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Næss, Petter; Vogel, Nina

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# Sustainable urban development and the multi-level transition perspective

Peter Næss<sup>1</sup> and Nina Vogel<sup>2</sup>

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## Abstract

This article discusses some challenges and possible adaptations of transition theory as a framework for analyzing the prospects for environmentally more sustainable development of urban land use and transport infrastructure. Rather than depending first and foremost on niche innovations, a transition toward sustainable urban development is a matter of changing the composition of existing multi-segmented land use and transportation regimes. Those well-experienced forms of built environment and transport infrastructure that are in line with sustainability objectives should be strengthened while those that are not should be actively constrained and reduced. Urban development in a Danish provincial city is used as a case to illustrate some of the points made in the theoretical part of the article. Due to the wide gap between present conditions and those required to realize a sustainable urban development, more attention should be directed toward landscape level conditions and possibilities for changing them.

## 1. Introduction

The topic of the present paper is to discuss a number of challenges arising when trying to apply the multi-level perspective of transition theory to sustainability-oriented studies of urban development and mobility, and to suggest some possible adaptations of the perspective in order to cope with these challenges. By urban development we here refer to the development of building stock, land use and transport infrastructure within functional urban regions. Our focus is thus not limited to particular districts within a city; what we are interested in is whether and how the functional city as a whole can develop in a way compatible with a low-carbon and environmentally more sustainable society.

Few previous studies have investigated transition toward sustainable urban development from the perspective of transition theory. During the latest decades, several studies have investigated the performance of different urban spatial structures against sustainability criteria (e.g. Næss, 1993; Tjallingii,

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<sup>1</sup> Aalborg University, Department of Development and Planning, Skibbrogade 5, 9000 Aalborg, Denmark; petter@plan.aau.dk

<sup>2</sup> Aalborg University, Department of Development and Planning, Skibbrogade 5, 9000 Aalborg, Denmark; nvogel@plan.aau.dk

1995; Newman & Kenworthy, 1999; Williams et al., 2000; Næss, 2001; Schremmer et al., 2011), and some studies have also addressed conditions for implementing more sustainable patterns of urban development (e.g. Næss, *ibid.*; Banister, 1998; Næss et al., 2011; Schremmer et al., *ibid.*). The former group of studies draws on a broad range of theories illuminating how urban development impacts on the natural environment during construction and from subsequent human activities facilitated or necessitated by the resulting urban structures (e.g. space heating and travel). The studies of conditions for implementation draw on theories from fields such as planning, political science, political economy, discourse theory, etc., but have so far not made use of transition theory to any great extent. A few examples incorporating transition-theoretical concepts into urban studies exist, including Bulkeley et al. (2011) and Hodson & Marvin (2010). A few authors have also addressed urban mobility and transport within the framework of transition theory (Köhler et al., 2009; Zijlstra & Avelino, 2011; Scheller, 2011 and Bertolini, 2011). None of the above-mentioned contributions inspired by transition theory have, however, dealt extensively with the development of urban land use and transport infrastructure nor have the various sustainability and climate-related impacts of this development been addressed in a comprehensive way. Coenen et al. (2012) criticize the ignorance in most transition theory literature of how transitions take place in spatial contexts/scales (local vs. international). While sharing this critique, our focus here is not so much on spatial conditions as *contexts* for transition, but rather on spatiality itself (i.e. the spatial extension and the internal spatial structure of cities/metropolitan areas) as the *object* of transition.

More precisely, the topic of this paper is the development of the building stock, land use and transport infrastructure in cities and the prospects of changing this development in a way compatible with a low-carbon and environmentally less unsustainable society. Section 2 will reiterate key sustainability challenges of urban development, which is followed by a brief account of the state of knowledge on sustainability-relevant impacts of urban spatial structures. Cities as objects of transition will then be discussed in the light of the multi-level perspective in Section 3. Next, Section 4 will consider some challenges of applying the multi-level perspective to sustainable urban transition, which will include proposals for possible adaptations of the theory to this field of transition. In section 5, the use of some of the above-mentioned framework adaptations is illustrated in an empirical case study of the provincial city of Fredericia in Denmark. Finally, Section 6 will end this paper with some concluding reflections on limitations and prospects.

## **2. Sustainability and urban development**

25 years have passed since the UN World Commission on Environment and Development put the issue of sustainable development on the international agenda as a common challenge for all nations. According to the Commission, the key tenet of a sustainable development is to meet basic human needs – especially the needs among the world's poor – in a way that sustains the possibilities for future generations to meet their own needs (WCED, 1987:43). Whereas raising housing standards and improving hygienic conditions may be important to meet basic needs among urban dwellers in poor countries, the most serious sustainability problems of cities in the affluent North are rooted in their high resource consumption and unsustainable ecological footprints. Based on this understanding of the concept, important challenges of a sustainable urban development in wealthy nations are to mitigate climate change, limit energy consumption, reduce

pollution, protect natural areas and arable land, and provide a safe and healthy environment for its citizens, in particular the most vulnerable groups (UN/ECE, 1998).

A large proportion of CO<sub>2</sub> emissions worldwide stem from buildings and transportation in cities, and the magnitude of these emissions can be considerably influenced by the solutions chosen for the development of the urban built environment. Achieving sustainable mobility (Holden, 2007) is an important part of the sustainability agenda of urban planners. Improved vehicle technology and provision of environmentally less damaging renewable energy may reduce the emissions per kilometer driven by cars and other motor vehicles. However, growth in urban traffic ties up (possibly renewable) energy resources that could have been used with higher benefits in other sectors of society. Moreover, many of the vehicle technology solutions proposed (e.g. hydrogen fuel cells) are not necessarily climate- and environmentally friendly when all chains in the production and consumption cycle are taken into consideration (Holden, *ibid*). Anyway, urban car traffic causes a number of social and environmental problems in addition to energy use and emissions, such as traffic accidents, barrier effects, congestion, noise, and the encroachments of transport infrastructure on green areas and existing built environments. These problems will not be solved through the introduction of 'clean cars'.

In many European countries, much discussion has evolved around the negative environmental consequences of a land-consuming and sprawling urban development in terms of, among others, loss of natural and agricultural areas and a high energy use for transport and in buildings. To a large extent, the predominant ideas of a sustainable (or rather: a less unsustainable) urban development in these countries appear to converge on the ideal of the "compact city" (cf. among others, Commission of the European Communities, 1990; Breheny, 1992; Jenks et al., 1996; Næss et al., 2011).

