Kilometre tax for heavy goods vehicles in Sweden
A proposal for a functional concept

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The ARENA project

ARENA is a national project that aims to build competence for a future introduction of a kilometre tax system for heavy goods vehicles (HGVs) in Sweden. The project was started when Swedish public authorities began considering the introduction of a kilometre tax for HGVs and as a means of harmonising the national development with the European. ARENA started in 2006 and is financed by the Swedish Road Administration and VINNOVA. NetPort.Karlskrona is the project coordinator.

The approach of ARENA is to take a broad view. Innovation potential, consequences and possibilities related to the introduction of a kilometre tax are just as important as the technical solutions as well as respecting that different stakeholders have different needs and requirements from the system. The role of the ARENA project includes the following elements:

• serving as the meeting point for all stakeholders in the industry – both nationally and internationally
• developing and supporting knowledge within the project and serving as coordinator between other projects

A concept for a kilometre tax system in Sweden is developed with a functional approach, which does not prescribe any technical solutions. The concept is generic rather than specific, in the sense that it should be possible to implement the result in several ways. Hence, the system must be flexible to meet the dynamics of technical development. The time horizon for realisation is 3-6 years in the future, and we can expect considerable changes in technical preconditions over this period. The concept, developed by ARENA, differs from existing systems in Germany, Austria, Switzerland and the Czech Republic. The ARENA concept allows more toll service providers, which is not accepted in the systems already in operation but is anticipated in the EU’s work. ARENA believes that greater openness will reduce costs and increase flexibility. When it comes to checking for compliance with the regulations, ARENA has also forged its own path to reduce system costs.

Swedish Road Administration

The Swedish Road Administration (SRA) is the national authority assigned the overall responsibility for the entire road transport system in Sweden. SRAs task is to co-operate with others to develop an efficient road transport network in the direction stipulated by the Swedish Government and Parliament. SRA has been commissioned to create a safe, environmentally sound and gender-equal road transport system that contribute to regional development and offers individuals and the business community easy accessibility and high transport quality.

VINNOVA

VINNOVA (Swedish Governmental Agency for Innovation Systems) is a State authority that aims to promote growth and prosperity throughout Sweden. VINNOVA’s particular area of responsibility comprises innovations linked to research and development. The tasks are to fund the needs-driven research required by a competitive business and industrial sector, and to strengthen the networks that are such a necessary part of this work.
Preface

This report summarises the results of the first part of the ARENA project based on the reports in the appended list. The text also includes direct references to some of the reports.

ARENA has developed a functional concept, the ambition of which is to meet Swedish and European requirements to the degree that they are known. Work with the concept is far from complete. More work is required both on the national and the European level.

The concept is structured to allow differentiation of the tax level, which offers the necessary flexibility to design a politically acceptable kilometre tax system. The structure of the ARENA concept differs from systems currently in operation primarily in regard to the control system, with ARENA taking inspiration from the control principles used in other domains as for income tax and customs. Furthermore, ARENA proposes a business model for the kilometre tax where most activities are carried out by private stakeholders at commercial terms and where the government collects tax revenue and serves a supervisory role. This basis is a rational response to the demand for a cost-effective system and provides a solution that works in harmony with the rest of Europe. There are, however, legal and organisational aspects that still require investigation. The concept does not describe any alternative system solutions, but during the course of the project some of the alternatives that have been brought up in the debate in recent years have been analysed in a comparative study1.

Opinions on road user charging vary. The project hopes that this report contributes to a constructive discussion. The report does not claim to represent the opinions or views of any government authority or stakeholder.

Continuation of ARENA

The work of the ARENA project continues in ARENA 2.0, where the functional concept for kilometre tax will be further developed in collaboration with researchers, government authorities and industries – both nationally and internationally. A demonstration of kilometre tax and associated applications will be created and used in conjunction with the ITS World Congress in Stockholm in September 2009. ARENA 2.0 also plans to establish a research environment in ITS and E-Transactions based on the knowledge gained during the course of the project. See section 7 for more information.

Some definitions

**Toll Charger (TC)**
The organisation/authority that levies kilometre tax. The Swedish Tax Agency and/or the Swedish Road Administration are likely to be Toll Charger after delegation.

**Toll Service Provider (TSP)**
An organisation that in accordance with EFC directive 2004/52 represents a vehicle owner and is responsible for submitting data collected from the vehicle to a Toll Charger as a route declaration.

**Route declaration**
The driving of a taxable vehicle (Route Declaration) shall be reported to the levying organisation following set requirements. The levying authority prepares a tax decision based on the submitted Route Declaration.
1 ARENA project

1.1 Build-up of competence for kilometre tax on heavy goods vehicles in Sweden

The ARENA project was started in April 2006 on several grounds:

- There is a political ambition to introduce a new HGV tax system that reflects the marginal cost principle and helps to achieve transport-policy goals
- Several European countries have started to implement distance-based road tolls using technology currently available
- The EU Commission has initiated intensive work to develop guidelines for a European Electronic Toll Service (EETS)
- Other projects indicated that introduction of road tolls on a national scale and the related technical development create the opportunity of innovation, both for technology and the transport system, which could be of interest to Swedish industry
- As a continuation of the former Tango Collect project

The ARENA project was established by the Triple Helix stakeholder NetPort.Karlshamn together with a number of project partners as an application of the methodology aimed at creating better conditions for innovation and implementation of new ideas in practice through new forms of co-operation between industry, universities and government authorities.

During the first part of the project, there was an extensive exchange of information between government authorities and other stakeholders both in Sweden and abroad. Kilometre tax and ARENA’s concept proposal have been discussed in regional and national policy forums in order to aid in the build-up of competence on kilometre tax for heavy goods vehicles in Sweden. The project also successfully arranged three international seminars on the ARENA concept in three different development stages. These served to confirm the realism of the concept and a great European interest in continued work.

