Environmental Zones

Towards Better Air-Quality in Inner Cities

Examples: Berlin & Milan

Vehicle Travel Restrictions…

- reduced particulate matter pollution in Berlin by 58% in 2012 compared to the baseline scenario
- reduced traffic volume by 21% in the first year of Ecopass in Milan

Various regulations restrict ownership and utilization of private vehicles. Numerous, especially Asian, cities use auctions to limit car ownership and number plate restrictions to reduce traffic volume. Car free days, car free roads or peak-hour driving restrictions are further alternatives to mitigate congestion and environmental consequences of urban transport. A new and successful trend is the combination of congestion charging and environmental restrictions. Many cities in Europe restrict the usage of cars in accordance with the current atmospheric pollution situation. **Environmental or low emission zones** that restrict the entry of a vehicle into the restricted area if the vehicle does not meet certain environmental criteria are gaining popularity, especially in Europe.

Transport Demand Management in Beijing – Emission Reduction in Urban Transport

The objective of this Project is to propose effective measures for TDM and evaluate their impact on the climate change according to internationally recognized methodologies. On behalf of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) and the Beijing Municipal Commission for Transportation (BMCT), GIZ and the Beijing Transport Research Center (BTRC) implement the project. For further information, please check: www.tdm-beijing.org or contact: tdm@giz.de

This fact sheet provides information on common vehicle restriction approaches while focussing on environmental and low emission zones.

Vehicle number plate restrictions

Vehicles are restricted to drive in an area based on the registration plate. The aim is to reduce private vehicles in use. The restriction can be limited to certain vehicle types, to days or areas. Number plate restrictions are often undermined by an increase in car ownership. Counter measures to avoid ownership of a second car is to limit the restriction to peak hours and to ban vehicles with several different, rotating numbers on the number plate from driving. Taxis are usually excluded from the restrictions and are therefore used more. This reduces the environmental and congestion reduction impact of such a scheme. However, the advantage is that it is not very costly to implement and usually easy to enforce. The short-term effect on traffic reduction can be significant. Usually number plate restriction targets a reduction in congestion and only considers environmental aspects as a co-benefit.

Vehicle restrictions for designated areas that are based on whether a vehicle's emissions are over a set emission level are called low emission zones (LEZ) or environmental zones. It is a restriction scheme especially for highly polluting vehicles. However, the restriction differs among the LEZs. Some cities ban *heavy goods vehicles*, some restrict or charge according to the *emission standard* of every vehicle that wants to enter the zone. Although the approach is often national with a regional implementation (see case study Germany below), in some cases the restriction is limited to a local initiative e.g. a motorway LEZ. Low emission zones are becoming increasingly popular in

On behalf of

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Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

of the Federal Republic of Germany

European cities as they are considered an effective measure in achieving the pollution reduction targets of the European Union.

Vehicle quota in Singapore

Singapore has successfully used auctions to limit the total number of vehicles registered in the city. The resulting fees exceed the value of most cars, essentially doubling vehicle purchase costs. The Land Transport Authority (LTA) determines the quota for each vehicle category every year. To acquire a car everybody must go through a bidding process and, if successful, a Certificate of Entitlement is obtained. This programme is successful because Singapore has very high quality public transit and taxi services meaning few residents need a personal automobile. Some other Asian cities (including Delhi, India and Hanoi, Vietnam) are considering increasing vehicle purchase and registration fees, primarily as a way to generate funding for public transit improvements.

Travel Impacts and Emission Reduction

The major objective of LEZs is to improve the health of residents in the city by reducing fine dust PM10 and PM2.5 and nitrogen dioxide, NO2, emissions through banning the most polluting vehicles. However, environmental zones - if implemented solely - usually have no significant impact on the traffic volume but rather on the fleet composition. In cases where the ban is combined with a charge it may also target a reduction of vehicle traffic and consequently reduced GHG. In such cases the most polluting vehicles would have to pay more than the most energy efficient ones.