The basic mechanisms through which urban structure influences travel are theoretically well understood and have been identified in numerous empirical studies (see Næss, 2012a for an overview of such studies within a Nordic context). Compact cities tend to be less car-dependent, provide for shorter trips and have lower per capita consumption of energy for transportation than do sprawling, low-density cities (see, e.g. Newman & Kenworthy, 1999; Næss et al., 1996, Lefèvre, 2010). It is difficult and expensive to provide high-class public transport services in low density urban districts. In contrast, dense urban development can provide accessibility to facilities through proximity instead of by means of a high mobility, thus combining important environmental and social aspects of sustainability. With short distances to potential destinations, a higher proportion of trips can be made by bike or by foot, and the remaining, shorter motorized trips will cause smaller emissions than if long distances have to be covered. In particular, locating a high proportion of new buildings close to the city center normally contributes to reduce energy use and greenhouse gas emissions from transport. This applies to residential development (see, e.g., Næss & Jensen, 2004; Næss, 2006 and 2011), office workplaces (see, e.g. Næss & Sandberg, 1996; Hartoft-Nielsen, 2001) as well as specialized service facilities. Local service facilities like primary schools, kindergartens and grocery shops should of course not be centralized to the downtown area but be interspersed with residential areas all over the city. Other exceptions from the general favorability of inner-city densification are freight-generating and area-demanding manufacturing industries and warehouses, which should rather be located close to suburban transport arteries than occupying inner-city sites more favorably utilized for higher-density land uses (Verroen et al., 1990).

If one assumes that people will aim at reducing travel time, improve travel comfort or reduce direct expenses related to travelling, improvements in transport infrastructure could be expected to induce more traffic in terms of trip frequencies, trip lengths and travel modes. International research during several decades has demonstrated theoretically and empirically that whereas improved public transport, better cycling facilities and improved conditions for pedestrians contribute to reduce the number of car travelers, road capacity increase to make car traffic flow more easily contributes to a growing traffic volume (Mogridge, 1997; SACTRA 1999; Litman, 2011).

Building types associated with high density are, other things being equal, more in line with low-carbon objectives than low-density building types. Multifamily houses require less energy for space heating and cooling per square meter than detached single-family houses (Høyer & Holden, 2001; Brown & Wolfe, 2007), and less material for the construction of the buildings themselves, sewers, cables and access roads (Burchell et al., 1998). By reducing the encroachments on surrounding natural areas, densification is also more favorable than sprawl in terms of maintaining the carbon sequestering capacity of forests (Lourenco et al., 2009).

Admittedly, there are also negative environmental impacts of making cities denser. For example, densification tends to reduce the available intra-urban green areas (at least per capita) and may hence make it more difficult to set aside sufficient intra-urban pervious surfaces to adapt cities to a changing climate with more heavy precipitation. Inner-city densification also tends to increase the number of people living or working in the parts of the city most exposed to local pollution, noise and risk of traffic accidents. Unless particular measures (such as restrictions on auto use) are taken to counteract these conditions, densification may lead to unfavorable public health impacts (Næss, 2012b). Urban densification can hardly be characterized as environmentally friendly in an absolute sense. Compared to urban sprawl it is still less environmentally harmful (Newman & Kenworthy, 1999; Næss, 2001). Buildings are seldom, if ever, constructed with environmental protection as a main purpose. Instead, construction takes place to accommodate growth in the number of households, jobs etc. and in the floor space per resident or employee. As the saying goes, you cannot make omelet without cracking eggs. In most situations fewer 'environmental eggs' will be cracked by densification than by urban sprawl. The negative impacts of densification tend, however, to be more pronounced the greater is the growth in the size of the building stock (Næss, 2012b).

Several of the above-mentioned influences of urban structural characteristics on sustainability parameters have been subject to controversies in public debates. Defending their position against criticism of unsustainable traveling patterns, advocates of low-density and decentralized urban developmental patterns (including supporters of alternative urban sustainability ideals such as 'the green city' or 'the polycentric city') have often raised doubt about the relationships between urban form and travel emphasized by compact city proponents (see, e.g., Breheny, 1992; Williams et al., 2000; Bruegmann, 2005). It is also not uncommon to encounter debaters denying that road capacity increase in urban areas induces more car traffic. Such counter-claims must, however, be evaluated on their own scientific credibility. Often, they are based on transport modeling simulations where the results merely reflect the assumptions fed into the models. In other cases, skeptics have drawn general conclusions about non-influence of urban structure on travel, based on investigations of relationships between other urban structural characteristics (such as neighborhood-scale density) or other aspects of travel behavior (e.g. travel time instead of

traveling distances or modal split) than those which, from theoretical considerations, could be expected to be the most important ones. Quite often, the counter-claims are raised by representatives of conservative think-tanks fearing that the research showing adverse environmental effects of sprawl and urban highway development could be used to change the status quo in urban development (Owens & Cowell, 2002; see also Jacques et al., 2008 for a wider account). Within academic scholarly work, there is rather overwhelming agreement that urban land use and infrastructural characteristics do influence greenhouse gas emissions from transportation as well as the other sustainability parameters discussed above (although the magnitude of the effects will necessarily vary, depending on the city context).

### 3. Cities as objects of transition

The so-called transition theory, dealing with transitions and system change and focusing particularly on technological transitions, has been developed mainly by Dutch authors since the beginning of the present century. Transition theory can be subdivided into three main directions: 1) a sociotechnical approach represented by scholars like Frank Geels and Johan Schot, where the focus is on ex-post studies of historical transitions, generally spanning several decades; 2) a complex system view represented by, among others, Jan Rotmans and Derk Loorbach; and 3) a governance perspective advocated by e.g. John Grin and Adrian Smith, focusing on transition management.

The so called multi-level perspective (MLP) is one of the most discussed transition concepts associated mainly with the socio-technical approach within transition studies. Within this strand, Geels & Schot (2007) have coined a typology of sociotechnical pathways. A key feature of this typology is a multi-level perspective (MLP), which understands transitions as the results of alignments between developments at multiple levels, reflecting variations of timing and nature of multi-level interactions. The multi-level perspective differentiates between three levels of analytical concepts: niche-innovations at a micro level, sociotechnical regimes at a meso level and sociotechnical landscapes at a macro level. According to Geels & Schot (ibid., pp. 399-400), the notion of *sociotechnical regime* refers to a broad community of involved groups including an engineering community, scientists, policy-makers, users and interest groups, their cognitive routines and their alignment of activities, resulting in development along 'technological trajectories'. *Technological niches* are the loci of emergence of radical novelties, brought forth by small networks of dedicated actors, often outsiders to or at the fringe of the existing regime. The sociotechnical landscape makes up a slowly changing exogenous environment that cannot be directly influenced by niche or regime actors. Key elements at this level are macro-economics, deep cultural patterns, and macro-political development. (Geels & Schot, ibid., p. 400.)

According to Geels & Schot, transitions happen as a result of interactions between the three levels. Niche-innovations can build up momentum through learning processes, improvements in price or performance, and support from powerful groups. In addition to being challenged by niche processes, changes at the landscape level can create pressure on the regime from above. Moreover, the regime itself can become destabilized due to inner tensions or pressure from outside, resulting in the emergence of windows of opportunity for niche-innovations. (Ibid., p. 400).