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3 Etzkowitz, H., Trippelhelix-dén nya innovationsmodellen. SNS Förlag 2005
4 ARENA REPORT 2008:12., “ARENA RUC Seminar 1&2 – Summary of the seminars”
2 New tax system on the way

2.1 Current tax system

The current tax system for heavy goods vehicles is based on fuel tax and vehicle tax. The vehicle tax is differentiated according to vehicle properties such as weight, number of axles and the environment-related properties of the engine. In addition to these taxes, there is also a road toll, or Eurovignette, for using the road network. The Eurovignette toll is a collaboration between Sweden, Denmark, Belgium, Luxemburg and the Netherlands. Germany has also been part of the collaboration, but withdrew when it introduced its kilometre tax (Maut) in 2005. In the agreement between the Eurovignette countries, Sweden receives an income of about SEK 600 million annually. The vignette tolls only cover specific roads (TEN road network) and cannot be considered a reflection of the strive for internalisation of external costs, which is an important goal of Swedish and European transport policy. In addition, the degree to which foreign carriers in countries that are not part of the Eurovignette agreement actually purchase a vignette when driving in Sweden is not known.

2.2 Possibilities of the future

New technology brings with it new possibilities to actually calculate costs based on vehicle properties, which roads are used and at what time. The EU Commission is working to define a Europe-wide road tolling system with which any Swedish kilometre tax system must comply. European experiences from the systems in use show that a kilometre tax can contribute to:

- An environmentally friendlier vehicle fleet
- More efficient use of heavy goods vehicles, increased load factor
- Fairer conditions for competition between domestic and foreign hauliers
- Possibilities to route traffic to roads where it is least disruptive
- In the long term – better conditions for increasing the proportion of rail and sea transport

2.3 Road traffic tax investigation

The principle of internalisation of external costs (such as road degradation, particle emissions and noise) were important when the road traffic tax investigation committee conducted its investigation from 2002 to 2004. The investigation included a review of all road and vehicle tax systems and proposed the introduction of a kilometre tax\(^5\). The proposed kilometre tax involves the levying of tax on all heavy goods vehicles (both foreign and Swedish) with a gross weight over 3.5 tonnes that use the public road network. The tax will be differentiated according to vehicle properties (weight and environmental class). Further differentiation was also discussed. The proposal was taken up in the transport policy proposition Moderna transporter (Modern transport)\(^6\) and was accepted with reservation of the Swedish Parliament in May 2006. The reservation required that the effect to businesses and regions be investigated before such a tax could be introduced. The government therefore commissioned SIKA and ITPS to analyse the impact that introduction of a kilometre tax would have on regions and industry\(^7\). Two investigations were completed in 2007.

\(^5\) SOU 2004:63 "Skatt på väg"

\(^6\) Prop 2005/06:160 "Moderna Transporter"

2.4 SIKA’s investigations

The following was written in SIKA’s investigation during 2007:8:
“If the kilometre tax is differentiated based on relevant properties of the vehicles as well as where and when the vehicles are driven, it can be a significantly more efficient instrument for internalizing the external effects of heavy traffic than the taxes and tolls in use today, that is to say diesel tax, vehicle tax and road tolls. A kilometre tax makes it possible to take payment from foreign heavy goods vehicles and also means that income distribution mirrors the distribution of traffic work.”

In its studies, SIKA presumed an average of SEK 1.40 per kilometre being added to existing taxes. The calculated production and employment effects were generally small and not clearly negative. A comparison of use of a weighted average of marginal costs was used as the basis for the tax levy versus differentiation based on rural or urban usage showed no significant difference. It is SIKA’s conclusion that differentiating the tax will likely only have marginal significance to the majority of industry. Round timber and wood products are the product groups in which the difference will be most noticeable. Regionally, the two differentiation alternatives did not show any significant differences.

Differentiation may be preferable in the inland part of northern Norrland. This would provide some relief in an area where forestry is particularly sensitive to increased costs. Further differentiation that generates lower costs for driving on a specially designed road network for freight indicates some rerouting to roads where the traffic is less disturbing and the risk of accident is lower.

2.5 The Climate Committee

In March 2008, “the Climate Committee”9 submitted its findings to the Swedish government, in which it suggests introduction of a kilometre tax for heavy goods vehicles from 2011. The investigation indicates that a kilometre tax should be introduced provided that technology with reasonable system costs has been sufficiently developed. Consideration should also be given to forestry transport, which has no alternative to use of heavy goods vehicles, so that it is not impacted by unreasonable consequences. The committee considers a kilometre tax a supplement to fuel taxes.

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8 SIKA Report 2007:2 "Kilometre tax for lorries"
9 SOU 2008:24 "Svensk klimatpolitik"
2.6 Milestones of the investigation work

The matter of a kilometre tax for heavy goods vehicles has been the subject of a number of studies in recent years. The figure below depicts some milestones in the work. The matter will likely be taken up again in political propositions expected at the end of 2008. There are still issues that require investigation, such as applicable tax levels, which roads should be considered kilometre-tax roads and legal conditions.

Figure 1: Milestones in the Swedish kilometre-tax investigation work
3 Europe implements distance-based road user charging

3.1 A European trend

The quickly growing transport sector in the EU increases the need for road investments and maintenance. The problems of congestion and particle emissions are also pronounced in many areas. Distance-based road user charging could generate a fairer and more correct levying of taxes and serve as an incentive for increased transport efficiency and reduced environmental impact. At present in Europe, heavy goods vehicles drive throughout the entire Union, but often only pay tax in the country of vehicle registration and where they purchase fuel. Many countries are considering implementing a kilometre tax to create a fairer tax system. The figure shows where kilometre tax is already in place and where it is planned.

