate such structures into the urban fabric. Many of the mitigation measures, such as the conversion of the energy system from fossil fuels to renewable energy supply, have the potential to either support or work against adaptation measures but depend heavily on the manner in which the policies are implemented. Should planners prioritize roof space for solar thermal and photovoltaic generation, or green roofs to handle storm water runoff and better insulation function? What is the optimum mix between policies that encourage high buildings to minimize land usage and ensuring solar or wind access rights? Neither Portland nor Copenhagen has begun to address such questions in any significant detail as of yet.

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Appendix 2 Research Diary

Week 4

Week 4 was mainly devoted to working on the article stemming from the Reykjavik research project conducted during the 9th semester. I started to gather some preliminary data from Copenhagen and Portland; a process that continued into week 5.

Week 5

Literature review and data collection

From Copenhagen, I found and printed the following documents:

1. Copenhagen Climate Strategy, 2009, both the English executive summary and the Danish full-length version;
2. Fingerplan, 2007;
3. Traffic plan, 2004;
4. Kommuneplan, 2009

From Portland, I found and printed the following documents:

1. Portland Climate Strategy, 2009;
2. Portland Plan, 2009 Background Report for Energy;
3. Portland Plan, 2009 Background Report for Natural Resource Inventory;
4. Portland Plan, 2009 Background Report for Watershed Health;
5. Portland Plan, 2009 Background Report for Housing and Transportation Cost Study;
6. Portland Plan, 2009 Background Report for Infrastructure Condition and Capacity, including extensive maps of transportation, water, environmental services and parks;
7. Portland Plan, 2009 Background Report for Urban Form;
8. Portland Plan Workshop Polling Results, 2009 (Sustainability and the natural environment were rated the most important issue facing the city).

From Metro, the elected regional government that encompasses three of the four counties that comprised the Portland/Vancouver metro area, I found and printed the following documents:

1. The Nature of 2040: The Region's 50-year plan for managing growth, 2000;
2. Regional Transportation Plan, 2009;
3. Regional Infrastructure Analysis, 2008

From a first pass (which is by no stretch the final list) the published literature on climate change, urban planning and compact cities I have found and printed is as follows:

1. "A Template for Integrated Community Sustainability Planning" by Ling, Hanna and Dale, 2009, Environmental Management. The article is based upon a case study research project in Canada and is primarily concerned with the integration of different planning approaches in order to realize sustainable community development;

2. “Thinking globally, acting locally: institutionalizing climate change that the local government level in Durban, South Africa, Roberts, 2008, Environment and Urbanization. This article is a case study of Durban, specifically exploring the ways in which climate change issues have been accommodated and incorporated with local governance. The author pays particularly close attention to the relationship between mitigation and adaptation as well;
3. “Residential location affects travel behavior-but how and why? The case of Copenhagen metropolitan area”, Næss, 2005;
4. ”Oslo’s farewell to urban sprawl”, Næss, Næss and Strand, 2010;
5. Case Study Research: Design and Methods, 4th edition, Yin, 2009;
6. Analyzing Qualitative Data: Systematic Approaches, Bernard and Ryan, 2010;
7. Interpreting Qualitative Data, 3rd edition, Silverman, 2006
8. The Politics of Climate Change, Giddens, 2009. I am especially interested in the chapter entitled “A Return to Planning?”
9. Explaining Society, Danemark, 2002

Week 6

Methodology

Worked through Yin’s Case Study Research, using the process to reflect on and refine the research design and to sharpen the research questions. Still would like to dig a bit deeper some of the various possibilities for analysis and interpretation of the data. After reading Yin, I am still unclear about whether or not I should structure this project as a pilot study that will feed into the doctoral thesis or keep it more open. An exploratory case study makes the most sense for now, especially given the lack of existing literature on the subject.

The analytic frame

I am working towards a rough outline of the type of analytic frame that I will be using to examine the gathered data. Based on the past experience, the analysis and interpretation is by far the most challenging aspect of social science research. Therefore I want to be certain that before I start tearing apart the material I have a flexible frame that can gently guide the data collection and still be open to discovery and change as a result of new information. It is a bit like pushing water uphill with your bare hands, however. I feel that the research questions need to be sharper, the theoretical frame more defined, and I need to come up with some hypothesis (or hypotheses). So to try to decide on the proper analytic frame now, without prejudging or conditioning the outcome, is rather complicated. Yin talks about the “Craft” rival hypothesis (the Null, Threats to Validity and Investigator Bias) and the “Real-life” rivals (Direct Rival, Commingled Rival, Implementation Rival, Rival Theory, Super Rival, and Societal Rival). But given that this case study is more exploratory than explanatory, it seems to me that looking for rival hypothesis would lead me in the cause-effect direction.

