# Forbruksbasert tilnærming til klimatiltak og urban miljømessig bærekraft

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*Eeva Säynäjoki et al.: A consumption-based approach to climate change mitigation and urban environmental sustainability*

Urban planning has a central role in the political visions of environmentally sustainable communities. Recent research strongly suggests that a consumption-based approach can supplement environmental analysis of urban areas. This article discusses the rationale of current urban planning policies and practices in their push for environmental sustainability and especially for reducing greenhouse gas (GHG) emissions in light of the consumption-based approach to urban environmental sustainability. The current scope of environmental considerations in urban planning is found to be limited to the consumption categories of ground transportation and housing, and urban densification is viewed as the primary means to pursue environmental improvements in sparsely populated regions. However, increase in other consumption categories may offset or even outpace the assumed benefits of urban densification. Furthermore, the modifications to urban form can instantly cause massive GHG emissions. Such investments aiming to reduce emissions may not be beneficial within the time frame of our national and international commitments to the mitigation of climate change.

*Keywords:* urban planning, sustainable development, consumption, GHG emissions

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**Introduction**

The gross global consumption and especially the consumption patterns in the developed countries cause serious environmental damage and threaten the carrying capacity of the Earth (Grimm et al. 2008; Simms et al. 2010; Rockström et al. 2009; Steffen et al. 2015). Due to the macrophenomena of urbanisation and globalisation, population and consumption systematically concentrate to urban areas that become the demand centres of the global economy (Rees and Wackernagel 1996; Bithas and Christofakis 2006; Grimm et al. 2008; Daffara 2011). Urban areas rely heavily on rural production and their environmental impacts extend far beyond the urban domain and national frontiers (Eaton et al. 2007; Dodman 2009; Kissinger and Rees 2010). Through trade and a highly complex web of supply chains, urban consumption causes spatially separated resource extraction, pollution, and habitat destruction outside of the urban territory (Ramaswami et al. 2008; Tukker et al. 2009; Wiedmann et al. 2011).

Urban environmental sustainability seems to be an urgent priority in the global push for sustainable development, and urban planning has become a key means of environmental governance (Bulkeley and Betsill 2005; Bithas and Christofakis 2006; Kenworthy 2006). A myriad of different sustainability schemes has emerged for the assessment of urban developments. Concern about climate change, especially, has gained strong political momentum, and commitments to the reduction of greenhouse gas (GHG) emissions drive both public and private actors to develop urban areas in a unified manner (Bulkeley 2010; Kunchornrat and Phdungsilp 2012; Edenhofer et al. 2014). The current regeneration of urban structures is seen as means of creating operational conditions for achieving environmental sustainability, facilitating the success of technical solutions and encouraging certain human behaviours (Bithas and Christofakis 2006; Eaton et al. 2007; Bourdic and Salat 2012; Hoornweg et al. 2011).

Environmental improvements can be promoted at both the production and consumption ends of the supply chain. Given that the priority and resources given to environmental work may vary among nations, the consumption end can have greater potential for radical change. At least consumption-based thinking provides a valuable framework for examining the drivers of environmental degradation. Therefore a consumption-based approach to urban environmental sustainability is suggested to add to the possibilities for influencing global issues through local actions (Holden and Norland 2005; Neuman 2005; Eaton et al. 2007; Hoornweg et al. 2011). The logic of a consumption-based evaluation is that urban areas are considered to be responsible for all the direct and indirect environmental impacts of all the products and services the inhabitants consume, regardless of where geographically the environmental impacts take place (Ramaswami et al. 2008; Weber and Matthews 2008; Kennedy et al. 2010).

This article discusses the rationale of current urban development policies and practices in their push for the reduction of environmental load as it relates to a consumption-based idea of urban environmental sustainability. Results of three dissertations (Heinonen 2012; Säynäjoki A. 2014; Säynäjoki E. 2015) and twelve journal papers included in them (Heinonen and Junnila 2011a, b, c; Heinonen et al. 2011a, b; Säynäjoki A. et al. 2011, 2012; Ristimäki et al. 2013; Säynäjoki E. et al. 2012, 2014a, b, c) are linked to critically examine the success of urban planning policies and initiatives in terms of environmental sustainability, in particular GHG emissions reductions. First the methodology of the research is introduced briefly. An integrated summary and discussion of the results follow. Finally, conclusions are presented.