Travel impacts can vary significantly depending on the type of vehicle restrictions and where they are implemented. Singapore's vehicle restriction programme is considered successful because it is integrated with other TDM strategies, including high quality walking, cycling and public transit, and efficient road pricing. However, vehicle restrictions often have small overall impacts, or may fail if residents find ways to circumvent these policies. Also modest increases in vehicle registration fees are unlikely to cause much reduction in vehicle ownership or vehicle travel. Restrictions that prohibit motorists from driving one weekday may cause some commuters to take taxis, some trips to shift days (for example, shifting an appointment to another day), or cause some households to purchase additional vehicles so one is always available. Restrictions on non-residents driving in a particular neighbourhood may shift travel to other destinations but cause little reduction in total vehicle travel.

Restrictions on vehicle ownership and use can reduce vehicle travel (see Impact Chain Figure 1), although their long-term benefits may be relatively small if households respond by purchasing new or second vehicles or by deferring travel to other times. Costs include regulation enforcement, and costs to motorists from reduced vehicle travel. Other planning objectives like road safety are not an aim, however, LZE can help to improve the conditions for non-motorized transport and in this way support the effects of complimentary measures.

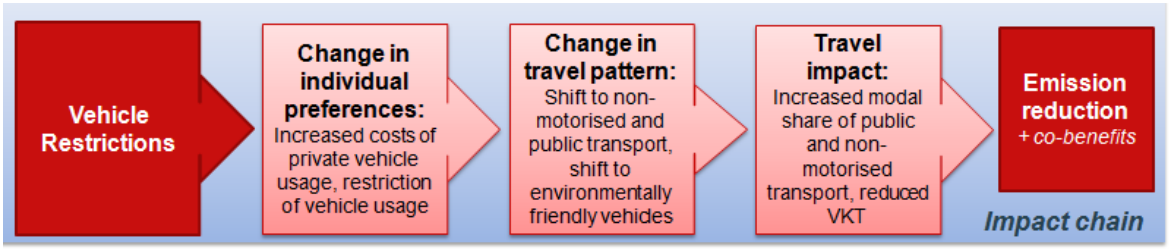

Figure 1. Impact Chain Vehicle Restrictions

The UK Department for Transport has sponsored a programme called "In Town Without My Car!" which supports car-free days in cities and towns. The DFT has produced a *In Town Without My Car! Good Practices Guide* which describes how to organize such events, and describes numerous successful case studies.

GHG Reduction Potential

To the degree that these restrictions reduce vehicle use, they can reduce emissions. Environmental zones can further lead to a low emission fleet as it encourages purchasing more efficient vehicles, if the restriction is based on emission standards, or an upgrade of diesel engines with a particulate filter. However, environmental zones have an impact on local pollutants but the impact on CO_2 emissions mainly depends on its design. If the environmental zone leads to a reduction in traffic (see Milan case study) the CO_2 emission reduce accordingly. If traffic is not reduced and only the fleet composition changes, the impact on CO_2 emissions is not significant.

Figure 2 shows all Environmental Zones in Germany. Red dots account for cities with the least restriction (yellow, red and green badges are allowed), yellow dots stand for cities that allow yellow and green badges and green dots for cities with the highest restriction (only green badges). Source: Baumer (2012)

Implementation requirements vary depending on the type of restriction. Environmental zones often require a national legal framework. It is essential that the national government defines the regulatory support i.e. the emission classes, signing, tax regulations and enforcement standards. However, based on the subsidiary approach local authorities should be responsible for its final design to be able to apply it to local circumstance (see Germany Case study). A difficulty in the implementation of environmental zones is the treatment of the government fleet, bus operators, emergency vehicles or other service vehicles. Often these vehicles do not fulfil the demanded criteria and are exempted from the zone which reduces its impact. Most of the light and heavy duty vehicles are equipped with a diesel engine that has a higher capacity in comparison to a private vehicle. At the same time diesel engine emissions can be up to 30 times higher and be reduced by 90% with a particulate filter. That is, including these vehicles in the environmental zones has a substantial impact.

