

Thesis 214

# Transport Demand Management in Reykjavík

A study of potential measures

---

Margrét Silja Thorkelsdóttir



Trafik och väg  
Institutionen för Teknik och samhälle  
Lunds Tekniska Högskola, Lunds universitet

# Transport Demand Management in Reykjavík

A study of potential measures

Margrét Silja Thorkelsdóttir

Examensarbete

CODEN:LUTVDG/(TVTT-5181/1-117 / 2010

Thesis / Lunds Tekniska Högskola,  
Institutionen för Teknik och samhälle,  
Trafik och väg, 214

ISSN 1653-1922

## Transport Demand Management in Reykjavík A study of potential measures

Margrét Silja Thorkelsdóttir

2010

*Keywords:*

Transport Demand Management, Private car, Sustainability, Balanced Modal Split, Measures

*Abstract:*

The aim of the thesis is to study potential measures within transport demand management to minimise the dominance of the private car in Reykjavík, Iceland. Firstly, facts are brought about to identify the problems of the system, secondly, a number of relatively cheap and simple measures are studied and, finally, a plan of measures is suggested aimed at increasing the sustainability of Reykjavík's transport system. The study is mainly carried out through a literature study, supported by a number of case studies, mapping of problems and discussions. The results show shocking numbers for car ownership, enormous supply of car parking free of charge and inefficient travel patterns. There is a great potential to implement many of the measures suggested, of which many are unexplored in Iceland, to reach a more balanced modal split and encourage the individual to contribute. The measures are among other things intended to minimise and make private car traffic more efficient, promote more environmentally friendly modes of transport, bring about economic savings and contribute to improved private and public health. In addition, the significance of improved cooperation between neighbouring municipalities, which all together form the coherent metropolitan area of Reykjavík, is addressed.

*Swedish title:*

Styrning av transportefterfrågan i Reykjavík –en studie av potentiella åtgärder

*Citation:*

Thorkelsdóttir, M. S., Transport Demand Management in Reykjavík –A study of potential measures. Lund University, Lund Institute of Technology, Department of Technology and Society, 2010. Thesis 214.

Trafik och väg  
Institutionen för Teknik och samhälle  
Lunds Tekniska Högskola, LTH  
Lunds Universitet  
Box 118, 221 00 LUND

Traffic and Roads  
Department of Technology and Society  
Faculty of Engineering, LTH  
Lund University  
Box 118, SE-221 00 Lund, Sweden

## Preface

When I moved to Lund to study civil engineering in the autumn 2004 I realised that it is not a natural right to own a private car and use it without considering the hazardous effects it causes to your surroundings. I have noticed enormous attitude change within myself, not only from the studies, but also from the attitude of the general public and their awareness of the importance to contribute as individuals. In Lund you are atypical for using the car, the opposite to Reykjavík where you are atypical for riding a bike.

I chose the specialty traffic planning out of pure interest and have never regretted that choice. It was during a lecture in the course ‘Safety and Environmental Effects of Traffic’ held by Prof. Bengt Holmberg in my fourth year of the program that I got the idea for this thesis. I contacted the city of Reykjavík and got positive reaction from Pálmi Freyr Randversson, who agreed to be my unofficial local supervisor.

I have learned incredibly much from writing the thesis and really enjoyed writing it. The topic is broad and at times I felt like I could continue for many more months. I however, feel that now is the time to be satisfied and I am certainly proud of the stage reached.

I want to thank my supervisor Prof. Bengt Holmberg for his support and good advice and Pálmi Freyr for his valuable assistance. In addition I want to thank my father, Keli, and partner, Raggi, for proofreading as well as all the experts that took their time to answer my questions.

Lund December 2009

---

Margrét Silja Thorkelsdóttir



# Table of Contents

<b>Preface</b> .....	4
<b>Table of Contents</b> .....	5
<b>Table of Figures</b> .....	8
<b>List of tables</b> .....	9
<b>Summary</b> .....	i
<b>1 Introduction</b> .....	1
1.1 Aim .....	1
1.2 Method and setup of the report .....	2
1.3 Limitations .....	2
1.4 Prerequisites .....	3
1.5 Historical background regarding traffic .....	4
1.6 Facts of interest .....	6
1.6.1 Demography and geography .....	7
1.6.2 Car ownership .....	8
1.6.3 Modal split and travel patterns.....	11
1.6.4 Climate.....	13
1.6.5 Public transport .....	14
1.6.6 Car parking .....	15
1.6.7 Air pollution.....	17
<b>2 Literature study of measures</b> .....	19
2.1 Parking policies.....	19
2.1.1 Parking guidelines developed by EPA.....	20
2.1.2 Four types of parking policies defined by the OECD.....	21
2.1.3 Travel responses to parking policy measures .....	23
2.1.4 Implementation .....	24
2.1.5 Case study: Free public parking on weekends in Oslo, Norway.....	24
2.1.6 Case study: Various Northern American Case studies .....	25
2.2 Carpools .....	26
2.2.1 Carpools for companies, institutes and organisations.....	26
2.2.2 Costs and benefits of a Carpool .....	28
2.2.3 Possibility of using municipal and state owned service cars as carpool cars outside working hours .....	29
2.2.4 Implementation .....	29
2.2.5 Ride-sharing.....	30
2.2.6 Case study: Vision Lundby.....	30
2.2.7 Case study: The Environmental Committee for the City of Göteborg. 31	
2.2.8 Case study: Smart car-sharing database in the Flemish region of Belgium.....	31
2.3 Public transport .....	32
2.3.1 Quality assessment of public transport services .....	33
2.3.2 Policies for urban public transport.....	34
2.3.3 Infrastructure, facilities and vehicles .....	34
2.3.4 Bus-lanes and possible High Occupancy Vehicle Lanes (HOV Lanes)	

2.3.5	Zero rates for public transport.....	36
2.3.6	Differentiated rates .....	37
2.3.7	Light rail .....	37
2.3.8	Case study: Public/private partnership in public transport services in Sweden.....	38
2.3.9	Case study: A trial of using hydrogen buses in Reykjavík 2001-2005	38
2.4	Biking and walking .....	39
2.4.1	Effects on health .....	39
2.4.2	Physical planning .....	40
2.4.3	Facilities and equipment .....	41
2.4.4	City bikes .....	41
2.4.5	Other measures .....	41
2.4.6	Case study: Quarter-hour bike map .....	41
2.4.7	Case study: The rescue from an unsustainable traffic situation in München, Germany .....	42
2.5	Education and information.....	43
2.5.1	Traffic education in schools.....	44
2.5.2	Driving education systems and Eco-driving .....	44
2.5.3	Course in Bikeability .....	45
2.5.4	Independent educational programmes .....	45
2.5.5	Health promotion .....	46
2.5.6	Case study: Achievement of behavioural changes among drivers.....	46
2.5.7	Case study: Annual ‘Biking to work’ competition in Iceland.....	47
2.5.8	Case study: Eco-Schools (Grænáninn) in Iceland .....	47
2.5.9	Case study: Environmental Protection in action (GAP program), Iceland.....	48
2.5.10	Case study: International promotion of EcoDriving, Sweden .....	48
2.5.11	Case study: Developmental project in Bikeability in an elementary school in Reykjavík (Álftamýrarskóli) .....	48
2.5.12	Case study: International Walk to School.....	49
2.5.13	Case study: ‘IT’S UP 2 U!’ Marketing Competition for Public Transport, the Netherlands.....	49
2.6	Economic measures.....	50
2.6.1	Taxation .....	50
2.6.2	Road pricing systems .....	51
2.6.3	Congestion pricing .....	52
2.6.4	Tax-exempts as an incentive.....	52
2.6.5	Subsidies from authorities.....	53
2.6.6	Pay-As-You-Drive insurance pricing .....	53
2.6.7	Case study: Workplace parking Levy in Nottingham.....	54
2.6.8	Case study: Congestion Charge Scheme in London, UK .....	54
2.6.9	Case study: Polis Direct PAYD insurance pricing, The Netherlands ..	55
2.7	Involvement of the private sector.....	56
2.7.1	Environmental certificates .....	56
2.7.2	Travel plans for private companies.....	57
2.7.3	Telecommunication .....	57

2.7.4	Various initiatives .....	58
2.7.5	Case study: Pfizer in Sandwich in the UK.....	58
2.7.6	Case study: Telecommuting program of First Interstate Bank, Los Angeles .....	59
2.7.7	Case study: Environmental Profile at Work (EPW) .....	59
2.7.8	Case study: Employees help staff ease their commuting headaches....	59
<b>3</b>	<b>A plan of measures</b> .....	<b>60</b>
3.1	General goals .....	60
3.2	Overall measures.....	60
3.3	Parking policy measures .....	61
3.4	Measures for Carpools .....	61
3.5	Public transport measures .....	62
3.6	Measures for biking and walking.....	63
3.7	Informative and educational measures.....	64
3.8	Economic measures.....	65
3.9	Involvement of the private sector.....	66
<b>4</b>	<b>Discussion and potential for implementation of measures</b> .....	<b>67</b>
4.1	Overall potential.....	67
4.2	Parking policies.....	69
4.3	Carpools .....	70
4.4	Public transport .....	71
4.5	Walking and biking.....	72
4.6	Information and Education.....	72
4.7	Economic measures.....	73
4.8	Involvement of the private sector.....	74
4.9	Expected effects .....	74
<b>5</b>	<b>Conclusion</b> .....	<b>76</b>
<b>6</b>	<b>Bibliography</b> .....	<b>79</b>
6.1	Written sources .....	79
6.2	Electronic sources .....	82
6.3	Unpublished works .....	87
<b>Appendices</b> .....		<b>89</b>
Appendix A Price comparison for carpools, rental cars and private car ownership.1		
Appendix B Route map for public transport in Reykjavík (Strætó).....		3
Appendix C An expert's estimation of the potential to implement the plan of measures.....		4



## Table of Figures

Figure 1-1	The eight municipalities referred to as Reykjavík in this report (nes Planners 2002).....	3
Figure 1-2	Reykjavík's roads were well prepared for the arrival of the car after the Age of Horse wagons (Valsson 2003).....	5
Figure 1-3	The army left a bonanza for the inhabitants of Reykjavík when they left after the WW II (Valsson 2003).....	5
Figure 1-4	The dominant planning method 'predict and provide' is retreating today (Sigurðsson 2004).....	6
Figure 1-5	A comparison between average population density (inhabitants/hectare) in Reykjavík, Western Europe and North America (Hönnun 2006).....	7
Figure 1-6	The division of Reykjavík into 11 quarters regarding traffic (Sigurðsson 2004).....	8
Figure 1-7	Passenger cars per 1 000 inhabitants in Iceland and Sweden 1950-2007 .	9
Figure 1-8	Passenger cars per 1 000 inhabitants in Iceland and Sweden year 1990-2007.....	9
Figure 1-9	Modal split in Reykjavík for all trips and work-related trips only (Sigurðsson 2004).....	11
Figure 1-10	Modal split –Comparison to other cities (Hönnun 2006).....	12
Figure 1-11	Charged parking zones in Reykjavík city (Reykjavíkurborg Bilastæðasjóður).....	16
1-12	Attitude development towards fee collection for parking services in Reykjavík 1996-2008 (Capacent Gallup 2008).....	17
Figure 1-13	Emissions of carbon dioxide 1997-2006 by source (Statistics Iceland 2009d).....	<b>Fel! Bokmärket är inte definierat.</b>
Figure 2-1	Trips that could be replaced with carpool cars (Göteborgs Stad Trafikkontoret n.d.).....	27
Figure 2-2	A summation of the cost and benefits of carpools (material from chapter 2.1 processed by author).....	28
Figure 2-3	Public transport reform in Sweden shown on the public transport policy graph (Örn 2005).....	34
Figure 2-4	Quarter-hour bike map (Umhverfissvið Reykjavíkurborgar 2006).....	42

## List of tables

Table 1-1	Car ownership of the eight municipalities in Reykjavík .....	10
Table 1-2	Distribution of trips regarding their length (Hönnun 2006).....	11
Table 1-3	Average minimum and maximum temperature (°C).....	13
Table 1-4	Average precipitation and number of wet days.....	13
Table 1-5	Average wind speed.....	14
Table 2-1	Modal split between private cars and public transport depending on parking facilities at worksites (Kollektivtrafikkommittén 2003).....	20
Table 2-2	Valuation of different time components of a public transport trip (TRAST 2007).....	33
Table 2-3	Development of participation and achievements reached in the campaigns ‘Bike to work‘ .....	41
Table 2-4	Benefit summary for teleworking (Victoria Transport Policy Institute 2008) .....	57



## Summary

Reykjavík is often referred to as ‘the most environmentally friendly capital of the north’, but it is not worthy of that title when regarding traffic. The planning method ‘predict and provide’ has been predominant throughout the years resulting in extremely high car ownership and car parking availability at its best.

The objective of the thesis is to address the problems of Reykjavík’s transportation system and apply travel demand management to increase its sustainability. The main aim is to study and suggest relatively cheap and simple measures to minimise traffic made by private cars by highlighting more environmentally friendly travel modes.

The thesis consists of four parts. The first is an introduction with an historical background and a presentation of problems. The study covers the whole Reykjavík metropolitan area, consisting of eight different municipalities with a total number of inhabitants of approximately 200 000. Car ownership has for long been associated with welfare and economic upswings and the private car has gained outstanding dominance in the modal split. There are more private cars than driver’s licenses in Reykjavík, more than half of all drivers are solo drivers, most households have more than one car and travel patterns are very inefficient. Furthermore, the supply of car parking is enormous and fee collection is rare. In most cases Reykjavík resembles the situation in North American cities more than neighbouring European cities.

The second part of the thesis is a literature study of potential measures to solve the problems addressed in the previous part. The measures studied are parking policies, carpools, public transport, biking and walking, education and information, economic measures and involvement of the private sector.

Parking policy measures are believed to be the largest single management tool in ‘modern mobility management’. The supply of free parking compromises the number of people choosing other modes of transport, especially for commuting trips. European Parking Association provides valuable parking guidelines for authorities and the OECD defines four types of policies that are discussed in the thesis.

Carpools, referred to as the phenomenon of short-term car rental, either run as a cooperative or commercially, are a potential tool to increase the efficiency of private car use. It is a way to outsource expensive administration and maintenance of one’s own car fleet, possible for private people and companies. It can replace many families’ extra car, allow adjustment of vehicle type to trip purpose, encourage better planning of trips and promote other transport modes, above all for shorter trips.

Public transport is a vital system for certain groups of people and a significant tool to limit private car traffic. It is an essential complement to many other measures, like parking policies and carpools, for them to be justifiable. Despite that the force of habit to pick the private car maintains strong. Particular focus on improving the level of service with more frequent trips, faster connections and increased comfort is necessary to attract private car users to public transport. Subsidised zero-rates are not considered to be cost-efficient and are rather thought to attract non-motorised travellers.

## Transport Demand Management in Reykjavík

Walking and biking are the most sustainable modes of transport; free of charge, very environmentally friendly and healthy. Pedestrian and bike networks should be built up similar to the road network, with high connectivity and proper maintenance as quality and extent of the network is much related to the use of it. They are indeed vital complements to justify many other measures like public transport. Successful campaigns promoting biking and walking imply the great potential to use the next group of measures, information and education, to promote these modes of transport.

Education and information are very successful tools in order to bring about mobility transition and have impact on perception, preferences and attitudes. Campaigns are often considered as a short-term instrument while education is considered to leave more permanent footprints. Information is essential in the starting stage and during implementation of many measures.

Economic measures have gained popularity for the principle ‘the polluter pays’ and are recommended by the OECD and the EU for transport demand management. The effects of economic measures are highly dependent on people’s willingness to pay for the benefits. Road pricing systems that are based on the distance driven are considered to encourage economic savings by contributing to sustainability. Economic incentives are also important for positive perception of measures.

The last measure, involvement of the private sector, is especially important for impact on commuting traffic. Private companies can contribute to sustainable travel habits e.g. by implementing travel plans for employees, facilitate biking to work, enable teleworking and by applying many of the measures mentioned above. Sustainable contribution by private actors is gaining increased popularity for marketing reasons.

The third part of the thesis is the plan of measures consisting of potential measures based on the previous literature study. The measures are not complete for implementation as further studies are required in most cases. It is, however, intended to work as a bank of ideas and be useful for future measure plan making.

The last part of the thesis is a discussion about measures, their potential to be implemented and a conclusion. All the measures are closely related and are thought to reinforce each other to reach the joint objectives. The overall potential for implementation is considered to be good due to many unexplored tools, but strongly dependent on political will and will of the neighbouring municipalities to cooperate. The ongoing economic crisis does have impact, some positive and other negative. The measures are believed to contribute to a balanced modal split by reducing private car traffic and promote more sustainable modes of transport, make trips more efficient and replace short motorised trips. With success, Reykjavík should be able to live up to expectations as ‘the most environmentally friendly capital of the north’!

# 1 Introduction

Reykjavík is unique for a variety of reasons. It is the capital city of a country that has so few inhabitants that it would be on the limit to even be considered a city elsewhere in the world. It is the northernmost capital in the world, known for its closeness to beautiful unspoiled nature and access to environmental energy resources. It is sometimes referred to as ‘the most environmentally friendly capital of the north’.

Reykjavík is also unique for much less impressive reasons; the significance of the private car. Car ownership is extremely high and use of public transport and other more sustainable travel modes is substantially low. The availability of car parking is at its best and in most places free of charge. Carrying capacity problems are solved by investing in new infrastructure. Whether this is the result of recent economic welfare and previous economic upswings linked to the arrival of the car or in general a lack of intervention from authorities is not the most important thing. Focus should be on future actions to improve these matters and the aim should be to live up to expectations as ‘the most environmentally friendly capital of the north’!

## 1.1 Aim

Following is a well known and frequently quoted definition:

*“Sustainable development is a dynamic process which enables all people to realise their potential and improve their quality of life in ways which simultaneously protect and enhance the Earth’s life support systems”* (Forum for the Future, annual report 2000)

The aim of the study is to

- point out facts that identify the problems in the traffic system of Reykjavík metropolitan area
- replace the common method ‘predict & provide’ to solve traffic problems with travel demand management
- study potential measures to minimize the dominance of the private car in Reykjavík
- study measures to make journeys, that occur despite the above mentioned measures, more effective
- create a plan of measures aimed at minimizing private car traffic in Reykjavík
- evaluate the potential for implementation of the plan

All above is meant to increase the sustainability of Reykjavík’s traffic system by highlighting environmentally friendly travel modes which, at the same time, bring about positive social and economic effects such as healthier lifestyles. The aim is to achieve these goals through implementation of relatively simple and cheap measures and thereby hopefully engage as many individuals as possible by giving them insight into how they can bring about important changes.

## **1.2 Method and setup of the report**

The report can be divided into five main parts:

1. A historical background and a presentation of problems
2. A literature study of measures
3. A plan of measures for Reykjavík
4. A study of potential for implementation of the plan of measures
5. Discussion and conclusion

The report as a whole will be introduced with a historical background of Reykjavík with emphasis on traffic and transportation. Interesting facts will be brought up to present the problems. This part will be based on a literature study as well as a collection and processing of data from statistical databases.

The second part, the study of measures, will be based on a literature study for a number of relatively cheap and simple measures aimed at minimizing and making traffic made by private cars in Reykjavík more effective. Case studies and ideas from other countries will be used to describe the measures.

The third part, the plan of measures, will be based on the previous part as a result from the literature study of measures and problems addressed in part one.

The fourth part, assessment of the potential for implementation of the plan obtained in part three, will be carried out mainly through an attitude survey among politicians and experts within relevant fields who will be asked to value the potential to implement the measures. The potential will, in addition, be based on existing future plans and current projects being carried out. The relevance of studied measures for Icelandic circumstances will be discussed in this part.

Finally, the report will be followed up with a discussion and a conclusion.

## **1.3 Limitations**

This thesis will be limited to person transport on land only so trucking, shipping and flying will be excluded.

Measures that will be discussed are limited to relatively small and cheap measures that enable every individual to contribute to minimised private car traffic. The classification of relatively small measures excludes measures such as building an underground railway system. Measures in form of urban planning will be excluded to limit the extent of the essay. Urban planning methods are, besides that, more applicable in areas that are to be built, which is unlikely the case for Reykjavík in the nearest future due to the economic crisis and the surplus of residential housing. Urban planning is, however, a vital tool to minimise traffic, especially when applied to minimize the travel demands. Traffic safety will also be excluded in the essay, but generally the number of accidents decreases as motorised traffic decreases. That automatically contributes to sustainable development. In addition, the amount of motorised vehicles has relatively small effect on noise levels emitted and factors like

## Transport Demand Management in Reykjavík

speed, vehicle and tire type, ground surface and surroundings are more significant. Therefore, noise will not get much focus in this context.

The measures suggested in the plan of measures are only suggestions based on the knowledge gained in the literature study of measures. If the measures are to be implemented in reality more detailed and specific studies will be required in most cases. No quantitative goals will be made for the plan and the effects will only be estimated roughly on a local level, excluding global effects. It is, however, very important to study in detail the overall effects of the measures if they are to be implemented.

### 1.4 Prerequisites

In this report Reykjavík will be used when referring to the metropolitan area of Reykjavík, including all eight municipalities that the capital area regional plan covers, and Reykjavík City will be used when only referring to the city itself.

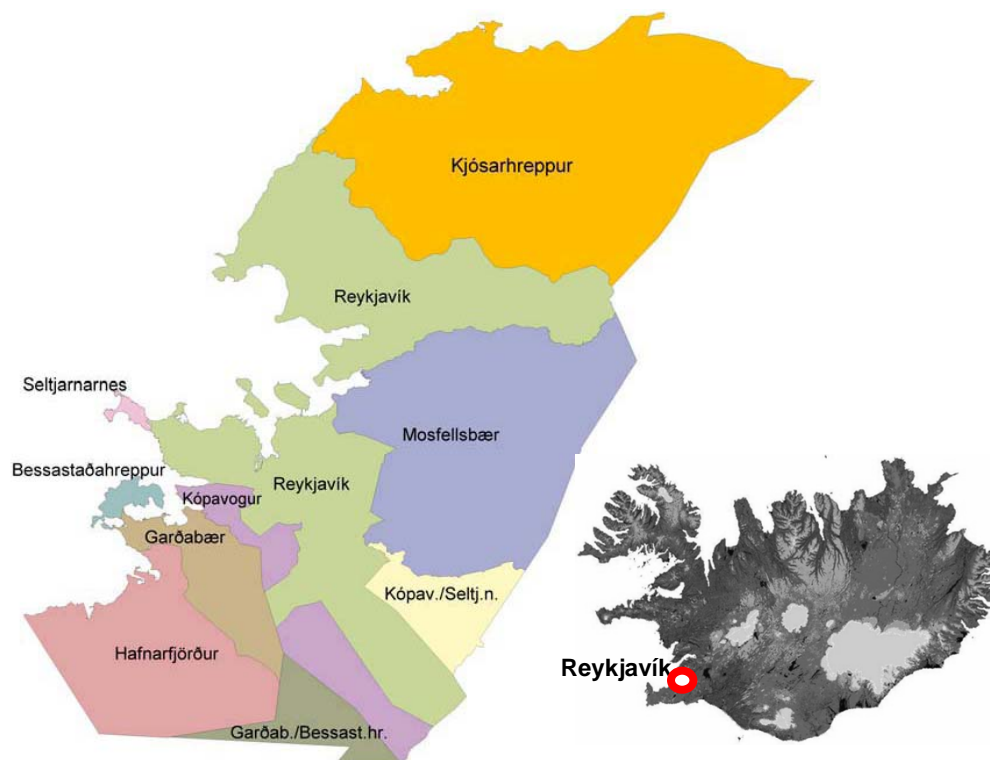


Figure 1-1 The eight municipalities referred to as Reykjavík in this report (nes Planners 2002)



## Transport Demand Management in Reykjavík

Prices will be given in Euros independent of original currency. The following exchange rates, taken from the Central Bank of Iceland will be used for price conversion.

1 Euro = 87.66 Icelandic Krona

1 Euro = 9.25 Swedish Krona

1 Euro = 1.37 US dollars

1 Euro = 0.68 British Pound

The exchange rates are average rates for the year 2007. It should, however, be kept in mind that the economic crisis, which hit Iceland in the autumn of 2008, has caused enormous changes in the exchange rates of the Icelandic krona. When comparing the average exchange rate for one year after the crisis first hit Iceland in October 2008 to the average for year 2007 the price of the US dollar has increased by 93%, the Swedish krona by 67% and the Euro by 91% towards the Icelandic krona. Even though it is uncertain whether the situation will stabilize any time soon it is considered to be more relevant to use the exchange rates from before the crisis as most of the prices referred to are from that time and have indeed not been updated since then (Seðlabanki Íslands 2009).

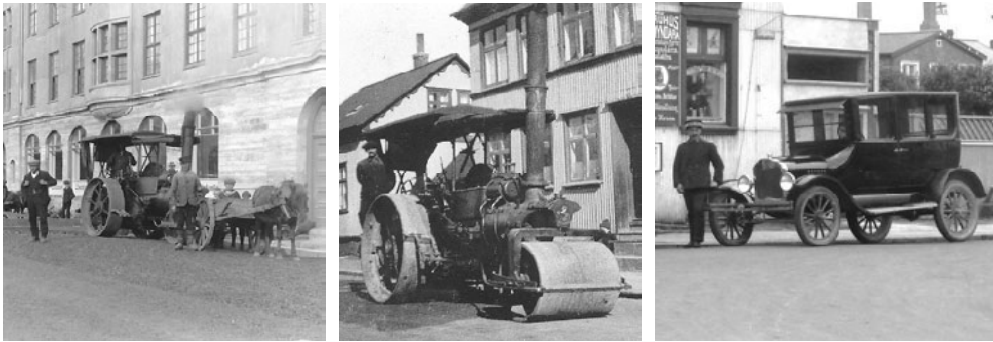
### **1.5 Historical background regarding traffic**

Reykjavík is the capital of Iceland founded in 1786. Reykjavík City became the centre of transportation early in the 19<sup>th</sup> century when the mail harbour was moved from Bessastaðir to Reykjavík city. At that point coastal shipping was the main transport mode and many settlements in rural Iceland were not connected to the road system until the mid 20<sup>th</sup> century. In late 19<sup>th</sup> century a new directive in transportation was issued saying that good roads were to be built in the most popular areas, which were decided before the first car arrived. The directive divided the road system into categories where the state was responsible for transportation routes, national routes and mountain routes, which an annual budget was allocated for, and counties and local districts were responsible for county- and local roads. This categorization was further developed into today's categories; primary roads, connecting roads, collecting roads and residential streets.

The first car arrived in Iceland in 1904, but it was not until 1913 that the first car arrived for private use. During the short Age of Horse Wagons in late 19<sup>th</sup> century many bridges and roads were built so the road system was relatively well prepared for the arrival of the car. The first street was asphalted in 1912 and all downtown streets of Reykjavík were asphalted in 1920. The suburbs and rural areas were, however, not asphalted for many more decades. The importance of roads increased during the World War I as import reduced and transport of agricultural produce from the countryside increased. Planning laws were made during the war and the first master plan for Reykjavík was finished in 1927. The number of cars grew from 130 in the year 1920 to 800 ten years later, putting great pressure on improvements of the road system. This faster way of travelling brought neighbourhoods closer to each other, allowing more interaction. This was also the beginning of a still ongoing problem, the phenomenon of increased dependence on motor vehicles in Iceland. Another problem was that prior to the Age of the Car, pedestrians and Wagon traffic could share street space, but the increased travel speed of the car emphasised the need for separation of

## Transport Demand Management in Reykjavík

these traffic modes. In the year 1900 the population of Reykjavík was 5 800, it had more than doubled in the year 1915 and grew by approximately 1000 inhabitants per year until 1945. As the town grew in space and population distances became longer and the need for public transport arose. The Reykjavík Bus Company was established in 1931 and six buses operated in route traffic the year after. Prior to the establishment of the company public transport was provided with passenger cars.



**Figure 1-2 Reykjavík's roads were well prepared for the arrival of the car after the Age of Horse wagons (Valsson 2003).**

The British and the American army brought a huge inflow of capital, large amount of high technology vehicles and employment during their occupation of Iceland in the World War II. Modern road transportation systems and airports were built, roads were paved and houses were built. Their stay was seen by many people as saviour from poverty, changing depression to an economic upswing.



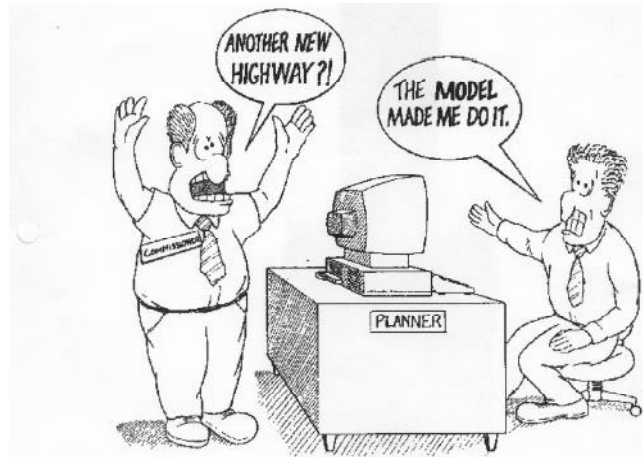
**Figure 1-3 The army left a bonanza for the inhabitants of Reykjavík when they left after the WW II (Valsson 2003).**

City planning gained popularity after the World War II and plans characterized by off-centre geometry, independent suburbs, vast green spaces and zoning of activities were dominant for approximately two decades. Suburbs were far too small to be self-sufficient, shopping malls were placed along highways instead of in the centre of settlements, wide avenues with up to eight lanes and space demanding intersections were built. All these characteristics lead to a dispersed settlement which the increase in car ownership after the war allowed. The area of Reykjavík city grew by 700% while the population only grew by 70%. These planning methods were at that point outdated elsewhere in the world as many foreign countries had already been badly burnt by the car. It was around 1972 that planning visions changed and a Development Office was established. The office took important steps towards

## Transport Demand Management in Reykjavík

improvement of environmental matters such as replacement of industrial areas with residential areas, abolishment of several highways from previous plans, introduction of a system of tracks for biking and pony trekking (Valsson 2003).

Until recently the planning method ‘predict and provide’ has been dominant, i.e. the supply of transportation systems has been determined by the demand rather than managing people’s travel choice into a positive direction by considering social, environmental, health and economical aspects (Sigurðsson 2004).



**Figure 1-4** The dominant planning method ‘predict and provide’ is retreating today (Sigurðsson 2004).

Referring to Reykjavík as ‘the most environmentally friendly capital of the north’ makes sense when considering the fact that heating and electricity are provided by hydrological and geothermal power. It sounds, however, very contradicting when considering car ownership, which is not only enormous, but also characterized by super jeeps weighing around two tons each (Valsson 2003).

Recently there has been an enormous awakening within municipal powers, especially the city of Reykjavík, which have been very active in e.g. encouraging people to walk and bike, rewarding environmentally friendly vehicles and improving the public transport through so called ‘Green Steps in Reykjavík’. This is a very positive development. Reykjavík is, however, very far away from having a sustainable transportation system and the purpose of this report is to find ways to take Reykjavík a step forward towards sustainability.