Figure 2: An overview of European development

3.2 The goals of kilometre tax systems already in operation

When the ARENA project was started in April 2006, kilometre tax (or distance-based road user charging) was in place in Switzerland, Austria and Germany. At the start of 2007, the Czech Republic also introduced kilometre taxation. The purpose behind introducing the tax varies by country.

- Switzerland, which taxes heavy goods vehicles on the entire road network, aims to limit growth of goods transport by road and its environmental impact as a means of protecting the environment of the Alps. There is an expressed aim of building railway tunnels since some of the income serves to fund a large railway project.
- Austria, which levies a toll on motorways, focuses on maintenance and expansion of the motorway network.
- Germany, which levies a toll on the motorway network, aims to collect funds for maintaining and constructing the road network, develop combined transport and reduce environmental impact.
- Czech Republic, which levies a toll on motorways and plans to apply the toll to the entire road network, aims to reduce transit traffic and collect funds for maintaining the road network.

A more detailed compilation of systems and reasons is available from SIKA10.
3.3 Experiences from abroad

Experiences from the countries that have implemented distance-based road user charging indicate a clear connection between the effects and the design of the tax systems. It is therefore important to evaluate the political goals when introducing such taxes.

Many studies have been conducted to analyse the effects of the new tax systems in Switzerland, Austria, Germany and the Czech Republic\textsuperscript{11}. A general conclusion is that the new tax systems contribute to increased efficiency. The load factor in the vehicle has increased and logistics systems have been further developed. In Switzerland and Germany, where the tax varies based on the vehicle’s environmental class, there was a market adaptation of the vehicle fleet to more vehicles of a higher environmental class (which reduces costs for the hauliers). The compilation of the vehicle fleet has also been adapted to the transport need to a greater degree. In general, little to very little effect has been seen to transport cost and production\textsuperscript{12}. In Germany, studies show a 0.15\% increase in consumer prices as the result of the kilometre tax and the cost for transporting by road increased an average of 5-7\%\textsuperscript{13}.

3.4 Impact on Swedish hauliers

A Swedish interview study shows that a kilometre tax in Sweden would increase costs for transporting by road by 6-10\% for Swedish hauliers\textsuperscript{14}. The tax levels used in the calculations are based on those suggested by SIKA\textsuperscript{15}. According to the EU directive, the current Eurovignette toll must be eliminated upon introduction of a kilometre tax. This has been included in the calculation along with the presumption that vehicle tax for heavy goods vehicles will be lowered to EU’s minimum level and the entire Swedish road network will be kilometre-taxed. The interviews show that the haulage companies will try to pass the increased transport costs onto the customers. At the same time, some feel it is possible to improve efficiency in the industry, particularly through co-operation between different haulage companies and improved co-operation with the customer. The study also shows that a kilometre tax would reduce some of the competitive advantage held by foreign vehicles. Foreign vehicles (particularly those from the east) have a relatively low tax level (vehicles tax and tax on labour). The introduction of a kilometre tax would be a greater total increase (as measured in percentage) for these vehicles than for Swedish vehicles. The hauliers interviewed felt it was important not to distort competition. Harmonisation with the rest of the EU is important as well as control being effective so that tax evaders are actually caught. Otherwise, it will be difficult for a new kilometre tax to gain acceptance.

\textsuperscript{11} Källström Lars., East West Report. “East West Transport Corridor – final report WP2”
\textsuperscript{12} Transport & Environment, “A price worth paying, v2”
\textsuperscript{13} Källström Lars., East West Report. “East West Transport Corridor – final report WP2”
\textsuperscript{14} Forss, M och Ramstedt, L., East West Report. “A kilometre tax for Heavy Goods Vehicles – impact on the Swedish haulier industry”
\textsuperscript{15} SIKKA Report 2007:2 “Kilometerskatt för lastbilar”
3.5 The European framework

There are two European directives that are important with respect to distance-based road user charging. The directive on the charging of heavy goods vehicles for the use of certain infrastructures, also known as the “Eurovignette Directive” (2006/38/EC) replaces directive (1999/62/EC), which built a framework for the implementation of road use charging. According to the revised directive, it is now permissible to implement tolls on the entire road network and levy tolls on vehicles with a total weight of 3.5 tonnes or more. The requirement that revenue must be directed to the road sector has been eliminated.

Directive 2004/52/EC on the interoperability of electronic road toll systems in the Community (EFC directive)\(^\text{16}\) aims for standardisation so that one vehicle unit can be used in all electronic toll systems within the EU. The directive defines the “European Electronic Toll Service” (EETS), which shall supplement any national road tolls in member states to ensure interoperability regarding technology, contracts and processes. The goal is for payment for road usage to be possible using the same on board equipment (OBE), same contract and result in a single, common invoice regardless where the haulier drives in Europe. To do so, the technical systems must fulfil a number of European standard requirements, the organisations that provide the service must satisfy a number of quality requirements and there must be agreements between these stakeholders that can be compared to the roaming agreements between mobile operators.

The directive also specifies that all new distance-based road user charging systems put into operation after 1 January 2007 must have one or more of the following technologies:

a) Satellite positioning (GNSS/GPS)
b) Mobile communication via GSM/GPRS
c) 5.8 GHz microwave technology (DSRC)

It is recommended that the new electronic fee collection system use satellite positioning and mobile communication, i.e. a combination of (a) and (b). Many member states have a national road toll system in place. These countries must ensure that they are able to offer the EETS service to all heavy goods vehicles within three years of the directive coming into force entirely.

\(^{16}\) EFC stands for Electronic Fee Collection
4 A possible Swedish system for kilometre taxation

The development of a possible Swedish solution for a kilometre tax system for heavy goods vehicles follows several stages, the first of which is developing a conceptual systems design. We have decided to use the term conceptual in order to underline that the solution shall be generic rather than specific, in the sense that it should be possible to implement the result in several ways. Hence, we are trying to define the system independently from its final technical design. The motivation for this is that the time horizon for realisation is far ahead, 3-6 years, and we can expect considerable changes in technical preconditions over this period. The text in this section is a summary of ARENA REPORT 2008:2, 2008:3, 2008:4 and 2008:5. The terminology used is taken from the work currently underway by the EU Commission.