Photo 1. Environmental Zone and direction signs near Stuttgart. Source: ehrenberg-bilder, Fotolia

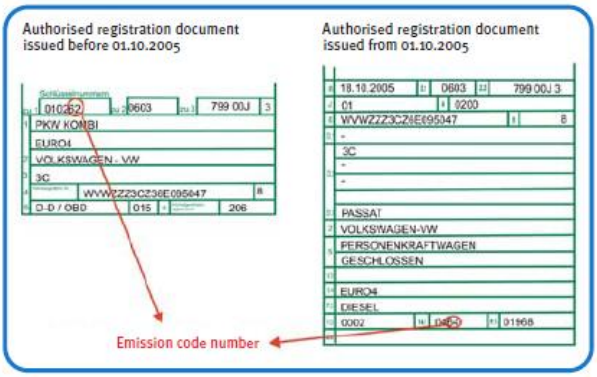

Figure 3. Vehicles that are registered in Germany receive a sticker based on a specific emission key number in the vehicle licence and on a potential certificate indicating that a diesel particulate filter was installed. Source: Berlin's Environmental Zone from 2008 – What Drivers need to know (2007), Berlin's Senate Department for Health, Environment and Consumer Protection

Case Study: Berlin Guiding the Way for Environmental Zones in Germany

Berlin

- 3.49 million citizens
- 0.32 **cars per citizen**
- Environmental **zone** 88km²

Photo 2. Berlin. Source: Robert Debowski, Flickr/Wikimedia (2005)

In Germany, so called Environmental Zones ("Umweltzone") are applied mostly by cities that exceed the pollutant emission threshold set by the European Union and are embedded in Air-Quality Plans. Currently around 50 environmental zones in Germany are in place. The legal and regulatory framework is defined by national law and regulations. Comprehensive strategies are, in line with the subsidiary principle, implemented on city or state government level in order to consider local conditions. All environmental zones in Germany are marked with the "Environmental Zone" sign (see Figure 4). Nationwide, every car wanting to enter the restricted zone, is categorised based on the European emission standards Euro 1-4. Parking or driving in the zone without meeting the emission standard leads to a penalty of up to EUR 40.

Figure 4. Environmental Zone Sign. The colours on the bottom indicate which cars are allowed in the zone.

The obligatory addition to the environmental zone sign informs the driver about the required badge to enter the zone. Table 1 gives an overview about the requirements for diesel and petrol vehicles for entering the environmental zone. The green badge for example is granted for all diesel engines that meet the Euro 4 or 3 (with particulate filter) emission standard or petrol vehicles with a catalytic converter.

Sticker	Requirement for diesel engine	Requirement for petrol engine
No Sticker	Euro 1 (or worse)	No catalytic converter
	**Euro 2** or Euro 1 with particulate filter	
	**Euro 3** or Euro 2 with particulate filter	
	**Euro 4** or Euro 3 with particulate filter	All petrol engines with catalytic converter and all LPG or natural gas vehicle.

Table 1. Three Emission Classes

In Berlin, the emission levels defined by regulations of the EU were widely exceeded. As a result, Berlin was required to develop a clean air action plan that defines measures to reduce emissions to meet the respective level. The plan's core instrument was a two stage implementation of an environmental zone. Almost one third of Berlin's residents live in the environmental zone and it is the most polluted area.

Stage 1 - All vehicles must at least meet the requirements of emission class 2 (red badge) of the national marking scheme. Vehicles with red, yellow or green stickers were allowed to enter the zone. Stage 1 is effective as of January 2008.

Stage 2 - Only vehicles within emission class 4 (green badge) or vehicles of emission class 3 that prove that the car cannot be upgraded with particulate filters are allowed in the environmental zone. Berlin is one of three cities in Germany that implemented stage 2. The development from stage 1 to stage 2 is only relevant for diesel engines as petrol vehicles either do not get a badge at all (without catalytic converter) or get a green badge (with catalytic converter). Stage 2 has been effective since January 2010.

Impact

In the first stage, particulate matters were reduced by 25% and Nitrogen oxides by 15% compared to the baseline scenario. In the second phase, particulate matter was reduced by 58% in relation to the baseline scenario (see Figure 5) and Nitrogen oxides by 20%. The emission reduction was achieved equally by the modernization of trucks and private vehicles. The fleet composition in the entire Berlin city area changed rapidly: Compared to baseline estimations, the percentage of trucks with green badges doubled and the percentage of diesel vehicles increased from 61% (projected percentage without environmental zone) to 87% (actual portion in 2011). The share of diesel engine vehicles with green badges increased by 38% from 2006 to 2011. The fleet composition adjustment was mostly due to installation of diesel particle filters. There are no significant differences in the composition of the fleet outside and inside the environmental zone.

