Manual for financial calculation model for electric roads
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1. Background and purpose

The calculation model is a tool designed to create a more in-depth understanding of the financial consequences for various actors in a future electric road system at system level, based on a financial profit-and-loss perspective. The model has been developed as part of the work on the report: "The electric road system’s actors and financial conditions – An analysis of the operator’s role and short and long-term scenarios". The calculation model is useful as a basis for discussion in order to assist in creating an increased understanding of what different conditions mean for a potential electric road operator and other actors in the electric road system. This does not imply, in itself, that there are any requirements for the establishment of the role of electric road operator. Other organisational forms are conceivable and possible.

The calculation model has been developed by the Electric Roads Programme in collaboration with EY. The calculation model should only be viewed as calculation support for various configurations of an electric road system. It cannot be used as decision data for decisions on investments in electric roads.

The application area of the calculation model only extends, on an overall level, to simulating consequences based on input data. Prior to investment decisions, the user should conduct his/her own analyses in his/her own models in order to obtain complete and accurate decision data. The Swedish Transport Administration does not accept any responsibility for the investment decisions taken by another party and where the calculation model has been used.

2. Scope of the calculation

The calculation model has been developed with a starting point in the investments assessed as necessary in order to establish an electric road system, as well as estimated operating and maintenance costs for the infrastructure. The model is based on a number of input values. These input values are adjustable and can be changed by the user based on existing knowledge and the test scenarios desired.

The purpose of the calculation model is to roughly calculate the financial effect on the actors involved in an electric road system. The following actors are included in the calculation model:

- Electricity suppliers
- Electricity grid operators
- Vehicle manufacturers
- Operators
- The State (in the role of recipient of tax revenue from e.g. fossil fuels)
- Swedish Transport Administration
• Haulage contractors

Annual costs/expenses are calculated for each actor with regard to:

• Depreciation of investment
• Operation and maintenance
• Electricity consumption
• Interest rate

Annual revenues from user fees are also calculated for the actors. In this way a result can be calculated and any financial robustness in the system identified. The calculation also includes an estimation of reduced CO2 emissions.

2.1 Delimitations

The calculation model is based on certain delimitations as well as limitations and should be used with caution. These include the following:

• The calculation model has its starting point in a financial profit-and-loss perspective and therefore shows costs, revenues and results for a given year. The model does not take into account or calculate discounted cash flows over time or balance sheet effects.

• The calculation model does not take into account the cost of shareholder equity.

• The calculation model cannot and must not be used as the basis for investment decisions, but should rather be viewed as a tool that can indicate which additional analyses may be interesting to perform.

• The project has taken into consideration whether to maintain the calculation model at a system-wide level, which is why more detailed calculations for each actor and investment component will be required for a more in-depth analysis.

• The calculation model has a financial perspective as its starting point. For the socio-economic effects of electric road investment, see the Electric Road Calculator.

• The calculation model does not take account of all of the current legal restrictions that may limit, for example, potential forms of ownership, resource availability and payment options within the roadway.
• In a long-term scenario, with a more comprehensive electric road development, there are several rates of development that can be tested hypothetically. The values used for an analysis of investments in the long term should therefore be viewed with extreme caution. The long-term results of the calculation are therefore primarily to be considered as an indication of the nature of the financial robustness in different options. It is likely that increased knowledge will be accumulated over time, which may mean a changed perception of these input values.

• The calculation model shows only one point in time and does not take into consideration any ramp-up periods for building electric roads.

• The calculation model should be updated continuously to reflect the current level of knowledge at any time.

• The calculation model only takes into account two types of fuel: electricity and diesel, or a combination of these two. This means, for example, that any environmental effects that occur if changing from diesel to biodiesel, for example, are not taken into consideration.

• The calculation has only been developed for the Swedish Transport Administration and no third party is entitled to draw on the model.

