

## SPEED LIMIT ENFORCEMENT AS A TOOL FOR CLIMATE CHANGE MITIGATION

### OGRANIČENJE BRZINE VOZILA KAO MERA ZA UBLAŽAVANJE KLIMATSKIH PROMENA

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**Abstract:** Being one the major global energy consumers, transport sector increasingly contributes to climate change. To achieve emissions reductions, measures and policy instruments must address transport sector. As driven speeds on motorways are well above the optimum for fuel efficiency, one of the measures for abating carbon dioxide emissions from this sector is speed limit enforcement. Lower speed limits have an impact on CO<sub>2</sub> emissions, while increasing traffic safety. This policy also results in smoother traffic flow and could be incentive for modal shift away from car, as a result of longer journey time.

**Key words:** speed limit, climate change, CO<sub>2</sub> emissions.

**Apstrakt:** Saobraćajni sektor, kao jedan od glavnih potrošača energije, intezivno doprinosi klimatskim promenama. Da bi se postiglo smanjenje emisije gasova staklene baštne, zakonske mere moraju da obuhvate i ovaj sektor. Pošto brzine kojima se vozi daleko prevazilaze optimum energetske efikasnosti, jedna od mera za smanjenje emisije ugljen dioksida iz ovog sektora je sprovodenje smanjenja brzine. Pri manjim brzinama manja je emisija ugljen dioksida, dok je u isto vreme povećana bezbednost u saobraćaju. Ova mera takođe doprinosi boljem protoku saobraćaja, a može i da bude podsticaj za manje korišćenje automobila, kao rezultat dužeg trajanja putovanja.

**Ključne reči:** ograničenje brzina, klimatske promene, emisija ugljen dioksida (CO<sub>2</sub>).

## 1 INTRODUCTION

Transport is one of the major global energy consumers. Transport's share of total primary oil use is expected to rise from 47% in 2005 to 52% by 2030 [1]. Rising greenhouse-gas (GHG) concentrations in the atmosphere, resulting mainly from fossil-fuel consumption, are leading to climate change. Approximately 20% of all CO<sub>2</sub> emissions are coming from road traffic [2].

At the UNFCCC meeting in Bali in December 2007, all countries agreed on a 'Bali roadmap'

## 1 UVOD

Saobraćaj je jedan od glavnih globalnih potrošača energije. Udeo transporta u potrošnji primarne nafte očekuje se da poraste sa 47% u 2005. godini na 52% u 2030. godini [1]. Povećane koncentracije gasova staklene baštne (GHG) u atmosferi, koje su pretežno rezultat korišćenja fosilnih goriva, dovode do klimatskih promena. Otpriklike 20% celokupne emisije CO<sub>2</sub> potiče od drumskog transporta [2].

Na UNFCCC skupu na Baliju, u decembru 2007. godine, sve zemlje su se složile oko "Bali roadmap"

with the aim to achieve global GHG emission reduction and mitigate climate change. The transport sector will need to comply with CO<sub>2</sub> emission reduction strategies to stabilize CO<sub>2</sub> concentrations.

One of the policies to achieve emission reductions from transport is speed limit enforcement. Carbon dioxide emissions—a by-product of any engine that burns fossil fuels—depend on fuel economy and thus speed. At high speeds, where fuel economy is poor, vehicles emit more CO<sub>2</sub> [3]. The introduction of speed restrictions on the motorway bring about significant reductions in vehicle emissions since vehicle emissions are at their lowest at around 50 mph (80 km/h) rising on average between 30% and 35% between 70 mph and 80 mph [4].

Traveling at moderate, steady speeds, as a result of speed limit enforcement, may contribute to reducing idling time and idling for more than half a minute burns more gas than it takes to restart the engine [5]. Furthermore, low vehicle speeds enable cars and other users to safely share road space [6].