Without the environmental zone Berlin would have exceeded the European PM_{10} emission standards for ten more days in a year. In 2010 the PM_{10} concentration was 7% smaller compared to the baseline scenario. The environmental zone had no measurable impact on the traffic volume neither inside nor outside the zone and hence no impact on CO_2 reduction. (Rauterberg-Wulff, 2011). This is especially due to the fact that it focuses on standards for pollutants (Euro) and not CO2 emissions or the fuel economy. There is also no link between the zone and pricing or specific times when entry is even more restricted.

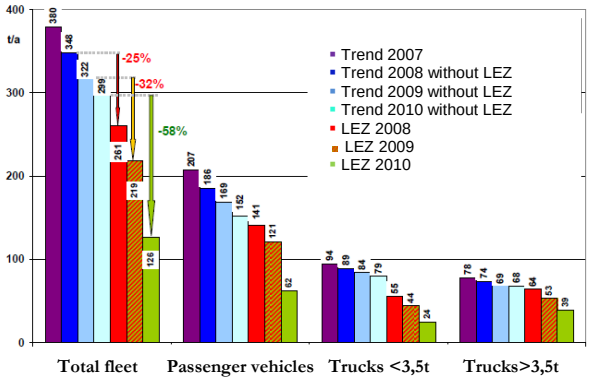

Figure 5. Reduction in particulate matter. Source: Senatsverwaltung für Gesundheit, Umwelt und Verbraucherschutz (2011), page 17

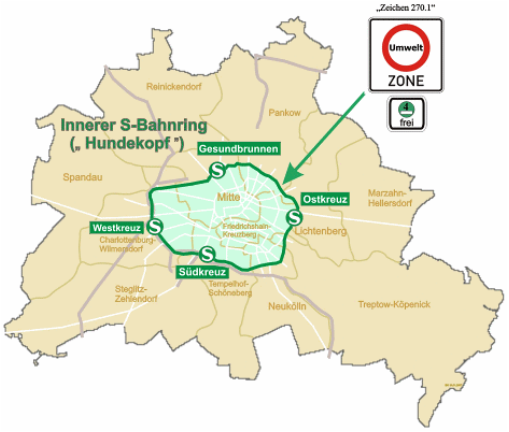

Figure 6. Low Emission Zone Berlin

Success Factors

The LEZ in Berlin is part of the Clean Air and Action Plan. Undoubtedly, the LEZ was the core measure of the action plan but it is accompanied by several of other measures:

(1) Improved parking management with a focus on peak-hour pricing
(2) Technical improvements of the bus fleet (diesel filter and LPG engines)
(3) Expansion of speed limits on high-concentration roads. (Although the effect of reduced speed is not significant, it may lead to a spread of traffic flow)
(4) Expansion of public and non-motorised transport
(5) Introduction of high environmental standards when purchasing municipal vehicles
(6) Other non-transport measures

Local efforts were supported by the federal government with a wrecking bonus. This was a subsidy that vehicle owners could obtain after an old car was demolished and a newer car registered. The objective was a "greener" fleet and to support the automobile industry. Further, tax cuts for vehicles with a diesel particulate filter and support to local governments in upgrading bus fleets were provided.

At the same time the validity of stickers all over Germany in any environmental zone ensure that drivers do not have to adhere to different standards in different German cities.

The actual implementation of the environmental zone is left in the hands of the local authorities. This ensures that the environmental zone and its restrictions are designed in a way that suits the local situation (geography, fleet composition, industry characteristics etc.).

Further Reading

More information can be obtained from the website www.berlin.de/umweltzone. The information is available both in German and English.
Further, general information on how Berlin is planning and monitoring its clean air initiative is published at www.berlin.de/sen/umwelt/luftqualitaet. Here you can find: Real-time information on the air quality, the Clean Air and Action Plan as a download, information on air quality over the last few years and the air pollution index of all main roads in the environment atlas.

Case Study: Milan Low Emission Zone and Charging

Milan

- 3.7 million citizens
- Centre of the Lombardy region with 9.5 million citizens
- 0.6 cars per citizen
- Ecopass area 8km²

Photo 3. Duomo di Milano. Source: Henry Bonn, Fotolia

Ecopass was a trial emission-based charging system in Milan, Italy. In contrast to the objectives of the "Efficient Road Pricing" schemes in Trondheim (financing of road network), Stockholm (reduction of congestion and financing of public transport) and London (mitigation of congestion), Ecopass' main objective was to reduce environmental impacts of urban transport through a targeted change in fleet composition. Hence, the charge differentiation was not based on travel time or congestion levels but on the vehicle emission standards. This approach was chosen mainly due to the fact that Milan was one of the cities with the highest particulate matter concentration in Europe.

