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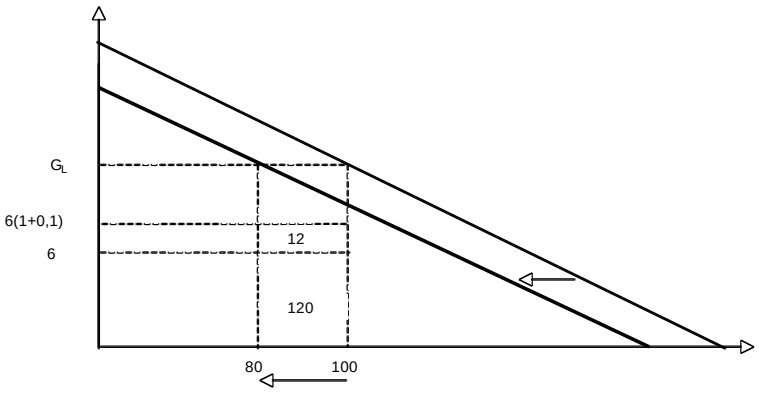

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Summary of the ASEK Guidelines

This is a summary of the recommended CBA principles, costs, prices and shadow-prices presented in chapters 5-15 of the ASEK report. ASEK is a Swedish abbreviation meaning the principles and values that are recommended to be used in social cost-benefit analyses (CBA) in the Swedish transport sector. The recommendations are mainly applied in CBA of publicly provided infrastructure investments (the major part of transport infrastructure in Sweden is publicly owned and managed by the Swedish Transport Administration). The latest version of the ASEK report, the one that is to be applied, is published on the web site of the Swedish Transport Administration: **www.trafikverket.se/ASEK**.

The ASEK recommendations are based on scientific results or well-known and commonly accepted procedures and facts. Suggested ASEK recommendations are usually subjected to second opinions from scientific experts before they are passed (or rejected). The present version of ASEK recommendations is ASEK 7.0, published 2020-06-15.

5. CBA and input values

5.1. Relevant costs and benefits

Cost data relevant to the CBA and treatment of "sunk costs"

Costs and benefits relevant to the CBA are:

- Only costs and benefits distinguishing between the evaluated project (in Swedish indicated UA standing for the "alternative being considered") and the reference scenario (Swedish indicated JA, "the comparing alternative") should be included in the CBA. Thus, the CBA should include the costs and benefits of the effects that will arise if the project (UA) is carried through but will not arise if the project is rejected (the reference scenario JA will be valid).

- Future costs and benefits, originating from the decision to choose the project (a certain investment or a certain way of action) that is evaluated by CBA. Costs that are already arisen and cannot be retrieved, i.e. sunk costs, should not be included in the CBA. Such costs are not relevant to the decisions for the future. However, sunk costs for planning the investment projects may be included in the investment cost for practical reasons. The costs for planning and administration that are sunk costs are difficult to separate from future over-head costs for administration and besides, the sunk costs for planning the investment constitutes a very small share of the total investment cost.

Investment costs in the reference scenario (indicated by JA)

If the reference scenario (JA) will require investment costs that are not yet decided on and therefore cannot be included in the reference scenario JA, these investment costs should be included in the analysis of the project (UA) as benefits or cost savings (savings of costs of JA).

The recommended decision criteria are positive net present value (NPV) and NNK_{idu} (the ratio of the net present value and the public sector support including operation and maintenance costs). When computing NNK_{idu}, the cost savings of JA should be included in the computation of the net present value (NPV) in the numerator, but not included in the investment cost in the denominator.

Investment costs that are required in both the project (UA) and the reference scenario (JA)) should not be included in the analysis. Such costs are required regardless of whether the project is carried through or not and not discriminating between the alternatives, and consequently not relevant for the analysis.

5.2. Updating and deflating prices

Update prices - new base of prices and new real price level

If prices increase at the same rate as inflation, then they are constant in real terms and need not be updated to new real price levels. But, if the common base of prices (the general price level) is changed, constant real prices have to be updated to the new price level by the consumer index CPI or producer price index PPI.

If a price increases more than all other prices, i.e. more than the increase of the general price level, which is the rate of inflation, then it is increasing in real terms (i.e. in terms of purchasing power). In this case the update of prices to a new price level has to cover both the change in general price level (new common base of prices) and the real change in specific prices. The indexes/measures used for the updates of different costs and prices are presented in table 1.

Table 1. Index to be used for updates of specific prices

Prices	*Index to be used*
Travel time savings, non-business trips	CPI + GNP per capita
Travel time savings, business trips	CPI + GNP per capita
Risk of accidents	CPI + GNP per capita
Accidents, Material costs	CPI
Noise	CPI + GNP per capita
Air pollution (except for carbon-dioxide)	CPI + GNP per capita
Tickets, regional trains	Specific index or CPI
Tickets, long distance trains	Specific index or CPI
Vehicle costs for private car users	CPI or specific index
Time savings of transport of goods	CPI or PPI
Vehicle operation costs, commercial car users	Specific index related to production costs or PPI
Vehicle operation costs, public transport	Specific index related to production costs or PPI
Vehicle operation costs, transport of goods	Specific index related to production costs or PPI
Cost of investment in infrastructure and costs of operation and maintenance of infrastructure	Index related to production costs, e.g. road construction index E84, or PPI

Shadow prices based on estimated willingness-to-pay (WTP), i.e. the value of time savings for non-business travels, the cost of noise, the cost of air pollution and the value of safety are assumed to increase with income (the latter is measured by the wage). Therefore these shadow prices have to be updated with respect to both CPI and the growth of real income per capita, the latter measured by the growth rate of GNP per capita. The value of travel time savings (VTTS) of business trips does also vary with real income, as it is determined by the wage (the

total cost for the employer, including all indirect taxes). Thus, also the VTTS for business trips has to be updated with respect to both the change in general price level (CPI) and the growth of real income (GNP per capita).

The update with respect to growth of real income is based on the assumption of an elasticity of income equal to 1, meaning that the WTP- shadow prices will increase by the same percentage as the rate of growth of the real GNP per capita.

Investment expenditures, operation and maintenance costs, some vehicle and traffic costs and fares have to be updated by use of special price indexes, instead of PPI, if they are assumed to change in real terms. Special price indexes for investments, operation and maintenance and traffic cover both real changes in prices and inflation. PPI may be used if real price changes are not likely to occur.

Deflation of prices and change of base year of real prices

All prices and shadow prices have to be expressed in real terms (adjusted for inflation) and in the price level of 2017. By doing so, differences in incomes, prices and purchasing power due to inflation are eliminated.

Conversion of prices and shadow prices to the base year of prices is made by:

- Consumer Price Index (CPI, in Swedish KPI), if the prices or shadow prices are related to consumption.
- Producer Price Index (PPI) if the prices or shadow prices are related to production.

Changes in real prices over the evaluation period

Shadow-prices based on WTP-values and the VTTS of business travels increase with increases in real income. Therefore, the growth of these prices during the evaluation period should be considered in the CBA. Table 2 presents the prices and shadow prices that should be subject to a real increase in value over the evaluation period.

Table 2. Increase in prices and shadow prices during the evaluation period

Prices and shadow prices	*Comments*
Shadow prices based on marginal willingness to pay: Time and comfort assessment for private trips, Risk assessment (part of the accident assessment), Air pollution, Noise	Continuous enumeration in the analysis tools with 1.5% per annum during the period (2017-2065).
Time values for business trips (valued via labor costs)	Continuous enumeration in the analysis tools with 1.5% per annum during the period (2017-2065).
Fuel price, product price and price including fuel taxes	

5.3. Economic model for investments

The following basic rules have to be applied:

The current base year for real prices (prices adjusted for inflation): The year 2017.

Consumer prices or factor prices: Generally, prices are (unless otherwise specified) consumer prices, i.e. factor prices plus indirect taxes (e.g. VAT). Costs paid by the public sector (e.g. costs for publicly provided transport infrastructure) do not include VAT, as governmental administrations do not have to pay VAT. Instead governmental expenditures are upgraded by the marginal cost of public funds.

The year of discounting, i.e. the time defined as present time: 2025.

The year of "opening the investment", i.e. when starting to use the investment and the first year of annual costs and benefits: The opening year of the investment is the same for all projects and the same as the year of discounting (the time defined as "present time"), i.e., 2025.

The year of starting the construction of infrastructure investments: The year of discount, and starting to use the investment, minus the time for construction (in number of years).

Base year for the forecast of future traffic:
The base for the prognosis of future traffic, and effects of traffic, is 2017.

The first year of forecast (the "base" for the estimation of costs and benefits of the CBA): The year is 2040.

The second year of forecast (to generate estimations of growth of traffic and to make an additional estimation of costs and benefits): The year is 2065.

The year of "breaking the growth": The 40th year of the evaluation period (if the period is longer than 40 years). After this year the annual growth of traffic is assumed be zero and the volume of traffic remains constant the rest of the evaluation period.

The growth of traffic: The growth of traffic, and thereby the estimated annual costs and benefits, is based on the two years of forecast and is assumed to be zero after the year of broken growth.

Distribution of the investment cost over construction time: Generally, the investment cost should be evenly distributed over the number of years of construction (100%/number of years). However, if the time of construction is 3 years, the second year should bear a larger portion of the investment cost. The recommended distribution of the investment cost is presented in table 3.

