SUMMARY CBA

Removal of a major bottleneck – Varberg tunnel on the Swedish West Coast Line

Draft No SEP-210898648

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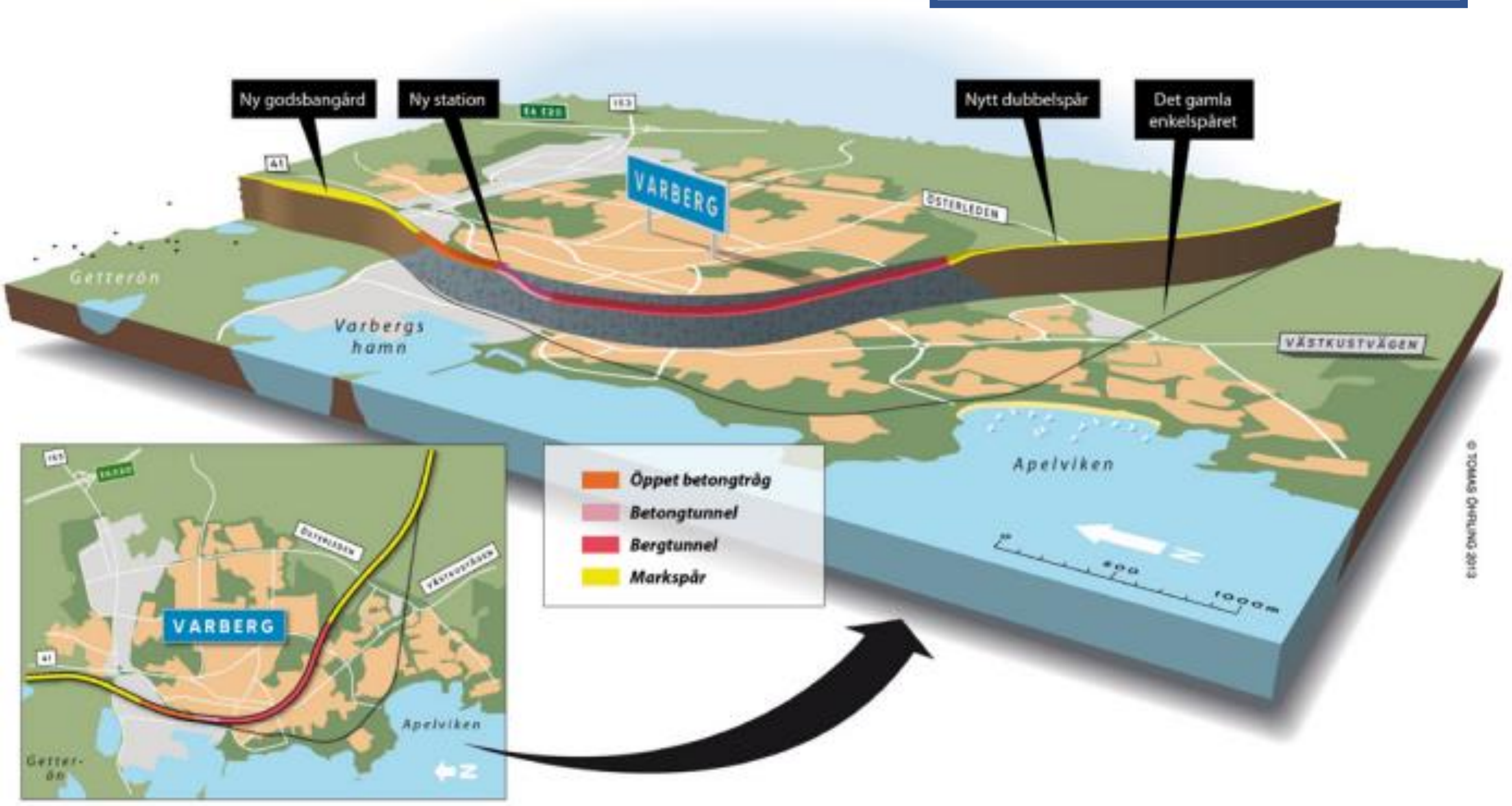