Photo 4. Ecopass Area Sign. Source: Damien Meyer Institute for Transportation and Development Policy, 2009

In a referendum in 2011, 80% of Milan's residents voted in favour of extending Ecopass. The successful trial period was consequently upgraded in 2012 into a combination of a common congestion charging system in the form of cordon pricing together with an emission based system called Area C.

During the trial period from 2008 to 2012, the limited traffic zone was controlled by cameras that recorded the license plate numbers and automatically determined the pollution class of the vehicle as specified in its registration booklet. The area had 43 gates at which the cameras were placed. The costs of implementation were rather low as the camera system was already in place for traffic control measures. The fee was charged between 7.30 am and 7.30 pm during weekdays. The emission group of vehicles was similar to the German model above. However, the limitations for gasoline cars and the direct charging of vehicles constitute a major difference to the German environmental zones. Gasoline vehicles and lorries (Euro 3 and later), diesel cars and lorries (Euro 4 and later) and vehicles with alternative fuel engines were not charged. All other cars were charged up to US$12 for entering the zone. Additionally, in Milan there was 50% rebate for the first 50 entries per year and a 40% rebate for the subsequent 50 entries. Furthermore, residents within the scheme area were able to get discounts. For a comparison between Berlin and Milan in terms of restrictions according to emission standards see table 2.

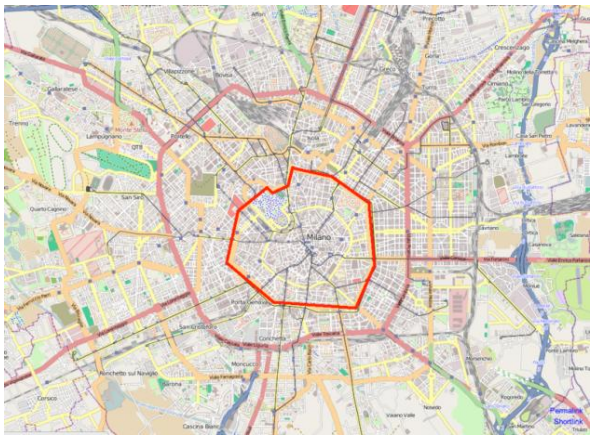

Figure 7. Ecopass traffic restricted zones. Source: Ita140188(2007)

In 2012, the new political leadership decided to extend the scheme to the so called "Area C", which is a congestion charging system in conjunction with environmental based charging. The area remained the same compared to the Ecopass scheme. The objective of the scheme is now to reduce congestion and to collect revenue to increase public transport supply. Every vehicle has to pay 5€ (residents 2€) when entering the restricted area. However, diesel vehicles with emission standards below Euro 3, and gasoline Euro 0, as well as vehicles longer than 7 metres, are not allowed

	Berlin		**Milan (Ecopass)**		**Milan (Area C)**	
Emission Standard	**Diesel**	**Petrol**	**Diesel**	**Petrol**	**Diesel**	**Petrol**
Euro 0	No entry	No entry	10€ (all vehicles)	5€ daily charge	No entry	No entry
Euro 1	No entry	Entry allowed (with catalytic converter)	5€ daily charge 10€ freight vehicles 10€ buses	2€ daily charge	No entry	5€
Euro 2	No entry	Entry allowed (with catalytic converter)	5€ daily charge 10€ freight vehicles 10€ buses	2€ daily charge	No entry	5€
Euro 3	Only with particulate filter	Entry allowed (with catalytic converter)	5€ daily charge (also freight vehicles) 10€ buses	Free	No entry	5€
Euro 4	Allowed to enter	Entry allowed (with catalytic converter)	Free with particulate filter (also freight vehicles) 5€ buses	Free	5€	5€
Euro 5	Allowed to enter	Entry allowed (with catalytic converter)	Free with particulate filter (also freight vehicles) 5€ buses	Free	5€	5€
LPG, Electric, Hybrid	Green badge		Free		Free	

Table 2. Comparison Entry Requirements Milan and Berlin. Source: Own

to enter the zone. Hybrid vehicles, bi-fuel natural gas vehicles, public utility vehicles are exempted from the charge. After having achieved a considerable change in fleet composition through Ecopass through Area C, both environmental and traffic reduction objectives can be achieved with the new scheme. The charge is collected between 7.30 am and 7.30 pm.