### **1.6 Facts of interest**

Various facts of interest will be brought up in this chapter to identify the problems in Reykjavík’s transportation system. In addition, the facts will be used later in the report when assessing the potential for implementation of measures as well as relating measures to Icelandic circumstances.

A very frequently used source in this subchapter is a household travel survey from the year 2002 made by Gallup. The survey was performed through telephone and the sample consisted of 4 941 people above six years of age. A committee assigned by the

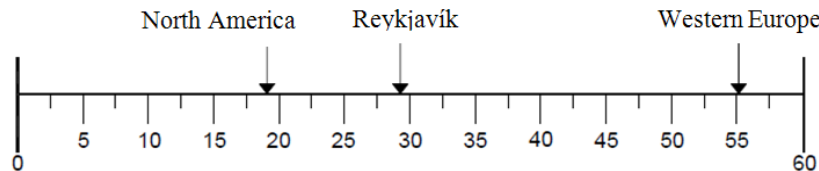
## Transport Demand Management in Reykjavík

city of Reykjavík estimated the number of trips to be underestimated by 30%. The number of trips is therefore taken from a traffic-model for Reykjavík for the same year. It should be kept in mind that the survey was performed during winter time. (Hönnun 2006)

Another frequently used source in this subchapter is Statistics Iceland, the National Statistical Institute of Iceland. Relevant data from their database has been processed and will be presented both in text, tables and diagrams.

### 1.6.1 Demography and geography

The population of Reykjavík city is 120 000, or one third of Iceland's total population of 319 000 inhabitants, and two thirds when referring to the Reykjavík metropolitan area (Statistics Iceland 2009a). The inhabited area of Reykjavík was approximately 6 300 – 6 500 hectares in 2004 making an average population density of 28.8 inhabitants per hectare. That is almost half the average population density in Western European cities and closer to Northern American cities (Hönnun 2006).



**Figure 1-5 A comparison between average population density (inhabitants/hectare) in Reykjavík, Western Europe and North America (Hönnun 2006).**

Reykjavík was divided into eleven quarters regarding traffic for the household travel survey made in 2002. The following figure shows the variation in population density for these eleven quarters<sup>1</sup> (Sigurðsson 2004).

---

<sup>1</sup> The population density in the figure excludes big areas occupied by industrial- and outdoor activities and areas of main roads that are not in direct connection to the inhabited areas.

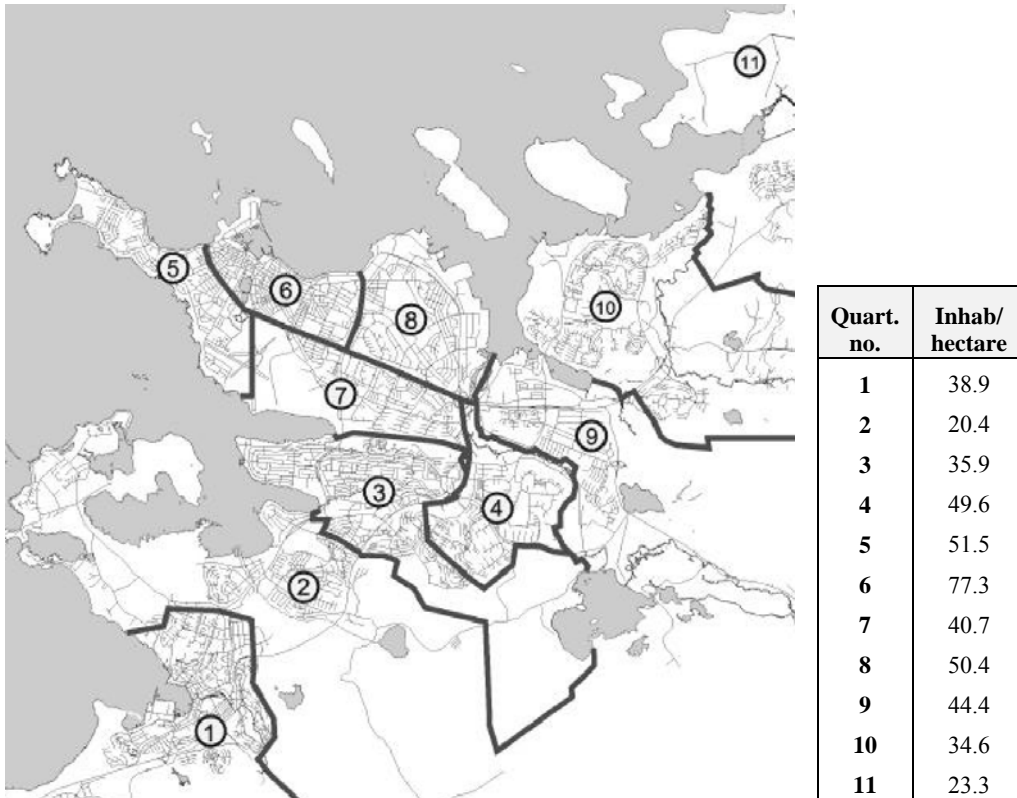


Figure 1-6 The division of Reykjavik into 11 quarters regarding traffic (Sigurðsson 2004).

There is a significant difference in age structure and educational level of the inhabitants of the different quarters, but these are among demographic factors that are known to be of significance when it comes to the choice of transport mode. A weighed age factor giving the age groups 13-24 years and above 55 years the most weight, as they are the most potential public transport users and pedestrians, the factor is lowest for the most central area, quarter six, and highest for quarters three and eight. The rate of unskilled inhabitants varies from 19.9% in quarter eight to 35.5% in quarter four and the rate of specialists varied from 5.7% in quarter one to 19.2% in quarter six (Sigurðsson 2004).

### 1.6.2 Car ownership

Car ownership in Iceland has grown from 42 per 1 000 inhabitants in 1950 to 667 in 2007 (Statistics Iceland 2009b). The following diagrams show the comparison in private car ownership between Iceland and Sweden during the period 1950-2007 with a closer look into the last two decades, 1990-2007. It can be seen that the curve for Iceland is growing much faster than the one for Sweden. (Diagrams are made from data form Statistics Iceland 2009b and Statistiska Centralbyrån 2009a and 2009b processed by the author.)

## Transport Demand Management in Reykjavík

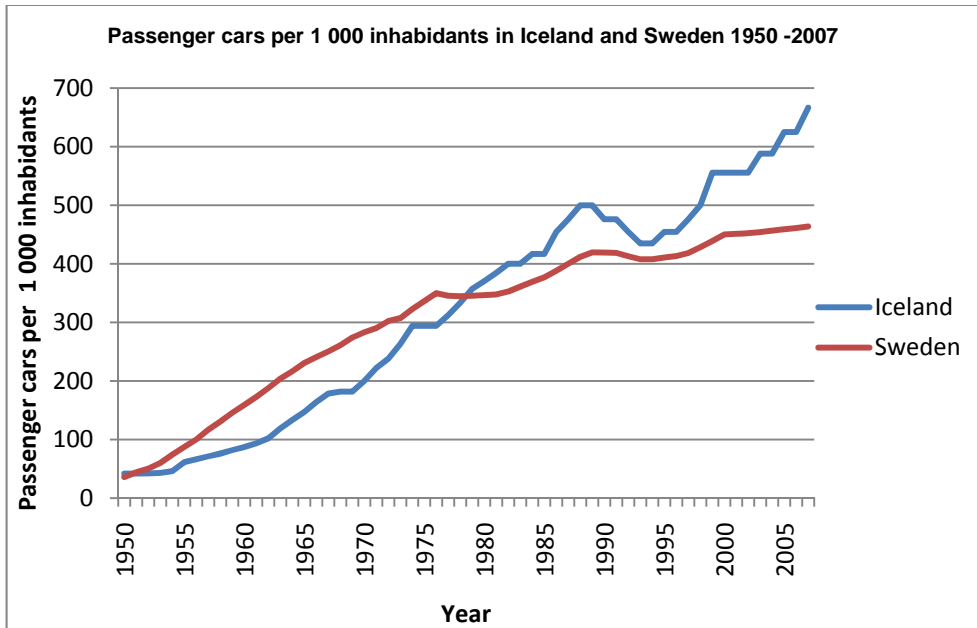


Figure 1-7 Passenger cars per 1 000 inhabitants in Iceland and Sweden 1950-2007

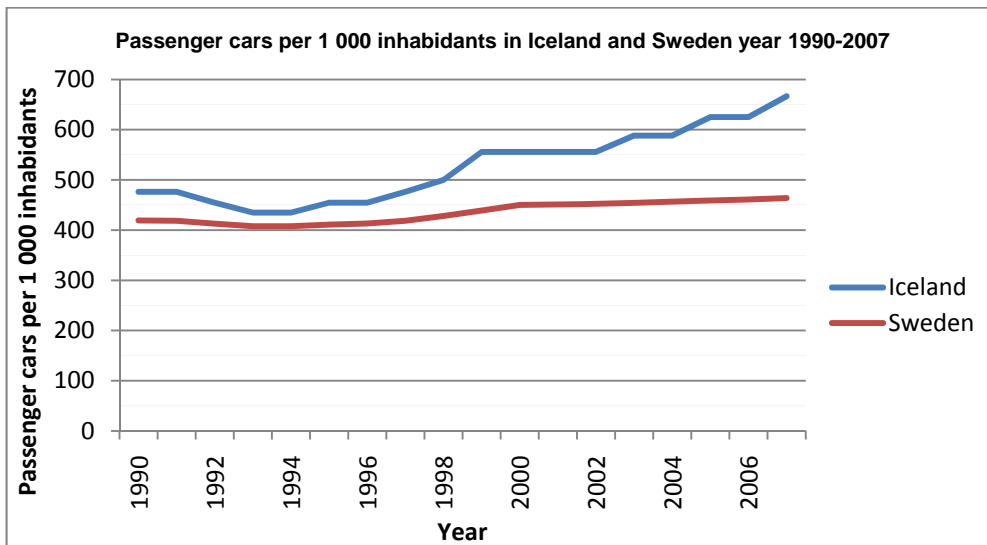


Figure 1-8 Passenger cars per 1 000 inhabitants in Iceland and Sweden year 1990-2007

Approximately 94% of all households in Reykjavík have one car or more and 50% two cars or more (Sigurðsson 2004). In the year 2006 there were approximately 1 100 passenger cars in Reykjavík per 1 000 driver's licenses<sup>2</sup> which indicates that saturation has occurred in car ownership in Reykjavík (Statistics Iceland 2009c). These numbers are more similar to numbers from the USA than other European countries.

<sup>2</sup> Árni E. Albertsson, assisting national commissioner of the Icelandic police, on 21 August 2009.

## Transport Demand Management in Reykjavík

Oil consumption by passenger cars and related equipment has increased hand in hand with the car ownership. The car ownership per capita increased by 40% and oil consumption per capita by 47% during the 10 year period 1988-2007, each inhabitant consuming 1.12 tons of oil in the year 2007 (Statistics Iceland, 2009f).

The local authorities in Reykjavík and the government own and operate a great number of vehicles for their services of which many are not used after work hours, during weekends and holidays. Table 1-1 shows the total number of cars owned and operated by the eight municipalities of Reykjavík.

**Table 1-1 Car ownership of the eight municipalities in Reykjavík**

Municipality	Total number of passenger cars	Direct ownership	Operational leasing	Lease purchasing	Rental car	Carpool
Kjósahreppur <sup>3</sup>	<b>0</b>	-	-	-	-	-
Mosfellsbær <sup>4</sup>	<b>6</b>	5	1	0	0	0
Reykjavík <sup>5</sup>	<b>100</b>	0	92	0	0	8
Seltjarnarnes <sup>6</sup>	<b>13</b>	5	5	1	2	0
Kópavogur <sup>7</sup>	<b>30</b>	-	-	-	-	-
Garðabær <sup>8</sup>	<b>16</b>	13	2	0	1	0
Álftanes	no information	-	-	-	-	-
Hafnarfjörður	no information	-	-	-	-	-

It is interesting that the city of Reykjavík has eight carpool cars, but the phenomenon of carpools is hardly known in Iceland. It is worth mentioning that 50% of the car fleet of Reykjavík City is classified as environmentally friendly vehicles but the other municipalities have mainly conventional cars of which many are indeed old and inefficient. Some of the cars owned by the government were pointed out to be equipped with rather specialised equipment which cannot easily be removed preventing the possibility to use them as carpool cars<sup>9</sup>.

<sup>3</sup> Sigurbjörn Hjaltason, chairman of the district council of Kjós, on 2 September 2009.

<sup>4</sup> Tómas Guðberg Gíslason, chief of Environment of Mosfellsbær, on 11 September 2009.

<sup>5</sup> Helgi Bogason, head of Purchase depm. of Reykjavík, on 15 September 2009

<sup>6</sup> Baldur Gunnlaugsson, manager of administration and service center of Seltjarnarnes, on 10 November 2009.

<sup>7</sup> Sigurður Björnsson, office manager of Kópavogur, on 10 November 2009.

<sup>8</sup> Sigurður Hafliðason, manager of the Environment of Garðabær, on 8 September 2009

<sup>9</sup> Daníel Árnason, head of Purch. and Equipm. Dept. of the Icelandic Road Administration, on 11 November 2009.

### 1.6.3 Modal split and travel patterns

According to the household travel survey from 2002, 75.4 % of all trips in Reykjavík were made by car, 19.5% by foot, 4% by public transport and 1.1% by other modes. The low rate of biking (belonging to other modes) and public transport is significant for the modal split. Approximately 56% of drivers in Reykjavík were solo drivers and 28% had only one passenger making the average vehicle occupancy at least 1.6 for Reykjavík. The use of cars becomes even more significant when looking at work-related trips, among of which 87.4% are made by car. The fact that the survey was done during wintertime might give lower share of walking and biking than it would have during summer time (Sigurðsson 2004).

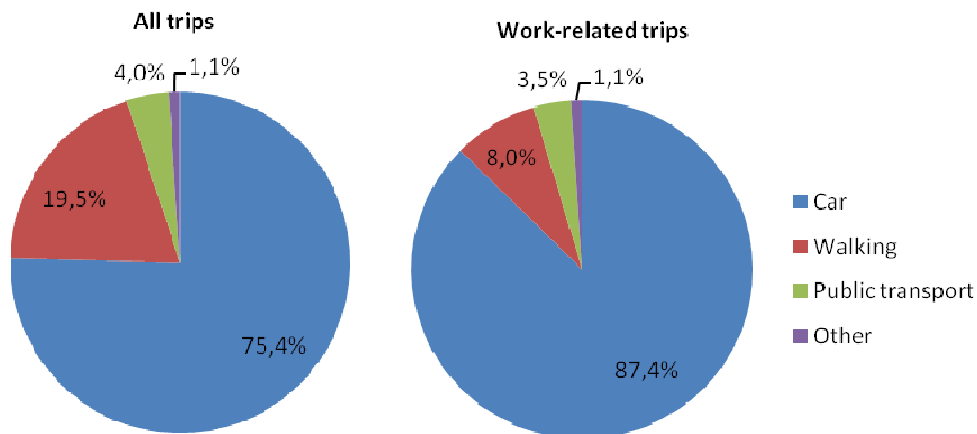


Figure 1-9 Modal split in Reykjavík for all trips and work-related trips only (Sigurðsson 2004)

The inhabitants of Reykjavík travelled on average 4.2 trips per weekday. The average distance travelled on each trip was 3.73 km, excluding trips made within zone. Work-related trips were on average 4.29 km, excluding trips made within zone. With the assumption that all trips within zone are shorter than 1 km the distribution of trips regarding their length is as follows (Hönnun 2006):

Table 1-2 Distribution of trips regarding their length (Hönnun 2006)

Length	%
< 1 km	33
< 2 km	52
< 3 km	62
< 4 km	70
< 5 km	76

Trips shorter than 1 km account for 33% of all trips and 52% are shorter than 2 km. Despite this high ratio of short trips, 50% of all trips shorter than 1 km and 61% of trips shorter than 2 km are made by car. The ratio of trips made by car grows rapidly with increasing travelling distance opposite to the ratio of trips made walking or biking, but they decrease even faster with increased distance. The ratio of trips made by public transport increases somewhat with increased distance and is almost negligible for trips shorter than 1 km. The high ratio of short trips made by car may to some extent be explained by multi-purpose trips (Hönnun 2006).



## Transport Demand Management in Reykjavik

The following figure shows a comparison<sup>10</sup> of modal split between a number of cities. Reykjavik has the biggest share of private car use of all the European cities in the example.

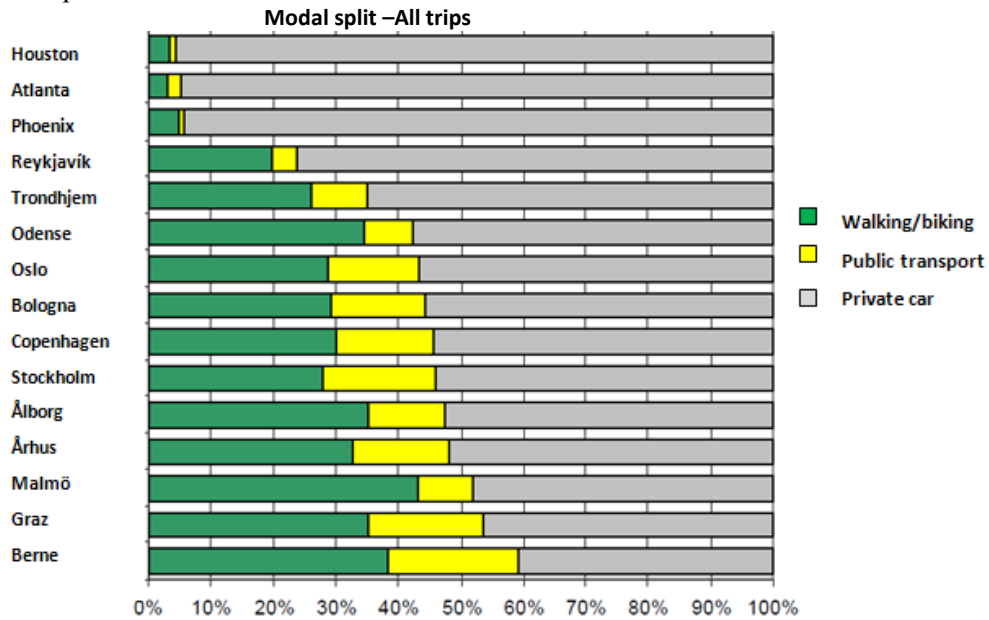


Figure 1-10 Modal split –Comparison to other cities (Hönnun 2006)

<sup>10</sup> The sample of the household travel surveys in the different countries may vary.

## Transport Demand Management in Reykjavik

### 1.6.4 Climate

The climate in Iceland is not as cold as its northern location suggests. Due to its coastal location the weather is tempered by the Gulf Stream, but prone to be windy and changes occur spontaneously. The following tables show the average climate conditions regarding temperature and precipitation in Reykjavik with comparison to Copenhagen and Stockholm (BBC Weather Centre 2009).

**Table 1-3 Average minimum and maximum temperature (°C)**

Average min temperature (°C)				Average max temperature (°C)			
Month	Reykjavik	Copenhagen	Stockholm	Month	Reykjavik	Copenhagen	Stockholm
Jan	-2	-2	-5	Jan	2	2	-1
Feb	-2	-3	-5	Feb	3	2	-1
March	-1	-1	-4	March	4	5	3
April	1	3	1	April	6	10	8
May	4	8	6	May	10	16	14
June	7	11	11	June	12	19	19
July	9	14	14	July	14	22	22
Aug	8	14	13	Aug	14	21	20
Sept	6	11	9	Sept	11	18	15
Oct	3	7	5	Oct	7	12	9
Nov	0	3	1	Nov	4	7	5
Dec	-2	1	-2	Dec	2	4	2

Stockholm has in fact somewhat colder winters than Reykjavik, but summers are by far the coldest in Reykjavik.

**Table 1-4 Average precipitation and number of wet days**

Average precipitation (mm)				Average number of wet days (+0,25 mm)			
Month	Reykjavik	Copenhagen	Stockholm	Month	Reykjavik	Copenhagen	Stockholm
Jan	89	49	43	Jan	20	17	16
Feb	64	39	30	Feb	17	13	14
March	62	32	25	March	18	12	10
April	56	38	31	April	18	13	11
May	42	43	34	May	16	11	11
June	42	47	45	June	15	13	13
July	50	71	61	July	15	14	13
Aug	56	66	76	Aug	16	14	14
Sept	67	62	60	Sept	19	15	14
Oct	94	59	48	Oct	21	16	15
Nov	78	48	53	Nov	18	16	16
Dec	79	49	48	Dec	20	17	17

Reykjavik has higher average precipitation during the winter time, but somewhat lower during the summer time. Reykjavik, however, has a higher number of wet days on average throughout the whole year.

The following table shows the average wind speed in the three cities compared above during the period 2001-2009 from 7 a.m. to 7 p.m. (Data for Reykjavik is gotten from the Icelandic Meteorological Office 2009 and data for the latter two is gotten from Windfinder.com 2009)

## Transport Demand Management in Reykjavík

**Table 1-5 Average wind speed**

Average wind speed (m/s)			
Month	Reykjavík	Copenhagen	Stockholm
Jan	5	6	5
Feb	5	6	5
March	6	6	5
April	6	5	5
May	6	5	5
June	6	6	5
July	6	6	5
Aug	6	6	5
Sept	6	6	5
Oct	6	6	5
Nov	6	6	5
Dec	5	6	5

The average monthly wind speed in the three cities is very similar, but the wind in Stockholm is somewhat calmer than the other two.

In general the average temperature in Reykjavík is rather stable throughout the year with little variation from summer to winter compared to Stockholm and Copenhagen. Precipitation and wind, however, are likely to be of more influence for people's travel choice.

### 1.6.5 Public transport

Public transport services in Reykjavík are still a municipal sector, run by Strætó bs. a municipal cooperative unit owned by eight municipalities in the metropolitan area of Reykjavík (all municipalities in figure 1-1 except for Kjósahreppur). Public transport in Reykjavík does not receive any governmental subsidies unlike e.g. in the capitals of the other Nordic Countries and many other European cities. Instead the public transport services pay high amounts of tax to the government (Hönnun 2006).

As shown in the chapter for modal split and travel patterns above the share of public transport is very low in Reykjavík. The average speed of private cars in Reykjavík is more than 60% higher than for public transport and almost half the travel time with public transport consist of waiting time and the time it takes to and from bus stops (Hönnun 2006). The most frequent routes are driven four times an hour, i.e. with a 15 minute interval (Strætó bs. 2009b). The route net can be found in Appendix B.

The average speed for public transport in Reykjavík is 22 km/h. The average speed is 40% higher in Oslo than in Reykjavík, 60% higher in Stockholm and 64% higher in Copenhagen. This difference is mainly due to the existence of railways in these cities. When considering the average speed of buses only, Reykjavík is similar to the average for Western Europe and North America (Hönnun 2006). Separate bus and taxi lanes have been designated on a few main roads in Reykjavík.

The number of boardings per inhabitant and year was 43 in Reykjavík in the year 2004, which is far below the average in our neighbouring Nordic capitals. Copenhagen and Oslo had over 200 boardings per inhabitant and year and Stockholm over 300. Reykjavík is once again more similar to patterns in Northern American cities (Hönnun 2006).

## Transport Demand Management in Reykjavík

All college and university students in Reykjavík were offered free public transport during the school years 2007-2009. Yet, less than 10% of the students at the University of Iceland took advantage of the offer.<sup>11</sup> This year student cards will be subsidised to half the normal price (Strætó bs. 2009a).

### 1.6.6 Car parking

According to Icelandic building and planning legislation there are strict requirements for the minimum number of parking space per gross building area but no requirements are made for the maximum number allowed. For residential housing bigger than 80 m<sup>2</sup> there should be a minimum of two parking spaces and a minimum of one for housing smaller than 80 m<sup>2</sup>. For every 35 m<sup>2</sup> of official buildings, service centres, commercial buildings and offices there should be a minimum of one parking space and minimum of one per 50 m<sup>2</sup> of other industrial and commercial housing. The minimum number of parking spaces per classroom at a college is five in addition to parking for staff members (Umhverfissráðuneytið 1998).

Parking requirements are rather high in Reykjavík when compared to, for instance, Malmö in Sweden. The city of Malmö requires one parking space per 125 m<sup>2</sup> gross area of offices in the most central parts of the city and one per 63 m<sup>2</sup> outside the most central areas. The requirements in Reykjavík are therefore 1.8-3.6 times higher than in Malmö. In addition only one parking space is required per 333 m<sup>2</sup> gross area of industry and commercial housing in Malmö making the requirements in Reykjavík almost seven times higher. Requirements for residence parking are more similar than for business activities. The city of Malmö requires 0.8-1.1 parking space per residence in an apartment house, 1.5-2 parking spaces per villa and 0.2 parking spaces per corridor room for students, all including visitor's parking (Malmö Stadsbyggnadskontor 2002).

When considering the centre for business in Reykjavík the average commercial building area per employee is 40 m<sup>2</sup>. It has been estimated that there is a maximum of 1 000 and minimum of 670 parking spaces per 1 000 employees in Reykjavík's business centre. This can be compared with an average of 270 parking spaces per 1 000 jobs in Western European cities and 500 in Northern American cities (Hönnun 2006).

Reykjavík Parking Services is a freelance company owned by the city of Reykjavík. They are responsible for parking management and policy making in Reykjavík city. The following map shows the charged parking zones in Reykjavík city.

---

<sup>11</sup> Ingjalður Hannibalsson, chairman of Planning Committee of the University of Iceland, on 5 October 2009.

## Transport Demand Management in Reykjavík

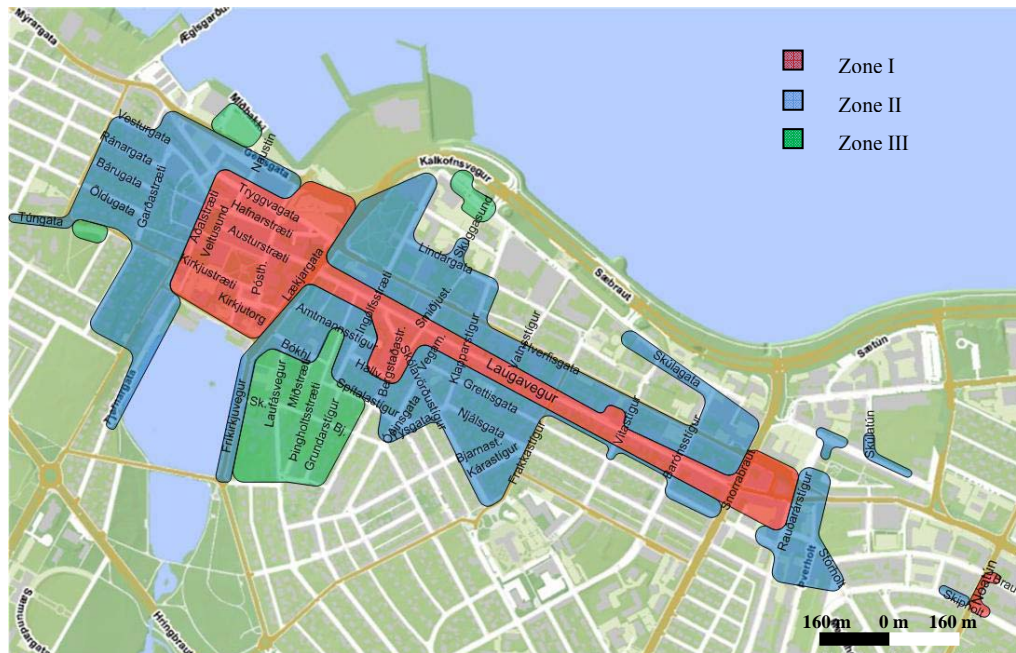


Figure 1-11 Charged parking zones in Reykjavík city (Reykjavíkurborg Bílastæðasjóður)

In addition to the zones shown on the map there are even a few charged short term parking spaces at Landspítali –University hospital as well as the recent parking fees introduced in September 2009 for a bit more than 100 parking spaces at the University of Iceland (located in the lower left corner of figure 1-11). This is only 5% of the total number of parking spaces at the university<sup>12</sup>. The student council has driven a campaign against this fee collection, claiming that it is punishing students for their travel choice and that the school’s environmental policy should benefit the students rather than putting expenses upon them (Helgason 2009). There are currently no charged parking zones outside Reykjavík city<sup>13</sup>.

Parking fees have not been updated since the year 2000 despite rapid economic upswings until mid year 2008. Parking fines are lower than the parking fee for a whole day at the most expensive zone, the fine is only € 11 (if paid within three days, otherwise € 17) compared to a fee of € 13.5 per day. Parking fines for illegal parking such as on a sidewalk or in handicapped parking without permission is only € 22 (if paid within three days, otherwise € 28.5) (Bílastæðasjóður 2009). Besides parking fines and fees being very contradictory in Reykjavík they are very low compared to for example Malmö in Sweden. The current fine for not paying parking charges or overrunning time in Malmö is € 32.5 and the fine for illegal parking is € 54 or € 75.5 depending on if there is a parking - or stop prohibition. Parking fees are therefore currently 250-350% higher in Malmö than in Reykjavík. In addition an increase has been discussed in Malmö that will likely be introduced in early year 2010.<sup>14</sup>

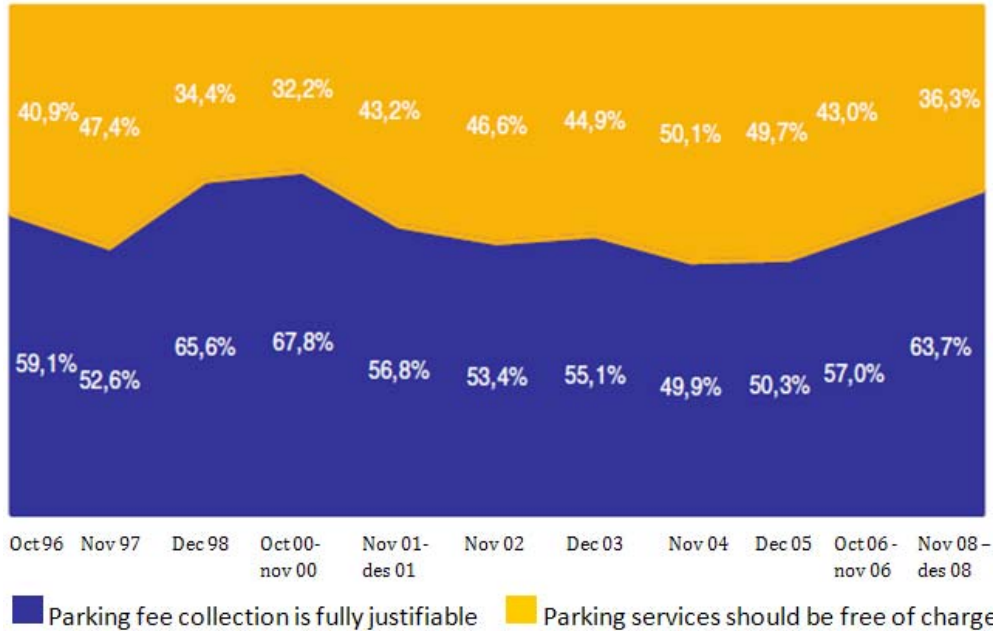
<sup>12</sup> Ingjaldur Hannibalsson, chairman of Planning Committee of the University of Iceland, on 5 October 2009.