Table 3. Distribution of investment cost over the construction time

Time of construction	*First year*	*2nd year*	*3rd year*	*4th year*	*5th year*
1 year	100%				
2 years	50%	50%			
3 years	25%	50%	25%		
4 years	25%	25%	25%	25%	
5 years	20%	20%	20%	20%	20%

The construction time: Determined by the best available information. If the construction time is uncertain, the rules below should be followed:

1 year of construction time if the cost of investment is < 75 million SEK
2 years of construction time if the cost of investment is ≥ 75 million SEK and < 150 million SEK
3 years of construction time if the cost of investment is ≥ 150 million SEK and < 750 million SEK
4 years of construction time if the cost of investment is ≥ 750 million SEK

The project appraisal evaluation period: The evaluation period is defined as the economic lifetime of the investment, counted from the starting-point of using the investment (the year of opening). (However, for infrastructure investments the total period is the number of years of construction plus the evaluation period). The estimated economic lifetimes of different infrastructure investments, and thus, evaluation periods for different infrastructure projects, are shown in table 4.

Table 4. Recommended economic lifetime of investments

Investment	*Economic lifetime*
New road or bearing capacity for road. New bridge or tunnel. General cases.	60
New roads with an expexted economic lifetime shorter than common road investments: For example roads inside a build-up area, bypasses, ”bottle-necks” and bus stops.	40
City road for busses	40
New railway (bearing capacity, rails), railway tunnel or bridge	60
Särskilda fall med kortare förväntad ekonomisk livslängd: Spårväg – kontaktledning och smalspåriga spårvagnsspår	25
New fairway or new lock	60
New airport	60
New lanes for cykling and/or walking	40

5.4. Decision criteria

In order to determine whether a single project is beneficial or to rank projects, without consideration of budget constraints, ASEK recommends the use of NPV (Net Present Value). The rank of projects, with respect to a budget constraint, should be based on the decision criteria RNPSS (The Ratio of NPV and public sector support). In Swedish this ratio is called NNK. From ASEK 6.1 and onwards, the recommendation is to rank projects according to the NNK_{idu}, defined as:

NNK_{idu} = NPV/(I + DoU) = The ratio of NPV with respect to the sum of the social cost of investment and the changes in social costs of operation and maintenance during the life time of the investment

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

The social costs of the investment and changes in costs of operation and maintenance are including 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 also includes over-head costs for planning and administration.

The decision criteria are:

$NPV \geq 0$ and $NNK_{idu} \geq 0$

When ranking projects, a larger value of NPV or NNK_{idu} are better than a lower value of the same measure.

In earlier versions of the ASEK-report, the NNK_i (The ratio of NPV with respect to the social cost of investment) was recommended for ranking of infrastructure projects. The reason to use the NNK_{idu} instead is that both investment and maintenance costs are financed through the infrastructure budget, i.e. are affecting the budget constraint.

5.5. Social rate of discount

The recommended social rate of discount is 3.5 percent.

There are many different views on what the size of social rate of discount should be. However, there is a consensus regarding what do determine the size of it. The estimation of the size of the social rate of discount is generally related to the so-called Ramsey equation;

$$i = z + ng$$

where i = the social rate of discount
z = the pure rate of time preferences (d) + risk of disaster (L)
n = the absolute value of the elasticity of the marginal utility of consumption
g = rate of growth of consumption per capita

The values of z, n and g, may be set based on results from empirical studies or based on ethical grounds.

It is reasonable that the ASEK makes the same assumptions about z and n as HEATCO[1] and HMTGB[2]. However, the value of g should be chosen in order to be consistent with the assumptions of future economic growth founding the assumed changes in real income and prices over the evaluation period. The assumed increase in real prices is based on an annual growth in GNP per capita (which is approximately equal to consumption per capita) of about 1.8 percent until 2050. If z=1.5, n=1 and g=1.8, then the Ramsey equation tells us that the social rate of discount is 3.3 percent.

Systematic risk may be an argument for a higher rate of discount than the one determined by the Ramsey equation. There are scientific arguments for a social rate of discount decreasing over time (see e.g. Weitzman (2001) and Gollier (2002)). To recommend the use of a rate of discount decreasing over time would, however, lead to practical complications as the modelling tools used for CBA are not designed to handle rates of discount variable over time. A rough way to make an approximation for a declining rate of discount is to set the constant rate of discount at a lower level. In both cases more weight will be placed on the value of future costs and benefits.

Based on the estimation of the Ramsey equation and discussions about risks and the rate of discount declining over time, the real social rate of discount was revised from 4 percent to 3.5 percent in the previous revision of ASEK recommendations (in 2012). ASEK still recommends the rate of 3.5 percent.

5.6. Indirect taxes, (VAT etc.)

Effects that are subjected to indirect taxation by VAT should be valued by market prices, i.e. prices including VAT and other indirect taxes, in the CBA. Exceptions may be allowed if there are well grounded reasons.

An indirect tax charge of 21 percent is applied when transforming factor prices to consumer prices. The charge of 21 percent corresponds to an average of different levels of VAT and other indirect taxes.

5.7. Marginal cost of public funds (MCPF)

Costs financed by taxes, i.e. costs of infrastructure investments and costs of operation and maintenance of the infrastructure (measured in factor prices) should be multiplied with a factor corresponding to the marginal cost of public funds. The MCPF multiplier is:

$$MCPF = (1 + MEB) = (1 + 0.3) = 1.3$$

where MCPF = the MCPF multiplier (in Swedish described as “the tax multiplier”)
MEB = the excess burden of taxes for every SEK of public funding

[1] HEATCO (2005) Developing Harmonised European Approaches for Transport Costing and project assessment.
[2] HM Treasury, The Green Book (2018) – CENTRAL GOVERNMENT GUIDANCE ON APPRAISAL AND EVALUATION.

Also the cost of infrastructure investments financed by public funds from congestion charges, or other efficiency related charges from existing infrastructure and traffic, should be upgraded by the tax multiplier of 1.3. The funds from such charges could be used to decrease taxes and thereby decrease the excess burden of taxes. Thus, these funds have an opportunity cost corresponding to the marginal cost of public funds (the cost is the loss of a decrease in excess burden of taxes).

Investment costs financed by private investors or by user fees should not be upgraded with the MCPF.

If the effects of the investment on economic growth are known, the MCPF may be applied on the net effect on the budget of the public sector.

5.8. Transport across the national border

Decreasing costs of transport across the national border, following a Swedish investment in infrastructure used mainly for such transports (e.g. fairways for shipping), may benefit both Swedish or foreign transport operators, producers or customers. If so, only part of the decrease of the transport cost should be included in the CBA.

Unless any other distribution of the benefit on Swedish and foreign economic agents can be motivated, ASEK recommends that the Swedish CBA includes:

- the estimated benefits and costs resulting from transportation within the Swedish border and
- the entire benefits and costs resulting from transportation on international water or in international air, between Swedish territory and the next (or previous) stop for unloading or loading.

If emissions of carbon-dioxide from air planes are subjected to trade by emission permits then the cost of emission trades has to be replaced by the ASEK-valuation of emissions of carbon-dioxide.

5.9. Sensitivity analyses

For the Swedish Transport Administration's socio-economic analyzes of infrastructure, where the expected construction cost according to plan is at least SEK 200 million, the following sensitivity analyses have to be made:

1. Higher investment cost assumed. An investment cost corresponding to the 85% level calculated by the successive calculation method. If the successive method is not used, the investment cost is assumed to be 30% higher, compared to the main analysis.

2. No traffic growth assumed for the reference scenario, from the base year for the traffic forecast to the end of the economic lifetime.

3. Larger traffic growth assumed, in cases where traffic growth is positive. The growth rate of traffic in the reference scenario is assumed to be 50 percent higher, from the base year of to the end of the economic lifetime, compared to the main analysis.

6. Investment cost and costs for operation and maintenance

6.1. The cost of investment

The cost of investment should be estimated by applying the method of ”Successive calculation”.

The cost of investment has to be estimated in current price level but expressed in the general price level of 2017.

The cost of investment has to be distributed over the construction time period according to the model presented in table 3.

The total estimated cost for planning and administration has to be included in the social cost of investment, even though a part of this cost may be a sunk cost. This is for practical reasons. It is very difficult to identify and separate the part of the cost that is non-retrievable. Besides, the sunk costs of planning and administration are small in relation to the total cost of investment and of no importance for the outcome of the analysis.

6.2. Operation and maintenance

The analysis should include all costs for operation and maintenance during the entire calculation period. Costs for planning and administration of operation and maintenance should be included in the analysis by a mark-up of 6%.

Costs of operation and maintenance should be estimated in actual and specific price level but converted to and presented in real terms and the general price level of 2017.

7. Value of travel time and transport time savings

7.1. Value of travel time savings (VTTS) for passengers on non-business trips

The recommended values of travel time savings for passengers on non-business trips are presented in table 5.

Table 5. Value of travel time savings (VTTS) for passengers on non-business trips. SEK$_{2017}$ per hour and passenger.