## 2 CARBON DIOXIDE ABATEMENT

According to the National Atmospheric Emissions Inventory [7] a medium sized diesel car will emit up to 14% more CO<sub>2</sub> per kilometre at 80 mph (129 km/h) compared to 70 mph. The Royal Commission on Environmental Pollution [8] found that enforcement of the 70 mph limit on dual and the 60 mph limit on single carriageway road would reduce CO<sub>2</sub> emissions from road vehicles by around 3% and a 55 mph limit would save a further 3%.

Figure 1 shows that petrol Euro II cars with engines between 1.4 litres and 2 litres emit 10% less CO<sub>2</sub> at 60 mph than they do at 70 mph, while diesel Euro II cars with engines under 2 litres emit about 16% less. At 80 mph, Euro II petrol cars with engines between 1.4 litres and 2 litres emit 14% more CO<sub>2</sub> per kilometre and cars with engines over 2 litres will emit 19% more CO<sub>2</sub> than at 70 mph [9].

sa ciljem da se postigne globalno smanjenje GHG i ublaže klimatske promene. Saobraćajni sektor će morati da učestvuje u strategiji smanjenja emisije CO<sub>2</sub> da bi se koncentracije ovog gasa u atmosferi stabilizovale.

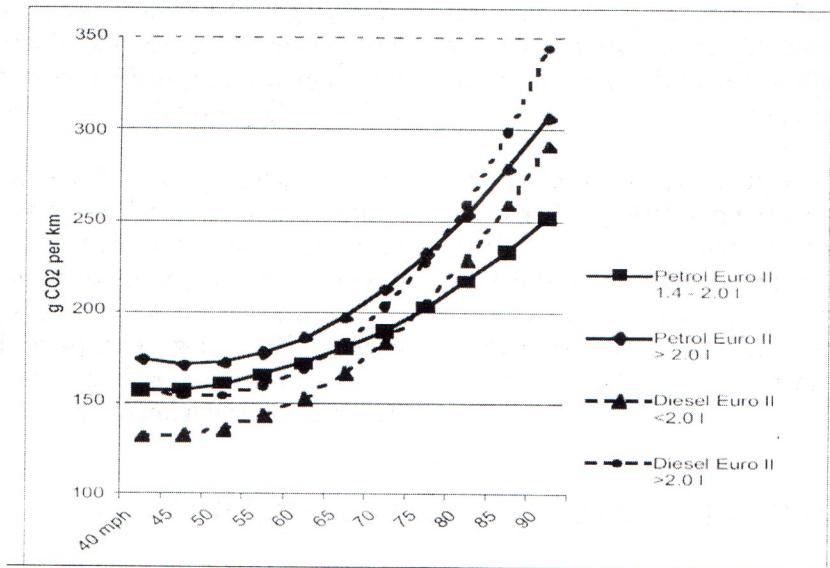
Jedna od mera za smanjenje emisije iz transporta je sprovođenje ograničenja brzine. Emisija ugljjen dioksida - nus produkt sagorevanja fosilnih goriva - zavisi od efikasnosti korišćenja goriva, a time i brzine. Pri velikim brzinama, gde je efikasnost korišćenja goriva slaba, vozilo emituje više CO<sub>2</sub> [3]. Uvođenje ograničenja brzine na autoputevima i magistralnim putevima rezultuje značajnim smanjenjem emisije iz vozila, pošto je emisija iz vozila najniža pri brzinama od oko 80 km/h, rastući u proseku za oko 30 - 35% pri brzinama između 113 i 129 km/h [4].

Vožnja pri manjim, ujednačenim brzinama, koja može biti rezultat ograničenja brzine, doprinosi smanjenju praznog hoda, a pri zastajanju na više od pola minuta, sagori se više goriva nego pri pokretanju vozila [5]. Pored toga, kada se vozila kreću manjom brzinom, omogućeno je bezbednije korišćenje puta i korisnicima vozila i ostalim učesnicima u saobraćaju [6].

