URBAN TOLLING IN NORWAY – PRACTICAL EXPERIENCES, SOCIAL AND ENVIRONMENTAL IMPACTS AND PLANS FOR FUTURE SYSTEMS

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Abstract

Norway has a long tradition of financing road infrastructure by toll and is a pioneering country on user based financing of urban transport infrastructure in major cities as well as practical solutions for large scale electronic toll collection projects. Our three major urban toll systems of Bergen (1986), Oslo (1990) and Trondheim (1991) have given us a lot of valuable experience to be shared with other countries. Today, seven Norwegian cities have toll systems in operation, and the development of more cost efficient and user friendly practical and technical concepts for toll collection in our cities continues.

The paper is focused on legal, organizational and political aspects in connection with the implementation of the Norwegian toll facilities, and explains how the Norwegian road authorities have succeeded in establishing a number of toll collection schemes which at the outset were unpopular with the public. It presents the state of the art of urban tolling in Norway including road pricing (congestion charging) and focuses on the social and environmental benefits from the toll ring in Oslo. Finally, the Norwegian technical specification for electronic fee collection (AutoPASS) is described, with its latest step towards full national interoperability and a new road tolling concept without cash payment named "fully automatic free flow toll stations".

1. HISTORY AND BACKGROUND OF ROAD TOLLING IN NORWAY

In Norway, we have more than 70 years of experience in using road toll payment as a financial instrument for building bridges, tunnels and roads. From 1930 to 1980, less than 5% of the total Norwegian road budget came from road toll revenues. During the last 20 years, however, road tolls have become an increasingly important way of financing road projects. In 2005 approximately 3,1 billion NOK (approximately 500 mill US dollar) or almost 35% of the total annual state road construction budget is expected to come from toll fees collected from road users. We now have more than 45 road toll projects throughout the country (see figure 1).

The background for all these road toll projects, the toll ring systems in our three major cities Oslo, Bergen and Trondheim included (1), is the need to obtain a faster realisation of important main road projects than would be possible if state funds alone were the financial source. Before 1980, typical Norwegian projects financed by road tolls were rural bridges replacing ferry connections. The bridge toll replaced the payment on the ferry. The population density in the surrounding districts was low, and so were the traffic volumes and the corresponding toll incomes. Road toll projects in more densely populated areas naturally yield higher incomes due to higher traffic volumes. Since the opening of the Bergen Toll Ring in January 1986, a major part of the increase in road toll revenues in Norway is therefore due to road toll projects in our cities (see figure 2).

Norway's fairly wild and rocky topography, means that road building is very expensive, and road budget priorities have always been a very important political question in our country. In the first four-year part of our ten-year road building programmes, every new road link of some importance is defined in detail. These programmes are discussed and sanctioned by the Norwegian Parliament. In the Parliament there was earlier a tendency to favour road projects in the districts when dealing with state road budgets. As a result of this it became more and more obvious during the eighties that some extra effort had to be made to bring the main road network in our major cities up to an acceptable level of safety, offering sufficient capacity and taking account of the environmental impact of the road traffic. So the situation was ripe for the political discussions and decisions to establish road toll schemes for our major cities.

2. GENERAL PRINCIPLES OF ROAD TOLLING IN NORWAY

Toll money collected is supposed to cover investment costs, not operation and maintenance of the road or public transport network. It is possible to some extent to differentiate charges, but it is not allowed to use the fee structure for traffic management purpose. The time limitation of a road toll project is normally 15 years, and shall not be more than 20 years. Normally, public funds are also allocated to projects, but no state guaranties are given.

In many European countries like France, Spain and Italy, most, or all, road toll systems are "closed" systems, where drivers pay according to the distance travelled. This principle demands a registration of vehicles when passing into the tolled road section and making the drivers pay in another toll plaza when leaving the tolled section. As opposed to this principle, all Norwegian road toll systems, including our urban toll rings, are "open" systems where drivers pay a fixed amount when passing the toll station, regardless of the distance travelled.

Traditional Norwegian open road toll systems, making people pay for using an expensive part of the road infrastructure like a bridge or a tunnel, were fair enough. When introducing the urban toll rings, we left the principle that only those benefiting from new road infrastructure should pay toll. When passing a toll ring to enter the central part of a city, there is, as mentioned, no differentiation of the payment concerning distance travelled, and there is no guarantee that the driver will benefit from driving on any new road at all on his trip.

The organisation of toll projects in Norway is different from the concessionary system used in various other countries. In Norway, the Norwegian Public Roads Administration is responsible for planning, building and operating the road projects financed by toll money and for planning and building the toll collection systems. For each toll project a dedicated toll company with limited responsibility is established by the local authority to operate the road toll system and to handle the money collected. Operating regulations are presented by the Ministry of Transport and Communications. When making drivers pay toll fees for the use of new roads, it is important to build on local initiatives and to have local operation of the system. In Oslo, the toll company, A/S Fjellinjen (2), is owned by the municipality of Oslo and the county of Akershus, which surrounds Oslo.

When the construction of a new road link takes place before the collection of toll fees starts, the toll company is the body which takes loans from banks etc to finance the part of the investments to be covered by the road tolls. This means that interest also has to be paid back in addition to the loans when money from the road tolls starts coming in.

3. IMPLEMENTING URBAN ROAD TOLL SYSTEMS IN BERGEN, OSLO AND TRONDHEIM

In general, road toll projects in Norway are based on local initiatives, local political agreement and approval by Parliament.

