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EMRECU

EFFECTS OF REALISED TRAFFIC MEASURES ON THE REDUCTION OF ENERGY CONSUMPTION IN URBAN TRANSPORT

Auswirkungen realisierter Verkehrsmaßnahmen auf die Reduktion des Energieverbrauchs im städtischen Verkehr

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and support of the

City of St. Veit an der Glan

English Project Summary

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An Example:

The city centre of Eisenstadt before / after pedestrianisation:
calculated minimum reduction of daily transport energy 18 GJ, i.e. 4.4 %

Background

With the aim to reduce energy consumption and carbon dioxide emission of traffic, some cities have started to realise integrated planning and organisational measures according to the principle of sustainable mobility. The effects of these measures are studied in depth within the SAVE project EMRECU in order to identify those measures of traffic organisation, transport and city planning which have the potential to reduce transport energy consumption effectively and lastingly. Effects of measures are specified not only qualitatively but also in their quantitative scale.

The quantification of energy related effects of measures requires a sound data base covering mobility as well as details of measure realisation allowing a proper before and after analysis. World-wide there are only very few cases where appropriate data are available. For Project EMRECU such data are made available and gathered respectively for the cities of Vienna (Austria) and Helsinki (Finland) - the capitals of two EC-member countries - as well as for the cities of Saarbrücken (Germany), Schlanders (Italy), Eisenstadt and St.Veit (Austria). The mobility data mainly comes from mobility interviews carried out using questionnaires in KONTIV design.

The study concentrates on the main modes of urban passenger transport, i.e. walking, cycling, public transport (PT) and private car. Modal split shift is seen as fundamental and strongest element of transport energy change.

Energy Consumption in Urban Transport

Energy consumed for travelling can be divided in internal energy, i.e. energy consumed inside the human body, and external energy, i.e. energy consumed outside the human body e.g. by mechanical means of transport.

As shown in earlier studies already the ratio of energy consumption of the different urban transport modes per travel time unit is roughly

walking : cycling : PT : car = 1 : 1 : 9-20 : 60-200 (and more)

These ratios pinpoint the potentials of energy savings very impressively. Relating energy consumption on travel time rather than travel distance is in harmony with the acknowledged principle of constant travel budget, which has been proved empirically.

Considering the differences in nature, scale and effects of internal and external energy the study deals solely with changes in external transport energy consumption. The knowledge about the role of internal energy on mobility pattern, however, forms the basis of understanding mobility behaviour. In this context a fundamental law of human perception (Law of Webner-Fechner) gains also particular importance.

External transport energy originates from different sources being related with different processes. Therefore all comparison has to been carried out on the level of primary energy, i.e. energy recovered directly from nature.

The Cities

The selection of cities has primarily been determined by the availability of comparable sets of before and after mobility data and extensive documentation of traffic measures. Special attention has also been paid to the fact that cities with different size and different functions are included (Table 1). So the studied cities, all of which showed a strong sense of ecological responsibility, can be examples for many other cities in and outside the Community.

City	**Function**	**Area [ha]**	Year of mobility survey	Inhabitants	Employees	Cars per inhabitant
Vienna	Capital City	41.495	1986	1.481.400	781.000	0,34
			1991	1.540.000	842.000	0,36
Vienna Inner Districts	Capital City	4.335	1986	439.000	276.000	0,33
	Inner Area		1991	458.000	296.000	0,34
Vienna Outer Districts	Capital City	18.977	1986	730.000	278.000	0,32
	Outer Area		1991	756.000	299.000	0,35
Vienna Suburban Districts	Capital City	17.882	1986	293.000	117.000	0,35
	Suburban Area		1991	308.000	135.000	0,40
Helsinki	Capital City	18.530	-	525.000	310.000	0,30
Eisenstadt	Province Capital	4.290	1988	10.100	11.100	0,48
			1995	10.500	11.700	0,57
St.Veit	District Capital	5.070	1988	12.000	6.100	0,32
			1992	12.200	6.100	0,39
Schlanders	Local Centre	1.140	1991	5.400	2.200	0,60
	in rural area		1997	5.600	2.200	0,61
Saarbrücken	Province Capital	16.700	-	190.900	101.500	0,51

Table 1: Details of the studied cities for which two sets of mobility data are available.

