NEUJOBS

CREATING AND ADAPTING JOBS IN EUROPE IN THE CONTEXT OF A SOCIO-ECOLOGICAL TRANSITION

SUSTAINABLE URBAN TRANSPORT STRATEGIES AND JOB CREATION

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Abstract

The socio-ecological transition is best defined as a major change in the patterns of human social organisation, culture, production and consumption that is driving society towards a more sustainable future. One particularly notable aspect of the current transition is determined by the size and organization of the urban system. Currently, 75% of the population in the European Union is living in urban areas and this is projected to rise to at least 80% by 2020 and more than 85% by 2030 (EEA 2006). Increasing the sustainability of urban traffic is therefore essential.

This deliverable combines literature review, case-studies and model results to gain insight in the impact of urban policy on sustainability, employment and other variables impacting the liveability of the city. We compare theoretical predictions with real city policies and show how these fit in the macro-trends of the socio-ecological transition. We also calculate job creation multipliers of different strategies, which we compare with literature and practice.

We find that the policies most likely to contribute to sustainability, while at the same time stimulating employment are 'pro-cycling policies', 'promotion of public transit' and 'promotion of energy efficiency'. Promotion of fuel efficient and electric vehicles has environmental benefits, but less beneficial and possibly negative impacts on employment and GDP.

TABLE OF CONTENTS

INDEX OF TABLES

INDEX OF FIGURES

Sustainable Urban Transport Strategies and Job Creation

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1. Introduction

The main aim of this deliverable is to study the impact of changes towards sustainable transport strategies on the urban level and link these changes with the labour market. We refer extensively to the urban economics literature and give examples of urban transport policy across Europe. The contribution of this paper lies in its combination of theory, policy study, case studies and modeling to gain insight in one specific question: "How does urban transport policy translate in livability and employment?" In the aspect of job creation, we follow an approach that resembles the one used in D14.2 (Meijer et al, 2012), by using job multipliers[1] to compare the impact of different transport strategies on employment.

Our basis is still in the same type of scenarios as those used on the macro-economic level in the previous paper (D15.2 -Heyndrickx et al, 2013), but with a radically different focus. We focus on urban policies that promote the sustainability of the transport system. We define a policy towards 'sustainability', as a policy that leads to a reduction in the environmental and/or social damage of transport, to a level that better reflects the economic and social benefits of transport.

This change in focus towards the urban transport system has a number of reasons:

The first is that the size and growth of the urban areas is an important aspect of the socio-ecological transition (Fischer-Kowalski M., Haas W., et al 2012) and is a main driver for changes in the transport system. By 2050, urban regions will have absorbed 3 billion new dwellers (UN, 2011). The growth of the urban region is strongest in the developing countries, but is nowhere near to stopping in the most developed countries. In 2050, more than 85% of the European population will live in urban (or urbanized) regions.

Secondly, the form and in particular the density of the urban region play a decisive role in transport energy requirements (Marshall, 2008). In fact, Marshall estimates that avoiding a further reduction of urban density in the US, in combination with a 1% annual improvement in energy efficiency could reduce urban automobile emissions with as much as 18 Gigatonnes until 2054. Weisz and Steinberger (2010) support this view and claim that the main way to reduce material and energy flows in the city is by reducing car dependence in the cities and reducing the material and energy

[1] These job multipliers are expressed in jobs created per million euros of investment or per million euros of energy savings.

requirements for buildings. Van de Weghe et al (2007), based on a transport census in Toronto, shows that suburban dwellers are much more dependent on automobiles. Piorr et al (2011) claim that urban sprawl in Europe is detrimental to sustainable development and deserves more attention within the European Union. Grazi et al (2008) show that transport-related carbon dioxide emissions are 47% in the highest population density class, compared to the lowest.

Finally, a number of interesting and innovative policies are being implemented on city level today, which may be a driver towards a generally more sustainable transport system in Europe. The urban system is a smaller, more compact version of the national economy, characterized by an important interaction between land use, job location and employment. The urban system provides an excellent case-study for sustainable strategies and green job creation. Adaptive and better urban (transport) planning and the request of innovative solutions could be a motor for green jobs. (UNEPb, 2011, see especially p.183)

The structure of this paper will be as follows:

We start this paper with some empirical facts on urbanization across Europe. To analyze the current trends in urban development and put it into perspective with the socio-ecological transition, we give an overview of the basic principles of urban economics. This theory will serve us to discuss some of the mayor trends in urban economics and to discuss the impact of urban policies more in detail.

In a next step, we connect the macro-scenarios from D15.2 with the present policies on the urban scale. We look into specific policies aimed at more sustainable urban planning that are currently being implemented in various cities in the EU and show that they can be arranged in the same lines as our macro-scenarios. We give examples of policy made on the EU, national and city level. Urban planning is a very broad domain, covering among others transport, energy, and waste management. In this report we will focus on policies related to urban transport. We will discuss these policies and check them against urban-economic principles.

Then this paper will focus on marginal changes towards sustainability. In D15.2 we developed complex scenarios of the future situation and modeled the impact of radical changes in the transport system. Here we develop multipliers on the basis of scaled-down scenarios, that can be applied on a much smaller scale and which are relevant for the present economic situation. In fact, while D15.2 would provide the result of promoting a certain policy (or set of policies) over a longer term, this paper shows what the marginal impact can be of policy when implemented now. Multipliers, as those calculated in this deliverable are an excellent tool to use on this more limited setting.

Based on the case studies and other studies, we present an overview that summarizes the main elements of a successful urban transport plan and gives an indication of possible effects on the side of the labour market.

2. Urbanization: theory and empirical findings

2.1 The role of cities

Economic explanations for the existence of cities focus on jobs and the location of employment. There are certain economic forces that cause concentration of employment in certain places. People will settle near these work places, leading to a concentration of residences. A city is the outcome of this process. According to Brueckner (2011) there are two important economic forces that govern this process: scale economies and agglomeration economies.

Economies of scale happen when businesses become more efficient at larger scales of operation. The cost per unit of output decreases with increasing scales, as fixed costs are spread over more units of output. A greater operational efficiency can also lead to lower variable costs. These economies operate within a firm , and favour the formation of large firms over small. The ability to exploit economies of scale in general depends on the size of the market, and the availability of input factors. In the context of urban economics, this comes down to the size of the city, in the sense that both the size of the market and the availability of labour force depends on population density. Of course, the markets of more distant regions can also be accessed, but this access is limited by transportation costs. Economies of scale explain the formation of company towns (e.g. automobile assembly plant). However, it cannot explain how very large urban agglomerations form. For this to happen agglomeration economies are necessary.

Agglomeration economies are the benefits that firms experience when locating in a large city. They are external to a firm. There is a distinction between pecuniary and technological agglomeration economies. Pecuniary agglomeration economies reduce the cost of firm's inputs without affecting the productivity of the inputs. Technological agglomeration economies on the other hand raise the productivity of the inputs without lowering their costs.

Pecuniary agglomeration economies occur for example in the labour market. The pool of specialized workers a firm is looking for is larger in big cities, and therefore the cost for finding this type of specialized personnel is lower. On its turn, this can attract more specialized labour, strengthening the agglomeration effect. Furthermore, in a big city there might be a large concentration of suppliers of a product or service that is used by a certain firm. This large concentration will increase competition, and bring down prices, leading to a lower production cost for the firm. Finally, a firm can reduce its transportation costs by moving close to its market, and close to its suppliers. For many types of enterprises, a big city represents a large market, and also hosts a large amount of suppliers.

In technological agglomeration economies one can distinguish between urbanization economies and localization economies. Urbanization economies occur if one firm's costs fall, with a rise in local output (regardless of industry). Localization economies occur if one firm's costs fall, with a rise in local output from other firms in same industry. Empirical research has found a positive relationship between worker productivity and total employment in a city (i.e. urbanization economies). But the link between worker productivity and employment within the own industry is much stronger (i.e. localization economies). There are different sources of localization economies. A first is the benefit of labour pooling. A concentration of firms generates a large pool of workers. The increased number of potential employers allows firms to make a better selection, and thus leads to a better match between workers and employers. A second type of benefit is the development of industries due to the increasing returns to scale in intermediate inputs for a product. Finally, there is a relative ease of communication and exchange of supplies, labourers and innovative ideas due to the proximity among firms. This latter is also known as "knowledge spillovers".

2.2 Urbanization trends across Europe

The world is becoming more and more urban. Since 2009, more than half of the world population lives in urban areas according to the World Urbanization Prospects (2010). In developed countries, this number is even higher: here 78% of the inhabitants lived in urban areas in 2011. Urbanization is expected to continue rising in both the more developed and the less developed regions so that, by 2050, urban dwellers will likely account for 86% of the population in the more developed regions (see Table 1).

Table 1. Percentage urban by development group, selected periods, 1950-2050 (from World Urbanization Prospects (2012))

	Percentage urban					Rate of urbanization (percentage)			
Development group	*1950*	*1970*	*2011*	*2030*	*2050*	*1950-1970*	*1970-2011*	*2011-2030*	*2030-2050*
World	29.4	36.6	52.1	59.9	67.2	1.09	0.86	0.74	0.57
More developed regions	54.5	66.6	77.7	82.1	85.9	1.01	0.38	0.29	0.23
Less developed regions	17.6	25.3	46.5	55.8	64.1	1.81	1.48	0.95	0.69

In the European Union (EU) over 75% of the population lives in urban areas today, with a projection for this to reach 80% by 2020 (EEA 2006). This translates to a dense urban network containing about 5000 towns with a population between 5000 and 50,000 inhabitants, and almost 1,000 cities with more than 50,000 inhabitants. However, only few of these cities are very large: only 7% of the EU population lives in cities bigger than 5 million inhabitants, compared to 25% in the USA, and only 5 EU cities appear among the 100 largest in the world (CEC 2008).

In WP 8.3 of the Neujobs project (Cullman & Geppert (2012)) a slow but constant trend of urbanisation was observed both for the EU15 and the EU12. The shares of large metropolitan areas in total population and total GDP are rising, the shares of small metropolitan areas are remaining constant and the shares of the other regions are falling. However, this gradual process of spatial concentration does not necessarily involve urbanisation in a stricter sense. Most of the large metropolitan areas consist of core cities and vast hinterlands of intermediate and rural territories. Such a regional concept is not really appropriate for the identification of potential changes in the behaviour of individuals or firms in terms of urban locations.

According to the Piorr et al. (2011), urban areas expanded their surface area by 78% between the 1950s and 1990. In the same period the population increased only by 33%.

This trend continued to 2000 where the population in the EU25 increased by 2% while the urban area increased by more than 5%, mainly as a result of increased numbers of households and decreasing size of households (Jansson et al. 2009). The result of this trend is urban sprawl: the physical pattern of low-density expansion of large urban areas, under market conditions, mainly into the surrounding agricultural areas (EEA 2006). The causes of urban sprawl are various: means of transportation, price of land, housing preferences, demographic trends, cultural traditions, attractiveness of existing urban areas, land use policies, etc. The urban model of section 3.1 provides a framework that links these factors and urban sprawl.

A case study for Germany in WP 8.3 reveals some interesting trends regarding the urbanization process. It was found that cities with a population of at least half a million were not affected by the general process of shrinking population, but instead increased the number of their inhabitants. Big cities are also getting younger compared to the national average. The number of people under the age of 18, for example, is decreasing only half as much in cities as in Germany as a whole. At the same time, the number of people aged 18-25 is growing nearly twice as fast in big cities as on average. The age group of 25-30 years is increasing in big cities but shrinking in Germany as a whole. From 1999 to 2010 the number of births has risen in the cities while having declined in the rest of Germany. The birth rate per inhabitant is now significantly higher in cities than in other areas. Regarding employment the process of spatial decentralisation of jobs and income that was observed until the second half of the 1990s has changed form. Since then, employment in big cities increased more than in other areas. Over the last 10 years, German cities have lost disproportionally more industrial jobs. The increase of total employment in big cities is mainly due to the improved position of cities in traded services, such as financing, insurance and consulting. Spatial clustering and localised knowledge spill-overs play an important role here. Two tendencies reinforce each other: knowledge-intensive firms are pulling skilled workers to urban places and skilled workers are pulling knowledge-intensive firms to these places. Cullman & Geppert (2012) conclude that there is a significant shift in the spatial distribution of population and employment, and that there is little reason to assume that this tendency is only happening in Germany.

Summarizing, we see that European society is characterized by an overall increase in the amount of urbanization. The Green Paper for Europe (GHG 2050) projects a further urbanization in Europe from 72% to 78% in 2030 and 84% in 2050. This urbanization process is incorporating two tendencies. The first is an increase in the amount of urban sprawl, which is the physical pattern of low-density expansion of large urban areas. Secondly, there is a re-urbanisation tendency. These findings are also confirmed in other studies such as Sessa & Enei (2009).

3. Urbanization and the transport system

3.1 Theory of urban economics: land use, commuting and transport

Urban economics describes the relationship between the spatial structure in a city and the location of households and firms. It can also be used more broadly to analyse topics such as public transit, education, pollution, crime, housing policy, and many others. Many analyses in urban economics rely on a particular model of urban spatial structure, originating from the work of Alonso, Muth and Mills (AMM) in the 1960s. The following discussion on this model is a summary of the excellent work of Brueckner J.K. (2011), for a more detailed analysis we refer to this author.