It is basically a rather unpopular thing to start collecting toll fees from people driving on roads where they have previously been driving without paying. It can therefore be a hazardous thing for a politician to put his name on an initiative designed to increase the speed of road building in a city by such means. It has been essential for the success of the toll ring schemes in Bergen, Oslo and Trondheim and indeed for the execution of the projects, that the two largest political parties in the city councils and in the Norwegian Parliament - the Labour and the Conservative parties - made it a common challenge.

3.1. The Bergen Toll Ring

In 1983 the Public Roads Administration proposed to implement a toll ring in Bergen, the second largest city in Norway, to be able to finance a new transport plan for the city. Due to clever marketing by one of the Public Roads Administration District Office leaders and an agreement between three of the major local political parties, the Bergen Town Council accepted the plan. It also played an important role in the local decision process that the government agreed to invest yearly as extra funding an amount equal to the one that would be collected from the toll ring users.

So, in January 1986, eleven years after the first urban toll ring successfully opened in Singapore, we opened the world's second toll ring in Bergen. It had 8 plazas and a vignette system for no stop payment for subscribers. Subscribers had to make a prepayment for an unlimited number of trips within a certain period (one month, six months or a year), and vehicles in the subscription lanes were video-pictured at random.

3.2. The Oslo Toll Ring

When introducing a similar but much larger toll ring in Oslo (1, 2) (see figure 3) we had the advantage of being able to refer to the Bergen project, and we built on experiences from that project. In Oslo as well the State is contributing to the infrastructure financing programme with extra funds (approximately 50%). In Oslo an important compromise to get the toll ring and road construction scheme accepted was to allocate 20% of the collected money for public transport infrastructure. The Oslo Toll Ring (19 toll plazas) was opened in February 1990. It is equipped with an automatic electronic fee collection system on a large scale.

3.3. The Trondheim Toll Ring

The Trondheim Toll Ring opened in October 1991 and had 12 toll stations from the beginning. It offers the same electronic payment system as the toll ring in Oslo. One important difference, however, is that only two of the toll stations in Trondheim are manned. The remaining ones offer self service payment by coin machines for those not being subscribers. Before opening the system in Trondheim, much effort was put into information campaigns to explain why collecting money through a toll ring was necessary to succeed in implementing the transport plan. Through this activity, feedback from future users of the toll ring resulted in

changes of the fee structure. The subscribers (more than 90% of passing volume) only pay once in one hour, there is an upper limit for total payment per month, they got the tag free of charge, they get 40-60% discount, and the payment may be drawn directly from their bank account. In Trondheim post payment is an option for drivers with direct debit agreement, and passing is free during weekends and after 6 pm (5 pm until 3 January 1998) on workdays for all users.

3.4. Reasons for why urban toll rings have been accepted in Norway

Foreign visitors in the first part of the nineties were studying the practical solutions and the technical systems of our urban toll rings (11). Several years later, more of them came back to learn how it was possible in Norway to get the necessary public and political acceptance of such a basically unpopular measure as an urban toll ring. To sum up, we have listed what we believe are some of the most important reasons for the Norwegian success of implementing urban toll rings in our three major cities:

1. The traffic conditions were basically inacceptable,
2. The major political parties agreed that something had to be done,
3. The collected money was allocated to new transport infrastructure,
4. The collection of toll was limited to approximately 15 years,
5. Extra state funds of approximately the same amount as the collected toll were granted to the road packages,
6. The fee levels were low,
7. Bergen was first,
8. Those opposed to the use of private cars in city centres appreciated that drivers had to pay,
9. 20% of the collected money was allocated for public transport,
10. User friendly fee systems, at least in Bergen and Trondheim ,
11. None of the toll stations are bottlenecks creating queues during rush ours.

4. STATE OF THE ART OF URBAN ROAD TOLLING AND CONGESTION CHARGING IN NORWAY

4.1. An overview

Till now, seven Norwegian cities have implemented urban toll rings of different size (see table 1). In the table the cities are listed chronologically. Bergen is listed twice as it started on its second period in April 2004. As in the city of Tønsberg, Bergen has been equipped with a new type of toll plazas with no lanes for stopping and cash payment. We call these plazas “Fully free flow toll stations”. The table shows that the Norwegian toll rings are quite different concerning size and principles of operation. Column number eight (“EFC %”) shows the percentage of drivers that are equipped with an electronic tag (Electronic Fee Collection) and drives in the non stop lanes for subscribers. The next column shows the approximate number of tags in operation, and the last column shows how much a driver without a tag has to pay in cash for passing with a light vehicle (allowed total weight not exceeding 3500 kg).

4.2. Road pricing (Congestion charging)

Most foreign visitors and many Norwegians as well, believe that one of the reasons for implementing the urban toll rings in Norway was to manage traffic demand to ease traffic congestion, but, as mentioned in my introduction, the reason for implementing the rings was for financing purposes only. The effect on the traffic volume has been relatively small, maybe less than a 5% decrease, mostly due to modest fee levels. Unfortunately, those driving in the peak hours are also those being less sensitive to road pricing.

The idea of using a price mechanism to reduce the peak hours demand for traffic capacity in our cities has, however, not been absent among Norwegian politicians and town planners. The Norwegian Ministry of Transport and Communication has been working on the idea of congestion charging for many years (10), and an amendment to the Norwegian Traffic Act forming the legal base for "Road Pricing" passed the Parliament in 2001.

According to this amendment, the main principles for road pricing in Norway are as follows:

1. Road pricing shall be cost-based charging for the use of roads. The more your trip cost the society (through delay by generating queues, through pollution and accidents), the more you have to pay.
2. The main task for a road pricing system is to regulate traffic,
3. Implementing a road pricing system shall be based on local initiative,
4. The revenues shall be earmarked local transport,
5. It is not allowed to use road pricing and toll financing in the same area,
6. A road pricing scheme has no time limitation.