## 2 SMANJENJE EMISIJE UGLJEN DIOKSIDA

Dizel automobil, srednje veličine, emituje do 14% više CO<sub>2</sub> po kilometru kada se kreće brzinom od 129 km/h u odnosu na brzinu od 113 km/h, procenjuje Nacionalni Inventar za Emisiju Gasova Velike Britanije [7]. Kraljevska komisija za zaštitu životne sredine, zaključuje da, ograničenje brzine od 113 km/h na putevima sa dve trake i 96,5 km/h na putevima sa jednom trakom, bi smanjilo emisiju CO<sub>2</sub> koja potiče od kopnenog saobraćaja, za oko 3%, dok bi primena ograničenja od 88,5 km/h sprečilo još dodatnih 3% emisije.

Na slici 1 vidi se da Euro II automobil sa benzinskim motorom zapremine između 1,4 i 2 litra, emituje 10% manje CO<sub>2</sub> kada se kreće brzinom od 96,5 km/h nego što emituje pri brzini od 113 km/h. S druge strane, automobil sa Euro II dizel motorom zapremine ispod 2 litra, emituje oko 16% manje. Pri brzini od 129 km/h, automobil sa Euro II benzinskim motorom zapremine između 1,4 i 2 litra emituje 14% više CO<sub>2</sub> po kilometru, a automobil sa motorom od preko 2 litra, emituje 19% više CO<sub>2</sub> nego pri brzini od 113 km/h [9].

Figure 1 Changes in CO<sub>2</sub> emissions with speed

(Source: NETECEN National Atmospheric Emissions Inventory in Anable et al., 2006)

slika 1 Promene emisije CO<sub>2</sub> sa promenom brzine

(Izvor: NETECEN National Atmospheric Emissions Inventory in Anable et al., 2006)

Table 1 presents savings of 4.87 MtC and 9.38 MtC, for 70 mph and 60 mph enforcement, in 5 years period, taking 2006 as a baseline. Given that business-as-usual projections for emissions for the total road traffic in the UK (all roads and all vehicle types) is projected to be 34.5 MtC in 2010, this policy could be responsible for a reduction of between 2.8% and 5.4% of carbon emissions from this sector [10].

U tabeli 1 se vidi da postoji ušteda od 4,87 MtC (megatona ugljenika) i 9,38 MtC ako se ograniči brzina na 113 km/h i 96,5 km/h, u periodu od 5 godina, uzimajući 2006. godinu kao osnovu. S obzirom da je procenjena očekivana emisija ukupnog transporta u UK (svi putevi i svi tipovi vozila) u 2010. godini 34,5 MtC, to znači da bi ovakve mere dovelle do smanjenja emisije ugljenika iz transportnog sektora za imedu 2,8 i 5,4 % [10].

Table 1 Carbon<sup>1</sup> savings from speed enforcement on motorways and dual carriageways in 2010 in the UKTabela 1: Ušteda emisije ugljenika<sup>2</sup> zbog sprovođenja ograničenja brzine na autoputu i magistralnom putu u UK u 2010. godini

	Per Annum carbon savings (MtC)					Total cumulative savings in 2010
	2006	2007	2008	2009	2010	
70 mph enforced (113 km/h)	0.94	0.96	0.98	1.00	1.00	4.87
60 mph enforced (96,5 km/h)	1.81	1.84	1.88	1.91	1.94	9.38

Evidence from France, reveals the reduction of CO<sub>2</sub> emissions by 19%, as a result of the strict speed enforcement on main motorways [11].

Primeri iz Francuske pokazuju smanjenje emisije CO<sub>2</sub> za 19%, kao rezultat striktnje primene ograničenja brzine na autoputevima [11].

<sup>1</sup> One ton of carbon equals 3.67 tons of carbon dioxide<sup>2</sup> Jedna tona ugljenika predstavlja 3,67 tona ugljen dioksida

A study by Umweltbundesamt (*CO<sub>2</sub>-minderung im Verkehr, 2003*) estimates CO<sub>2</sub> emissions reductions of 10 and 20 per cent, as a result of a 120 and 100 km/h speed limit respectively, on German motorways [12].

According to Anable et al. [9] reductions in CO<sub>2</sub> emissions could come immediately, after speed limit enforcement. Furthermore, longer travel times may lead to decrease in car use and thus, in the medium term, CO<sub>2</sub> savings from reduced speeds and more balanced speed distributions will be higher than in the direct short-term impacts.