<sup>13</sup> Kolbrún Jónatansdóttir, manager of Reykjavík Parking Service, on 29 September 2009.

<sup>14</sup> Ulf Nilsson, Parkering Malmö, on 30 October 2009.

## Transport Demand Management in Reykjavik

Figure 1-12 shows the results from an annual<sup>15</sup> attitude survey showing the inhabitant's attitude towards parking fee collection.



**1-12 Attitude development towards fee collection for parking services in Reykjavik 1996-2008 (Capacent Gallup 2008)**

The positive attitude towards parking fee collection has increased steadily since the year 2004, but has not yet reached the same acceptance as around the millennium. In the survey performed in 2008, an increase in acceptance was noticed with an increase in age, income and education (Capacent Gallup 2008).

### 1.6.7 Air pollution

Air pollution caused by road traffic due to gas emissions and particle release increases with the rising number of vehicle kilometres of travel. Nitrogen oxide (NO<sub>x</sub>), carbon monoxide (CO), carbon dioxide (CO<sub>2</sub>), non-methane volatile organic compounds (NMVOC), ozone (O<sub>3</sub>) and minute airborne particles are among gases polluting the atmosphere, threatening the environment and people's health. Airborne particles and ozone cause the biggest threat to people's health pointing at cardiovascular diseases, asthma and other respiratory tract diseases. Non-methane volatile organic compounds increase the risk for cancer and nitrogen oxides cause eutrophication of soil and water as well as respiratory diseases. Emissions of carbon dioxide from road traffic are a great contributing factor to increased green house effects and cause global as well as local problems (Sjöberg et al. 2005).

The total emissions of carbon dioxide (CO<sub>2</sub>) in Iceland caused by road transport has increased by 58% during a period of 10 years, from 545 000 tons to 856 000 tons per year. In the year 2006 road transport accounted for 28% of all man-made emissions of CO<sub>2</sub>. Figure 1-13 shows that the share of emissions from road transport is increasing while emissions from other fuel combustion is decreasing. (Statistics Iceland 2009e).

<sup>15</sup> Except for the year 1999 and 2007 when the survey was not performed

## Transport Demand Management in Reykjavik

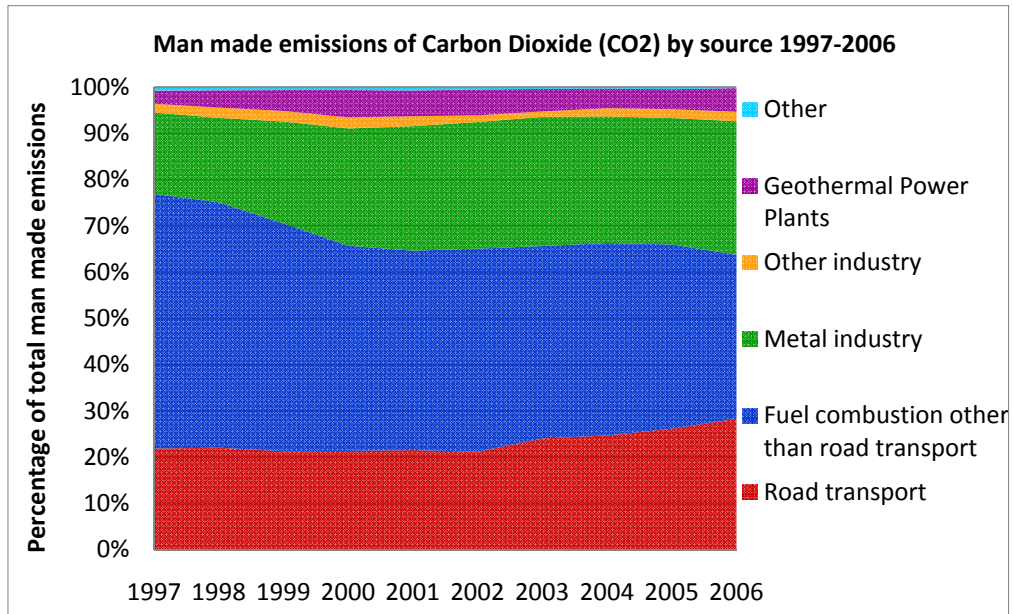


Figure 1-13 Emissions of carbon dioxide 1997-2006 by source (Statistics Iceland 2009d).

The total emissions of greenhouse gases caused by road transport have increased by 60% over the same period of time and accounted for 21% of all man-made emissions of greenhouse gases in Iceland in the year 2006.

Emissions of carbon monoxide caused by road transport decreased by 34% during the 10 year period 1997-2006, but road transport is still the main contributor of CO in Iceland and accounted for 86% of the total man-made emissions in 2006 (Statistics Iceland 2009e). The decrease by 34% is likely due to the increase in the number of catalytic converters in cars. Modern catalytic converters can decrease the emissions of CO by approximately 95% during the service lifetime of a car compared with a car without one. Catalytic converters were made obligatory in new cars within the European Union in 1993 and 1995 in Iceland (Andersson et al. 2007; Umhverfisstofnun 2009).



## 2 Literature study of measures

Even though the use of private cars has enabled great progress in the speed of travel and lead to economic growth and freedom of movement, it has reached a level which must be considered a problem if all three components of sustainable development, social, economic and environmental, are to be respected. It has contributed to serious public health problems such as overweight and obesity due to a sedentary lifestyle, increased the risk of isolation and segregation, complicated social relations in residential areas, decreased the freedom of movement for certain social groups, not forgetting the massive harm to the environment and people's physical health due to polluting emissions and noise (Faskunger 2008).

A number of measures will be studied below. They are all meant to bring Reykjavik's transportation system closer towards sustainability by first and foremost minimising the traffic made by private cars. The measures include both physical, organisational and behavioural change measures e.g. by rewarding or punishing certain transport behaviour. By taking advantage of already carried out studies or actions in Iceland as well as elsewhere in the world we can get closer to a conclusion on what works and what does not. The chosen measures to be studied go under the groups of parking policies, carpools, biking and walking, public transport, education and information, economic measures and involvement of the private sector.

### 2.1 Parking policies

The total area needed for one parking space, including the access area, is approximately 25 m<sup>2</sup> (Vägverket 2004). Considering the fact that there are between 670 and 1 000 parking spaces per 1 000 employees in Reykjavik (see chapter 1.6.6) the total area occupied by car parking is between 1.7 to 2.5 hectares per 1 000 employees in the business centre of Reykjavik. The supply of free parking is known to significantly compromise the number of people choosing other modes of transport beyond the private car, but the supply of uncharged parking is enormous in Reykjavik. One of the biggest problems in urban traffic systems are the high peaks occurring during the journey-to/from-work causing environmental pollution and congestion, creating demand for increased carrying capacity and waste of energy (Feeney 1986). This indicates the importance of measures being implemented at worksites, both private and public. The following table shows the modal split between private cars and public transport depending on parking availability at worksites in Norwegian towns and cities in 2001 (Kollektivtrafikkommittén 2003).

**Table 2-1 Modal split between private cars and public transport depending on parking facilities at worksites (Kollektivtrafikkommittén 2003)**

	<b>Car %</b>	<b>Publ. transp. %</b>
Free parking at worksite, always available	76	6
Free parking at worksite, limited availability	65	12
Charged parking at worksite	52	25
On-street parking, free of charge	64	10
On-street parking, charged	37	36
No parking offered	16	55



Parking policies are very important tools in urban planning and can easily be used as modes of control by regulating the number, type, location and pricing of car parking. The reason is not only to manage private car traffic, but also to limit the area occupied by parking spaces and thereby promoting higher population density and decreasing dependence on motorized vehicles. Parking is considered to be the largest single management tool in 'modern mobility management' (COST 2006). It would be optimal if parking policy measures were "...accepted by the motoring public as a necessary evil" (Feeney 1986).

### **2.1.1 Parking guidelines developed by EPA**

The European Parking Association (EPA) has developed parking guidelines for national governments and local authorities as a part of COST 342 project. EPA recommends that parking policies promote off-street parking in preference to on-street parking. 'Search traffic' is a known problem with unregulated on-street parking that is too cheap or free of charge as it causes unnecessary traffic flows and congestion. Parking standards in Reykjavík are currently set as minimum levels, not allowing any control of oversupply of car parking. Standards for new development and redevelopment should rather be set as maximum levels<sup>16</sup> defined locally or regionally. A right level of parking fees can ensure the optimal occupancy of car parking and eliminate 'search traffic'. Another solution is to substitute on-street parking with off-street parking, eliminating 'search traffic' as well as giving additional space to non-motorized traffic and public transport. On-street parking should always be more expensive than off-street parking and prioritised for short-term use (max 30 minutes) and disabled parking. Residents should be encouraged to park off-street and on-street regulations should be strict. Park and ride (P+R) facilities are a good option where parking and traffic problems are very local. The facilities should be easily accessible by car and offer good connections either by public transport, on foot or by bike (European Parking Association 2001; COST 2006).

Parking offences should be seen as serious to avoid judicial authorities preferring to concentrate on more serious offences. The EU's Technical Committee of Transport recommends a full separation of police involvement in parking regulation enforcement as it is unlikely to be of priority within the police. Instead the services should be left to local authorities. In general, fines for parking offences and the chance of being caught should be so high that nobody would take the risk of not paying and getting away with it. It is therefore important that fines are not contradictory like in Dresden in Germany where the fine for overrunning the time paid is three times the fine for not paying at all, or like in Reykjavík where the fine is lower than the fee for a whole day (European Parking Association 2001; COST 2006).

Motorists prefer having high cost parking to having no parking, but car parking that is free of charge or too cheap increases the risk of too high occupancy rates. As the right level of parking fees can ensure the optimal occupancy of parking, ensuring availability without affecting the number of cars parked, the effects of parking charges on local economy should not be harmful as often stated. A number of cases where

---

<sup>16</sup> Maximum parking norm is a definition of maximum number of parking spaces allowed at a certain place in relation to e.g. number of employees at a worksite, floorspace of a building, number of inhabitants etc.

parking charges have been lowered with the aim to increase retail activity have shown no success. Opposite to the aim it can increase 'search traffic' and parking spaces getting occupied by employees rather than shoppers, thus decreasing retail activity (see case study in chapter 2.1.5). What is much more important for the local economy is the accessibility in general together with the range and quality of activities offered.

EPA points out that cities that can afford restricting accessibility for cars are cities with high accessibility with other modes of transportation. A balanced modal split characterises a good overall accessibility. It can, among other things, be improved by increased capacity and level of service of public transport. Parking should be seen as a compliment to public transport, not a substitute.

Successful parking management requires essentially good enforcement of regulations and quality of facilities. Pricing, fines for offences, marketing and communication are among important components. Examples of information that should be mediated to motorists are location, occupancy rates, directions, opening hours, parking fees, availability, payment options and more. Various media such as parking-guide systems, brochures, maps, TV, internet, newspapers and advertisements can be used for informing motorists (European Parking Association 2001).

### **2.1.2 Four types of parking policies defined by the OECD**

EPA points out that every city is unique so different cities therefore require varying policies. The OECD defines four types of parking policies. *Type one* is based on the common planning method 'predict and provide' i.e. the supply of parking is controlled by the demand. This type of parking is most often free of charge, but in case parking fees are collected they are not used as a managing tool, but rather as an income generator. In the *second policy type*, commuter parking is limited by regulating the price and supply of public parking, creating space for visitors, shoppers and residents. By charging public parking, long term parking becomes less attractive increasing short-term parking, which can per se increase car traffic in the area as more than one vehicle will use the same parking space consecutively. Therefore, regulations of parking supply are used together with the charge regulations. The *third type* is directed towards private parking, often related to commercial activities and land use, aimed at minimising private car traffic, mainly by commuters. The tool applied is mainly limitation of parking supply, e.g. with maximum parking norms. The third policy often goes hand in hand with a good level of public transport in the area. The *fourth*, and the last, type is very similar to the third one with the common aim of limiting private car traffic, but with an additional goal to guarantee traffic-generating activities to be located, where accessible with public transport. This is done with a location policy for specific land uses combined with the limitation of private parking supply.

The four types described above all have their advantages and disadvantages and relate to one another in many ways. The effects of the policies vary with varying circumstances where they are adopted. Type one is common in small towns where motorized traffic is not considered to be a problem and public transport is not a competitor to the private car which is provided with great accessibility. It can, however, be very expensive in bigger towns and cities and is very much in favour of

## Transport Demand Management in Reykjavík

the private car at the expense of other transport modes that benefit from more dense settlement.

The situation in Reykjavík resembles in many ways policy of type one, except for the very central parts of Reykjavík City that would probably come under policy of type two. As mentioned above, policy of type two can generate more traffic, but promotes other modes of transport for commuters. It is not uncommon that areas just outside the managed area become very attractive as parking spaces calling for the need to extend the management area. As policy of type two only applies to public parking, private parking can ruin the effects by offering a great number of commuters parking. It can be solved by adopting policy of type three.

Policies two and three create a risk for the area of becoming less attractive by the visitors causing business and services to move outside the charged zone e.g. to suburbs, but a good level of public transport minimises the risk. In case the risk of relocation of businesses is very high a policy of type four might be needed. Type four policies sometimes only include a land use policy forgetting the limitation of parking, leading to very much traffic by private cars calling for the need for policy of type three. In general, the step from type one to type two is relatively simple as they only apply to public parking operated by the same operator. Types three and four also apply to private parking making the adoption much more extensive and complicated (Martens 2005).

### 2.1.3 Travel responses to parking policy measures

Parking policy making can be very difficult and the effects of the policy even more difficult to foresee as each situation is unique. A generalised cost of a journey is one way to estimate possible travel responses of different policy measures. It can be calculated with an in-vehicle component and an out-of-vehicle component as follows:

$$c = t_{iv} + t_{ov} + m_{iv} + m_{ov} \quad \text{[Equation 2-1]}$$

c: generalised cost  
t: time cost  
m: money cost  
iv: in vehicle  
ov: out of vehicle

A change in the components in equation 2-1 can be caused by e.g. congestion, fuel price, parking price or walking distance, the first two considered as in-vehicle components and the latter two as out-of-vehicle components. Any change in these components can result in various travel responses. Possible short-term responses are a change in parking location, travel mode selection, destination, rescheduling or even abandonment of a trip, depending on the original purpose of the trip. It is likely that the different factors above have varying responses due to differing perception of cost by the driver e.g. fuel cost is made periodically and the fuel is used for all trips made by the car while parking cost transaction is often made for each trip. Elasticity<sup>17</sup> is often used to measure and estimate the effects of parking policies. Price elasticity is a very common measurement of how sensitive variables are towards a change in price, e.g. if the price elasticity of a number of parkers is 0.3, the number of parkers would decrease by 3% if the price was raised by 10%. Elasticity differs very much between places and circumstances and can seldom be transferred from one study to another.

When aiming to change travel responses in work-related-trips the options are limited as it seldom allows a change in destination or abandonment of the trip. Rescheduling, mode choice and changed parking location are more likely responses. The first one is of limited interest as it leads to a displacement of existing parkers. Multi-trips can complicate effects of parking policies on work-related-trips i.e. when a person is dependent on a car during working hours, shares a car with other family members or does trips with other purposes directly before or after work. Multi-purpose-trips made by car are therefore likely to be affected by choice of parking location rather than choice of travel mode. That, however, can lead to secondary effects at the expense of other facility users, hopefully resulting in a more environmentally friendly choice of mode. It is important to keep in mind that in order for a rise in parking price to minimise car use, the next best option by car must be more expensive than the parking price and the wanted option less expensive. An example of negative effects is a person being driven to and picked up from work without the trip having any other purpose, resulting in doubling the number of trips. That, however, increases the in-vehicle cost which should therefore be higher or similar to the parking cost (Feeney 1986).

---

<sup>17</sup> Elasticity is a measurement for how sensitive a variable is to a change in another variable. E.g.  $\Delta Y/Y = \Delta X_i/X_i * b_i$  where  $b_i$  is the elasticity of Y regarding changes in  $X_i$  (Holmberg, B. et al., 1996. *Trafiken i samhället, Grunder för planering och utformning*. Lund: Studentlitteratur)

### **2.1.4 Implementation**

Responsibility for parking policy making depends on at which level the policy is made –national, regional, local or private. EPA, for instance, gives international guidelines and advice to national and local authorities that implement their own parking policies. COST recommends that parking measures should be mentioned in the national transport policy as an important steering tool in car mobility as well as guidance for maximum parking standards should be given (COST 2006).

When a parking policy is to be introduced it is very important to approach the public carefully to gain better compliance and acceptance. Therefore communication is the first step to be taken when adopting a parking policy. Reykjavík Parking Service points out that a vital step in their strategic planning is to improve the public image of the company. Another thing on their agenda is to introduce their covered car parks and the alternative ways of payment well to the public (Bílastæðasjóður 2009).

The great potential for drivers to choose another location to park their car rather than altering their modal choice emphasises the importance of parking policies being widely implemented and homogeneous for close areas to avoid dislocation of the problem and to achieve the set objectives. It also emphasises the need for simultaneous measures such as ensuring access to transport, telecommunication and shower facilities at worksites as well as flexible working hours to reinforce the parking policy measures (Feeney 1986).

Different from work-related trips, a change of destination is not uncommon in non-work-related trips, depending on car parking availability. A well known example is the location of shopping centres in the suburbs of cities with an unlimited number of parking spaces creating enormous traffic. A parking policy for Reykjavík would need to span Reykjavík as a whole, to avoid moving the traffic elsewhere and discriminating among geographic areas by letting some gain marketing advantage.

### **2.1.5 Case study: Free public parking on weekends in Oslo, Norway**

In 1996 a decision was made by the city council of Oslo to offer free public parking in the city centre during weekends with the aim of strengthening commercial activity. Half a year later the area of free parking was extended outside the city centre to all public parking spaces in Oslo. The effects on the commercial activity in the city were studied in 1997 by interviewing car and shop owners and with an examination of 750 parking spaces. The results showed negative effects on the commercial activities and no increase in retail trade. The rate of parked cars was almost 100% compared with 90% during weekdays, parking time was 30% longer during weekends and at 11 a.m. all public spaces were occupied, likely by workers in commercial and service activities who had parked their cars before the shops opened. Shop owners were negative towards free parking as their customers could not find available parking. Activities along the shore experienced that boat owners occupied their parking spaces during weekends leaving no spots for e.g. museum visitors. Due to the bad success of the arrangement the city council ended free parking during weekends in the year 2000. During the period of four years the Municipality of Oslo experienced an income loss of € 4.9 million. However, approximately € 1.9 million were gained as income during the same period due to parking fines for illegal parking but many people chose to park

illegally instead of paying for private parking when all public parking was full. Income generation through fines is definitely nothing to be strived for (COST 2006).

#### **2.1.6 Case study: Various Northern American Case studies**

An old study from 1978 showed that an increase in municipal parking fees in downtown Chicago by 38-138%, or to a similar level as surrounding privately-owned parking, resulted in a 72% reduction of all-day parkers. Prior to the implementation, fees had remained the same for a period of 10 years. What is very interesting is that these previous car parkers did not show up at neighbouring car parks, but are thought to have changed their travel choice to transit or taken up car sharing. In another study from 1975, the Canadian Government introduced parking fees for their employees at car parking that were previously free of charge, resulting in a decreased number of solo drivers by 21% and an increase in use of public transport by 16%.

There are examples of private companies in Los Angeles calculating how much each parking space costs the company and demanding full ridiculously high payment from their employees resulting in an enormous decrease of solo drivers (Feeney 1986).

## **2.2 Carpools**

Car sharing in the form of carpools originated in Switzerland in the 1980's and has spread worldwide since then (Sunfleet 2009). The term carpooling is often used for any kind of car sharing, but in this paper it will refer to the phenomenon of short-term car rental with self-service by simple booking through the internet or via telephone. Carpools vary in organisation, price and size. A carpool is usually either a cooperative driven by a group of people that have agreed on sharing cars, paying cost price for the use of it, or run commercially and therefore often more expensive. Maintenance, administration and other services, however, are most often included in commercially driven carpools while work effort can be required from the member in the cooperative type. Some carpools have such high-tech service that people can access their booked vehicles with smartcards or their mobile phones, thus avoiding the inconvenience of restricted opening hours and long queues when accessing car keys. Usually the user pays a refundable deposit and a fixed monthly fee in addition to a rent based on the time of use and distance travelled. Price examples for carpools in comparison to rental cars and private cars can be found in Appendix A. Depending on travel patterns, carpools are often the most economic option. A rule of thumb says that carpools are economic for people driving less than 10 000 km per year (Vägverket & Hållbart resande i Storstockholm 2009).

The idea of a carpool is that a number of people share a car and thereby increase its efficiency. Instead of having high fixed cost by owning a car, members of a carpool only pay for the time they actually use the car. An average car stands parked for 23 hours every 24 hours which indicates a great potential to increase its efficiency by sharing it with others. In addition carpools mainly include a variable cost, which people are often more aware of than fixed cost, which hopefully contributes to a more efficient use of the car. An example of a more efficient use is that people run more than one errand on the same trip and choose other modes of transport for shorter trips, benefitting both the environment and people's private economy. Carpools have many advantages such as the age of the car fleet and the great potential to use modern and environmentally friendly cars with a high level of safety. In addition, it is easy to adjust the size and type of car according to the purpose of the trip such as booking a jeep for the few times a year when it is needed instead of using the jeep for all trips (Vägverket och Hållbart resande i Storstockholm 2009; Åkvist 2009).

Carpools can either be an option for people, not owning any private car, as a complement to other transport modes or as a family's extra car. It is known that carpools are especially convenient for people that use a car occasionally rather than on a regular basis such as driving daily to and from work. It is likely that a family's extra car is used rather occasionally which makes a carpool an optimal replacement.

### **2.2.1 Carpools for companies, institutes and organisations**

Carpools are not only an option for private users but also for companies, institutes or organisations. Carpools for companies can either be in the form of hiring a commercial carpool or establishing a private carpool with neighbouring companies. There are two main types of company carpools; an internal carpool where the company itself owns and administrates the vehicles and an external carpool where the company outsources its vehicle management by hiring a commercial carpool. There is

## Transport Demand Management in Reykjavik

a higher risk factor for the company as well as quite extensive administration in the internal carpool whereas an external one has a much lower risk factor as well as greater flexibility suitable for varying car demand. An external carpool can either be open or closed meaning that the company either shares the carpool with other companies or is the only member of the carpool.

Carpools can replace rental cars, high perquisite payments towards car expenses and high fixed cost of operating your own car fleet. In addition they allow simple book-keeping, easy follow-up and a possibility to relate each trip to a project. Whether there is an economic saving gained by connecting to a carpool depends on e.g. previous levels of compensation for private car expenses, driving patterns, administrative load and more. It is important that all costs such as administration of compensation for private car expenses are taken into account when a company considers whether to connect to a carpool or not. Carpools are known to have positive effect on trip-planning resulting in 10% to 20% less travelling without affecting the work performance, they provide a car for business errands for even those who do not have access to a private car as well as being very positive from a marketing and reputation point of view (Göteborgs Stad Trafikkontoret n.d.).

The following figure shows the wide scope of use for which a carpool can be a suitable transport mode.

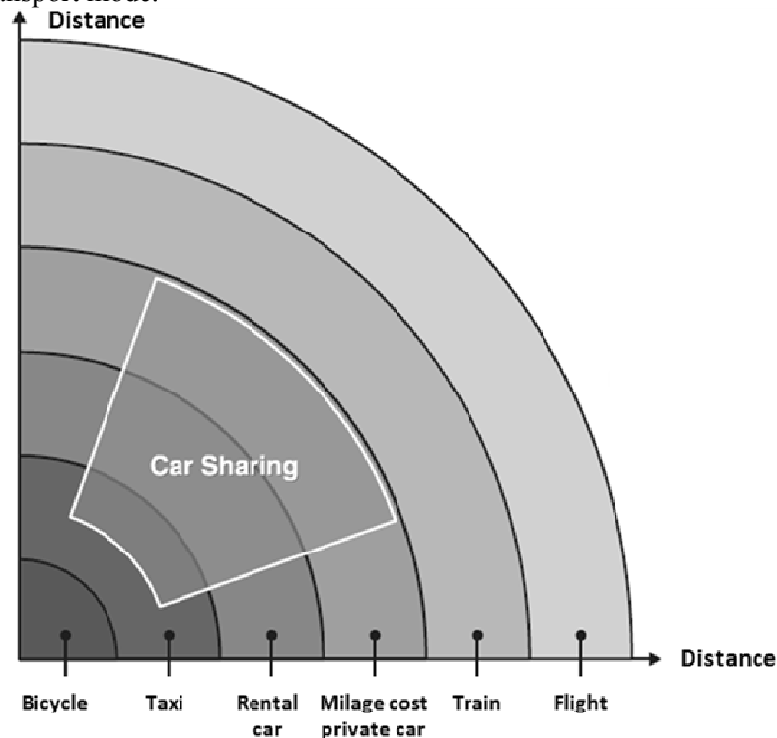


Figure 2-1 Trips that could be replaced with carpool cars (Göteborgs Stad Trafikkontoret n.d.)



### 2.2.2 Costs and benefits of a Carpool

Following is a short summation of costs and benefits of carpools, given as general costs and benefits as well as specific for company carpools.

<b>Benefits</b>	<b>Costs</b>
<ul style="list-style-type: none"> <li>• High potential for use of environmentally friendly cars</li> <li>• Modern well equipped safe cars</li> <li>• Promotes better planning of trips and thereby more efficient trips</li> <li>• Simple 'key' delivery with modern technique</li> <li>• Car size adjustable to trip purpose</li> <li>• More economic (depending on travel habits)</li> <li>• Maintenance, insurance, parking, fuel and taxation is shared with other pool members</li> <li>• Low investment cost</li> <li>• Possible return for money otherwise invested in a car</li> <li>• Little administration required</li> <li>• Low risk factor in investment</li> <li>• Promotes use of other transport modes than the car when possible</li> </ul>	<ul style="list-style-type: none"> <li>• The booking and planning process can take effort</li> <li>• Risk for cars not being available</li> <li>• Environmentally friendly cars can be expensive to operate</li> <li>• Risk for late delivery of cars</li> <li>• Less feeling of responsibility causing bad treatment of the car</li> <li>• Nearest car can be far away</li> <li>• Less economic (depending on driving habits)</li> </ul>
<p><i>Specific for company carpools</i></p> <ul style="list-style-type: none"> <li>• No travel receipts</li> <li>• Flexibility for employees providing a car at work</li> <li>• Free travel choice to and from work</li> <li>• Contributes to an environmental profile and certification</li> <li>• Possible extra cars for employees outside working hours</li> <li>• Simple book keeping</li> </ul>	<p><i>Specific for company carpools</i></p> <ul style="list-style-type: none"> <li>• Decreased flexibility can be experienced when a driving policy forbids use of private cars</li> </ul>

Figure 2-2 A summation of the cost and benefits of carpools (material from chapter 2.1 processed by author)

### **2.2.3 Possibility of using municipal and state owned service cars as carpool cars outside working hours**

Many companies and institutes own and operate a high number of service cars. Only six out of eight municipalities in Reykjavík operate approximately 170 service cars (see table 1-1 in chapter 1.6.2). These cars often stand still during evenings, weekends and holidays which is typically the period with highest occupancy for carpool cars. The option whether companies' service cars can be rented out as carpool cars outside service hours and thereby make the use of the cars more efficient and hopefully replace many families' extra car would be worth studying in more detail. Taxation and competition law have to be taken into consideration.

### **2.2.4 Implementation**

The implementation of carpools depends on many external factors so other measures might be necessary to make carpools more successful. Increased taxation of fuel and on a household's second car, abolishment of perquisite payments towards car expenses and parking fees are examples of economic measures. Another method is to limit the number of parking spaces where the carpool is to be started, but access to free parking limits the benefits of carpools. A carpool car with a provided parking space would be of greater benefit to people that have to pay high parking fees at their home or at work than to people that have access to free parking (Robertsson 2006).

Enforced measures can, however, be experienced as negative and it is therefore important to inform the employees or inhabitants well and use good marketing methods for implementation. Positive marketing could include introducing the carpool as a solution to a limitation rather than the limitation being the consequence of the carpool. The possibility for an employee to accept a pay rise instead of perquisite payments towards car expenses as well as the company's carpool being available for employees outside working hours are among very positive incentives experienced by members of a company carpool (Person & Hjelm 2002). Incentives such as discount of public transport and bikes for carpool users as well as replacing old parking spaces with something contributing to a pleasant town character are also possible (Robertson 2006).

To avoid negative attitudes among new carpool users, it is important to ensure good availability of cars at the introduction stage. After some time and experience the number of cars can be reconsidered and systems to solve late deliveries can be adopted e.g. by easy access to rental cars. Other modes of transport, such as service bikes, taxis and access to public transport should also be offered in case of a company carpool (Vägverket och Hållbart resande i Storstockholm 2009).

Experience has shown that carpool users walk, bike and use public transport more than non-carpool users. This emphasizes the opportunity to implement further measures within these areas simultaneously. It is important that authorities are involved in the implementation process at an early stage to ensure strategic planning and comprehensive overview (Robertson 2006).

### **2.2.5 Ride-sharing**

Any kind of car-sharing is indeed positive to increase the efficiency of journeys and minimize the number of private cars in traffic. Ride sharing is common among friends and family members, but it is even possible to find potential candidates, e.g. colleagues or strangers, to share a ride through car-sharing databases or announcements (see case studies 2.2.8 and 2.7.8). In addition, High Occupancy Vehicle lanes (HOVL), which will be taken up in chapter 2.3.4 encourage ride-sharing.

### **2.2.6 Case study: Vision Lundby**

Vision Lundby was a project in the city district Lundby in Gothenburg during the period 2000-2005 aimed at creating a more effective transportation system in Lundby with the main focus on the environment. As a part of the project a Mobility Centre was established and among other aims the number of carpools and their members was to be increased, e.g. with behavioural change and informative methods. Information meetings, brochures, advertisements, campaigns, cooperation with private parties and participation in activities outside the project were among methods applied. Inhabitants and companies were invited to the information meetings and a group of people got to be trial carpool members for a few months. Cooperation with a building contractor of a new residential area, promoting carpools for new inhabitants at an early stage, knock-on-doors campaigns and various down town events were thought to be very successful. In addition to the methods mentioned above a company network was established, counselling offered and a newsletter published.

No quantifiable goals were set for the project other than the aim to increase the awareness of carpools, their number and members. As carpools were relatively new in Sweden at the start of the project it was seen as an opportunity to develop and try out various methods and work procedures rather than having predefined processes and exact quantified goals. During the five year period a rapid increase in interest and attendance to meetings was noticed. In the end of the project, in 2005, 61% of Lundby's inhabitants had got information on carpools to their home, compared with only 34% three years earlier. The attitude and awareness change during the five year period was most noticeable through questions asked by the public changing from very basic and simple questions such as 'what is a carpool?' to advanced and conscious questions that require basic knowledge about carpools.