The Measures and their Effects

The study deals with measures in the direct field of all urban modes. It covers most of the measures frequently connected with potential energy savings. The effects on energy consumption are calculated indirectly through their effects on mode choice. To exclude the influence of improved (drive) technologies and local peculiarities standard values for the specific external primary energy consumption of car and PT are defined for the analysis of measure effects. Since there are always several measures and sometimes also combination of measures realised in the period between before and after mobility surveys, a clear assignment of changes in mobility pattern to specific measures is complicated due to effect overlap and overlay. This circumstance is counteracted by using a careful approach yielding minimum effects which are always on the safe side.

The final report in German language summarises the effects of the measures on city and on measure level. Following a summary on measure level is given. Yet the last section of the summarising tables 2 - 4 indicates the minimum reduction of daily transport energy caused by the specific measures in the individual cities.

Especially the **measures promoting the non-motorised modes** come up to the expectations of reducing daily transport energy consumption. Besides their merely traffic-related effect their influence on city structure has not to be disregarded. The non-motorised modes are closely connected with fine-meshed and dense city structures, which can be called sustainable not only because of their smaller transport energy consumption. They also favour local economy. The quality of the urban environment has great importance for the acceptance of these modes. Therefore design quality plays a significant role for specific measure effects per unit (e.g. per m² pedestrian precinct). Specific effects are also influenced by local parameters (e.g. topography) and the standard before measure realisation. These measures perform best in dense city areas and smaller cities.

Table 2 summarises the calculated minimum effects of the introduction and extension of pedestrian precincts, bicycle infrastructure, 30km / h speed limit areas and residential streets.

	Minimum Change of Primary Transport Energy Consumption on an Average Working Day																		
	Absolute [GJ]							Per Unit [MJ]						% of Daily Transport Energy					
Measure	V2	V3	V4	EI	SV	SL	Unit	V2	V3	V4	EI	SV	SL	V2	V3	V4	EI	SV	SL
Pedestrian Precinct				-18	-21	-13	m²				-3.4	-1.3	-2.3				-4.4	-6.5	-7.3
Bicycle Infrastructure	-70	-110	-90	-5	-18		m	-1.8	-0.9	-0.8	-1.3	-4.4		-0.6	-0.5	-0.9	-1.3	-5.3	
30 km / h Areas	-120	-310	-260		-21	-7	m	-3.4	-1.4	-1.0		-0.7	-1.5	-1.1	-1.3	-2,5		-6.4	-4.3
Residential Streets					-18		m					-2.5						-5.4	

Table 2: Effects of realised measures promoting the non-motorised modes (abbreviations see 1**).**

The energy saving effect of pedestrian precincts has been considerable in the smaller cities where they have been introduced between the mobility interviews. A reduction of car share in mode choice between 2 and 3 percentage points minimum could be worked out. The minimum effect estimate yielded reductions from 4,4 to 7,3% of daily transport energy consumption. Minimum specific effects came up to 3,4 Mega Joule per square metre precinct in Eisenstadt, where at least 18 Giga Joule primary energy could be saved through stimulated mode shifts in daily urban transport. A threshold size has been established.

The extension of bicycle infrastructure networks also showed significant energy savings. The greatest reduction of the share of the motorised trips (by car and PT) could be observed in St.Veit (3 percentage points minimum), where the measures has been realised most resolutely, resulting in a reduction of daily transport energy of 5,3% at least. Specific effects reach from 0,8 (suburban districts of Vienna) to 4,4 (St.Veit) MJ per metre bicycle infrastructure and day minimum.