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1. Introduction

This document provides a summary of the cost benefit analysis (CBA) for the Project; Removal of a major bottleneck – Varberg tunnel on the Swedish West Coast Line, Draft No SEP-210898648. The CBA:s performed in Sweden are included in a document called *Overall Impact Assessment (Samlad Effektbedömning),* henceforth abbreviated SEB). The SEB is a larger document, composed of presentations of results from different kinds of analyses of investments in the transport system, one of which is a CBA. For the purpose of this document, the Swedish CBA will be referred to as the CBA presented in the SEB, while CBA will refer to the method in general or when stated, to the methodology recommended by the European Commission and Directorate-General for Regional and Urban Policy (DG REGIO).

The first part of this report, chapter 2, describes the current situation. Chapter 3 presents information regarding the calculations made for the project. This is then followed by a presentation of the CBA presented in the SEB, as well as the results from CBA presented in the SEB recalculated using the standards recommended by the European Commission and DG REGIO. Chapter 4 contains a description of the CBA calculations used in the Swedish SEB, as well as a discussion of the differences between the Swedish methodology and DG REGIO's methodology. The fifth and final chapter contains a description of Sweden's infrastructure planning process.

2. General description of the current situation, including needs and objectives

There is a growing need to consider sustainable multimodal infrastructure solutions covering both passenger and freight transports. One such solution is to transfer passengers from road transport to railways. In order to reach such a goal, passengers need to be confronted with viable alternatives. For more energy efficient and environmentally sound alternatives to be perceived as beneficial in terms of time consumption and convenience, a combination of pull and push factors may have to be implemented. This project will increase the attractiveness of public transport, by reducing vulnerabilities and travel times. The investments will have positive effects within the entire Scan-Med Corridor between Oslo and Copenhagen.

The West Coast line (Västkustbanan in Swedish) connects Gothenburg with Malmö and Copenhagen through Varberg and is important for both passenger and freight transport. With this project, trains on the minor railway Viskadalsbanan will also benefit from the project since it connects to the West Coast line. Since the West Coast line is limited to single-track south of Varberg, the speed for trains are limited to 90 km/h. Further, the line has six level crossings in Varberg, thus creating a barrier in the built environment. The stretch is one of the last bottlenecks along the whole line and the project will reduce travel times and delay times, while increasing flexibility.

2.1 Brief description of the Project

The Varberg – Hamra section is one of the last single-track sections along the West Coast Line (stretching from Gothenburg to Lund). The plan is to expand the section to double-track, as well as reconstruct Varberg station. The Project also entail the relocation of the freight yard and moving the railway tracks underground. As a direct result of the project, the distance is reduced by 1.2 kilometres which will affect all trains. This is shown in figure 1.

FIGURE 1: THE PLANNED TUNNEL (GREEN AND PURPLE) UNDER VARBERG AND EXTENSIONS OF NEARBY RAILWAY SECTIONS. THE GREY LINE IS THE CURRENT RAILWAY. VISKADALSBANAN CONNECTS TO THE WEST COAST LINE IN THE NORTHERN PART OF THE MAP.

3. The SEB

The Swedish Collected assessment of effects, or SEB, is a document providing information to decision makers, composed by presentations of results from different kinds of analyses of effects of investments in the transport system. One kind of analysis is economic cost-benefit analysis (CBA), and the others are an analysis of distributional effects and an analysis of the contributions to attaining the national transport policy goals. The CBAs made in the transport sector, and presented in the SEB, follow the recommendations by ASEK-report (the Swedish CBA guidelines for transport investments) regarding prices/shadow prices and principles of analysis.