When it comes to traffic managing by pricing, Norwegians are as negative as people in any other country, even if we are used to pay toll in urban toll rings. Remonstrances to road pricing are numerous in Norway as well as in other countries (3, 4, 5, 6, 7, 8, 9). Our experience is that there tends to be resistance to any change in existing tolling schemes. There will always be someone loosing when a system is changed, and they will protest strongly.

4.3. What does the future hold?

The possible future situation concerning tolling and road pricing in our three major cities is as follows:

As *Bergen* in January 1986 was the first Norwegian city to implement a toll ring, we were anxious to see what would be the situation when it was due to be removed in 2001. The city of Bergen decided to go for a new period of tolling without any pricing or traffic management part built into the system. The toll ring has been expanded from eight to nine toll stations, EFC following the Norwegian AutoPASS standard has been introduced, and the fee has been increased to NOK 15 for light vehicles, in order to be more equal to fees in other toll rings.

In the *Oslo* Toll Ring, an additional NOK 2 to every passing was introduced in 2001. This is known as Oslo Package 2 and is allocated to public transport only. Public transport passengers contribute to Oslo Package 2 as well, with NOK 0,75 added to every ticket. The Oslo Toll Ring is due to stop its toll collection in 2007. A working group has been planning what is going to happen in Oslo after 2007, if there may be another toll system or maybe a road pricing system. This project is called Oslo Package 3. There is a need for more funds in order to realise a very expensive tunnel project across Bjørvika Bay, and one possible outcome is a

prolongation of the life span of the existing system. A more radical alternative with several concentric toll rings, two way payment and time differentiated fee, has however been among the schemes being discussed (see figure 4).

The *Trondheim* Toll Ring opened in 1991 and was expanded from a 12 station toll ring to a 22 station and distributed toll collection system in 1998. In 2003 the toll scheme got an additional five toll plazas in order to increase the income and the number of trips being paid for. The toll system in Trondheim was also due to end its life in 2007, but a couple of years ago an important road project (The Northern Tangent) in the Trondheim Road Package lost its support in the Trondheim City Council, and as a consequence of this, the toll system in Trondheim may end its life earlier, maybe in 2005. Experts believe that there will not be sufficient political support for a new period of tolling or road pricing in Trondheim after 2005.

5. SOCIAL AND ENVIRONMENTAL IMPACTS OF URBAN TOLL SYSTEMS

To present Norwegian experiences in this context, I will focus on our largest urban toll system, the Oslo Toll Ring.

The payment of toll has in itself had only a minor impact on the traffic demand. After approximately 5% reduction in traffic the first months after opening of the payment system, the traffic situation went back to normal, and we have had a steady growth in traffic in Oslo as in our other cities. The important impacts of the toll system is connected to the new road infrastructure which it has been possible to realise in a much shorter time than if it should have been based on state funds only. The largest and most important of these projects are the tunnels on the main road network.

The most important impacts are as follows:

1. Reduction of queuing and delays due to enhanced road capacity and removal of severe bottlenecks and reduced travel times outside the peaks due to a better main road standard.
2. Use of earlier main roads to purposes of a more local character, maybe not allowed for road transport at all. This includes the removal of barrier effects to pedestrians and bicyclists.
3. Reduced noise level and reduced pollution.
4. Better traffic safety conditions on a main road network of a higher technical standard.

5.1. Removing bottlenecks

This reduces the loss of time to the transport business and drivers and passengers in general, and was the main reason for establishing the Oslo Package 1 Road Construction Programme.

In Oslo, little effort was made in order to improve driving conditions through the city in the two decades prior to implementing the toll ring. Public transport was the solution. With traffic signals and severe bottlenecks on every main road through Oslo, the situation was ripe for a new solution. The road authorities opened the largest tunnel in the “Oslo Package”, the Castle Tunnel, two weeks before opening the payment system. This turned the square in front of the city hall from being the worst traffic jam in Oslo to an open space for walking and relaxing, and it was possible to pass the very centre of Oslo by car almost without delay, where it was more than half an hour delay before.

There is, however, a tendency that traffic demand increases when traffic conditions get better, and the queue will move to the second worst bottleneck when the worst is removed. In the case of the Castle Tunnel, the bridge on the E18 at the city border took over as the major bottleneck for those coming from the west, and when this bottleneck a few years later was reduced by another tunnel linking the outer ring road to the western arterial outside the bottleneck on the city border, the major queues in the peaks were moved even further out of town. Nevertheless, each new removal of a bottleneck has been a step in the right direction even if the worst delays still are of the same size as before. Now, the local authorities and the business communities west of Oslo want to solve the capacity problems through their districts with another tunnel, but I am afraid that the worst bottleneck then again will be in the centre of Oslo where the spare capacity of the Castle Tunnel is limited. Where the queues are standing today, the conditions are good for buses and taxis passing in separate lanes for public transport. Such extra lanes will not be available to the same extent in the centre of Oslo where the land costs are higher.

5.2. The use of earlier main road surface

It is important to relieve local space from noisy traffic which takes up a lot of space. As a major example, the City Hall Square (see figure 5), where 80 000 vehicles a day used to pass in 8 lanes, is now a quiet pedestrian link between the centre of Oslo and the recreational, business, shopping and living areas of Aker Brygge, a former shipyard. At the City Hall Square, there is now plenty of space to arrange exhibitions, festivals, sports events and public celebrations when needed. Oslo did not have a large public space like that before, and to calculate the value of this is hardly possible.