In their development of the multi-level perspective, Geels & Schot (2007) use historical examples as illustrations. A common feature of these examples is that they involved a change from one type of artifacts (cesspools, horse-carriages, sailing ships, traditional factories) to a different kind of artifacts (sewers, automobiles, steamships and factories built for mass production, usually also involving a change in related infrastructures. For our study topic, defining the subject of transition is less straightforward. At the outset, cities include a multitude of categories of urban neighborhoods (high- density, low density, central, peripheral, etc.), building types (high-rise and low-rise, apartments and single-family homes, etc.) and transport infrastructures (motorways, metro lines, mixed-use streets, bus lanes, bike paths, parking areas, etc.). It is therefore problematic to define regimes if these are to be understood as single, dominating technological solutions. Moreover, it is difficult to envisage that a transition process toward sustainable cities would result in such monolithic solutions.

As a technical artifact, a city is so to speak by its nature unstable. Transitions in urban built environment and transport infrastructure take place continually, since new buildings are each year added to the existing urban fabric, new roads and parking spaces are established, expanded or changed in other ways, metro and streetcar lines are sometimes opened or closed down, and road space is sometimes reallocated between different forms of transport, made unidirectional or opened for two-way traffic. Of course, the stock of steamships within a steamship regime for sea transport also undergoes change as new ships are built and old ones are taken out of use or wrecked. The changes regularly taking place in the urban built environment and transport infrastructure are, however, of a qualitatively much more extensive nature. This raises the question of what 'urban transition' is to mean in terms of transition theory.

Arguably, 'business as usual' changes in the urban structure are not the kinds of transitions that transition theory is dealing with. Instead, what should be considered as urban transition within the perspective of transition theory are *changes in the ways in which urban structures change*. Such changes can be for the better or for the worse, seen from a sustainability perspective (cf. the discussion in the previous section). Often, the change will consist of a combination of positive and negative traits, i.e. change-elements contributing to bring the cities closer to the sustainability goals as well as traits of development pulling in the opposite direction. For the change to contribute to more sustainability, the sustainability-positive changes must dominate over the traits of development that are not in line with sustainability criteria.

As criticized by Coenen et al. (2012), the historical narratives often used in transition theory analyses may create the impression of causalities merely based on sequences of events, where a deeper analysis uncovering the generative mechanisms and causal influences of structures as well as agency would be more appropriate. Giddens' (1984) structuration theory, which is referred to in much of the literature on MLP as far as structure-agency relationships are discussed (e.g. Geels & Schot, 2007) claims that structure and agency are mutually constitutive and cannot be analytically untied. In our view, this ontology directs the attention away from the specific properties and powers of structures and agents, respectively, and how they influence each other. Instead, an ontology should be applied which recognizes the relative permanence of social structures and the time-lag between structures' influences on agents' actions and the agents' actions serving to reproduce or transform the structures, such as the Transformational Model of Social Activity proposed by Bhaskar (1993) or Archer's (2000) morphogenesis model. As a particular kind of socially constructed structures, the built environment exerts its own causal influences. The permanence of the material urban fabric calls for a structure-agency ontology acknowledging the *long-durée* and path-

dependency effects of the existing built environment on cityscape as well as its influences on daily-life mobility (Bhaskar, 1993).

#### **4. Challenges of applying the MLP perspective to a sustainable urban transition**

In line with Geels & Schot (2007) we consider it crucial to combine theories from various substantive fields in order to explain *why* certain niche innovations and regimes turn out to be successful while others never win through or are destabilized. Theories within the relevant substantive fields are in our view the basic ones when studying, for example, urban developmental processes, and many interesting studies of such processes have been carried out without the guidance of transition theory. Yet, we see the multi-level perspective as a fruitful descriptive framework and a device for structuring narratives about transition processes.

However, when the subjects of change are high-complexity and context-dependent entities such as cities' built environment and concern the prospects for transition toward an environmentally more sustainable, low-carbon society, the multi-level perspective needs to be translated and adapted to cater for the differences such a transition process would represent, compared to the processes studied so far within this perspective. Below, some challenges of applying the multi-level perspective to processes of transition toward urban sustainability will be discussed. The discussion is based on a reinterpretation and inductive aggregation of experiences from previous case studies of urban development and does not purport to be exhaustive.

##### ***The complexity, scale and context-dependency of cities***

Compared to the historical examples of multi-level interaction given by Geels & Schot (2007), the socio-spatial structures and mobility patterns of cities are arguably more complex systems. Unlike a technical invention, such as an automobile, cities are shaped in very different ways dependent on the natural, social, cultural, economic and political conditions. Cities vary very much in population size, composition of trades, affluence level, positions in hierarchies of central places, access to national or international transport infrastructure, etc., as well as in climate, land use in the hinterland, etc. Although, for example, automobiles are supplied in different sizes and brands, the content of the concept of 'car' is arguably less variegated and context-dependent than the concept of 'city'.

The large scale of cities and the interrelatedness of new, environmentally sound elements of the urban fabric with existing, less environmentally favorable structures mean that positive synergies between different sustainability-oriented 'niche solutions' may not manifest themselves in current practice. For example, even if you build a new high-density residential district close to the city center, with a high number of workplaces and service facilities within short reach, the gains in terms of less car commuting can be reduced if, for example, some of the central workplaces are at the same time moving to a new office park at a car-based location on the urban fringe. In order to illuminate whole-scale transitions toward sustainable urban spatial structures, thought experiments in the form of scenarios for cities developed consistently according to sustainability principles over a long period will probably have to be constructed



(see below). In this sense the city scale represents some particular challenges compared to analyses of transitions where the solution to be promoted already exists in fully developed form as a niche product (e.g. a heat pump system for utilizing the temperature of the underground for space heating or cooling).

The complexity of cities implies that an assessment of whether or not a transition toward sustainability is taking place must be based on a range of indicators rather than just recording whether one kind of technological system is being replaced with a new system. The differences between 'technologies' (for example low-density versus high-density urban form) are often gradual, not categorical. It is therefore not straightforward to tell what should be considered – in a particular context – as a car-dependent versus a transit-oriented city, a high-density versus a low-density city or urban district, or a high or low provision of bike paths. The same applies to the changes in the spatial urban structure taking place over a period: how dense and centralized must, for example, new housing and workplaces be built, compared to what was built in previous periods, in order to justify a statement that a transition in urban development has taken place from sprawl to compact city development? For example, the population density within the continuous urban area of Greater Oslo increased by 27% over the period 1985-2011, with an increase of more than 40% within Oslo's Inner Zone. Does this represent a transition toward a sustainable urban form? Maybe in some respects, whereas other aspects (e.g. road development) have followed less sustainable trajectories, and the steady growth in building stock has contributed to increase the overall environmental load (Næss, 2012b). The relativity of transition necessitates qualitative judgment in order to state whether a change in the trajectory of urban development is sufficiently significant to be called a transition (see also Hodson & Marvin, 2010).