The cooperation with the building constructor was an important step and thought to be a good way to attract potential carpool users and to solve the problem of bad availability to suitable carpool parking. It is therefore stressed that carpools are given consideration already in the planning stage of a quarter (Robertson 2006). A successful example is Hammarby Sjöstad in Stockholm. The number of parking spaces was limited, carpools were promoted and parking spaces reserved for carpool cars from the beginning. Today every tenth household in the quarter is a member of a carpool and resident parking for conventional private cars is very expensive (Exploateringskontoret Stockholm Stad 2007).

### **2.2.7 Case study: The Environmental Committee for the City of Göteborg**

In 1995 the environmental committee of the City of Göteborg started a project in car sharing with the main goal to minimize the negative effects on the environment by using newer vehicles for service trips. The committee has an ISO 14001 certification (see chapter 2.7.1). The number of employees is 120 of whom 80 use the carpool. Originally there were 20 cars, but later the number was decreased to 15 cars. The effort is that most of the cars are more environmentally friendly than conventional cars driven by petrol. Using these cars, however, proved to be up to 60% more expensive per 10 km than using conventional cars. The distance driven has, on the other hand, decreased by 30% which makes the driving costs stable since the implementation of the carpool. The decrease in driven kilometres is partly related to the implementation of the carpool through better planning of trips, increased environmental awareness and reduction of non-relevant trips during working hours as some people actually made profit due to high payments for car expenses. The main decrease is, however, related to changed habits such as inviting customers rather than visiting them.

The reduction in distance driven and increase in the use of environmentally friendly cars is estimated to have reduced discharge of carbon dioxides by 50% and nitrogen oxides and polynuclear aromatic hydrocarbons (PAH) by 70%. The number of employees walking, biking or using public transport to and from work increased from 62% to 81% in 1992-2002.

Younger employees were in general more satisfied with the implementation of the carpool than older employees, seeing the great advantage of not having to invest in their own private car to use at work. Nine out of ten employees had become more positive towards the carpool ten years later. In general the employees of the environmental council were satisfied with the arrangement giving it the grade 4.2 out of 5. It was experienced as a very positive method to start with many cars and decrease the number with time and demand. The importance of a user friendly booking system as well as the importance of keys being accessible at a known place was stressed, but the carpool is rather old fashion with one person responsible for the keys to each car. At last, creating an atmosphere in the carpool where respect is paid towards other members was considered to be of great importance to ensure a well working cooperation where e.g. failures are reported and tanks are refilled etc. (Person & Hjelm 2002).

### **2.2.8 Case study: Smart car-sharing database in the Flemish region of Belgium**

In the year 2007 research showed that 9-13% of all Flemish commuters in Belgium shared a ride to work, usually with colleagues or other family members. A new database 'Carpoolplaza' was established in the year 2007 which aimed at meeting the high potential for car sharing in the region. Individuals and employers can register their work schedule and commuting route and the system matches shared routes, working hours, driver or co-driver as well as in- or outside the commuter's company. The result is a list of potential candidates to share a ride with. The main advantage of the smart system is that it takes the entire route into consideration instead of only starting point and destination. Already in the first year, 41 000 people had registered

to the database of which 11 000 were active and 30 000 passive members (Meuleman 2008).

### **2.3 Public transport**

Public transport is a very important subsystem of urban transportation systems. It is a vital system for those who cannot, or choose not to, travel individually as well as it is a very significant tool to limit congestion, energy consumption and polluting emissions from motor vehicles (Jönsson & Tengström 2005). Public transport is, however, a very broad and complex topic providing enough material for a whole separate thesis. The topic will therefore only be touched on briefly enough to address its importance, identify obvious problems and bring up effective measures within the scale of relatively small and cheap measures that contribute to less private car traffic.

Economic growth has gone hand in hand with increased travelling and further distances travelled. Instead of spending more time travelling people tend to choose faster modes of transport. There are several factors contributing to the speed of a transport mode such as access time, frequency of service and number of transfers (Marks 2005). All of the factors mentioned above help to explain what a tricky competitor the public transport has –the private car. The private car has already gained its dominance in Reykjavík and the force of habit is known to be really strong to maintain that choice. In addition to the force of habit there are a few main factors that affect the choice of mode; comfort, price, time, safety, reliability and simplicity. A different perception of these factors is of great influence. Comfort is generally more important to private car users than public transport users while price tends to be more important to the latter group. Public transport users tend to overestimate their travel time creating more stress and the private car is experienced as safer than public transport, despite the opposite being true. It is known that a poor level of public transport services in combination with excellent conditions for private car-use encourages those who can afford it to use the car. On top of everything public transport often has the image of being the transport mode of last resort. Once again, attitude and perception seem to be a large part of the problem addressing the need for informative and educational methods (Anastasiadis 2005).

It is known that improved public transport services have little effect on private car traffic alone, but are however, vital to enable private car users to select public transport alternatives. Public transport is therefore an essential complement to many other measures (Stockholmsförsöket 2006).

In some places, e.g. Stockholm and London, public transport is looked upon as a vital service function, no different from water supply and electricity, where it is run as a branch of the city or county council's administration. In other cities public transport is more of a business than social service or city function. In the latter type the network can become fragmented with operators and routes independent of each other, often offering a high level of service along popular routes, but without area coverage or accessibility as a whole like a coordinated network does (Örn 2005).

### 2.3.1 Quality assessment of public transport services

The quality of public transport services can be assessed by the following components: accessibility, network structure, travel time, traffic safety, reliability, security and comfort. Accessibility is the most important component and it is recommended that walking distances to bus-stops are not longer than 400 meters for 90% of the inhabitants. Comfort and time are of great importance to private car users but travel time also influences the passenger's experienced comfort of the trip. Valuation of different time components of a trip made by public transport is shown in the table below.

**Table 2-2 Valuation of different time components of a public transport trip (TRAST 2007)**

Time component		Weight
Driving time		1.0
Walking time		2.0
Wait	0-10 min	2.0
	> 10 min	1.0
Transfer time		2.0
Transfer punishment		5 min per transfer
Time standing	0-10 min	1.4
	> 10 min	1.6
Time in crowding		+ 0.1
Delay		4.0

The table shows that reliability is very important as delay time is experienced as four times the driving time. Other significant components from time perspective are walking-, waiting- and transfer time all experienced as double the driving time. Travel time is greatly influenced by the trip interval and number of transfers. The trip interval is preferably 10-15 minutes in a city with over 50 000 inhabitants and an interval exceeding 30 minutes is not recommended. A trip interval less than or equal to 10 minutes brings the advantage of passenger not minding the time table. Public transport is considered to be competitive to the car when the travel time-ratio is two for trips shorter than five kilometres and less than two for trips longer than five kilometres (including all components of the trip, walking, waiting, transferring vs. walking and parking) (TRAST 2007).

### 2.3.2 Policies for urban public transport

The European Union has done research and policy development for urban public transport. The EU Commission recommends following:

*A combination of transport authority planning and control of public transport services on the one hand and competition between independent operators for the operation of public transport services on the other has the strongest merit. (Örn 2005)*

The recommendation above can be described as controlled competition with ‘public/private partnership’ (PPP) where for example planning is kept as public responsibility and the operation is subcontracted as known in public transport services in Sweden since 1989 (see case study in chapter 2.3.8). The left half in figure 2-3 shows how the benefits of a coordinated network can be kept despite increased competition. (Örn 2005).

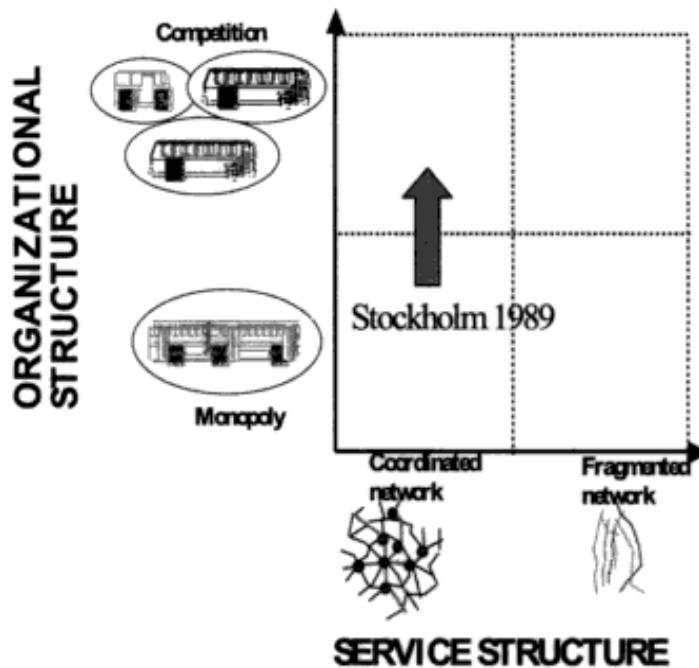


Figure 2-3 Public transport reform in Sweden shown on the public transport policy graph (Örn 2005)

Finally, it is very important that mixed messages are not sent out to the public and that political popularity does not weigh too much in decision making. Anastasiadis (2005) states that “coherence is absolutely essential: you can improve public transport as much as you like, but if there is a major motorway and road building going on in the same area, urban transport will remain problematic”.

### 2.3.3 Infrastructure, facilities and vehicles

Reykjavik’s route net is an integrated system where smooth transfers are of importance. Transfer stations should therefore be designed with comfort and fast

transfer process in mind. A 'journey time elasticity' of  $-0.9$  is commonly used in the UK, meaning that a 10% reduction in travel time will lead to a 9% increase in demand (AEA Technology Rail 2004). One of the objectives of Reykjavík Local Agenda 21 is to double the bus use in the capital area in the next 20 years e.g. by implementing park-and-ride bus service to the city centre (City of Reykjavík n.d.). Park-and-ride and bike-and-ride facilities can be effective in a spread settlement such as Reykjavík enabling those who live outside the area provided with good public transport to drive their car or ride their bike to the nearest facility and use public transport for the rest of the trip. It also allows the public transport services to concentrate on a more narrow area by providing this alternative.

The climate in Iceland is not very mild during wintertime and indeed rather unpredictable so it is often not very attractive for waiting outdoors for public transport. Therefore it is important that bus-stops are well equipped with facilities like shelters and de-icing equipment. This concerns the bus-stop as well as the way to and from the bus-stop. Bike parkings at bus stops are important facilities for the bike-and-ride option mentioned above.

The fuel used to operate the public transport vehicles does not affect the number of private cars in traffic, but it is an essential factor for the environmental effects caused by public transport. A case study is taken up for a hydrogen bus trial in Reykjavík in chapter 2.3.9.

### **2.3.4 Bus-lanes and possible High Occupancy Vehicle Lanes (HOV Lanes)**

It is important to achieve a reasonably high operating speed for the public transport system to make it economically efficient, attractive and to achieve preferred travel time-ratios. For that reason it is often necessary to allocate separate spaces for buses (Örn 2005). Separate bus-lanes also make timetable planning much easier, increasing the reliability of public transport.

High Occupancy Vehicle Lanes (HOV) are lanes reserved for vehicles with one or more passengers in addition to the driver. The phenomenon is common in the USA and indeed often referred to as a carpool, not meaning a carpool as defined above, but car sharing. The idea is to reward vehicles contributing to increased carrying capacity, less congestion and pollution by giving them priority during rush hours.

As mentioned in chapter 1.6.5, separate bus lanes have been built in a few places in Reykjavík to prioritise public transport and taxis. In one of these streets, Miklabraut, the highest frequency of buses in one direction is 12 per hour<sup>18</sup>. Considering the fact that 56% of all drivers in Reykjavík are solo-drivers and 28% have only one passenger (see chapter 1.6.3) makes the proportion of cars with two or more passengers relatively small. It would be worth studying the possibility of making these bus lanes HOV lanes without sacrificing the accessibility of buses.

---

<sup>18</sup> All buses arrive at similar times of the hour, or three buses in a period of three minutes four times an hour (Strætó bs. 2009b).



### **2.3.5 Zero rates for public transport**

One of the objectives of Reykjavik Local Agenda 21 is to double the bus use in the capital area in the next 20 years e.g. by exploring the possibility of reducing or eliminating bus fares (City of Reykjavik n.d.). Free public transport causes both positive and negative effects. The positive effects are increased use of public transport and public transport being available to everyone independent of their private economy. Public transport users walk on average three times more than the private car users leading to very positive effects on public health. It is, however, very expensive to operate public transport without any income from bus fares as well as the increased demand calls for increased capacity meaning additional expenses. Free public transport has a risk of being used as a place to hang out, increasing the risk of vandalism and too high occupancy rate lowering the quality of service. It is not necessarily the rate of the bus fare that determines people's choice of travel mode, especially not for private car users. The quality of the service and its reliability is, in fact, a much more important factor for private car users than the price (Boholm 2009). Price reduction is known to rather attract pedestrians and cyclists (Teknologi-rådet 2006). In order to attract private car users to public transport it might be more effective to allocate the same amount of money lost by offering free transport to invest in better service such as more frequent and faster bus trips. It is important to keep in mind that a drastic rise in bus fare rates is very unpopular and can lead to decreased use of public transport that can take a long time to recover. It is therefore important to consider the long term effects if free public transport is to be offered only temporarily with the aim to attract more customers (Boholm 2009).

An examination was done by a group of experts on the consequences of introducing zero-rates for public transport in Denmark. The results were that zero-rates have very limited effect on motorists, congestion, environment and health compared to the enormous costs it would involve. It is considered to be a very cost-ineffective measure and the same effects could be gained in much cheaper ways. It was stressed that in order to tempt motorists to public transport, parallel 'sanctions' such as parking fees or road pricing would have to be introduced. In addition, travel time was pointed out to be at least as important as the rate for public transport and zero-rates are indeed considered to risk lowered quality which could in worst case lead to decrease in number of passengers (Teknologi-rådet 2006).

### 2.3.6 Differentiated rates

Differentiated bus fares can vary for the time of the day, often offering cheaper fares or free transport during low occupancy periods, or vary for customer groups such as youth, students, pensioners, unemployed etc. Differentiated bus fares during low occupancy periods are a good option to offer cheaper or zero rate bus fares without creating additional expenses for increased demand as there is a surplus of supply during that period. There will be a loss in fare revenues due to lower fare rates, but the increase in number of passengers will hopefully partly make up for that loss (Boholm 2009). The expert group that examined the consequences of zero-rates for public transport in Denmark suggests that zero-rates or reduced rates can be good in the form of differentiated rates e.g. for certain groups and periods for marketing reasons. Monthly passes for commuters are mentioned as especially important to tempt motorists. With differentiated rates, income loss can be somewhat controlled and indeed be looked at as the price for marketing (Teknologi-rådet 2006). As mentioned above, the effects of rate increase should be taken into account when temporary periods of zero- or reduced rates are considered.

Strætó bs. in Reykjavík offers 'primary- and elementary school cards' enabling groups of students to travel by bus such as for field-trips during low occupancy hours (9-15 o'clock). The aim is to introduce public transport to children and teenagers. Each card is for use within the school and the charge for it is very limited. As mentioned in chapter 1.6.5 all college and university students in Reykjavík were offered free public transport during the school years 2007-2009 and 50% discount the school year 2009-2010 (Strætó bs. 2009a).

### 2.3.7 Light rail

A pre-feasibility study was made for a light rail system in Reykjavík in the year 2004. A light rail system certainly has its benefits such as higher operational speed, better reliability, high capacity, shorter perceived travel time by car drivers than on a bus and less environmental pollution. However, a light rail system will be highly dependent on interchanges with feeder buses, and the disadvantages of a bus network therefore remain. Light rail systems are good for high passenger flow rates, which are not expected in Reykjavík. A light rail is not feasible everywhere due to curvatures and tight gradients again showing its dependence on bus network. Car drivers tend to rather consider using a light rail than a bus. Light rail operates on permanent routes that many people experience as very simple to use as well as giving people confidence in it. It is the author's opinion that as rail transport would be new in Iceland, it would be free from the stamp of being a 'transport mode of last resort' which certainly gives it a marketing advantage ahead of a bus network. A light rail, however, is a very expensive investment and therefore outside the frame of relatively small and cheap measures. It can, nonetheless, be an option worth studying in more detail, but the fact that Reykjavík's inhabitants are 'beginners' in using public transport a bigger share in bus usage might be a reasonable first step (AEA Technology Rail 2004).

### **2.3.8 Case study: Public/private partnership in public transport services in Sweden**

The public sector monopoly for public transport services had become outdated, but the Swedes wanted to preserve the benefits of the old coordinated network avoiding unlimited competition resulting in a fragmented network. The unit of Public Transport Authority (PTA) was established in 1989 and made responsible for planning of public transport routes, providing infrastructure, terminals, bus stops etc. and the planning thereby kept as public responsibility. In addition, PTA negotiates and subcontracts operators and manages and monitors their performance (Örn 2005).

### **2.3.9 Case study: A trial of using hydrogen buses in Reykjavík 2001-2005**

A four year trial of using three hydrogen buses was carried out in Reykjavík in 2001-2005 and was in fact the first time hydrogen technology was introduced for transport purposes in Iceland. Approximately 70% of all energy demand in Iceland is provided with renewable energy but transportation accounts for a big part of the remaining 30% provided with non-renewable energy. The fuel was made from water and electricity at a hydrogen station that was built for the project. The experience of the trial was very positive during the project, but media coverage was higher than expected and surveys showed very positive perception by the public creating high expectations for a continuation of the project. However, very little success was reached in continuing after the trial period, partly due to lack of effort from the government and unstable economy. The trial was initially organized for learning purposes for further future hydrogenisation of the society so it will at least be of good use as valuable experience (Maack 2006).

## **2.4 Biking and walking**

Biking and walking are sustainable modes of transport, very positive from all perspectives of sustainability -environmental, social and economic. Except for the very low investment cost, compared with private cars, it is free of charge to bike. It is very positive from a social and public health point of view as well as it does not emit any pollutants to the environment. In addition, increased share of biking and walking is considered to contribute to improved traffic safety, security and equality.

Biking has developed from being a vital mode of transport to being more of a recreational tool in today's society. In Sweden 90% of all school children biked or walked to school in the fifties compared to only 77% in the mid nineties and 58% in the year 2006 (Faskunger 2008).

Bike and pedestrian traffic should weigh at least as much in modern traffic planning as driving and indeed be seen as modes of transport rather than a group of unprotected travellers. Policies that aim at an increase in walking and biking should emphasise replacing short enough motorised trips for which walking and biking are competitive to the car (Dora & Phillips 2000). If the bike is considered to be competitive to the car the travel time-ratio should be around 1.5 and not higher than 2.0, i.e. a trip by bike should never take double the time it takes for a car, including time for parking and walking to and from the car (TRAST 2007).

A number of attitude surveys have shown that current bike users mainly complained about a bad infrastructure as a hindrance for biking whereas non-bike users rather referred to their personal evaluations such as it being too difficult, too bad weather and the disadvantage of sweating (TRAST 2007). As previously mentioned the force of habit is known to be very strong to maintain the choice of transport mode, which would be very positive once the use of a preferred transport mode is obtained as a habit. Therefore it is very important to get private car users to try out e.g. public transport and biking.

### **2.4.1 Effects on health**

Physical activity has very positive effects on people's health, both physical and psychological. It can reduce sickness absence and production losses, prevent chronic illnesses and human suffering. This is why walking and biking are sometimes referred to as active transport and seen as a potential tool to improve public health (Faskunger 2008; Dora & Phillips 2000).

Regular physical activity can be practiced by e.g. biking or walking to work or school. It can reduce the risk of coronary heart diseases, adult diabetes and obesity by 50%, reduce the risk of developing hypertension by 30% and have similar effects on blood pressure as medicine among others. A Danish study has shown that people who regularly bike to work are 30% less likely to die prematurely compared to those who do not bike to work every week (Ahlström 2004; Andersen 2005). Transportation is the main contributor to noise pollution in Europe and increased share of walking and biking can contribute to decreased noise pollution. Noise can have serious effects on school performance, sleep, cardiovascular activity, hearing and more (Dora & Phillips 2000).

## Transport Demand Management in Reykjavík

Regular walking to school has shown very positive effects on school children such as preventing depression and anxiety, improving lung conditions and mobility skills as well as leading to better concentration in school. The fact is that most children prefer to walk or bike to and from school instead of being driven (Faskunger 2008).

Walking and biking, however, are not free from association with accidents. Preliminary analyses in the UK have nevertheless shown that the benefits of biking to life expectancy are 20 times the injury risk (Dora & Phillips 2000). In addition collisions between cyclists and pedestrians do not cause the serious accidents, but 99% of all fatal collision accidents among pedestrians in Sweden in 1990-1995 occurred due to a collision with a motor vehicle (Ahlström 2004).

### **2.4.2 Physical planning**

The pedestrian and bike network should be built up in a similar way as the road network with a main network and a local network with high connectivity. The main network should serve travellers travelling longer distances, preferably consisting of separate roads for the specific transport mode, connecting main destinations like big worksites, commercial centres, big schools, hospitals etc. The local network should serve travellers travelling shorter distances within the city district, consisting of both separate roads for biking and walking as well as the local streets for motorised traffic. The local network should connect local centres, shops, public service, public transport facilities, local schools etc. A pedestrian and bike network with high accessibility is of great importance to the public transport services as well as most public transport users walk or bike a part of their trip (TRAST 2007).

It is not uncommon that cyclists and pedestrians are forced to disobey traffic regulations due to bad planning of transportation structure, thus reducing their traffic safety. The traffic environment therefore greatly affects the traveller's behaviour, making attractive and safe physical surroundings very important for non-motorised traffic (Ahlström 2004). Measures to increase traffic safety for cyclists and pedestrians have great impact in promoting these two modes of transport. Overpassed crossroads, speed reduction, elevated crossings, designation of areas for cyclists at light controlled crossroads and cyclist paths, lighting and winter maintenance are among very important factors.

As mentioned in the chapter on parking policy measures, the cities that can afford parking policy measures to manage private car traffic are cities that offer other modes of transport and have a balanced modal split. Improvements of all factors mentioned above as well as promotion of walking and biking as preferable modes of transport are important tools to obtain a balanced modal split. There is a relationship between the extent of the bike infrastructure and the actual usage –the bigger the bike road net is the more it is used (Faskunger 2008). In addition, by transferring from unsustainable transport patterns to more sustainable patterns social exclusion can be decreased directly (Anastasiadis 2005).

### **2.4.3 Facilities and equipment**

Despite the often very inconvenient climate for outdoor activities in Iceland, the climate cannot always be the excuse all year round as many conditions can indeed be solved with the right equipment and fittings.

*“An unequipped bike belongs to a storeroom -while a fully equipped bike copes with all conditions”  
(Reykjavíkurborg 2006)*

Bike parking and sheds should be required by law just like a minimum number of car parking spaces are required per area of activity or residents. Their quality is also important. No different from car traffic, road signs are very important for cyclists and pedestrians, but these are often missing. Specific for work-related trips, shower facilities and changing rooms should be available at the workplaces to make it easier for employees to choose to walk or bike to work. This is especially important at worksites where a dress code is required (Faskunger 2008).

### **2.4.4 City bikes**

City bikes are in many cities available for inhabitants and visitors. The aim is to limit traffic made by cars and thereby minimise pollution and noise in the most central parts of cities. Originally the idea was that people could take an available bike in one place and leave it for someone else in another place, but it has been difficult to find a well functioning system due to disrespect, vandalism and lack of collective responsibility. One solution is to charge a small refundable deposit to unlock the bike which is repaid when it was handed back. This appears to be another bad success in many cities like in Vienna where 800 bikes disappeared in just a few weeks. People saw it as a very cheap ‘price’ for a bike for private use. Finally a successful way to offer city bikes has been achieved in Oslo and other cities. The method is to make the user personally responsible for the loan by registering the name and a valid address providing the user with a card against a deposit of approximately € 10. A bike can be borrowed from an automat with this card for three hours at the time and the bike has to be returned to the same or another automat. If the user fails to fulfil the conditions three times the card will expire. A user that does not hand in a borrowed bike is considered to have stolen it and has thereby broken the law and risks being prosecuted (Kristjánsson 2009).

### **2.4.5 Other measures**

In addition to physical measures directly encouraging and bringing about improvements for pedestrians and cyclists, many informative and educational measures are relevant and indeed needed to obtain a change in attitude towards walking and biking. Furthermore, economic measures and involvement from the private sector can have a big impact. These will be taken up in upcoming chapters.

### **2.4.6 Case study: Quarter-hour bike map**

The Environmental division of the city of Reykjavik did a study in the autumn of 2006 on how far one could bike from the city of Reykjavik’s weighted residential centre in 15 minutes. The aim of the study was to bring forward biking and walking as an alternative travel mode to the private car and to express the opportunity to use daily

## Transport Demand Management in Reykjavík

transportation as daily exercise. Increased share of biking in the modal split would benefit society, the environment and last but not least, the individual himself.

A person biked on main tracks according to Reykjavík's bike map in three directions creating an average radius reachable in 15 minutes. The average speed was a little less than 20 km/h making a radius of approximately 3.9 km as can be visualised on the map in figure 2-4. The area spans a surprisingly big part of Reykjavík city.



Figure 2-4 Quarter-hour bike map (Umhverfissvið Reykjavíkurborgar 2006)

Considering the fact that 70% of all trips made in Reykjavík are shorter than 4 km makes the potential to increase the share of biking in the modal split very high.

### 2.4.7 Case study: The rescue from an unsustainable traffic situation in München, Germany

For over 30 years the authorities in Munich in Germany have strived for improving the potential for biking and walking in the city due to an unsustainable traffic situation. Broad expansion of subventions for biking infrastructure, speed reducing physical measures as well as reduction of parking spaces for motorised traffic are among successful actions taken during the period. The result of the action was an increase in biking by 150% from 1972 to 1995. Today it is possible to rent a bike at train stations and more places and a whole quarter is reserved for bike parking outside the train station (Faskunger 2008).

## 2.5 Education and information

To start with it is very important to make individuals realize that they can contribute to sustainability. Education and information are potential tools that can be applied for minimising traffic made by private car and for promoting sustainability in general. The two tools can be looked upon as separate instruments but are often much related.

As mentioned in the chapter on historical background for Reykjavík the private car has for long indicated welfare and wealth and left a footprint in many Icelander's habits making it the first choice of transport mode. Albert Einstein once said:

*“We need a new way of thinking to solve the problems caused by the old way of thinking.”*  
*Albert Einstein*

Einstein's quote is very relevant for the need to change people's travel habits. Information and campaigns are very successful and important tools in order to bring about mobility transition as well as being vital tools in having impact on people's perception, preferences and attitudes. As mentioned in many of the measures above, information is essential in the starting stage and during implementation of the measures to ensure the best possible results. Besides that, campaigns can be used as a tool to promote most of the measures mentioned above. Campaigns can be a very useful tool to reach out to the public with information, awakening and encouragement. Campaigns are, however, often a short-term instrument as people constantly need to be reminded as well as there will be new generations to inform and involve (Faskunger 2008). A long term success with campaigns is when they leave a permanent footprint by changing people's habits and thereby hopefully affecting upcoming generations too. Depending on the target group there can be various ways to carry out campaigns. One of the most successful ways is through media such as television, radio, newspapers and magazines. In addition, 'knock on door' campaigns have shown great success, especially in combination with other measures (Trivector Traffic AB 2006).

To complement for the short term effects of campaigns education is a great tool to apply in the upbringing of new generations. By including education regarding sustainability in the compulsory education system, information and knowledge can surely be shared with everyone in the relevant group in addition to the great potential for revision to leave a permanent footprint. Besides that, sustainable education and promotion of alternative transport modes to the private car can be included in education indirectly with transportation policies of educational institutes. The UN has designated the years 2005-2014 as the UN decade for education for sustainable development. A Nordic action plan aims at including sustainable development studies in curricula and guidelines for all educational levels before the year 2020 (Nordic Council of Ministers 2009).

Day-care centres and schools are important institutes when it comes to promoting healthy habits at a young age. Staff members should be well educated and informed about health, diet and physical activity (Nordic Council of Ministers 2006). There is a great opportunity to link travel habits to health education, by promoting environmentally friendly modes of transport as it involves both physical- and



environmental health in addition to economic aspects as appears in the chapters on walking, biking and public transport.

WHO emphasises the importance of implications of different transport modes and policies being widely known and accessible by public and policy makers. Education, information and communication are pointed out as effective means to do that (Nordic Council of Ministers 2006). A number of studies have shown that people pick the private car out of habit, without even considering the possibility of other transportation modes. This implies the importance of information being spread out to people, introducing alternative travel modes (Kollektivtrafikkommittén 2003).

### **2.5.1 Traffic education in schools**

A report was written for the Icelandic Ministry of Transport, Communication and Local Government in 2008 about the need for traffic education in Icelandic schools, preferably from nursery school into adulthood. The need for clear regulations, organization, task distribution as well as sufficient financial resources from the authorities was emphasized.

Traffic education currently belongs to a course named 'Life skills' in the Icelandic national curricula, but it lacks a clear definition, textbooks and specialised teachers for traffic education. The traffic education in Icelandic primary schools is very limited and in addition mainly focuses on traffic safety. In the same way as traffic safety is to be taught in schools education in sustainable traffic behaviour could also be taught. No objective evaluation has been done for the traffic safety education, making it difficult to estimate whether it is successful or not. Experience, however, implies success. Effective cooperation between teachers, parents, children and others that care for children's welfare is emphasised to achieve the best possible results (Briem 2008).

### **2.5.2 Driving education systems and Eco-driving**

Eco-driving is a term used for a specific way of driving aiming to reduce fuel consumption and thereby air pollution caused by motorised traffic. Fuel consumption is influenced by the driver's behaviour to a great extent and the styles taught in eco-driving training are among other things, optimal gear changing, effects of engine idling as well as driving and route planning. The fuel and economic saving possible by adopting eco-driving technique is on average 13%<sup>19</sup>, depending on the driver's previous driving behaviour (The Swedish National Association of Driving Schools STR 2009a).

The driver education system in Iceland is governed by a national curriculum and built up as compulsory education, both practical and academic, as well as a non compulsory private practice. The education is very focused on traffic safety and technical skills, lacking focus on the environmental, social and health effects of driving (Umferðarráð 2000). The Icelandic National Association of Driving Instructors has produced educational material for Eco-driving adjusted to Icelandic conditions. Eco Driving courses in Iceland have mainly been attended by companies or organisations rather than individuals. The course is offered by less than 10 driving schools in the whole of Iceland and costs between € 170-230 for an individual, which people tend to find too

---

<sup>19</sup> Based on approximately 65 000 who have undergone the education EcoDriving in Sweden.

expensive. The main motivation, so far, for companies to train their employees in eco-driving has been based on economic considerations rather than environmental. Some, however, use it as a contribution to their environmental profile. The motivation is not only missing for individuals, but sadly also for driving instructors. It has been discussed to implement EcoDriving as an obligatory moment in the Icelandic driver education system but authorities have prevented that. In case EcoDriving is to be implemented in the national curriculum it is recommended that the moment takes place together with the driving assessment required two years after people get their driver's license. It is considered to be necessary to have gained some driving experience to be able to adopt the techniques of eco-driving.<sup>20</sup>

Assuming that an individual drives 15 000 km/year, consuming on average 0.08 l/km before adopting eco-driving techniques and that a litre of petrol costs € 2 the individual can save more than € 300 in one year by reducing its fuel consumption by 13%. Considering this amount an EcoDriving course would therefore pay in less than a year. To put this into context for public, information could be a vital instrument.