There are a number of simplifying assumptions in the basic model that still capture essential relationships in cities, but at the same time allow for an easier analysis. The first assumption in this model is the existence of a Central Business District (CBD) located in the center of the city, which is collapsed into one point. We assume that all consumers need to commute to this CBD to earn a certain income (y) which is independent from their commuting costs. The second assumption is that the use of transport for commuting is a real cost to the consumer and thus does not contribute to the utility of the consumer. We also assume that there is a transport network going to / from the CBD, such that the total transport cost of the household strictly rises when the household is locating farther from the CBD. The two former assumptions give the basic premise of the model: the disposable income of the household goes down when locating farther from the CBD. All households have the same preferences, which are given by a utility function with 2 variables: 'housing' and 'other goods'.

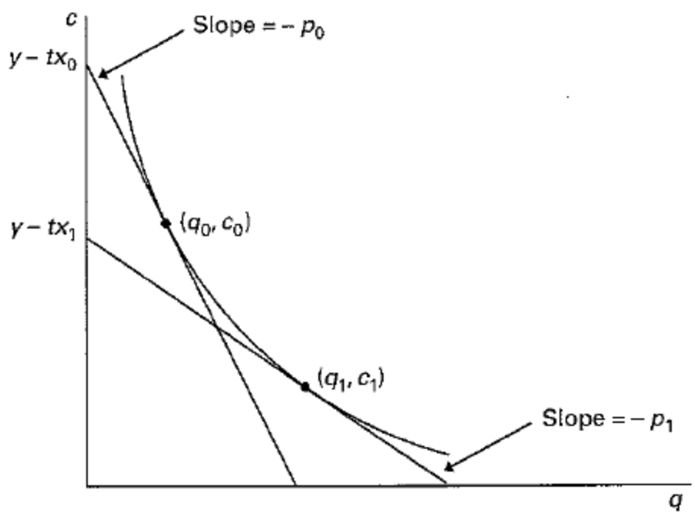
Consumers are thus maximizing a utility function u(c,q) that expresses their satisfaction over the current amount of housing (q) and other goods (c). Consumers try to maximize their satisfaction given their budget constraint. This budget constraint is determined by their income (y) minus the total transportation cost (t.x). This represents the transport cost per km t (consisting of various components such as gasoline, insurance, depreciation, opportunity cost) and the distance from the CBD (x). The price of other goods is put equal to 1 and is used as a numeraire, only the price of housing (p) varies when moving away from the CBD.

$$c + pq = y - tx \quad (1)$$

The final assumption necessary to solve this model is that the consumers are distributed over all locations such that the utility of the households is equal in all locations. In this way no consumer has an incentive to deviate from his/her choices of location. This is called a consumer locational equilibrium. In this equilibrium all consumers having the same preferences are equally well off in terms of utility, regardless where they choose to locate their residence.

For this to be possible, the housing price p should be a function of the distance to the CBD. As can be seen in Figure 1, people living closer to the CBD have a higher consumption budget (after deduction of the travel costs). To end up with equal utility as people living further (and thus having a lower net consumption budget), prices of housing should be higher near the CBD. This means in turn, that the higher the locational distance of the consumer from the CBD, the more living space they can consume. It is exactly this trade-off which is leading to the formation of a dense core-city with high housing prices in the center and a sub-urban periphery with low densities and low prices per square meter. This trade-off is represented in Figure 1.

Figure 1. Consumer choice (Brueckner J.K, 2011)



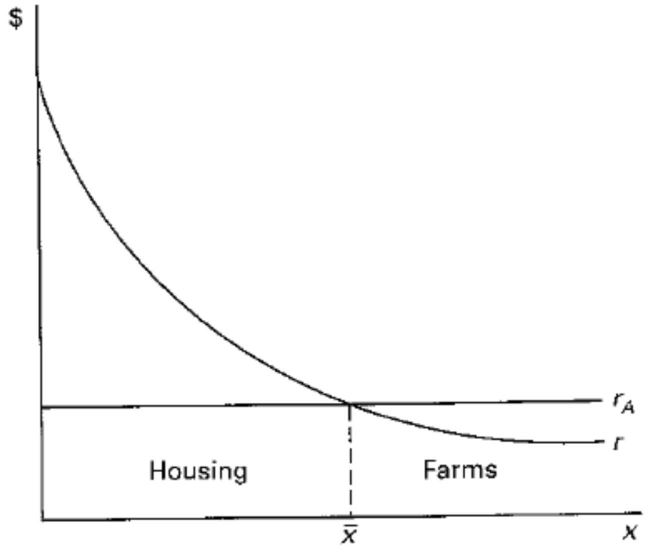
Further mathematical analysis shows that the slope of the housing prices as a function of the distance to the center is given by the following equation:

$$\frac{\partial p}{\partial x} = -\frac{t}{q} \quad (2)$$

This **model thus predicts that pricing per square meter drops when moving away from the city center, relative to the increase in transportation costs incurred by a representative commuter**. This outcome is consistent with what can be observed in reality (see e.g. Coulson, 1991 for an empirical study).

The model also links population and land use with income and commuting cost. To accomplish this, it is assumed that there is a **supply-demand equilibrium** in the city, meaning that the number of citizens wanting to live in the city equals the amount of dwellings in the city. The number of dwellings in a city is determined by the size (i.e. land area) of the city. This land area is on its turn determined by the land price: if the price that land developers are prepared to pay becomes too low, it will be better to use the land for other purposes (e.g. agriculture). This determines the size $\bar{x}$ of the city. Note that the price land developers are prepared to pay is related to the price p consumers are prepared to pay for their dwellings, which is on its turn determined by the commuting cost t and the income y.

Figure 2.City size determined by an outside price for agricultural land (r), Brueckner J.K (2011)



This is illustrated in Figure 2, the area of the city (housing) is characterized by a declining price for building grounds while moving away from the center (CBD). At some point $\bar{X}$, the alternative price for land use r_A (given in this example by agricultural use) is higher than the land rent for building. This determines the size of the city.

If the bid price for building grounds shifts upwards, because:

- The population of the city increases and hence the demand for building grounds, this is actually characterized by a lower utility of the consumers (u)
- The transport system is improved and is characterized by a lower relative cost per kilometer (t)
- The income in the city increases, which leads to a higher disposable income (y)

Then the city will grow until a new point is reached where the land rent (r) is equal to r_A .

3.2 From model to reality: understanding urban transport policy

The model described in the former section offers a strong basis for analyzing urban transport policy. Of course, it is impossible to review all possible applications of this model for urban transport, but summarizing its main conclusions will help us to gain better understanding of urban policies.

The main conclusion is that there is an intricate link between the transport system, the housing and land prices and the system of urban settlements. The lower the transportation costs to and from the city center, the lower the land rents within the city and the lower the population density of the city altogether. Urban systems characterized by very low transport costs will spread out remarkably far from the center and will be characterized by low population densities. Baum-Snow N. (2007) shows empirical proof of the link between the introduction of highways and the rise of suburban settlement in the United States.

Starting from the mechanisms explained above, it is easy to understand that if the personal cost of transport is lower than the full social costs of transport, cities will be too big and characterized by a lower efficiency of land use. If transport users can be made to pay the external costs of transport (f. ex. congestion, environmental damages and accident costs), cities become smaller and denser with a better functioning transport system.

In theory, the social optimum can be reached by introducing a system of variable road charging on the transport network, treated a.o in Small & Verhoef (2007), Anas A. et al (2006). In the absence of a system of road charging, which is often hard to realize politically, cities have tried to use alternative measures to reduce the external costs of urban transport.

- Urban planning and implementing 'soft' measures to reduce the capacity for road traffic in the city center (narrowing streets, creating speed bumps, introducing low traffic zones, reducing accessibility for car transport to certain hours, etc.)
- Investing in public services and city amenities to increase the attraction of the city and its central region for households (Thisse et al, 1999).
- Tax based policies: taxation of the suburban land use and land development taxes
- Fiscal stimuli to promote the use of public transport for commuting (Hirte et al, 2011).
- Decreasing the amount of parking space in the city or equivalently increasing the cost of parking in the center (Anderson et al, 2004; Arnott J. ,2010)
- Urban growth boundaries (Brueckner J.K., 2007)
- Investments in public transport, especially within the city. Sometimes combined with park & ride solutions or so called 'Fringe parking'.
- Access restrictions for certain types of transport (freight, high polluting transport) or certain users (residents only) within the city, sometimes combined with a Low Emission Zone (LEZ) or other systems of urban tolling.

We will consider several of the alternatives mentioned above in more detail in the following sections. For a theoretical exposition of the impact of several of these measures in a city level general equilibrium, we can refer to Anas A. (2012).

Alternatively, many interesting cases for the analysis of urban transport actually arise for those situations where the AMM model does not exactly hold or should be adapted to better fit with reality. Interesting real world deviations arise for example when:

- Not all jobs are located in the center (CBD), but are subdivided over a number of sub-centers (SBD's). This is often referred to as polycentric cities. Polycentric cities are often characterized by lower densities and an absence of a clear 'rent curve' moving outward from the city. They are more difficult to understand than the standard AMM. Fujita & Ogawa (1982) give a theoretical exposition on how this type of urban configuration can originate, based on the location costs, transport costs and benefits of co-location of firms and households. Polycentric cities are in general characterized by low transport costs and higher degree of urban sprawl. However, it is hard to prove that large poly-centric city would be less environmentally friendly than compact mono-centric cities (f. ex. Thisse et al, 2010).

What matters is the mix between the population density and global pattern of activities.

- Locating in the city gives consumers the possibility to use a number of public goods that cannot be consumed outside the city. Examples are cultural services (theaters, movie theaters, musea, historical buildings, etc.), educational services (good quality schools, universities) and public services (fire protection, police,…). It is claimed by for example Thisse et al (1999) that the presence of this type of amenities in Europe leads to a higher degree of mono-centricity and promotes the central location of rich households, compared to the US.
- Access to distribution services, shopping centers, goods moving inward from ports, access to agricultural goods, transport costs of goods,… play a larger role in the location of people than commuting. Even in a city where the commuting costs are non-existent, pricing differentials can arise caused by accessibility to consumption goods.
- There are multiple types of consumers, with a different income earning characteristic. These consumers have access to different types of transport modes (for example public versus private transport) and hence differ in their locational preference within the city. This is easily extended to other parameters than only income, such as access to a more extensive social network or even racial discrimination. This can also be used when there are obvious asymmetries in income and access to information, for example in the case of unemployment. This has been treated from example in Wrede (2011) and Zenou Y. (2003, 2005, 2010).

4. Current measures and policies in urban transport

This section discusses current measures, policies and initiatives relating to urban transport that are taken at different institutional levels in Europe.

4.1 EU level: Green paper on urban mobility and action plan & White Paper

Over 60% of the European population lives in urbanized areas and urban mobility causes around 40% of all road CO2 emissions and 70% of the other pollutants of transport Congestion in and around urban areas is estimated to cost nearly 100 billion euros (1% of the EU GDP), annually. The EC underlines the importance of a joint framework for assessing the impact of transport on the urban environment, but refers to the city level as the base place to take concrete actions[2].

In 2009, the European Commission adopted the EU level action plan on urban mobility (EC, COM/2009/0490 final). The European Commission places itself mainly as a supporter of innovation in urban policy, providing stimulus and facilitating communication between the actors. Significant funding is provided through the Structural and Cohesion Funds, of which urban policy is an extension.

[2] http://ec.europa.eu/transport/themes/urban/urban_mobility/

The plan is built around 6 themes.

1) Theme 1: Promoting integrated policies
2) Theme 2: Focusing on citizens
3) Theme 3: Greening urban transport
4) Theme 4: Strengthening funding
5) Theme 5: Sharing experience and knowledge
6) Theme 6 Optimizing urban mobility

In the EC White Paper (2011), the focus is on an integrated urban mobility. This concerns three concrete measures, based on the green paper on urban mobility.

1) **Establishing urban mobility plans**, with independently validated Urban Mobility Performance and Sustainability certificates. These plans can be the basis for assigning regional development and cohesion funds.

2) **Establish an EU framework for urban road user charging:** this would be a legally valid framework of access restrictions and road charging.

3) **A strategy for near zero emission urban logistics in 2030:** guidelines to manage urban freight flows, regulatory limitations, charging zones (LEZ)

The action plan under theme 2 and theme 3, proposes a number of measures to reduce the environmental cost of transport, some of which were also treated within D15.1 and D15.2 of the NEUJOBS project. The match between the action plan and the policy scenarios is presented in

Table 2.

Under theme 2, these are related to passenger rights (Action 4) and accessibility for all citizens (Action 5). Under theme 3, actions are focused mainly on promoting clean vehicles and pricing. Supporting research into lower zero emission vehicles, such as electric vehicles (Action 10) and an internet guide on efficient vehicles (Action 11). Pricing actions are: internalization of external costs (Action 12) and exchange of urban pricing schemes (Action 13). Under theme 4, this is confirmed again by maintaining support of the programs STEER and URBACT (Action 14) as well as the successful CIVITAS program (Action 15).

Under theme 6, the main actions are related to supporting research in urban freight transport planning (Action 19) and the use of the new Galileo system for transport purposes (Action 20).