3.1 Results from the CBA presented in the SEB

The results of the CBA performed in the SEB are summarized below (all costs in SEK). The CBA presented in the SEB uses a time horizon of 60 years, beginning year 2020. The residual value is set at zero because the economic lifetime of the asset is the same length as the time horizon. The social discount rate used in this analysis is 3.5 percent. The investment cost of the project is 7 billion SEK in 2014 prices, the equivalent of 645 million EUR.[1]

Economic analysis, results – summary

Net present value of investment, in million SEK	+	Environmental effects that have not been monetary valued	+	Other effects that have not been monetary valued	=>	Assessment of economic results
-947		*Positive*		*Positive*		*Not viable*

Effects included in the economic analysis – summary

[1] Values expressed in EUR, EUR-SEK conversion rate used, 1 EUR = 10.9243 SEK (October 2022)

Effects that were monetarily valued		
	Examples of effects in 2040	**Present value (million SEK)**
Travelers	*Travel time: -270 kh/year*	*4 812*
Freight transport	*Transport costs: -4 million SEK/year*	*250*
Passenger transport enterprises	*Operating costs: -9.6 million SEK/year*	*587*
Traffic safety	*Deaths and severely injured: 0 DSI/year*	*43*
Climate	*CO2 emissions: -980 ton/year*	*45*
Health	*Reduced noise: 11.41 million SEK/year*	*285*
Miscellaneous	*O&M costs: -7.5 million SEK/year*	*81*
Investment cost	*Annuity costs: 282.6 million SEK/year*	*-7 049*
Net present value of investment		*-947*

Ratio based on priced effects					
***NNK-i=**	*-0,13*	***NNK-i** (sensitivity analysis) **=**	*XX*	***NNK-idu =**	*-0,14*

Summary of effects that were not monetary valued				
Interested in/affected by effect		**Assessment**	**Overall assessment**	**Short summary of effects**
Environment	**Climate**	*Negligible*	*Positive*	*Effect included in economic analysis.*
	Health	*Negligible*		*Effect included in economic analysis.*
	Landscape	*Positive*		*The tunnel entails reduced barriers for other modes of transport and provides increased opportunities for urban development*
Others	**Travelers**	*Positive*	*Positive*	*Increased convenience as a result of the travel center*
	Freight transports	*Negligible*		*Effect included in economic analysis.*
	Passenger transport company	*Negligible*		*Effect included in economic analysis.*
	Traffic safety	*Positive*		*The travel center and multilevel passages to the platforms provide increased safety, for example, when changing means of transport*
	Others	*Positive*		*Prerequisite for municipal urban development*
Overall assessment of the combination of all effects not monetary valued			*Positive*	

3.1.1 Assumptions and calculation

In the following subchapter, the assumptions and calculations used in the CBA for the project presented above are discussed. For further details about the Swedish CBA method used in the SEB, please consult chapter 4.

The models used to calculate the effects of this project are Bansek and Plankorsningsmodellen.

Bansek is an Excel-based tool used to analyze infrastructure measures and track charges within the railway system. The model calculates effects for passenger transport enterprises, public budget effects, passenger effects, effects for freight transports and external effects. In Bansek, the analyst can see the effects on separate track lines of passenger trains and freight trains, but not divided by geography so that side effects outside the transport market can be described (this must be evaluated separately).

Plankorsningsmodellen (Plk) is an Excel-based tool for economic calculations of measures for level crossings. The model calculates effects on travel time, vehicle costs, accidents, emissions, and the cost of operation and maintenance of the Swedish Transport Administration's facilities. Plk can be set up together with an estimate by means of Bansek to provide insight regarding the impact of railway measures on road traffic when, for example, a level crossing is removed.

Time savings and traveler's valuation of time

Capacity improvements achieved are calculated in terms of time gains, compared with an option where the project is not being implemented. Capacity utilization depends on the number of trains that operate the tracks and the infrastructure. The higher the capacity utilization, the more the different types of trains interfere with each other, and the greater the increase in travel time. New infrastructure, which increases the capacity, thus lowers travel time. The effects are calculated with mathematical capacity calculations and changed capacity extensions. The capacity calculations are performed in accordance with the methods described in the International Union of Railways (UIC) leaflet 406. Estimated time savings for travelers are 42.6 million SEK for the year 2040 in 2017 prices.