## Methodology

The methodology of the three dissertations, on which this article is based, is briefly presented here. The constitution and rationale of prevalent procedures through which urban planning attempts to promote and facilitate environmental sustainability are examined qualitatively. Triangulation of three methods (multiple case study, literature-based analysis and focus groups) is applied to collect divergent data and to investigate the current understanding and policies through varying analyses. Three research perspectives, namely *standards for sustainable urban planning*; *the position of environmental sustainability in urban planning decision-making processes*; and *the consumption-based approach to the environmental burden of urban communities*, are used to guide and itemise the research (see Säynäjoki E. 2015).

The impacts of urban structure on consumption patterns and related GHG emissions are investigated by combining the methods of life cycle assessment (LCA) and multiple case study. A streamlined input-output-based hybrid LCA model is developed to compare consumption-based GHG emissions within different types of urban structure in Finland. The model is primarily based on the Carnegie Mellon University Economic Input-Output Life Cycle Assessment (EIO-LCA) matrices (Carnegie Mellon University Green Design Institute 2008). The emission sources that are identified as major in the context of the multiple case studies are assessed using process data. The Finnish consumer survey (Statistics Finland 2007) is used as the input data (see Heinonen 2012).

Similarly, LCA and case study methods are combined to assess the GHG emissions of new construction. Two more streamlined input-output-based hybrid LCA models are developed, one of which is based on the EIO-LCA matrices and the other on the Finnish ENVIMAT-model (Seppälä et al. 2009). Local process data are used to replace some of the IO-data and thus to enhance the IO-model into a relevant hybrid LCA model in each case study. These hybrid models combine the strengths of IO LCA and process LCA, allowing avoidance of boundary definition problems but still using the most accurate data for the most central parts of the analysis. New construction is also examined through multiple case studies in Finland. In addition, a single case study is conducted to investigate the life cycle viability and environmental benefits of alternative energy systems in a residential area (see Säynäjoki A. 2014).

## Urban environmental sustainability in sparsely populated regions

Both a wide body of literature (e.g. Kenworthy 2006; Norman et al. 2006; Eaton et al. 2007; Grazi et al. 2008; Dodman 2009; Kennedy et al. 2009; Glaeser and Kahn 2010; Satterthwaite 2011) and the international evaluation schemes for environmentally sustainable urban development (see Säynäjoki E. et al. 2012) place compactness of urban structure at the core of current guidelines for urban environmental sustainability. To be cost effective, infrastructure and services for public transportation, recycling of waste materials, and combined heat and power or waste-to-energy generation require a sufficient level of population density. Short distances encourage walking and cycling as an alternative to private driving. Limited living space reduces use of heating or cooling energy in apartments and high building density enables district heating. Therefore, insufficient density of urban structure is generally seen as a key constraint to major environmental improvement (see Säynäjoki E. et al. 2012, 2014c). Density is even used as a direct indicator for urban environmental sustainability (see Säynäjoki E. et al. 2014b).

In sparsely populated regions, where population density is not necessarily *high* in the absolute sense, even in the major cities, a political push for urbanisation and urban densification seemingly provides an ideal win-win solution. More centralised structures and shorter distances seem likely to bring about both environmental benefits and monetary savings for municipalities. Therefore, in sparsely populated regions, environmental sustainability can be systematically targeted through higher urban density (see Säynäjoki E. 2015). However, short-term economic considerations are found to dominate municipal decision-making (see Säynäjoki E. et al. 2014c), whereas environmental evaluations are not integrated into the decision-making phases of urban planning processes (see Säynäjoki E. et al. 2014a). The impacts of increased density might not be fully understood since the associated lifestyle changes are not considered or even understood (see Heinonen 2012). As a result, urban development may be characterized by values such as *new construction*, *improved consumption facilities* and *shopping-mall-like spatial design* even if it was originally intended to be environmentally sustainable (see Säynäjoki E. et al. 2014a).