3. Calculation tool structure and usage

The calculation model consists of three stages, which are described in more detail below:

1. Input data
2. Calculation
3. Results

3.1 Input data

In the first stage, input data, the information used in the calculation, is entered. The input data are structured according to the categories of: traffic, truck, fuel, financing and environment. For each category there are a number of subcategories where one value is selected for each subcategory. The structure for the input data is shown in Figure 1 below.
### Traffic

**Data:**
- Number of days in a year: 365
- Total ADT (annual average daily traffic): 2,281,250
- Percentage of daily ADT driven on ERS: 0.01%
- Number of passages per day per HGV: 150
- Annual vehicle kilometres per HGV: 101,773
- Percentage of HGV kilometres driven on ERS: 60%
- Percentage of the road that is electrified: 13%
- Total ERS length: 6,58
- Electric road infrastructure: 1,368,750
- Cost of electric road infrastructure: 1,368,750
- Number of HGVs in Sweden: 150
- Cost per payment transaction: 0.35
- Total fee for ERS usage: 0.03

**Comment:**
- Total fee for ERS usage: Highest possible user fees that can be charged without exceeding the diesel price.
- Electric road infrastructure: Can be reduced by the equivalent investment in electric road infrastructure and road furniture (such as barriers or other adaptations in the roadway). Since, in the assumptions made, the electricity grid must be routed along the whole section of road, this investment is not affected by the length of road to be electrified.

The next step is to make selections in the various categories:

- **Traffic:** Here, enter the ADT (annual average daily traffic), which is the average traffic flow over 24 hours during a year in both directions that is expected to use the electric road (i.e. electric road (ERS) adapted trucks). In addition, select the proportion a truck drives on the electric road in relation to the total mileage expected per year, which you enter as "Vehicle kilometres on electric road". This must not be mixed up with "Percentage of the road that is electrified", which is the percentage of the ERS section that the model should calculate as requiring ERS infrastructure.

If this percentage is lowered to below 100%, it is assumed that the investment in ERS infrastructure and road furniture can be reduced by the equivalent investment expenditure. If the figure is below 100% then this indicates a sectioning of the ERS installation, where the gaps without ERS infrastructure are assumed to be drivable.
using diesel or battery operation. Finally, enter the number of payment transactions and price per payment transaction, which is one way of calculating how much revenue an actor responsible for measurement, billing and access control could be expected to obtain from the users in order to cover its costs, should such a charge be applied.

- **Truck:** Here, select the amount for truck premium, i.e. if a government grant shall be paid for the purchase of/conversion to electric truck. The model assumes that the truck premium cannot exceed the additional cost of converting to an electric truck. Here, also enter the annual mileage for a truck.

- **Fuel:** Here, enter the price of diesel per litre (excl. VAT), diesel consumption per kilometre and the tax on diesel. Here, also enter the price of electricity per kWh (excl. VAT), the tax on electricity and the charges for power and transmission for the electricity grid. Finally, also enter a value here for any additional willingness to pay for electric roads on the part of the customer.

- **Financing:** Under this category, enter a value for economies of scale (discount) in electric road related investments. This means any economies of scale when building electric roads, in order words, the coast saving per km possible for larger installations. Enter this as a percentage reduction in the cost of investment per kilometre. This is applied for investments in electricity grids, electric roads, and road furniture.

- **Environment:** In the final category, select an emissions factor for CO2 for trucks, which means emissions of CO2 in tonnes per kilometre driven.

### 3.2 Calculation

In the next stage, perform the calculations based on the input data chosen in the first stage. The calculations are made for investments, expenditure and income for each component in an electric road, where each component is represented by a row. The components are as follows:

- Construction and operation of electricity grid (beside the roadway)
- Construction and operation of ERS infrastructure (within the roadway)
- Construction and operation of road furniture (within the roadway)
- Additional cost, electric truck
- Electricity consumption
- System for measuring and billing

In addition to input data, you also need to make certain selections in this step (see below). The cells that can be adjusted are in yellow. The calculations take place in the white cells.
3.2.1 Investments

In this step, first perform calculations linked to investments in the various components, see Figure 2 below. In the column "Actor responsible for investment", select which actor it is that is responsible for the investment and consequently any costs for depreciation and interest.