The number of people who benefit from the time savings is calculated with help from the forecast of the 2040 traffic flows made by the Swedish Transportation Administration. The forecast enables estimations on the number of people that are expected to travel the route in 2040. The tool used to make the forecasts is the national transport model, Sampers, which is held to the highest international standards. Based on travel times and number of passengers already using the railway, the number of new passengers switching from other modes of transport (i.e. car), as well as entirely new passengers in the system can be calculated. This is done by elasticity calculations.

Based on the calculations of the number of people who will travel the route in 2040, estimations on the value of travel time savings have been conducted. The total time savings are multiplied by the value of time to estimate the total value of time savings from the project. In the CBA presented in the SEB, the value of passengers' time is differentiated based on purpose and distance. The time value of each train is thus a function of the purpose of the passenger's trips and the distance traveled. The time value of (reduced) delays is estimated as higher than the time value of time saved due to faster travel, since delays are assumed to cause more inconvenience per minute.

The valuation of time in the transport sector's socioeconomic calculations is based on the marginal value of one hour of saved time. The valuation of travel time for private trips is estimated based on the traveler's own values. However, different individuals have different values, and the valuation of the individual may also differ from one occasion to another. These values are obtained using value of time studies. Different values of time have been used in the calculations based on the type of trip made. The value of time for new passengers is valued using the rule of half, i.e. half the added value of their time savings is added to the project.

The valuations of time are taken from the Swedish Guidelines. For further information and specific values, an English language summary is available (*Chapter 19 - English summary of ASEK Guidelines)*.

Based on these assumptions, the proposed project will result in the following average time savings and reduced distances:

West-coast line, north of Varberg:

Värö-Varberg	High-speed	Inter-regional	Freight
Trains per day	24	94	38
Travel time (min)	0,25	0,25	2,50
Delay (min)	0,25	0,25	2,50

West-coast line, south of Varberg:

Varberg-Hamra	High-speed	Inter-regional	Freight
Trains per day	24	66	30
Travel time (min)	2,00	2,75	2,00
Delay (min)	2,00	2,75	1,50
Distance (km)	1,2	1,2	1,2

Viskadalsbanan, north of Varberg;

Varberg-Tofta	High-speed	Inter-regional	Freight
Trains per day	-	32	2
Travel time (min)	-	0,25	0,25
Delay (min)	-	0,25	0,25

Traffic and traffic growth

Forecasts of traffic are made using freight and passenger transport models based on today's transport- and travel patterns. Data on current and future infrastructure, traffic and costs are included as input data to the models, as well as information on environmental conditions, population, economic development and fuel costs. The Swedish Transport Administration obtain data from official and well-established sources such as Statistics Sweden and the Swedish Ministry of Finance.

The CBA presented in the SEB uses the following annual growth rates for passenger traffic and freight, traffic based on estimates by the Swedish Transport Administration:

West-coast line		
	2014-2040	2041-2080
Passenger	1,60%	0,90%
Freight	2,33%	1,36%

Viskadalsbanan		
	2014-2040	2041-2080
Passenger	1,60%	0,90%
Freight	0,62%	1,36%

Passenger transport enterprises

It is assumed that time savings are beneficial for passenger transport enterprises, as train will become a more attractive mode of transport, resulting in better business for these companies. The greatest benefit for passenger transport enterprises is the additional revenue from ticket sales; however, they also benefit from reduced operation costs as a result of reduced travel time.

Freight transportation

Freight benefits consist of two components: the first is reduced costs for being able to transport capital goods faster (in other words, the goods spend less time in transit); and the second is reductions in operating costs as a result of reduced travel time.

Budgetary effects

Budget effects are generated mainly from additional revenues in terms of railway fees due to an increase number of trains that will traffic the rails. Furthermore, this includes the changes in revenue from taxes, primarily decreased government revenues from taxes on fuel, as travelers choose train over car travel. The purpose of budgetary effects in the CBA presented in the SEB is explained further in chapter 4.1.

Operational and maintenance costs

The total cost for maintenance and operation will increase as the size of the railway increases.

External effects

External effects included in the calculations are road safety, climate and health effects. All these effects result from modal shifts. Since transport by train is safer and less detrimental to the environment than transport by car, an infrastructure project that increases train travel increases these benefits.