### 3 IMPLEMENTATION PRACTICE

Camera-based speed enforcement is the most reliable method [13]. The four year evaluation report from the UK [14] found that SPECS time-over-distance cameras reduced vehicles exceeding the speed limit by 53%, and those exceeding it by more than 15 mph by 100%. There are also 'in car' adaptations that could be utilised such as intelligent speed adaptation, in car speed warning systems, redesigned speedometers that are easier to read, and in-car fuel management information.

The enforcement costs are to a large extent offset by reductions in accidents and casualties [15]. It is estimated that enforcing the speed limit of 70 mph on motorways in the UK would reduce the number of motorway deaths by around 60 a year, saving around £105m per annum [16]. Additionally, it would reduce serious injuries by around 270 a year, saving a further £58m. Finally, when the carbon pricing is taken into account, enforcement of speed limit, due to carbon savings, may be seen as a profit.

### 4 ANCILLARY IMPACT OF SPEED LIMIT ENFORCEMENT

#### Safety

Speed limit reduction brings safety benefits. It is estimated that enforcement of 70 mph limit in the UK would prevent over 300 deaths and serious injuries per annum, on motorways alone. A 60 mph limit would prevent over 600

Studija koju je sproveo Umweltbundesamt (*CO<sub>2</sub>-minderung im Verkehr, 2003*) ocenjuje da bi ograničenje brzine od 120, odnosno 100 km/h na autoputevima u Nemačkoj dovelo do smanjenja emisije ugljendioksida za 10, odnosno 20% [12].

Do smanjenja emisije došlo bi odmah nakon sporvođenja mera ograničenja brzine, prema Anable et al. [9]. Uz to, povećanje trajanja putovanja može da dovede do smanjene upotrebe automobila, tako da bi u nekom srednjem vremenskom periodu ušteda u emisiji CO<sub>2</sub> zbog smanjenja brzine i bolje izbalansiranog raspona brzine, bila veća nego pri direktnim kratkotrajnim meraima.

### 3 PRIMENA U PRAKSI

Sprovodenje ograničenja brzine uz primenu kamara za merenje brzine pokazalo se kao najpouzdaniji metod [13]. Evaluacija četvorogodišnje primene SPECS kamere (specifikacione kamere koje određuju minimalnu distancu "time-over-distance") u UK pokazuje smanjenje prekoračenja brzine za 53%, a prekoračenje veće od 24 km/h je smanjeno za 100%. Postoje i adaptacije za same automobile koje se mogu koristiti, to su inteligentni brzinski adapter, upozoravajući sistem u kolima, redizajnirani brzinometri koji su jednostavniji za upotrebu, i menadžer potrošnje goriva za kola.

Cena uvođenja ovih mera u velikoj meri je nadoknađena smanjenim brojem saobraćajnih nesreća [15]. Procenjuje se da bi sporvođenje ograničenja brzine od 113 km/h na putevima u UK, godišnje smanjilo broj poginulih u saobraćajnim nesrećama za 60 i uštedelo 105 miliona funti godišnje [16]. Pored toga, godišnje bi se smanjile ozbiljne povrede za oko 270 slučajeva, sa dodatnom uštedom od 58 miliona funti. Konačno, ako bi se uračunala cena ugljenika (carbon cost), sprovodenje ograničenja brzine, zbog smanjene emisije, može se računati kao profitabilno.

### 4 SPOREDNI UTICAJ SPROVOĐENJA OGRANIČENJA BRZINE

#### Bezbednost

Smanjenje brzine doprinosi većoj bezbednosti u saobraćaju. Sprovodenje ograničenja brzine od 70 mph (1mph≈1,61 km/h) u Ujedinjenom Kraljevstvu sprečilo bi 300 smrtnih slučajeva i težih povreda godišnje, samo na regionalnim i magistralnim

deaths and serious injuries [9]. By reducing the average speed of cars on motorways from 71 mph to 66 mph, through strict speed enforcement, it would still save around 60 lives and prevent 270 serious injuries a year [9] (Table 2).