Yin lists five types of analytic techniques: Pattern Matching, using non-equivalent dependent variables or rival explanations as patterns; Explanation Building; Time-Series Analysis; Logic Models and Cross-Case Synthesis. At this stage, I would tend towards a pattern matching technique using non-equivalent dependent variables. I am going to spend more time on this in the coming week, reading two other books in the SAGE series (Analyzing Qualitative Data and Interpreting Qualitative Data).

To do for week 7:

1. Read through the climate strategies for both CPH and Portland, looking for commonalities and differences.
2. Return to the study questions, refine and expand
3. Firm up the research design, including setting out my propositions, establish a data collection protocol (esp. the reasoning for including some documents and not others) and clarifying the linkages of the data to the analysis and interpretation.
4. Check the literature review to broaden, weed out or otherwise sharpen the focus.

Week 7

By the end of the week, I am 95% complete with the literature review. The process of sharpening the research questions and sub-questions is on-going, but I am much clearer about where to place this study in the planning theory context. The development of the sustainable urban form/mobility discourse has far outpaced that of the climate change/urban planning discourse. What little that has been done in the field of climate change and urban planning is mostly focused on the mitigation side. Now that adaptation has risen up the policy and planning agendas, there is an identifiable need within planning theory to begin to understand the potential and actual synergies and conflicts between mitigation and adaptation policies and strategies.

I have yet to finish the first read-through of both PDX and CPH climate strategies, but I have identified four common area of concern in both strategies: 1) Built environment/infrastructure, 2) Transportation, 3) Energy and 4) Natural Systems. These four categories are also prominent in sustainable urban development allowing me an opportunity to compare how the existing development goals of PDX and CPH support or work against the stated goals of the respective climate strategies.

The next step is to finish the research design in Week 8. I need to complete: 1) The linkages between the research questions, the literature, the type of empirical evidence needed and the sources as well, 2) The propositions and 3) The data collection protocol. The bibliography is mostly complete and I have begun writing the outlines of the literature review chapter. By the end of Week 8, I should have completed the rough outline for the lit review and started to write more substantial portions of that chapter.

Week 8

The research design is mostly completed and is awaiting supervisor comments. The bibliography and literature review are also done, again, pending supervisor comments and review. I did not get to the substantial writing portion of the literature review, but I did start to structure the chapter and begun to fill sections in with some preliminary thoughts.

Week 8 was mostly taken up by preparations for the conference presentation that I was to give in Reykjavik 26 Feb. 2010. The title of the conference was Sustainable Mobility: The Transport and Land Use Connection. My particular talk was entitled “Sustainable Mobility in Reykjavik: Strategic Challenges and Opportunities”. There were approximately 105 people in attendance drawn from city planners and politicians (both from the land use side and the transport side), private planning consultancies, the National Road Administration, and academics and students from both Reykjavik

University and University of Iceland. The keynote speakers were Terry Moore from Portland, Oregon and Ben Hamilton-Baillie from Britain, talking about their experiences linking transport and land use. The conference suggested, to me at least, that there is a noticeable shift happening within the city planning institutions regarding the attitudes to sustainable mobility questions. Based on the research that we conducted last fall, we noted a remarkable difference in attitudes toward sustainable mobility between generations of transportation engineers. The older generation was overtly skeptical if not hostile to the notion. However, the newer generation of planners seems to have been able to get the politicians on board with at least the concept of sustainable mobility, if not the practice. I was also able to have a working session with Ásdís Hlökk Theodórsdóttír while there to discuss what needed to be done to finish the research report and get some papers written.

Week 9

This week has been devoted to finishing up the research design. I am still caught in a bit of a struggle regarding the scope of the project. Research question 1, the strategic reinforcements/conflicts between climate change strategies and sustainable urban development principles, could reasonably be a project on its own. Research question 2, the ties between mitigation and adaptation, has also the possibility of standing on its own. My main concern with including both research questions is time- and resource-related. Taking on both may be too much.