Because of their traffic calming quality the introduction of 30km/h speed limit areas also promotes the non motorised modes, cycling in particular. Considering the documented reduction of specific fuel consumption due to smoother driving as well specific minimum energy savings from 0,7 (St.Veit) to 3,4 (inner districts of Vienna) MJ per meter 30 km/h speed limit area on an average working day could be calculated. While in the smaller cities savings resulting from mode choice shift dominated, in the big city the larger part of savings resulted from smoother driving.

The introduction of a residential street network in St.Veit was part of expansive traffic calming. Their estimated specific minimum effect (2,5 MJ per metre and day) exceeds that of 30 km/h speed limit areas clearly. The resulting total energy saving comes to 18 GJ on an average working day which equals a transport energy reduction of 5,4%.

While in the smaller cities measures promoting non motorised modes result in largest transport energy reductions, in the bigger cities **promotion of PT** is more effective. In Vienna the extension of the rapid PT network, underground in particular, has been given priority. The dense tram and bus network takes the decisive feeding function. Specific primary energy saving minimums from 0,1 (direct catchment area) to 0,06 (indirect catchment area) per additionally run train kilometre and day could be assigned to the measure (compare Table 3 which summarises the findings for the PT related measures), resulting in a reduction of daily transport energy in Vienna by 980 GJ minimum, i.e. by 2,1 percent. However, very likely similar energy savings could also be achieved by extension of overground PT networks based on bus and tram.

	Minimum Change of Primary Transport Energy Consumption on an Average Working Day															
	Absolute [GJ]						Per Unit [MJ]					% of Daily Transport Energy				
Measure	VI	V2	V3	EI	SV	Unit	VI	V2	V3	EI	SV	VI	V2	V3	EI	SV
Extended PT Supply	-980	-590	-420			addly. run train km	-.16	-0.1	-.06			-2.1	-5.2	-1.8		
				±0	-5	additional service					-288				±0	-1.6
Acceleration of PT	-500					m segregated track/lane	-12					-1.1				
				-16	-3	saved minute and train				-45	-15				-4.0	-1.0
PT (ticket) Integration				-1.4											-0.3	

Table 3: Effects of realised measures promoting Public Transport (abbreviations see 1**).**

The introduction of urban PT in smaller cities (even down to 10.000 inhabitants) proved to have no negative effect on daily energy consumption, even if almost exclusively non-motorised trips are replaced by the new mode. Yet the substitution of only very few car trips is needed that this - from a transport planning point of view recommendable - measure performs at least neutral in respect of energy consumption.

Increased PT supply on major regional routes resulted in estimated 288 MJ primary energy savings per additional service between St.Veit and Klagenfurt, the nearby capital of the Province of Carinthia.

The acceleration of PT by segregation from (congested) car traffic proved to be very efficient in reducing daily transport energy. A specific energy reduction of 12 MJ per metre segregated track/lane could be worked out. Still it has to be noted, that the required space has not to be gained at the expense of the non-motorised modes since in this case negative effects are likely to prevail.

Primary energy savings of 45 MJ per saved minute and train in Eisenstadt and 15 MJ in St.Veit could be assigned to the acceleration of the main regional train connections.

The energy saving effect of integrated ticketing in a large area in the very east of Austria including Vienna and Eisenstadt could be estimated with 1,4 GJ per day in Eisenstadt alone.

The analyses of **measures related directly to car traffic** brought varied results. The crucial role of parking supply in mode choice has been confirmed. Commuting traffic shows strongest affinity to unrestricted parking space. The supply of private off-street parking in the neighbourhood of the destination has to be considered for all measures. Accordingly, relevant Building Standards should be checked for their usefulness.