4.1 Requirements of a Swedish kilometre tax system

During conceptual development, we have given consideration to requirements and preconditions that we know of or anticipate. These requirements are divided as follows:
- System requirements from legislators
- User requirements
- Requirements relating to safety and reliability
- Requirements from supplementary services
- Requirement for interoperability

The requirements that are key to the concept design are:
1. A system that makes it possible to levy tax throughout the entire road network
2. A system that allows differentiation as regards road characteristics
3. A system that allows differentiation of static and dynamic vehicle properties
4. A system that is interoperable with the coming EETS service (see section 3.5)

These requirements serve as the basis of the concept design, which is summarised below.

4.2 System overview

The ARENA project describes a kilometre tax from two perspectives – a functional perspective to define a system according to “how it looks” and a stakeholder perspective to define “who does what”. These perspectives are correlated, which means that the selected functional solution will impact the roles and division of responsibilities among the stakeholders and vice versa.
Figure 3 shows a kilometre tax system in its context, defined as a function. The system handles the processes needed to enable a user (or customer) to correctly pay tax. The tax authority provides a transport service and collects a kilometre tax for this. This results in a claim to the user, who makes payment to the tax authority.

The two main functions “Collect Kilometre Tax” and “Perform Payment” are separated. The first function is handled by the kilometre tax system while the other process uses established services in bank and financing systems. Important parts of the latter process will be defined through the European Electronic Toll Service (EETS). Accordingly, concept development in ARENA focuses on the “Collect Kilometre Tax” function, which involves measuring, calculating and supplying all information needed to pay the correct tax. The function also ensures that the tax is correctly paid.

The concept is limited to tax levying within the borders of Sweden. How Swedish vehicles pay road tolls in foreign road user charging systems is outside the scope of this project. This must be handled within the European Electronic Toll Service (EETS).
4.3 Payment process

The ARENA concept is based on:

- Vehicles subject to kilometre tax having specific vehicle equipment for this purpose –OBE (On board Equipment).
- The OBE continually registering the vehicle’s position and time (which is supported by, for example, GNSS) in a protected memory card.
- Use of an OBE is mandatory, but the system must offer an emergency solution if, for example, the OBE stop working.

The three most important stakeholders in the kilometre tax system are the User, who pays for road usage, the Toll Charger (TC)\(^\text{17}\), which levies the tax (e.g. the Swedish Tax Authority) and the Toll Service Provider (TSP), which serves as the middleman between these two stakeholders and also supplies system functions and equipment\(^\text{18}\). In addition, there may be organisations that offer a European Electronic Toll Service (EETS) that can be used to pay kilometre tax in Sweden. In its most developed form, there could be several competing Toll Service Providers (TSP) operating in Sweden.

The payment process can be described as follows:

1. **Position with a time stamp is continually registered and sent to a Toll Service Provider (TSP) regularly.** A compilation of the information registered in the vehicle, including dynamic data (such as connected trailer) is sent to the Toll Service Provider when special conditions are fulfilled (such as time restrictions, certain distance driven, etc.). The system can, for example, use mobile communication for this purpose. The Toll Service Provider can be approved for the EETS service or operate nationally only.

2. **Receipt for transmitted information saved in the vehicle.** A receipt is generated by the OBE, saved and transmitted. The recipient (Toll Service Provider) sends a receipt to the OBE to confirm delivery.

3. **The Toll Service Provider translates the received information into a route declaration.** The Toll Service Provider translates the data received into a road description through map matching. The road description along with static and any dynamic vehicle data are compiled into a route declaration, which follows the principles laid out by the Toll Charger.

4. **The route declaration is sent to the Toll Charger.**

5. **Tax is calculated by the Toll Charger.** The tax calculation is based on the route declaration.

6. **The Toll Charger sends a tax claim to the Toll Service Provider.**

7. **The Toll Service Provider pays the Toll Charger.** The claim is verified and payment is made following the agreed payment guarantee.

8. **The Toll Service Provider invoices the customer (User).** The Toll Service Provider adds the tax claim to the customer’s invoice as per their agreement.

9. **The User pays the invoice from the Toll Service Provider.**

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\(^{17}\) Definition of Toll Charger as per CESARE III+IV projects

\(^{18}\) This role is best described as EETS Provider as per CESARE III+IV projects
4.4 Functions of the concept

The process described in the nine steps above can be translated into a number of functions that together form the overarching function “Collect Kilometre Tax” discussed earlier:

1. Establish User Contract
2. Register Track Data (route and time)
3. Charge Payment (tax calculation and payment)
4. Compliance Control

The ARENA concept presents two parallel services to carry out payment in a Swedish kilometre tax system. One is a national service that only works within the borders of Sweden. The other is the European Electronic Toll Service (EETS), which is required as per the EFC directive (see section 3). EETS is neither fully specified nor implemented at present. It is also likely that it will be different in different countries since it must be adapted to local tax systems and procedures linked to such. The ARENA concept includes and gives consideration to actual requirements and procedures agreed at the European level thus far.

A contract is established (Function 1) between the User (vehicle owner, linked to a specific vehicle) and a Toll Service Provider, which can be a Swedish organisation (private or public) that only offers its services within the borders of Sweden or an organisation that operates throughout Europe and offers the European Electronic Toll Service (EETS) in countries including Sweden. When the contract is signed, the User receives an OBE from the Toll Service Provider. This OBE is linked to the User’s identity in a clear and manipulation-proof manner. Depending on which Toll Service Provider is chosen, the OBE can either be used throughout Europe (EETS) or can only be used in Sweden. The contract specifies vehicle properties and other User information that is used for tax calculation and defines the payment terms between the User and Toll Service Provider.

