



# FINEST LINK WP2

## Appendix 4.

# Standard Cost-Benefit Analysis



EUROPEAN UNION  
European Regional Development Fund



# Standard Cost-Benefit Analysis

- The cost-benefit analysis studies the difference between the fixed link in contrast to the reference scenario (0+ -alternative)
- The analysis is carried out following and applying the general guidelines of the EU Guide to Cost Benefit Analysis of Investment Projects (2014)
- The wider economic impacts of transport investment are not included in the standard cost-benefit analysis
- Construction of the fixed link is assumed to start 2025, **construction time** is assumed to be **15 years** and the fixed link is opened 2040
- Railway infrastructure project life cycle 30 years after construction
  - Project reference period is 45 years (years 2025–2069)
- Socio-economic **discount rate** in the calculation is according to Finnish guidelines **3.5 %**

# Investment and Maintenance Costs

- Infrastructure investment cost for the fixed link is **16000 M€** (input from WP3)
  - There is no assumption about the EU grant at the moment
- There are assumed to be no significant investment savings due to the fixed link
  - This means that the investments in the 0+ -alternative would also be made in the case of the fixed link alternative
- The fixed link infrastructure operation and maintenance costs are assumed to be **58 M€ / a** (input from WP3)
- The residual value of the investment after 30 years is **47 %** of the original investment cost, if the life cycle of the tunnels is assumed to be 100 years

# Time savings

- Time saving represent the most important part of the benefits
- The **average time saving** for a passenger changing mode from ferry to fixed link train is **2 h 10 min** (components of savings are: travel time  $120-40=80$  min, waiting time  $30-10=20$  min and access times  $50-20=30$  min)
- Every **new passenger** that starts to e.g. commute across the Gulf of Finland using the fixed link gets a **benefit of 1 h 5 min (rule of half)**
- In year 2050 the total time benefits for passengers are:
  - Time savings of the existing users (travel time, access times and waiting time together) are 7.6 Mh / a
  - Convenience factors of the existing users (weight of the waiting time) represent a benefit of 0.6 Mh / a
  - Benefits of new generated traffic are 9.4 Mh / a (the rule of half)
- The increasing number of passengers during the project reference period 2040–2069 is taken into account in the calculation

# Monetarized Time Savings

- The unit values of time for Finnish travelers are from the Finnish guidelines for assessment (base year 2013, increase 1.125 % / a)
  - Business trips 23.7 €/h, trips to work 10.7 €/h and other trips 6.8 €/h
- The unit values for Estonian travelers (excluding Estonian commuters) are assumed to be 30 % of the Finnish values in year 2016 due to a difference in income levels
- The Estonian values are assumed to increase faster than the Finnish ones: this means that in year 2050 the Estonian unit values would be about 50 % of the Finnish values
- In year 2050 the monetarized time benefits are:
  - Time savings of the existing users **104 M€ / a**
  - Convenience factors of the existing users (weight of the waiting time) represent a benefit of **8.0 M€ / a**
  - Benefits of new generated traffic **155 M€ / a** (calculated using the rule of half)

# Producer Surplus (Passenger trains)

- The costs of operating passenger trains in the fixed link are assumed to be **53 M€ / a** (input from WP3)
- The unit cost of a passenger train tickets are:
  - 18 € / trip for single trips
  - 15 € / trip for frequent travelers
  - $480 / 40 = 12$  € / trip for the users of 30-day card
  - 70 € / car for transferring a private car in a shuttle
- The passenger rail fare revenues for the train operator in year 2050 are **226 M€ / a**
- In the cost-benefit calculation the tunnel operations have zero percent tax rate VAT

# Producer Surplus (Ferries)

- The operators of the ferries lose some of their revenues from transport services in the case of fixed link:
  - It is assumed that there are 3 daily ferries less between Tallinn and Helsinki due to the tunnel, which has an effect on operating costs => estimated operating cost decrease is **24 M€ / a**
  - The number of passenger is smaller, which effects fare revenues = > estimated fare revenue decrease year 2050 is **43 M€ / a**
- It is not possible to estimate all the effects of the fixed link to the ferry operators:
  - The ferries are used both by freight transport and passengers
  - The ferry companies also provide other services (restaurants, shopping etc. on board)