	In-vehicle time		*Time to connect main travel mode*		*Time to change travel mode*	
	2017	Prognosis 2040	2017	Prognosis 2040	2017	Prognosis 2040
Long distance:						
Car	126	178	-	-	-	-
Bus	45	64	62	87	114	161
Train	85	120	117	164	213	301
Ferry	126	178	171	242	315	444
Air	126	178	171	242	315	444
Regional/local travels:						
Car, commuting	101	143	-	-	-	-
Car, other travels	69	97	-	-	-	-
Bus, commuting	62	87	62	87	155	219
Bus, other travels	38	54	38	54	97	136
Train, commuting	80	113	80	113	202	285
Train, other travels	62	87	62	87	155	219
Ferry	63	89	63	89	157	222

7.2. Value of travel time savings (VTTS) for passengers on business trips

The recommended values are presented in table 6. VTTS for business trips must not differ between remaining travelers/trips and new travelers/trips or passengers/trips transferred from other modes.

Table 6. Value of travel time savings (VTTS) for passengers on business trips. SEK$_{2017}$ per hour and person.

	In-vehicle time		*Time to connect main travel mode*		*Time to change travel mode*	
	2017	Prognosis 2040	2017	Prognosis 2040	2017	Prognosis 2040
Car	339	479				
Airplane	339	479	339	479	339	479
Train, long distance	288	406	339	479	339	479
Train, short distance	288	406	339	479	339	479
Bus and ferry	339	479	339	479	339	479

7.3. Average value of travel time savings for all private travels by car

Table 7. The average value of standard traveling time for all travels by car. SEK_{2017} in 2017 and 2040.

Type of travels	*Distribution based on type of travels.*	*Price level 2017*	*Prognosis 2040*
Private travels by car	52% long distance travels, 13% regional business travels, 35% other regional travels.	103 SEK per hour and person	145 SEK per hour and person
All travels by car, private and business travels	10% business travels and 90% private travels, whereof 47% long distance travels, 12% regional business travels, 32% other regional travels.	126 SEK per hour and person	178 SEK per hour and person
All travels by car, private and business travels	Distribution based on type of travels as above, including a utilization rate of 1.77 persons/car for private travels and 1.28 for business travels.	206 SEK per vehicle hour	291 SEK per vehicle hour

7.4. Differences in value of time for present travelers and new travels/travelers

Time values for business trips should be non-discriminating between present travels/travelers and new travels/travelers or travelers changing travel mode.

7.5. Value of a tighter time-table

The values for travelers of an additional departure in a time-table of public transportation are presented in Table 8 – 10.

Table 8. The value for regional/local travellers of additional departures in the time-table of public transport. In SEK_{2017}.

Departure interval in minutes	*< 10*	*11-30*	*31-60*	*61-120*	*121-480*	*> 480*
Price level 2017						
Bus, commuting	70	57	28	17	8	8
Bus, other travels	44	36	17	10	6	6
Train, commuting	93	76	37	22	12	12
Train, other travels	70	57	28	17	8	8
Ferry	72	59	29	17	9	9
Prognosis 2040						
Bus, commuting	99	81	39	25	12	12
Bus, other travels	62	51	25	15	8	8
Train, commuting	132	107	53	31	16	16
Train, other travels	99	81	39	25	12	12

Ferry	102	84	41	25	13	13

Table 9. The value for long-distance travellers of additional departures in the time-table of public transport. In SEK_{2017}.

Departure interval in minutes	*<60*	*61-120*	*121-480*	*> 480*
Price level 2017				
Bus	23	12	12	9
Train	44	23	23	17
Air	65	34	34	26
Ferry	65	34	34	26
Prognosis 2040				
Bus	33	16	16	13
Train	62	33	33	25
Air	92	48	48	36
Ferry	92	48	48	36

Table 10. The value for business travellers of additional departures in the time-table of public transport. In SEK_{2017}.

Departure interval in minutes	*<60*	*61-120*	*>120*
Price level 2017			
Bus	182	182	150
Train, regional/local travels	301	211	211
Train, long distance	237	166	142
Air	260	217	173
Ferry	237	166	142
Prognosis 2040			
Bus	257	257	212
Train, regional/local travels	424	298	298
Train, long distance	334	234	201
Air	367	306	243
Ferry	334	234	201

7.6. Value of travel time savings (VTTS) and travel comfort for cyclists

The recommended values are presented in table 11.

Table 11. Value of travel time savings (on-vehicle time) for cyclists and pedestrians. SEK$_{2017}$ per hour and person.

Traffic environment	*Time for cycling or walking*		*Waiting time*	
	2017	Prognosis 2040	2017	Prognosis 2040
Cycling:				
Mixed traffic	175	247	175	247
Lane for cycling in the road	158	222	158	222
Land for cycling at the road	146	205	146	205
Lane for cycling	140	198	140	198
Pedestrians:				
Walkway in mixed traffic on road/street	234	330	292	412
Walkway among cyclists	222	313	277	391
Free walkway	208	293	260	366

Waiting time for cyclists is the same as for travel time (the on-vehicle time) and the waiting time for pedestrians are 1.25 times the standard walking valuation. For cycling the default value of speed is 15 km per hour, for all kinds of cycling lanes. The recommended standard speed for walking is 5 km per hour.

7.7. Value of time savings (VTTS) for transport of goods

Values of time savings for transport of goods by lorry or by car are presented in table 12.

Table 12. Value of transport time savings. SEK$_{2017}$ per vehicle-hour in 2017 and 2040 in factor prices (VAT excluded) and consumer prices (VAT included).

	2017	*2017*	*Prognosis 2040*	*Prognosis 2040*
Means of transport	Excluding VAT	Including VAT	Excluding VAT	Including VAT
Lorry without trailer	5.45	6.59	6.56	7.94
Lorry with trailer	25.42	30.76	30.63	37.06
Car in commercial traffic	2.18	2.64	2.63	3.18

Table 13. The time value of the good is expressed in SEK_{2017} per ton and hour for each SAMGODS-commodity group.

		2017	*2017*	*Prognosis 2040*	*Prognosis 2040*
	SAMGODS-commodity group	Time value excl. VAT	Time value incl. VAT	Time value excl. VAT	Time value incl. VAT
1	Products of agriculture, hunting, and forestry; fish and other fishing products (excl. round wood)	0.30	0.36	0.34	0.41
2	Coal and lignite; crude petroleum and natural gas	0.27	0.33	0.27	0.33
3	Metal ores and other mining and quarrying products; peat; uranium and thorium	0.08	0.10	0.09	0.11
4	Food products, beverages and tobacco	2.03	2.45	2.48	3.00
5	Textiles and textile products; leather and leather products	16.61	20.10	16.20	19.61
6	Wood and products of wood and cork (except furniture); articles of straw and plaiting materials; pulp, paper and paper products; printed matter and recorded media	0.65	0.78	0.62	0.76
7	Coke and refined petroleum products	0.42	0.51	0.44	0.53
8	Chemicals, chemical products, and man-made fibres; rubber and plastic products; nuclear fuel	2.71	3.28	3.21	3.88
9	Other non-metallic mineral products	0.49	0.60	0.52	0.63
10	Basic metals; fabricated metal products, except machinery and equipment	1.97	2.38	1.91	2.31
11	Machinery and equipment n.e.c.; office machinery and computers; electrical machinery and apparatus n.e.c.; radio, television and communication equipment and apparatus; medical, precision and optical instruments; watches and clocks	19.85	24.02	23.67	28.64
12	Transport equipment	10.03	12.14	10.38	12.55
13	Furniture; other manufactured goods n.e.c.	4.07	4.92	4.02	4.86
14	Secondary raw materials; municipal wastes and other wastes	0.31	0.37	0.28	0.34
15	Round wood	0.06	0.07	0.06	0.07
16	Air freight				
	Average value, all goods	0.91	1.10	1.09	1.32

8. Value of time and congestion for transport of good

8.1. Value of travel time reliability and delays

Travel time in congestion should be valued as well as reliability in transport time (or delays) in case these problems appear simultaneously. Variations in travel time for travels by car are measured by changes in the standard deviation of the travel time.

Delays for travels by car should be valued only when disturbances in the traffic are so severe that the traffic does not work normally.

Valuation of travel time savings in congestion is made only for non-business trips.
Reliability in transport is valued for all travels, both non-business and business travels.

Table 14. Value of travel time savings in congestion and value of reliability

	Car	*Public transport*
Reliability of travel time (measured by standard dev.)	0.9 × in-vehicle time	
Delays (average time of delay)	3.5 × in-vehicle time	3.5 × in-vehicle time
Congestion (travel time under conditions of congestion)	1.5 × in-vehicle time	

Table 15. The value of average saved time of delay for public transportation. SEK$_{2017}$ per person and hour of delay.

	Valuation of time of delay, private travels with public transport		*Valuation of time of delay, business travels with public transport*	
Price level, year	*2017*	*Prognosis 2040*	*2017*	*Prognosis 2040*
National/long distance travels:				
Bus	160	225	1 188	1 675
Train	298	420	1 008	1 422
Ferry	441	622	1 188	1 675
Air	441	622	1 188	1 675
Regional/local travels:				
Bus, work	216	305	Same as above	
Bus, non-work	135	190	Same as above	
Train, work	282	397	Same as above	
Train, non-work	216	305	Same as above	
Ferry	220	311	Same as above	

Table 16. The value of saved time of delay and congestion for private travels by car. SEK$_{2017}$ per person and hour.