Table 2. Match between policy scenarios treated in D15.2 and the EU action plan on urban mobility

	Policy scenarios in D15.2	EU policy under action plan
1&2	(Fuel) efficiency	Driving education for more efficiency (Action 9) Low and zero emission vehicles (Action 10) Internet guide on clean vehicles (Action 11)
3	Electrification of transport	Low and zero emission vehicles (Action 10) Support for STEER project (Action 14)
4	Internalization of external costs of transport	Internalization of external costs in urban systems (Action 12) Support of urban pricing schemes (Action 13)
5	Reduced use of own car transport in favour of public transit and car sharing	Passenger rights (Action 4) Accessibility of transport for persons with reduced mobility (Action 5) Behavior for sustainable transport use (Action 8)
6	Increasing transport efficiency Reduction in administrative inputs to transport (E-Freight)	Improving travel information (Action 6) Urban freight transport (Action 19) Intelligent transport systems for urban mobility (Action 20)

Analyzing the actions falling within these themes, we see that the EC strives to accelerate the take-up of sustainable mobility in the urban transport plans. The EC refers mainly to 'soft and informational' measures, such as: internet databases, exchanges between stakeholders, support to innovation, exchange of good practices and recommendations. The urban mobility action plan does not refer to strong commitments, other than those that fall within the Structural and Cohesion Funds. Within CIVITAS (action 14), eight thematic categories of measures have been identified as the basic building blocks of an integrated strategy for sustainable mobility. These building blocks put in place a planning framework, guarantee political involvement and establish partnerships. Each city chooses a set of mobility solutions from these building blocks according to their local priorities.

1. **Clean fuels and vehicles**: promoting hybrid private and public vehicles, increase penetration of electric vehicles and improving fuel economy
2. **Collective passenger transport:** promoting novel strategies for collective transport, changing travel behaviour, promote and intensify public transit use
3. **Demand management strategies:** urban pricing, introducing road charging, introduce low emission zones, parking permits and prices
4. **Mobility management:** promotion of public transport, improve planning for public transit on city level, raise awareness for mobility campaigns
5. **Safety and security:** security improvements in public transport, cycling, pedestrian security
6. **Car-independent lifestyles:** car sharing, city bike schemes, bicycle rental

7. **Urban freight logistics:** restrictions for freight transport in cities, central delivery points for freight
8. **Transport telematics:** traveller information, capacity and network loads, improve network management

4.2 National and local level

4.2.1 Examples of pilot projects from the NICHES and NICHES + projects

The NICHES (2004-2007) and NICHES + (2008-2011) projects collected a number of innovative practices for urban transport, that fit within an overall progress towards more sustainable cities. These are also comparable with CIVITAS measures

Table 3. Match between D15.2 scenarios and urban policy scenarios in the NICHES projects

	Policy scenarios in D15.2	Urban policy in NICHES and NICHES + projects
1 & 2	Fuel efficiency of cars (and full economy)	Policy strategy for clean vehicles (NICHES) Joint procurement of clean vehicles (NICHES) Biogas in captive fleets (NICHES) Environmental data management (NICHES +)
3	Electrification of transport	Using electric vehicles in city car schemes (NICHES +)
4	Internalization of external costs of transport	Transportation Management Associations (NICHES) Local taxes or charges – road charging(NICHES)
5	Reduced use of own car transport in favour of public transit and car sharing	Urban lift services (NICHES) Public bicycles (NICHES) Call-a-bus services (NICHES) Travel training for public transport (NICHES +) Innovative cycling facilities (NICHES +) Infrastructure for innovative bus systems (NICHES +) Tailored traveler information for users with reduced mobility (NICHES +) Infrastructure for innovative bus systems (NICHES +) Neighborhood accessibility planning (NICHES +) Group Rapid Transit (GRT) and Personal Rapid Transit (PRT) (NICHES+)
6	Increasing transport efficiency Reduction in administrative inputs to transport (E-Freight)	Space management for Urban Delivery (NICHES) Inner-city night delivery (NICHES) Alternative solutions for home delivery (NICHES) Financing and implementing traffic management centres (NICHES +) Mobile information services for public (NICHES +)

4.3 Policy on the level of the city: Copenhagen, London and Milan

4.3.1 Introduction

In the paragraphs below, we discuss the city level policies of three cases in particular: Copenhagen, London and Milan. We have chosen these three cities for a number of reasons.

The first is that the policies implemented by these cities have received a lot of attention and were particularly successful or interesting in a number of aspects. London, Copenhagen and Milan are not unique in their implementation of policies, but have been forerunners in implementing particular urban transport policies. Some examples being: urban road tolling, management of public transport, urban planning, promoting electric vehicles, access restrictions and cycling policy.

The second reason is that, while the strategy of each city is comparable to some degree, the cases are very diverse and show notable differences in the historical background conditions and the city's culture. Each of these cities can be considered as an important economic centre within their respective country. Each city has inherited a number of particular problems which are particular for its location. Each city has taken up policies that reflect and try to mitigate those particular problems. The idea to focus on a small number of different cities and discuss these with a relative amount of detail also reflects the 'small-N' idea used throughout the Neujobs project.

The third and last reason is that there is plenty of information on each of these cities, as well as critical analysis of the policies. Within the budgetary and time limits of Neujobs, we were unable to gather a lot of additional information on each city or perform interviews with the responsible administration. These three cities fitted perfectly within the framework of Neujobs and could be used to provide practical examples of sustainable transport strategies, without falling into a 'data gap'.

4.3.2 Copenhagen

The city of Copenhagen is a famous example of urban planning in Europe. Confronted with uncontrolled growth of the city and difficulties in the development of public transport, it was decided to implement the famous 1947 'Fingerplan' that expanded the city along newly constructed railway lines, with larger green wedges for agricultural and recreational purposes in between. This plan was largely successful in controlling the pressure of the urban environment on the surrounding area, while allowing commuters from surrounding municipalities to access the dense metropolitan area by the 'extended' S-train fingers. It can be interpreted as a remarkable success in urban planning, which contributed largely to the livability of Copenhagen in Europe.

Following the logic of the concepts explained in the previous chapter, the 'Fingerplan' allowed for a controlled expansion of the urban area, allowing consumers to access unused land minimizing the environmental externality caused by their increased demand for transport. The 'Fingerplan' was updated several times, allowing for the construction of a sixth finger, also known as the Ørestad development, which was enabled in 1992 by the Ørestad Development Corporation (ODC). The ODC was a new concept in urban planning, consisting of public-public cooperation between the national government (55% of land owned) and municipality (45% of land owned). The idea of the ODC was to develop the famous driverless 'mini-metro' line, financed by the increase in land value in the area and the income from ticket prices.

This concept had more mixed results (Majoor S.J.H, 2008), due to lower than anticipated demand for land in the Ørestad area (-15%) and property tax income (-60%), higher development costs (+66%) conflict between the goals of the federal government and municipality (for example in the implementation of an out-of-centre shopping mall) and lower than forecasted profit on the new metro line (-146%). Eventually the plan had to receive additional financing from national level and required a number of important adjustments in the foreseen land use, moving from land from office space towards a larger share for housing. Until today the area remains quite lowly developed, though the new connection with the airport and the shopping mall have attracted additional passengers. In general it has been much more difficult than initially anticipated to make the area attractive, given its distance from the city centre. The result was that the city decided to pursue a goal of more demand-oriented policies, rather than the supply oriented policy it has taken.

The current master plan for urban transport planning in Copenhagen consists of a Transport and environment plan (2004), a cycle policy (2002-2012), the Copenhagen climate plan (2009) and a Municipal strategy (2009). The core elements of the plan can be summarized in 3 points.

1. **Cycle plan**: Removing missing links, increasing safety of biking, implementing of green waves for cyclists at traffic lights, etc. The main goal is to make at least 1/3 trips in Copenhagen a 'cycle trip'.
2. **Integrated public transport**: A number of policies were implemented to develop interconnections between the different public transport systems, such as simplifying ticketing, introducing fast lanes and allowing for real time information and route planning.
3. **Close to station concept** (1987): Which aims to increase density around stations, favoring public transport use and concentration of high density buildings around trains stations. It also includes increasing the attractiveness of station areas for housing and recreation.

We see that in Copenhagen, urban planning was of primary importance in shaping the city and increasing the sustainability of transport. While the city was quite successful in increasing liveability of the city and reducing congestion and environmental pressures of transport, it was not always successful in reaching all of its development goals, for example in Ørestad.

The city is focussing many of its current policies on the promotion of cycling and public transit. Urban planning and promoting development around the main public transport hubs is still one of the primary elements of the municipal plans of Copenhagen.

4.3.3 London

When one thinks about traffic management and London, the London Congestion Charging Scheme (LCCS), introduced in 2003, immediately pops into the mind. The city of London suffered a constant decline of driving speed in the city centre since the 1980's. From 1986 till 2002 average speeds on the network decreased from 17.2 km/u to 14.2 km/h. The constant increase in traffic congestion led to a number of transport policies, mainly involving the further extension of metro lines and changes in traffic management and parking.

The introduction of the charging scheme was very effective in the first years of the scheme. Reduction in congestion was -30% in the first year of the scheme, but reduced each year, to reach 2002 conditions around 2007 (Tfl, 2007). Public acceptability of the scheme increased strongly in the first years of the charge, but has since been moderate. Extension of the LCCS to the west of London was met with substantial public opposition and was eventually abolished in 2011. The apparent lack of longer term effects of the scheme seem to be caused by a reduction in the available road capacity, increase in bus transit and changes in traffic management. Some authors, such as Santos (2008), claim that matters would have been worse without the congestion charging system in place. One important aspect of the charging system is its aspect for redistribution of revenues. Any revenues collected need to go (within a 10-year span) exclusively to the improvement of the road and public transit network. This was an important aspect to gain public acceptability for the scheme.

It must be said that the congestion charge was criticized for a number of important defects that were contrary to theoretical recommendations:

- For giving large discounts to residents of the central area (-90%) and other exemptions
- Little difference in timing, location and trip distance (not kilometre dependent)
- High operational cost and implementation costs (£200 million)
- The limited area it extends to (central city alone)

Instead of extending the LCCS for Greater London, a Low Emission Zone (LEZ) was established to stimulate renewal in the car fleet and reducing the environmental impact of transport. This was combined with government efforts to promote and popularize electric vehicles, adding up to 25,000 recharging points by 2015 and introducing purchase incentives for low carbon vehicles. The city has also taken more advanced technological measures, for example by introducing a parking charge that is dependent on the type of vehicle. More polluting vehicles are subjected to a higher parking charge.

One notable policy that has helped to stimulate public transit, beside the LCCS, was the introduction of the Oyster pass, which allows seamless transport across the public transit system and has reduced on-bus ticket purchases to just 5%. This has led to a reduction in waiting time of around 24% overall across Greater London and 30% in the charging zone (Santos, 2008).

Besides the charging and pricing aspect, the new municipal transport plan for London allows for a stimulation of cycling and walking. The aim is to increase the modal share of soft modes from 25-30%. The currently low (5% of trips) share of cycling should be turned into a real 'cycling revolution'. Bike sharing programs and investments in cycling paths should facilitate this revolution.

In conclusion, it seems that London is taking a very technology oriented development strategy, which fits within the EU urban policy, but draws heavily on (innovative) systems of transport charging and public transport investments.

4.3.4 Milan

Milan is one of the largest Italian metropolitan areas. It is characterized by a relatively small medieval centre and a very extensive urban area. Urban planning has in general been of less importance in Milan and the transport network has evolved adapting the historical networks on an ad-hoc basis. Although the area has a relatively dense public transport network, travellers have a high reliance on car use for travel. Milan itself has the highest car concentration in the world with 0.6 cars / inhabitant (Danielis R., et al, 2010). Currently the subway network is the basic pillar of the public transport network within the city, with tram and bus lines mainly serving as feeder networks in the main public network. However, the integration of the different public transport systems is not optimal. Congestion within the central part of the city is an important problem, due to unadjusted transport connections and small, difficult to access streets.

Urban sprawl around Milan is an important issue, as the growth of the city was uncontrolled and followed the extensions of the road network. Due the structure of Greater Milan, it is difficult to connect the periphery of the city with the centre by public transport. The historical value of some parts of the city hinders changes in urban transport planning.

The city of Milan is pursuing a strategy towards investing in mass transit, notably in extending the current metro lines, as well as redeveloping areas with new metro and tram connection. More low cost options, oriented towards promotion of bike sharing and changing driver behaviour, have only recently been started up.

One of the most striking decisions of the city, was to implement an LEZ zone from 2008-2011, known as the Ecopass zone which implemented a differential system of road charges according to the type of vehicle and its environmental (EURO) class ranging from €2 to €10. Ecopass was implemented in 2008, together with a number of other transport policies, in order to improve the quality of the urban environment. Pollution of car travel in the Greater Milan area is considered especially problematic, due to the specific geographical situation of Milan, which leads to a retention of many of the emissions of transport. Compared to London and Stockholm the charged area in Milan is relatively small and comprises only 5% of the city (7 sq. km versus respectively 22 & 30 sq. km). Also (in fact similar to London), the charge had no difference in the charging window and no difference in the distance of the trip.

Ecopass was quite successful in reducing the impact of transport on the environment. Average particulate matter (PM10) concentrations decreased with 20% in 2010, compared to 2007, which was mainly caused by a drastic change in the composition of the fleet. Traffic decreased by -21% in the first year. However, the change in fleet composition led to a decrease of the effectiveness of the Ecopass system, such that, by

2009, traffic began to steadily rise again. The environmental benefits stabilized and the revenue of the system decreased (Danielis R., et al, 2010).

Since 2012, the Ecopass system has been replaced by a real road charge called Area C. The original Ecopass system had a large window for charges with respect to the pollution class of the vehicle, the replaced Area C is a simplified charge of €5 for each vehicle entering the zone. Residents of the area have 40 free accesses per year and enjoy a reduced fee of €2. The city is considering an extension to the charged area, but currently it is still identical to the old Ecopass area.

One other, small initiative that deserves some attention is the CITYPLUS urban consolidation centre which was established in Milan in 2005. This is small provider of freight services, subsidized by the city, operating with 7 low emission vehicles. CITYPLUS collects goods in specific area and performs 'last mile' transport from so called 'freight consolidation areas' outside the main city centre. This type of initiatives have been started up in many Italian cities, but have (Danielis et al, 2010) not been able to take much urban freight from the road.