### ***Multi-segmented regimes***

In most of the transition theory literature, transition is illustrated as processes within different arenas of society where one regime is by and large replaced with a new one (possibly after an interim period after the de-alignment of the old regime where several niche actors compete for the new regime position). When it comes to urban spatial structures and mobility patterns, the situation is less clear-cut. Several different 'technologies' for, e.g., housing, neighborhood design and urban transportation often exist alongside each other with relatively stable market shares and without clear signs of some solutions replacing their competitors. Although some of the transition theory researchers who have addressed urban mobility talk about a 'car regime' (Zijlstra & Avelino, 2012), the car is hardly so dominant in urban transportation in European cities that it can be attributed a regime status on its own. According to Pucher (1990), West European cities were during most of the 20<sup>th</sup> century characterized by much higher degree of automobile-oriented policies and travel behavior than the Soviet Union and the East European countries, but at the same time by much lower automobile-orientation than the United States and Canada. A similar situation applies to housing, where single-family homes played a much stronger role in USA and Canada than in the Soviet Union and Eastern Europe, where apartment buildings were dominating. Again, West European cities were in a middle position. Pucher attributed the large differences between USA/Canada and Soviet/East Europe to a high extent to ideological differences (individual versus collective solutions), with the more mixed situation in West Europe reflecting more pragmatic, less ideologically fixed land use and transport policies (Pucher, *ibid.*). Our point here is that West European cities have inherited a building stock and transport infrastructure featuring different housing types and transport modes. Current land use

and transport policies seem to a high extent to reproduce these multi-modal structures (see, e.g., Næss et al., 2011). The different components of this multi-modal mix (such as apartments, row houses and single-family homes within the housing sector, or infrastructure for cars, public transport and non-motorized modes within the transportation sector) could be viewed as solutions targeted at different market segments reflecting differences in income, household structure, lifestyles and attitudes. In a market-liberal society, offering products satisfying the preferences of different market segments is arguably one of the main tenets.

Arguably, therefore, in contemporary (neo-)liberal European societies, sociotechnical regimes are increasingly becoming multi-modal rather than single-modal: there should be 'something for every taste'. Combined with the inherited material structures facilitating different modes of housing and other urban functions as well as transport, this speaks in favor of characterizing *multi-segmented regimes* as typical for urban land use and transportation in many European cities. In other words, the very nature of a regime can be its multi-modality (= offer something for all consumer segments). For example, according to the Danish National Infrastructure Commission (2008, p. 69), "it is not about giving priority to one mode of transport rather than another one, but to ensure the correct combination of efforts".

Such multi-segmented regimes could be viewed as compromises (or agreed mix) between different 'technologies' reflecting a situation where no political ideology (individualistic or collectivistic) is completely dominant. Such a multi-segmented conception of regimes squares well with what we can observe in the urban land use and transport policies of many European countries, where investments in public transport like metros or light rail take place alongside with road capacity increases, and where new housing development has for many decades taken place as a combination of apartment buildings, row houses/terraced housing and single-family homes.

### ***Changing the composition of well-experienced old solutions***

Distinct from sociotechnical change where a dominant technological system is replaced with a new technology promoted by niche actors, the 'technologies' that could contribute to more sustainable urban development are not necessarily 'new'. They are often old and well-established (e.g. high-density urban districts, apartment buildings, bikes, streetcars, buses), but exist along with less sustainable 'technologies' and have too low 'market shares' compared to their competitors. Their market shares are still in most European countries not so low that they can be considered as being relegated to marginalized niche products.

A transition toward a low-carbon and environmentally more sustainable society requires a departure from the combined (and ambivalent) development of environmentally less damaging and environmentally harmful housing types, transport modes, etc. characterizing current multi-segmented regimes. At least, the market shares of the environmentally favorable solutions must be increased significantly at the cost of the more polluting and resource-consuming ones. Instead of stepping on the accelerator (building more roads) and the brake (improving public transport) at the same time, the foot must be moved away from the speeder in order to halt the racing toward higher greenhouse gas emissions and environmental encroachments.

### ***'Sustainable' and 'unsustainable' niche technologies***

In addition to increasing the shares of the environmentally less damaging housing types, modes of transport, etc., these modes should themselves be subject to 'green' innovations, e.g. in terms of improved energy and land efficiency, better adaptation to climate change, etc. New urban development contributing to a particularly high degree to low carbon dioxide emissions from transport as well as from the buildings and with a high performance measured against other relevant sustainability criteria could be considered as 'niche products' in a sustainability transition perspective. So-called 'sustainable', 'car-free' (Scheurer, 2001) or 'smart' city districts are examples of this.

However, it is important also to be aware that environmentally sound 'niche technologies' in urban development are not the only 'niche technologies'. The liberal principle of offering 'something for every taste' also applies to niche developments. Environmentally less favorable or outright unfavorable 'niche technologies' (e.g. information technology geared at diverting traffic away from peak periods in order to increase the total number of cars that can be accommodated on the urban road and parking network over the day) complement and counteract the new 'green' technologies. Such niche solutions, the actors promoting them and the vested interests they represent seem to be somewhat overlooked in the transition theory literature (yet there are exceptions, such as Cohen's (2009) analysis of the emergence of a highly unsustainable niche of personal aeromobility in the USA, and the call by Coenen et al. (2012) for a stronger focus on struggles between different interest groups each seeking to realize their desired version of the sustainable society). Sustainable urban development and mobility development is not only about promoting the environmentally less damaging niche technologies and products, it is also about actively constraining and shrinking the existence of the unsustainable 'products' – novel as well as old ones that are part of the multi-segmented regimes.

### ***The inertia of the existing built environment***

The overall built environment of a city normally changes very slowly. There is considerable inertia in the existing building stock and transport infrastructure, making radical changes in the environmental performance of the urban built environment a long-term affair. The existing infrastructure and buildings represent 'sunk investments' and create path dependencies that may only be overcome through strong and deliberate policies. A new 'technology' will have to co-exist with artifacts of the 'old regime' for a very long time before it eventually becomes dominating. Again, the situation is different from those mentioned by Geels & Shot (2007) in some of their historical illustrations of transition, where, for example, the horse-carriages, as well as their supporting infrastructures (stables etc.) disappeared when electricity-based transport entered the scene - and the electric tram and trolley line cables in their turn were dismantled when the car became the dominant mode of transportation in the USA.

Different niche solutions for low-carbon and environmentally more sustainable built environments and mobility schemes will usually only change the overall urban structure marginally unless they are implemented consistently (ousting other, less favorable solutions) over a long period. We are not knowledgeable of any historical examples of cities where such a consistent process of sustainable urban

development can be studied. It may be possible to learn from more or less favorable ‘best practice’ examples, but since these examples usually include a combination of more and less sustainable elements, the performance of a consistently implemented low-carbon urban strategy has yet to be seen. Needless to say, this represents a methodological problem in transition studies. Our suggestion is to combine case studies of actual urban development with backcasting involving normative sustainability scenarios and pathways towards their realization (see below).