*Table 2 Casualty reduction potential of enforcing the 70 mph and 60 mph limit on the motorways in the UK*

*Tabela 2 Mogućnost smanjenja nesrećnih slučajeva pri sporvođenju smanjenja brzine na putu sa 70 na 60 mph u UK*

	2003	If average speed 66 mph (70 mph enforcement)	If average speed 60 mph (60 mph enforcement)
Deaths	217	156	102
Deaths and serious injuries	1451	1120	802

Source: Road Casualties Great Britain 2004 in Anable et al., 2006

Izvor: Smrt na Putu u Velikoj Britaniji u 2004. godini (Road Casualties Great Britain 2004 in Anable et al., 2006)

The French Government strict speed limits enforcement, on main motorways, succeeded in reducing accidents by 30 per cent [11].

#### Environmental improvements

Besides CO<sub>2</sub> emissions reductions with speed limit, NO<sub>x</sub> emissions reductions occur as well, due to the fact that the NO<sub>x</sub> emission index increases with higher engine loads (= higher temperatures) [12]. Speed reduction in Rotterdam, from 100 to 80 km/h, gave a 25% reduction in NO<sub>x</sub> emissions from traffic [12]. The response of HC and particular matters emissions is also positive, as a result of the reduced spread in speed distribution. Furthermore, slower speed reduces the noise level.

#### Smoother journeys

The benefits of the controlled motorway include smoother and more reliable journeys and reduction in stress for drivers [11]. The 60 mph has a smoothing effect, reducing harsh driving styles and overtaking which can cause flow breakdown, crashes and disruption [10]. It has been found that intercity roads reach their maximum capacity at around 50 mph, and a more homogeneous traffic flow reduces congestion. Experience from Rotterdam showed that the speed reduction to 50 mph enabled the better capacity utilization [12]. The speed limit of 50 mph may, to greatest extent, modify aggregate traffic flow behaviour that could be exploited towards more efficient traffic flow [17].

putevima. Ograničenje od 60 mph sprecilo bi preko 600 smrtnih slučajeva i ozbiljnih povreda [9]. Smanjenje prosečne brzine automobila na putevima sa 115 km/h na 106 km/h, kroz primenu striktnog poštovanja ograničenja brzine, moglo bi da spasi 60 života i spriči 270 nesreća godišnje [9] (Tabela2).

Francuska Vlada je usled striktnog sprovođenja organičenja brzine na glavnim putevima uspela da smanji broj nesrećnih slučajeva za 30% [11].

#### Pozitivan uticaj na životnu sredinu

Pored smanjenja emisije CO<sub>2</sub>, sa smanjenjem brzine dolazi i do smanjenja emisije NOx (azotovih oksida), imajući u vidu da NOx emisioni indeks raste sa povećanjem opterećenjem motora (više temperature) [12]. U Roterdamu je smanjenje brzine sa 100 na 80 km/h, dovelo je do smanjenja emisije NOx iz saobraćaja za 25% [12]. Uticaj na ugljovodonike (HC) i čestice je takođe pozitivan, a rezultat je manjih raspona u brzini. Uz gore navedeno, manja brzina smanjuje i nivo buke.

#### Ujednačena brzina putovanja

Pozitivni uticaj striktnije kontrole na putevima uključuje i ujednačena i pouzdana putovanja i manji stres za vozače [11]. Ograničenje brzine na 96,5 km/h utiče na bolju prohodnost puteva, tako što spričava oštru vožnju i preticanje, koji mogu da dovedu do narušavanja toka saobraćaja, sudara i dezorganizacije [10]. Poznato je da međugradski putevi dostižu svoj maksimum kapaciteta pri brzinama od oko 80 km/h, a pri homogenijem protoku saobraćaja smanjuje se saobraćajna gužva. Primer iz Roterdama, pokazao je da smanjenje brzine na 80 km/h omogućava bolje iskorišćenje kapaciteta [12]. Brzina ograničena na 80 km/h u najvećoj meri može da utiče na zbijeni protok vozila, i doprinese uspostavljanju efikasnijeg toka saobraćaja [17].