5.3. Reduced noise level and reduced pollution

The benefit of noise reduction and reduced pollution in narrow surface streets is obvious. Exhaust from vehicles that drive through tunnels is removed from the local streets where these vehicles were driving and maybe queuing before the tunnels in question was built. The polluted air from the tunnels is cleaned before it is let out high above the pedestrians through high ventilation towers.

We must not, however, forget that car drivers in the tunnels experience increased noise and pollution. But, the drivers are creating the noise and pollution and will have a higher motivation for not getting disturbed.

5.4. Better traffic safety conditions on a main road network of a higher technical standard

In general, the traffic safety conditions are better on a new main road network of a higher technical standard and good separation between different categories of road users, than on an old main road network of poor standard, with for instance traffic signals, pedestrians crossings etc. Especially in tunnels, the risk for pedestrians or animals suddenly crossing the road in front of a car is very little, and the road surface will seldom be slippery due to heavy rain or snow. Sun dazzling and strong winds will not occur.

On the other hand, accidents resulting in fire and gas leakage etc. will create more dangerous conditions in a tunnel. Also, people suffering from for instance claustrophobia may have problems driving through tunnels.

In Oslo, all tunnels are under supervision 24 hours a day by camera systems linked to the control centre for the tunnels and the most important main roads in the Oslo region.

6. TECHNICAL DEVELOPMENT

The new and innovative era of cost efficient road toll collection in Norway started when we introduced the Bergen Toll Ring in January 1986. To make the toll plazas as small as possible, due to the limited and expensive space available, no stop tolling was introduced. As the no stop lanes for subscribers have a very high capacity, the necessary number of payment lanes was reduced by approximately 50%. These small size toll plazas we prefer to call toll stations.

6.1. Introducing Electronic Fee Collection (EFC)

Our next step was to introduce electronic fee collection, to make the enforcement more efficient, and to give the less frequent drivers the opportunity to use the non stop subscription lanes. In October 1987, a single toll station located between two 4 km long tunnels running under the fjord outside the city of Ålesund in the western part of Norway, was opened, offering the use EFC tags in separate subscription lanes. As far as we know, this was the worlds first toll plaza with a full scale electronic fee collection system, and the system is still in operation.

The Oslo Toll Ring was opened 1. February 1990 and was offering EFC from December of the same year. The subscribers in Oslo may still choose whether they will prepay for an unlimited number of trips within a time period, as in Bergen, or a certain number of trips according to the Norwegian standard of road toll fee systems. The options when choosing a number of trips are 25, 100, 175 or 350 trips. One might call this an electronic punch card.

Passing in the no stop lanes give the driver several advantages. He saves time, he does not have to care about having the proper amount of cash with him, he does not have to stop and open the window of the car to pay manually, he avoids extra delay due to queuing in the manual payment lanes, and he pays less. Therefore, in my opinion, less frequent drivers in the Oslo area have been and still are surprisingly slow in adapting to the use of the no stop lanes, as they still constitute almost 20% of the passing traffic volume. In comparison, more than 90% of the passing drivers in Trondheim and Stavanger are tag holders.

The functionality of a Norwegian no stop lane is as follows (see figure 6): The tag is attached behind the rear view mirror inside the windscreen of the vehicle. When the vehicle approaches the gantry with the tag reader, the antenna reads the unique number of the tag. Under the gantry there is a detector registering the vehicle and giving an immediate message to the video camera which takes several pictures of the vehicle's front licence plate. For night conditions there is a steady light source half way between the detector and the camera, illuminating the licence plate. As the vehicle passes through the payment lane, the station computer checks out whether the number of the tag corresponds to a valid subscription or not. As a result of this check the driver will receive a signal at the end of the payment lane. An

invalid passing gives a yellow signal (a horizontal bar), if he soon will have to do a new prepayment, he is warned with a white ”plus” symbol, and a valid passing may give a green plus symbol (not in use in Oslo). In general, we reckon that EFC lanes have a capacity of 1600 vehicles per hour. Attended lanes and lanes with coin machines may have a capacity in the range of 200 – 400 vehicles per hour depending on the fees, drivers, type of machines etc.

The registration of tag numbers as well as the photographing of licence plates is managed even at high speeds, drivers passing at 150 km/hour constitutes no problem. For safety reasons, however, the maximum speed limit through our toll stations is 60 km/hour, as we have no multilane EFC system without physical islands between the payment lanes implemented yet. The weakest point of the system is maybe the success rate of the video system due to dirt on the license plate in adverse weather conditions. The video pictures may also be of bad quality in difficult weather conditions such as falling snow or low sun etc. Even if the video system during difficult periods only identifies 70% of the violaters, however, this has not been a major problem, as the number of drivers passing without paying is limited.

6.2. Introducing unattended toll stations

When the Trondheim Toll Ring opened in October 1991, the innovation was brought one step further. To save operation costs in connection with manning all the stations in the ring, ten out of twelve stations were made completely unmanned (see figure 7). Those drivers not being subscribers had to pay to a self service low cost low capacity coin machine. These machines are of the same type that you may find at parking lots. All data communication between the station computers and the central computer system, passing transactions and video pictures from the enforcement system, was taken care of by an ISDN communication link. In 1991 the use of this link was also a pioneering effort.

Another pioneering step in Trondheim was the 1998 expansion of the system from 12 toll stations forming a toll ring cordon line to more than 20 toll stations in a more distributed “zonal” system.