For week 10 and 11, I need to mostly complete the literature review. Portions of the methodology chapter have been written, but more needs to be added. In order for that to happen, I need to make a decision about the research questions and the scope of the project. That is probably the biggest issue that I am facing now. I have a reasonably good idea of how to analyze the data but would benefit from some suggestions on that as well.

Weeks 10 and 11

After the last supervision meeting with Petter, it was decided that in order to keep the research project within manageable bounds that I should jettison the second main research question concerning the differences between climate change mitigation and adaptation strategies. The broad outlines of the similarities and differences will be discussed in the literature review chapter but any systematic investigation and analysis will have to wait for the doctorate. The relationship between mitigation and adaptation is understudied in the literature, implying that, depending on the direction of the PhD, a significant amount of empirical data gathering will be necessary. The broad outlines of the research is still forming in my mind but for now I can see that the different conceptualizations and practical application of uncertainty, risk, vulnerability are some of the essential components of any climate change adaptation study.

The literature review chapter has a reasonably solid structure and I have been filling the gaps over the past two weeks and am generally satisfied with the development so far. I have found that as I read an article/book/document it is better to write immediately as I proceed rather than attempting to read a mass of literature and then attempt to recapitulate the main ideas and positions. It also helps me to draw upon varied sources in turn. For example, after reading an article discussing the compact city as the more sustainable city, I will then turn to an article (e.g. Neuman's The Compact City Fallacy) that

takes a critical stance. By turns, I find that this process allows for a more nuanced and rounded appreciation for the issues at play.

In the methodology chapter, I have been working through the SAGE series on qualitative data analysis, interpretation, and research design. I find that the more I read about the various methodological challenges, for both qualitative and quantitative research, the more confused I become. For this project, one of the biggest methodological challenges that I face is that I am building the case solely around document analysis. This leaves open numerous potential validity and reliability concerns due to the lack of triangulation of data. However, I will specifically position the research as a reconnaissance mission, in that this portion of the research will serve as a map of the territory rather than a definitive guide. I have acquired, but not yet read and wrote about, some of the writings of critical realist methods. After finishing Bhaskar's Plato, Inc: The Problems of Philosophy and Their Resolution I have become even more determined to return back to the foundation of western philosophy in order to ground myself intellectually and to be able to comprehend the issues. Causality, validity, the mind/body divide, foundationalism/essentialism are just a few of the ideas that have pique my interest. Together with six other PhD students in the UPM and SEPM group, I have started a monthly gathering where we will each, in turn, lead a discussion on a given writer. In April, we will start with Dewey and see where the conversation goes. No matter what direction it goes, we all agreed that it is often easier to work through philosophical questions together rather than trying to work it out alone.

Charles Sanders Peirce is also moving up higher on my reading list, specifically his writings on abductive reasoning. I recently read Chomsky/Foucault: On Human Nature and came across something that Chomsky said that intrigued me. One of Chomsky's formative philosophical influences upon the development of his theory of generative grammar was Peirce's assertion that there are certain forms of logic and understanding that are intrinsic to humans. At this stage, I am not certain how much, if at all, I would include in this project but I am nonetheless interested in pursuing this line of inquiry further. I have also read Kuhn's The Structure of Scientific Revolutions this past week and am still processing and digesting that.

Another milestone in the methods chapter was the completion of the research design and the insertion into the draft report. In previous projects, I have not spent as much time in the front-end of the research to link up the research questions, theory, type of data and sources used. I have found it to be a valuable, albeit challenging, use of my time and energy. I will definitely follow a similar path in the initial stages of future research.

The next two weeks will be devoted to finalizing the literature review and the methods. I will, by the beginning of week 14, begin the analysis of the data. I will use strategic goals the climate change plans as my analytic categories and compare them to other plans relating to the urban form, transport, energy and natural systems.