Our conclusion is that Milan is pursuing a policy oriented towards investments in public transport and road charging, similar to London, but less reliant on technological development. Changes in urban planning are difficult to realize in its setting, due to the complicated urban structure and strongly sprawled urban area.

4.3.5 Conclusion

Above, we have analysed the policies of three very different cities: Copenhagen, London and Milan. All of these cities have implemented strategies to control and reduce urban passenger and freight traffic, while at the same time making improvements in the liveability of the city and the mobility of its population.

These cases are interesting and to some degree comparable, as all of the cities have received particular attention for implementing successful urban policies, even when their starting point is very different. Copenhagen is well known for its urban planning and the implementation of its 'Finger-plan', London for its metro system and congestion charge, Milan in particular for its experiment with the Ecopass/Area C charging.

Analysing the type of policies implemented, we can retrieve a number of important elements.

Urban planning

The city of Copenhagen was able to reduce the impact of urban sprawl, by implementing an urban extension plan based on efficient public transit connections at an early stage of urban development. This strategy allows increasing the density of the city in some areas and is less damaging to the open space and environment around the city, while at the same time promoting public transit over private road transport. Admittedly, urban planning cannot avoid urban sprawl completely and Copenhagen's strategy may have even enforced it to some degree, by allowing the growth of suburban areas, now connected by railways. The case of Ørestad also shows, that this type of project should be to a certain extent demand-driven and not go against the logic of urban development. For example, Ørestad created out-of-center office space, while there was already was a surplus in many central areas.

The case of Copenhagen stands in sharp contrast to the city of Milan, which has sprawled over a large area and has a much less hierarchically organized transport system. Therefore the city has more problems to connect its various suburbs to the main city, as well as moving people towards mass transit and away from private car transport. The case of London stands between the extremes of Copenhagen and Milan in this respect. London is strong in urban planning and organization of its public transit system, but it may be that the city's large overall density and sprawl as well as its historical development, make it difficult to reach the same degree of liveability as Copenhagen.

Road charging

Not many cities have implemented a road charging system in the way it is theoretically intended, namely: 'a kilometre and time-dependent road charge to optimise the use of the capacity and reduce external congestion costs. However, the idea of access restrictions and charges is slowly finding its way into people's mind, sometimes against substantial public opposition. In the cities where road charging or a similar type of charges were introduced (London, Milan, Stockholm[3]), public acceptance seemed to grow substantially after introduction[4].

The impact of a road charge is largest when the charge is first introduced and has often led to significant reductions in traffic and emissions. The impact on longer term is often lower, as people tend the change their travel behaviour and/or location or exploit certain exemptions built into the scheme. In fact, this makes clear that road charging is only one of the tools a city can use to improve the urban traffic flow and that its set-up should be considered carefully.

Still, it seems that road charging will more and more be used as a primary tool for the regulation of urban traffic.

Low Emission Zones (LEZ)

Low Emissions Zones are zones implementing an access restriction for road traffic in one part of the city, often in combination with a charge. LEZ's have found their way into urban planning and are now gaining acceptance among a wider range of stakeholders. Recent history has shown that, LEZ's provide a way to reduce the emissions of road traffic and leading to short-term reduction in congestion. Milan provides an interesting case were an LEZ zone was introduced and under public pressure, upgraded to a full road charging system. In this way, it seems that LEZ's provide a way to introduce road charging in a publically acceptable way.

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[3] This case was not discussed above, but is known as a successful case of implementing a road charge.

[4] Though in all honesty, in neither of these cases, the incumbent mayor authorizing the scheme was voted back into office after elections.

Urban freight

To reduce the impact of urban freight in the city, cities tend to work with access restrictions for heavy goods or only allow deliveries within a certain window of time. For example, in London, deliveries may only take place during weekdays and never at night. Milan has included urban freight in its congestion charging system (during Ecopass), but only for polluting vehicles.

Many cities are currently considering the implementation of Urban Consolidation Centers (Brown M., 2007) with mixed successes.

Public transport

Each of the cities discussed relies heavily on subway, tram and bus networks to move passengers across the city. The case of London and Copenhagen has shown that improvements in ticketing, such as standard tickets across all intra-city transport and 'fast-passes' such the Oyster pass, can reduce waiting times substantially and make public transport more attractive.

In the case of London, earmarking the taxes from the road charge, has substantially helped to gain public acceptance for the scheme. Also, it creates a direct link between the revenues collected from road charges (and thus from congestion) and investments in public roads and public transport.

Promotion of fuel efficient and electric vehicles

All of the cities discussed are enabling some kind of promotion of electric vehicles and hybrids. Both under the Ecopass and the new Area C system, electric vehicles are free of charge in Milan. The same is true for the London Congestion Charge and London LEZ.

Electric vehicles in London and Copenhagen can park free of charge and new parking spaces are being created to allow free recharges for electric vehicles. Milan, Copenhagen and London are buying electric vehicles for use within the municipality.

Promotion of cycling and walking

In all cities some promotion of cycling was taking place, even though in London (1%) and Milan (<1%) only a very small share of the transport trips are taking place by bike. Copenhagen has the most ambitious biking strategy and is on its way to reach 33% share of all transport trips.

Match between NEUJOBS scenarios and city policies

The table below provides an additional match between the NEUJOBS policy scenarios and the city level policies.

Table 4. Match between key points of the traffic and travel management plan and D15.2

	Policy scenarios in D15.2	Copenhagen	London	Milan
1&2	Energy and fuel efficiency	Promotion of cycling Promotion of low carbon solution -> Copenhagen carbon free in 2025	Hybridization of public busses Tax discounts for low polluting vehicles	EcoPass system differential charging for low polluting vehicles,
3	Electrification of transport	EV parking free of charge – 85% of municipal vehicles electric (by 2015) Increase in EV recharging points and parking places Plans for full scale infrastructure adaptation.	Installation of recharging points – reaching 8% of penetration by 2025 No parking charges + other government stimuli towards EV's	Milan one of first cities in Italy with recharging point for EV's Area C exempts EV's and hybrid cars from charges.
4	Internalization of external costs of transport	Drawing up of parking strategy Noise abatement Introduction of road pricing New speed limits Road charging is being considered.	London congestion charge (LCCS) LEZ zone for Greater London Innovative parking charges (time and emission dependent) Access restrictions for freight during night and weekends[5]	Ecopass and its suitor Area C.
5	Reduced use of own car transport in favour of public transit and car sharing	More cycle tracks + more cycle routes Enlarging of the metro + public transport in development areas Change travel habits Improve bus mobility and safety	Bike sharing program Public transit education program Integration of ticket charging system (Oyster) Public transit education	Bike sharing program Investments in mass transit and redevelopment of areas
6	Increasing efficiency of transport		Differential charging in LEZ scheme	Lower entry charges for commercial vehicles in Area C. CITYPLUS initiative

[5] This is not placed under point 6) as this type of regulation will increase, rather than decrease the cost for freight transporters within the city.

5. Job creation effects of sustainable urban transport strategies

5.1 Introduction and use of this section

A strategy that is often used to calculate job market effects of investments in public transport on the urban scale, is by applying so called 'job multipliers'. These allow researchers to convert parameters in monetary units from studies in sustainable transport (investments, energy savings or fuel savings, increase in tax income) to 'job creation' effects in Full Time Equivalents (FTE). We make a literature review of these multipliers and their use in other studies.

In each section, we compare the results from literature with the results from our own calculations, based on the EDIP computable general equilibrium model. The reference year for the simulations is 2010. The figures on employment and unemployment are based on the socio-economic database of the WIOD (World Input Output Database) project.

When possible, we make the comparison with the policy scenarios defined in D15.2 and the implied job creation multiplier, when making small changes towards sustainability. This section can thus be seen as a small scale translation of 'marginal moves' towards sustainable transport policy and how this affects job creation in several EU countries. This opposes D15.2, which focusses on the global scenarios and the long term projections of full transition towards sustainability.

5.2 Jobs associated with public investments and subsidies in transport

5.2.1 Introduction and review

The UITP (2005) mentions 2 numbers related to creation of new jobs per million of euro spent on public infrastructure. Based on the TRANSECON study for Europe (2003) and a study performed in the US by Cambridge Systematics (1999) the impact of investments in infrastructure is estimated to be around 30 jobs per million of euros invested in public infrastructure and 57 jobs per million euros in public transport operations. The American TCRP (2009) advises using a value of 36 jobs[6]/ million dollar investment.

A more recent study performed by GHK consulting (2011) estimates, based on a study of the AAM (2009) and the existing figures from the TransEcon study (2003) that a 1 million euro investment in public transport reflects in an addition of 16.7 jobs related to the infrastructure works and 4.8 induced jobs caused by increases in household spending. This gives a total of 21.5 jobs / million euros for investments in rail and public infrastructure. This is close to the TCRP (2009) estimate.

As for the impact of infrastructure spending on domestic product (GDP), a very high range of values is available. Leduc & Wilson (2012) conclude in their study on Highway grants in the US that *the multiplier is at least two* (sic). They find that on initial impact, the multipliers range from 1.5 to 3, depending on the method for calculating the multiplier. In the medium run, the multipliers can be as high as eight. Over a 10-

[6] 27 jobs / million euro, using an exchange rate of 1.3 dollars / euro

year horizon, their results imply an average highway grants multiplier of about two. This value is similar to the conclusion of the TCRP (2009), using a value of 1.8. Broyer et al (2012), in applying a VAR model of infrastructure spending in Spain, France, Germany and Italy find even higher multipliers ranging from 2 for 4 for short run impacts and 14-22 in the long run.

5.2.2 *Comparison with results from the EDIP model*

We run a static simulation for a larger number of EU countries, increasing the production subsidy for land transport, water transport, air transport and auxiliary transport services with 1%. This increase in government subsidies is paid from a lump sum transfer from the consumer budget.

We calculate a 'job multiplier' (M_{jobs}) as the amount of jobs created per million euro of subsidies in public transport on land (rail and busses). This can be represented by the following formula.

$$M_{jobs} = \frac{\Delta Employment\ (jobs)}{\Delta Subsidy\ (Meuro)}$$

We verify the results on job creation for this simulation with the impact on GDP. This is similar to the indicator calculated above, but shows the impact of each euro spent on production subsidies for transport on GDP.

This is calculated as:

$$M_{GDP} = \frac{\Delta GDP\ (Meuro)}{\Delta Subsidy\ (Meuro)}$$

As can be seen in Table 5 our results come remarkably close to the GHK consulting estimates (2011), but show an important difference between Eastern EU countries (BG, CZ, HU, LV, RO,…) and the older more developed EU countries (AT,BE, DE, NL,…). On average, job creation per million euros of subsidy is about 3 times lower in the case of the older EU countries, with the exception of Spain (ES), Italy (IT) and Portugal (PT). Greece (GR) is not in this group. Job creation effects on Malta (MT) and Cyprus (CY) are comparable to the more developed EU countries.

Table 5 shows a remarkable coherence between the impact of the production subsidy and the impact on GDP. With relatively little outliers, the impact of 1 million euros spent on production subsidies for transport services leads to a gain in GDP of around 0.3 – 0.5 million euros, with an unweighted average of 0.34 million euros for old and 0.36 million euros for new EU countries. So contrary to the job creation effects, there is little to no difference between the 2 groups. Our value for the GDP multiplier is substantially lower. We remark here that we took into account the 'financing' effect of the investment, which is paid by lump sum taxes from the consumer budget. Other studies have not taken this into account.

Table 5. Job creation and GDP effect per million euro subsidy in public transport

Group 1	M_{jobs}	M_{GDP}
AT	7.07	0.26
BE	9.23	0.45

Group 2	M_{jobs}	M_{GDP}
BG	57.99	0.31
CZ	20.55	0.29

CY	8.49	0.13
DE	9.29	0.34
DK	8.52	0.42
ES	18.82	0.54
FI	8.51	0.41
FR	2.73	0.05
GR	7.46	0.31
IT	11.97	0.43
MT	8.74	0.20
NL	7.85	0.34
PT	22.83	0.44
SE	8.00	0.40
UK	6.83	0.31
Average [7]	**9.76**	**0.34**

EE	40.35	0.56
HU	32.68	0.48
LV	59.94	0.56
PL	25.08	0.29
RO	26.26	0.24
SK	25.50	0.26
Average	**36.19**	**0.36**

5.3 Jobs associated with gains in energy efficiency, fuel economy and introduction of electric vehicles

5.3.1 Introduction and review

Improvements in energy efficiency are claimed to create jobs by 2 mechanisms. The first one is by generating investments in manufacturing, R&D, construction and other labour intensive sectors. The second is by moving consumer preferences away from imported and capital intensive energy goods to more labour intensive industries. Bell C. (2012) gives an example of a simple calculation using the relative job intensity of the sectors in the US economy. Given that the job creation effect of 1 million dollar investment in energy is 10 jobs, compared to an overall 20 jobs in construction and 17 jobs in the overall economy, net job creation effects can occur when reduction in energy demand is switched for construction (20-10 = 10 net jobs) or temporarily during construction phase (20-17= 3 net jobs). This refers to the overall approach of the American Laitner et al (2012), which calculated the overall impact of energy efficiency improvements in the US economy leading to a respective decrease of 11.6 trillion dollars in the net energy bill, would lead to 1.3 million jobs. This is about 0.112 jobs per million dollar saved in energy. This is low, compared to other studies (see below).