6.3. AutoPASS – The Norwegian technical specification for EFC

In 1999, the Norwegian Public Roads Administration began developing a standard technical specification for electronic fee collection (EFC) named AutoPASS. AutoPASS is owned by the Norwegian state and was created in full compliance with the current European standards for dedicated short range communication (DSRC) on 5,8 Ghz radio wave frequency. During 2001 and 2002 almost 1 million AutoPASS tags were offered to drivers in Norway to replace the first generation electronic Q-Free tags operating in the 856 Mhz frequency band. These original tags, being in operation since the opening of the Oslo Toll Ring in 1990, had no battery and a very long lifetime, but they could no longer be used, as their working frequency was conflicting with the frequency allocated during the nineties for digital television in Europe. After this shift of system, all new toll stations in Norway have to be equipped with EFC systems following the AutoPASS standard.

6.4. AutoPASS contractual interoperability between toll companies

One important part of the AutoPASS project is the contractual interoperability between all different toll companies offering EFC implemented 1 February 2004. With this function (12),

AutoPASS tag holders will no longer have to sign a separate subscription contract with each different toll company to be able to drive legally in the no stop lanes in different Norwegian road toll projects. When they sign the contract for being a subscriber with their "home" toll company, they may in the same form sign for subscribing to the "national payment system", giving legal access to any AutoPASS lane in Norway.

We also try to harmonise the fee system in Norwegian road toll projects. Except for road toll replacing ferries, the normal standard fee system has two vehicle classes, light and heavy vehicles. Heavy vehicles are those with an *allowed* total weight exceeding 3500 kg. They normally pay the double of the fee for light vehicles. MC's are free. For subscribers, prepayment of 350 trips will give up to 50% discount, and there are other alternatives as well.

6.5. Nordic work on interoperability for user fee collection

Having the power to harmonize Norwegian toll collection systems, the Norwegian Public Roads Administration (NPRA) plays a vital role in setting up codes of practice on road tolling, building an increasing number of toll stations and implementing toll collection equipment before the complete systems (still owned by NPRA) are operated by the toll companies. In this context NPRA also have been taking part in a project on road user fee collection operability together with the other Nordic countries Sweden, Finland and Denmark. This Nordic cooperation was named MÅNS and included 9 working groups focusing on various issues, such as manual payment, electronic fee collection, classification and information to drivers, to mention some. The MÅNS Guidelines are available on the VIKING web site: *http://www.viking.ten-t.com*

Another harmonizing activity between Nordic countries is named NorITS (Nordic Interoperability for Tolling Systems). The background for this work is the cooperation between Sweden and Norway on building a new bridge crossing a deep fiord constituting the border between our two countries due to be opened in June 2005 (100 years after the end of the political union between the two countries. Within the NorITS project we are aiming at full interoperability throughout Denmark, Sweden and Norway for EFC, and hopefully this interoperability will spread to more countries in Europe. Different EFC-tags (for instance BroBIZZ in Denmark (at the Storebælt Bridge) and in Sweden (at the Øresund Connection between Sweden and Denmark and PISTA in other European countries)) are all supposed to comply with the European standard for EFC. This make the different tags readable from one antenna in the toll plazas. The necessary step for interoperability will then be to install different dedicated software in the plaza computers handling the small differences between the separate tags.

6.6. Introducing fully automated free flow road toll stations

2 February 2004 the new concept of "fully automated free flow road toll stations" was introduced in urban toll rings in the cities of Tønsberg (110 km south of Oslo) and Bergen. The main aspect of this concept is that there are no separate lanes where the drivers may stop and pay with cash (see figure 8). The concept has much in common with the toll systems in operation in Singapore, Toronto and Melbourne. The owners of vehicles not having an AutoPASS tag are identified through the video enforcement system and will receive a bill by mail approximately once a month, covering the exact fee.

Three major challenges have been pointed out concerning this new concept:

1. Privacy concerns

2. Drivers have a right to be offered to pay cash in accordance with the Norwegian Act of Finance
3. How to inform uninformed drivers

The first challenge was the most difficult to solve. Our solution is to offer those who want it an anonymous tag. The tag is bought anonymously and prepaid in cash. The driver will not be videoed as long as there is a positive balance on the account connected to the tag (and the system works properly). And the toll companies do not know who owns the tag.

The second challenge is solved by offering the drivers to pay cash at a nearby fuel station. Then the video picture will be deleted from the system faster.

Informing drivers not familiar with the system is another challenge. We have tried to solve this by several traffic signs explaining the functionality of the new concept (see figure 9). In addition we have established a special phone service reached by a short number (02012) announced on signs after the toll station, for those who want to talk to someone, maybe because they did not really understand that they actually passed a toll station. On the main roads we have also introduced lay-bys with textual signs where people who need more information may stop and read more details on large signboards.

Thank you for your attention!