During driving, the OBE continually reports the track positions (Function 2) and transmits this information for processing in Function 3, Charge Payment. Here, there is a determination as to whether a vehicle that has reported its route is liable to pay tax. This determination is based on the distance driven and the user information in the contract. The function also considers possible deductions or surcharges based on vehicle properties, previous registrations and payments made. The Swedish organisation appointed as Toll Charger (TC), possibly the Swedish Tax Authority, supplies applicable tariff information to each Toll Service Provider (TSP).

The Toll Charger sends an invoice to the Toll Service Provider or to a provider of the European Electronic Toll Service (EETS). This provider forwards the claim to the User.

Compliance Control (Function 4) consists of several functions. For example, there is a real-time check that the OBE is operational, a check that the information reported by the OBE is correct and that the positioning unit provides correct information. Compliance Control also includes a function to check that the tax calculation is correct. This is also used for other sources (such as tachometers) for feasibility assessments.

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19 There are no technical limitations to this service working abroad
Compliance control is the key to successful implementation of kilometre tax system in Sweden. A well designed control system is cost effective, ensures user integrity and serves as the basis for user acceptance.

A control system based on physical installations throughout the entire taxed road network (like in Germany, Austria and the Czech Republic) is too expensive in relation to the anticipated income of a Swedish system. The Swedish road network is too large for control to be based on this type of road installation.

Based on the idea that control of correct kilometre tax levy should be on par with control of other taxes in Sweden, ARENA suggests the following strategy:

- Focus on control mechanisms related to business processes, which means more intelligence and less hardware (compare with Swedish Customs’ Service Steps strategy)
- Add more control responsibility to Toll Service Provider (TSP) through contractual relationships between the User and the Toll Service Provider.
- Appoint a supervisory authority for roadside checks with the powers required to stop vehicles.

A summary of the control measures suggested by the ARENA project follows.

**A mandatory OBE makes the vehicle known by the Toll Charger (TC)**

Vehicles in the Swedish vehicle register with suitable vehicle characteristics will be automatically linked to the kilometre tax system through the OBE. Foreign vehicles will be required to use an approved OBE. These factors together mean that the Toll Charger (TC) will at any point in time know which vehicles are liable to pay the tax.

**Border registration**

The Toll Charger (TC) registers the number plates of all heavy goods vehicles that enter and leave the country with the help of cameras at the borders. This means that the Toll Charger at any point in time know which vehicles are expected to submit a route declaration. The project anticipates registration via video and that this project can be co-ordinated with Customs. It should also be possible to co-ordinate with Finnish Customs, which already conducts this type of border registration for all vehicles.

**The Toll Charger (TC) requires a route declaration**

When a vehicle is about to leave the country, the Toll Charger (TC) requires a final route declaration upon border crossing. If this is not done within a certain time period, the vehicle is blacklisted. The next time the vehicle enters Sweden, the authorities are notified that a “tax dodger” is on the roads.

**The Toll Charger (TC) checks the Toll Service Provider (TSP)**

The Toll Charger (TC) focuses its checks on the Toll Service Providers operating in Sweden. This includes both national Toll Service Providers and providers of the European Electronic Toll Service (EETS). Certain basic requirements must be fulfilled in order to become a Toll Service Provider in Sweden. Any Toll Service Provider who wants to operate in Sweden must provide detailed information on its system and services before the company is approved based on the guidelines established for the EU.

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20 ARENA REPORT 2008:11., “PM kring kostnadsberäkning”
21 ARENA REPORT 2008:4., “ARENA Control Concept”
22 Service Steps – a strategy developed by Swedish Customs to reduce customs cost and ensure a safe and efficient flow of goods
23 Requirements for certification as an EETS provider will be governed by EU legislation
The Toll Service Provider must provide consistent and complete declaration

Each Toll Service Provider will be responsible for all route declarations as well as ensuring that they fulfil all requirements and that there are no “holes” in the declaration of the distance driven. If the Toll Service Provider finds that a vehicle/driver intentionally provides false information, it must further investigate or inform the Toll Charger (TC) of such.

The Toll Service Provider checks connected OBEs
The requirement for the Toll Service Provider to provide “consistent and complete declaration” means that the subscribers’ OBE status must be checked. This check can be both status and position indication (“where is the OBE and in what condition is it?”). It must be possible to perform this check continually or randomly.

The Toll Charger (TC) performs random checks
The Toll Charger has the resources to gauge deceptive/missing declarations. Random checks along the roadside can be performed through simple observation of vehicles (number plate, vehicle properties, time and location24) for comparison with route declarations received later. The purpose of random checks is to ensure that the level of cheating is kept to a reasonable level in various environments and situations (byways, rural roads, at night, etc.). If the level of cheating exceeds a specific level, the Toll Charger will increase the number of roadside checks or increase penalties.

Roadside checks performed by the police
The primary tool for checking for violations is roadside checks performed by the police or a similar authority. These checks can be co-ordinated with the digital tachograph. The anticipated check level stipulated by directive 2006/22/EC25 also satisfies the needs of kilometre tax checks.

Toll Charger review transport firms
Companies providing transport services must fulfil certain requirements. The Toll Charger can review the transport firm and check that operations are run properly. This review can include how the companies handle kilometre tax declaration, equipment, OBE status, etc.

Comparative checks
It is possible to compare information obtained from several systems. Data from digital tachographs can be validated against the data from the OBE and data from the road meter can be used to validate route declarations, e.g. during the annual vehicle inspection. Such checks may not provide sufficient evidence of cheating, but could lead to intensified checks of the vehicle, transport firm or Toll Service Provider.