**Figure 2: Calculations linked to investment**

Perform the calculation in the column "Total investment for entire section (ERS) (SEK)", which is affected by the option selected in the column "Selection of level of investment". In the column "Select level of investment", decide what investment/km and component to include in the calculation. The options are Low, Medium or High, and equal the values in the columns of the same name.

The values selected in the columns "Depreciation period (years)", "Percentage financing by loan (%)" and "Interest rate (%)" determine the annual cost that will be incurred as a result of the investment. In the column "Depreciation period (years)", select how many years the investment over which the investment shall be written off. In the column "Percentage financed by loan (%)", select how large a percentage of the investment shall be financed by loan, and in the column "Interest rate (%)", select the interest at which the loan is assumed to be taken out. The part that is not financed by loan is financed indirectly via shareholder's equity, but the model does not take into account the cost of shareholder's equity.

3.2.2 Costs

The structure for the annual costs is shown in Figure 3. The rows represent different subcomponents as in Figure 2.

**Figure 3: Calculation of costs**

In the column "Depreciations", calculate the annual cost for depreciation based on the previously calculated investment as well as selected depreciation period. Three columns
then follow linked to operation and maintenance for each respective component. First select which actor should bear the cost of operation and maintenance, since this does not necessarily need to be the same actor as the one responsible for the investment. In the column "% of investment", select the amount for the operation and maintenance cost as a percentage share of the amount of the investment. In the next column, calculate the cost based on this selection. For the component "System for measuring and billing" (the row at the bottom in Figure 3), select a value for operation and maintenance directly in the cost column.

In the column "Electricity", calculate the cost of the electricity consumption based on previous selections made. In the next column, calculate the interest cost for the investment based on previously selected interest rate. A column for other costs is available in the cases that the costs in addition to those already calculated are considered necessary to add. Finally, calculate the total costs for each component in the column "SUM costs".

3.2.3 Revenues and results

The structure for the calculation of revenues is shown in Figure 4. As in Figure 2 and Figure 3, the rows consist of components.

![Figure 4: Calculations of revenues and results](image)

When calculating revenues, first select the actor to which the revenues for each component are due. The select what proportion of the user fees should be allocated to each component. In the next column, calculate the revenues from the user fees, based on the two previous options selected, as well as how many kilometres are driven on electric roads and which thereby form the basis for the user fees. There is a column available for revenues from additional services if it is considered that such services might be provided. Finally, there is a column available for results, where costs and revenues for each component are summed up.

3.3 Results

The results from the calculation model are compiled for each actor in a table, see Figure 5.
The table consists of nine columns for each actor. In addition to the actors that could previously be selected for investments, costs and revenues, the "State" is also included in the results. Here, the State's costs consist of revenue loss in the form of diesel tax and VAT in the transition to electric power. The revenues consist of tax on electricity consumption as well as VAT for this.

The columns in the table are as follows:

1. **ERS investment (SEK)** – Total of the investments calculated in the column "Select" under Step 2 (Calculations)

2. **Cost (SEK per year)** – Total of columns "Depreciations", "Operation and maintenance", "Electricity", "Interest" and "Other costs" from Step 2 (Calculations)

3. **Revenue (SEK per year)** – Total of columns "Revenues from user fees" and "Additional services" from Step 2 (Calculations)

4. **Revenues from user fees (SEK/km)** – Revenues per kilometre from user fees

5. **Result (SEK per year)** – Difference between revenue per year and cost per year

6. **Result in relation to investment** – Result per year in relation to the investment

7. **Profit margin** – Result as proportion of revenues

8. **Deficit (SEK per year)** – Annual deficit, if the cost is higher than the revenues

9. **Payback period (years)** – number of years before the investment has been paid back by the revenues.

The results of the calculation model also include a compilation of the distribution of user fees between the actors, see Figure 6, Annual result per actor, see Figure 7, as well as reduced emissions per year, see Figure 8.
Figure 6: Distribution of user fees per actor

Figure 7: Result per actor

Figure 8: Reduced emissions