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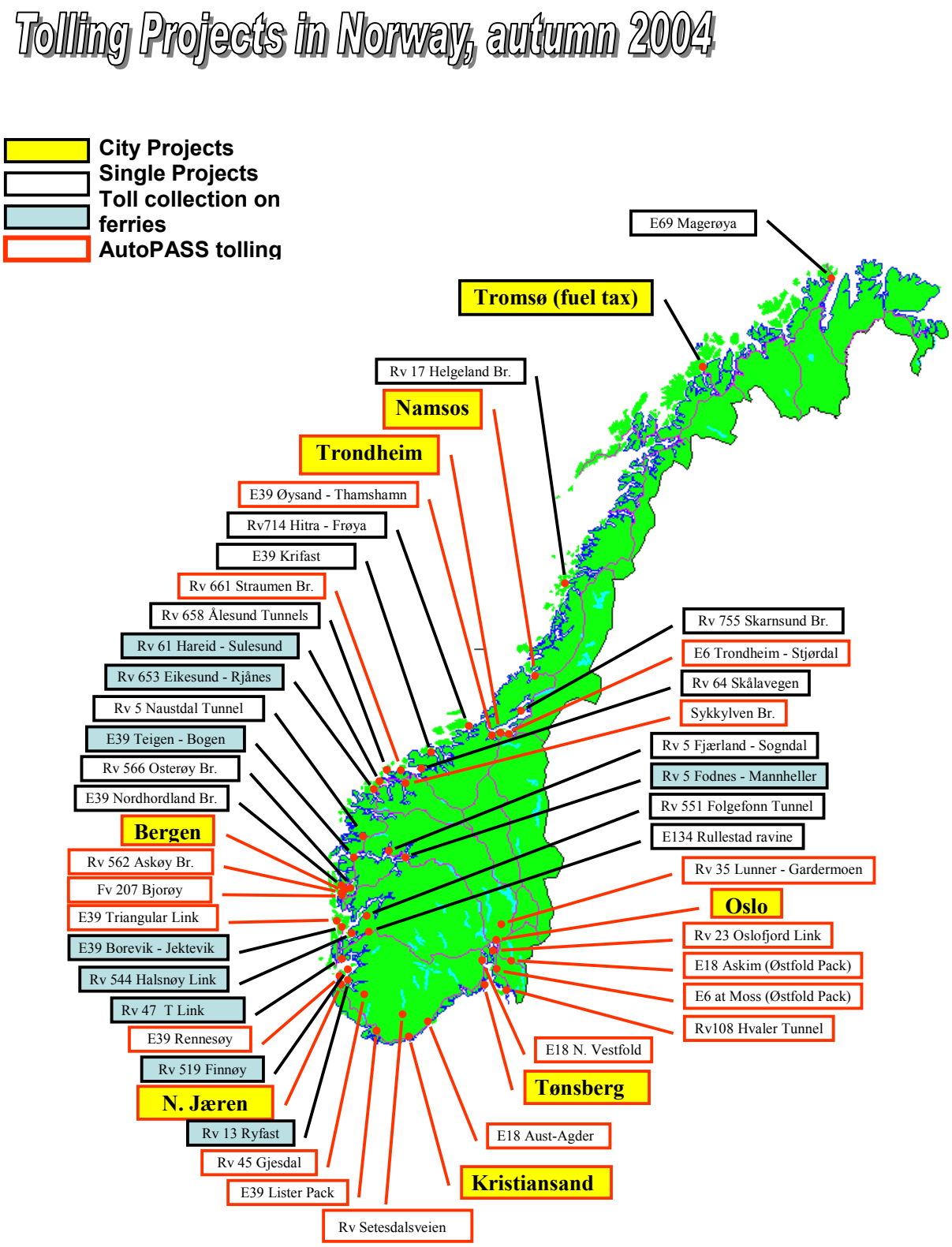


Figure 1: Road toll projects in Norway

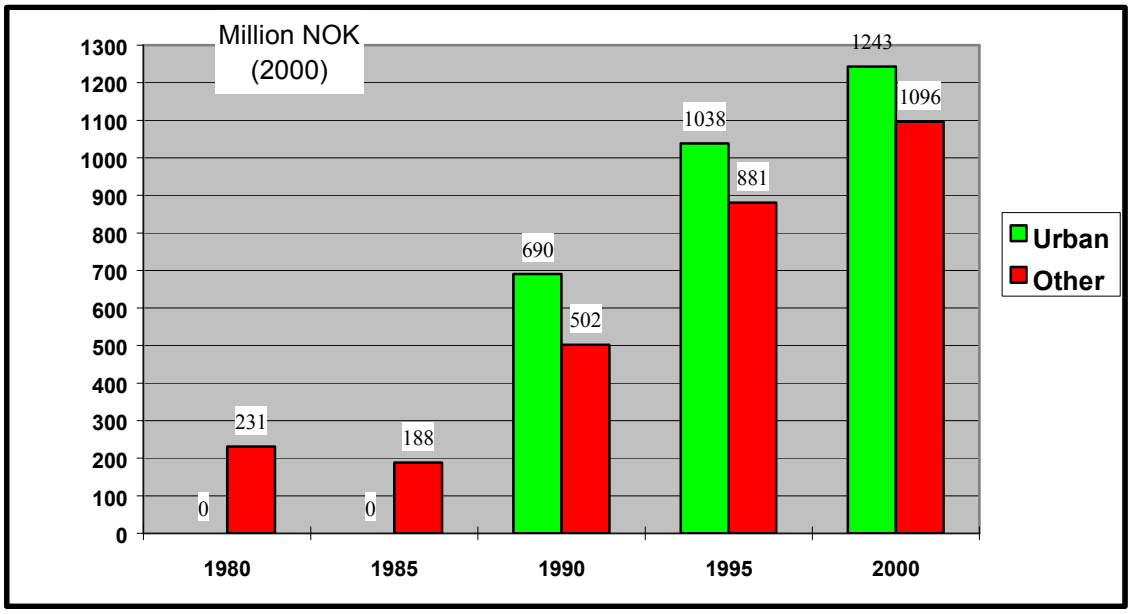


Figure 2: Road toll income in Norway 1980, 1985, 1990, 1995 and 2000 (1 USD = 6,5 NOK)