## The environmental problematic of new construction

New buildings and infrastructure typically consume less energy compared to the old building stock and infrastructure, and new technologies are constantly developed for further benefits. Therefore, new construction can be seen to contribute to climate change mitigation by improving the use-phase energy efficiency of the built environment. However, new construction causes a substantial amount of emissions, i.e. the *carbon spike*, and the gains of energy efficiency contribute to climate change mitigation only after the carbon spike is redeemed (see Säynäjoki A. et al. 2012). For that reason the GHG emissions of new construction often conflict with short and midterm climate change performance (see Heinonen et al. 2011b). Introducing a temporal perspective into the study of GHG emissions of the built environment emphasises the harmfulness of the early phase emissions and questions the contribution of new construction to current climate targets.

*Figure 1* shows how long the payback times for new construction scenarios can be, despite the significantly higher energy use of the current building stock (see Säynäjoki A. et al. 2012). The *base case* is a standard building. *LE-50* stands for a low energy house (heating and cooling of 50 kWh/m$^2$/a) and *PH-15* for a passive house (15 kWh/m$^2$/a). *R-80s* represents average building stock from the 80s (185 kWh/m$^2$/a) and *R-60s* even older building stock being energy renovated to the *LE-50* level. Besides heating and cooling, the model includes communal building electricity consumption, while household electricity is excluded. Only the passive house scenario is beneficial compared to the 80s building stock, and only after 40 years. Within the 50 year time frame, none of the new building scenarios are beneficial compared to the energy renovation of the 60s buildings.

The example may be an extreme case, but presents a potential outcome. Even if the *car-*

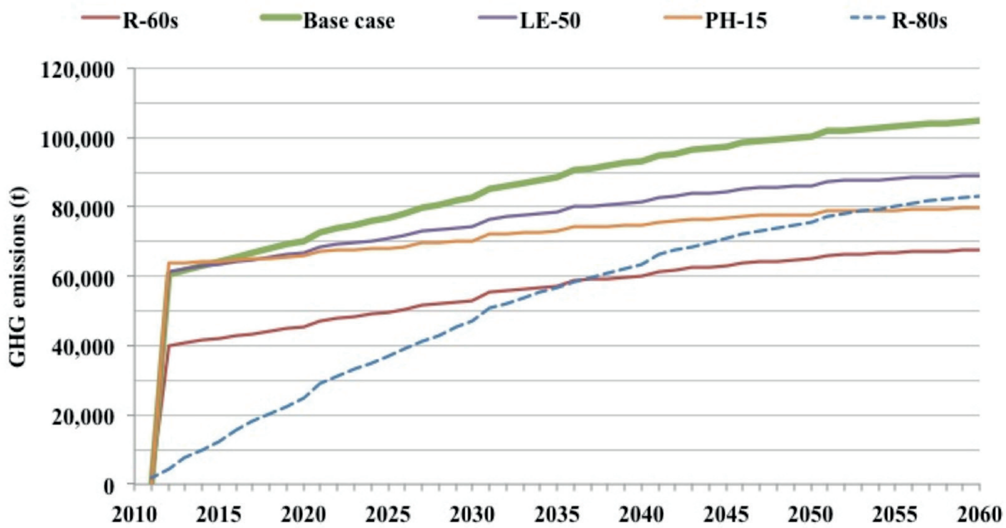


*Figure 1 GHG emissions of various new construction and renovation options during a 50-year time frame (Säynäjoki A. et al. 2012)*

*bon payback time* was cut into half, the *carbon spike* should still be taken into account when urban GHG mitigation strategies are designed. Massive emissions investments may not even be redeemed, let alone be beneficial, within the time frame of our national and international commitments to mitigation of climate change. The problem with current policies and practises is that the emissions reduction targets are set to a reference year, at which the use-phase emissions are supposed to be cut to a certain level. The cumulative accrual is not considered, however, and thus the *carbon spike* of new construction is likely to be ignored. The rationale of such an environmental strategy is questioned also with respect to transportation infrastructure (Chester and Horvath 2012; Chester et al. 2013).

Furthermore, the temporal occurrence of GHG emissions is very important (see Säynäjoki A. et al. 2012). The construction-phase emissions occur entirely at the beginning of the life cycle, whereas use-phase emissions contribute to climate change only gradually during the operational phase. Compared to the instant construction-phase emissions, use-phase emissions are susceptible to numerous uncertainties. The carbon intensity of energy production is currently relatively high in Finland compared to the other northern countries, but may decrease sharply in the near future. Significant reductions of GHG emissions in energy production during the operation phase of the new urban structures might reduce or even negate the anticipated benefits of improved energy efficiency. Moreover, use-phase emissions significantly vary amongst current alternative energy solutions in buildings (see Ristimäki et al. 2013). In fact, Ottelin et al. (2015) recently showed how in Finland in the 2000's the heightened energy efficiency requirements for new residential buildings have reduced the GHG emissions in less dense urban areas, but not in the densest cores.