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24 Speed cameras could be used for this purpose.
25 This directive has been in force since 1 April 2007 and specifies the control level for driving and rest time regulations within the EU. During the first stage of the directive, 1 % of workdays will be checked. This level will be 3 % from 2010. The directive specifies that at least 30% of these checks must be performed at the roadside.
4.6 Business model

The prevalent market for road user charging is characterised by a bilateral relationship between a User and a Toll Service Provider (TSP) in a union with a Toll Charger (TC). An introduction of the EETS service forces an organisational separation between the Toll Charger and Toll Service Provider, since the former must be able to handle several Toll Service Providers. This separation changes the market, opening it to independent Toll Service Providers and permitting competition between them. Competition is not only financial; it is also through an attractive offering of services other than kilometre tax.

The ARENA project has proposed a business model for the kilometre tax system\(^\text{26}\) which is reflected in the control concept. The model can be considered a natural consequence of introduction of the European Electronic Toll Service (EETS), since this will also be an alternative for Swedish hauliers.

- The Toll Charger draws up contracts with Toll Service Providers, including those offering the European Electronic Toll Service (EETS). The contract grants the provider permission to operate in the Swedish kilometre tax system.
- The Toll Service Provider attracts customers by (possibly in competition) offering quality services for specific compensation, which is specified in a contract with the User. Vehicles driving in Sweden will be able to choose between use of a Swedish or an EETS OBE\(^\text{27}\).
- The Toll Service Provider is responsible for each subscriber's OBE as well as its procurement, installation, integration and usage.
- The Toll Service Provider collects all data necessary to create route declarations, compiling such for the Toll Charger.
- The Toll Service Provider pays the Toll Charger in accordance with the applicable payment requirements (payment guarantee) and invoices the customer. This means that the Toll Charger has no direct contact with Users.
- The Toll Service Provider is entitled to reasonable compensation from the Toll Charger for services performed, including compensation for risks and payment guarantee.
- Toll Service Providers are responsible for checking their subscribers and their OBEs as well as checking the feasibility of submitted route declarations.
- The Toll Charger checks what routines the Toll Service Provider has in place and how they are carried out.
- The Toll Charger is responsible for compliance control and validates system performance through random roadside checks and other logical processes.

This business model creates an organisation in which responsibility and control follow contractual relationships. Allowing competition between Toll Service Providers supports the development of new, innovative and more effective solutions.

\(^{26}\) ARENA REPORT 2008:5., ARENA market-based approach
\(^{27}\) The concept is based on mandatory use of an OBE. There may, however, be vehicles with faulty or broken on board equipment and there may be equipment that has been manipulated.
4.7 Revenue and costs for a Swedish system

According to SIKA the revenue for a future kilometre tax would be about SEK 4.2 billion annually\textsuperscript{28}, without tax differentiation between rural and urban roads.

When a new tax system is put into operation, costs for running such system must also be taken into consideration. The ARENA project performed an approximate cost calculation for a future kilometre tax system in conjunction with SIKA’s investigations in 2007\textsuperscript{29}. This cost calculation is based on the following preconditions:

- The kilometre tax covers the entire road network and the tax can be differentiated between different road types, regions, areas or the like
- Swedish and foreign vehicles with a total weight exceeding 3.5 tonnes are subject to the tax
- Vehicles subject to the tax have a mandatory vehicle unit (OBE), using positioning technology to register the route and using GPRS/3G to communicate data to a Toll Service Provider.
- Registration of all heavy goods vehicles is done using cameras at the Swedish borders
- The camera system for speed monitoring (ATK) is used for random sampling
- The system comprises approx. 90,000 Swedish vehicles and 10,000 foreign vehicles

Based on calculation results, the system is expected to cost approximately SEK 250 million per year (investment and operating costs) for the first few years. In addition, there could be transfers between system stakeholders to compensate for financial risks and allocated work tasks. This “credit and transaction cost” is calculated at approximately 2% of the collected tax, that is to say about SEK 100 million. In other words, this is a cost that depends on the business model selected and is not a system cost per se.

Based on the rapid technical development, the price of the vehicle equipment (OBE) is expected to drop. Costs may also be reduced if the required electronic equipment can also be used for other purposes by the Toll Service Provider.

\textsuperscript{28} SIKA REPORT 2007:5 “Kilometerskatt för lastbilar – tilläggsuppdrag”
\textsuperscript{29} ARENA REPORT 2008:11., “PM kring kostnadsberäkning”
5 Technical aspects

5.1 The goal of the system determines the technical solution

When several European countries have already implemented a distance-based road user charging system, the obvious question is why can’t we just copy a working system with known reliability? Germany, Austria, the Czech Republic and Switzerland have each selected pretty different technical and administrative solutions (for more on the systems in operation, see SIKA 2007:230). Furthermore, they are also incompatible with each other:

- Germany, Austria and the Czech Republic each have a toll/tax on motorways only with different technical solutions
- Switzerland, however, levies a tax on the entire road network using a special tachograph

When specifying a Swedish system, a basic condition is that it meets Swedish requirements as well as European. The choice of technical solution is primarily dependent on which roads will be taxed. If the tax is limited to certain parts of the road network, DSRC can be used to register entry onto and exit from the road network and use this information to calculate distance driven. This solution was chosen in Austria and the Czech Republic. In order to tax a "limited region", a whole country (all roads), the DSRC must be combined with a tachograph to measure the distance driven. This, in general, is the solution chosen by Switzerland.

In summary:
- Upon differentiation based on type of road and when the entire road network is taxed, there is always a need for some type of positioning technology. This is the most flexible solution.31
- If kilometre tax is only charged on motorways, DSRC can be an option
- If the entire road network is taxed equally, a tachograph solution can be an option

5.2 Technical conclusions and considerations

Although the ARENA project does not form an opinion as to which technology the Swedish system should use, it is clear that the concept design affects the technical solution. There are great differences in relation to the systems in Austria, Switzerland and the Czech Republic while the functionality described is similar to the German Toll Collect system32. The project recommends a few special properties in a Swedish kilometre tax system:

System interface
Sweden will need to fulfil the requirements of the European Electronic Toll Service (EETS), which means that Sweden must accept OBEs from a number of different EETS providers. The ongoing European development work gives reason to believe that a Swedish Toll Charger (TC) will not communicate directly with the On Board Equipment units (OBE).