### Economic effect on car drivers

Speed limit decrease would bring direct benefits in fuel savings and operating costs to motorists. The assessment of the potential of a 55 mph motorway speed limit to reduce fuel demand, estimates that this measure would achieve a 3.3% reduction in transport fuel use in European countries [18].

A possible rebound effect of highway speed limit enforcement is an increase of travel-km due to lower fuel cost [15]. On the other hand, it increases the cost of a journey, through time penalties and the discouragement of longer journeys [9].

### Increase in journey time and modal shift

Reducing average speeds may result in longer traveling time and encourage drivers to make fewer journeys, choose closer destinations or encourage modal shift toward rail, cycling and walking. Thus, speed limit enforcement has a potential to reduce present levels of traffic and slow the rate of traffic growth.

### Effect on car market

Speed limit decrease enforcement may have a negative effect on the car market as top-performance vehicles become less attractive [11]. The interest in high-speed tires, which add to fuel consumption, may decline as well [15]. On the other hand it can incentivise the market for lighter and less powerful cars.

## **5 CONCLUSION**

Driven speeds on motorways are well above the optimum for fuel efficiency. Carbon dioxide emissions, coming from transport, contribute to climate change. Besides having an impact on CO<sub>2</sub> emissions, speed limit enforcement leads to increase in traffic safety. Lower speed limits could be introduced almost immediately, and require no technological innovation. It is simultaneously a demand management measure by having an effect on traffic flow and journey time. Finally, speed limit reduction has certain outcome, as there is a physical relationship between speed on the one side and energy consumption and emissions on the other side.

### Ekonomski uticaj na vozače

Smanjenje brzine obezbeđuje direktnu dobit za vozače kroz uštedu u potrošnji goriva i troškovima održavanja vozila. Pri potencijalnom ograničenju brzine od 88,5 km/h na putevima, procenjuje se mogućnost uštede goriva od 3,3 % od ukupne potrošnje goriva u saobraćaju u evropskim zemljama [18].

Manja potrošnja goriva, usled smanjenja brzine na autoputu, mogla bi kao bumerang efekat da podstakne da se više putuje [15]. S druge strane, ova mera na neki način i povećava cenu putovanja, kroz negativan uticaj na dužinu putovanja, čime duža putovanja čini manje privlačnim [9].

### Porast u dužini trajanja putovanja i preraspodela korišćenja prevoznih sredstava

Samnjenje prosečne brzine kojima se vozila kreću može da dovede do povećanja dužine trajanja putovanja i da podstakne vozače da manje putuju, izaberu bliže destinacije ili se opredеле za voz, bicikl ili šetnju. Na ovaj način sprovođenje smanjenja brzine može da smanji trenutni nivo saobraćaja i ublaži porast u saobraćaju.

### Uticaj na tržište automobila

Mera smanjenja brzine u saobraćaju može da ima negativan efekat na tržište automobila tako što vozila vrhunske performanse čini manje atraktivnim [11]. Moguć je i pad interesovanja za gume za velike brzine, koje dovode do veće potrošnje goriva [15]. S druge strane, ova mera može da ima pozitivan uticaj na tržište manjih automobila i vozila manje snage.

## **5 ZAKLJUČAK**

Brzine kojima se vozi na putevima su značajno iznad optimuma za efikasno korišćenje goriva. Emisija ugljen dioksida koja potiče iz saobraćaja, doprinosi klimatskim promenama. Pored toga što dovodi do smanjenja emisije CO<sub>2</sub>, smanjenje brzine doprinosi i povećanju bezbednosti u saobraćaju. Ograničenje brzine moglo bi praktično momentalno da se sporvede i ne zahteva razvoj novih tehnologija. To je istovremeno i mera kontrole u saobraćaju, jer utiče na protok saobraćaja i vreme putovanja. I na kraju, ova mera daje sigurne rezultate, jer postoji fizička veza između brzine, na jednoj strani, i potrošnje energije i emisije, na drugoj strani.

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