In D14.2 of the NEUJOBS project, (Meijer, Vischer et al (2012)), a calculation is made of the impact of energy renovation of the housing stock. The authors refer to a study of the French Ministry for Ecology, Energy, Sustainable Development and Spatial Planning. For each €1 million investment in energy renovation, it was estimated that 14.2 jobs could be gained (L'Union Social pour l'Habitat, 2011). A similar study of the Green Jobs Initiative (2012) found that (converted from dollars) 15.7 jobs could be created by energy efficiency improvement in housing. In conclusion, D14.2 cites a

[7] Unweighted (!) average of all countries

number of other sources (UNEP, 2008), ILO (2012), EEIF(2012), BPIE (2011) all presenting job multipliers between 11.3 & 19 jobs per €1 million investment.

Several studies have claimed that an increase in fuel efficiency of vehicles can lead to economic benefits and job creation. PERI (2009) estimate, using an input-output model that 17 jobs can be gained per million dollars for clean energy investments and 5 jobs per million euros of fossil fuel savings. Roland-Holst of the CERES centre (2008) while calculating the impact of energy efficiency policy on the Californian economy, refers to a study of UCS (2007) on impact of fuel economy savings. They estimate that a fleet wide average of 35 mpg[8], leads to fuel savings of 61 billion dollars in gasoline and would generate 241,000 jobs. This is equivalent with 3.95 jobs per million dollars saved in gasoline. A more recent study, again from CERES (2011), makes an estimate of 700.000 jobs for fuels savings of 152 billion dollars, calculated from an Input Output model of the US economy. This is about 4.6 jobs per million dollars.

A European study from Riccardo AEA (2013) found similar results for the new 95 g/km and 147 g/km standards, respectively for passenger vehicles and vans. They find a gain of 356.000 jobs and a gain of 16 billion euros in GDP for fuel savings of 57 billion euros. A more stringent standard delivers 443.000 jobs and 10 billion euro gain in GDP for fuel savings of 79 billion euros. This is respectively a gain of 6.2 jobs and 5.6 jobs gained per million euros in fuel economy and a 0.28 and 0.12 million euros in GDP per million euro of fuel savings.

The impact of electric mobility on job creation is controversial. Some studies (Friedrich, Ebert Stiftung, 2010) claim that the short term impact can be positive, due to increased car sales but that the less complicated production of electric vehicles requires less staff and can be automated more easily. Hence, on longer term the employment in the sector falls due to its low labour intensity and lower maintenance costs. Mc Kinsey (2010) use a value-added based multiplier in their calculation of the impact of electric mobility, which is 3.3 jobs per million euro of value added generated. They estimate a net gain of 61 billion euros of value added globally, due to a switch from conventional to electric propulsion, which would result (globally) in 204.000 jobs in 2020. The main gains are in the battery market (45 billion). Another study (Roland Berger Strategy Consultant, 2025), found that in the most optimistic scenario (10% electrification and 40% hybridization of car fleet) a net increase of 700,000 jobs can be realized. A study of Friends of the Earth (1997) projected an increase of 6200 jobs in the UK when 5% of the car fleet would be electrified.

A study from Renault, on the impact of electrification of vehicles showed that electric vehicles require less maintenance than conventional cars. According to Sia (the French society of automotive engineers, this would lead to a destruction of 1000 jobs in maintenance for every million electric cars in circulation).

5.3.2 *Results from EDIP model*

We will now compare the results for increased energy and fuel efficiency with results from EDIP. We run 3 scenarios:

[8] About 6.7 liters / 100 kilometers

1. **Energy**: An overall economy wide increase in energy efficiency of 1%, based on NEUJOBS (D15.2) policy scenario 1
2. **Fuel:** An improvement in the fuel economy of 1%, based on NEUJOBS (D15.2) policy scenario 2
3. **Electric:** A 1% switch from conventional fuel transport, towards electric transportation, based on NEUJOBS (D15.2) policy scenario 3

These scenarios are implemented in a similar way as is described in section 3.3.1, 3.3.2 and 3.3.3 of D15.2. However in this case, the changes implemented are only marginal and are not taking into account the elaborate background scenarios of the NEUJOBS project. This makes them comparable with the findings from literature described above. As in the previous section, we calculate the multiplier for job creation effects and multiplier for GDP when introducing these efficiency gains. We calculate the amount of total jobs created per million euro in energy savings (energy), fuel savings (fuel) and per million euro spent on nonconventional vehicles (electric). The numbers in Table 6 are to be interpreted as the extra jobs and extra million euros in gross domestic product for each million euro saved.

As in the analysis above, we split our countries in 2 groups. The amount of job creation differs considerably among the different countries. There are quite a few outliers, especially in group 2, where the quality of the data on fuel use is an issue. Still these results show some interesting trend. Job creation from overall gains in energy efficiency seems to be significantly larger than job creation from fuel economy and introducing electric mobility, per million euro saved. Especially in group 2 countries, as well as CY, ES, PT, AT in group 1, the amount of jobs created from energy savings is substantial in ranges from 23 -67 jobs per million euros saved. Fuel economy seems to be much less effective to create jobs and reaches values (comparable with the review above) of 3-6 jobs per million euro of fuel economy. Electric mobility is even less effective as a stimulator of job creation and its overall (unweighted) average shows negative values. Looking at the GDP multiplier, we see that (contrary to study of Riccardo AEA, 2013) our results imply negative impacts on GDP. This is caused by a loss in tax income, both the in fuel economy and the electric mobility case. This stands in meek comparison with gains from overall improvements in energy efficiency.

The difference between the Western European, Southern European and Eastern European countries are noticeable and important. We are not the first to remark the big differences between member states. The Green Jobs Initiative[9] (2012), already found that in certain Eastern European countries far more jobs could be created per million euro than in other countries. The Energy Efficiency Industrial Forum (2012) found a high 19 jobs per million euro job multiplier, but acknowledged the large difference between individual member states. The main reason for these differences is labour cost and labour productivity.

[9] See also Meijer, Vischer et al (2012)

Table 6. Job creation and GDP effect per million euros energy saved

	M_{jobs}			M_{GDP}		
Group 1	**Energy**	**Fuel**	**Electric**	**Energy**	**Fuel**	**Electric**
AT	26.70	2.75	0.17	8.48	-0.30	-0.06
BE	2.99	2.93	0.63	1.32	-0.03	-0.03
CY	39.73	10.72	3.57	2.19	0.08	0.04
DE	6.07	3.93	0.73	1.52	-0.26	-0.08
DK	6.15	2.04	-9.55	1.95	0.05	0.01
ES	23.45	6.36	-0.25	1.79	-0.10	-0.04
FI	5.96	2.50	-1.31	1.43	-0.05	-0.05
FR	9.46	4.57	1.94	1.39	-0.15	0.15
GR	11.01	3.55	-2.57	1.42	-0.10	-0.11
IT	9.10	10.86	-0.68	1.47	-0.38	-0.01
MT	7.91	0.09	-0.24	1.11	0.01	0.02
NL	9.07	2.62	-0.22	1.92	-0.08	-0.01
PT	29.54	6.44	0.24	1.94	-0.20	-0.01
SE	9.03	2.79	0.15	1.54	-0.31	-0.07
UK	13.68	3.35	0.39	2.33	-0.45	-0.09
Average [10]	**13.99**	**4.37**	**-0.47**	**2.12**	**-0.15**	**-0.02**

	M_{jobs}			M_{GDP}		
Group 2	**Energy**	**Fuel**	**Electric**	**Energy**	**Fuel**	**Electric**
BG	67.51	6.32	-2.21	1.83	-0.08	-0.07
CZ	57.33		18.54	2.85		0.31
EE	47.66	6.20	-15.76	2.29	-0.19	-0.31
HU	46.93	5.89	-2.08	2.48	-0.13	-0.11
LV	84.80		-3.95	2.24		-0.02
PL	6.20	-8.76	0.07	1.30	-0.42	-0.10
RO	31.72	2.24	2.91	1.84	-0.22	-0.09
SK	47.38	7.51	-3.23	0.62	-0.02	-0.10
Average [11]	**48.69**	**3.23**	**-0.71**	**1.93**	**-0.18**	**-0.06**

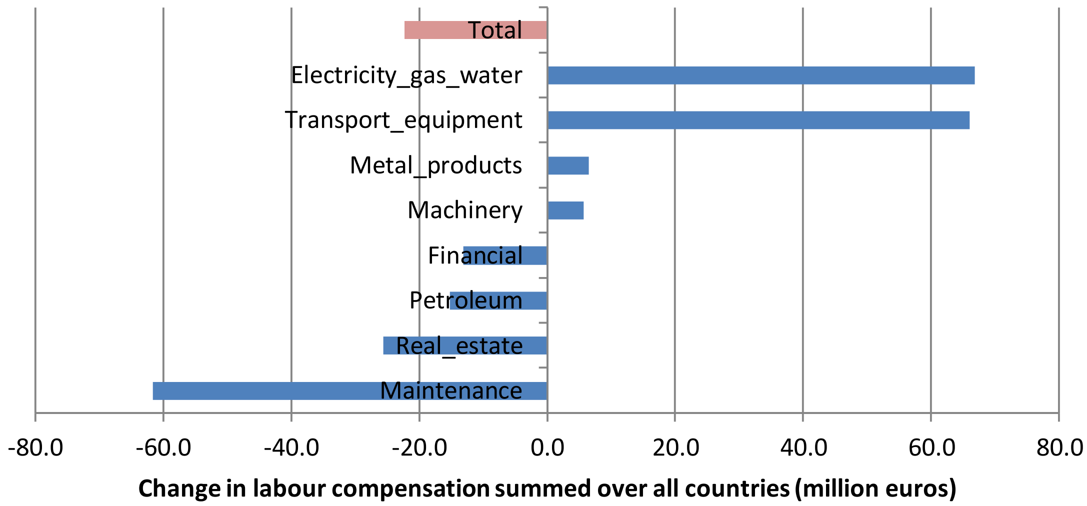
Given the relatively counter-intuitive result on electrification of transport, we go into more detail on this simulation. We find that the nature of the negative job creation in electric mobility was mostly due to a reduction in car maintenance expenditure. Electric mobility stimulates job creation in the wholesale trade, car manufacturing, energy sector and distribution, but leads to relatively important losses of jobs in maintenance and other car related services. Also, consumption of electricity by electric

[10] Unweighted (!) average of all countries

[11] Unweighted (!) average of all countries

vehicles, leads to small increases in the energy price, which can affect industrial production and employment levels negatively. Overall, the impact is slightly negative, though not in all countries. We illustrate this quite remarkable result in the figure below, where we aggregated the monetary compensation of labour over all countries in the simulations performed above. This result is in line with the argument that job losses in maintenance when introducing electric mobility, will outweigh the job creation effects.

Figure 3. Monetary compensation of labour in the top 4 'winning sectors' and top 4 'losing sectors' when moving towards electric mobility



Exploration of the impact of electrification on net job creation within each country, shows remarkable differences. Looking at the top 4 'winning' countries and top 4 'losing' countries (Figure 4), we remark that DE and the UK gain respectively 1105 and 404 jobs for an introduction of 1% electrification of transport. Followed by RO (245 jobs) and CZ (101 jobs). The main loser from electrification, is DK (-1557 jobs), followed by IT (-443 jobs), ES (-83 jobs) and PT (-53 jobs).

Differences between the countries are explained by the relative labour intensities of the 'winning' and 'losing' sectors. More analysis of the results, in Figure 5 shows a link between the low share of labour compensation in the car-manufacturing sector of DK (0.25% of total) and the high share in DE (4.62%). The job losses in IT are explained from the high share of labour compensation in car maintenance (6.7%), compared to DE (2.09%) and UK (2.65%). The net job market effect for all countries together is about zero.