### **2.5.3 Course in Bikeability**

The Icelandic Mountain bike club and the Icelandic Cyclists' Federation have actively promoted biking and agitated for diverse improvements for cyclists throughout the years due to their interest in sustainable development and the environment.

The idea of teaching 'bikeability' was brought to Iceland from the UK in 2007 during a week dedicated to communication in Reykjavík city. The organisations mentioned above are in charge of the course which is divided into three levels. Level 1 is for parents who are teaching their children to bike or for beginners where mainly technical skills are taught in the absence of other traffic. Level 2 includes adjustment of bike equipment and fittings as well as technical skills by biking in calm traffic. For level 3 experience of biking is required and full participation in regular traffic is expected. In total six teachers in Iceland are certified teachers in bikeability. The aim of the education is to increase traffic safety and understanding of traffic systems as a whole at the same time as biking is promoted as a transport mode. A developmental project has been carried out in Iceland in combining the course into elementary education in Iceland (see case study in chapter 2.5.11) (Gunnarsdóttir & Traustadóttir 2009).

### **2.5.4 Independent educational programmes**

There are various international programmes that can be adopted by educational institutes at all levels in form of extracurricular activities. Eco-Schools is one of them. It is for environmental management, certification and sustainable development education. The programme consists of seven steps including among them the establishment of a committee, an action plan with achievements, monitoring and evaluation, informing and involving. It is approached by a combination of learning and action. It has many benefits besides the environmental achievements such as national and international networking, possible financial savings, democratic

---

<sup>20</sup> Guðbrandur Bogason, former chairman and present manager of the Icelandic National Association of Driving Instructors, on 2 October 2009.

participation and decision taking for pupils. After a period of participation schools are awarded with the Eco-School Green Flag if they have succeeded. The programme is not only meant to influence the students, but also staff, families, local community and authorities. The programme is implemented with help from a national FEE (Foundation for Environmental Education) member in each country (Foundation for Environmental Education n.d.).

Another programme, Global Action Plan (GAP), is an international network of organisations at the forefront of education for sustainable development and behaviour change not as focused on education in schools but to the public. The common aim is to increase the sustainability of people's life and work with empowerment. GAP has member organizations in 20 different countries which are responsible for appropriate programs supported by GAP International which provides courses, workshops and guidance (Global Action Plan 2008).

### **2.5.5 Health promotion**

An unhealthy diet, inactivity and overweight have been pointed out by the World Health Organisation (WHO) as very serious global problems threatening the individual's quality of life as well as welfare and economy. That does not exclude Iceland (Nordic Council of Ministers 2006). Campaigns are commonly directed towards increased level of physical activity. Different from contribution to environmental improvement individuals experience the contribution to health improvement directly themselves which is often a better motivation to contribute.

The Nordic Council of Ministers adopted a Nordic Plan of Action on better health and quality of life through diet and physical activity in 2006. The plan of actions includes goals and visions of at least 75% of the adult population becoming physically active (moderate intensity) for at least 30 minutes per day (Nordic Council of Ministers 2006). It has been pointed out that public transport users walk in general three times more than the private car user and 70% of all trips in Reykjavík are shorter than 4 km. This implies that the goal can easily be fulfilled by many inhabitants of Reykjavík by biking or walking to and from work as the average person can bike 3.7 km in 15 minutes. In addition an increase in use of public transport is certainly a step in a positive direction. Some important benefits of regular physical activity are mentioned in chapter 2.4.1 above.

The main problems of promoting health benefits of walking and biking in transport policies is the general lack of appreciation of the extent of the benefits. It is therefore very important that scientific evidence for the balance between health benefits and costs are made clear and available as well as the possibility to value the benefits of these health effects in economic terms (Dora & Phillips 2000).

### **2.5.6 Case study: Achievement of behavioural changes among drivers**

Emphasis changes in the Danish driver education system, regarding defensive driving and risk awareness, lead to a decrease in accidents among young drivers. Another study showed that when a two-phase driver education system was introduced in Luxemburg a decrease occurred in fatal accidents. This indicates that driver education can be used as an effective tool to achieve changes in behaviour if the right teaching methods are applied (Nyberg & Örjan 2008).

### 2.5.7 Case study: Annual 'Biking to work' competition in Iceland

The National Olympic and Sports Association of Iceland has held an annual encouragement campaign called 'Biking to work' since the year 2003. The aim is to promote biking as a healthy, environmental and economic way of travelling at the same time as teamwork and better and healthier atmosphere at workplaces is promoted. Other environmentally friendly travel modes, such as walking, rollerblading and walking in relation to use of public transport was allowed in the 'competition'.

The campaign has been a great success as can be seen in the increased participation and achievements reached each year. The table below shows the development in participation and achievements since the beginning of the campaign in 2003. It is worth mentioning that the campaign lasted for one week in the beginning, extended to two weeks in 2005-2007 and was last extended to three weeks in 2008.

**Table 2-3 Development of participation and achievements reached in the campaign 'Bike to work'**

Year	Number of workplaces	Number of teams	Number of participants	Total distance biked in km.	Number of rounds around the globe
2003	45	71	533	21 967	0.5
2004	162	289	2 510	93 557	2.3
2005	254	488	5 076	173 762	4.3
2006	246	539	5 296	230 543	5.8
2007	409	913	6 642	417 106	10.4
2008	431	1 017	7 056	410 398	10.2
2009	468	1 147	8 041	493 202	12.3

Some personal experiences from participants are available at the webpage for the campaign of which many include very valuable advice that should be taken into account when planning for walking and biking. These are, for example, comments on broken glass being the cyclist's biggest enemy, the importance of being visible to other road users, safe passage across roads, that property owners respect the boundaries between sidewalks and their garden and that the bike network is seen as a whole with proper connections like the ones provided for motorised traffic (Íþróttá og Ólympíusamband Íslands 2009).

### 2.5.8 Case study: Eco-Schools (Grænfáninn) in Iceland

*Landvernd* has been an FEE member since the year 2000 and is responsible for the programme Eco-Schools (*Grænfáninn*) in Iceland. When the programme was first introduced to all primary and elementary schools in Iceland in the year 2001 only 12 schools participated. Today, eight years later, over 160 schools at all educational levels have implemented the programme involving 28% of all students in the country. This year 30 schools were awarded with the international acknowledgement, the Green Flag, for their success (Landvernd 2009a; Landvernd 2009b).

### **2.5.9 Case study: Environmental Protection in action (GAP program), Iceland**

Environmental protection in action (*Vistvernd i verki*) is a Global Action Plan (GAP) project in Iceland aiming to instruct people to live a sustainable way of life. Participants are divided into groups of people from five to eight households. They attend seven guided informative meetings during a period of 12 weeks. The topics taken up are waste, energy, transportation, shopping and water. The aim is to find ways to improve the sustainability of their lifestyle, not only regarding the environment but also private economy, health and general well being. Although the meetings are guided by an instructor it is up to the group and the individual to engage in areas of interest as empowerment is one of the most important tools in the project. The project has been sponsored by various private companies throughout the years since its start in 2002 and over 1000 people have participated in Iceland and millions of people worldwide (Landvernd 2009c).

### **2.5.10 Case study: International promotion of EcoDriving, Sweden**

The Swedish National Association of Driving Schools (STR) has more than 10 years of experience in teaching EcoDriving. They now think it is important to share their experience and insights with the rest of the world. As a part of their international work STR made a contract with SEMBRA Energy and SoCalGas in Los Angeles and San Diego through the Swedish Energy Agency in 2007. A pilot training course was held during the summer 2008 resulting in a 17% reduction of fuel consumption. SEMBRA Energy was very satisfied with the results and is planning to give its employees training in EcoDriving. STR also impressed representatives from large American companies such as Cathey Pacific Cargo and Walt Disney at the Swedish Consulate in Los Angeles with a presentation of EcoDriving training and its achievements.

With help from the Swedish-Chilean foundation STR has educated eight Chilean bus drivers in heavy vehicle EcoDriving as well as presented it to the Ministry of Transport in Chile. The eight bus drivers reduced their fuel consumption by 29% after the course. Additionally, STR has participated in various international events, among others the ITS World Congress in 2008 in New York (The Swedish National Association of Driving Schools STR 2009b).

### **2.5.11 Case study: Developmental project in Bikeability in an elementary school in Reykjavík (Álftamýrarskóli)**

A developmental project was held in an elementary school in Reykjavík during the school year 2008-2009. All students in 4<sup>th</sup> to 7<sup>th</sup> grade (9-13 years) were offered a course in 'bikeability' (see chapter 2.5.3) during school hours. The participation varied from 50-75%. During the project the teaching material was adjusted to Icelandic circumstances. In addition, the students' parents were engaged in the project by providing them with the teaching material and information in the project. In general parents and students that participated were very satisfied with the course and the majority of the parents that responded to a questionnaire thought all school children in Iceland should undergo the course. The course has gained considerable attention by diverse private and public parties and discussion in media has been very positive. A contact network has been established with a number of institutes such as the ministries

of Education, Communication, Health and Environment (Gunnarsdóttir & Traustadóttir 2009).

#### **2.5.12 Case study: International Walk to School**

Walking to school is a program originated in Great Britain and launched internationally in 2000 with the aim to do a permanent change in communities worldwide by promoting health, physical activity, less private car traffic, environmental concern and traffic safety for school children. In 2007, 42 countries participated in the program which a whole month was dedicated to. Originally it was a day, later a week, now a month and the aim is to extend the program to year-round program and thereby reach a permanent change in travel habits among school children (IWALK Steering Committee 2009).

Iceland has participated in the program since 2007. The goals of the program vary somewhat between countries and communities but each school can decide to what extent they participate. The organisers of the program in Iceland are the Road Traffic Directorate, The National Olympic and Sports Association of Iceland, The ministry of Education among others and their assignment is to give guidelines, ideas and support for implementation of the program. By encouraging the children, parents and other family members are encouraged at the same time. Children can be encouraged by setting up competitions between classes with awards for most walkers, bring in guest lecturers, engaging them and their parents in the arrangement, arrange walking theme days such as a 'bring healthy lunch day', 'high visible colours day' etc. (Íþróttá og Ólympíusamband Íslands et.al. 2009).

A similar and related project 'Safe Routes to School' that 'Walk to School' is partly based on, has more than tripled the levels of biking pupils to school in a community school in Hampshire in the U.K. during a period of 10 years. Infrastructure work was not even needed to achieve this increase (Whitelegg 2005).

#### **2.5.13 Case study: 'IT'S UP 2 U!' Marketing Competition for Public Transport, the Netherlands**

The competition 'IT'S UP 2 U' took place in the Netherlands in 2007 as a part of the EU Project EMOTIONS. The project was organised by marketing students and the aim was to develop a campaign or commercial that would influence people's attitude towards sustainable transport modes positively. The main approach was required to be positive emotions. The competition lasted for a year and was very reality-related as participants were provided with support from professional marketing bureau's and prize money was offered. It was introduced at 40 educational institutes within economics, marketing, design, audio and visual techniques, media and entertainment, mobility and traffic, making the competition very interdisciplinary as is often the case in reality (Guikink 2007).

## 2.6 Economic measures

It is a widely known fact that motorists are sensitive to economic incentives. Economic measures can therefore be used to manage travel demand by affecting people's choices and behaviour. Typical economic measures are parking fees, environmental subventions, taxation and charging on fuel, vehicles, congestion and more. The effects of economic measures are highly dependent on people's willingness to pay for cleaner air, faster and safer transport etc.

Road traffic creates costs to society and there is always a question of who should pay these costs. Economic measures have gained popularity as the principle 'the polluter pays' has become more and more common. Agenda 21 from 1992 encourages countries to apply economic measures and so has the Organisation for Economic Co-operation and Development (OECD). The EU has encouraged their member countries to by degrees abolish subventions that clearly strive against sustainable development such as exemptions from tax related to private car use and more. Economic measures are considered to be effective when they are simple and allow cheap administration and surveillance, are fast working, cost-effective, stimulate development of new techniques and make improvements for the environment profitable (Naturvårdsverket 2005). Only 50 years ago the oil consumption in the world was four billion barrels of oil per year while 30 billion were found, compared to in the year 2005 when the consumption was 30 billion barrels while only 5-7 billion were found (Trivector Traffic 2006). By considering this reverse development, the need for measures to enable development of new techniques and alternative fuel to oil must be emphasised.

Price-elasticities are very commonly used tools to estimate the effects of various economic measures. As mentioned in the chapter on parking policies, elasticities are unique for each situation making it difficult to transfer it between studies. Tax elasticity, for instance, strongly depends on the size of the tax e.g. varying from 0.01 in the USA to 0.13 in Denmark (Johansson & Schipper 1997).

A number of measures taken up in the previous chapters partly belong to economic measures, such as parking policy measures and rates for public transport. They will therefore not be taken up here again.

### 2.6.1 Taxation

Road traffic tax can impact the number of vehicles, amount of driving as well as vehicle and fuel choice. Fuel tax is very commonly used and has shown successful effects on total traffic volumes. It is in fact a great source of government revenue in many countries. It is a relatively cheap instrument to implement and has its advantages and disadvantages. Fuel taxation can e.g. vary for varying fuel types but cannot distinguish between varying vehicles or time of day like advanced road pricing systems can. It is a good instrument to minimise air pollution by reducing the share of the most polluting fuels but is weak in solving periodical congestion compared to e.g. peak-road pricing. As vehicles become more fuel-efficient the fuel-tax revenue per distance travelled reduces but revenue is still needed to maintain the road network. A known feedback effect of fuel taxation in countries with borders to other countries on the mainland is foreign traffic not experiencing the tax increase and indeed benefitting from the decreased road traffic (Mayeres 2000). Since Iceland is an island such

counter effects are not experienced there. In general, an increase in fuel price has to be quite drastic to affect private car traffic as the price elasticity is fairly low (Holmberg et al. 1996).

Another very common tax is an annual vehicle tax. It is often based on the vehicle's weight, volume or power of the engine, emission level of the vehicle, fuel efficiency, age of the vehicle and more. In addition a selective tax on the purchase of the car is levied in some countries, among other Iceland. It is commonly based on technical features such as the piston displacement of the engine as well as the value of the car. By relating the tax to the vehicle's value the ability to pay is included (Mayeres 2000).

Johansson and Schipper pointed out that taxation should occur as directly as possible. For example, if the aim is to limit fuel consumption fuel should be taxed directly instead of taxing e.g. car ownership. The aim is however often very complex such as minimising congestion, noise and pollution and as fuel consumption can for instance be minimised with choice of car only it does not solve congestion or noise. Taxation related to the distance driven might be a better method for that purpose. A road-pricing system taking time, space and vehicle characteristics into account may be a solution worth striving for (Johansson & Schipper 1997).

### **2.6.2 Road pricing systems**

Road pricing has gained increased recognition supporting the principle 'the user pays'. Infrastructure expansions have often shown very short term effects as increased demand leads to further congestion and emissions in the future. The public acceptance for road charging is strongly dependent on the road user's perception of the relationship between the fee paid and benefit gained. According to an expert group that examined the consequences of free public transport in Denmark, road pricing is an inevitable measure in a comprehensive traffic policy to obtain the benefits of decreased private car traffic (Teknologi-rådet 2006).

Today's technique offers various road pricing possibilities such as Satellite Positioning, Automatic Number Plate Recognition Systems, Electronic Vehicle Identification, odometers and tachographs. It is possible to differentiate the charge for different vehicle types, time of day, service level of the road and more, i.e. the price is based on the place and time of use of the vehicle.

Distance related charging is thought to be a better tool to manage travel demand independent of fuel type or efficiency. Enforcement is an essential process to ensure rules being obeyed by everyone in such schemes. It is possible to give discounts for fuel efficient vehicles to promote these but they will still generate revenues for the use of the road system. Many distance-related charging systems have had problems fulfilling requirements on accuracy and got in conflict with rules for privacy (Nazer & Pickford 2007). Distance-based pricing will be taken up in more detail in the chapter on Distance-Based Insurance pricing in chapter 2.6.6).



### **2.6.3 Congestion pricing**

Congestion pricing involves a price being charged for entering zones or city parts that are dealing with severe congestion problems instead of increasing the carrying capacity of the road system. The term congestion tax is used when the profit goes to the public exchequer and congestion charge when the profit is to be invested within the area it was collected. Both aim to reduce traffic congestion and promote other modes of transport than private cars. The city of London launched a very successful congestion charge scheme in the year 2001 for which a case study is taken up later in chapter 2.6.8.

Stockholm congestion tax trial 2006 is another successful example where traffic flows were cut, emissions reduced, use of public transport increased as well as the acceptance among public and business owners was gained despite the short trial period of only six months. In general, road pricing systems are quite expensive to implement and will therefore not be suggested within the frame of relatively cheap and simple measures. An example is the Stockholm trial for which the payback time was estimated to be four years due to the high initial cost. It should, however, be kept in mind that a payback time of four years is indeed short compared to the payback time of road investments which are typically 15-25 years. An important conclusion was drawn from the Stockholm trial, that public transport on its own does not solve congestion, but is a very central contributor in combination with other measures such as congestion charge (Stockholmsförsöket 2006).

When congestion is to be solved, counter effects in form of new traffic being tempted have to be taken into account. Examples have shown a higher price elasticity for off-peak traffic than peak traffic making peak traffic pricing more effective during off-peak periods (Mayeres 2000).

### **2.6.4 Tax-exempts as an incentive**

Many perquisites for employees, e.g. public transport cards provided by the employer, are taxable while a provision of parking space is seen as natural. According to Swedish law free parking provision should be taxable, but the law is seldom followed and it is difficult to survey. Health care perquisites such as fitness cards and home computers are among things that are commonly exempted from tax. A committee with a number of experts was selected by the Swedish government in the year 2001 to do a detailed evaluation and suggest improvements for the public transport services in Sweden. The committee has suggested a number of ways for how to increase the use of public transport services with help from economic measures.

The committee suggests that public transport cards provided by the employer should be exempted from tax. It is possible to require a 'green-travel plan' from the employer to allow the employees to take advantage of the tax deduction. In addition it is pointed out that these cards should be personal to avoid people handing them over to other family members or friends that already use public transport. If many people take advantage of the perquisite there will certainly be some tax revenue reduction for the state, but increase in use of public transport will hopefully lead to other benefits making up for the revenue loss (Kollektivtrafikkommittén 2003). Car tax deduction is commonly given for employees that travel during working hours. The committee suggests the introduction of kilometre based travel tax deduction independent of travel

mode, i.e. the employee could benefit personally from choosing public transport instead of a private car. This measure can only be applied in places where public transport is available (Kollektivtrafikkommittén 2003).

As shown in table 2-1 availability of free parking at worksites is determinant for the choice of travel mode. Therefore, taxation of free parking is considered to have significant effects. This can, however, be difficult to survey and risks not being followed as in the case of Sweden. Another possibility is to charge the employer for the number of parking spaces offered encouraging him to limit the supply and manage its employees' travel habits. The effect on the number of workers driving to work is expected to be somewhat less when the employer is charged instead of the employee directly but the surveillance is much easier. The employer could decide to charge its employees himself (Kollektivtrafikkommittén 2003).

The Icelandic minister of the Environment has suggested exemptions from excise tax and tariffs for bikes in Iceland to promote biking as a preferred mode of transport (Guðmundsson 2009).

### **2.6.5 Subsidies from authorities**

Authorities can manage travel demand by subsidising certain modes of transport or choice e.g. with tax-exempts mentioned in chapter 2.6.4. Public transport services are commonly subsidised services, which is the case in Reykjavík (municipal, not governmental subsidies). Subventions are indeed often necessary for instance to encourage development of alternative 'green fuel' to take market share from the conventional fossil fuels (Johansson & Nilsson 2004).

There is a great potential to use revenue from fuel and car stock taxation, parking fees and road pricing to raise the subsidies to public transport. Subsidies have, however, shown a very limited effect on welfare benefits and in the worst cases a welfare loss. In addition subsidies often result in high national economical cost compared to the actual environmental gain. Each situation is unique and it is therefore important to study each situation in detail to evaluate the total costs and benefits. As the willingness to pay for environmental improvements increases, subsidies will likely be more effective (Mayeres 2000).

### **2.6.6 Pay-As-You-Drive insurance pricing**

Vehicle insurance is most commonly charged as a fixed annual cost regarding vehicle use, allowing no possibility for savings by limiting the use. Pay-As-You-Drive pricing (PAYD), sometimes called Distance-Based pricing, makes insurance cost a variable cost encouraging drivers to save money by reducing their driving. The reduced driving contributes to reduced congestion, increased equity, road safety, pollution reduction as well as cost savings for the consumer. In general PAYD systems are considered to be technically and economically feasible benefitting both the consumer and society. There are several ways to implement PAYD systems which vary in implementation cost and effectiveness. Some are related to fuel pumping which is not actuarially accurate as it depends on the fuel consumption of the vehicle and risks illegal fuel purchases. Per-kilometre premiums demand odometer audits in vehicles which are actuarially accurate and relatively cheap in implementation. Odometer based systems are estimated to bring about 10-12% reduction in vehicle travel per

vehicle affected and considered to be likely to attract 25-50% of motorists. There is, however, a slight risk for odometer frauds. GPS-Based pricing is the most accurate method but is very expensive and not very likely to bring about consumer savings if the consumer needs to invest in the equipment. It is, however, more and more common that new vehicles are factory equipped with GPS and additional cost is therefore expected to decline in the nearest future. Today less than 10% of consumers are expected to be attracted by the option. Privacy concerns have risen with GPS-Based pricing as it identifies when and where a vehicle has been driven. This problem is avoided with odometer based pricing. If congestion and pollution problems are of interest GPS-based pricing allows extra incentives to relate pricing to peak-period driving which might even justify partial subsidy of the option.

The fact that not more insurers have implemented PAYD systems is likely because the benefits are mainly the consumer's rather than the insurer's. (Litman 2005)

### **2.6.7 Case study: Workplace parking Levy in Nottingham**

In the year 2000 laws called the 2000 Transport Act were taken in force in Great Britain enabling municipalities to either implement congestion charge or parking fees. Nottingham chose parking fees to solve congestion problems. Employers had to pay for the number of parking places they offered and it was up to the employer whether he took the cost or carried it over to the employee. In the beginning the fee was € 220 per parking space per year and was raised to € 515 in a 10 year period. The money raised from the charge is to be invested back in public transport services in Nottingham (Kollektivtrafikkommittén 2003).

### **2.6.8 Case study: Congestion Charge Scheme in London, UK**

As a part of a transport strategy published in 2001 a congestion charge scheme was launched in the city of London in the UK in the year 2003 of which the charging zone was extended in the year 2007. The city suffered from serious traffic congestion and drivers in central London spent around 50% of their time in queues. Vehicles that drive within a defined charging zone are charged by € 12 per weekday between 07:00-18:00. All revenue raised by the charges is used for traffic facility investments in the city. Road space gained has been allocated for pedestrians and other road users.

Traffic entering the original charging zone has decreased by 21% since the implementation and traffic entering the extended zone has decreased by 14% at the same time as bike trips have increased by 12%. Number of bus passengers has increased by 6% and € 200 million have been raised in the financial year 2007/2008 to invest in improved infrastructure in London.

Despite decreased traffic levels brought about by the charge, congestion has reached the same level as before the charges due to decreased level of road space. The congestion would, however, be significantly worse with remained or increased traffic levels (Transport for London 2009).

**2.6.9 Case study: Polis Direct PAYD insurance pricing, The Netherlands**

Polis Direct is a major Dutch insurance company that started offering a kilometre based policy in the year 2004. To be able to choose the option the vehicle owner has to fulfil certain requirements for age, vehicle price and maximum distance driven per year. The advanced premium for the following years is based on the actual number of kilometres driven in the previous year. The mileage is collected at the annual vehicle inspections and registered in the national vehicle registration database.

## 2.7 Involvement of the private sector

*“Three years ago I would have said that all this talk about sustainability was nothing for my business, except from just some unnecessary obligations and costs. But just the fact that my company is operating in a community with such a good sustainability profile has really improved the image of the company among the customers. It’s a privilege from a marketing point of view to have the opportunity to participate in this development”.*

*(Ólafur Rögnvaldsson, C.E.O of Snæfellsnes’ largest fish industry, 2005)*

The ‘unnecessary obligations and cost’ that sustainability requires is unfortunately a widespread misunderstanding. It is worth striving for to make all private actors realise what Ólafur has realised. It is not only the government that can contribute to sustainable development of traffic. There are several actions that can be taken by private companies that can make a big difference –both for themselves and society. Companies can for example contribute by encouraging their staff members, become members of carpools, use an environmentally friendly carfleet and offer telecommunication. The motivation for private actors is often based on economic considerations, marketing reasons or simply a sense of responsibility. It is important that authorities act as role models and encourage private actors to take actions contributing to sustainability with varying incentives, regulations, cooperation and more.

### 2.7.1 Environmental certificates

Environmental responsibility should be seen as a marketing advantage for companies. Authorities can help promoting this with marketing certificates for environmental profiles as an incentive for companies to promote greater awareness among their employees.

Companies can also take up international environmental management systems (EMS) such as within the ISO 14000 family. ISO 14001:2004 is a general standard for all businesses that helps to identify and control environmental impacts of their activities, products and services, improve their performance and set environmental aims and demonstration of achievements. Organisations can benefit from the implementation of ISO 14000 standards. Investment in environment related measures can bring return in form of reduced waste management cost, decreased energy consumption and distribution cost as well as a very positive corporate image. It can indeed be a waste of money not to take environmental management into consideration (International Organization for Standardization a).

It is worth mentioning that The International Organization of Standardization (ISO) also offers The Kid’s ISO 14000 Programme supported by the United Nations. It is meant to develop environmental awareness among children and youth by teaching them the approach of ISO 14000 in homes and communities, allowing international communication and networking in relation to the programme. It is an interesting option as an educational measure taken by either private or public initiatives (International Organization for Standardization b).

There are fewer than 10 companies that have received the ISO 14000 certificate in the whole of Iceland.<sup>21</sup>

There are several other environmental certificates, both international and local, that private companies can benefit from and contribute to sustainability.

### **2.7.2 Travel plans for private companies**

Private companies can contribute to sustainable travel habits by implementing travel plans for their employees. These travel plans can contribute to environmental certificates and awards, benefit the companies from a marketing point of view or directly through better health of their employees. As mentioned in chapter 2.6.4 on economic measures it is possible to require such a plan from employers to be able to accept tax exemptions from public transport prerequisites. A case study of commuter plans will be taken up in chapter 2.7.8.

### **2.7.3 Telecommunication**

Telecommunication has affected travel demand ever since the arrival of the telephone. There is a great potential to substitute physical travel with telework. An example of telework is telecommuting where employees work from home, satellite office or local work centres for various businesses to reduce travel need to central offices, video-conferencing substituting physical meetings. The main objectives of teleworking are often economic savings in the form of less travel cost and travel time benefitting the environment.

Telework is not suitable for all types of jobs, but tends to be most suitable for information management such as software programming, planning, analysis and design which is estimated to be 50% of all jobs though not nearly 50% of all employees are attracted by teleworking. It can be technology demanding as computers, high-speed internet, copiers, fax machines and such equipment are often required. In addition many employees lack self-motivation, value social interaction and supervision more than the flexibility. Encouragement from employers is important for teleworking by, for instance, offering cash payments equivalent to prerequisites that employees would otherwise have received at a central office.

Teleworking is considered to be a potential tool to minimise commute travel. A combination of teleworking and attending a central office can be a feasible option as by teleworking two times a week, commuting is reduced by 40%. As telework tends to attract long-distance commuters, it contributes significantly to a reduction in vehicle kilometres travelled. There are risks for several counter effects of teleworking such as increased urban sprawl as employees might justify moving further away from a worksite knowing that they will only need to commute a few times a week. It may cause an increase in number of trips due to additional errands that would have been run during a commute and the general risk of more travelling due to increase in long-distance relations.

---

<sup>21</sup> Hjörtur Hjartarson, publicity and marketing manager of Icelandic Standards (IST), on 31 October 2009.

## Transport Demand Management in Reykjavik

Some studies have shown a reduction in commuting travel and no significant signs of counter effects while others have estimated a minor reduction in travel due to various counter effects. It is pointed out that implementation of other transport demand management measures in conjunction with teleworking is essential to reinforce the effects of teleworking on travel demand (Victoria Transport Policy Institute 2008).

Table 2-4 shows a benefit summary for teleworking.

**Table 2-4 Benefit summary for teleworking (Victoria Transport Policy Institute 2008)**

Objective	Rating	Comments
Congestion Reduction	3	Is particularly effective at reducing commute trips.
Road & Parking Savings	2	Reduces vehicle travel and trips.
Consumer Savings	2	Reduces vehicle travel.
Transport Choice	3	Increases transport choice and convenience.
Road Safety	1	Reduces vehicle travel.
Environmental Protection	1	Reduces vehicle travel.
Efficient Land Use	-2	Can encourage more dispersed land use.
Community Liveability	2	Reduces vehicle travel.

\*Rating from 3 (very beneficial) to -3 (very harmful). A 0 indicates no impact or mixed impacts.

### 2.7.4 Various initiatives

Private companies can adopt many of the measures mentioned in the previous chapters. Informative and educational measures are especially suitable as the worksite can be seen as a school for adults. Businesses that involve driving can require a course in Eco-driving for all their drivers, companies can encourage their employees to participate in 'bike to work' and run campaigns and competitions encouraging alternative modes of transport. Companies can revise their car fleet and establish or join a carpool, replace perquisite payments towards car expenses with subvention for public transport passes or bike investment, enable teleworking, facilitate biking and walking by offering shower facilities, implement environmental certificates and travel plans etc (Anastasiadis 2005).

Apart from for the contribution to sustainability, private companies can, in addition, benefit directly from most of the measures. Walking and biking, for example, lead to better health among the employees and decreased demand for expensive car parking. Drivers educated in Eco-driving can reduce fuel cost significantly, telecommunication can save time and travel cost, and contributions to environmental profiles such as achievements of certificates can be essential factors in marketing.

### 2.7.5 Case study: Pfizer in Sandwich in the UK

In early 2004 the pharmaceuticals company Pfizer started paying their employees for not driving a car to work as it costs the company €9 per parking space and day. Instead they paid their employees up to €7 per day for walking, biking or taking public transport resulting in reduced car use by 15% and an economic save by €145 in one year (Anastasiadis 2005).

### **2.7.6 Case study: Telecommuting program of First Interstate Bank, Los Angeles**

First Interstate Bank, employing approximately 3 500 people, established a telecommuting program in 1991 aimed at increasing productivity and flexibility for employees. It is required that employees have worked for the bank for a minimum of one year to be empowered to telecommute and a signed agreement is made to ensure all policies, procedures and expectations being understood by all parties. Business-related phone calls are reimbursed and some equipment is provided by the bank.

Both managers and telecommuters have been very positive towards the program. It has benefitted the managers with increased productivity and less time off among their employees and the commuters with fewer distractions and better balance between work-related and personal responsibilities (Victoria Transport Policy Institute 2008).