	Delay time, SEK/hour of delayed travel time		*Congestion time, SEK/hour of travel with congestion*		*Unreliability of travels, SEK/hour of reduced travel deviation*	
Price level, year	*2017*	*Prognosis 2040*	*2017*	*Prognosis 2040*	*2017*	*Prognosis 2040*
Private car travels:						
National/long distance travels	441	622	189	266	113	160
Regional/local travels: Work	355	502	153	215	91	128
Regional/local travels: Non-work	241	340	103	146	62	87
Business travels by car:						
Long distance travels	1 188	1 675	-	-	305	431
Regional/Local travels	1 188	1 675	-	-	305	431

8.2. Value of travel comfort in public transport

The value of travel time savings (VTTS) for non-business trips should be multiplied with the factors in table 17 when evaluating a project that aims at decreasing the congestion in means of public transport. A corresponding conversion of the VTTS should not be made for business-trips. The multipliers in table 17 regard single trips, not average occupancy per unit of time (day or year).

Table 17. Factors correcting VTTS with respect to the effect of congestion on travel comfort

Utilization of capacity, %	*Sitting Work*	*Sitting Non-work*	*Standing Work*	*Standing Non-work*
50	0.86	1.04		
75	0.95	1.14		
100	1.05	1.26	1.62	1.94
125	1.16	1.39	1.79	2.15
150	1.27	1.53	1.99	2.39
175	1.40	1.69	2.20	2.64
200	1.55	1.86	2.44	2.93

8.3. Value of delays in transport of goods

The value of transport time savings for goods is derived by taking the VTTS for normal transport time for good is multiplied by 3.5 (VTTS × 3.5).

Table 18. The value of saved time of delay of goods transport, excluding and including VAT. Sek per vehicle hour, in prices of 2017.

	2017	*2017*	*Prognosis 2040*	*Prognosis 2040*
Vehicle	*Time value excl. VAT*	*Time value incl.VAT*	*Time value excl. VAT*	*Time value incl. VAT*
Lorry without trailer	19,07	23,07	22,97	27,80
Lorry with trailer	88,98	107,67	107,21	129,73
Car in commercial traffic	7,63	9,23	9,19	11,12

Table 19. The value of saved time of delay per SAMGODS-commodity group, excluding and including VAT. SEK$_{2017}$ per ton and hour.

		2017	*2017*	*Prognosis 2040*	*Prognosis 2040*
	SAMGODS-commodity group	Time value excl. VAT	Time value incl. VAT	Time value excl. VAT	Time value incl. VAT
1	Products of agriculture, hunting, and forestry; fish and other fishing products (excl. round wood)	1.05	1.27	1.19	1.44
2	Coal and lignite; crude petroleum and natural gas	0.95	1.15	0.95	1.15
3	Metal ores and other mining and quarrying products; peat; uranium and thorium	0.28	0.34	0.32	0.39
4	Food products, beverages and tobacco	7.09	8.58	8.69	10.52
5	Textiles and textile products; leather and leather products	58.14	70.35	56.71	68.62
6	Wood and products of wood and cork (except furniture); articles of straw and plaiting materials; pulp, paper and paper products; printed matter and recorded media	2.26	2.74	2.18	2.64
7	Coke and refined petroleum products	1.47	1.78	1.55	1.87
8	Chemicals, chemical products, and man-made fibers; rubber and plastic products; nuclear fuel	9.50	11.49	11.22	13.58
9	Other non-metallic mineral products	1.73	2.09	1.81	2.19
10	Basic metals; fabricated metal products, except machinery and equipment	6.90	8.34	6.69	8.10
11	Machinery and equipment n.e.c.; office machinery and computers; electrical machinery and apparatus n.e.c.; radio, television and communication equipment and apparatus; medical, precision and optical instruments; watches and clocks	69.48	84.06	82.84	100.23
12	Transport equipment	35.10	42.47	36.32	43.94
13	Furniture; other manufactured goods n.e.c.	14.25	17.24	14.07	17.02
14	Secondary raw materials; municipal wastes and other wastes	1.07	1.29	0.99	1.20
15	Round wood	0.20	0.25	0.20	0.25
16	Air freight				
	Average value, all goods	3.18	3.85	3.83	4.63

9. Safety and cost of accidents

The cost of an accident is to a certain extent internal, (i.e. considered and valued by the one who causes the risk and the accident) even though the internal part of the cost is relatively small. Here the internal cost of accidents is assumed to be zero, for all modes of transport. Thus, the cost of accident risks and accidents is treated as an external cost, which is in accordance with the recommendations of HEATCO.

9.1. Car accidents

Table 19 presents the recommended values of accidents by car. The economic cost consists of medical and rehabilitation costs, administration costs and production losses. The value of safety is derived from an estimation of the value of a quality adjusted life year (QALY).

Table 20. Values of casualties avoided in 1000 000 SEK_{2017} per person (dead or injured).

	Economic costs and material damage 2017	*Value of safety 2017*	*Total cost for one casualty 2017*	*Economic costs and material damage Prognosis 2040*	*Value of safety Prognosis 2040*	*Total cost for one casualty Prognosis 2040*
Fatality (DF)	6.23	44.02	50.25	6.23	62.07	68.30
Severe injury (AS)	0.97	12.93	13.90	0.97	18.24	19.21
- whereof very severe injury (MAS)	4.53	13.26	17.79	4.53	18.70	23.23
- whereof severe injury, excluding very severe injury (AS-MAS).	0.36	11.52	11.88	0.36	16.25	16.61
None-severe injury	0.04	4.56	4.60	0.04	6.44	6.48
Property damage	0.015	0	0.015	0.015	0	0.015

Table 21. Weights for calculating the actual number of accidents from the number of accidents reported by the police.

Type of injury/accident	*Weights*
Fatality	1.0
Severe/slight injury in accident with motor vehicle.	
- Rural areas	1.7
- Urban areas	1.5
Severe/slight injury in accident with no motor vehicle.	10
Property damage, motor vehicle	7
Accident with hoofed animals	2

9.2 Marginal cost of accidents for road traffic

Marginal costs of road accidents consists of the expected socio-economic accident cost that the increased risk of one additional vehicle in traffic contributes to.

Table 22. Average marginal cost for accidents in SEK_{2017} per vehicle and km.

	Glesbygd 2017	*Tätorter 2017*	*Glesbygd 2040*	*Tätorter 2040*
Lights vehicles (<3,5 ton)	0,024	1,087	0,034	1,533
Heavy vehicles (>3.5 ton)	0,815	2,627	1,149	3,704

Table 23. Average cost in SEK_{2017} of an average accident at a level crossing.

	2017	*Prognosis 2040*
Average cost per accident	31780	43333

9.3 Marginal cost of accidents for railway traffic

Table 24. Marginal cost of accidents at level crossings in SEK_{2017} per train and crossing.

	Full barrier	*Half barrier*	*Sound/light*	*Unprotected*
2017				
Public/regional roads	2.20	3.12	34.82	
Roads, other roads	0.92	1.22	8.33	7.60
Private roads	0.11	0.14	0.84	1.24
Prognosis 2040				
Public/regional roads	3.10	4.40	49.10	
Roads, other roads	1.30	1.72	11.74	10.71
Private roads	0.15	0.20	1.18	1.75

Table 25. Average marginal cost in SEK_{2017} per train-km.

Type of accident	*2017*	*2040*
Level crossing	2.28	3.22
Other accidents	1.81	2.55
Total	4.09	5.77

9.4 Bicycle- and pedestrian accidents

The risk of accidents is reduced by 40 percent then cycling is separated from traffic by motor vehicles (cars, buses etc). For every million vehicle-kilometres of cycling there is on average 2.5 accidents. The average cost for one injured cyclist is 3.7 million in SEK_{2017}.

Table 26. Valuation of accidents involving pedestrians and cyclists in SEK_{2017} per accident. Average risk per million kilometers of mileage.

Cost and cost parameters	*2017*	*Prognosis 2040*
Bicycle accident, single vehicle accident	3 700 000 SEK	5 217 000 SEK
Pedestrian accident, single accident	3 261 000 SEK	4 598 000 SEK
Average risk for cyclists. Accidents/million km of cycling.	2.5	
Average risk for pedestrians. Accidents/million km of walking.	5	
Accident reduction for cyclists from separation of cyclists and motor vehicles.	40%	
Accident reduction for pedestrians from rebuilding roads to pedestrian streets.	60%	

10 The cost of noise

10.1 Noise from road traffic

The recommended values for computing the cost of noise from road traffic are presented in table 27. These values were produced by VTI (The Swedish National Road and Transport Research Institute, VTI 2009) in the REBUS-project. The price level in REBUS was 2006, but the values have been updated by consumer price index (KPI) and the growth of GNP per capita to the present base year of prices, 2017. The values from REBUS regarded the disutility of being

disturbed by noise. These original values have been upgraded in order to capture also the negative health effects of noise.

Table 27. Cost of noise from road traffic (disturbance- and health effects) when being outdoors respectively indoors. SEK_{2017} per person and year.

Level of noise outdoors	*Cost of disturbances, 2017*	*Cost of health effects, 2017*	*Total cost, SEK per person and year, 2017*	*Total cost, SEK per person and year, prognosis 2040*
50	168	0	168	238
51	525	0	525	740
52	1 071	0	1 071	1 510
53	1 804	0	1 804	2 544
54	2 726	0	2 726	3 844
55	3 836	0	3 836	5 409
56	5 134	0	5 134	7 239
57	6 621	0	6 621	9 335
58	8 296	74	8 370	11 802
59	10 159	134	10 293	14 513
60	12 210	223	12 433	17 531
61	14 451	327	14 778	20 837
62	16 879	461	17 340	24 449
63	19 495	624	20 119	28 368
64	22 300	803	23 103	32 575
65	25 292	996	26 288	37 066
66	28 474	1 220	29 694	41 868
67	31 844	1 472	33 315	46 975
68	35 401	1 754	37 156	52 390
69	39 147	2 056	41 203	58 096
70	43 082	2 403	45 486	64 135
71	47 205	2 768	49 973	70 461
72	51 516	3 160	54 676	77 093
73	56 015	3 583	59 598	84 033
74	60 702	4 036	64 738	91 281
75	65 579	4 533	70 112	98 857

Table 28. Cost of noise from road traffic when being outdoors (50% of the cost) respectively being indoors (50% of the cost). The indoor noise is assumed to be the outdoor noise with a 27 dBA facade noise reduction. SEK_{2017} per person and year.