## The environmental problematic of improved consumption facilities

Almost all consumption causes GHG emissions, but some consumption activities are more carbon intensive than others. Urban planning is supposed to facilitate emissions reductions through lifestyle shifts in the consumption categories of housing and ground transportation. Shorter distances and improved public transportation services are supposed to reduce private driving, and limited living space to reduce the energy consumption in buildings. What is not always considered is how the lifestyle shifts affect other consumption patterns and the total emissions of all consumption (see Säynäjoki et al. 2014c).

For example, short distances and improved public transportation may optimally lead to a situation in which a consumer does not need to own a private car anymore. Even if the change significantly reduces emissions in the consumption category of ground transportation, the net effect to climate change is dependent on how the consumer re-invests the monetary savings. If the consumer travels abroad more often, for example, the increased air travel can undercut the benefits of decreased private driving and in the worst case the net effect is negative. Overall, the choice to live in a dense city centre is basically a trade off between one's own living space and availability of service spaces in the near proximity. Thus, people living in small apartments may extend their living space into public and commercial service premises. They may also possess summer cottages or second homes, completely equipped with modern technology and heated all year round.

A recent study by Strandell and Hall (2015) confirmed that the so-called compensation effect can be seen to take place in Finland. This means that the residents of the densest urban areas are more likely to travel away for holidays and weekend trips than those living in lower urban density, in areas characterised by detached houses. As a result, a person spending an evening in a restaurant, for example, may consume heating energy, furniture, appliances and maintenance operations in three places at the same time. In addition, moving between these extensions of living space may increase traffic.

The annual per capita GHG emissions tend to increase through increased consumption when the disposable income increases, but the correlation is diminishing rather than linear (see Heinonen and Junnila 2011a). The effect of urban density on the consumption categories of housing and ground transportation is relatively modest and can be easily overridden with factors such as the local energy production system, the energy efficiency of the housing stock and the share of services in total consumption (see Heinonen and Junnila 2011b). The core elements of the urban environmental sustainability idea, population density, distances and daily journeys, public transportation facilities and housing type, seem to have little effect on the total GHG emissions of an average consumer (see Heinonen and Junnila 2011b).

It may seem to be contradictory, but the per capita emissions related to urban lifestyles are substantially higher than those related to rural and semi-urban lifestyles (see Heinonen and Junnila 2011c). The socioeconomic standard of living in the urban environments, potentially combined with improved consumption facilities, seems to generate more consumption-intensive lifestyles. This explains the higher per capita GHG emissions loads compared to those related to suburban living or rural lifestyles and a lower standard of living (see Heinonen et al. 2011a). The surrounding urban form seems to have little effect on the carbon footprint of an average consumer, compared to the impact of the person's overall consumption volume. Within denser urban structure, ground transportation generates a lower amount, housing a similar amount and other consumption a significantly higher amount of GHG emissions (see Heinonen 2012).

### The limited scope of urban environmental sustainability

Regional assessment schemes for eco-efficiency and environmental sustainability of the built environment are found to not consider the environmental burden of total consumption (see Säynäjoki E. et al. 2014b). Professionals of urban planning confirm that the scope of promotion and facilitation of environmentally sustainable lifestyles through urban planning is limited to the consumption categories of ground transportation and housing (see Säynäjoki E. et al. 2014c). The share of *other consumption*, referring to consumption categories other than housing and ground transportation, varies from a quarter to a half of regional GHG emissions (see Säynäjoki E. et al. 2014b). Remarkably, the share of *other consumption* is significantly larger than that of ground transportation, regardless of the type of region. The higher the level of urbanisation, the larger the share of emissions attributed to *other consumption*. At its largest, the share of *other consumption* surpasses even that of housing. Given that the absolute per capita emissions of total consumption are substantially higher in urban than rural and semi-urban areas (see Heinonen and Junnila 2011c) and increase towards the densest urban core (see Heinonen et al. 2011a), the potential emissions reductions of urban densification seem to be offset by an increase in *other consumption*.