### **2.7.7 Case study: Environmental Profile at Work (EPW)**

Environmental Profile at Work is an interactive awareness initiative taken by Ericsson in the year 2000 to encourage employees to take steps to improve the environment and make a contribution towards sustainability. Employees could calculate the environmental impact of their travels and compare it to the average of the rest of the employees by creating their own profile in the program. The program also makes suggestions and encouragements on how to improve their travels. Over 40 000 of Ericsson's office workers had participated in the program (Ericssons 2001).

### **2.7.8 Case study: Employees help staff ease their commuting headaches**

As commuting in many urban areas of Canada has become very costly, time-consuming and stress-inducing, Agence Métropolitain de Transport, a transportation agency in the Montreal-area of Canada, offers help for employers to set up commuting programs for workers. The agency helped the company Bombardier among others to reduce parking demand instead of expanding parking facilities by suggesting car-sharing programs and parking spaces set aside for employees participating in the program. The company provides employees with taxi-chits for emergency errands so that a private car is not required by the employee. The company that employs 11 000 people in Montreal has built around 500 carpool teams, decreasing the demand for new parking spaces by 600. Bombardier states that the measures contribute to better environment, economic savings, better image and positive appreciation by their employees.

Car-sharing plans suit companies differently and a program implemented for Enmax showed much less success than the one for Bombardier. Only 30 out of total 3 000 registered to the program and even fewer succeeded in finding a suitable commuter to share a ride with. The reason is thought to be due to the nature of the business, but employees work shifts, located in industrial areas making it difficult to run errands such as dry-cleaning or grocery shopping during lunch hours etc. The program is, however, appreciated by the managers and employees as it gives the possibility to use it a few times a week in addition to the possibility of getting to know your colleagues better (Vu 2003).



### 3 A plan of measures

Following is a plan of measures suggested for the metropolitan area of Reykjavik based on the literature study made above. The plan is not a full-scale or a complete plan for implementation, but is meant to work as a bank of ideas and a base for further and more detailed measure plan making. No quantitative goals will be made. If the measure is not marked with a letter at the end it is suggested to be implemented as soon as possible. The following notations will be used to indicate if immediate implementation is not suggested as well as if there is anything special about the measure.

[15]	The measure should be implemented within five years
[110]	The measure should be implemented within ten years
[L]	The measure is mainly meant to give long term effects
[C]	The measure is very costly when compared to most of the other measures which might be an obstacle for implementing it
[E]	The measure does not necessarily limit the traffic made by private cars directly, but is meant to make the remaining trips more effective

#### 3.1 General goals

- a. Replace the authorities' common method of 'predicting and providing' with transport demand management.
- b. Increasingly apply the reasoning 'the polluter pays'.
- c. Reykjavik should be able to live up to the expectations of being 'the most environmentally friendly capital of the north'.
- d. Attitude change needs to be brought about among the inhabitants of Reykjavik to make them realise that they can contribute to sustainability and to create acceptance for implementation of measures.
- e. A balanced modal split should be reached and people should make conscious choices of transport mode.

#### 3.2 Overall measures

- a. Improve the uniformity of measures taken by the eight different municipalities in the Reykjavik metropolitan area by establishing tight cooperation and creating basis to establish a common regional plan for the area regarding traffic.
- b. Decide on a hierarchy for a balanced transportation system, i.e. an order in which transport modes should be prioritised.
- c. Thoroughly inform about all the measures mentioned below before they take place to gain acceptance among those they concern.

### 3.3 Parking policy measures

- a. Convert the present combination of type one and type two policies, according to OECD's definition, to a policy of type two only and expand the charged zones so that it covers the whole metropolitan area of Reykjavík, not only the city of Reykjavík. With time the policy should be converted to a type three policy, by introducing regulation for private parking, but only if good public transport services are ensured.
  - i. Expand the charged parking zones in Reykjavík and introduce parking fees at all public and municipal buildings in Reykjavík.
- b. Revise the Icelandic building and planning legislation
  - i. by lowering the requirements for a minimum number of parking spaces and adding maximum norms to allow control of oversupply of parking spaces.
  - ii. by creating room to allow private property owners to charge for parking facilities e.g. with parking meters.
- c. Raise present parking fees and fines radically according to what is known in our neighbouring Nordic Countries and ensure consistency between fines and fees. The price elasticity should be studied to help to decide the raise.
- d. Eliminate search-traffic with strict regulations of on-street parking i.e. with limited amount, time-limits and pricing.
- e. Provide Park+Ride facilities in accordance with the future public transport network. [C]
- f. Perform a count of the total number of parking spaces in Reykjavík.

### 3.4 Measures for Carpools

- a. Provide support and information for pioneers interested in starting a commercial or a private carpool. [E]
- b. In case interest is limited among private actors to establish a carpool the eight municipalities in Reykjavík should establish a commercial carpool in the form of a municipal cooperative unit which could later be privatised. [C, E]
- c. The municipalities themselves should set a good example and
  - i. rethink their vehicle fleet and its organisation. [E]
  - ii. consider whether a carpool is suitable for them. [E]
  - iii. in case a carpool is suitable, the possibility of offering employees to become members should be studied. [E]
  - iv. provide other modes of transport than cars for work related trips.
- d. Promote carpool membership to individuals and families [E]
  - i. as a good option for families' extra car.
  - ii. by using the private economic savings as a campaign tool.
  - iii. by using knock-on-door-campaigns.
- e. Promote car-sharing

## Transport Demand Management in Reykjavík

- i. by encouraging the development of a smart car-sharing databases, especially for commuters.
- f. Establish a collaboration with building contractors to promote sustainable planning e.g. by planning with respect to carpools from the very beginning.

### 3.5 Public transport measures

- a. Prioritise public transport systems as a vital service system similar to water supply and electricity.
- b. Revise the public transport system of Reykjavík by
  - i. establishing a public transport policy like recommended by the EU, i.e. public/private partnership, and retain a coordinated network by keeping planning and provision of infrastructure with the local authorities, but subcontract the operation and management.
  - ii. aiming for the recommended frequency of minimum 10-15 minutes and maximum 30 minutes. [C]
  - iii. redesigning the route net so that maximum walking distance to bus stops is 400 meters in the zones provided with public transport (can be exceeded in sparsely populated residential areas). [C]
  - iv. providing zones outside the public transport service zones with P+R facilities. [C]
  - v. improving physical connections at bus-stops and transfer stations to minimise transfer times. [C]
  - vi. harmonising time tables to minimise transfer times.
  - vii. providing all bus stops with weather shelters [C]
- c. Public transport should not be offered free of charge, but differentiated fares should be considered. Investments should rather be made on the improvements mentioned in measure b.
- d. Renew the bus fleet used for public transport services and invest in vehicles run by more environmentally friendly fuel than conventional fossil fuels. [I10, C, E]
- e. Allocate more space for bus-lanes and study the possibility of using bus lanes as a combined bus-lane and High-Occupancy-Vehicle lane (HOV) without sacrificing the accessibility of buses.
- f. Affect the ‘force of habit’ to pick the private car with campaigns e.g.
  - i. by offering trial periods for new public transport users
  - ii. run campaigns and projects that focus on children and youth as target groups. [L]
  - iii. by cooperating with private and public worksites and thereby reaching out to commuters.

### 3.6 Measures for biking and walking

- a. Expand and categorise the walking and biking path network and maintain it like the road network. The main network should connect worksites, commercial centres, big schools, hospitals etc. and the local network should serve travellers travelling shorter distances within city districts. [C, I5]
- b. Improve the quality of the bike infrastructure by
  - i. extending the network [C]
  - ii. ensuring good connectivity within and between all municipalities in Reykjavík
  - iii. prioritising bike traffic e.g. with elevated crossings and providing space among car traffic at suitable light controlled crossroads.
  - iv. providing road signs for bike traffic.
  - v. adding requirements on bike parking in the Building and Planning legislation.
  - vi. separating pedestrians and bicyclists. [C, I10]
  - vii. improving bike and walking paths to schools so that the infrastructure is not the obstacle forcing parents to drive their children to school.
- c. Run campaigns
  - i. directed towards school children and their parents to bike or walk to school.
  - ii. for walk and bike paths being respected by surrounding property owners.
  - iii. similar to ‘bike to work’ and extend these successively with time.
  - iv. to promote the health benefits of walking and biking.
  - v. on the ‘quarter hour bike map’ and try to encourage similar initiatives.
  - vi. to encourage public and private companies to facilitate walking and biking by offering shower facilities and changing rooms at worksites as well as rewarding those who walk or bike.
- d. Create information material such as walking and bike path maps and distribute it widely.
- e. Establish a cooperation with
  - i. potential organisations like The Icelandic Mountain bike club and the Icelandic Cyclists’ Federation and take advantage of their ambition and interest.
  - ii. with interested parties such as the board of public health, sports organisations and more to promote the health benefits of walking and biking.
- f. Provide city bikes where the borrower is personally responsible for the borrowed bike by law.

### 3.7 Informative and educational measures

- a. Start incentives to accelerate the development of alternative fuels. [E]
- b. Run knock-on-door campaigns to promote alternative travel modes to the private car.
- c. Encourage private companies to establish a transportation policy and reward those who do have one.
- d. Revise the national curricula
  - i. for driving education in Iceland and make eco-driving an obligatory moment which should preferably take place together with the driving assessment required two years after people get their driver's license.
  - ii. and clearly define the course 'Life Skills' for primary-, elementary schools and colleges. Education in sustainable development should be included in the course and course material provided.
- e. Run a campaign for
  - i. Eco-driving by promoting the economic benefits
  - ii. Eco-Schools and encourage all schools to participate
  - iii. the course in bikeability and promote it to all primary and elementary schools.
  - iv. the project Environmental Protection in Action
  - v. the project 'International Walk to School' and extend it.
  - vi. the Kid's ISO 14000 Programme
- f. Run projects
  - i. that engage students e.g. by implementing competitions for the best idea for a campaign aimed at minimising traffic by private cars.
  - ii. that involve parents of school children by e.g. designating parent's boards aimed at promoting sustainable travel habits.
  - iii. in cooperation with educational institutes at all levels e.g. by engaging students in innovation and marketing competitions.
- g. Make scientific evidence of the health benefits of walking and biking widely known and available and try and create basis to evaluate the benefits of the health effects in economic terms.
- h. Reward companies for good initiatives promoting sustainability which could e.g. give them a marketing advantage.

### 3.8 Economic measures

- a. Thoroughly examine, and implement if suitable, a Road Pricing System that considers diverse components such as distance travelled and time of travel instead of fuel consumption only. [L10, C]
  - i. Give discounts for vehicles that meet requirements for being ‘environmentally friendly’. [E]
  - ii. Search for solutions to the privacy invasion concerns of the most accurate techniques such as GPS-based systems.
- b. Study the possibility of differentiating taxation on a household’s first and second car etc. (i.e. higher tax on the second car, possibly as a function of the nature of the household)
- c. Allow tax-exempts for public transport cards and bike subsidies provided by employers
  - i. Require an implementation of a ‘green-travel plan’ from the employee instead.
  - ii. Public transport cards provided by employers should be personal.
- d. Look upon provision of free parking at worksites as perquisites and tax it as such. The company should be charged for the number of parking spaces supplied and encouraged to charge its employees for the use.
- e. Introduce a kilometre-based travel tax deduction independent of travel mode. (Measure is dependent on improvements of the public transport services) [I5]
- f. Minimise the share of jeeps and fuel demanding vehicles by increasing the tax and tariffs on these vehicles [E]
- g. Enable and inform about Pay-As-You-Drive insurance pricing systems for vehicles. Authorities should consider whether it is in their interest to subsidise certain specific pricing systems such as GPS-based pricing.
- h. Subsidise
  - i. development of alternative ‘green fuel’ [E]
  - ii. public transport services with governmental subsidies (together with the municipal)
- i. Abolish
  - i. excise tax and tariffs for bikes
  - ii. perquisite payments towards car expenses. To gain acceptance, perquisites that do not contradict sustainability could be offered instead.
- j. Focus on accentuating the benefits gained for the fee paid by the user in all the economic measures.

### 3.9 Involvement of the private sector

- a. Provide guiding information material for private companies interested in offering teleworking.
- b. Reward companies that have achieved environmental certificates by promoting these.
- c. Encourage companies to
  - i. facilitate walking and biking by offering shower facilities at work. (same as measure 3.6 c-vi)
  - ii. implement travel policies for their employees.
  - iii. implement environmental management systems
  - iv. implement parking fees (dependent on measures 3.3 b-ii & 3.8 d)
  - v. subsidise bike investments (related to measure 3.8 c)
  - vi. subsidise public transport for employees (related to measure 3.8 c)
- d. Run campaigns on
  - i. environmental certificates.
  - ii. benefits of carpools for companies
  - iii. travel policies for private companies and provide support to create these.
  - iv. telecommunication that can replace physical travels.
  - v. eco-driving for companies.
  - vi. the benefits of contributing to sustainability by adopting more sustainable modes of transport (possible economic savings, health benefits and more)

## 4 Discussion and potential for implementation of measures

### 4.1 Overall potential

The Manager of the Student Council for the University of Iceland said the following about implementation of parking fees at a few parking spaces at the University of Iceland:

*Students should not have to pay for such a humble facility as a proper parking space. University authorities, together with the city council and the state, need to realize that most Icelanders have chosen the private car as their first modal choice. Therefore, these institutes should not trick us to ride a bike, walk or use public transport to commute school, only to get away from their responsibility to provide decent parking facilities – even if it is fine to ride a bike, walk or take the bus to school, if people prefer to do so.*

*Authorities should emphasise work to make it easier for students to use the private car, not to try and pressurise us not to use it...*

This is what he has to say about the student council providing great discount for students on fuel prices, ensuring the lowest fuel price on the market:

*Authorities should see this contract as exemplary and aim in the same direction as the student council. Members of the council do not care for meter maids making themselves at home on campus nor having to slop through mud on their way to class. Authorities should be capable of paving the gravel parking spaces and ensure thoroughfares with a high standard of service to and from campus because we all have better things to do with our time than spending it in traffic congestion.*

*Jóhann Már Helgason, Manager of the Student Council for the University of Iceland, 16 October 2008.<sup>22</sup>*

The quotation above is sadly a widespread attitude among the public and university students. Based on this, the potential of implementing many of the measures above is very poor. This, however, highlights the need for informative and educational measures to ensure a change of attitude.

Political barriers in the form of a lack of political will are well known obstacles for taking necessary actions. Luckily, an enormous awakening has occurred recently among Icelandic politicians regarding a more sustainable transportation systems and the need to manage private car use. Nevertheless, an attempt to get around 20 power holders –politicians and experts within the field of transportation, planning and

---

<sup>22</sup> Article published at the webpage for Vaka, the Democratic Student Alliance on 16 October 2008. Article translated by author.



## Transport Demand Management in Reykjavík

environment, to estimate the potential for implementation of the plan brought forward in chapter three, did not succeed. The almost negligible response was caused by a combination of bad timing and lack of time together with a general lack of interest among those asked to respond to the survey. Hopefully, this lack of interest does not reflect the actual interest in these matters in today's politics. A detailed estimation of the potential to implement the measures, by a transportation expert from the city of Reykjavík can be found in Appendix C.

The Association of Local Authorities in Iceland and the Ministry of the Environment are responsible for assisting municipalities to establish a Local Agenda 21 according to the United Nations Conference held in Rio de Janeiro in Brazil in 1992. Local Agenda 21 is a local plan of actions for sustainable development. Around 50 Icelandic municipalities, hosting 90% of the population, have started this process, thereof all eight municipalities in the Reykjavík metropolitan area. (Samband Íslenskra Sveitafélaga 2009)

The eight different Local Agendas 21 vary considerably in emphasis, but some focus much on sustainable transport while others hardly mention private car traffic. Very few, but positively some, include education and information as important actions. Some of the plans have not been revised for nine years, but it is important that the Local Agendas 21 are not half hearted efforts.

The fact that Reykjavík metropolitan area consists of eight different municipalities with very limited cooperation, makes the potential to implement certain measures weak. To increase the potential, make measures more successful and avoid contradicting interests between neighbouring municipalities a tightened cooperation needs to be established between them. The first step was taken in the year 2001 when the first Regional Plan, covering all eight municipalities, was established. The Regional Plan, however, deals mainly with strategy and planning and direct actions are not put forward. A comprehensive plan of actions, acting like a Regional Agenda 21, for the whole Reykjavík metropolitan area would improve the potential for implementation of measures.

The distribution of responsibility is not always clear and that is often a big hindrance in taking actions. Problems such as boundaries between municipalities and the state being responsible for certain roads and the local authorities for others are common. It is suggested in the Local Agenda 21 for the City of Reykjavík that the city takes over responsibility of all roads within the urban area of the municipality to enable simple administration and speed up decision making.

Recently the city of Reykjavík has been very active in revision and formulation of a new General Plan for the year 2030 by inviting the public to open house meetings and thereby involving them in the idea process. Team work in form of a 'World Café' was established to bring ideas for the future of the city. The results were very positive as they were characterised by increased interest in more sustainable transportation. No more overpassed crossroads, safe ways for school children to school, transforming streets to pedestrian streets, an extended charged parking zone, implementation of electric buses, the need for more dense public transport network as well as bike and pedestrian roads were among ideas brought by the public (Netspor 2009). This is a

## Transport Demand Management in Reykjavik

very positive sign and indicates a potential for better public acceptance for many of the measures suggested in the plan of measures. Additionally, Reykjavik City is applying for the title 'European Green Capital' year 2012 or 2013, nominated by the European Union. This will hopefully stress the need for implementation of many of the measures in the plan (Reykjavíkurborg 2009e).

The still ongoing economic crisis that first hit Iceland in October 2008 influences the potential to implement measures. Many people are economically vulnerable making people more willing to find ways to cut costs.

Many of the role models referred to in the literature study above are foreign examples, especially many Scandinavian. The transferability to Icelandic circumstances can be discussed. To start with the climate has often been used as an excuse for the high share of the private car and low share of the modes of transport such as walking, biking and public transport. The climate facts in chapter 1.6.4, however, indicate that the climate difference cannot be blamed entirely. The force of habit is more likely to be of influence.

As mentioned before, the plan of measures is not a complete plan as further and more detailed studies are required in many cases. Follow-up on the measure plan is really important to evaluate the effects of measures and to analyse how they can be improved. The results of such follow-up should be used to create synergy and thereby add value to already taken initiatives for further use. The paper can be extended in various ways, for instance, with quantitative goal making and estimation of effects which is indeed necessary if the measures are to be implemented.

Following is a discussion on each separate group of measures in the plan.

### **4.2 Parking policies**

Figure 1-12 in chapter 1.6.6 implies that 63.7% of people find parking fee collection fully justifiable. This acceptance has increased steadily since the year 2004. This upwards going development indicates a great potential to implement a parking policy of type two, later developed to a type three, as suggested in the plan. Even though a policy of type two does not require fee collection for private parking, it is necessary to create a room in the legal framework allowing private property owners to charge for their provision of parking spaces.

When requirements for minimum number of parking spaces and parking fees are compared to, for instance, Malmö in Sweden it is possible to lower the Icelandic requirements and raise the fees vastly before getting close to the levels of Malmö. Public transport services are, however, very good in Malmö making fee collection more acceptable. Parking policy measures and fee raise should therefore go hand in hand with the improvements of public transport services.

Due to the urban sprawl in Reykjavik, operation of public transport services can be difficult. Therefore, Park+Ride facilities are a potential solution for those who live outside the zones serviced by public transport or those for whom public transport for the whole trip is an unrealistic option. As car accessibility is already very high in

## Transport Demand Management in Reykjavík

Reykjavík, implementation of Park+Ride facilities should not increase the demand for private cars, it should rather enable people, who had not taken public transport, to do so. The high car accessibility, however, decreases the chance of private car users to choose other modes of transport. Therefore, private car accessibility in the centrum needs to be decreased for Park+Ride to be successful. This is especially important for commuters from outside the city that will probably not bother to change travel modes if the remaining trip is just a matter of a few minutes due to the high accessibility for private cars. Commuting traffic from outside the city is relatively large as a result of fast rising housing prices in Reykjavík before the crisis.

There is an active discussion on transforming shopping streets like Laugarvegur into a pedestrian street. The suggestion to limit access to on-street parking leaves space to create attractive surroundings for pedestrians and bicyclists in the most central areas.

The suggestion to implement parking fees at all public and municipal buildings in Reykjavík is according to the suggestion in Reykjavík city's Local Agenda 21 to implement fees at all big public buildings and the recent implementation of fees at the University of Iceland.

Parking fees can be a great income generator and money can be invested back in more sustainable transport services and thereby making the public enjoy the benefits for which they pay.

### **4.3 Carpools**

The fact that an average car stands parked for 23 hours every 24 hours indicates a great potential to make the use of cars more efficient by sharing it with others. Additionally, 94% of all households in Reykjavík have more than one car and 50% more than two making the potential for a carpool car to replace a family's extra car high. It is, however, very rare that parking fees are collected at residential houses in Reykjavík, making the benefits for potential carpool users less than if parking fees were collected. A parking policy, including charged residential parking would reinforce the implementation of carpools. A shortage of suitable parking for carpools is a known problem in many already built areas. That should be relatively easy to solve in Reykjavík as there is a surplus of car parking in many places, easily allowing some to be reserved for carpools. A good level of public transport is pointed out as a key factor for a carpool to succeed, indicating the great dependence on measures improving the public transport services.

The fact that the phenomenon of carpools is new to most Icelanders, might either make carpools very exciting or the force of habit stays strong and people prefer to own their private car. In both cases, the need for information being provided to public is great.

The idea brought up to use municipal and governmental service cars as carpool cars e.g. for employees, possibly meets legal barriers regarding today's regulations. It also appeared that very few of the municipalities' service cars were environmentally friendly, except for the city of Reykjavík's, reducing the possible environmental benefits. It, however, makes the potential for the municipalities to seriously revise

their car fleet, and thereby set a good example, very good. A few of the respondents, on behalf of the municipalities, regarding their car fleet expressed their plans and interest in investing in more sustainable vehicles in the nearest future. Many of the cars, as the ones of the Icelandic Road Administration, are not suitable for carpooling due to attached specialised equipment. It seems like the possibility is greater for companies that hire carpool-services, to offer their employees to join the carpool.

### **4.4 Public transport**

The EU recommends a public-private-partnership (PPP) to operate public transport services. PPP has become more and more popular in Iceland the most recent years but the economic crisis, however, complicate implementation of such a system today. The state has increasingly been taking over companies to prevent them from bankruptcy. There are not many potential candidates at the moment to run the services mainly due to difficulties in loan accessibility. There will be a great opportunity to change the organisational structure when the economy starts recovering. Present owners can use the time until the economy gives a green light to prepare the conversion and work on improving the image of the service making it more attractive for private companies to operate. In addition, the potential to promote “cheap” modes of transport is great in times of economic crisis as people are economically vulnerable.

The fact that the distance travelled in each trip is relatively short as shown in table 1-2 makes public transport less competitive with the private car, but it has great potential for non-motorised travel modes which is very positive.

Public transport measures are expensive, but in the long run reduction in private car traffic is cost saving. Increased trip frequency, a denser route network and faster connections demand high initial cost that will hopefully partly pay back with increased use and ticket revenues. Experience has shown that free public transport rather attracts previous bicyclists and pedestrians than private car users. There is a slight chance that this is not as typical in Reykjavík as the grouping of people in different transport modes has not occurred to the same extent as in many other places as can be seen by the predominant majority of private car users. Anyhow, money is suggested to be allocated to improving the level of service rather than subsidising zero-rates. In addition, zero-rates are unlikely to be subsidised at time of economic crisis.

In case the PPP-policy is to be taken up, investment in buses driven by more environmentally friendly fuel or electricity should wait as vehicles will be the private partners' responsibility (even though functional requirements may be kept public responsibility). The present owners can, on the other hand, start examining the most feasible solution and start its development. The fact that the hydrogen trial stopped due to lack of political will does unfortunately not make the potential for implementation high. What went wrong in that implementation process should be avoided and used as valuable knowledge the next time.

The weather in Reykjavík is not always the most attractive for outdoor activities. Even though the climate data in chapter 1.6.4 did not show enormous difference in weather conditions it indicated more precipitation in Reykjavík compared to Copenhagen and

Stockholm. Precipitation can be experienced as bothersome when waiting for buses but can easily be solved with shelters. Shelters require initial cost and maintenance, but make public transport more attractive.

Several roads in Reykjavík are multilane roads. Existing car lanes can be converted into bus-lanes and thereby create priority for public transport. Additionally, it is possible to combine bus-lanes and HOV lanes and thereby reward those contributing to efficient transport modes with priority, not by building new lanes. Considering the high number of solo drivers in Reykjavík, there is a great potential to decrease that number. The city of Reykjavík is already a step ahead of the plan as they have recently added a few new bus lanes and traffic lights giving priority to public transport as well as agreed on a trial period for the first HOV lane in Reykjavík starting next year. However, these are all new lanes instead of rearranging traffic on existing roads. (Reykjavíkurborg 2009b; Reykjavíkurborg 2009c).

### **4.5 Walking and biking**

If the authorities start regarding the pedestrian and bike network as important as the road network by maintaining and expanding them similarly, that perception might be passed over to the public. It is known that biking and walking increase hand in hand with the extent of the bike network.

As mentioned earlier the number of short trips travelled indicates a great potential to increase the share of walking and biking. The fact that most children indeed prefer to bike or walk to school indicates a great potential if it is made possible for the parents and they are encouraged doing so. Campaigns are potential tools to promote walking and biking.

Increased public health awareness makes biking and walking very positive. To be able to combine exercise and commuting, worksites need to contribute with facilities. The earlier mentioned potential to promote “cheap” modes of transport, due to economical vulnerability in times of economic crisis, is especially appropriate for walking and biking.

Members of organised interest groups often have the best user experience so advice from them should be taken seriously. Their ambition is often great providing power holders and decision makers with voluntary assistance.

### **4.6 Information and Education**

Generally regarding information and education, Iceland has a good potential due to short and efficient communication channels, high level of education and information technology.

By including education in sustainable behaviour at all educational levels, starting as early as in kindergarten, implies a great potential to gain long term attitude change as it is always harder to teach an old dog new tricks. As the force of habit is known to be

## Transport Demand Management in Reykjavík

very strong it is certainly worth striving for more sustainable habits with the upcoming youth.

The increased interest throughout the years for programs like Eco-Schools and 'bike to work' points towards a great potential to apply education and campaigns to achieve set goals and promote sustainable transport modes. In addition, as mentioned above, increased health awareness helps promoting biking and walking. By making scientific evidence about the health benefits widely known, campaigns and education might be more successful. Jóna H. Bjarnadóttir, employed by The National Olympic and Sports Association of Iceland, has been in charge of the programs 'bike to work' and 'Walk to school'. She confirms a great success and increased awareness for walking and biking as modes of transport during the most recent years. She further states that the projects have been run on very limited budget not leaving much for advertising campaigns which she believes would lead to even faster and more success (Bjarnadóttir 2009).

The encouragement of companies to establish transportation policies should be successful as some companies have already established 'green policies'. The city of Reykjavík recently implemented a travel policy for their employees acting as a great role model for other companies and municipalities. Additionally, the Ministers of Transport and the Environment agreed on motivating companies and institutes to establish transportation strategies with the aim to limit the use of private cars last August (Guðmundsson 2009). By rewarding companies that take initiatives in promoting sustainability more companies are expected to follow.

### **4.7 Economic measures**

Tax increase and implementation of new taxes are frequently used governmental tools aimed at solving the ongoing economic crisis. This gives tax related measures a greater potential and possibly makes the public more understanding towards economic measures. Taxation of free parking provision and a tax increase on a households' extra car can be seen as a tempting income generator. For the same reasons tax-exempts and subsidies might not be very feasible at times of economic crisis where the main focus is to cut costs. It can, however, be argued that the benefits gained for the fee paid must be highlighted by offering something positive to draw the attention from measures experienced as negative by the public. Positively, the Ministers of Transport and the Environment agreed on reconsidering taxation of vehicles in favour of environmentally friendly modes such as bikes in August this year (Guðmundsson 2009).

The economic crisis, on the other hand, limits the space to invest in public transport services and infrastructure suggested. Furthermore it is likely that measures such as development of new techniques, road pricing system, alternative fuel or innovation will not be prioritised due to high initial costs and little economic revenue in the beginning.

The suggestion to introduce new perquisite payments towards car expenses independent of transport mode allows space to lower car expenses and moves the effort to bring about efficiency to the employer. People are often more willing to

contribute when they experience the benefits personally. Now is the optimal time to promote measures that involve economic savings for people as many are looking for ways to cut costs. Pay-As-You-Drive insurance pricing systems is a great way to do that. A problem is to make it an attractive option for the insurers to offer.

### **4.8 Involvement of the private sector**

Private companies sometimes resemble private people as they often look for sustainable contributions that benefit themselves, especially economically. Teleworking can indeed benefit both the employer and the employee. If environmental contributions were converted into economic values, such as by valuating the marketing advantage gained, it is likely that more companies will get attracted. Yet again, the city of Reykjavík has set a good example with tightened inspection and regulations for car expenses for their staff members resulting in 72% reduction in travel cost in one year (Reykjavíkurborg 2009d). This being possible indicates a great potential for other companies to do the same.

### **4.9 Priority and expected effects**

The measures are expected to minimise traffic made by private car by engaging as many individuals as possible to contribute to sustainable travel habits. Measures making walking, biking and public transport more competitive to the private car are expected to balance the modal split and thereby allow implementation of strict parking policies and economic measures. The stricter parking regulations and fee collection is believed to encourage more efficient trips, car sharing and people choosing other modes of transport. In addition, the regulations are expected to strengthen business and commercial activities in city centres as parking availability is made more likely and contribution to a more attractive city environment is made.

With successive improvements and priority given to public transport services together with limited supply of car parking, a number of commuters are expected to choose public transport. Additionally, revision of taxation for perquisites and incentives from private companies is expected to help. Increased use of public transport is expected to contribute to better public health, not the least mental health as it encourages social interaction instead of people passing each other as fast as possible in their own private metal shell.

A number of companies, both private and public, will likely outsource their vehicle fleet to carpools, and thereby increase their travel efficiency and cut costs. Families are expected to reconsider their car ownership and some expected to replace their extra car with a carpool car. Short trips are believed to be replaced by walking or biking with improved infrastructure and promotion of these two modes of transport and their benefits. The benefits are without doubt enormous for the individual and public health in addition to the economic, social and environmental gains contributing to sustainable development. The pattern of the modal split is expected to move from the Northern American pattern towards the Scandinavian one.

HOV lanes and parking fees are expected to attract people to share a car, especially for commuting trips. Thereby the number of solo drivers is expected to reduce. Fuel

## Transport Demand Management in Reykjavík

consumption is expected to decrease due to reduction of traffic, more efficient use of cars as well as increased fuel efficiency. Compulsory education in Eco-driving will also contribute to increased efficiency.

Increased emphasis on campaigns promoting contribution to sustainable travel habits are expected to contribute to a new way of thinking and with time leave a permanent footprint. Education is expected to do the same, especially for the younger generations. Information will, in addition, play a vital role in informing about all measures.

People are expected to be tempted by various ways to cut costs and measures like distance related insurance payments and tax-exempts are expected to be effective. Environmental certificates and contributions from private companies are expected to give competitive advantage when the economy starts recovering and therefore gain popularity.