Level of noise outdoors	*Cost of noise outdoors 2017*	*Cost of noise outdoors Prognosis 2040*	*Level of noise indoors, with a 27 dB average facade noise reduction*	*Cost of noise indoors 2017*	*Cost of noise indoors, prognosis 2040*
50	84	119	23	84	119
51	263	370	24	263	370
52	535	755	25	535	755
53	902	1 272	26	902	1 272
54	1 363	1 922	27	1 363	1 922
55	1 918	2 704	28	1 918	2 704
56	2 567	3 619	29	2 567	3 619
57	3 310	4 668	*30*	3 310	4 668
58	4 185	5 901	*31*	4 185	5 901
59	5 146	7 256	*32*	5 146	7 256
60	6 217	8 765	*33*	6 217	8 765
61	7 389	10 418	*34*	7 389	10 418
62	8 670	12 225	*35*	8 670	12 225
63	10 060	14 184	*36*	10 060	14 184
64	11 552	16 288	*37*	11 552	16 288
65	13 144	18 533	*38*	13 144	18 533
66	14 847	20 934	*39*	14 847	20 934
67	16 658	23 487	*40*	16 658	23 487
68	18 578	26 195	*41*	18 578	26 195
69	20 601	29 048	*42*	20 601	29 048
70	22 743	32 067	*43*	22 743	32 067
71	24 986	35 231	*44*	24 986	35 231
72	27 338	38 547	*45*	27 338	38 547
73	29 799	42 017	*46*	29 799	42 017
74	32 369	45 641	*47*	32 369	45 641
75	35 056	49 429	*48*	35 056	49 429

10.2 Noise from railway traffic

The recommended values for computing the cost of noise from railway traffic are presented in table 29. These values are produced by VTI (The Swedish National Road and Transport Research Institute) in the JÄSMAGE study (VTI 2010).

Table 29. Cost of noise from railway traffic (disturbance and health effects) when being outdoors respectively indoors. SEK_{2017} per person and year.

Level of noise outdoors	*Cost of disturbances, 2017*	*Cost of health effects, 2017*	*Total cost per person and year, 2017*	*Total cost per person and year, prognosis 2040*
50	67	0	67	95
51	209	0	209	294
52	423	0	423	596
53	710	0	710	1 001
54	1 071	0	1 071	1 510
55	1 503	0	1 503	2 120
56	2 010	0	2 010	2 834
57	2 590	0	2 590	3 652
58	3 243	74	3 316	4 676
59	3 969	134	4 102	5 784
60	4 768	223	4 990	7 036
61	5 639	327	5 967	8 413
62	6 584	461	7 045	9 933
63	7 602	624	8 226	11 599
64	8 694	803	9 497	13 391
65	9 858	996	10 854	15 304
66	11 096	1 220	12 316	17 365
67	12 406	1 472	13 878	19 568
68	13 790	1 754	15 544	21 917
69	15 246	2 056	17 302	24 396
70	16 777	2 403	19 180	27 044
71	18 380	2 768	21 148	29 818
72	20 055	3 160	23 215	32 733
73	21 805	3 583	25 388	35 797
74	23 627	4 036	27 663	39 005
75	25 523	4 533	30 056	42 378

Table 30. Cost of noise from railway traffic when being outdoors (50% of the cost) respectively being indoors (50% of the cost). The indoor noise is assumed to be the outdoor noise with a 27 dBA facade noise reduction. SEK_{2017} per person and year.

Level of noise outdoors	*Cost of noise outdoors 2017*	*Cost of noise outdoors 2040*	*Level of noise indoors, with a 31 dB average facade noise reduction*	*Cost of noise indoors 2017*	*Cost of noise indoors 2040*
50	67	95	*19*	0	0
51	209	294	*20*	0	0
52	423	596	*21*	0	0
53	710	1 001	*22*	0	0
54	970	1 367	*23*	101	143
55	1 240	1 749	*24*	263	371
56	1 472	2 075	*25*	538	759
57	1 784	2 515	*26*	807	1 137
58	1 984	2 797	*27*	1 333	1 879
59	2 051	2 892	*28*	2 118	2 986
60	2 495	3 518	*29*	2 495	3 518
61	2 983	4 206	*30*	2 983	4 206
62	3 522	4 967	*31*	3 522	4 967
63	4 113	5 800	*32*	4 113	5 800
64	4 749	6 695	*33*	4 749	6 695
65	5 427	7 652	*34*	5 427	7 652
66	6 158	8 683	*35*	6 158	8 683
67	6 939	9 784	*36*	6 939	9 784
68	7 772	10 959	*37*	7 772	10 959
69	8 651	12 198	*38*	8 651	12 198
70	9 590	13 522	*39*	9 590	13 522
71	10 574	14 909	*40*	10 574	14 909
72	11 608	16 367	*41*	11 608	16 367
73	12 694	17 899	*42*	12 694	17 899
74	13 832	19 502	*43*	13 832	19 502
75	15 028	21 189	44	15 028	21 189

10.3 Noise from air traffic and shipping

ASEK have no estimates of the cost of noise from air traffic. The cost of noise from road traffic has been considered a better approximation of the cost of noise from air traffic, compared to the cost of noise from railway traffic. It is however, well known that noise from air traffic is more disturbing, at a certain level of noise, compared to noise from road or railway traffic. Therefore, ASEK recommends that the cost of noise from road traffic is multiplied by 1.4 when used as a proxy for the cost of noise from air traffic.

Our knowledge about noise from shipping is poor. However, ASEK recommends the same estimated values of noise from shipping as for noise from air traffic.

11 The cost of air pollution

The air pollutants of traffic that are measured are pollutants due to exhaust gases from combustion of fuel as well as pollution by particles that arise due to friction between tires and the road surface.

Effects of air pollution usually are divided into three different categories: local, regional and global effects. By global effects of air pollution is meant the climate effects that can occur as a result of emissions of carbon dioxide, methane and the like. The assessment of climate emissions and climate effects is discussed in Chapter 12. The air pollutants dealt with in this chapter are those that produce local and / or regional effects.

Table 31. Cost of local and regional effects of air pollution. SEK$_{2017}$ per kg emitted substance. Local effects are valued given a general national population exposure: 0,885 (µg/m3)* person/kg.

Effects	*Type of emission*	*Damage cost (given national exposure) SEK/kg emissions 2017*	*Damage cost (given national exposure) SEK/kg emissions 2040*
Local effects:			
Health effects: Exhaust particles Wear particles	 Particles $PM_{2.5}$ Particles PM_{10}	 6 900 1 400	 9 729 1 974
Buildings etc.:	Particles PM_{10}	319	450
Regional effects:			
Effects of ground-level ozone	Nitrogen oxides, NO_x	Mean 1.00 Norrland 0.50 Svealand 1.00 Götaland 1.50	1.40 0.70 1.40 2.10
Natural Environment Effects: Marine Overfertilization	Nitrogen oxides,NO_x Ammonia,NH_3	2 8	2,8 11.3

Table 32. Cost of local effects of air pollution differentiated with regards to population exposure. SEK$_{2017}$ per kg emitted sustance.

Effects	*Type of emission*	*Damage cost, SEK per (µg/m³) and person, year 2017*	*Damage cost, SEK per (µg/m³) and person), year 2040*
Local effects:			
Health effects:			
Exhaust particles	Particles $PM_{2.5}$	7 800	10 998
	Particles PM_{10}	1 600	2 256
Wear particles			
Buildings etc.:	Particles PM_{10}	360	508

12 The cost of global warming

The global environmental effects of transport are mainly due to traffic emissions of greenhouse gas carbon dioxide (CO2), which is formed when combustion of carbon compounds in fossil fuels. The uncertainty is very high about what effects climate change will have. The purpose of climate policy and climate action is essentially to reduce the risks of the serious consequences that can arise if the world community fails to reverse the emission trends. The focus in climate work has so far focused on limiting emissions so that the temperature increases do not exceed +2 ° C. It is above all the risks of self-reinforcing non-reversible tipping points. Examples of such risks are that the rise in temperature can cause the powerful greenhouse gas methane to seep out of thawing tundra.

ASEK recommends 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.

Table 33. Marginal cost (MC) of emissions of carbon dioxide from road traffic. In SEK$_{2017}$ per vehicle-km.

Vehicle	*MC Rural areas*	*MC Urban areas*	*Average marginal cost*
Passenger car all fuels	0.94	1.16	1.01
Passenger car gasoline	1.11	1.38	1.20
Passenger car diesel	0.74	0.93	0.81
Light goods vehicle all fuels	1.03	1.09	1.05
Heavy goods vehicle without trailer	3.05	3.66	3.25
Heavy goods vehicle with trailer	4.47	5.57	4.69

Table 34. Marginal cost (MC) of emissions of carbon-dioxide from road traffic year 2040, according to prognosis A and B. SEK/vehicle km in 2040 price level, expressed in 2017 base year value. Vehicle type distribution according to HBEFA.