I have also been writing an article for the elite study course on scientific writing skills. I severely compressed the electric vehicle article that Tim, Patience, Asdis and I wrote based on the 9th semester research project. I found it to be rather invigorating to wield the editorial scalpel so ruthlessly. I had to condense a 6000-word article down to 2 ½ pages following the IMRaD model. While the article most definitely lacks nuance, one really good result was that I was able to make a coherent paper with so little space. The table structure that I came up with for the article I then replicated and expanded in the original research report (which is still under revision). I also sent out a questionnaire to four people

who were the lead authors of Copenhagen's and Portland climate change plans. I primarily was interested in the ways in which they accounted for and addressed the relationship between adaptation and mitigation and what some of the broader issues that were addressed in making the adaptation strategy.

Weeks 12-14

Most of weeks 12 and 13 have been dedicated to building the literature review chapter. I have been expanding the bibliography over these past weeks in response to the holes in the argumentation. My schedule has slipped by two weeks, so that now I intend to begin the analysis and interpretation 14 April. The primary reason for the schedule slippage is the vast quantity of reading that has been necessary in order to develop the overall argumentation. This has been an emerging process of discovery in terms of trying to come to grips with the state of knowledge concerning sustainable urban development and climate change issues. The main points so far are as follows:

1. Compaction of the urban form, coordinated with sustainable energy and transport policies, is the prevailing model for the sustainable city.
2. Many of the strategies and policies of the compact city model are complementary and supportive of greenhouse gas mitigation strategies, with an important difference. A majority of greenhouse gas emission strategies are neutral toward issues of social equity and the maintenance of healthy eco-systems.
3. Adaptation strategies have the potential to pull urban development pathways in different directions. The need to create defensible spaces, adapt to increased extreme weather events such as floods and more powerful storms and the account for large sea-level rises puts pressure on the compaction and densification of the existing urban area.
4. Integration is the watchword for both climate change strategies and sustainable development strategies. Mitigation and adaptation need to be addressed together in order to identify areas of synergy and areas of conflict. Climate change strategies need to be integrated into sustainable development strategies in order to be able to take into account and understand the tradeoffs between economic, social and environmental goals.
5. Finally, underpinning the logic of both sustainable urban development strategies and urban climate strategies is the belief in the perennial extensive physical and economic growth.

These are subject to revision and refinement, but they indicate the areas of concern for the analytic phase of the research project. The methodology chapter still needs to be cleaned up and revised a bit which will happen during week 15. I intend to read through Næss and Saglie, Bergene and Danermark/Ekstrom/Jakobsen/Karlsson in order to flesh out the sections on causality, generalization and inferences. As much as I find Yin's method of case study to be a useful guide to social science research, it feels incomplete. There is strong guiding structure built around the natural science paradigm of event regularities and replication logic within Yin that I would like to explore. I also need to work through the table linking the research questions to the data, doing a more thorough job of connecting the sources to the questions.

For the analytic portion of the report, I will be drafting on an outline of the analytic frame during week 14. I plan to use a pattern-matching technique, drawing from the main outlines of the climate strategies and comparing the goals and outcomes to the published plans concerning urban morphology, transport,

energy and natural systems. I will be looking for areas of synergy and areas of conflict between them. What I will require is to first finish the literature review chapter and then pull out the main areas of concern. Then I would like to create a series of questions that I will "ask" the data. These questions will be key to the analysis and therefore it is critical to make certain that I have a solid understanding of how they will connect to the research questions. The analysis and interpretation should take approximately 4 weeks (the end of week 19), leaving a bit more than three weeks before submission for conclusions, policy implications, editing/revisions and reference check.

Week 15

The analytic frame has been reviewed and revised. The methodology chapter is substantially complete leaving aside minor additions and revisions that will be necessary to complete the applied methods sub-section once the analytic phase is done. The literature review is 90% done, with small sub-sections to complete and a final edit yet to be done. 19 April will be the starting point for the analytic portion of the research. My schedule allows for analysis and interpretation to run until 22 May 2010 leaving two full working weeks for conclusions, revisions, final edits, bibliographic checks and layout prior to printing on 8 June. The next month will be extremely busy and intensive but I feel that the analytic structure is fundamentally sound.

Weeks 16-17

The past two weeks have been spent finalizing the theory chapter and conducting the analysis of the Portland Metropolitan region. The analytic questions that I have posed seem to be functioning well but there remains a need to narrow down the scope somewhat. I plan to leave the winnowing-out phase until the Copenhagen case is mostly done which should be by the end of week 18. That leaves one week for cross-case analysis and conclusions. I have set a deadline of 14 May to finish the analysis in order to devote sufficient time to editing and amending the research report as well as writing the paper for submission to a peer-reviewed journal.