*Figure 2* shows how increased air travel, for example, can undercut the benefits of decreased private driving. *HMA* refers to Helsinki Metropolitan Area, the densest urban settlement in Finland. The categories *cities*, *semi-urban* and *rural* include all the areas of these particular types in Finland.

Professionals of urban planning struggle with the extremely complex challenge of urban environmental sustainability. Decision-makers require environmental aspects to be simplified and quantified in order for them to take these aspects into consideration in decision-making processes (see Säynäjoki E. et al. 2014c). The environmental manifesto should support or be included in other political agendas, and not be in conflict with them. The perception of urban density as an indicator for environmental sustainability fits these requirements perfectly. The connection between urban structure and environmental sustainability could not be simpler or any easier to quantify than *the denser the better*. Furthermore, densification is assumed to provide both environmental benefits and monetary savings for the municipality. However, local inhabitants are not always happy with densification policies (Vallance et al. 2005; McGuirk and Argent 2011; Buys and Miller 2012; Kyttä et al. 2013).

Density is considered to be an imperative character of urban structure when considering environmental sustainability (see Säynäjoki E. et al. 2014c). The dominant belief is that densification has a strong positive impact on environmental sustainability. Professionals of urban planning do not, however, take into account a connection between urban structure and sustainable lifestyles or consumption choices, except in relation to housing and private driving. Urban planners would like to support sustainable lifestyles (see Säynäjoki E. et al. 2014c) but this is evidently difficult in the increasingly convenient centres of consumption that urban developments currently create (see Säynäjoki E. et al. 2014a).

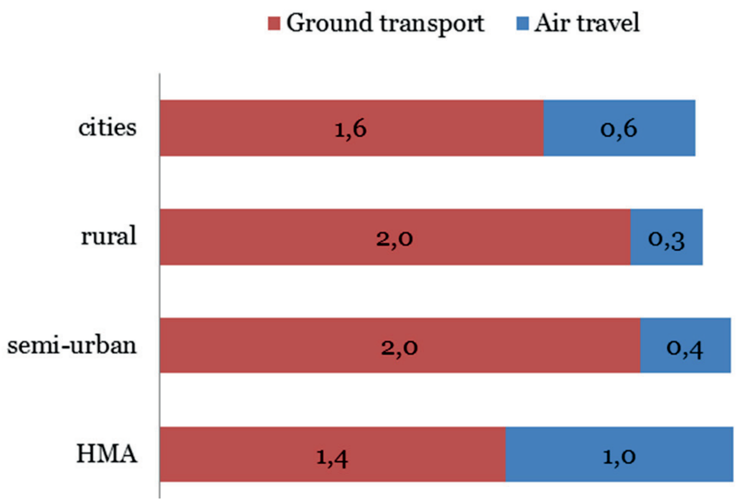


*Figure 2 Comparison of GHG emissions of an average consumer (t $CO_2$/yr.) between different area types in the consumption categories of ground transportation and air travel*

## Conclusions

The consumption-based approach to urban environmental sustainability is not claimed to be superior to more traditional approaches, but offers an additional and important point of view to this topical issue. Urban planning decisions can have long-term and large-scale consequences. Urban development systematically steers societal development towards a particular path, and choosing one path may preclude the possibility to take another. Where negative social impacts of urban development are justified on environmental grounds, for example, it should be ensured that reductions in the total environmental burden are truly achieved. Most critically, the temporal occurrence of GHG emission and the *carbon spike* of construction activities should not be ignored. Energy renovation and the maximum advantage of the current building stock should be considered as an alternative to new construction in order to both minimise the *carbon spike* and efficiently reduce the use-phase emissions.

Density is used as an indicator for environmental sustainability even if denser areas host more consumption and thus cause more environmental degradation per capita. The chosen strategy of attempting to build sustainable communities based on urban densification, and limiting the scope of the environmental considerations to ground transportation and housing, carries the risk of leading to a net increase in consumption. If all the direct and indirect environmental impacts of all consumption were taken into account, alternatives to densification could potentially be found to be more successful in reducing the environmental burden of urban communities.

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