Short term parking space appeals only to trip purposes/activities with short length of stay, e.g. shopping. A common measure aiming at reducing energy consumption of (commuting) traffic is the conversion of unrestricted in short term parking space. Especially in smaller cities the number of unrestricted parking spaces (including private) remaining within walking distance has to be taken into account. If it is large enough, the hoped-for energy saving effect does not prove true. More likely the increased car usage for other purposes than commuting results in growing energy consumption. For these purposes the all-day capacity of parking supply is more important than the mere number of parking spaces. Therefore special attention has to be paid that shorter parking duration does not increase this capacity. This would inevitably result in increased transport energy consumption in these sectors of mobility. A reduction of the absolute number of short term parking supply, however, can decrease energy consumption considerably.

Increased energy consumption could be assigned to the introduction of a parking guidance system in Saarbrücken as well as to the improvement of the road connections to the nearby regional centres through the construction of main road bypasses in Eisenstadt and St.Veit.

	Minimum Change of Primary Transport Energy Consumption on an Average Working Day																		
	Absolute [GJ]							Per Unit [MJ]						% of Daily Transport Energy					
Measure	VI	HE	SA	EI	SV	SL	Unit	VI	HE	SA	EI	SV	SL	VI	HE	SA	EI	SV	SL
Unrestricted Parking		+24		-8	-7	+2	uPS		+26		-19	-39	+50				-1.9	-2.0	+1.1
Short Term Parking	-260	+470		-1.2	+15	+4	sPS				-13	+54	+54	-0.5			-0.3	+4.6	+2.1
Parking Guidance			+90																
Main Road Bypass				+15	+6												+3.7	+1.8	

Table 4: Effects of realised measures directly related to car traffic (abbreviations see 1).

Table 4 presents the results of the analysis of to the measures directly related to car traffic. The supply of unrestricted parking spaces, which is crucial for the mode choice of commuters, has been changed differently in the studied cities. Its increase in Schlanders resulted in an estimated increased energy consumption of 50 MJ minimum per unrestricted parking space and day, its reduction in Eisenstadt and St.Veit in specific energy savings of 19 MJ and 39 MJ. In Helsinki increased energy consumption due to extended off-street parking supply diminished the effect of reducing unrestricted on-street parking at least by 26 MJ per off-street parking space and day.

The increased number of short term parking spaces in St.Veit and Schlanders produced an energy consumption increase of about 54 MJ per space and day due to their effects on shopping traffic alone. Energy savings of 260 MJ per day could be assigned to the introduction of short term parking in most of the inner districts of Vienna, i.e. 0,5% of daily transport energy consumption, resulting mainly from mode shift in trips with longer parking duration. A similar measure in the city centre of Helsinki resulted in an increase of daily energy consumption for activities related with shorter parking duration, i.e. excluding working and education trips, of 470 GJ.

The analysis of **land use measures** confirmed that measures influencing urban structure have an immense effect on transport energy consumption. The currently still prevailing tendencies in city planning lead to increasing transport energy consumption, which can not only compensate but also exceed energy savings achieved by realised traffic measures. The study shows this clearly and identifies only Schlanders as exception of this development. This can be attributed to the strict land use laws of Southern Tyrol.

Land use measures are typical long-term measures. Thus their effects are always overlapped and overlaid by those of other realised measures. To separate the effects of structural changes and changes in the transport system a strategic model has been used for Vienna. So the compensating effects of successful efforts to reduce energy consumption through traffic measures and the increase of consumption resulting from land use changes could be proved in detail.

Conclusion

Project EMRECU succeeded in quantifying the effects on energy consumption of various traffic measures, also related to the non-motorised modes, which are frequently connected with potential savings. Presenting an analysis approach based on the key elements of the transport system, its users, it not only presents a collection of examples but also can be used as a guide for identifying energy saving potentials of different measures in different cities in and outside the Community.

[1] *Abbreviations*

[1] VI	Vienna
V1	Vienna centre
V2	Vienna inner districts
V3	Vienna outer districts
V4	Vienna suburban districts
HE	Helsinki
SA	Saarbrücken
EI	Eisenstadt
SV	St.Veit
SL	Schlanders
MJ	Mega Joule
GJ	Giga Joule
uPS	unrestricted parking space
sPS	short term Parking space