Better solidarity is expected in actions taken by the neighbouring municipalities in Reykjavík and measures are expected to reinforce each other. In the long run, enormous economic savings are expected due to reduced demand for costly expansion of infrastructure for motorised traffic in addition to the economic value of the health and environmental benefits.

It is difficult to consider one measure more important than another as it is the “plan as a whole” that is important and many of the measures are indeed dependent on each other. In general, it is important to successively reduce the attraction of the private car at the same time as other comfortable modes of transport are guaranteed. Even more important, a shift in attitude is required, where information and education play a vital role. The fact that economic crisis are ongoing should be used as an opportunity rather than a threat. It is therefore suggested to give parking policy and economical measures together with promotion of walking and biking priority in the short term perspective and public transport and attitude targeting measures in the long term perspective.



## 5 Conclusion

Reykjavík does not live up to the expectations as ‘the most environmentally friendly capital of the north’. The City of Reykjavík is, however, applying for the title ‘European Green Capital’ year 2012 or 2013. Serious actions will be needed within transportation to be worthy of that title. The municipalities of the metropolitan area of Reykjavík certainly have great aims for the future in trying to contribute to sustainability. Aims and visions are, however, not enough, they risk being half hearted efforts, actions need to be taken. A common plan of actions, acting like a Regional Agenda 21, is necessary as well as increased cooperation between the different municipalities in general.

Car ownership has been associated with welfare since it was first brought to the country in times of an economic upswing. The force of habit is known to be very strong and motorisation in Reykjavík resembles North American cities more than neighbouring European cities. The planning method ‘predict and provide’ has been dominant in Reykjavík’s transportation system reflected in a car ownership that has reached saturation, with around 1 100 passenger cars per 1 000 driver’s licences and requirements of a minimum number of car parking being 80-360% higher than in Malmö in Sweden. In addition, travel patterns point towards inefficiency, as 75% of all trips are made by car, despite half of all trips being shorter than two kilometres. In addition, 94% of all households have more than one car and 56% of all drivers are solo drivers. Provision of free parking spaces encourages people to drive at the expense of public transport, walking and biking, but parking fees are very rarely collected and are indeed 250-350% lower in Reykjavík than in Malmö in Sweden. The share of public transport is less than 5 % and is not considered to be competitive to the private car.

To solve the problems addressed above, a plan of measures is suggested. It consists of potential measures that are relatively cheap and simple, all meant to move Reykjavík’s transportation system closer towards sustainability by first and foremost minimising the traffic made by private cars. The measures are expected to contribute to a more balanced modal split.

Parking policies are among very potential measures. Without managing the supply of car parking, driving will continue to be attractive. The OECD defines four types of parking policies of which type two, later developed into a type three, is suggested for Reykjavík. A policy of type two attracts short-term instead of long-term parking by regulating price and supply of public parking. Type three includes measures for private parking too with e.g. maximum parking norms. For a city to afford limitation of car parking, public transport services need to be of good standard.

Carpools is a potential and unexplored tool to minimise private car traffic in Iceland. Carpools mainly contribute to greater efficiency of trips and the potential to replace families’ extra car is considered to be great. Just like the parking policy measures carpools are dependent on a good level of public transport services. Carpools is no less a potential tool for companies than the public, contributing to a better planning of trips, fuel efficiency and in most cases economic savings. With revision of the legal

## Transport Demand Management in Reykjavík

framework further efficiency should be possible by enabling a combination of carpools for companies and the public.

Public transport services are essential to complement many of the measures of the plan. In accordance with the EU's recommendation the organisational structure of public transport services should be reformed, preferably when the ongoing economic crisis starts recovering. To attract previous private car users the focus should be on increasing the service level rather than subsidising bus fares. Increased priority for public transport, such as separate bus lanes, contributes to the competitiveness of buses towards the private car.

Walking and biking are without a doubt the most sustainable modes of transport and need to gain recognition and be prioritised by authorities. The fact that distance travelled in each trip in Reykjavík is on average very short makes the potential to increase the share of these two transport modes very high. The benefits of increased share of walking and biking are enormous for the individual and public health, along with longer life expectancy, improved physical condition and concentration. In addition, walking and biking contribute to economic, social and environmental gains contributing to sustainable development. Extension of the infrastructure together with active promotion is necessary to bring about increase in the share of these two transport modes.

A shift in attitudes is required to change the force of habit to see the private car as the best and sometimes only mode of transport. Einstein's quote "We need a new way of thinking to solve the old way of thinking" is perhaps the key to this project. Education and information are key factors in bringing about this attitude change. Information is indeed considered to be an essential part of the implementation of all measures suggested in the plan of measures to gain acceptance among people affected.

Economic measures are popular and recommended by the EU and OECD. Taxation should occur as directly to the aim as possible for the best possible results. As the aim is often complex, an advanced road pricing system based on e.g. distance driven should be taken up. Tax-exempts can be applied for encouragement purposes which is indeed necessary together with levies to avoid lack of acceptance due to negative perception. The potential for economic measures is twofold at times of economic crisis as authorities and the public are looking for ways to cut costs. By offering people alternatives they can be tempted to save money by contributing to sustainability. Public transport, together with good opportunities to bike or walk, are necessary complements to economic measures. In addition, economic measures can target biking and walking directly with subsidies and incentives.

The last group of measures, involvement of the private sector, is especially important when targeting commuting traffic. Private companies can contribute to sustainable travel habits by adopting many of the measures above. In addition, private companies are encouraged to implement travel plans for employees, adopt environmental management systems, enable teleworking, manage parking supply, offer shower facilities etc. Sustainable contribution from private companies is expected to gain more importance in the future as it can contribute to competitive advantage.

## Transport Demand Management in Reykjavík

The different measures are indeed closely related and often dependent on each other. They are all thought to reinforce each other to reach the joint objectives. The overall potential to implement them is considered to be good. Implementation is, however, strongly dependent on political will and interest which is difficult to estimate. The most recent actions taken by the City of Reykjavík are very promising for the future, making the potential to implement many of the measures great. It is, however, not enough that only the City of Reykjavík acts; cooperation by all the eight municipalities of Reykjavík metropolitan area is needed. The ongoing economic crisis is positive for some measures but an obstacle for others. People are economically vulnerable and looking for ways to cut costs. The fact that so many unexplored tools exist makes the potential for improvement great. There are social groups that will be more difficult to convince than others, like the majority of the student council of the University of Iceland. Demography is an important factor to study when choosing methods for implementation of measures as well as to estimate the effects. Furthermore it is important to consider all three components; social, economic and environmental, to ensure sustainable development. First and foremost, solidarity and cooperation need to be obtained among the different municipalities to ensure solid success.

## 6 Bibliography

### 6.1 Written sources

- AEA Technology Rail, 2004. *Reykjavík light rail Pre-feasibility study report*. Reykjavík: City of Reykjavík. (p. 7)
- Ahlström, I., 2004. *På cykel för miljö och hälsa*. Stockholm: Länsstyrelsen i Stockholms län.
- Anastasiadis, S., 2005. Complex Urban Transport in Europe: Tackling Problems, Finding Solutions. In G. Jönsson & E. Tengström eds., 2005. *Urban Transport Development*. Berlin: Springer. Ch. 15, pp. 221-225, 241-243.
- Andersen, LB., 2005. Does cycling and improvement in cycling habits prevent premature death?. In E. Martin-Diener & M. Wanner, *WALK21 Satellite Symposium on transport related physical activity and health*. Zurich, 18-20 September 2005. Swiss Fedelar Institute of Sports & Swiss Federal Office of Sports: Magglingen.
- Andersson, Stig., Sonesson, Artur., Kivik, Ola Svahn. & Tullberg, Aina., 2007. *Gymnasiekemi A. 3rd edition*. Stockholm: Liber. (p. 295)
- Bílastæðasjóður, 2009. *Starfs- og fjárhagsáætlun 2009*. Reykjavík: Bílastæðasjóður.
- Boholm, Anna., 2009. *Kostnader och konsekvenser av nolltaxa/differentierad taxa i kollektivtrafiken*. Norrköping: Tekniska kontoret.
- Briem, Valdimar., 2008. *Umferðarfræðsla í skólum*. Reykjavík: Samgönguráðuneyti.
- Capacent Gallup, 2008. *Bílastæði í Miðborg Reykjavíkur Viðhorfsrannsókn*. Reykjavík: Bílastæðasjóður. (p. 10)
- City of Reykjavík n.d. *Shaping Reykjavík –Reykjavík Local Agenda 21: policy formation towards sutainble community in Reykjavík to 2015*. Reykjavík: City of Reykjavík.
- COST, 2006. *Parking Policies and the Effects on Economy and Mobility -Report on COST action 342*. Brussel: Technical Committee on Transport. (p. 11-14)
- Dora, C. & Phillips, M., eds., 2000. *Transport, environment and health*. Copenhagen: WHO Regional Office for Europe. (p. 9, 30, 32-33)
- Ericsson, 2001. *Ericsson Environmental report 2000 -Influencing our world*. Stockholm: Telefonaktiebolaget LM Ericsson (p. 10-11)
- Faskunger, Johan., 2008. *Aktiv transport –på väg mot bättre förutsättningar för gång och cykeltrafik*. Östersund: Statens folkhälsoinstitut. (p. 8, 14, 17-19, 20, 22, 28, 42)

## Transport Demand Management in Reykjavík

- Feeney, Bernard P., 1986. *A Review of the Impact of Parking Policy Measures on Travel Demand*. Linköping: Swedish Road and traffic Research Institute. (p. 1, 3-7, 20-25, 35-36, 43-44)
- Gunnarsdóttir, B. & Traustadóttir, S., 2009. *Hjólaferni –hjólum og verum klár í umferðinni*. Reykjavík.
- Göteborgs Stad Trafikkontoret, n.d. *Är en bilpool något för oss? En enkel handledning*. Göteborg: Göteborgs Stad.
- Holmberg, B. et al., 1996. *Trafiken i samhället, Grunder för planering och utformning*. Lund: Studentlitteratur. (p. 77, 121,194)
- Hönnun, 2006. *Samgönguskipulag í Reykjavík*. Reykjavík: Reykjavíkurborg, (p. 3-4, 14, 17-19, 21, 31-32, 63)
- Johansson, H & Nilsson, L., 2004. Klimatstrategi för vägtransportsektorn, rapport 2004:102, ISSN: 1401-9612. Borlänge: Vägverket.
- Johansson, O. & Schipper, L., 1997. Measuring the Long-Run Fuel Demand of Cars. *Journal of transport Economics and policy*, 31(3), p. 277-292.
- Jönsson, G. & Tengström, E., Eds., 2005. *Urban Transport Development*. Berlin: Springer. (p. 27)
- Kollektivtrafikkommittén, 2003. *Kollektivtrafik med människan i centrum, SOU 2003:67*. Stockholm: Näringsdepartamentet. (p. 78-79, 308-315)
- Litman, Todd., 2005. Pay-As-You-Drive Vehicle Insurance –Implementation, Benefits and Costs. In: Ungemah, David. *Transportation Research Board Annual Meeting*. London, 1 January 2006, Transportation Research: London. (p. 1, 4, 6-8, 11)
- Maack, M., 2006. *Case 22: ECTOS hydrogen project*. Reykjavík: Icelandic New Energy and University of Iceland.
- Malmö stadsbyggnadskontor, 2002. *Parkeringsnorm för bil och cykel i Malmö*. Malmö: Malmö Stad. (p. 6-10)
- Marks, David H., 2005. Academic Studies of Complex Engineered Systems: How this New Knowledge can be Used to Improve Education and Practice for Mobility. In G. Jönsson & E. Tengström eds., 2005. *Urban Transport Development*. Berlin: Springer. Ch. 18, pp. 271.
- Martens, Karel., 2005. *The Effects of Restrictive Parking Policy on the Development of City Centers*. Tel Aviv: Ministry of Transport. (p. 14-17)

## Transport Demand Management in Reykjavík

- Mayeres, Inge., 2000. The Efficiency Effects of Transport Policies in the Presence of Externalities and Distortionary Taxes. *Journal of Transport Economics and Policy*, 34(2), p. 233-260.
- Nazer, Zeina. & Pickford, Andrew., 2007. Advanced Technologies for Road User Charging: International Experience and Future Trends. In: Ungemah, David. *Transportation Research Board Annual Meeting*. London, 31 July 2006, Transportation Research: London.
- Naturvårdsverket, 2005. *Ekonomiska styrmedel för miljöns skull*. ISBN 91-620-8215-9. Stockholm: Naturvårdsverket. (p. 6, 11)
- nes Planners, 2002. *Svæðisskipulag höfuðborgarsvæðis 2001-2024, Greinagerð með svæðisskipulagi*. Reykjavík: Samvinnunefnd fyrir svæðisskipulag á höfuðborgarsvæðinu. (p. 12)
- Nordic Council of Ministers, 2006. *A better life through diet and physical activity*. Copenhagen: Norden. (p. 4-5, 11)
- Nordic Council of Ministers, 2009. *Sustainable Development –New Bearings for the Nordic Countries, Revised edition*. Copenhagen: Norden. (p. 31)
- Nyberg, Anders. & Ellström, Örjan., 2008. *Driver education systems – a preliminary study*. Borlänge: The Swedish Road Traffic Inspectorate. (p. 21)
- Person, Martin & Hjelm, Sara., 2002. *Bildelning i företag och offentlig sektor*. Stockholm: Göteborgs Stad Trafikkontoret. (p. 4-6, 19-21)
- Robertsson, Ulla., 2006. *Bilpooler i Lundby*. Lundby: Lundby Mobility Centre (p. 19-22)
- Sigurðsson, Haraldur., 2004. *Um ferðamáta á höfuðborgarsvæðinu*. Reykjavík: Borgarfræðasetur. (p. 5, 12-13, 15-16, 19)
- Stockholmsförsoket, 2006. *Facts and Results from the Stockholm Trial –Final Version –December 2006*. Stockholm: Congestion Charge Secretariat. (p. 1, 23)
- Sjöberg, K., Persson, K. & Brodin, Y., 2005. *Luftkvalitet i tätorter 2004 (IVL rapport B 1607)*. Göteborg: Svenska miljöinstitutet AB.
- Teknologi-rådet, 2006. *Perspektiver ved indførelse af gratis offentlig transport – vurderinger og anbefallinger fra en arbejdsgruppe under Teknologirådet*. København: Teknologirådet. (p. 10-143)
- TRAST, 2007. *Trafik för en attraktiv stad -Underlag, Utgåva 2*. Sveriges Kommuner och Landsting, Vägverket, Banverket & Boverket. (p. 163-166, 176, 186-187)
- Trivector Traffic AB, 2006. *LundaMaTs II*. Lund: Lunds kommun. (p. 11-13)

## Transport Demand Management in Reykjavík

- Umferðarráð, 2000. *Námsskrá fyrir almenn ökuréttindi Flokkur B*. Reykjavík, Umferðarráð.
- Valsson, Trausti., 2003. *Planning in Iceland*. Reykjavík: University of Iceland Press. (p. 72, 87-88, 118, 122-123, 127-143, 149-153, 427.)
- Vu, Uyen., 2003. Employers help staff ease their commuting headaches. *Canadian Reporter*, 16,21(ABI/INFORM global). (p. 1-6).
- Vägverket, 2004. *Vägar och gators utformning, VGU, Publikation 2004:80*. Borlänge: Vägverket (p. 102, sektion tätort).
- Whitelegg, J., 2005. Examples of Positive Changes of Complex Urban Transport Problems in Europe . In G. Jönsson & E. Tengström eds., 2005. *Urban Transport Development*. Berlin: Springer. Ch. 12, pp. 177.
- Örn, H., 2005. Urban Public Transport in an International Perspective. In G. Jönsson & E. Tengström eds., 2005. *Urban Transport Development*. Berlin: Springer. Ch. 5, p. 48-50, 53-56.

### 6.2 Electronic sources

- BBC Weather Centre, 2009. *Average conditions*. [Online] Available at: [http://www.bbc.co.uk/weather/world/city\\_guides/](http://www.bbc.co.uk/weather/world/city_guides/) [Accessed 25 August 2009]
- European Parking Association, 2001. *EPA Urban parking policy guide I Statement for COST 342*. [Online] (Updated February 2001) Available at: <http://www.europeanparking.eu/> [Accessed 16 September 2009]
- Exploateringskontoret Stockholm Stad, 2007. *Parkering i Hammarby Sjöstad*. [Online] (Updated 1 October 2007) Available at: [http://www.hammarbysjostad.se/service/pdf/Parkeringsinfo\\_071012.pdf](http://www.hammarbysjostad.se/service/pdf/Parkeringsinfo_071012.pdf) [Accessed 8 September 2009]
- Foundation for Environmental Education, n.d. *About Eco-Schools*. [Online] Available at: <http://www.fee-international.org/en/Menu/Programmes/Eco-Schools> [Accessed 30 October 2009]
- Global Action Plan, 2008. *About GAP International*. [Online] Available at: <http://www.globalactionplan.com/> [Accessed 31 October 2009]
- Guðmundsson, Magnús Már, 2009. Ráðherrar vilja að stofnanir niðurgreiði strætó. *Vísir*, [internet] 21 August. Available at: <http://www.visir.is/article/20090821/FRETTIR01/112649537> [Accessed 25 August 2009]
- Guikink, Don., 2007. *IT'S UP 2 U! Marketing Competition for Public Transport (the Netherlands)*. [Online] (Updated October 2007) Available at:

## Transport Demand Management in Reykjavík

[http://www.epomm.org/study\\_sheet.phtml?sprache=en&study\\_id=1573](http://www.epomm.org/study_sheet.phtml?sprache=en&study_id=1573)  
[Accessed 1 October 2009]

Helgason, Jóhann Már, 2009. *SHÍ -Stöðumælaverðir á bílastæðum Háskóla Íslands?* [Online] (Updated 13 May 2009) Available at:  
[http://www.student.is/frettir\\_studentarads/stodumaelaverdir\\_bilastaedum\\_haskol\\_a\\_islands](http://www.student.is/frettir_studentarads/stodumaelaverdir_bilastaedum_haskol_a_islands) [Accessed 26 August 2009]

International Organization for Standardization a. *ISO 14000 essentials*. [Online] Available at:  
[http://www.iso.org/iso/iso\\_catalogue/management\\_standards/iso\\_9000\\_iso\\_14000/iso\\_14000\\_essentials.htm](http://www.iso.org/iso/iso_catalogue/management_standards/iso_9000_iso_14000/iso_14000_essentials.htm) [Accessed 30 October 2009]

International Organization for Standardization b. *The Kid's ISO 14000 Programme*. [Online] Available at:  
[http://www.iso.org/iso/iso\\_catalogue/management\\_standards/iso\\_9000\\_iso\\_14000/kidsiso\\_home.htm](http://www.iso.org/iso/iso_catalogue/management_standards/iso_9000_iso_14000/kidsiso_home.htm) [Accessed 30 October 2009]

IWALK Steering Committee, 2009. *iwalk...The official Website of International Walk to School*. [Online] Available at: <http://www.iwalktoschool.org> [Accessed 21 September 2009]

Íþróttá og Ólympíusamband Íslands, 2009. *Hjólað í vinnuna um allt land*. [Online] Available at: <http://hjoladivinnuna.is/Heim> [Accessed 3 October 2009]

Íþróttá og Ólympíusamband Íslands et.al., 2009. *Göngum í skólann*. [Online] (Updated 20 August 2009) Available at: <http://www.gongumiskolann.is/> [Accessed 21 September 2009].

Kristjánsson, Gísli., 2009. *Borgarhjól / Almenningshjól í Ósló og víðar*. [Online] (Updated 3 June 2009) Available at: <http://lhm.is/content/view/302/153/> [Accessed 3 October 2009]

Landvernd, 2009a. *Graenfáninn um allt land*. [Online] (Updated 30 June 2009) Available at: <http://www.landvernd.is/graenfaninn/frettirpage.asp?ID=2324> [Accessed 31 October 2009]

Landvernd, 2009b. *Um verkefnið*. [Online] (Updated 30 June 2009) Available at: <http://www.landvernd.is/graenfaninn/yflokkar.asp?flokkur=1055> [Accessed 31 October 2009]

Landvernd, 2009c. *Vistvernd í verki*. [Online] Available at: <http://www.landvernd.is/vistvernd/flokkar.asp?flokkur=90> [Accessed 31 October 2009]

Meuleman, Angelo., 2008. *Smart car pool database in Flemish Region (Belgium)*. [Online] (Updated May 2008) Available at:  
[http://www.epomm.org/study\\_sheet.phtml?sprache=en&study\\_id=1871](http://www.epomm.org/study_sheet.phtml?sprache=en&study_id=1871)  
[Accessed 3 September 2009]



## Transport Demand Management in Reykjavík

- Netspor, 2009. *Miðborg –Stefnumót 2030. Mitt hverfi-mín borg. Minnispunktar frá opnu húsi um framtíðarskipulag í Miðborg, 26. nóvember 2009.* [Online] (Updated 26 November 2009) Available at: [http://www.reykjavik.is/Portaldata/1/Resources/adalskipulag/mappa/minnispunktur\\_Midborg\\_26\\_nov\\_09.pdf](http://www.reykjavik.is/Portaldata/1/Resources/adalskipulag/mappa/minnispunktur_Midborg_26_nov_09.pdf) [Accessed 9 December 2009]
- Reykjavíkurborg, 2006. *Hjólreiðar að vetri til.* [Online] (Updated 12 December 2006) Available at: [http://www.rvk.is/desktopdefault.aspx/tabid-1006/1507\\_read-4924](http://www.rvk.is/desktopdefault.aspx/tabid-1006/1507_read-4924) [Accessed 3 September 2009]
- Reykjavíkurborg, 2009a. *Welcome to Reykjavík.* [Online] Available at: <http://www.rvk.is/DesktopDefault.aspx/tabid-714> [Accessed 7 August 2009]
- Reykjavíkurborg, 2009b. *Samnýttir bílar njóti forgangs á Hlíðarfæti.* [Online] (Updated 26 August 2009) Available at: [http://www.reykjavik.is/desktopdefault.aspx/tabid-259/1198\\_read-16432/](http://www.reykjavik.is/desktopdefault.aspx/tabid-259/1198_read-16432/) [Accessed 27 August 2009]
- Reykjavíkurborg, 2009c. *Nýjar forgangsreinar og umferðarljós fyrir strætó.* [Online] (Updated 23 November 2009) Available at: [http://www.rvk.is/desktopdefault.aspx/tabid-757/521\\_read-17735/521\\_page-3/](http://www.rvk.is/desktopdefault.aspx/tabid-757/521_read-17735/521_page-3/) [Accessed 9 December 2009]
- Reykjavíkurborg, 2009d. *Ferðakostnaður Reykjavíkurborgar hefur lækkað um 72%.* [Online] (Updated 17 November 2009) Available at: [http://www.rvk.is/desktopdefault.aspx/tabid-757/521\\_read-17617/521\\_page-4/](http://www.rvk.is/desktopdefault.aspx/tabid-757/521_read-17617/521_page-4/) [Accessed 9 December 2009]
- Reykjavíkurborg, 2009e. *Reykjavíkurborg sækist eftir því að vera tilnefnd Græna borgin í Evrópu.* [Online] (Updated 3 November 2009) Available at: [http://www.rvk.is/desktopdefault.aspx/tabid-757/521\\_read-17424/521\\_page-6/](http://www.rvk.is/desktopdefault.aspx/tabid-757/521_read-17424/521_page-6/) [Accessed 9 December 2009]
- Reykjavíkurborg Bilastæðasjóður. *Um bílastæðasjóð.* [Online] Available at: <http://www.rvk.is/desktopdefault.aspx/tabid-2231/> [Accessed 22 September 2009]
- Seðlabanki Íslands, 2009. *Tímaraðir í Excel.* [Online] (Updated 14 October 2009) Available at: <http://www.sedlabanki.is/?PageID=37> [Accessed 14 October 2009]
- Statistics Iceland, 2009a. *Population by municipalities, sex and age 1 January 1998-2009.* [Online] (Updated 24 Feb 2009) Available at: <http://www.statice.is/Statistics/Population/Municipalities> [Accessed 11 April 2009]
- Statistics Iceland, 2009b. *Registered motor vehicles 1950-2008.* [Online] (Updated 12 March 2009) Available at: <http://www.statice.is/Statistics/Tourism,-transport-and-informati/Vehicles> [Accessed 11 April 2009]

## Transport Demand Management in Reykjavík

- Statistics Iceland, 2009c. *Motor vehicles by registered domicile of owner 2001-2006*. [Online] (Updated 19 October 2007) Available at: <http://www.statice.is/Statistics/Tourism,-transport-and-informati/Vehicles> [Accessed 19 August 2009]
- Statistics Iceland, 2009d. *Population by municipalities, sex and age 1 December 1997-2008*. [Online] (Updated 22 December 2008) Available at: <http://www.statice.is/Statistics/Population/Municipalities> [Accessed 19 August 2009]
- Statistics Iceland, 2009e. *Gas emission*. [Online] (Updated 22 July 2008) Available at: <http://www.statice.is/Statistics/Geography-and-environment/Gas-emission> [Accessed 27 October 2009]
- Statistics Iceland, 2009f. *Oil use 1983-2007*. [Online] (Updated 22 October 2008) Available at: <http://www.statice.is/Statistics/Manufacturing-and-energy/Energy> [Accessed 20 August 2009]
- Statistiska Centralbyrån, 2009 a. *Befolkningsstatistik*. [Online] (Updated 17 Feb 2009) Available at: [http://www.scb.se/Pages/TableAndChart\\_26046.aspx](http://www.scb.se/Pages/TableAndChart_26046.aspx) [Accessed 11 April 2009]
- Statistiska Centralbyrån, 2009 b. *Personbilar i trafik 1923-2007*. [Online] (Updated 25 Apr 2008) Available at: [http://www.scb.se/Pages/TableAndChart\\_34762.aspx](http://www.scb.se/Pages/TableAndChart_34762.aspx) [Accessed 11 April 2009]
- Strætó bs., 2009a. *Grunnskólakort auka færni barna í að nýta sér strætó*. [Online] (Updated 1 October 2009) Available at: <http://www.straeto.is/um-fyrirtaekid/frettir/nr/89> [Accessed 2 October 2009]
- Strætó bs., 2009b. *Leiðarkerfi*. [Online] (Updated 23 August 2009) Available at: <http://www.straeto.is/leidarkerfi/> [Accessed 2 October 2009]
- Sunfleet Carsharing, 2009. *English Version*. [Online] (Updated 2009) Available at: <http://www.sunfleet.com/> [Accessed 11 September 2009]
- Samband Íslenskra Sveitafélaga, 2009. *Vegvísir Sveitastjórnarmanna*. [Online] (Updated 12 March 2009) Available at: <http://www.samband.is/template1.asp?Id=1945> [Accessed 10 August 2009]
- The Swedish National Association of Driving Schools STR, 2009a. *EcoDriving*. [Online] (Updated 2 February 2009) Available at: <http://www.str.se/Fler-webbplatser---In-English/EcoDriving/> [Accessed 1 October 2009]
- The Swedish National Association of Driving Schools STR, 2009b. *EcoDriving - International*. [Online] (Updated 3 March 2009) Available at:

## Transport Demand Management in Reykjavík

<http://www.str.se/Fler-webbplatser---In-English/EcoDriving/International/>  
[Accessed 1 October 2009]

Transport for London, 2009. *About the Congestion Charge*. [Online] Available at:  
<http://www.tfl.gov.uk/roadusers/congestioncharging/6710.aspx> [Accessed 30  
October 2009]

Umhverfisráðuneytið, 1998. *Byggingareglugerð, 64. gr. Bílastæði á lóð*. [Online]  
Available at: [www.reglugerd.is](http://www.reglugerd.is) [Accessed 23 August 2009]

Umhverfisstofnun, 2009. *Hvarfakútar fyrir bensínvélar*. [Online] Available at:  
<http://www.ust.is/Mengunarvarnir/Mengunarvarnabunadur/Hvarfakutar/>  
[Accessed 27 October 2009]

Victoria Transport Policy Institute, 2008. *Telework: Using Telecommunications to  
Substitute for Physical Travel*. [Online] (Updated 18 August 2008) Available at:  
<http://www.vtpi.org/tdm/tdm43.htm> [Accessed 2 December 2009]

Vägverket och Hållbart resande i Storstockholm, 2009. *Bilpool – Ett samarbete mellan  
Vägverket, bilpooler, kommuner och regioner*. [Online] Available at  
<http://www.bilpool.nu/> [Accessed 27 August 2009]

Windfinder.com, 2009. *Wind and weather statistics*. [Online] (Updated October 2009)  
Available at: <http://www.windfinder.com/windstats/> [Accessed 19 November  
2009]

Åkvist, Ylva E., 2009. *Bilpool*. [Online] (Updated 16 February 2009) Available at:  
[http://www.lund.se/templates/Page\\_\\_\\_\\_\\_2275.aspx](http://www.lund.se/templates/Page_____2275.aspx) [Accessed 2009-09-11]

### 6.3 Unpublished works

- Albertsson, Árni E., 2009. Statistics from the National Commissioner of the Icelandic Police about the number of drivers license in the capital region in the year 2006. [e-mail] (Personal communication, aea@rls.is, 21 August 2009)
- Árnason, Daníel., 2009. *Information on the number of cars owned or operated by the Icelandic Road Administration in Reykjavík.* [e-mail] (Personal communication, daniel.arnason@vegagerdin.is, 11 November 2009)
- Bjarnadóttir, Jóna H., 2009. *Feedback on the plan of measures from an employee of The National Olympic and Sports Association of Iceland.* [e-mail] (Personal communication, jona@isi.is, 15 December 2009)
- Björnsson, Sigurður., 2009. *Information on the number of cars owned or operated by the Town of Kópavogur.* [e-mail] (Personal communication, sigurdurbj@kopavogur.is, 10 November 2009)
- Bogason, Guðbrandur., 2009. *Information on EcoDriving education in Iceland from the former chairman and present manager of the Icelandic National Association of Driving instructors.* [Telephone] (Personal communication, +354 8921422, 2 October 2009)
- Bogason, Helgi., 2009. *Information on the number of cars owned or operated by the City of Reykjavík.* [e-mail] (Personal communication, helgi.bogason@reykjavik.is, 15 September 2009)
- Gísladóttir, Guðrún Þórunn., 2009. *Statistics from the Icelandic Meteorological Office about average montly wind in Reykjavík from 2001-2009.* [e-mail] (Personal communication, +354 5254538, 19 October 2009)
- Gíslason, Tómas Guðberg., 2009. *Information on the number of cars owned or operated by the town of Mosfellsbær.* [e-mail] (Personal communication, tomas@mos.is, 11 September 2009)
- Gunnlaugsson, Baldur., 2009. *Information on the number of cars owned or operated by the Town of Seltjarnarnes.* [e-mail] (Personal communication, asa@seltjarnarnes.is, 10 November 2009)
- Hafliðason, Sigurður., 2009. *Information on the number of cars owned or operated by the Town of Garðabær.* [e-mail] (Personal communication, sigurdurhaf@gardabaer.is, 8 September 2009)
- Hannibalsson, Inggjaldur., 2009. *Information on recently implemented parking fees on a portion of parking spaces at the University of Iceland from the chairman of the school's planning committee.* [Telephone] (Personal communication, +354 525 4538, 5 October 2009)

## Transport Demand Management in Reykjavík

- Hjaltason, Sigurbjörn., 2009. *Information on the number of cars owned or operated by the district of Kjós.* [e-mail] (Personal communication, oddviti@kjós.is, 2 September 2009)
- Hjartarson, Hjörtur., 2009. *Information on the total number of companies that have received the ISO 14000 certificate in Iceland from the publicity and marketing manager of Icelandic Standards (IST).* [e-mail] (Personal communication, hjortur@stadlar.is, 31 October 2009)
- Jónatansdóttir, Kolbrún., 2009. *Parking information in Reykjavík from the manager of Reykjavík Parking Service.* [e-mail] (Personal communication, kolbrun.jonatansdottir@reykjavik.is, 29 September 2009)
- Nilsson, Ulf., 2009. *Information on parking fees in Malmö from an employee at Parking Malmö.* [Telephone] (Personal communication, +46 40605677, 30 October 2009)
- Randversson, Pálmi Freyr., 2009. *An expert's estimation of the potential for implementation of the plan of measures.* [e-mail] (Personal communication, palmi.randversson@reykjavik.is, 11 December 2009)

## **Appendices**

**Appendix A Price comparison for carpools, rental cars and private car ownership.**

Following examples show three different scenarios for individuals A, B and C that have differing travel habits. The comparison is taken from an article in the magazine “Vi bilägare” (We carowners) published 9 October 2007. The travel conditions are given for each example. Capital cost has not been taken into account in the calculations but it is furthestmost of interest for private car ownership but also for the refundable deposit required in many carpools. Prices for carpools and rental cars are gotten from each company’s webpage and the price for operating a private car is based on information from the Swedish Consumer Agency given that the car is kept for a period of three years. Prices have been converted from Swedish krona to Euros (€) with the exchange rate 1 Euro = 0.108 SEK (according to the exchange rates given in chapter 1.4).