ASEK's valuation of carbon dioxide emissions has traditionally been linked to political goals and instruments being based on citizens' direct or indirect addressed value and costs associated with damage, which is normally the case. In ASEK 7, the effects of climate change have been considered too extensive, long-term oriented, complicated and uncertain to be able to be assessed in an adequate way through socio-economic damage cost calculations.

Emissions of carbon dioxide or carbon dioxide equivalents must be valued at a political shadow price derived from the reduction obligation and the reduction obligation fee (SOS 2018: 195, SFS 2017: 1201). The valuation in ASEK applies to all greenhouse gases, not just carbon dioxide emissions. The valuation of emissions of other climate-affecting gases, such as methane, is made on a standard basis in terms of carbon dioxide equivalents. Conversion to carbon dioxide equivalents is done based on corresponding greenhouse gas GWP values (Global Warming Potential, according to the UN Climate Panel IPCC) where carbon dioxide has a GWP value of 1.

ASEK recommends that in socio-economic analysis of investments in infrastructure measures use a cost estimate of SEK 7 per kilo of carbon dioxide emissions, or carbon dioxide equivalents, expressed in the 2017 price level. The calculation value shall be constant in real terms over the entire calculation period.

There are ambitious political goals for climate, society in general and for the transport sector in particular, which led to significantly more instruments being in use than before. The transport sector now set the target of fossil-free car transports and 70% less greenhouse gas emissions by 2030. An increase in the considered value of climate emissions, compared to previous versions of ASEK, has therefore been considered reasonable.

Socio-economic investment

The socio-economic cost of the investment in the CBA presented in the SEB includes the marginal cost of public funds, i.e. the economic inefficiency caused by the collection of taxes. In accordance with ASEK-recommendations, the CBA presented in the SEB uses a factor (*the tax factor*, or *skattefaktor*) of 1.3 for this.

3.2 Results of the CBA presented in the SEB using DG Regio recommendations

The results from the CBA presented in the SEB has been recalculated using the standards recommended by the European Commission and DG REGIO.

Since the CBA presented in the SEB uses a 60-year time horizon, the present values for the project presented above have been recalculated to annual effects for the time horizon of 60 years using the estimations of economic development and traffic growth used in the CBA presented in the SEB. Using these multipliers, the values for the relevant effects have been recalculated annually for a 40-year time horizon in accordance with the European Commission and DG REGIO's recommendations. The residual value of the investment for its remaining 20 years of economic life has been calculated according to the recommendations of the European Commission and DG REGIO, by computing the net present value of remaining economic costs and benefits for the life years beyond the 40-year time horizon. The tax factor, used to account for the marginal cost of public funds, has been removed from the calculation, in accordance with the approach recommended by the European Commission and DG REGIO. All values are converted to EUR.[2]

The results of this recalculation are presented in the following subchapters. All costs are in EUR. The analysis uses a period of 40 years, starting with year 2021. The social discount rate used in this analysis is 3.5 percent. The financial discount rate for the financial analysis is 4 percent.

3.2.1 Financial analysis

The financial analysis includes the initial investment cost of the project, replacement costs and operations and maintenance costs. Revenues to the project are composed of track fees, plus the maintenance and replacement subsidies for the increased costs of operations. In the second chart, the effect of the CEF contribution, corresponding to 30 % of the eligible 170 million EUR investment cost (The cost for the Project) is shown.

Return on investment without CEF	NPV @ 4%
Project investment cost	-540,400,801
Replacement cost	-
Project O&M costs	-22,190,811
Total revenues	22,208,519
Residual value of investment	2,330,288
FNPV(C)	**-538,052,805**
FRR(C)	**-9.6%**

Return on investment with CEF	NPV @ 4%
Project investment cost	-540,400,801
CEF contribution	51,022,168
Replacement cost	-
Project O&M costs	-22,190,811
Total revenues	22,208,519
Residual value of investment	2,330,288

[2] Values expressed in EUR, EUR-SEK conversion rate used, 1 EUR = 10,9243 SEK (October 2022)

FNPV(C after CEF)	-487,030,637
FRR(C after CEF)	-9.3%

Financial net present value is calculated to -538 million EUR, while the financial rate of return is -9,6%. With the CEF contribution, financial net present value is calculated to -487 million EUR, while the financial rate of return is -9,3.