Vehicle	*MC Rural areas*	*MC Urban areas*	*Average marginal cost*
Passenger car, gasoline and diesel, prognosis A	0.36	0.46	0.30
Passenger car, gasoline and diesel, prognosis B	0.06	0.08	0.07
Passenger car, gasoline, prognosis A	0.74	0.94	0.80
Passenger car, gasoline, prognosis B	0.22	0.27	0.24
Passenger car, diesel, prognosis A	0.45	0.57	0.49
Passenger car, diesel, prognosis B	0.20	0.25	0.22
Light goods vehicle, gasoline and diesel, prognosis A	0.38	0.41	0.39
Light goods vehicle, gasoline and diesel, prognosis B	0.08	0.09	0.09
Heavy goods vehicle without trailer, diesel, prognosis A	1.15	1.37	1.22
Heavy goods vehicle without trailer, diesel, prognosis B	0.34	0.41	0.36
Heavy goods vehicle with trailer, diesel, prognosis A	2.55	3.16	2.67
Heavy goods vehicle with trailer, diesel, prognosis B	0.92	1.13	0.96

Table 35. Marginal cost (MC) of emissions of carbon-dioxide from truck traffic. SEK/vehicle km in 2017 price level. Average cost for all traffic environments. Vehicle classification according to the Samgods model.

Vehicle	*Year 2040 prognosis A*	*Year 2040 prognosis B*
Light Truck	0.33	0.07
Heavy truck, 3.5-16 tons	0.52	0.09
Heavy truck, 16-24 tons	0.70	0.12
Heavy truck, 25-40 tons	1.81	0.61
Heavy truck, 25-60 tons	2.79	1.01

Table 36. Marginal cost of emission of carbon-dioxide from railway traffic in SEK_{2017}/liter diesel.

Vehicle	*2017*	*Prognosis 2040*
Railcar average	17.78	17.78
Locomotive average	17.78	17.78

Table 37. Average emission factors and marginal cost of carbon dioxide emissions from shipping.

Fuel	*Emissions kg / kg fuel*	*MC for emissions, SEK / kg fuel*
Marine diesel, Marine gas	3,2	21,63

13 Operating costs for passenger traffic

This chapter describes vehicle costs for passenger traffic by road, rail and by air. The chapter starts with fuel costs and then goes through driving costs (excluding fuel costs) for private motorists, traffic costs for bus traffic, for passenger and rail traffic, and vehicle costs for cyclists. Private car and bicycle traffic are different from other types of traffic in that the road user is both a passenger and a "traffic operator" and that there are costs for vehicles and fuel but no personnel costs or administrative costs.

13.1 Fuel prices

Table 38. Fuel price for passenger car, SEK per liter, and annual price increase. Price in 2017 level and prognosis for 2040 and 2065, expressed in 2017 base year value.

	2017	*2040*	*2065*	*Increase/ year 2017-40*	*Increase/ year 2040-65*
Gasoline, prognosis A, SEK/liter:	5% ethanol	5% ethanol	5% ethanol		
Product price, excl fuel taxes and VAT	5.10	7.31	7.58	1.1%	0.2%
Price at pump, incl fuel taxes and VAT	14.13	21.26	29.37		
Gasoline, prognosis B, SEK/liter:	5% ethanol	10% ethanol, 63% HVO	10% ethanol, 90% HVO		
Product price, excl fuel taxes and VAT	5.10	12.16	14.98	4.0%	0.2%
Price at pump, incl fuel taxes and VAT	14.13	27.33	38.63		
Diesel, prognosis A, SEK/liter:	5% FAME 18% HVO	5% FAME 18% HVO	5% FAME 18% HVO		
Product price, excl fuel taxes and VAT	6.59	9.95	10.72	1.2%	0.3%
Price at pump, incl fuel taxes and VAT	13.85	21.02	27.49		
Diesel, prognosis B, SEK/liter:	5% FAME 18% HVO	7% FAME 65% HVO	7% FAME 93% HVO		
Product price, excl fuel taxes and VAT	6.59	12.70	15.29	2.9%	0.2%
Price at pump, incl fuel taxes and VAT	13.85	24.46	33.20		
Electricity for passenger cars, SEK / kWh					
Product price, excl fuel taxes and VAT	1,7236	2,9913	3,5612	2.5%	0.7%
Electricity price, incl energy tax and VAT	2,5420	4,1599	4,8723		
Biofuel for mixing fuel, SEK/liter:					
Ethanol, price excl fuel taxes and VAT	5.86	8.25	8.68	1.5%	0.2%
HVO, price excl fuel taxes and VAT	10.59	14.91	15.68	1.5%	0.2%
FAME / RME, price excl fuel taxes and VAT	6.85	9.65	10.14	1.5%	0.2%

13.2 Vehicle costs for car users

Table 39. Vehicle costs for cars in SEK_{2017}

Price of a new car (including VAT)	202 000
Price of tires (including VAT), SEK per tire	1 057
Mileage, km per year	12 200
Utilization, hours per year	8 760
Annual depreciation, % of the price of a new car	13%
Depreciation related to mileage, % of total annual depreciation	33%
Depreciation, distance related, SEK / km, incl. VAT	0.71 kr/vkm
Interest, SEK / vehicle hour, not dependent on distance	
Maintenance and repairs: Component wear SEK / vkm, including general VAT surcharge	0.16 kr/vkm
Maintenance and repairs: Salary cost (incl. income tax), SEK / hour	199 kr/timme
Maintenance and repairs: Wages (incl. income tax), SEK / vehicle hour, incl. General VAT premium (0.00069 * hourly wage)	0.14 kr/vkm

Table 40. Average driving cost for fuel, for passenger car traffic

Average fuel cost	**SEK per vehicle km**
Year 2017	1.019
Year 2040	0.862
Year 2065	0.857

13.3 Occupancy of cars and purpose of the trips

Occupancy rate and purpose of the trip are parameters needed to convert costs or valued benefits between personal and vehicle related units and to differentiate or weight values with respect to travelers with different cases.

Table 41. Occupancy of cars (mean value) in 2010. Number of persons.

Purpose of the trip	*Occupancy*
Non-business travel:	
Long distance (> 100 km,Samkalk)	2.22
Short distance, all travels (Samkalk)	1.61
Short distance, work (Samkalk)	1.13
Short distance, non-work (Samkalk)	1.89
All non-business travels (EVA)	1.77
Long distance (> 50 km, EVA)	2.06
Short distance, all travels (EVA)	1.58
Business travels:	
Long distance (Samkalk)	1.24
Short distance (Samkalk)	1.31
All business travels (EVA)	1.28
Long distance (> 50 km, EVA)	1.27
Short distance (EVA)	1.30
All travels	1.71

Table 42. Distribution of travels by car on business and non-business trips.

	All travels	*Long distance (> 50 km)*	*Short distance (< 50 km)*
Business travel (the EVA model)	0.10	0.14	0.08
Non-business travel (the EVA model)	0.90	0.86	0.92

13.4 Operating costs for public transport by bus

Table 43. Operating costs for transport by bus, in SEK_{2017}, VAT excluded.

Cost related to:	*Vehicle, SEK_{2017} per year*	*Time, SEK_{2017} per year*	*Distance, SEK_{2017} per timetable- km*	*Vehicle and time, SEK_{2017} per wagon-hour*
Urban traffic:				
Bus, low floor	455 000	338	6.13	507
Bogie bus, low entrance	-*	-	-	-
Articulated bus, low floor	613 000	338	9.83	507
Short distance:				
Bus, low floor	581 000	402	5.60	750
Bogie bus, low entrance	645 000	402	6.02	782
Articulated bus	687 000	402	8.98	803
Long distance:				
Express bus	666 000	359	5.29	550

*not used in urban traffic

Table 44. Fixed cost and marginal cost, excl VAT, for standard bus in urban traffic. (Samkalk)

	Cost
Fixed cost of distance, SEK/km	6.17
Marginal cost of distance, SEK/person and km	0.154
Fixed time cost, SEK per vehicle and minute	5.69
Marginal time cost, SEK per person and minute	0.142
Fixed wear cost, SEK per km	0.40
Marginal cost of wear, SEK per person and km	0.008
	Parameter
Bus size, number of seats	40
Occupancy	0.6

13.5 Operating costs for public transport by train

Table 45. Vehicle operating costs. VAT excluded.

Train type	*Distance-dependent Basic cost SEK / train-km*	*Distance-dependent Marginal cost SEK/train-km*	*Time dependent Basic cost SEK/minut*	*Time dependent Marginal cost SEK/minut*	*Nr of seats*	*Occupancy*
High-speed rail	36,94	0.12	97.33	0.28	460	0.65
Fast trains	31,79	0.12	91.78	0.29	370	0.65
Interregional train C250	23,85	0.09	80.16	0.23	300	0.65
Interregional train C200	16,85	0.08	48.06	0.13	330	0.50
Night train	48,58	0.16	103.14	0.26	500	0.50
Commuter train	20,43	0.09	43.58	0.10	215	0.35
Commuter train in Sthlm	33,80	0.08	37.04	0.05	375	0.35
Regional train Bimodal C160	15,83	0.09	50.08	0.17	150	0.35
Regional train bimodal C140	28,78	0.18	50.08	0.17	150	0.35

13.6 Operating costs for air traffic

Table 46. Costs for air traffic.