Impact

Since 2008, European regulations require that the daily average of PM_{10} should not exceed 50 $\mu g/m^3$ for more than 35 days a year. The City of Milan exceeded this threshold in 2005 with a total of 151 days. In 2010, two years after the charging system was implemented, the threshold was exceeded with a total of 86 days. In the first year, PM_{10} decreased by 19%, NO_x by 14%, and CO_2 by 15%. These results are quite similar to the ones of the congestion charge systems in London and Stockholm. However, the 8 km^2 restricted zone in Milan is much smaller than the one in London (22 km^2) and Stockholm (47 km^2). This large reduction in local pollution was mainly due to the fact that transport was the main polluting sector as Milan has one of the highest European car ownerships, ranked second just after Rome (Italy). In order to ensure that environmental zones are successful the contribution of the transport sector should be scientifically confirmed. Compared to Berlin, the scheme in Milan led to a significant reduction in traffic volume. In the first year, traffic volume decreased by 21%. In the first 6 months of 2010, the reduction compared to the baseline scenario was 12%. However, compared to the year 2009, traffic increased by 2% in the first 6 months of 2010. This was due to the rapid change in the composition of the fleet that allowed more cars to enter the restricted area. The number of vehicles entering the charged zone belonging to the classes that are charged (see table 2) was reduced by 70%. This was one of the reasons why the City moved to the more comprehensive Area C charging system.

The speed of public transport (bus) increased by 9.3 km/h on average. However, the effect is attributable to both the Ecopass scheme and the improvement in the bus network (e.g. reserved lanes).

Since Area C has only been in operation from January 16, 2012, an impact assessment is not yet meaningful. Nonetheless, although to be read with care, during the first week of implementation, traffic was reduced by 37% and there were reductions in black carbon (-30%), ammonia (-37%), carbon dioxide (-29%), oxides of nitrogen (-14%) and particulates (-24%). (Data source: Russo et al. (2011) and several reports by Genzia Milanese Mobilità Ambiente)

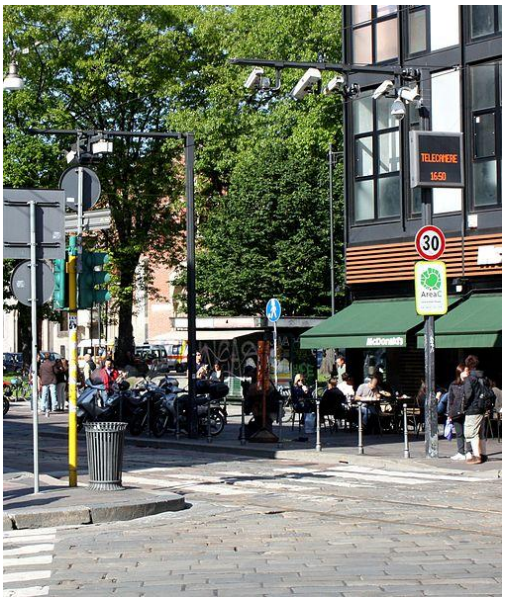

Photo 5 shows the monitoring cameras for Area C. With 8km^2 the environmental zone is much smaller than the ones in Berlin, Stockholm or London. Nevertheless, the success was outstanding. Source: Ita140188 (April 2012)

Success Factors

Milan exceeded the regulated emission limits set by the European Union several days a year. This required a more comprehensive strategy than the emission based charging. The policy package is part of the "Piano Generale del Traffico Urbano". The main objective of the plan is more efficient transport planning without major infrastructure investments. It includes short-term policies such as traffic calming measures, new bus lanes, increased bus frequency, increase in parking restriction and fees, and medium-term policies such as park-and-ride facilities. Together with the start of Area C in 2012, the City of Milan increased the number of bus trips by 166 per day with an increased capacity of 30.500 seats daily.

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