Funding Gap	-538,001,585
Funding Gap Rate	99.6%

The funding gap (i.e. the difference between discounted revenues, costs and residual value and the investment cost of the project) is calculated to -538 million EUR and the funding gap rate is 99,6 %.

3.2.2 Economic analysis

The economic analysis includes the investment cost of the project, replacement costs and operations and maintenance costs combined with the economic benefits, which include travel time gains, delay reductions, freight benefits, passenger transport enterprises, traffic safety increases and reduced CO_2 emissions. This project is economically viable.

	NPV @ 3,5%
Project investment cost	-540,400,801
Replacement cost	-
Project O&M costs	-23,830,572
Residual value of investment	129,113,524
Total economic costs	-435,117,849
Time gains (passengers)	71,792,272
Reduced delays (passengers)	262,125,236
Freight benefits	19,782,500
Passenger transport enterprise	44,384,154
Traffic safety	8,302,263
Climate effects	12,245,998
Noise effects	21,238,808
Total economic benefits	439,871,231
ENPV / Net benefits	**4,753,381**
ERR	**3.5%**
B/C RATIO	**1.01**

Total economic costs of the project are calculated to 435 million EUR, while the total economic benefits are calculated to 440 million EUR, generating a net benefit of 4,74 million EUR. The economic rate of return is 3,5 %, and the benefits to costs ratio is 1,01.

4. The Swedish CBA method

In Sweden, ASEK (the Swedish CBA guidelines for transport investments) recommends the principles, costs, prices, and shadow-prices that are used in social cost-benefit analyses (CBA) in the Swedish transport sector. The recommendations are proposed in the ASEK-report and approved by the Swedish Transport Administration. The current version of ASEK recommendations is ASEK 7.0 (published 2020-06-15). This application however is based on ASEK 6.0, a previous version. ASEK reports are published on the website of the Swedish Transport Administration. An English language summary is available (*Chapter 19 - English summary of ASEK Guidelines*).

The recommendations are primarily applied to analyses of publicly provided infrastructure investments, as the major part of transport infrastructure in Sweden is publicly owned and managed by the Swedish Transport Administration.

ASEK recommendations are based on scientific results or well-tried and commonly accepted procedures and facts. Suggested ASEK recommendations are subject to second opinions from scientific experts before they are accepted (or rejected). Commonly known sources are recommendations from the HEATCO project, funded by the EU Commission, along with various studies carried out in Sweden, for example by the Swedish National Road and Transport Research Institute.

The aim of the CBA presented in the SEB is to provide quantitative data on how much a project contributes to efficient and sustainable economic, environmental and social development. The same methodology for socio-economic studies (socioeconomic and/cost benefit analyses) has been used by the Swedish Transport Administration for many years. This makes it possible to compare the social net benefit of historical projects.

In order to determine whether a single project is beneficial, or to compare projects without consideration of budget constraints, ASEK recommends the use of NPV (Net Present Value). To compare projects with respect to budget constraints, ASEK recommends the decision criteria RNPSS (The Ratio of NPV and public-sector support). In Sweden, this ratio is indicated by a *nettonuvärdeskvot* (Net Present Value Quota, abbreviated NNK).

There are two different NNK recommended be used. , which is the ratio of NPV and the social cost of the investment:

$$NNK - i = NPV/I$$

Where I = the social cost of investment. The second is:

$$NNK - idu$$

Which is the ratio of NPV and the sum of the social cost of investment and the social costs of operation and maintenance during the lifetime of the investment:

$$NNK - idu = NPV/(I + DoU)$$

Where I = the social cost of investment, and DoU = changes in the social costs of operation and maintenance due to the investment.