Calculation parameters	
Fixed distance cost, SEK/km and vehicle	10.02
Fixed time cost, SEK/minute and vehicle	327
Marginal distance cost, SEK/km of space	0.195
Marginal cost of time, SEK/space and minute	12.88
Number of seats, diminish planes	18
Maximum occupancy	0.8

13.7 Vehicle cost for cyclists

Table 47. Vehicle costs for bicycles, including VAT.

		SEK/km
Capital costs		0.46
Operating costs:		0.23
Insurance	0.12	
Repair	0.06	
Maintenance	0.06	
Total costs		0.70

14 Operating costs for transport of goods

The fuel costs that ASEK recommends are presented below. For the fuel price of diesel for road traffic, two different forecasts are presented with different proportions of low biomass fuel mix. In Forecast A, today's low biofuel mix, 5% FAME and 18% HVO, remains unchanged throughout the forecast period. In prognosis B, the low biomass fuel mix increased from 5% FAME and 18% HVO in 2017 to 7% FAME and 63% HVO in 2040 and to 7% FAME and 93% HVO by 2065.

Annual increase in product price excluding fuel taxes and VAT is 1.2% for 2017-40 and 0.3% for 2040-65 in prognosis A and 3.8% for 2017-40 and 0.4% for 2040- 65 in prognosis B.

Table 48. Fuel costs for diesel (bulk) for lorry without trailer (LBU), lorry with trailer (LBS) and passenger car in commercial traffic (PBY). SEK / liter expressed in 2017 prices.

SEK/liter diesel	*2017*	*2040 Prognosis A*	*2065 Prognosis A*	*2040 Prognosis B*	*2065 Prognosis B*
Product price, excluding fuel taxes and VAT (Samkalk, Bansek)	5.15	8.92	9.61	12.30	15.29
Product price, excluding fuel taxes incl. VAT (EVA)	6.44	11.15	12.01	15.37	19.11
Diesel price, including fuel taxes but excl. VAT (Samgods)	9.64	15.79	20.87	19.17	26.56
Fuel taxes, including VAT	5.61	8.58	14.08	8.59	14.09
Diesel price "at pump", including all taxes	12.05	15.79	20.87	23.96	33.20

Table 49. Fuel costs for maritime transport, in SEK_{2017}.

SEK/ton	*2017*	*2040*	*2065*
Bunker oil, IFO 380, (excl. fuel taxes and VAT)	3 615.0	4 865.6	5 114.8
Marine diesel (MDO), Marine gas (MGO)	4 080.0	5 491.3	5 772.6

14.1 Operating costs for transport of goods on road

ASEK recommends the costs, related to time and distance (direct operational costs) and vehicles (indirect costs) and costs of loading /unloading, reported in the tables below.

Table 50. Operating costs, excluding VAT, for goods vehicles, in prices of 2017. All costs except fuel (incl fuel taxes) are assumed to be constant to 2040 and 2065.

Cost categories:	*LGV3 Light goods vehicle, max 3 tonnes*	*MGV16 Medium-heavy goods vehicle, max 16 tonnes*	*MGV24 Medium heavy goods vehicle, max 24 tonnes*	*HGV40 Heavy goods vehicle, max 40 tonnes*	*HGV60 Heavy goods vehicle max 60 tonnes*
Distance related costs: SEK/vkm					
Fuel (incl. Fuel taxes)	0.70	1.58	2.14	2.62	3.39
Service & repairs	0.33	1.06	1.26	1.19	1.04
Tyres	0.51	0.32	0.64	0.94	1.18
Distance related depreciation (capital cost, wear)	1.08	1.69	2.07	1.78	1.95
Total distance related cost 2017	2.63	4.66	6.11	6.53	7.56
Fuel (incl. Fuel taxes) in 2040 and 2065	0.45	1.33	1.42	2.85	3.99
Total distance related cost 2040 and 2065	2.38	4.41	5.39	6.76	8.16
Time related costs: SEK / hour					
Labour cost (wage)	254	254	245	245	254
Total time related cost	254	254	245	245	254
Vehicle related costs distributed by operating hours: SEK / vehicle hour.					
Insurance and damage, IT equipment and mobiles, other fixed costs	17.27	29.05	36.45	31.16	32.20
Taxes and tolls (annual vehicle related taxes)	1.90	5.28	6.45	7.95	7.95
Capital cost, Depreciation	12.06	16.30	26.58	27.33	29.91
Capital cost, Interest	4.37	13.21	20.84	19.07	20.87
Total vehicle related cost					

Table 51. Vehicle related costs for goods vehicles, excluding VAT. SEK per year in prices of 2017. The costs are assumed to be constant to 2040 and 2065.

Cost categories:	*LGV3*	*MGV16*	*MGV24*	*HGV40*	*HGV60*
Vehicle related costs, SEK / year:					
Insurance and damage, IT equipment and mobiles, other fixed costs	33 167	58 095	72 906	109 046	112 696
Vehicle tax and tolls (annual vehicle related taxes)	3 651	10 553	12 898	27 818	27 818
Capital cost, depreciation	23 155	32 597	53 146	95 658	104 679
Capital cost, Interest	8 396	26 424	41 689	66 752	73 057
Total vehicle related costs, SEK per year	68 369	127 669	180 639	299 274	318 250

Table 52. Cost of loading/reloading, excl VAT. SEK_{2017} per ton, 2014, 2040 and 2065.

	LGV3	*MGV16*	*MGV24*	*HGV40*	*HGV60*
Dry bulk	10	10	10	10	10
Liquid bulk			16	16	16
Other good	104	52	42	21	21
Container				9	9
Stuffing & stripping of container 40 foot	67	67	67	67	67

Table 53. Vehicle costs (incl. general VAT) and other parameters, in prices 2017. Costs and parameters are assumed to be constant to 2040 and 2065.

	LBU, Lorry without trailer	*LBS, Lorry with trailer*	*PBY, Car in commercial traffic*
Price of vehicle, thousand SEK	1 585	3010	309
Tires, SEK per tire	4 276	4 902	1 043
Annual mileage, km	42 000	125 000	18 000
Annual operating hours, hours/year	1 800	3 300	1 920
Wage rate of driver, SEK/hour	278	278	278
Occupancy, persons per vehicle	1.2	1.0	1.2
Wages, SEK/hour	334	278	334
Cost of repair, wage	196	196	196
Capital cost:			
Annual depreciation, % of price of vehicle	13%	13%	13%
Distance related depreciation, % of annual depreciation	100%	100%	100%
Capital cost: distance related depreciation,SEK/km	4.90	2.25	2.23
Capital cost: interest, SEK/hour	22.02	22.80	4.02

14.2 Operating costs for railway transport of goods

For analyzes based on total traffic costs (direct operative and indirect) for electrically driven freight traffic by rail, ASEK recommends the calculation values presented in the tables that follow.

Table 54. Distance related costs of electric trains (excl VAT, fuel taxes and passenger fees on Öresund Bridge and Great Belt). SEK per train-kilometer 2017, 2040 and 2065, in SEK2017

Train	*Cost of electricity 2017*	*Cost of electricity 2040*	*Cost of electricity 2065*	*Infra-structure fees in Sweden, 2017*	*Infra-structure fees in Sweden, 2040 and 2060*
201 Kombi short	12.06	19,74	23,12	12.54	21.36
202 Feeder	8.08	13,22	15,48	10.98	17.77
204 System train Stax 22.5 (SYS22)	16.05	26,26	30,75	17.03	31.59
205 System train Stax 25 (SYS25)	18.66	30,54	35,76	18.80	35.66
206 Ore Stax 30 (SYS30)	100.60	164,63	192,78	81.62	179.25
207 Wagon load short	12.63	20,67	24,20	13.91	24.47
208 Wagon load medium	14.45	23,65	27,69	15.65	28.45
210 Kombi long	13.88	22,72	26,61	14.03	24.76
211 System train Stax 22.5 (SYS22) long	19.12	31,29	36,64	19.37	36.94

Table 55. Time related costs and over-head costs (distributed on operating time) for electric freight trains, excluding VAT. SEK per train hour, in the 2017 prices. The costs are assumed to be constant to 2040 and 2065.

Train	Locomotives	Wagons	Personnel (drivers)	Total Time dependent costs	Overhead costs
201 Kombi short	1 853	797	521	3 170	495
202 Feeder	1 853	635	521	3 009	472
204 System train Stax 22.5 (SYS22)	1 853	843	521	3 217	502
205 System train Stax 25 (SYS25)	1 853	843	521	3 217	588
206 Ore Stax 30 (SYS30)	3 705	1 006	521	5 233	1 239
207 Wagon load short	1 853	891	521	3 265	508
208 Wagon load medium	1 853	1 059	521	3 433	534
210 Kombi long	1 853	949	521	3 323	517
211 System train Stax 22.5 (SYS22) long	1 721	934	521	3 139	487

Table 56. Costs of loading and unloading (reloading) freight trains (node costs). SEK per tonne, in 2017 prices. The costs are assumed to be constant to 2040 and 2065.