Weeks 17-20

Like many deadlines, the 14th of May proved to be ambitious and ultimately unrealistic. The last three weeks have been spent continuing to build and refine the three working papers (the Copenhagen, Portland and cross-case analysis). The working process has consisted of a pendulum movement back and forth between analyzing the gathered data in light of the questions for each category (urban morphology, path dependency, synergy/conflict, and governance), refining the questions where they are too vague and reflecting on and modifying the Portland case and the Copenhagen case in light of new evidence that each presents. The cross-case analysis has added a third leg of the analytic triangle, forcing me to refine and clarify the findings from the individual cases. Changes that become necessary as result of the findings from the cross-case analysis necessitate a return to the particular case (and often the original source material) in order to ensure the validity of the findings. Where Yin recommends writing first one case report, then the second (third, fourth, etc.) before writing the cross-case conclusions, I have found that running the three working papers in tandem has allowed for a sharpening of the research frame and has resulted in a (hopefully) clearer understanding of what I am finding and how to make sense of it. Week 21 will primarily consist of finishing the analysis, writing

the conclusions and reflecting on the theoretical implications of the findings. I will also be working on the first draft of the article during this time. Week 22 will be devoted to final revisions and editing of the research report and completion of the article.

Weeks 21-22

This will be the last entry in this diary. The previous two weeks have consisted of finishing the two individual cases, working through the cross-case analysis and writing the bits and pieces for the overall report, such as the abstract, introduction, preface, etc. Overall, I am reasonably satisfied with both the research process and the outcome. If I had to do this project over, I would have started it in the 9th semester and make a long thesis out of it, giving me the time to conduct interviews with the planners, consultants and policy makers that were involved in crafting the climate strategies. There were many times that I felt the limits of desk research during the course of this project, questions that cannot be put to a document. At best, the conclusions and findings of this report are the first stage in a much larger research project that will hopefully be carried out during the course of my doctoral studies. I am interested in the role that abductive reasoning may or may not play in decision-making in highly uncertain environments. Mitigation and adaptation planning cut across disciplines, sectors and competences. Planners are operating in an environment that is in many senses new and unique, where existing theoretical and practical knowledge may be lacking. How then, to make good decisions with little collective experience and in an environment where crucial information is either fuzzy or unavailable. As noted in Næss and Saglie's *Surviving Between the Trenches* article, abductive reasoning approaches may be just as common in planning as the hypothetical-deductive model.

> In many cases, still, the problem issues addressed in planning research are ones where previous research and established theories provide little guidance to the development of hypotheses. Often, the research takes as its point of departure a puzzling or surprising fact that cannot be explained by our existing knowledge. The researcher then tries to imagine possible factors due to which the surprising phenomenon would be explainable. Lave and March (1975) have termed this way of developing and testing hypotheses "hypothetical-deductive modeling". In our opinion, this way of generating hypotheses is very similar to what the American philosopher of science C. S. Peirce describes as abduction (Blanco 1994, Kirkeby 1994). In planning research, such an approach is probably just as common as deriving hypotheses from theory (Næss & Saglie, Surviving between the trenches: Planning research, methodology and theory of science, 2000, p. 15).

There were a few surprising conclusions from this research project that were interesting to me, but the most surprising was the lack of linkages between the climate strategies and other social, economic and urban development goals. Treating them as separate policy areas does not make intuitive sense to me since so many of the climate change measures have either positive, negative or uncertain effects on pre-existing planning goals and aims in both Portland and Copenhagen. I hope to be able to continue to follow this line to investigate the relationship between abductive reasoning and the manner in which planners respond and adapt to highly uncertain policy environments.

Coda

The last entry here is to note that I have succeeded, in working cooperation with my supervisor from the previous semester, Tim Richardson, in completing a conference paper to be delivered at the

upcoming Association of European Schools of Planning (AESOP) conference in Finland (6-11 July 2010), thus completing one of the core expectations of the elite study to produce an article of sufficient quality to warrant publication in a peer-reviewed journal. The paper, concerning the contested storylines of sustainable mobility in Reykjavik, Iceland will be submitted after receiving feedback from the conference presentation, inputs from the remainder of the research group and a further refinement of the argumentation in July.