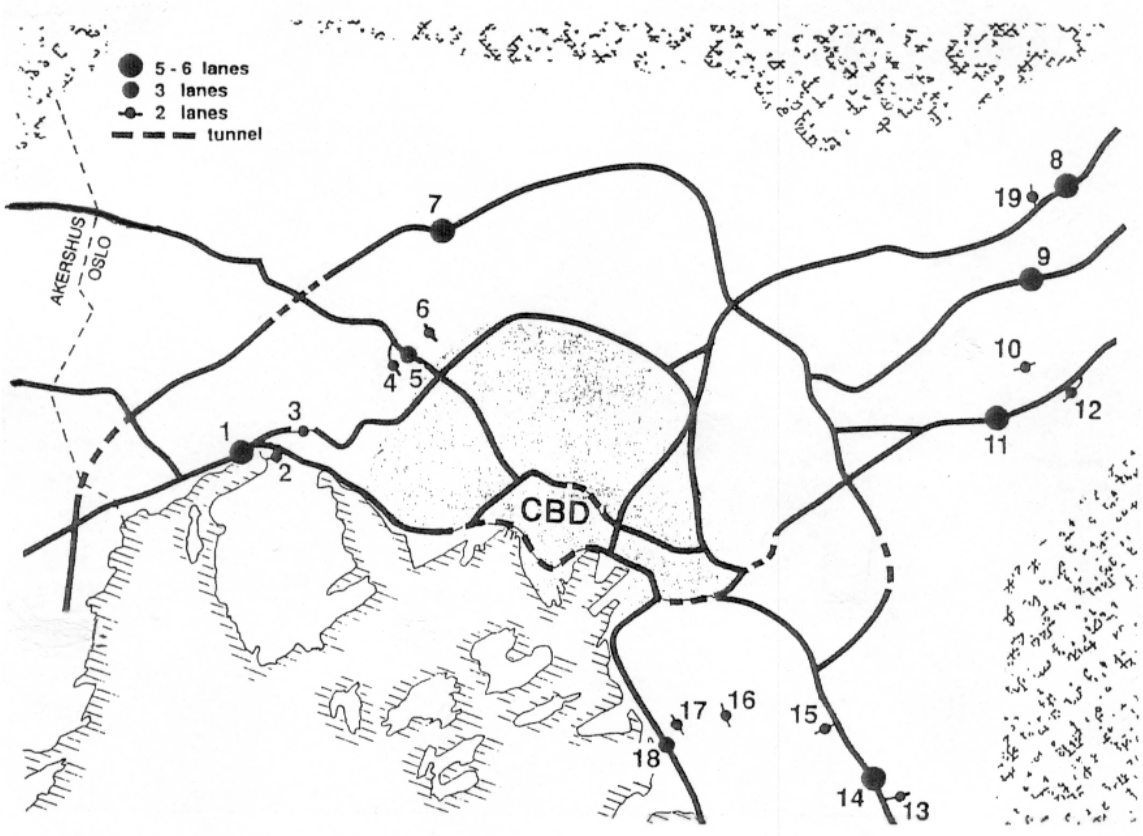
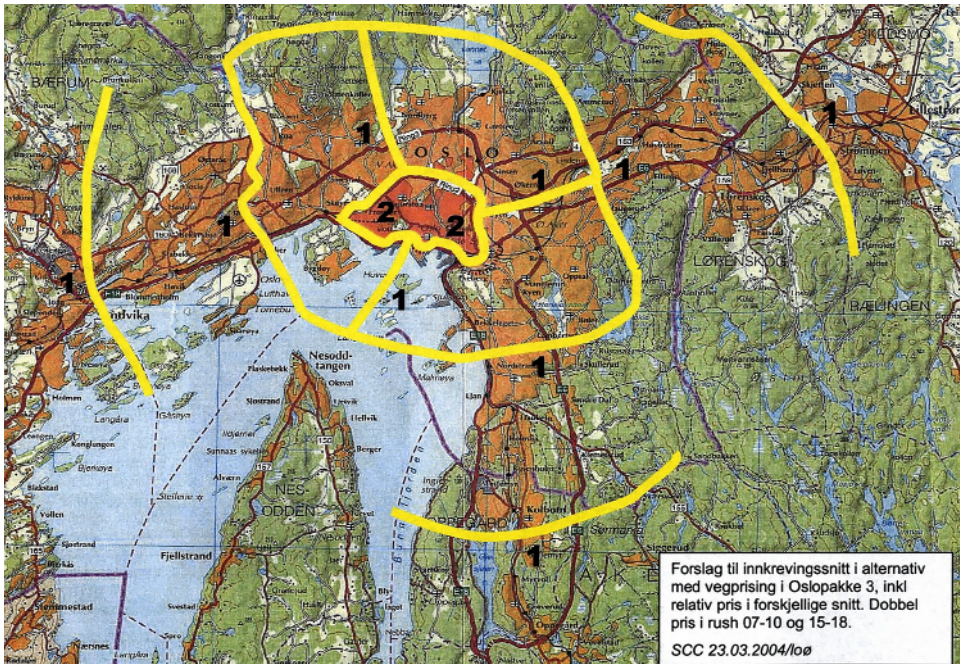


Figure 3: The Oslo Toll Ring

City	Pla-zas	Start	End	Pop. in ar.	In op.*	AADT **	EFC%	Tags	NOK /Pbe
Bergen 1	8	1986	2004	300’	16/5	60’	-	-	5-10
Oslo	19	1990	2007	900’	24/7	250’	81	400’	10-20
Trondheim	12 *17* *23*	1991 *1998* *2003*	2005	250’	11/5 12/5	100’	94	150’	10 15
Kristian-sand	5	1997	2007	100’	24/7	55’	83	30’	10
N. Jæren (Stavanger)	21	2001	2011	230’	12/5	150’	90	110’	5/10
Namsos	3	2003	2017	15’	12/5	7’	87	10’	13
Tønsberg	6	2004	2019	50’	24/7	50’	84	35’	15
Bergen 2	8	2004	2014	300’	24/6	100’	85	105’	15