#### ***A transition towards non-growth of building stock and mobility?***

There is an element of technology optimism inherent in the traditional MLP conception of innovative, ‘green’ technological solutions developing in niches from where they can by and large challenge and replace the existing sociotechnical regime. Much of the literature on MLP and sustainability transitions seems to be permeated by a tacit assumption of continual economic growth. Although this assumption is often not made explicit, the focus on niche innovations has clear connections to the discourse of ecological modernization, according to which innovation can stretch and redefine ecological limits and the production can be redirected towards environmental goals in order to decouple economic growth from environmental degradation (Smith et al., 2010).

But what if the problem is not primarily to add something new, but to change the composition as well as to shrink the overall volume of the urban built environment? As indicated in Section 2, ‘smart’ spatial/physical solutions for urban development are environmentally friendly only in a relative sense, not in absolute terms. Policies for sustainable urban development should therefore also problematize growth in building stock and in urban mobility. Today, changes in the urban fabric are usually the result of growth in the building stock and in the provision of infrastructure. Old material structures are rarely being removed to the same extent as new ones are added. Since growth in mobility and in the building stock, other things equal, contribute to increase the environmental load, a sustainable urban transition is usually framed as a matter of obtaining as high degree of decoupling (OECD, 2002) as possible between negative environmental and climate consequences and growth in floor area and mobility. This requires more environmentally sound ways of adding new elements of the built environment as well as environmentally sound refurbishing of the existing urban fabric. However, full decoupling over a long period of time is probably not possible (Næss & Høyer, 2009; Xue, 2012), and in a longer term stabilization or even decline in the building stock and mobility, at least per capita, will probably be necessary in order to obtain environmental sustainability. This might involve removal of the environmentally most damaging buildings, urban districts and infrastructures to compensate for new construction, and maybe even resulting in overcompensation (leading to shrinkage of the material urban fabric) if the built environment has reached a per capita volume beyond a sustainable threshold level.

Such a non-growth agenda for building stock and mobility would, in our view, necessitate a shift in emphasis from niche innovations to current growth dynamics operating on the landscape level, which has in transition theory traditionally been treated as merely exogenous.

#### ***Landscape-level conditions hampering environmental sustainability***

The task of envisaging transition from unsustainable to sustainable ways of developing urban built environment and mobility patterns is very different from that of describing e.g. the transition from sailing ships to steamships. The latter could take place with less profound changes at the landscape level than those probably required for a transition away from the current practice of 'offering something for every taste', which appears to be closely tied to the prevailing neoliberal economic paradigm. Even more dramatic changes at landscape level would probably be required if we are to depart from the consumerism represented by ever-increasing mobility and consumption of floor area. As discussed by Geels et al. (2012) in a forthcoming book on the prospects for transitions toward sustainable mobility, current traits of development at landscape level tend to stabilize rather than disrupt the existing regime within the domain of transport.

The implication of this is that more attention than usual among transition theory researchers should be directed toward the landscape level and the need for changes at this level in order to enable sustainable urban transitions. Partly, this applies to the need for national-scale regulations preventing municipalities from adopting lax environmental regulations in order to obtain competitive advantages. Landscape-level analyses should, however, also include critical analyses of overall political-economic structures and mechanisms acting as driving forces towards generally increased consumption levels, single-family and car-based housing and mobility schemes, and weak urban land use regulations (Harvey, 2010).

Notably, barriers to sustainability constituted by the capitalist economic system through its growth imperative, competition, uneven spatial development and aversion against regulations hampering environmentally harmful entrepreneurialism need to be addressed, as well as strategies by which these barriers could be overcome. Especially, this seems necessary if adherence to ecological limits (which may require zero-growth or shrinkage of the urban building stock and road infrastructure in wealthy countries) is to be combined with ensuring a decent standard of living for the least affluent inhabitants. In a shrinking total economy, there is a risk that low-income people will be locked in continual or even worsened poverty, unless this is counteracted by active redistributive policies. The above circumstances call for a focus on *political* niche actors and their strategies for transition, rather than technological niche actors and technologies. Some inspiration could perhaps be gained from Geels' (2011) discussion about the lessons learned from the history of political revolutions, as well as a host of other literature in the same vein.

### ***Backcasting the utopian sustainability***

Whereas most transition theory literature has arguably depicted sustainability transitions as something that is possible within the existing overall social structure, we think a transition involving departure from the prevailing growth paradigm is utopian in the sense that it cannot be realized under the present politico-economic conditions. Envisaging a development based on normative values differing markedly from those promoted by the presently most powerful actors therefore calls for a counterfactual approach. *Backcasting* in the form of the construction of normative, sustainability-oriented future scenarios and analyzing the conditions and processes necessary for their realization seems to be a fruitful approach for concretizing the currently utopian (Dreborg, 1996; Vergragt & Quist, 2011). Examples of backcasting studies addressing urban sustainability include Næss (1993a), Gullberg et al. (2007) and Gunnarsson-Östling & Højer (2011), although none of these studies have applied conceptual frameworks of transition theory. The specification

of the underlying assumptions of each scenario should be based on *retroductive* thinking, i.e. thought operations aiming to reconstruct the basic conditions for something (here: a possible future situation) to be what it is (Bhaskar, 2008). In scenario construction, this will require the use of qualitative knowledge about natural mechanisms, social contexts, causal complexes, and links between the different processes that together account for the trajectory of each scenario (Patomäki, 2006).

In line with Vergragt & Quist (2010), who call for a coupling of backcasting studies with sociotechnical transition studies, we recommend to envisage scenarios and pathways showing how environmentally sound 'niche solutions' (or maybe rather 'best-practice neighborhood-scale solutions', cf. above) for urban development could become dominating, and what kind of resulting urban structure this would entail. A backcasting approach allows a view on short-term steps necessary to realize long-term scenarios and the contexts enabling or preventing such steps from being made. The magnitude of achievement compared to 'business as usual' as well as to the requirements of a truly climate-friendly and sustainable urban development should be crudely assessed. Such an assessment would also be necessary in order to judge whether the environmentally more sustainable 'best practices' and 'niche technologies' are sufficient – given that they become widespread – to enable continual growth in the built environment and in mobility or some limits to this growth have to be imposed in order to meet goals of environmental sustainability.

## **5. The case of Fredericia, Denmark**

Below, some of the above-mentioned adaptations of the multi-level perspective will be illustrated with the provincial city of Fredericia in Denmark as an empirical case. The case, which is rather typical for urban development of smaller and medium-sized cities in Denmark, exemplifies the multi-segmented regimes within transportation and land use policy as well as the prevailing growth imperative as a landscape condition hampering more consistent advances toward sustainability. The case inquiry so far builds on the analysis of municipal as well as regional planning documents, strategic and visionary papers and meetings with local actors as well as an interview with the director of the Triangle Region in 2011.

The municipality of Fredericia has a population of approximately 50,000 (of which 40,000 in the continuous urbanized area) and is a part of the polycentric Triangle Region including six municipalities with a total of around 350,000 residents. The Triangle Region is part of the so called East Jutland Growth-Corridor, encompassing 17 municipalities from Randers in the north over Aarhus to the Triangle Region in the south. Since 2006, this corridor has been given attention in national planning documents as a growth center along with Copenhagen Metropolitan Area (Ministry of Environment, 2006).