**Example 1**

<b>A</b>	<b>Carpool 1</b> <i>(City Car Club)</i>	<b>Carpool 2</b> <i>(Stockholms Bilpool)</i>	<b>Rental car 1</b> <i>(Avis)</i>	<b>Rental car 2</b> <i>(OKQ8)</i>	<b>Private car 1</b> <i>(Ford Focus '07)</i>	<b>Private car 2</b> <i>(Ford Focus '04)</i>
<b>Total montly price</b>	119,5	84,3	553,9	237,6	309,4	285,2
<b>Total price per 10 km</b>	8,0	5,6	36,9	15,8	20,6	19,0

A carpool is the best economic option for person A. A used private car is 238% more expensive for given travel conditions. The reason why rental car 1 is so expensive is that Avis only offers fixed daily price with unlimited distance travelled. Rental car 2 is also a cheaper option than the private car. In fact it would be more economic for person A to take taxi these 60 times a year than driving an own car.

**Example 2**

Person B uses a car for weekly shopping and running errands every now and then. He visits his family in northern Sweden occasionally and even uses the car for vacations. In total he drives approximately 8 000 km per year of which approximately 60 errands are 30 km, 6 times 700 km during weekends in addition to 2000 km for a one week vacation.

### Transport Demand Management in Reykjavik

<b>B</b>	<b>Carpool 1</b> <i>(City Car Club)</i>	<b>Carpool 2</b> <i>(Stockholms Bilpool)</i>	<b>Rental car 1</b> <i>(Avis)</i>	<b>Rental car 2</b> <i>(OKQ8)</i>	<b>Private car 1</b> <i>(Ford Focus '07)</i>	<b>Private car 2</b> <i>(Ford Focus '04)</i>
<b>Total montly price</b>	286,4	245,6	729,2	374,9	400,0	336,9
<b>Total price per 10 km</b>	4,3	3,7	10,9	5,6	6,0	5,1

As for person A the carpool is the most economic option for person B, but not as extreme as for person A. A rental car from OKQ8 is an equivalent option to the private car.

#### **Example 3**

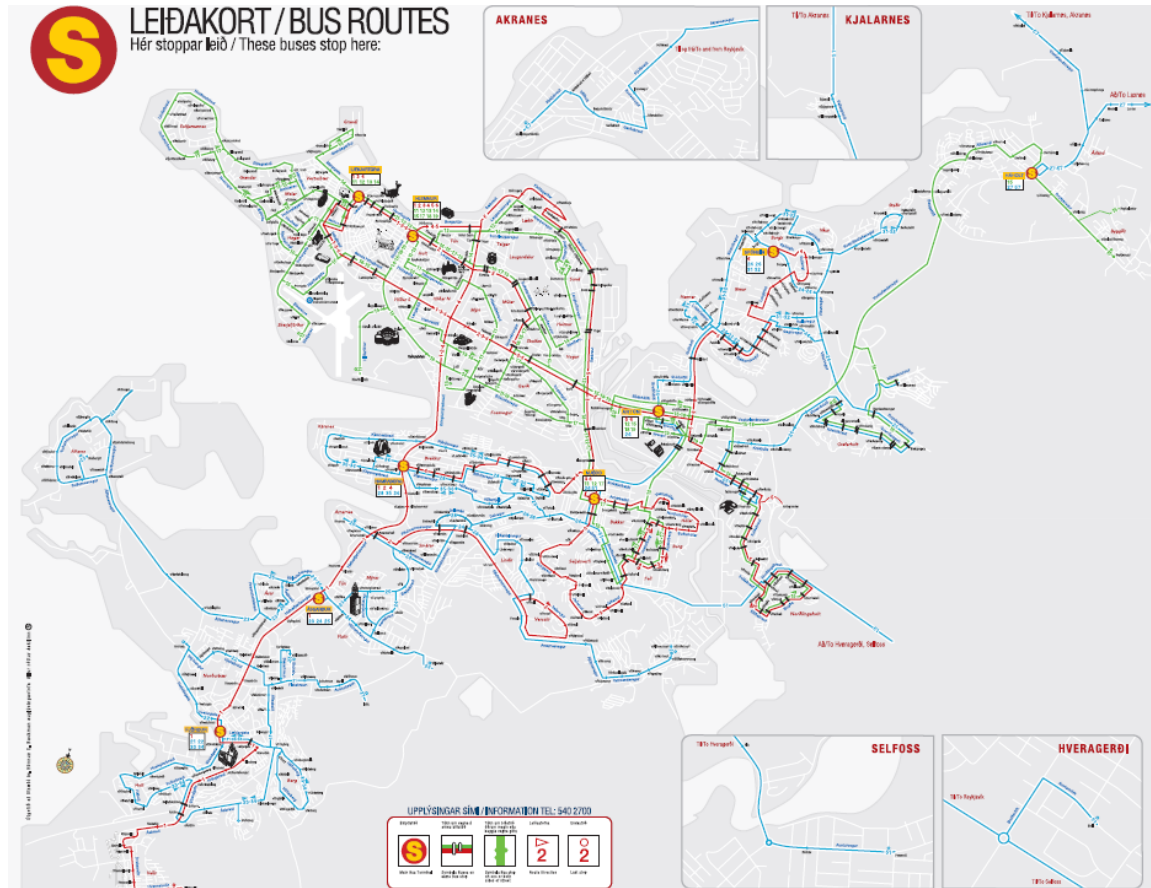
Person C does not use a car during weekdays but prefers access to car for regular visits to his summerhouse as well as for summervacation. In total he drives approximately 17 000 km per year of which 20 are visits to the summerhouse during weekends of 700 km each in addition to 4 week summervacation driving 3000 km.

<b>C</b>	<b>Carpool 1</b> <i>(City Car Club)</i>	<b>Carpool 2</b> <i>(Stockholms Bilpool)</i>	<b>Rental car 1</b> <i>(Avis)</i>	<b>Rental car 2</b> <i>(OKQ8)</i>	<b>Private car 1</b> <i>(Ford Focus '07)</i>	<b>Private car 2</b> <i>(Ford Focus '04)</i>
<b>Total montly price</b>	546,1	Not a bookable option	584,9	418,0	502,7	437,0
<b>Total price per 10 km</b>	3,9	-	4,1	3,0	3,5	3,1

Example 3 is an example where the carpool is among the least economic options. A rental car from OKQ8 is the best option closely followed by the used car.



Appendix B Route map for public transport in Reykjavík (Strætó)



- Red lines (no. 1-6)
- Green lines (no. 11-19)
- Blue lines (no. 21-36)


Red lines operate mostly on main streets, while green lines serve as feeder buses from quarters to the red lines and the blue lines operate mainly as routes within quarters and city districts.

## Appendix C An expert's estimation of the potential to implement the plan of measures

The plan of measures was sent to a number of politicians and experts within the field of traffic and they were asked to rate the potential for implementation of the measures. Following questions were asked for each measure and an answer on the scale 1-5 requested:


1 How realistic do you find the measure?

1- very unrealistic 2- unrealistic 3- not sure 4- realistic 5- very realistic




2 Would you support the implementation of the measure?

1- very unlikely 2- unlikely 3- not sure 4- likely 5- very likely



3 Do you find the measure likely to be successful?

1- very unlikely 2- unlikely 3- not sure 4- likely 5- very likely



Following is an estimation made by a transportation expert at the division of Environment and Transportation of Reykjavík City. (Umhverfis og samgöngusvið Reykjavíkurborgar).

### 3.2 Overall measures

a. Improve the uniformity of measures taken by the eight different municipalities in the Reykjavík metropolitan area by establishing tight cooperation and creating basis to establish a common regional plan for the area regarding traffic.

Q1 Unrealistic Q2 Likely Q3 Likely

b. Decide on a hierarchy for a balanced transportation system, i.e. an order in which transport modes should be prioritised.

Q1 Unrealistic Q2 Uncertain Q3 Uncertain

c. Thoroughly inform about all the measures mentioned below before they take place to gain acceptance among those they concern.

Q1 Uncertain Q2 Unlikely Q3 Unlikely

### 3.3 Parking policy measures

- a. Convert the present combination of type one and type two policies, according to OECD's definition, to a policy of type two only and expand the charged zones so that it covers the whole metropolitan area of Reykjavík, not only the city of Reykjavík. With time the policy should be converted to a type three policy, by introducing regulation for private parking, but only if good public transport services are ensured. 

Q1	Very unrealistic	Q2	Uncertain	Q3	Uncertain
----	------------------	----	-----------	----	-----------
- i. Expand the charged parking zones in Reykjavík and introduce parking fees at all public and municipal buildings in Reykjavík. 

Q1	Unrealistic	Q2	Likely	Q3	Likely
----	-------------	----	--------	----	--------
- b. Revise the Icelandic building and planning legislation
- i. by lowering the requirements for a minimum number of parking spaces and adding maximum norms to allow control of oversupply of parking spaces. 

Q1	Realistic	Q2	Very likely	Q3	Very likely
----	-----------	----	-------------	----	-------------
- ii. by creating room to allow private property owners to charge for parking facilities e.g. with parking meters. 

Q1	Realistic	Q2	Likely	Q3	Likely
----	-----------	----	--------	----	--------
- c. Raise present parking fees and fines radically according to what is known in our neighbouring Nordic Countries and ensure consistency between fines and fees. The price elasticity should be studied to help to decide the raise. 

Q1	Uncertain	Q2	Very likely	Q3	Very likely
----	-----------	----	-------------	----	-------------
- d. Eliminate search-traffic with strict regulations of on-street parking i.e. with limited amount, time-limits and pricing. 

Q1	Unrealistic	Q2	Likely	Q3	Likely
----	-------------	----	--------	----	--------
- e. Provide Park+Ride facilities in accordance with the future public transport network. [C] 

Q1	Unrealistic	Q2	Unlikely	Q3	Unlikely
----	-------------	----	----------	----	----------
- f. Perform a counting of the total number of parking spaces in Reykjavík.

### 3.4 Measures for Carpools

- a. Provide support and information for potential pioneers interested in starting a commercial or a private carpool. [E] 

Q1	Realistic	Q2	Likely	Q3	Uncertain
----	-----------	----	--------	----	-----------
- b. In case interest is limited among private actors to establish a carpool the eight municipalities in Reykjavík should establish a commercial carpool in the form of a municipal cooperative unit which could later be privatised. [C, E] 

Q1	Uncertain	Q2	Uncertain	Q3	Uncertain
----	-----------	----	-----------	----	-----------

## Transport Demand Management in Reykjavík

- c. The municipalities themselves should set a good example and
- i. rethink their vehicle fleet and its organisation. [E]  

Q1	Realistic	Q2	Likely	Q3	Likely
----	-----------	----	--------	----	--------
  - ii. consider whether a carpool is suitable for them. [E]  

Q1	Realistic	Q2	Likely	Q3	Likely
----	-----------	----	--------	----	--------
  - iii. in case a carpool is suitable, the possibility of offering employees to become members should be studied. [E]  

Q1	Realistic	Q2	Likely	Q3	Likely
----	-----------	----	--------	----	--------
  - iv. offer other modes of transport than cars for work related trips.  

Q1	Realistic	Q2	Likely	Q3	Likely
----	-----------	----	--------	----	--------
- d. Promote carpool membership to individuals and families [E]
- i. as a good option for families' extra car.  

Q1	Uncertain	Q2	Likely	Q3	Uncertain
----	-----------	----	--------	----	-----------
  - ii. by using the private economic savings as a campaign tool.  

Q1	Uncertain	Q2	Likely	Q3	Uncertain
----	-----------	----	--------	----	-----------
  - iii. by using knock-on-door-campaigns.  

Q1	Uncertain	Q2	Likely	Q3	Uncertain
----	-----------	----	--------	----	-----------
- e. Promote car-sharing
- i. by encouraging the development of a smart car-sharing databases, especially for commuters.  

Q1	Realistic	Q2	Likely	Q3	Uncertain
----	-----------	----	--------	----	-----------
- f. Establish a collaboration with building contractors to promote sustainable planning e.g. by planning with respect to carpools from the very beginning.  

Q1	Unrealistic	Q2	Likely	Q3	Uncertain
----	-------------	----	--------	----	-----------

### 3.5 Public transport measures

- a. Prioritise public transport systems as a vital service system similar to water supply and electricity.  

Q1	Uncertain	Q2	Uncertain	Q3	Uncertain
----	-----------	----	-----------	----	-----------
- b. Revise the public transport system of Reykjavík by
  - i. establishing a public transport policy like recommended by the EU, i.e. public/private partnership, and retain a coordinated network by keeping planning and provision of infrastructure with the local authorities, but subcontract the operation and management.  

Q1	Realistic	Q2	Likely	Q3	Likely
----	-----------	----	--------	----	--------

## Transport Demand Management in Reykjavík

- ii. aiming for a frequency of minimum 10-15 minutes and maximum 30 minutes. [C]
 

Q1	Realistic	Q2	Likely	Q3	Likely
----	-----------	----	--------	----	--------
    - iii. redesigning the route net so that maximum distance to bus stops is 400 meters in the zones provided with public transport (can be exceeded in sparsely populated residential areas). [C]
 

Q1	Uncertain	Q2	Likely	Q3	Likely
----	-----------	----	--------	----	--------
    - iv. providing zones outside the public transport service zones with P+R facilities. [C]
 

Q1	Uncertain	Q2	Likely	Q3	Likely
----	-----------	----	--------	----	--------
    - v. improving physical connections at bus-stops and transfer stations to minimise transfer times. [C]
 

Q1	Realistic	Q2	Likely	Q3	Uncertain
----	-----------	----	--------	----	-----------
    - vi. harmonising time tables to minimise transfer times.
 

Q1	Realistic	Q2	Likely	Q3	Likely
----	-----------	----	--------	----	--------
    - vii. providing all bus stops with weather boards [C]
 

Q1	Uncertain	Q2	Uncertain	Q3	Uncertain
----	-----------	----	-----------	----	-----------
- c. Public transport should not be offered free of charge, but differentiated fares should be considered. Investments should rather be made on the improvements mentioned in measure b.
 

Q1	Unrealistic	Q2	Uncertain	Q3	Unlikely
----	-------------	----	-----------	----	----------
- d. Renew the bus fleet used for public transport services and invest in vehicles run by more environmentally friendly fuel than conventional fossil fuels. [I10, C, E]
 

Q1	Realistic	Q2	Very likely	Q3	Very likely
----	-----------	----	-------------	----	-------------
- e. Allocate more space for bus-lanes and study the possibility of using bus lanes as a combined bus-lane and High-Occupancy-Vehicle lane (HOV) without sacrificing the accessibility of buses.
 

Q1	Realistic	Q2	Very likely	Q3	Very likely
----	-----------	----	-------------	----	-------------
- f. Affect the ‘force of habit’ to pick the private car with campaigns e.g.
  - i. by offering trial periods for new public transport users
 

Q1	Realistic	Q2	Realistic	Q3	Uncertain
----	-----------	----	-----------	----	-----------
  - ii. run campaigns and projects that focus on children and youth as target groups. [L]
 

Q1	Realistic	Q2	Very likely	Q3	Very likely
----	-----------	----	-------------	----	-------------
  - iii. by cooperating with private and public worksites and thereby reaching out to commuters.
 

Q1	Realistic	Q2	Very likely	Q3	Very likely
----	-----------	----	-------------	----	-------------

### 3.6 Measures for biking and walking

- a. Expand and categorise the walking and biking path network and maintain it like the road network. The main network should connect worksites, commercial centres, big schools, hospitals etc. and the local network should serve travellers travelling shorter distances within city districts. [C, I5]
- |    |                |    |             |    |             |
|----|----------------|----|-------------|----|-------------|
| Q1 | Very realistic | Q2 | Very likely | Q3 | Very likely |
|----|----------------|----|-------------|----|-------------|
- b. Improve the quality of the bike infrastructure by
- i. extending the network [C]
- |    |                |    |             |    |             |
|----|----------------|----|-------------|----|-------------|
| Q1 | Very realistic | Q2 | Very likely | Q3 | Very likely |
|----|----------------|----|-------------|----|-------------|
- ii. ensuring good connectivity within and between all municipalities in Reykjavík
- |    |           |    |             |    |             |
|----|-----------|----|-------------|----|-------------|
| Q1 | Uncertain | Q2 | Very likely | Q3 | Very likely |
|----|-----------|----|-------------|----|-------------|
- iii. prioritising bike traffic e.g. with elevated crossings and providing space among car traffic at suitable light controlled crossroads.
- |    |                |    |             |    |             |
|----|----------------|----|-------------|----|-------------|
| Q1 | Very realistic | Q2 | Very likely | Q3 | Very likely |
|----|----------------|----|-------------|----|-------------|
- iv. providing guide boards for bike traffic.
- |    |           |    |           |    |           |
|----|-----------|----|-----------|----|-----------|
| Q1 | Realistic | Q2 | Realistic | Q3 | Uncertain |
|----|-----------|----|-----------|----|-----------|
- v. adding requirements on bike parking in the Building and Planning legislation.
- |    |           |    |             |    |             |
|----|-----------|----|-------------|----|-------------|
| Q1 | Realistic | Q2 | Very likely | Q3 | Very likely |
|----|-----------|----|-------------|----|-------------|
- vi. separating pedestrians and bicyclists. [C, I5]
- |    |                |    |             |    |             |
|----|----------------|----|-------------|----|-------------|
| Q1 | Very realistic | Q2 | Very likely | Q3 | Very likely |
|----|----------------|----|-------------|----|-------------|
- vii. improving bike and walking paths to schools so that the infrastructure is not the obstacle forcing parents to drive their children to school.
- c. Run campaigns
- |    |           |    |             |    |             |
|----|-----------|----|-------------|----|-------------|
| Q1 | Realistic | Q2 | Very likely | Q3 | Very likely |
|----|-----------|----|-------------|----|-------------|
- i. directed towards school children and their parents to bike or walk to school.
- |    |                |    |             |    |             |
|----|----------------|----|-------------|----|-------------|
| Q1 | Very realistic | Q2 | Very likely | Q3 | Very likely |
|----|----------------|----|-------------|----|-------------|
- ii. for walk and bike paths being respected by surrounding property owners.
- |    |           |    |           |    |           |
|----|-----------|----|-----------|----|-----------|
| Q1 | Uncertain | Q2 | Uncertain | Q3 | Uncertain |
|----|-----------|----|-----------|----|-----------|
- iii. similar to ‘bike to work‘ and extend these successively with time.
- |    |           |    |             |    |             |
|----|-----------|----|-------------|----|-------------|
| Q1 | Realistic | Q2 | Very likely | Q3 | Very likely |
|----|-----------|----|-------------|----|-------------|
- iv. to promote the health benefits of walking and biking.
- |    |                |    |             |    |             |
|----|----------------|----|-------------|----|-------------|
| Q1 | Very realistic | Q2 | Very likely | Q3 | Very likely |
|----|----------------|----|-------------|----|-------------|
- v. on the ‘quarter hour bike map‘ and try to encourage similar initiatives.
- |    |                |    |             |    |             |
|----|----------------|----|-------------|----|-------------|
| Q1 | Very realistic | Q2 | Very likely | Q3 | Very likely |
|----|----------------|----|-------------|----|-------------|

## Transport Demand Management in Reykjavik

vi. to encourage public and private companies to facilitate walking and biking by offering shower facilities and changing rooms at worksites as well as rewarding those who walk or bike. 

Q1	Realistic	Q2	Likely	Q3	Likely
----	-----------	----	--------	----	--------

d. Create information material such as walking and bike path maps and distribute it widely. 

Q1	Realistic	Q2	Very likely	Q3	Very likely
----	-----------	----	-------------	----	-------------

e. Establish a cooperation with

i. potential organisations like The Icelandic Mountain bike club and the Icelandic Cyclists' Federation and take advantage of their ambition and interest. 

Q1	Very realistic	Q2	Very likely	Q3	Very likely
----	----------------	----	-------------	----	-------------

ii. with interested parties such as the board of public health, sports organisations and more to promote the health benefits of walking and biking. 

Q1	Very realistic	Q2	Very likely	Q3	Very likely
----	----------------	----	-------------	----	-------------

f. Provide city bikes where the borrower is personally responsible for borrowing the bike by law. 

Q1	Realistic	Q2	Very likely	Q3	Likely
----	-----------	----	-------------	----	--------

### 3.7 Informative and educational measures

a. Start incentives to accelerate the development of alternative fuels. [E]

Q1	Realistic	Q2	Very likely	Q3	Very likely
----	-----------	----	-------------	----	-------------

b. Run knock-on-door campaigns to promote alternative travel modes to the private car. 

Q1	Uncertain	Q2	Likely	Q3	Likely
----	-----------	----	--------	----	--------

c. Encourage private companies to establish a transportation policy and reward those who do have one. 

Q1	Very realistic	Q2	Very likely	Q3	Very likely
----	----------------	----	-------------	----	-------------

d. Revise the national curricula

i. for driving education in Iceland and make eco-driving an obligatory moment which should preferably take place together with the driving assessment required two years after people get their driver's license. 

Q1	Very realistic	Q2	Very likely	Q3	Very likely
----	----------------	----	-------------	----	-------------

ii. and clearly define the course 'Life Skills' for primary-, elementary schools and colleges. Education in sustainable development should be included in the course and course material provided. 

Q1	Uncertain	Q2	Uncertain	Q3	Uncertain
----	-----------	----	-----------	----	-----------

e. Run a campaign for

i. Eco-driving by promoting the economic benefits

Q1	Realistic	Q2	Unlikely	Q3	Likely
----	-----------	----	----------	----	--------

## Transport Demand Management in Reykjavík

- ii. Eco-Schools and encourage all schools to participate

Q1	Realistic	Q2	Unlikely	Q3	Likely
----	-----------	----	----------	----	--------

- iii. the course in bikeability and promote it to all primary and elementary schools.

Q1	Very realistic	Q2	Very likely	Q3	Likely
----	----------------	----	-------------	----	--------

- iv. the project Environmental Protection in Action

Q1	Realistic	Q2	Likely	Q3	Likely
----	-----------	----	--------	----	--------

- v. the project 'International Walk to School' and extend it.

Q1	Realistic	Q2	Very likely	Q3	Very likely
----	-----------	----	-------------	----	-------------

- vi. the Kid's ISO 14000 Programme

Q1	Uncertain	Q2	Uncertain	Q3	Uncertain
----	-----------	----	-----------	----	-----------

- f. Run projects that

- i. engage students e.g. by implementing competitions for the best idea for a campaign aimed at minimising traffic by private cars.

Q1	Uncertain	Q2	Very likely	Q3	Uncertain
----	-----------	----	-------------	----	-----------

- ii. involve parents of school children by e.g. designating parent's boards aimed at promoting sustainable travel habits.

Q1	Realistic	Q2	Very likely	Q3	Uncertain
----	-----------	----	-------------	----	-----------

- iii. in cooperation with educational institutes at all levels e.g. by engaging students in innovation and marketing competitions.

Q1	Realistic	Q2	Very likely	Q3	Uncertain
----	-----------	----	-------------	----	-----------

- g. Make scientific evidence of the health benefits of walking and biking widely known and available and try and create basis to evaluate the benefits of the health effects in economic terms.

Q1	Realistic	Q2	Very likely	Q3	Very likely
----	-----------	----	-------------	----	-------------

- h. Reward companies for good initiatives promoting sustainability which could e.g. give them a marketing advantage.

Q1	Uncertain	Q2	Very likely	Q3	Very likely
----	-----------	----	-------------	----	-------------



### 3.8 Economic measures

- a. Thoroughly examine, and implement if suitable, a Road Pricing System that considers diverse components such as distance travelled and time of travel instead of fuel consumption only. [L10, C]

Q1	Uncertain	Q2	Likely	Q3	Likely
----	-----------	----	--------	----	--------

- i. Give discounts for vehicles that meet requirements for being 'environmentally friendly'. [E]

Q1	Very realistic	Q2	Very likely	Q3	Very likely
----	----------------	----	-------------	----	-------------

- ii. Search for solutions to the privacy invasion concerns of the most accurate techniques such as GPS-based systems.

Q1	Uncertain	Q2	Likely	Q3	Likely
----	-----------	----	--------	----	--------

- b. Study the possibility of differentiating taxation on a household's first and second car etc. (i.e. higher tax on the second car, possibly as a function of the nature of the household)

Q1	Uncertain	Q2	Very likely	Q3	Very likely
----	-----------	----	-------------	----	-------------

- c. Allow tax-exempts for public transport cards and bike subsidies provided by employers

Q1	Very realistic	Q2	Very likely	Q3	Likely
----	----------------	----	-------------	----	--------

- i. Require an implementation of a 'green-travel plan' from the employee instead.

Q1	Very realistic	Q2	Very likely	Q3	Very likely
----	----------------	----	-------------	----	-------------

- ii. Public transport cards provided by employers should be personal.

Q1	Very realistic	Q2	Very likely	Q3	Uncertain
----	----------------	----	-------------	----	-----------

- d. Look upon provision of free parking at worksites as perquisites and tax it as such. The company should be charged for the number of parking spaces supplied and encouraged to charge its employees for the use.

Q1	Uncertain	Q2	Very likely	Q3	Very likely
----	-----------	----	-------------	----	-------------

- e. Introduce a kilometre-based travel tax deduction independent of travel mode. (Measure is dependent on improvements of the public transport services) [I5]

Q1	Uncertain	Q2	Very likely	Q3	Very likely
----	-----------	----	-------------	----	-------------

- f. Minimise the share of jeeps and fuel demanding vehicles by increasing the tax and tariffs on these vehicles [E]

Q1	Very realistic	Q2	Very likely	Q3	Very likely
----	----------------	----	-------------	----	-------------

## Transport Demand Management in Reykjavik

- g. Enable and inform about Pay-As-You-Drive insurance pricing systems for vehicles. Authorities should consider whether it is in their interest to subvention certain specific pricing systems such as GPS-based pricing.

Q1	Uncertain	Q2	Likely	Q3	Likely
----	-----------	----	--------	----	--------

- h. Subsidise

- i. development of alternative 'green fuel' [E]

Q1	Realistic	Q2	Very likely	Q3	Very likely
----	-----------	----	-------------	----	-------------

- ii. public transport services with governmental subsidies (together with the municipal)

Q1	Uncertain	Q2	Very likely	Q3	Very likely
----	-----------	----	-------------	----	-------------

- i. Abolish

- i. excise tax and tariffs for bikes

Q1	Realistic	Q2	Very likely	Q3	Uncertain
----	-----------	----	-------------	----	-----------

- ii. perquisite payments towards car expenses. To gain acceptance, perquisites that do not contradict sustainability could be offered instead.

Q1	Uncertain	Q2	Very likely	Q3	Likely
----	-----------	----	-------------	----	--------

- j. Focus on accentuating the benefits gained for the fee paid by the user in all the economic measures.

Q1	Realistic	Q2	Very likely	Q3	Very likely
----	-----------	----	-------------	----	-------------

### 3.9 Involvement of the private sector

- a. Provide guiding information material for private companies interested in offering teleworking.

Q1	Uncertain	Q2	Very likely	Q3	Uncertain
----	-----------	----	-------------	----	-----------

- b. Reward companies that have achieved environmental certificates by promoting these.

Q1	Very realistic	Q2	Very likely	Q3	Likely
----	----------------	----	-------------	----	--------

- c. Encourage companies to

- i. facilitate walking and biking by offering shower facilities at work. (same as measure 3.6 c-vi)

Q1	Very realistic	Q2	Very likely	Q3	Uncertain
----	----------------	----	-------------	----	-----------

- ii. implement travel policies for their employees.

Q1	Very realistic	Q2	Very likely	Q3	Likely
----	----------------	----	-------------	----	--------

- iii. implement environmental management systems

Q1	Very realistic	Q2	Very likely	Q3	Likely
----	----------------	----	-------------	----	--------

## Transport Demand Management in Reykjavík

iv. implement parking fees (dependent on measures 3.3 b-ii & 3.8 d)

Q1	Very realistic	Q2	Very likely	Q3	Very likely
----	----------------	----	-------------	----	-------------

v. subsidise bike investments (related to measure 3.8 c)

Q1	Very realistic	Q2	Very likely	Q3	Very likely
----	----------------	----	-------------	----	-------------

vi. subsidise public transport for employees (related to measure 3.8 c)

Q1	Very realistic	Q2	Very likely	Q3	Uncertain
----	----------------	----	-------------	----	-----------

d. Run campaigns on

i. Environmental certificate

Q1	Very realistic	Q2	Very likely	Q3	Uncertain
----	----------------	----	-------------	----	-----------

ii. benefits of carpools for companies

Q1	Very realistic	Q2	Very likely	Q3	Uncertain
----	----------------	----	-------------	----	-----------

iii. travel policies for private companies and provide support to create these

Q1	Very realistic	Q2	Very likely	Q3	Likely
----	----------------	----	-------------	----	--------

iv. telecommunication that can replace physical travels.

Q1	Very realistic	Q2	Very likely	Q3	Uncertain
----	----------------	----	-------------	----	-----------

v. eco-driving for companies.

Q1	Very realistic	Q2	Very likely	Q3	Uncertain
----	----------------	----	-------------	----	-----------

vi. the benefits of contributing to sustainability by adopting more sustainable modes of transport (possible economic savings, health benefits and more).

Q1	Very realistic	Q2	Very likely	Q3	Uncertain
----	----------------	----	-------------	----	-----------