Figure 4. Net jobs created with 1% electrification, 4 top and 4 losing countries (in FTE's)

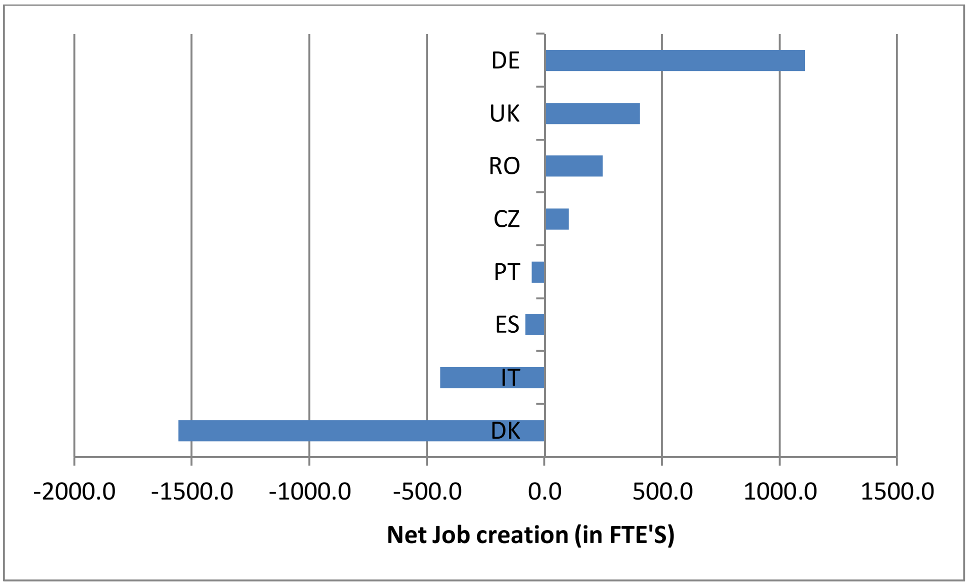
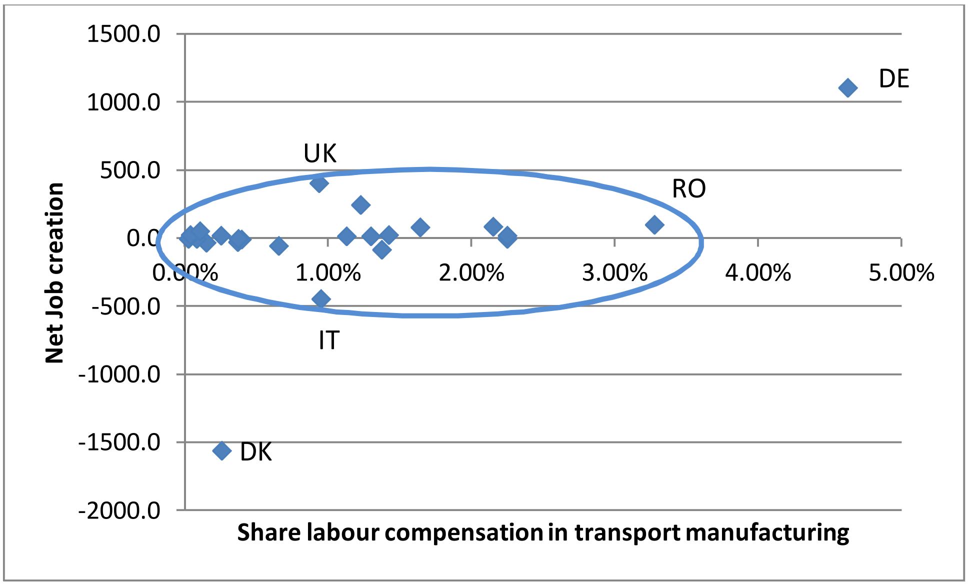


Figure 5. Correlation of share of labour compensation in transport manufacturing on net job creation



5.4 Jobs associated with decreasing private transport use

5.4.1 Introduction and review

Decreasing the use of private transport and moving transport kilometres towards the public transit sector, is often claimed to have a net positive effect on the job market. In principle this seems logical, a private car is driven by a private citizen, who is (in generally) not paid to spend money in traffic. Switching towards a public transit system requires engaging a driver, so would (at least in theory) result in more employment. Of course, this type of effects should be considered carefully, given that 1 driver can carry up to 100 people in one bus, 300 people in a tram and more than 1000 people in a train. Therefore only when a relatively large amount of private users switch to public use of transport, a notably positive impact on job creation could be expected.

Friends of the earth claimed in 1997, that an increase of train passenger kilometres and bus kilometres with 35 % would create an additional 130,000 jobs related to the public transport sector in the UK. Not many other studies have calculated job market effects of changing behaviour towards public uses.

5.4.2 Results from EDIP model

We base ourselves on a simplified version policy scenario 5 in NEUJOBS D15.2, we assume that people change their preference for private transport, such that they switch 1% of their total transport needs from private transport towards public transit services. This is an impact created purely by a change in passenger demand. We assume that people are motivated by 'soft measures' (information campaigns, courses in public transport use etc.) to change their behaviour in traffic. No extra investments in public infrastructure are assumed from outside the sector, but the sector reacts to the extra demand by engaging new labour and other inputs to production.

As in the previous sections, we calculate the net impact on job creation, using a multiplier based on a monetary (million euros) basis. The denominator in this case, is the amount of consumption in private transport[12] averted towards purchased transport services (taxi, bus, train, trams). We do the same for the GDP multiplier, which is used to examine the impact of the policy on domestic production.

Table 9 shows the results in the same format as the one used above. We see that the increase in demand for public transport has some positive impact on jobs, which is mainly caused by a direct increase in employment of the transport sector. Overall, the job creation effect of private transport demand is low, because the policy leads to a loss in jobs in vehicle manufacturing and maintenance services (see also D15.2), which offsets some of the positive effects of the extra demand for transport services. We see that taking an average over all countries, the job creation effect is around 1.88 jobs per million euros averted from private car use in the group 1 countries and 6.21 jobs in group 2 countries. Only in IT the impact is negative, which was found to be due to its high share in transport maintenance jobs. Figure 6 gives a by country overview of the net amount of jobs created for switch 1% of expenditures on private transport towards

[12] This is a consumption bundle, containing both expenditures on fixed costs (vehicle, insurance, network tax) and variable costs (fuel, maintenance).

public transport and services. The impact is largest for DE (4750 jobs), FR (2940 jobs) and UK (2430 jobs). The impact on GDP is close to zero and slightly negative in quite a few countries, which is caused by a reduction of car sales, maintenance and an increase in subsidies for public transport offsetting positive impacts on transport services. In general, the impact on GDP is neglible.

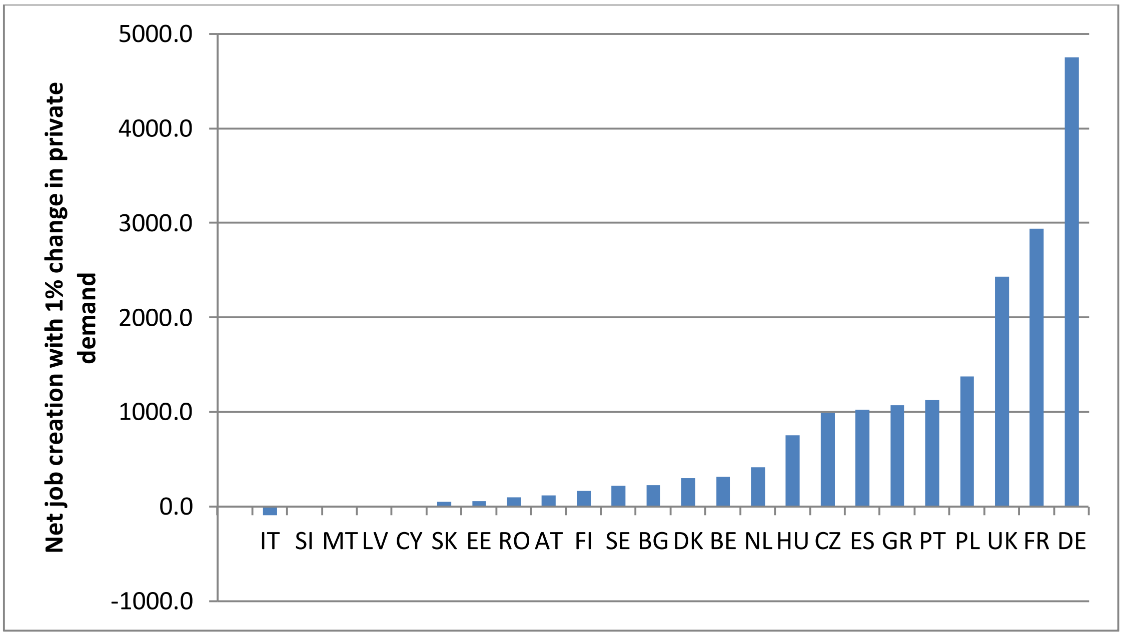
Table 7. Job creation and GDP effect per million euros averted from private car use

Group 1	M_{jobs}	M_{GDP}
AT	0.87	-0.05
BE	1.35	0.00
CY	1.19	-0.03
DE	2.11	-0.02
DK	1.69	-0.10
ES	1.32	-0.03
FI	1.90	-0.03
FR	1.31	-0.37
GR	5.42	0.08
IT	-0.09	0.06
MT	0.23	-0.13
NL	1.64	-0.08
PT	6.43	0.01
SE	1.36	0.00
UK	1.39	-0.03
Average [13]	**1.88**	**-0.05**

Group 2	M_{jobs}	M_{GDP}
BG	9.57	0.01
CZ	17.06	0.22
EE	5.04	0.00
HU	7.94	0.01
LV	0.11	-0.06
PL	7.52	-0.09
RO	0.64	0.01
SK	1.78	0.01
Average	**6.21**	**-0.03**

[13] Unweighted (!) average of all countries

Figure 6. Net job creation of 1% change in private to public transport expenditures of consumers



5.5 Jobs associated with sustainable freight transport

5.5.1 Introduction and review

Freight transport within and between cities is a large consumer of energy, as well as a cause for congestion on city level. Traditionally, there was not so much attention to urban freight within transport planning; however access of goods to the business districts is an important part of the travel demand in any city. Freight vehicles typically represent 15% of total traffic flow in urban areas but when they park to make collections or deliveries outside designated parking spaces, they can reduce road capacity and contribute to congestion (DG MOVE, 2012).

One idea, which has been popular in the last decade, was to increase the bundling of urban freight by creating so called Urban Consolidation Centers (UCC, Browne et al, 2007). The idea is that some central, publicly operated company is collecting urban freight outside the city center. In a second stage, the packages can be transported by low emission vehicles or by cycling. Theoretically this can improve bundling of freight and draw some of the heavy good transport out of the city. This may have also have some job effects, through employment connected at the center.

More efficient urban freight traffic can lead to more job creation in a number of ways:

- Reduction of traffic congestion within the city, which increases accessibility for other transport users
- Reduction of cost for retail sector, horeca, postal communications sector, construction and waste (DG MOVE, 2012). Transport and distribution costs represent respectively 3% and 6.6% of the total turnover. In London about 2.4% of

all employment is related to transport and distribution. Indirectly wholesale (4.3%), Retail (9.6%) and Manufacturing (6%) are associated with urban transport deliveries, as well as other transport sectors (1.6%) (Schoemaker J. et al, 2006).

- Stimulating small scale transport services, with a high labour intensity such as delivery by bicycle, or small scale delivery with electric vehicles.
- Stimulating small businesses within the city, which are closer to consumers and require less time and input of private transport compared to large supermarkets outside the city

Increasing efficiency of transport, especially where it concerns the efficiency of sectors providing auxiliary services to freight and passenger transport can be controversial. It is clear that a set of next generation technologies are available, that can substantially decrease the administrative burden for the transport sector. In D15.2 (Heyndrickx, et al, 2013) we introduce an E-Freight scenario, based on recent research (2013)[14] performed by Transport & Mobility Leuven in cooperation with TNO. We found that the potential for 'net job creation' from an increase in efficiency is substantial, but leads to a loss of jobs within the auxiliary transport sector itself. A similar finding is found in the (draft) impact assessment of the Single European Sky (EC, 2013). The potential for savings in the European traffic control system is substantial. In the US, similarly sized en-route airspace is controlled by a single service provider as opposed to 38 service providers in Europe. The US service provider controls almost 70% more flights with 13% less air traffic controllers and in total 38% less supporting staff (p.14).

The impact assessment therefore estimates in a 'fully optimised' impact scenario that almost 3 billion euros can be saved (summing up cost of delays, personnel costs, flight efficiency) of which 750 – 900 million euros would result in additional GDP. The reduction in administrative cost is much more modest and would be around 13.8 to16.8 million euros. An alternative 'risk optimised scenario' leads to lower economic gains of 2 billion euros, a relatively high gain in jobs (10,000) with a lower reduction in jobs at the service provider (3400 instead of 9,400 jobs) and 600-700 million euros in GDP (p.69)

Calculating a job creation multiplier, based on the reduction in total costs, we have a net job gain of 3,400 jobs for 3 billion euros of savings or 1.13 jobs per million euros in the performance scenario. In the 'risk optimised' scenario we have 6,600 jobs for 2 billion euros of saving, resulting in a 3.35 jobs per million euros multiplier. The difference lies in more labour saving technologies in the 'optimised scenario'. The relevant GDP multiplier is equal to 0.25 – 0.3 for the fully optimised and 0.3-0.35 for the 'risk optimised' scenarios.

5.5.2 *Results from EDIP model*

Similar to the cases above, we base ourselves on a scaled-down version of the E-Freight scenario, used in D15.2. We reduce the input of auxiliary transport services for road transport with 0.3%, water transport with 0.1% and air transport with 0.01%. This is

[14] http://www.tmleuven.be/project/efreight/home.htm. The full report is unfortunately confidential, however we used a scaled down and simplified version of the scenario in D15.2.

100 times smaller than the original scenario. This represents a reduction in administration costs and costs of services provided at harbour, stations and other transport nodes. From these marginal changes we can calculate the relevant GDP and job multipliers, as we did in previous sections of this chapter.

The results are presented in Table 8 and a limited analysis on the level of the sectors in Figure 7. In Figure 7, we show the top 4 gaining and top 4 losing sectors. Improving the (administrative) efficiency of transport leads to losses in a number of sectors supporting the transport sectors, especially in the 'auxiliary transport services'. These are services supporting transport, performed at airports, harbours and other transport hubs. The largest gains are in the transport service sectors (land and water transport sector), retail and distribution sectors. The total economy-wide use of labour (measured here in total compensation for labour) increases substantially, as much more sectors gain than lose from the improvement in efficiency.