Reflecting a general increase in the awareness about climate change and its consequences, many cities are aiming to take responsibility to tackle causes and adapt to conditions and so is Fredericia. The municipality plans to reduce its CO<sub>2</sub> emission by 25% in 2015 (with reference to 2006) and participates in a few climate initiatives launched within the Triangle Region's network (Triangle Region Denmark, 2009). However, the land use and infrastructure plans of Fredericia reflect no clear development strategy, continuing a trend of sprawling development with expansion of the urban area demarcation, while simultaneously planning for inner-city densification, notably the new city district 'Fredericia C'.

### ***Fuzzy transitions***

In order to analyze the spatial urban development in Fredericia we have adopted the general frame of the MLP with its three analytical levels. These would translate as described in the following:

The Triangle Region as a municipal network has no authority power on municipal planning practice, however, relevant though are the mediations of planning approaches for the overall region and what is understood as valuable and necessary development. Here, landscape pressure is exercised by the general trends of coupling between economic growth and growth transport, a culture where high mobility is seen as an important aspect of freedom, and the notion of competition between urban areas internationally, nation-wide (the East Jutland Growth Corridor versus Copenhagen Metropolitan Area) as well as between municipalities in the Triangle Region (especially Fredericia, Kolding and Vejle).

Consequently, Fredericia values spatial expansion of housing and commercial development as competitive advantage and this is for example reflected in the municipal planning practice in the western part of Fredericia with a spacious zoning plan for urban expansion (residential and commercial) as well as a reluctance toward limiting the size of the vast areas already set aside for commercial and industrial development in the industrial park Danmark C. Both of these examples have infrastructural concerns too. The highway infrastructure is understood as a logistic necessity for the industrial park and more generally as a major growth-generating asset of the region. The geographical context of the case municipality is as such interesting, because the region is promoting its location as logistic advantage and furthermore as argument for the expansion and construction of transport infrastructure being an important Danish transport hub (Fredericia Kommune, 2011). Generally speaking, the Triangle Region is one of the Danish regions with an outstanding high automobility and highly car-dependend land use structures (Krawack, 2011).

Fredericia though is under normative pressure from the environmental discourse. The municipality has formulated an ambition for transition towards more sustainable urban development and does take effort in implementing measures and stimulate processes. Currently Fredericia's focus is directed toward the urban transformation project Fredericia C, where a former industrial area at the harbor is redeveloped into a dense and multi-functional city district. This appears to be a positive transition towards more sustainable structures in urban spatial planning, and it is branded as a sustainable flagship project. Additionally, local mobility management projects concerned with travel to work, parking policies, buses running on alternative fuel or pilot projects introducing electric vehicles try to address a change in travel patterns and lower-emission transport towards more sustainable conditions. Certainly, the aspiration is there to develop towards more sustainable regime patterns in Fredericia, but this appears as slender chance under current conditions of a general lack of an integrated approach of land use and transport planning towards more sustainable mobility. Thus Fredericia C meets demands among people preferring multistory inner city living, but at the same time plans are made for low-density development geared toward another part of the multi-segmented regime.

In Fredericia there are hardly any niche developments evolving within land use and transport infrastructure development. The only niche we can identify concerns the mobility management field. However, such niche development does neither affect the spatial urban development nor address transport demand reduction or modal shift; instead the efficiency and capacity problems of car travel are in focus. Unless these

approaches are being backed up sufficiently, they risk to be inefficient or outweighed by more dominant practices of daily mobility patterns, car-lobbies or businesses in general that would lose profit through major changes. Thus sustainability initiatives run the risk of being subordinated to or coopted by a dominating strategy of increasing the city's economic competitiveness (Fredericia C, 2011).

The transitions taking place in Fredericia and the Triangle Region may slightly adapt the regime structure to an increasing pressure to act more sustainably, but in the main the regime remains. This means that policies for more sustainable mobility are pursued under a general acceptance of the region's car-dependent structure, focusing on car-pooling, mobility management and zero-emission vehicles rather than aiming to make people shift from cars to other modes. To influence the 'mobility culture' of the Triangle Region would definitely call for greater transitions of the regimes for land use and transport infrastructure development, which would in their turn depend on significant changes on the landscape level. This will be illustrated in the scenario introduced below.

### ***Alternative prospects for Fredericia***

Below, an image of Fredericia's possible 'sustainable urban land use and transportation future' will be presented, building on principles introduced earlier in this paper and advancing these to meet the sustainability vision. The backcasting approach in this research will be development in steps; 1) creation of a rough normative scenario of the case development (as introduced forthcoming), which will be used as input in interviews, 2) further development with estimation by stakeholders and theoretical knowledge, 3) final discussion and development of a sustainability scenario for the case. Steps 2 and 3 are still pending and the interviews will be carried out in the near future.

Fredericia in 2050 reflects a clear separation between urbanized and non-urban land surrounding Fredericia and the encroachments on natural areas and farmlands is down to zero since the municipality focuses on available brownfields for development proportional to actual development needs estimated from a comparison of the available building stock and the expected future numbers of households and jobs. The new buildings are thus constructed to match demographic changes and changes in employment but not to accommodate increase in per capita consumption of floor area.

Personal car traffic is banned from the inner city. Car-parking facilities are located on the fringe, outside Fredericia's historical town wall. Permission is given to businesses for unload goods only or other temporary traffic. There exists personal motorized transport in the rest of the city but with strict parking regulations. No further increase in road and parking capacity has taken place; instead some road lanes for car traffic and parking spaces have been reallocated to other purposes such as bike paths, lines of trees or building sites. Sydtrafik, the public transport network of southern Denmark, has extended its cooperation with the different transport suppliers in the region, such as services by Movia, Arriva and DSB. Mobility Management concentrates at first on transport demand reduction measures in their service and counseling, which is taking place in close cooperation to decisions in the housing and commercial sector, before improving capacity and efficiency.

Accordingly planning approaches a) reduce land consumption by re-using already developed areas as well as increasing the efficiency of plots due to higher density, b) impose physical and fiscal restrictions on car



traffic, c) improve public transport services in the whole region and d) with an on-going education of planning and political authorities as well as civil society they offer a different approach to growth with clear separation between needs and desires. Consequently the political climate and planning authorities go beyond technological solutions within the transport sector and towards a deviant mobility culture and norms.

### ***Key conditions and obstacles for realizing a sustainability scenario***

In this paper we have focused on the building stock and transport infrastructure and could identify major challenges in the existing multi-segmented regimes. Ensuring a consistent sustainability policy requires that multiple measures in many sectors (and regimes) have to play in concert to promote a more sustainable development. Efforts have to be taken to support evolving developments towards more sustainable urban form and transport while simultaneously regulating and preventing unsustainable practices and structures presently bolstered by powerful landscape conditions.