# Benefits of Freight Transport

- The benefits of freight transport originate from reduced operating costs between Helsinki and Tallinn. The benefits are not separated to users and producers benefits.
- The unit costs of freight transport operation (including terminal costs) across the Gulf of Finland are assumed to be:
  - Ferries: 15.6 € / ton
  - Fixed link truck shuttles : 12.3 € / ton and freight trains: 5.8 € / ton
    - The average cost using the fixed link is 10.3 € / ton
  - The benefit for the existing demand is  $15.6 - 10.3 = 5.3$  € / ton and for the new demand 2.7 € / ton (the rule of half)
- The benefits of freight transport year 2050 are **23 M€ / a**
  - The benefits for the existing demand 14.3 M€ / a
  - The benefits for the new demand 4.0 M€ / a
  - The fare revenues from the new demand are 4.9 M€ / a



# Externalities

- The environmental impact savings are **0.6 M€ / a** if we use the average properties of Finnish electricity production for the energy of the tunnel
  - The tunnel uses electricity 935 MWh / d (WP3)
  - If there are about 3 daily ferries less between Tallinn and Helsinki due to the tunnel, the energy savings in ferry traffic are about 383 MWh / d
  - There are also about 59 Mtonkms / a less traffic on the streets of Helsinki and Tallinn due to the new location of terminals
- There are no such accidents on railway traffic or sea traffic that should be taken into account in the cost-benefit analysis: Therefore, it is assumed that the fixed link has **no significant effect on traffic safety** or the number of accidents