Table 8. Job creation and GDP effect per million euros averted from auxiliary transport services

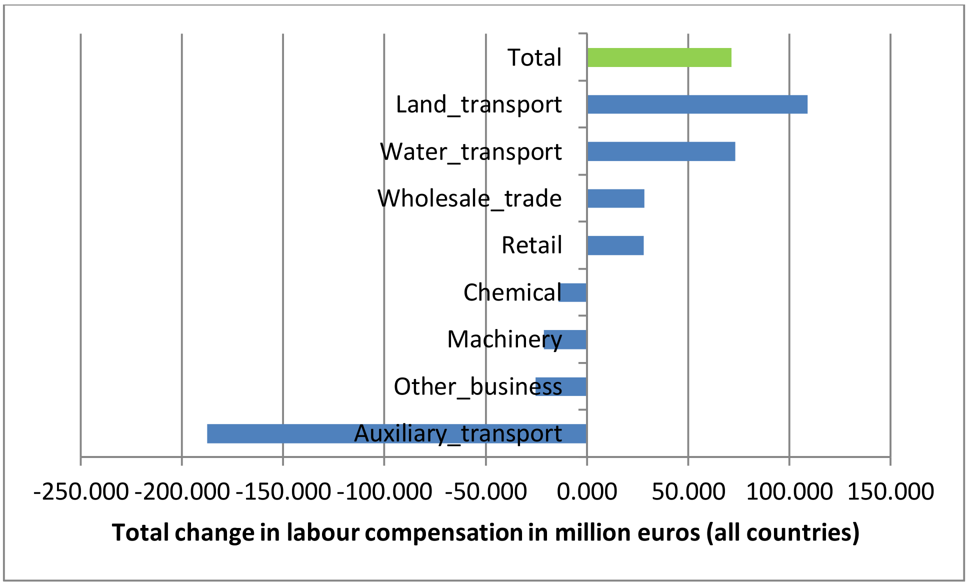
Group 1	M_{jobs}	M_{GDP}
AT	2.38	1.11
BE	1.49	1.08
CY	1.19	1.12
DE	-0.33	1.05
DK	-1.78	1.12
ES	16.29	1.41
FI	3.58	1.23
FR	-1.02	0.95
GR	4.19	1.02
IT	6.97	1.32
MT	32.72	1.25
NL	5.56	1.19
PT	20.33	1.36
SE	2.90	1.20
Average [16]	**6.53**	**1.18**

Group 2	M_{jobs}	M_{GDP}
BG	3.71	1.09
CZ	22.27	1.48
EE	33.39	1.50
HU	26.87	1.42
LV	58.44	1.35
PL	15.90	1.07
RO	32.35	1.32
Average	**27.56**	**1.22**

[15] Unweighted (!) average of all countries

[16] Unweighted (!) average of all countries

Figure 7. Monetary compensation of labour in the top 4 'winning sectors' and top 4 'losing sectors' when increasing efficiency of transport services



Further analysis of the inter-country differences showed that the relative size of the labour compensation in land and air transport sector (water transport to a minor degree), auxiliary transport sector and wholesale trade contributed positively to the job multiplier. The size of the machinery and basic metal sectors contributed negatively to the job multiplier. By far the largest impact was caused by the size of the land transport sector (Figure 8) and auxiliary transport sector (Figure 9). This is not that surprising, as both indicators reflect the dependence of the economy on transport services. Our results imply that if the auxiliary transport sector is relatively big, so are the potential gains of administrative efficiency. This would in turn imply, that countries with a large (auxiliary) transport sector, should not refrain from using the potential of labour saving technologies. The savings caused by the efficiency gains lead to an important net increase in the economy wide employment. This follows the same logic as (SWD(2013) 206 final.

Figure 8. Correlation between share of labour compensation in land transport and the job multiplier

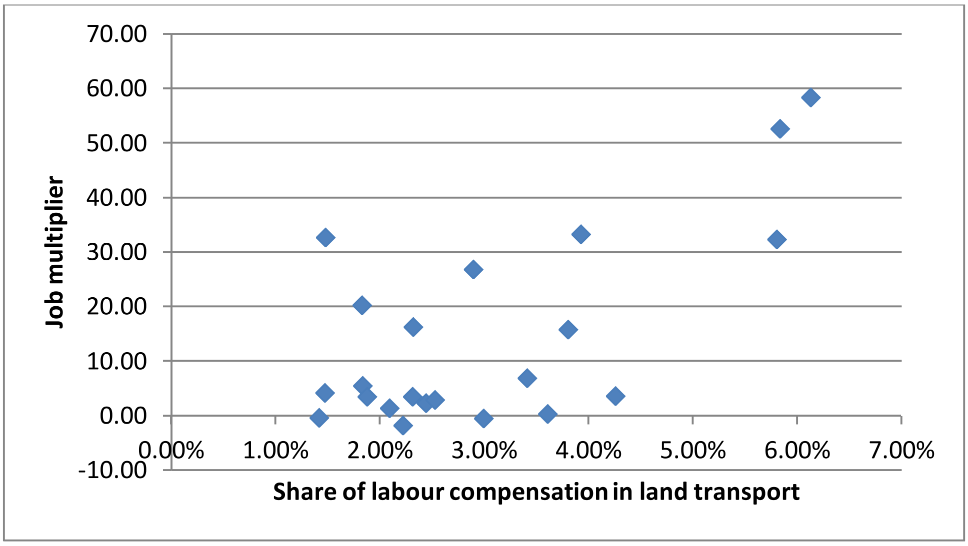
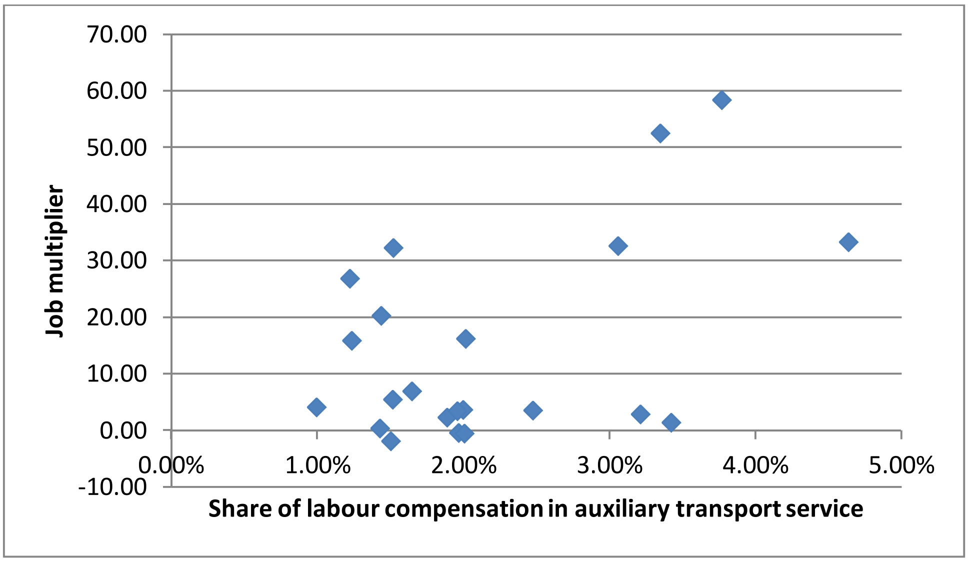


Figure 9. Correlation between share of labour compensation in auxiliary transport services and the job multiplier[17]



5.6 Overview and conclusion

In Table 9 below, we give an overview of the job and GDP multipliers calculated above. We see that the values of EDIP match relatively well with our review of literature, but diverge in a number of critical aspects, especially when looking at GDP impacts.

The first is methodological. We base our results on a full-scale general equilibrium model, taking into account all price changes on internal and external markets. In

[17] Please note that the size of the auxiliary transport sector correlates strongly with the size of the land transport sector, such that both graphs look similar.

general, our results are lower than the ones of the other models. Theoretically, this is perfectly understandable, as these studies use Input/Output models that do not take into account changes in prices and calculate the impacts linearly. Hence, Input/Output models will commonly overestimate job creation effects.

The second is that there is a big difference in jobs created within the richer and more developed Western and Northern EU countries (BE, DE, FR, FI, DK,…), Southern EU countries (ES, IT, GR) and Eastern EU countries (PL, BG, CZ, ..). This runs parallel with the relative labour intensity of the economy, the wage rates and the current unemployment rates. This would imply that job creation is quite different in the developing EU economies.

Energy efficiency improvements and transport subsidies deliver about 3 times more jobs in the Eastern European (Group 2) than in the other countries. We are not the first to remark this difference in the relative impact of improvements in energy efficiency. Both the Green Jobs Initiative[18] (2012) and the Energy Efficiency Industrial Forum (2012) found similar differences when studying the impact of a number of renovation projects across the European Union and the US.

No such differences between countries become apparent in fuel economy and electrification. If any difference it all, the model implies a lower effectiveness of fuel economy standards and electrification on job creation. This also reflects in lower and even negative impacts on GDP, when moving towards less polluting vehicles. The reason for these negative values is mainly the interaction with government tax income (see also Van Dender et al (2011)).

The third aspect, in which our study diverges considerably, is in its treatment of electrification of vehicles. We show that the impact of electric vehicles on job creation is limited at best and reduces jobs in maintenance and transport services. This is compensated by an increase of jobs in the energy sector and car manufacturing. While some countries gain (DE, UK), the net effect is slightly negative or in the best case, close to zero. This is in sharp contradiction with the findings of Mc Kinsey (2010), who predicts a large increase in value added due to the size of the battery market.

The fourth aspect relates to the GDP impact of infrastructure investments. Studies based on econometric results, for example VAR based studies, such as Broyer S. (2012) or input output models (TCRP, 2009) generally find very large multipliers. Our EDIP results however, take into account the financing of the infrastructure by lump sum taxes, which leads to a lower estimate of around 0.36 euros, per euro spent on infrastructure.

Our study is also the first one to link the reduction in administrative costs for transport to a computable general equilibrium model, with the goal to calculate the impact on employment. The efficiency gains realized in this way reduces the demand for auxiliary transport services and leads to job losses in associated sectors, but is compensated by increased employment in the transport services, retail and distribution sectors. Those countries with the largest transport sector were also the countries that can potentially gain the most from the reforms.

[18] See also Meijer, Vischer et al (2012)

Auxiliary transport operators are often reluctant to promote labour efficient technologies, as these technologies can lead to a loss in employment within the sector. We show that this is true, but that the potential gains are substantial and clearly compensate for the loss in employment. This runs parallel with the conclusion of the draft impact assessment of the new European Single Sky initiative (EC, 2013). Comparing the implied impact on net-job creation and GDP per million euros, we find that our EDIP simulations are much more optimistic. This is caused by a difference in the set-up of the study, the limitation to air and the larger and more diverse gains in efficiency in the impact assessment. This makes it near to impossible to compare these two numbers.

The final aspect, in which this study diverges considerably from other studies, is in its calculation of the impact of demand effects on public transport, separate from the investment and subsidy impacts. We model the marginal impact of a change in travel behaviour on job creation. For each million dollars averted from private transport, we show that (with one exception) the relative impact of stimulating public transport services is positive, even when we take into account a reduction in the demand for vehicles, maintenance and energy inputs.

Table 9. Overview of job multipliers (+source) in FTE's per million euro[19]

Investment / Subsidy	Energy Efficiency	Fuel economy	Electrification	Changing behaviour	Efficiency
REVIEW					
21.5 (GHK,2011)	13.09 (PERI, 2009)	3.8 (PERI, 2009)	3.3[20] (Mc Kinsey, 2010)	No estimate available in monetary cost	1.13 -3.35[21] (EC, 2013)
30 (TransEcon,2003)	7.7 (Bell C., 2012)	3.5 (CERES, 2011)			
	11-19[22] (D14.2)	3 (UCS, 2007)			
		6.2 /5.6 (Riccardo AEA,2013)			
EDIP (own calculations)[23]					
9.76 (group 1)	13.9 (group 1)	4.37 (group 1)	-0.47 (group1)	1.88 group 1)	6.53 (group 1)
36 (group 2)	48.69 (group 2)	3.23 (group 2)	-0.71 (group2)	6.21 (group 2)	27.56 (group 2)

[19] The values from American studies (in million dollars) were transformed with an exchange rate of 0.77 euros / dollar (1.3 dollars/ euro)

[20] In millions of euros of value added

[21] Based on the draft impact assessment for airlines

[22] This represents values used in NEUJOBS D14.2 (Meijer, Vischer et al (2012))

[23] These represent the averages by group, calculated in the previous section. Please note that the inter country variation is large and that these numbers are only taken as indicative.

Table 10. Overview of GDP multipliers (+source) in euros

Investment / Subsidy	Energy Efficiency	Fuel economy	Electrification	Changing behaviour	Efficiency
REVIEW					
2 (Leduc et al, 2012)	No estimate available	0.12-0.28 (Riccardo AEA, 2013)	No estimate available	No estimate available	0.2-0.35 (EC, 2013)
1.8 (TCRP, 2009)					
2-28 (Broyer et al, 2012)					
EDIP (own calculations) [24]					
0.34 (group 1)	2.12 (group 1)	-0.15 (group 1)	-0.02 (group 1)	-0.05 (group 1)	1.18 (group 1)
0.36 (group 2)	1.93 (group 2)	-0.18 (group 2)	-0.06 (group 2)	-0.03 (group 2)	1.22 (group 2)

6. Impacts of urban policy: summary of effects

This last section provides a summary of this deliverable and discusses some of the main impacts of urban transport policy on the level of the city. We use a summarizing table (Table 11), indicating the impact of policies we discussed in this deliverable on 7 important indicators on the level of the city, referring to literature, case-studies and model results. For NEUJOBS the indicator 'employment' is of central importance. The other indicators refer to the size of the city (sprawl), prices (transport & housing), pollution, traffic congestion and public finance. We indicated the potential impacts of each policy with reduction (- or --), increase (+ or ++), no discernible effect (0) or ambivalence[25] (≈).

The first three measures (general efficiency standard, fuel efficiency and electrification) were discussed in detail in section 5.3. Positive job creation effects were strong for general efficiency standards and positive for fuel efficiency, but the results for electric vehicles were ambivalent and in many countries negative. For both electric vehicles and fuel efficiency standards, we expect ambivalent changes in the price of transport. This indicates two things: 1) fuel efficient vehicles are subsidized 2) fuel efficient vehicles have a higher purchase price, but have a lower variable cost of driving. The result is that increased fuel efficiency can result in increased congestion, as stated in Van Dender et al (2011). Moreover, the impact on public finance is negative, due to losses in tax income on fuels and the payment of subsidies to car owners.