The case reflects the need to critically approach the landscape level conditions for sustainable transition as well as the requirement for much higher degree of political steering. More radical niche development was faint, reflecting the strong position of the 'broadly customized' multi-segmented regime and dominant landscape influences. Pressure from political niche actors would probably be necessary to provoke and counter present unsustainable conditions and to gain momentum in the current regime structures, but such political niches are hardly yet to be found in Fredericia.

Developing Fredericia towards the sustainability scenario requires an integrative and more regulatory planning of land use and transport, as well as measures to prevent competition from leading to 'a blind race for growth' without any holistic evaluation of its local and global environmental and social impacts. Hence a governance structure has to be prevalent that sets a clear regulative frame with strong national guidelines and regional embeddedness, e.g. a Triangle Region Plan as binding policy paper, with the ability to efficiently influence land use and infrastructure systems. State interventions, regional regulations, changed political agendas as well as changed responsibilities for planners would be crucial conditions for realizing less unsustainable futures, as well as more profound transitions of social structures necessary to enable these changes. The outlining of such a multi-governance structure was, however, not the focus of the present paper.

## **6. Concluding remarks**

Transition theory offers, as we see it, a useful framework for describing processes of major sociotechnical change. However, the complexity, scale and context-dependency of cities, the relative permanence of the urban built environment and the strong vested interests, cultural norms and lifestyles associated with present modes of urban development present huge challenges to a transition toward sustainability, politically as well as analytically. The multi-level perspective needs to be translated and adapted to cater for the differences such a transition process would represent, compared to the processes studied so far within this perspective. Rather than depending on niche innovations, a transition toward a more sustainable urban

development is a matter of changing the composition of existing multi-segmented land use and transportation regimes. Those well-experienced forms of built environment and transport infrastructure that are in line with sustainability objectives should be strengthened while those that are not should be constrained and reduced. The inertia of the existing built environment makes radical changes in the environmental performance of urban land use and infrastructure a long-term affair. Moreover, resource-saving technological solutions will hardly be sufficient to compensate for the environmental impacts of continual growth in the building stock and in mobility in a long-term perspective. This raises new challenges to the MLP.

Notably, the current strong landscape pressure for increased consumption and individualized, resource demanding solutions e.g. in terms of housing types and transport modes calls for a greater attention directed toward the landscape level and its interplay with regimes than what has hitherto been common in research inspired by transition theory. In particular, basic economic, social and discursive landscape-level structures should be addressed, drawing on relevant theories from each of these fields. Our case example (Fredericia and the Danish Triangle Region) also illustrates the need for curbing unsustainable parts of existing multi-segmented regime solutions as well as for integration of regimes within different domains, such as transport planning, housing policies, business development and land use planning. Due to the wide gap between present landscape conditions for urban development and those required to realize an environmentally sustainable urban development, the scenario method of backcasting could preferably be integrated into the analytical framework of sustainability-oriented transition studies.

## References

- Archer, M. 2000. *Being Human: The Problem of Agency*. Cambridge University Press, Cambridge.
- Banister, D. 1998. Barriers to the implementation of urban sustainability. *International Journal of Environment and Pollution* 10, 65-83.
- Bertolini, L. 2011. Achieving sustainable urban mobility: What can we learn from transition theory? Paper presented at the 3rd World Planning Schools Congress, Perth, Australia, 4-8 July 2011.
- Bhaskar, R. 1993. *Dialectic: The Pulse of Freedom*. Verso, London.
- Bhaskar, R. 2008. *A Realist Theory of Science – with a new introduction*. Routledge, London and New York.
- Breheny, M. 1992. The Contradictions of the Compact City: A Review, in Breheny, M. (Ed.): *Sustainable Development and Urban Form*, pp. 138-159. London: Pion Limited.
- Brown, M., Wolfe, M. 2007. *Energy Efficiency in Multi-Family Housing: A Profile and Analysis*. Energy Program Consortium, Washington DC.
- Bruegmann, R. 2005. *Sprawl: A compact history*. Chicago: University of Chicago Press.
- Bulkeley, H., Broto, V.C., Maassen, A. 2011. Governing urban low carbon transitions, in: Bulkeley, H., Broto, V.C., Hodson, M., Marvin, S. (Eds.) *Cities and Low Carbon Transitions*. Routledge, London, pp. 29-41.
- Burchell, R. et al. 1998. *The Costs of Sprawl – Revisited*. National Academy Press, Washington.
- Cohen, M. 2009. Sustainable mobility transitions and the challenge of countervailing trends: the case of personal aeromobility. *Technology Analysis and Strategic Management*, 21, pp. 249-265.
- Coenen, L., Benneworth, P., Truffer, B., 2012. The geography of transitions. Addressing the hidden spatial dimension of socio-technical transformations. *Research Policy* 41 (6): 955-967.

- Commission of the European Communities 1990. Green paper on the Urban Environment. Luxembourg: Office for the Official Publications of the European Communities.
- Danish National Infrastructure Commission 2008. Danmarks Transportinfrastruktur 2030. Betænkning 1493. Danish National Infrastructure Commission, Copenhagen.
- Dreborg, K.H. 1996. Essence of backcasting, *Futures* 28, pp. 813-828.
- Fredericia C 2011. Process tool and note on economy – January 2011. Fredericia C, Fredericia.
- Fredericia Kommune 2009: Kommunestruktur - Kommuneplan 2009-2021. The Municipality of Fredericia, Fredericia.
- Fredericia Kommune, 2011. Juni 2010: Borgmester Thomas Banke: DanmarkC er Danmarks centrum [online]. Available from: <http://www.fredericia.dk/OmKommunen/Sider/DanmarkC/Danmarks-centrum.aspx> [Accessed 8th June 2012].
- Geels, F.W. 2011. The multi-level perspective on sustainability transitions: Responses to eight criticisms, *Environmental Innovation and Societal Transitions* 1, pp. 24-40.
- Geels, F.W., Dudley, G., Kemp, R. 2012. Findings, conclusions and assessments of sustainability transitions in auto-mobility, in Geels, F., Kemp, R., Dudley, G., Lyons, G. (Eds.) *Automobility in Transition? A Socio-Technical Analysis of Sustainable Transport*. Routledge, London (in press), chapter 8.
- Geels, F.W., Schot, J. 2007. Typology of sociotechnical transition pathways, *Research Policy* 36, pp. 399-417.
- Giddens, A. 1984. *The Constitution of Society. Outline of the Theory of Structuration*. Polity Press, Cambridge.
- Gullberg, A., Höjer, M. & Pettersson, R. 2007. Bilder av framtidsstaden: tid och rum för hållbar utveckling [Images of the future city: time and space for sustainable development]. Symposium, Eslöv.
- Gunnarsson-Östling, U. & Højer, M. 2011. Scenario Planning for Sustainability in Stockholm, Sweden: Environmental Justice Considerations. *International Journal of Urban and Regional Research*.
- Hartoft-Nielsen, P. 2001. Arbejdspladslokalisering og transportadfærd. Forskningscenteret for skov og landskab, Hørsholm.
- Harvey, D. 2010. *The Enigma of Capital*. Oxford University Press, Oxford.
- Hodson, M. & Marvin, S. 2010. Can cities shape socio-technical transitions and how would we know if they were? *Research Policy* 39, 477-485.
- Holden, E. 2007. *Achieving Sustainable Mobility. Everyday and leisure-time travel in the EU*. Ashgate, Aldershot.
- Høyer, K.G., Holden, E. 2001. Housing as basis for sustainable consumption, *International Journal of Sustainable Development* 4, pp. 48-58.
- Jacques, P. J.; Dunlap, R. E. & Freeman, M. 2008. The organisation of denial: Conservative think tanks and environmental scepticism. *Environmental Politics* 17, pp. 349-385.
- Köhler, J., Whitmarsh, L., Nykvist, B., Schilperoord, M., Bergman, N., Haxeltine, A. 2009. A transitions model for sustainable mobility, *Ecological Economics* 68, pp. 2985-2995.
- Krawack, S. 2011. Interview with Susanne Krawack, Director of the Triangle Region, 09.06.2011, Kolding.
- Lefèvre, B. 2010. Urban transport energy consumption: determinants and strategies for its reduction. An analysis of the literature. *Sapiens*, Vol. 2, pp. 1-17.
- Litman, T. 2011. *Generated Traffic and Induced Travel. Implications for Transport Planning*. Victoria Transport Policy Institute, Victoria.
- Lourenco, J. et al. 2009. Land use changes in the Douro Valley and carbon emissions. Paper for the 45th ISOCARP Congress in Porto, October 18-22, 2009.