* Hours a day and days a week
** During hours of operation

Table 1: Urban toll systems in Norway



- 1 = NOK 3,- (1 unit) in both directions
- 2 = NOK 6,- (2 units) in both directions
- Double fees in peak periods
- Free periods late evening and night
- Double fees for heavy vehicles
- Investments favouring public transport

Figure 4: “Congestion Charging light” in Oslo and the surrounding municipalities

Figure5: Oslo City Hall Square seen from above and from Aker Brygge

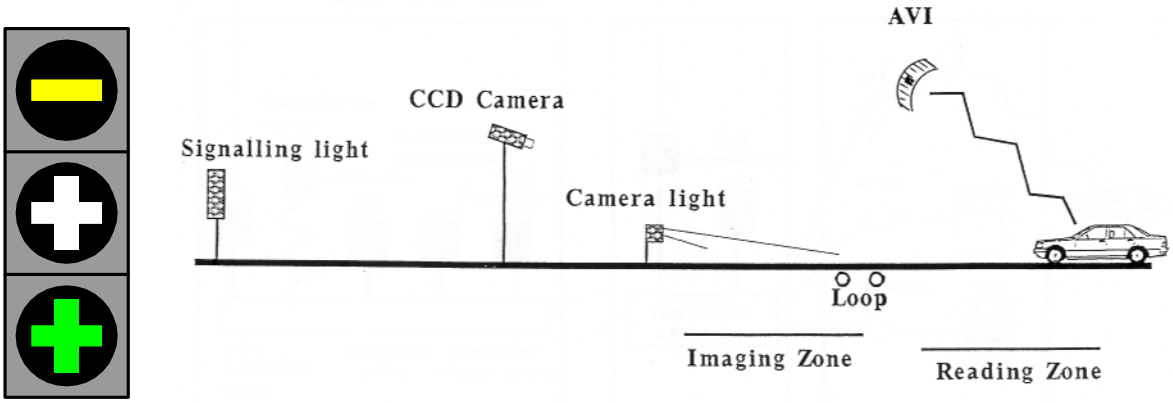
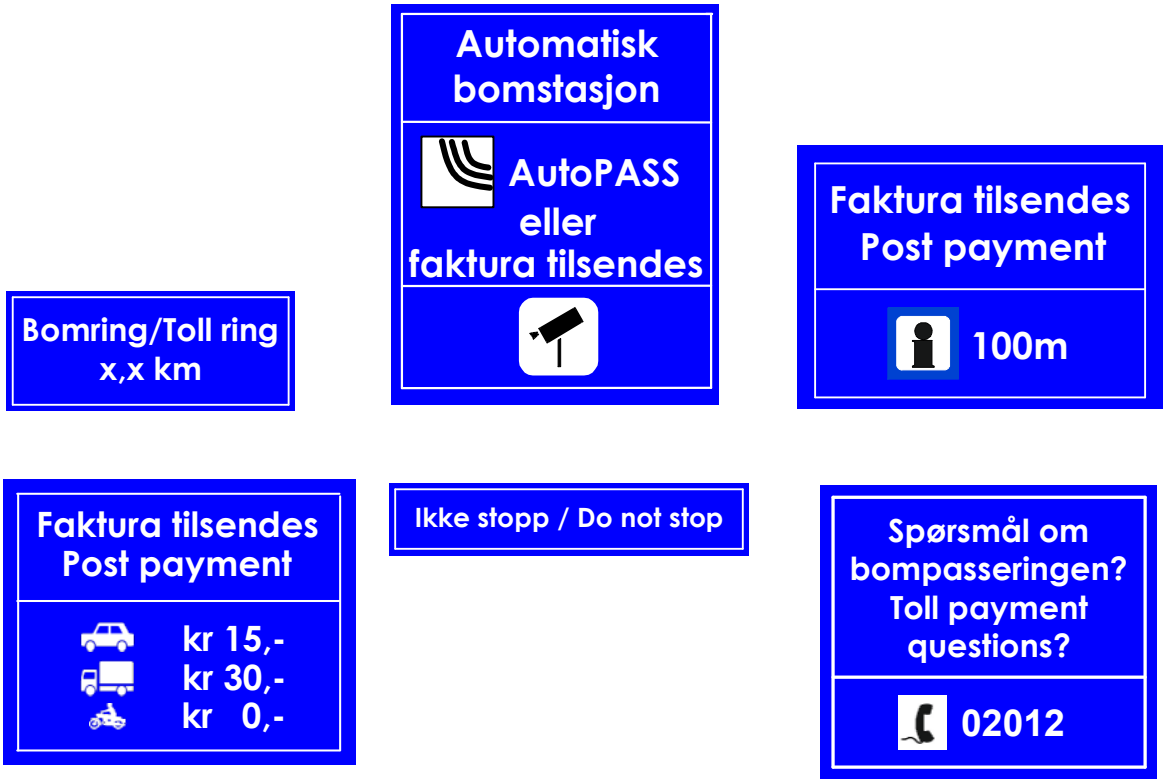


Figure 6: The equipment in a Norwegian EFC lane

Figure 7: An unmanned toll plaza in Trondheim with a two level low cost coin machine

Figure 8: Fully automated free flow road toll stations in Tønsberg and Bergen



The meaning of the signs is from left:

- Pre-warning about toll
- Main warning about free flow stations
- Information in English and pre-warning of an information lay-by
- Information about fees (close to the payment point gantry)
- Information on the payment point gantry
- About the call centre (after the gantry)

Figure 9: Traffic signs in fully automated free flow road toll stations