Train	Dry bulk	Liquid bulk	Other goods	Container
201 Kombi, reloading of goods				15
201, Kombi, only shunting of wagons				1,6
202 Feeder train, reloading of goods	9	10	15	16
202 Feeder train, only shunting of wagons				3
204 System train Stax 22,5	13	17	31	
205 System train Stax 25	13	17	31	
206 Ore Stax 30	13	17	31	
207 Wagon load, short, reloading of goods	19	17	27	15
207 Wagon load, short, only shunting of wagons	2	2	2	3
208 Wagon load, medium, reloading of goods	19	17	27	15
208 Wagon load, medium, only shunting of wagons	1	1	1	2
210 Kombi, only shunting of wagons				1,6
211 System train Stax 22,5	13	17	31	

Table 57. Operational costs for goods transport by train, incl. VAT excl. track access charges. Costs in 2017, 2040 and 2065 in 2017 prices..

Type of transport	*Electric drive SEK/ton and km*	*Electric drive SEK/ton and hour*	*Diesel drive SEK/ton and km*	*Diesel drive SEK/ton and hour*
Wagonload long-distance	0.149	6.508	0.159	6.508
Wagonload short-distance	0.220	11.280	0.240	11.280
Wagonload average	0.176	7.955	0.190	7.955
System	0.110	5.130	0.119	5.130
System Stax 25	0.097	4.481	0.103	4.481
Ore Stax 25	0.069	2.279		
Ore Stax 30	0.061	1.999		
Kombi	0.136	6.377	0.148	6.377

14.3 Operation costs for maritime goods transport

Table 58. Operation costs for maritime goods transport, excl. fairway charges and loading costs. Costs excl. VAT. Costs 2017, 2040 and 2065 in SEK_{2017}.

Type of ship	*Distance related cost, SEK/km Within SECA*	*Distance related cost, kr/km Outside SECA*	*Time related cost, SEK/hour*	*Positioning costs, SEK/ship*
Container ship 5 300 dwt	43.7	58.8	2 595	
Container ship 16 000 dwt	97.6	131.3	4 802	
Container ship 27 200 dwt	145.7	196.1	6 628	
Container ship100 000 dwt	401.2	540.0	15 620	
Other ships 1 000 dwt	10.3	13.8	1 287	85 743
Other ships 2 500 dwt	19.7	26.5	1 805	97 721
Other ships 3 500 dwt	24.7	33.3	2 062	97 728
Other ships 5 000 dwt	30.3	40.8	2 391	97 577
Other ships 10 000 dwt	51.0	68.6	3 240	111 051
Other ships 20 000 dwt	79.5	107.0	3 999	122 137
Other ships 40 000 dwt	121.8	163.9	5 212	135 027
Other ships 80 000 dwt	187.0	251.7	7 462	183 795
Other ships 100 000 dwt	207.1	278.7	8 042	200 788
Other ships 250 000 dwt	353.9	476.4	11 507	281 606
Ro/ro-ship 3 600 dwt	51.6	69.4	2 787	
Ro/ro-ship 6 300 dwt	75.5	101.6	3 642	
Ro/ro-ship 10 000 dwt	102.9	138.4	4 618	
Car ferry 2 500 dwt	73.3	98.6	5 327	
Car ferry 5 000 dwt	132.4	178.3	10 521	
Car ferry 7 500 dwt	170.4	229.4	16 559	
Train ferry 5 000 dwt	107.1	144.2	7 534	

Table 59. Specific time related costs for transport of goods by sea. Cost excl fairway charges and loading- and unloading costs and VAT. Costs 2017, 2040 and 2065 in SEK_{2017}.

	Dry bulk, SEK/hour	*Liquid bulk, SEK/hour*	*Other good SEK/hour*
Other ships 1 000 dwt	1 409	2 410	855
Other ships 2 500 dwt	1 809	2 941	1 378
Other ships 3 500 dwt	1 996	3 181	1 650
Other ships 5 000 dwt	2 225	3 467	2 003
Other ships 10 000 dwt	2 785	4 148	2 944
Other ships 20 000 dwt	3 560	5 041	4 378
Other ships 40 000 dwt	4 658	6 236	6 592
Other ships 80 000 dwt	6 999	7 858	10 049
Other ships 100 000 dwt	7 652	8 499	
Other ships 250 000 dwt	11 111	11 969	

Table 60. Costs for loading/unloading ships (node cost). Costs excl. VAT. Cost of 2017, 2040 and 2065 in SEK_{2017}.

Type of ship	*Dry bulk SEK/ton*	*Liquid bulk SEK/ton*	*Other good SEK/ton*	*Container SEK/ton*
Container ship 5 300 dwt				74
Container ship 16 000 dwt				74
Container ship 27 200 dwt				74
Container ship 100 000 dwt				73
Other ships 1 000 dwt	16	18	132	
Other ships 2 500 dwt	15	18	123	
Other ships 3 500 dwt	15	18	123	
Other ships 5 000 dwt	15	18	122	
Other ships 10 000 dwt	15	15	122	
Other ships 20 000 dwt	14	14	119	
Other ships 40 000 dwt	14	14	114	
Other ships 80 000 dwt	14	14	114	
Other ships 100 000 dwt	14	14	114	
Other ships 250 000 dwt	14	14	114	
Ro/ro-ship 3 600 dwt	67	67	67	67
Ro/ro-ship 6 300 dwt	67	67	67	67
Ro/ro-ship 10 000 dwt	67	67	67	67
Car ferry 2 500 dwt	11	11	11	11
Car ferry 5 000 dwt	11	11	11	11
Car ferry 7 500 dwt	11	11	11	11
Train ferry 5 000 dwt	20	20	20	20

15 Land use

15.1 Visual intrusion, losses of important sites and impairment of landscape

Effects like visual intrusion, losses of valuable natural environment and impairment of landscape are difficult to value in monetary terms, particularly in the standardized CBA-models we use in the transport sector (environmental effects of this kind are heterogeneous and difficult to assign standard monetary values). This kind of effects has to be treated outside the calculation of NPV and the NNK_{idu}-measure.

The recommendation is that effects like visual and physical intrusion, losses of important sites and impairment of landscape are described and presented in addition to the calculation of the NPV and NNK_{idu}.

15.2 The value of making land available for other uses

When a project contributes to the releasing of useful and attractive land, e.g. when routing a road or railway through a tunnel, this effect should be carefully valued. In the main analysis, the effect of releasing land for other uses than transport should be considered by describing the effect, in addition to the calculation of NPV and NNK_{idu}. A monetised valuation of such an effect should not be included in the main analysis, but may be subjected to a sensitivity analysis.

16 Other effects and valuation problems

This chapter discusses miscellaneous effects and special cases of valuation.

16.1 Valuation of “sunk costs”

“Sunk costs”, i e costs that have already occurred when the cost-benefit analysis is made, and/or the decision on action is already taken, should generally not be included in the analysis.

Exceptions to the principle of not including "sunk costs" should be made for planning costs embedded in the estimated investment cost, even though part of the planning have already been made when analysis is made. This is justified by practical difficulties in making a proper estimation of the remaining planning cost, and that an adjustment of the planning cost would be rather small.

17 Complementary analyses

17.1 Distribution of income and consumption

ASEK recommends that distribution effects should not be analyzed and presented in the CBA. They are to be analyzed and assessed in a separate special analysis, in addition to the CBA. The results of the analysis shall be presented in the Overall Impact Assessment (in Swedish Samlad effektbedömning, SEB) section on distribution effects.

17.2 Regional development

If a project can be assumed to be of particular importance for regional economic development and income distribution, a distribution analysis can be made where the benefits of the CBA calculation are distributed to smaller regions (e.g. counties or municipalities).

The regional economic distribution analysis must be reported in a special memorandum. The results of the analysis can also be summarized briefly in "Overall effect assessment" (SEB) under the heading "In-depth distribution analysis".

17.3 Business impact description

In a business impact description calculated effects for enterprises, in terms of costs and revenues and verbal descriptions of consequences that are difficult to quantify and evaluate, can be reported. The tool used is an Excel form together with a manual describing the implementation. The method consists of three steps: Initial analysis, selection and interview

survey, compilation of results. In the preliminary analysis, background information on the proposed measure is compiled, information on the purpose of the measure, geographical location, type of transport concerned etc. Then the expected effects of the infrastructure measure on freight transport are analysed.

18 CBA within Overall Impact Assessment (Samlad effektbedömning, SEB)

The overall impact assessment (SEB) is a document in which a proposed measure and the prepared decision basis for the measure in question are presented in a structured and summarized manner. The underlying purpose is for the assessment to be a decision basis and information material for decision-makers, officials and citizens alike. The overall impact assessment should also serve as an input for those who wish to seek further information on the measure in question.

Within the Swedish Transport Administration, the overall impact assessment, which is also a basic template in MS Excel, is used to structure and summarize a proposed measure or package of measures (projects) in the transport sector, its costs and the effects that it is expected to have if implemented. The overall impact assessment should be a decision basis with the aim of supporting planning, decisions and follow-up. SEB (method and template) describes the effects of the measure from three decision perspectives:

- CBA (priced and non-priced effects)
- Distribution analysis (how the benefits are distributed among different groups)
- Transport policy goals analysis (how are the transport policy goals affected)

CBA made by or for the Swedish Transport Administration should always be presented within the framework of the Overall effect assessment method. The overall impact assessment shall be prepared for government measures, operational measures, maintenance strategies, different types of investment measures (projects), impact measures, policy measures and packages of measures that work together to solve an identified need. The scope of the decision basis must be adapted to the size and stage of the investigation.