The social costs of the investment and changes in operation and maintenance costs include the marginal cost of public funds due to the public funding of infrastructure investments and infrastructure operation and maintenance. The social costs of investment and operation and maintenance includes overhead costs for planning and administration.

The decision criteria are as follows:

$$NPV \geq 0, \qquad NNK - idu \geq 0$$

When ranking projects, a larger value of NPV or NNK-idu is better than a lower value of the same measure. NNK values are used to rank and prioritize between projects and should be above zero in order to be economically viable.

Key values for measuring the effectiveness of attaining the transport policy goals should be expressed in terms of effect per thousand Swedish kronor (thousand SEK) invested, instead of the cost in SEK per unit of effect. The reason for this is to facilitate comparisons of key values for different projects and different goals.

Note: ASEK previously recommended using two different calculations of NNK, as discussed above relayed to the ASEK 6.0 that this SEB is based on. In the current recommendations only the NNK-idu is used. This is due to the fact that investment cost, as well as costs for operation and maintenance, should be taken into account when evaluating projects.

4.1 General differences between the Swedish implementation of CBA and CBA according to EU standards

ASEK recommendations and the CBA presented in the SEB are generally consistent with economic theory and cost-benefit analysis practice. Both use the real values of price level, and the price level is equal to the base year. The CBA presented in the SEB has a wider scope than a traditional CBA, and all effects are presented in this CBA, including taxes and VAT. To correct for the tax and VAT, the CBA presented in the SEB has a section of budgetary effects. These budgetary effects are not direct effects on consumption or production, but pure redistribution effects. Such effects do not affect the net result in a calculation. To translate the CBA presented in the SEB to a CBA according to EU standards, the taxes and VAT reporting have to be added to either the producer or the consumer surplus. In short, the Swedish CBA is what in English is called an Economic Analysis.

Another difference between the CBA presented in the SEB and a CBA according to the EU is the time horizon. The European Commission and DG REGIO recommend a time horizon of 30-40 years, while 40-60 years is the norm in the Swedish CBA. Furthermore, the Swedish CBA assumes that the time horizon matches the economic lifetime of the asset. In the translation from the CBA presented in the SEB to a CBA according to EU standards, the Swedish CBA has been recalculated to 40 years, plus a residual value for the remaining 20 years. The residual value of the investment for its remaining 20 years of economic life has been calculated according to the recommendations of the European Commission and DG REGIO, by computing the net present value of remaining economic costs and benefits for the remaining life years beyond the 40-year time horizon. For the financial analysis, the residual value has been calculated with the same method but using the present value of cash flows.

The CBA uses a discount rate of 4 percent while the CBA presented in the SEB has the standard discount rate of 3.5 percent. In the translation from Swedish CBA to a CBA according to the recommendations of the European Commission and DG REGIO, no changes were made to the discount rate. This is due to the amount of work it would have taken to recalculate the effects in relation to the difference it would mean for the results.

5. The Swedish planning system

The planning process for infrastructure in Sweden is divided into two parts: the physical planning process and the financial planning process. The physical planning includes investigations on what projects are needed, the design and the location of the project. The financial procedure decides on which projects will be implemented, given the means allocated to infrastructure.

The physical planning process is usually preceded by a Study of Strategic Choice of Measures (*Åtgärdsvalsstudie*) in accordance with the “four-step principle”. In step one, projects that affect travel demand and mode choice are considered. In step two, projects that make more efficient use of the current transport system are considered. In the third and fourth step, reconstruction and/or new construction is considered. Projects that are conceived in steps three and four are used in the physical planning process. The final decision, however, depends on the financial planning process.

The financial planning process is based on results from the physical planning process. The role of the financial planning process is to select projects for implementation. The process begins with a Strategic Study (*Inriktningsplanering*) of the future needs of the transport system, and what general projects are required to meet those needs. When the Strategic Study is complete, Project Planning (*Åtgärdsplanering*) commences. This step aims to identify objects that are in line with the strategic plan and the political goals for the transport system. The ultimate output from the financial planning process is the collection of projects that will be implemented in the following 12 years.