30 SIKA Report 2007:2, “Kilometerskatt för lastbilar”, section 6
31 ARENA REPORT 2008:8
32 www.toll-collect.de
5.3 Dimensioning aspects

Sweden should use a “thin client”
In the German toll system, Toll Collect, the entire price list and map database are stored in each OBE (a so-called “heavy client”). With this solution, there are huge needs for updating each individual OBE, for example when a new country is covered, tolls are changed, road standards are changed or new roads are built. ARENA recommends that Sweden invests in a so-called “thin client”, which the functionality of the OBE is limited to registering and communicating driving information. Mapping and route declaration are handled by a Toll Service Provider and the final tax calculation is handled by the Toll Charger (TC).

Sweden should use a secure core
In the German and Swiss systems, the OBE itself is a “secure environment” and it is not permissible to use the components for purposes (services) other than tax levying. In Austria and the Czech Republic, the OBE has no positioning and no communication functions, which are required for many commercial services. ARENA recommends that it should be possible to implement a “kilometre tax function” in the vehicles’ existing or coming ICT platforms, since positioning and communication equipment is already used to a certain degree. For this reason, a security solution similar to that used in mobile phones should be used, i.e. an IC card/Smartcard that is issued by the Toll Charger (TC) and securely and clearly identifies the OBE and its link to a specific vehicle. Kilometre tax based on a “thin client” depends on timely delivery of positions for the heavy goods vehicles to the Toll Service Provider (TSP), which then handles mapping and the route declaration based on such information. In order to prevent loss of data and late deliveries, the system must be dimensioned with sufficient capacity. ARENA has analysed different possibilities of using existing mobile and wireless systems (particularly GPRS, UMTS and WLAN) for both streaming and bulk transfer of position data. The analysis shows that it is possible for sensible combinations of sampling and reporting intervals to ensure effective and economic reporting. The mobile networks in existence today would be able to handle the added load of reporting kilometre tax in Sweden with the proposed concept.

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33 ARENA REPORT 2008:6. Eliasson, C och Fiedler, M., "Dimensioning study for road user charging"
5.4 Security aspects

When the system for kilometre taxation is put into operation, it is important that the system cannot be manipulated and affected by outside factors. For this reason, a threat analysis has been performed on the solution, including the Smartcard-based OBE system suggested\textsuperscript{34}. The threat analysis focuses on the OBE, communication links, data and central servers. The threat can be physical, logical or human. Physical threats are threats that could physically affect the system or its components, such as theft or hardware error. Logical threats are logical routines or software, such as overload attacks or software errors. The third group of threats focus on problems related to human error. The study found more than thirty different threats, with many aimed at more than one resource. Physical threats include manipulation of the OBE and logical threats include errors in the central server, lost communication channels or software error. Finally, human threat includes problems with usability, i.e. system components being used improperly.

\textsuperscript{34} ARENA REPORT 2008:7. Boldt, M et al., “Hotanalys för positionsangivelsekedjan”
6 Legal aspects

The introductory work of defining a solution for kilometre tax in Sweden has shown that many of the principles established, e.g. for the Stockholm congestion tax, are difficult to apply to the kilometre tax. This means that when it comes to the kilometre tax legislators must find new solutions for aspects, such as handling foreign vehicles, which are not covered by current legislation. In addition to national legislation, there must be compliance with the European directives. The EFC directive (2004/52/EC) specifies that member states can introduce road tolls for different types of vehicles – locally or nationally – but points out that all solutions must satisfy the principles of free mobility, non-discrimination and protection of personal integrity.

6.1 Mandatory OBE and tax on entire road network

ARENA’s proposal for a kilometre taxation concept requires a mandatory OBE for all system users, including foreign vehicles. Discussions with the EU Commission indicate that this will be possible. A mandatory OBE is already required in the Austrian system, with the argument that the OBE is inexpensive and very easy to install in vehicles. ARENA presumes it will be possible to develop a very simple OBE for the Swedish system, but this requires further investigation.

ARENA also proposes that the entire Swedish road network be subject to kilometre tax, even if the tax is not levied for all roads. This means that certain parts of the road network will have null tax. The main argument for this is that if facilitates more control for the tax.35

6.2 Payment base on declaration

Declaration duty
The term declaration duty has been introduced. That is to say, vehicles subject to the tax are obligated to report their movement patterns as the basis for calculating tax and the subsequent tax decision. This also requires that vehicle owners (or the Toll Service Provider, TSP) keep track of when there is a declaration duty. Legislation must regulate when the declaration must be reported and at what intervals or on what occasions.

A Toll Service Provider is an intermediary
A future kilometre tax will also apply to foreign vehicles. As per the EFC directive and the definition of the European Electronic Toll Service (EETS), the vehicle owner’s representative, the Toll Service Provider (TSP), has a representative duty to pay. In turn, the vehicle owner has a duty to pay the representative. If there is no representative, the tax claim is directed right to the driver/vehicle owner.

35 In this manner, the declared distance can be compared to the distance driven by the vehicle during the annual vehicle inspection
Payment services
There are organisations that provide the service of payment function handling. For example, this is seen with congestion tax in Stockholm. It means that a service company serves to monitor tax decisions and implement payment on assignment of the vehicle owner. Establishment of this type of service should be taken into consideration in coming legislation.

Manual tax statement
It should be possible to issue a manual tax return, if the electronic declaration service is non-operational.