The next two measures (discussed in sections 4.3 and 4.4), present the case of Milan and London. Low Emission Zones (LEZ) and road charging schemes are to some degree comparable, though their objectives are different. They impose costs to road

[24] These represent the averages by group, calculated in the previous section. Please note that the inter country variation is large and that these numbers are only taken as indicative.

[25] With this, we indicate that the result can either be positive, negative or unequally distributed.

users entering designated areas of the city. The main difference is that in LEZ, decreasing congestion is generally a secondary goal, while it is the primary objective in the case of road charging. While theoretically, LEZ and road charging would raise the price of housing, especially in the center, the scarce empirical evidence (Zhang, 2006; Perccoco M., 2012) points more towards a decrease in the attractiveness of the center, conversion of commercial buildings to housing and a resulting decrease in housing prices. It may however be, that the adjustments of the housing sector are going to slowly to make these results reliable. The impact of road charging on employment is controversial, though a CGE analysis in Steiniger (2006) and Heyndrickx et al (2009) showed that employment can be impacted positively when the revenue is recycled (partially) towards reduction of labour taxes. Without this type of revenue recycling, the impact is most likely negative.

Access restrictions for freight transport reduce the efficiency of deliveries within the city and will generally have an economic cost and reduce employment in the distribution sector (Schoemaker et al, 2006). Imposed delivery windows in cities restrict freight to either daytime (London) or nighttime (Paris) deliveries. These reflect city level preference for noise avoidance (daytime) or congestion avoidance for urban freight (nighttime). Therefore, the impact on either congestion or noise avoidance is somewhat ambivalent and depends upon the type of scheme imposed.

Urban growth boundaries encompass a number of measures to restrict development of the city to certain areas. This type of measures impose costs on the city population in terms of higher housing prices, but can lead to benefits through higher city density and lower congestion (Anas A. (2006) and Brueckner J.K (2007)). In addition, it can be part of a strategy to preserve certain 'Green Areas' around the city. The impact of urban growth boundaries on employment and on economic development is somewhat ambivalent, though the economic rationale is to say that they are negative, due to the costs urban growth boundaries impose on consumers and firms. Cost-benefit evaluation of urban growth boundaries in empirical situations is often negative, especially when development is easily relocated to uncontrolled regions and causes suburbanization beyond the city borders (Myung Jin, 2004).

One type of policy much used by cities are parking policies. As discussed in section 4, advancement in parking technology currently allow to charge different rates to vehicles according to arrival time and emission intensity of the vehicle. While more stringent parking policies can be a second-best strategy for road charging (Calthrop et al, 2000), there is a huge discussion whether too stringent parking policies may lead to extra cruising and cause additional traffic congestion in the city (Arnott, 2010 & Fosgereau M. et al, 2013). The presence of private parking spots or parking at the workplace as extra-legal benefit reduces the effectiveness of this type of policies.

Policy towards promoting of the use of cycling takes many forms. Many cities are subsidizing bike programs and improving the traffic infrastructure for cycling. Copenhagen is a forerunner in this aspect, strongly promoting cycling as the main option for intra-urban travel. Cycling is the fastest intra-urban transport mode and has strong health benefits. Commuting by bike is associated with higher work productivity and lower sick days (Rabl A. et al, 2012). Grous A. (2011) analyses the success of the 'cycling economy' and possible positive economic effects of cycling for the first time.

He found that each cyclist contributes £230 to the UK economy, with a total of £2.92 billion for the whole economy. This is composed of £2.47 in retail sales, £0.5 in wages, £0.1 in taxes and £0.128 in health benefits. Promotion of cycling may actually be one of the best policies available to increase sustainability of urban traffic. It is clear however, that promotion of cycling will only be effective, if the infrastructure is present, accessible and safe.

We discuss investments in public transport in section 5.2. While potentially generating employment and allowing a shift towards public transit, the impact of costly infrastructure projects on city finance should not be underestimated. Additionally, transport infrastructure, be it for public or private transit, potentially leads to expansion of the city and thus to urban sprawl and suburbanization. In this sense the Copenhagen administration was especially visionary to designate areas for city expansion in a controlled way when applying the Finger plan.

Promotion of public transit is a soft measure that has been shown to stimulate the use of public transit to some degree. Publicly funded training programs may help to familiarize new users with public transit, but may not lead to any structural change towards public transit use. Other measures to promote public transport, such as establishing a unified ticketing system for public transit or improving and visualizing transport schedules are more likely to lead to long term results. Santos G. (2008) argues, that in the case of London, the simplification of the ticketing system, through the Oyster pass, was a very effective way to reduce waiting lines and reduce the cost of taking public transit.

We treat Urban Delivery Centers in Section 4.3 & 4.4. Especially in Italy, many cities experimented with UDC's. These are publicly supported freight consolidation centers, with the aim of bundling urban freight transport on low emission vehicles. The Italian experience was rather mixed, as most of the centers were costly on public finance and had too little impact on city traffic to be effective (Danielis et al, 2010). The experience of Genua was particularly positive and shows that UDC's may have potential, if supported by the local distribution sector.

Dynamic transport management (Schoemaker et al, 2006) is an efficient way to improve the efficiency of traffic flows, without creating new and costly infrastructure. It is unable however, to create any structural change to the urban environment.

Cities consider investments in new road infrastructure, when the network is congested. While in some cases, new capacity may be necessary, increase in road capacity should be weighed against its negative impact on sustainability. Investments in road infrastructure are costly on the public budget, increase urban sprawl (Baum-Snow N., 2007), increase private use of cars, traffic pollution and only have a transient effect on congestion, due to induced travel demand effects (see for example: Litman, 2013).

In the home-work balance, commuting is of primary importance. The theory of urban economics provides plenty of evidence, that when the private cost of transport does not reflect the total social (external) cost of transport, the city density will be lower than optimal, congestion higher and the total commuting distance longer. The link between environmental costs and excess private transport is self-evident. The social cost of commuting may be equally important however. Sandow E. (2013), shows using longitudinal data from 1995-2005 for Sweden, that couples under stress of long-distance commutes have higher separation rates. Novaco et al (2009) link many elements of psychological and health related illness to commuting and point to telecommuting as a possible solution to improve home-work balance.

Fuhr & Pochiask (2010) are especially positive about this sort of incentives, pointing out that the reduced demand for office space would lead to lower energy consumption and lower land use in the city. Rietveld (2011) finds that the specific 'Dutch' practice of working at home during the morning and leaving later to work, can balance traffic flows more evenly during the morning, but may affect the home-work balance and congestion during evening hours negatively. Rhee (2009) finds that work at home incentives can lead to more urban sprawl. Macharis et al (2011) analyses a series of interviews and shows that the impact of the scheme is reduced when a large share of the commuters are already taking public transit. Furthermore, energy consumption at home during home-work days is substantially larger than under normal working days. The presence of rebound effects in the energy use at home and latent demand of non-teleworkers, make it questionable if teleworking can really have any significant results on pollution.

Table 11. City level policy and estimated impacts on sprawl, price of housing and transport, pollution, congestion and employment (own assessment)

	Policy	**Urban Sprawl**	**Price of housing**	**Price of transport**	**Pollution**	**Congestion**	**Public finance**	**Employment**	**References**
1	General energy efficiency standards	0	+	0	-	0	+	++	Section 5.3 & D15.2
2	Fuel efficiency standards	≈	0	≈	-	+	-	+	Section 5.3 & D15.2
3	Electrification of transport	≈	0	≈	-	+	-	≈	Section 5.3 & D15.2
4	Low Emission Zones	≈	≈	+	-	-	+	≈	Section 4.3 Danielis et al (2010) [1] Percocco M. (2012)
4	Road charging	-	≈	+	-	--	+	-	Sections 3.2 & 4.3 Leape (2006), Tfl (2007) Danielis et al (2010) [1] Steiniger et al (2007)
4	Access restrictions for freight	0	≈	+	≈	≈	0	-	Section 4.3 Schoemaker et al (2006)
4	Urban growth boundaries	--	++	0	≈	≈	-	-	Section 3.2 Anas A. (2006) Brueckner J.K., (2007)
4	Parking policy	0	≈	+	-	≈	+	≈	Arnott R.J (2010) Fosgereau et al (2013)

5	Cycling policy	0	0	0	-	-	+	+	Rabl A. et al (2012) Grous A. (2011)
5	Investments in public transport	+	≈	0	-	-	--	+	Section 5.2
5	Promoting public transport	0	0	0	-	-	≈	+	Section 5.4
6	Urban Delivery Center	0	0	≈	≈	≈	-	≈	Section 4.3 Browne et al (2007) Danielis et al (2010) [2]
6	Dynamic transport management	0	0	-	≈	-	≈	0	Schoemaker et al (2006)
6	Investments in road infrastructure	++	-	-	++	≈	--	+	Section 5.2
6	Work @ home incentives	+	-	-	≈	-	0	+	Fuhr & Pociask (2010) Rietveld (2011) Macharis (2011) Rhee (2009)

7. Conclusions

This is a very diverse deliverable, which tries to combine theoretical predictions from urban economic literature, EU policy, literature review and economic modeling. Its main contribution is to provide a more in-depth review of current transport policies on urban level in the EU.

We gave a short review of urban economic theory, to show that there is an intricate link between the transport system, the form of the urban region and the housing market. This means that we should not see transport policy independent from urban planning. We show that many of the EU policies on urban level are a part of the general NEUJOBS policy scenarios we have introduced in D15.1 and analyzed in D15.2. We discussed three city level case-studies: London, Milan and Copenhagen. Each of these cities has implemented transport policies, which have received worldwide attention and acclaim: London for the LCCS, Milan for its Ecopass system and Copenhagen for its Finger plan. We see how these schemes fit in the city's planning history, where Copenhagen focusses on urban planning, London on technological innovations and Milan on pricing and investments in public transport.

In the next section we revisited the policy scenarios that were performed with the EDIP model in D15.2, but with a more in-depth analysis of the marginal impacts of each policy. The idea of this section was to couple the macro-level changes proposed in D15.2, with micro-level changes that happen on the level of the city. We showed that the results of EDIP are comparable to other studies, but that the inter-country variation is substantial and at times counter-intuitive. Investments in public infrastructure, increased efficiency of traffic and improvements in energy efficiency have the largest relative impact on employment per million euros, especially in Eastern and Southern European countries. The impact of fuel efficiency is generally positive on employment, but the results for electrification of transport are in many cases negative. Reduction of private car use is slightly positive through increased employment in public transport.

In the last section, we discuss the impact of a number of policies on the level of the city on 7 important indicators of city livability. These are urban sprawl, congestion, price of housing, price of transport, pollution and employment. In the absence of hard quantitative evidence, we discuss the most likely direction of each policy on the chosen indicators. The policies most likely to contribute to sustainability, while at the same time stimulating employment are 'pro-cycling policies', 'promotion of public transit' and 'promotion of energy efficiency'. Promotion of fuel efficiency and especially electric vehicles can contribute to sustainability, but are less cost-effective. To allow cities more control over urban traffic, we advise to establish road charging zones or alternatively low emission zones. Not only does this give cities a flexible tool for redirecting traffic flows, congestion charges provide the city with revenues that can be redistributed for greater social surplus. When at least a part of the revenues is recycled towards labour market efficiency, the impact on overall employment is most likely positive. Where road charges are difficult to implement, parking charges may be a second-best solution, especially if the charges are time and vehicle dependent.

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ABOUT NEUJOBS

"Creating and adapting jobs in Europe in the context of a socio-ecological transition"

NEUJOBS is a research project financed by the European Commission under the 7th Framework Programme. Its objective is to analyse likely future developments in the European labour market(s), in view of four major transitions that will impact employment - particularly certain sectors of the labour force and the economy - and European societies in general. What are these transitions? The first is the **socio-ecological transition:** a comprehensive change in the patterns of social organisation and culture, production and consumption that will drive humanity beyond the current industrial model towards a more sustainable future. The second is the **societal transition,** produced by a combination of population ageing, low fertility rates, changing family structures, urbanisation and growing female employment. The third transition concerns **new territorial dynamics** and the balance between agglomeration and dispersion forces. The fourth is **a skills (upgrading)** transition and and its likely consequences for employment and (in)equality.

Research Areas

NEUJOBS consists of 23 work packages organised in six groups:

- **Group 1** provides a conceptualisation of the **socio-ecological transition** that constitutes the basis for the other work-packages.
- **Group 2** considers in detail the main drivers for change and the resulting relevant policies. Regarding the drivers we analyse the discourse on **job quality**, **education**al needs, changes in the organisation of production and in the employment structure. Regarding relevant policies, research in this group assesses the impact of changes in **family composition**, the effect of **labour relations** and the issue of financing transition in an era of budget constraints. The regional dimension is taken into account, also in relation to **migration** flows.
- **Group 3** models economic and employment development on the basis of the inputs provided in the previous work packages.
- **Group 4** examines possible employment trends in key sectors of the economy in the light of the transition processes: energy, health care and goods/services for the **ageing** population, **care services**, housing and transport.
- **Group 5** focuses on impact groups, namely those vital for employment growth in the EU: **women**, the **elderly**, immigrants and **Roma**.
- **Group 6** is composed of transversal work packages: implications NEUJOBS findings for EU policy-making, dissemination, management and coordination.

For more information, visit: www.neujobs.eu

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