- Mogridge, M.J.H. 1997. The self-defeating nature of urban road capacity policy. A review of theories, disputes and available evidence. *Transport Policy* 4, pp. 5-23
- Newman, P. W. G. & Kenworthy, J. R. 1989. *Cities and Automobile Dependence*. Aldershot: Gower Publications.
- Newman, P. W. G. & Kenworthy, J. R. 1999. *Sustainability and Cities. Overcoming Automobile Dependence*. Washington DC/Covelo, California: Island Press.
- Næss, P. 1993. Can Urban Development be Made Environmentally Sound?, *Journal of Environmental Planning and Management* 36, pp. 309-333.
- Næss, P. 2001. Urban Planning and Sustainable Development, *European Planning Studies* 9, pp. 503-524.
- Næss, P. 2006. *Urban Structure Matters: Residential Location, Car Dependence and Travel Behaviour*. Routledge, New York/London.
- Næss, P. 2011. 'New urbanism' or metropolitan-level centralization? A comparison of the influences of metropolitan-level and neighborhood-level urban form characteristics on travel behavior, *Journal of Transport and Land Use* 4, pp. 25-44.
- Næss, P. 2012a. Urban form and travel behavior: experience from a Nordic context, forthcoming in *Journal of Transport and Land Use* 5.
- Næss, P. 2012b. Economic growth, urban development and environmental sustainability, forthcoming in: Moccia, F. D (Ed.) *Living in the ecologic city-Abitare la Città Ecologica*. CLEAN, Naples.
- Næss, P., Høyer, K.G. 2009. The Emperor's Green Clothes: Growth, Decoupling and Capitalism. *Capitalism, Nature, Socialism* 20, pp. 74-95.
- Næss, P., Jensen, O.B. 2004. Urban Structure Matters, Even in a Small Town, *Journal of Environmental Planning and Management* 47, pp. 35-56.
- Næss, P., Næss, T., Strand, A. 2011. Oslo's farewell to urban sprawl, *European Planning Studies* 19, pp.113-139.
- Næss, P., Sandberg, S.L. 1996. Workplace Location, Modal Split and Energy Use for Commuting Trips, *Urban Studies* 33, pp. 557-580.
- Næss, P., Sandberg, S.L., Røe, P.G. 1996. Energy Use for Transportation in 22 Nordic Towns, *Scandinavian Housing & Planning Research* 13, pp. 79-97.
- OECD, 2002. *Indicators to Measure Decoupling of Environmental Pressure from Economic Growth*. Paris: OECD.
- Owens, S. & Cowell, R. 2002. *Land and Limits*. London/New York: Routledge
- Patomäki, H. 2006. Realist ontology for futures studies, *Journal of Critical Realism* 5, pp. 1-31.
- Pucher, J. 1990. Capitalism, Socialism, and Urban Transportation Policies and Travel Behavior in the East and West, *Journal of the American Planning Association* 56, pp. 278-296.
- SACTRA 1994. *Trunk Roads and the Generation of Traffic*. Standing Advisory Committee on Trunk Road Assessment, UKDoT, HMSO. London
- Scheurer, J. 2001. *Urban ecology, innovations in housing policy and the future of cities: towards sustainability in neighbourhood communities*. Ph.D. thesis. Perth, Australia: Murdoch University.
- Schremmer, C. et al. 2011. *Planning resource-efficient cities*. SUME synthesis report. Österreichisches Institut für Raumplanung, Vienna.
- Sheller, M. 2012. The Emergence of New Cultures of Mobility, in Geels, F., Kemp, R., Dudley, G., Lyons, G. (Eds.) *Automobility in Transition? A Socio-Technical Analysis of Sustainable Transport*. Routledge, London (in press), chapter 9.

- Smith., A.; Voss, J. P. & Grin, J. 2010. Innovation studies and sustainability transitions: The allure of the multi-level perspective and its challenges. *Research Policy*, 39.
- Tjallingii, S. 1995. *Ecopolis: strategies for ecologically sound urban development*. Backhuys, Leiden.
- Triangle Region Denmark 2009. *Climate Initiatives in the Triangle Region*. The Triangle Region, Kolding.
- UN/ECE (United Nations' Economic Commission for Europe) 1998. *Major Trends Characterizing Human Settlements Development in the ECE Region*. United Nations, New York and Geneva.
- Vergragt, P.J., Quist, J. 2011. Backcasting for sustainability: Introduction to the special issue, *Technological Forecasting & Social Change* 78, pp. 747-755.
- Verroen, E.J., Jong, M.A., Korver, W., Jansen, B. 1990. *Mobility profiles of businesses and other bodies*. Rapport INRO-VVG 1990-03. Institute of Spatial Organisation TNO, Delft.
- WCED 1987. *Our Common Future*. Oxford University Press, Oxford/New York.
- Williams, K., Burton, E., Jenks, M. (Eds.) 2000. *Achieving Sustainable Urban Form*. Pion Limited, London.
- Xue, J. 2012. Limits to decoupling strategies for sustainable housing development: The Hangzhou experience, forthcoming in *Journal of Environmental Planning and Management* 54.
- Zijlstra, T., Avelino, F. 2012. A Socio-Spatial Perspective on the Car Regime, in Geels, F., Kemp, R., Dudley, G., Lyons, G. (Eds.) *Automobility in Transition? A Socio-Technical Analysis of Sustainable Transport*. Routledge, London (in press), chapter 8.