6.3 Border and control problems

Mandatory tax statement at border
According to EU’s rules on free mobility, Sweden does not have the right to stop vehicles at the border if there is no special cause for such. In order to facilitate compliance control in a kilometre tax system, there should be a requirement that the driver automatically submits an electronic route declaration when the vehicle exits Sweden.

Photographing vehicles
All vehicles subject to the tax must be known to the Toll Charger. This is solved by allowing the government agencies to photograph all heavy goods vehicles that enter and exit the country and by reading the number plate. This is already done in Finland.

Right to check vehicles
The project presumes that the Toll Charger or an appointed supervisory authority (police) have the right to perform random sampling of vehicles travelling the road network. They must have the right to stop vehicles to check that equipment is operational and they must have the right to photograph vehicles in order to identify them via the number plate and verify information with submitted declarations. If the “vehicle” cannot prove that it handled the route declaration correctly, the photo must be saved. The controller must also have the right to charge a penalty tax on site before the vehicle is allowed to continue.

Driver’s responsibility
There must be clarity as to what responsibility the driver has for ensuring that tax is levied correctly and on what grounds the driver can be prevented from continuing travel if he or she violates the rules.

6.4 Currency and VAT

Currency risk
According to the EFC directive and the payment guarantee for the European Electronic Toll Service (EETS), all distance-based road user charges, regardless of where in Europe the vehicle travelled, must be compiled to an invoice sent by the Toll Service Provider used by the haulier. The Toll Service Provider should normally invoice the customer in the customer’s currency, but the Service Provider may have to pay the toll/tax in other currencies. There must be an investigation to determine whether a Swedish kilometre tax must also be accepted in currencies other than SEK in order to handle any currency risk.
VAT
The kilometre tax should be exempt from VAT, but this could conflict with EU directives. The problem is that VAT could be difficult to demand on claims against foreign drivers or Toll Service Providers. This is also problematic since Swedish hauliers have the right to be represented by a foreign Toll Service Provider, and thereby receive an invoice for Swedish kilometre tax from abroad.

6.5 Supplementary services
Several stakeholders have pointed out that it must be possible to systematically co-ordinate a future Swedish kilometre tax with other telematics services. For this reason, there should not be any legal hinders for use of the vehicle equipment for purposes other than kilometre taxation. The OBE that registers and communicates route should not be covered by legislation. The fact that the OBEs of foreign Toll Service Providers must be allowed is another reason to avoid technical solutions/locking in legislation.

6.6 Need for Swedish specification
The ARENA project presumes that when procuring a kilometre tax system, no reference will be made to international standards. It may therefore be a good idea to establish a “national specification” similar to that done for DSRC prior to introduction of congestion tax. A possible solution could be to develop the concept description to a specification that is an important document during future procurement.
7 ARENA 2.0 – next steps in the project

7.1 Swedish development of technology and organisation with EU perspective

ARENA 2.0 builds further on work with a national and international environment to by 2010 develop the concept for a Swedish kilometre tax for heavy goods vehicles. The concept shall fulfil Swedish requirements technically, organisationally, administratively and legally. At the same time, it shall be harmonized with European development. The goal is to develop a function description that can be used as a basis for decision making and for procurement of a technical system. This requires deepening of the work performed in the project thus far. In addition, the concept must be adapted and discussed with important national and European stakeholders. A proposal for a national organisation must be drawn up, with roles and responsibilities allocated in an international context that responds to the legal preconditions of both Sweden and the EU.

It is also important to view a Swedish kilometre tax for heavy goods vehicles from a broader telematics perspective. A kilometre tax with the characteristics defined by ARENA creates the preconditions for additional telematics services of value to society and business, improved traffic safety, more efficient transport planning and improved use of the road transport system.

7.2 Industry co-operation validates the concept and creates understanding

Practical trials and demonstration activities will play an important role in ARENA 2.0 in order to sample different solutions, test interoperability and create understanding of the possibilities and limitations of the kilometre tax system within industry, government authorities and political forums. Co-operation with industry and system manufacturers makes it possible to validate the concept of the kilometre tax system and associated applications that are developed. Knowledge and experiences from projects with similar demonstration activities can be obtained nationally and from abroad and the Swedish results can be spread.

7.3 Demonstration during ITS World Congress 2009

ARENA 2.0 intends to build a demonstration environment that can be displayed during the ITS World Congress, which will be held in Stockholm in 2009. The idea is for the trial area’s focus to be expanded to E-Transactions and be a resource for any subsequent implementation process for a kilometre tax system, such as for certification and demonstration in a procurement procedure.
7.4 Continued work

The need for continued work can be summarised in the following points:

• The concept, including the control system, must be further developed in co-operation with interested parties – both national and international. There is a need for deeper understanding of the practical, legal, organisational and administrative consequences of the concept.

• ARENA’s endeavour based on co-operation and trust between different stakeholders in a kilometre tax system requires more analysis of business models and process in order to ensure that the system stimulates “correct” behaviour.

• There must be investigation of how system design is affected by what the market can deliver in terms of technical equipment and services and what roles can/should be entrusted to public stakeholders.

• The interoperability between different systems must be developed and shown in practice. Furthermore, related responsibility issues (for payment) and associated sanction possibilities must be defined.

• A Swedish system for kilometre tax must meet Swedish needs but at the same time be integrated in a European solution. Swedish requirements must therefore be taken up in international forums that have significance in the EU.

• There will be development of ITS-related services regardless of any decision on continued development of a kilometre tax system. It is therefore important that the industry, decision makers and those forming opinions develop a future vision for a sustainable transport system.

• ARENA 2.0 will be demonstrated during ITS World Congress 2009.

• Efforts are needed to continue the network building started by ARENA. This is a unique opportunity to further international knowledge development in the interfaces industry, universities, politics and public administration.

• ARENA has started competence build-up that should be made use of and further developed during the next phase of the work. The intention is to prepare and initiate a research centre with a link to e-payments/e-transactions for national, long-term development.
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