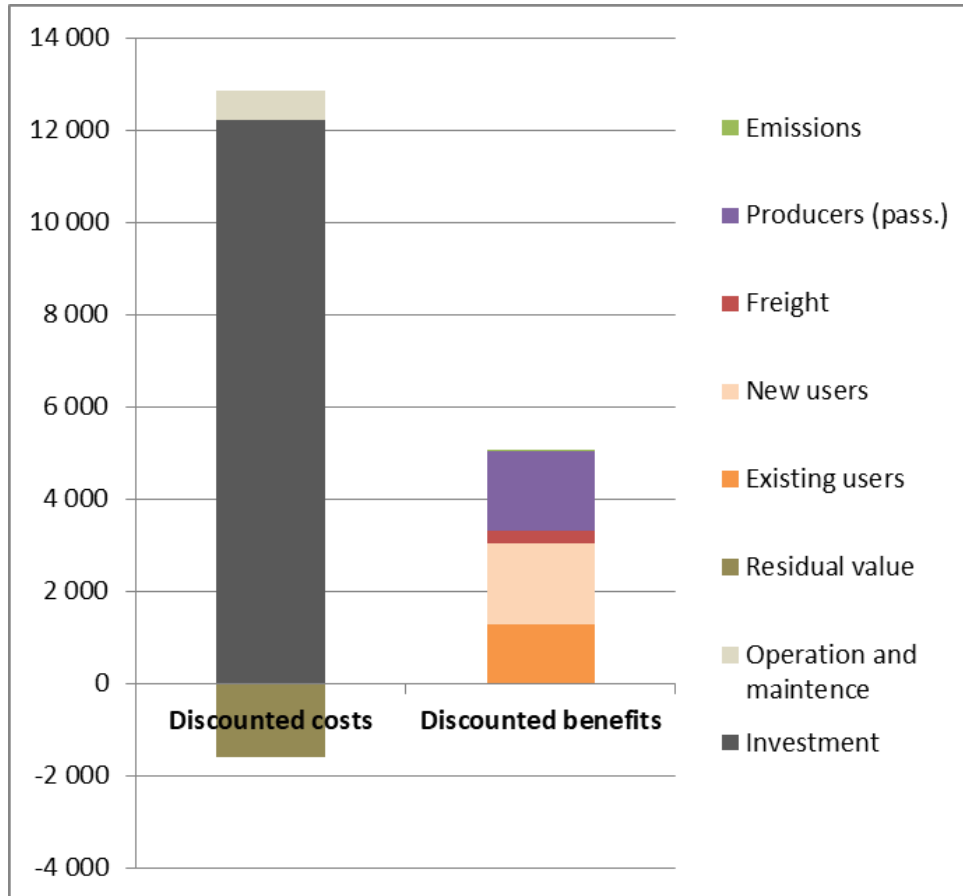
# Calculation table

ECONOMIC PERFORMANCE INDICATORS		2025	2031	2039	2040	2044	2050	2054	2059	2064	2069		
		1	7	15	16	20	26	30	35	40	45		
		Construction				Operation							
<b>Calculation of ERR and B/C</b>		<b>NPV 3.5 %</b>											
Investment cost	M€	12 206	735	1 892	533								
Infrastructure operation and maintenance costs	M€	634				58	58	58	58	58	58		
Residual value of investment	M€	-1 602									-7 531		
<b>Total economic costs</b>	<b>M€</b>	<b>11 239</b>	<b>735</b>	<b>1 892</b>	<b>533</b>	<b>58</b>	<b>58</b>	<b>58</b>	<b>58</b>	<b>58</b>	<b>-7 473</b>		
<b>CONSUMERS (USERS) SURPLUS</b>		<b>M€</b>	<b>3 044</b>			<b>200</b>	<b>224</b>	<b>268</b>	<b>293</b>	<b>324</b>	<b>355</b>	<b>386</b>	
<b>EXISTING USERS</b>		<b>M€</b>	<b>1 277</b>			<b>84</b>	<b>94</b>	<b>112</b>	<b>123</b>	<b>136</b>	<b>149</b>	<b>162</b>	
Value of time savings	M€	1 186				78	87	104	114	126	138	150	
Value of level of service change (convenience)	M€	91				6	7	8	9	10	11	12	
<b>NEW USERS</b>		<b>M€</b>	<b>1 767</b>			<b>116</b>	<b>130</b>	<b>155</b>	<b>170</b>	<b>188</b>	<b>206</b>	<b>224</b>	
Generalized users cost surplus (rule of half)	M€	1 767				116	130	155	170	188	206	224	
<b>BENEFITS OF FREIGHT TRANSPORT</b>		<b>M€</b>	<b>261</b>			<b>19</b>	<b>21</b>	<b>23</b>	<b>25</b>	<b>27</b>	<b>28</b>	<b>30</b>	
<b>PRODUCERS SURPLUS (PASSENGERS)</b>		<b>M€</b>	<b>1 727</b>			<b>128</b>	<b>137</b>	<b>154</b>	<b>163</b>	<b>175</b>	<b>187</b>	<b>198</b>	
Passenger train operating costs	M€	-597				-42	-46	-53	-57	-62	-66	-71	
Rail fare revenues (passengers)	M€	2 549				181	197	226	242	263	283	304	
Ferry operating costs	M€	264				24	24	24	24	24	24	24	
Ferry fare revenues	M€	-489				-35	-38	-43	-46	-50	-54	-58	
<b>EXTERNALITIES</b>		<b>M€</b>	<b>7</b>			<b>0</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	
Emissions	M€	7				0	1	1	1	1	1	1	
<b>Total economic benefits</b>	<b>M€</b>	<b>5 039</b>				<b>347</b>	<b>383</b>	<b>446</b>	<b>481</b>	<b>526</b>	<b>570</b>	<b>615</b>	
<b>ENPV / Net benefits</b>	<b>M€</b>	<b>-6 199</b>	<b>-735</b>	<b>-1 892</b>	<b>-533</b>	<b>290</b>	<b>325</b>	<b>388</b>	<b>423</b>	<b>468</b>	<b>513</b>	<b>8 088</b>	
<b>ERR</b>		<b>0.8 %</b>	Economic Net Present Value (ENPV)										
<b>B/C RATIO</b>		<b>0.45</b>	<ul style="list-style-type: none"> <li>The difference between the discounted total social benefits and costs</li> </ul>										
			<ul style="list-style-type: none"> <li>Economic Rate of Return (ERR)</li> <li>The rate that produces a zero value for the ENPV</li> </ul>										
				Benefit/Cost Ratio									
				<ul style="list-style-type: none"> <li>The ratio between discounted economic benefits and costs</li> </ul>									

# Calculations base year to the opening year according to Finnish guidelines

ECONOMIC PERFORMANCE INDICATORS			2025	2031	2039	2040	2044	2050	2054	2059	2064	2069
			-14	-8	0	1	5	11	15	20	25	30
			Construction				Operation					
Calculation of ERR and B/C		NPV 3.5 %										
Investment cost	M€	20 449	735	1 892	533							
Infrastructure operation and maintenance costs	M€	1 062				58	58	58	58	58	58	58
Residual value of investment	M€	-2 683										-7 531
<b>Total economic costs</b>	<b>M€</b>	<b>18 828</b>	<b>735</b>	<b>1 892</b>	<b>533</b>	<b>58</b>	<b>58</b>	<b>58</b>	<b>58</b>	<b>58</b>	<b>58</b>	<b>-7 473</b>
<b>CONSUMERS (USERS) SURPLUS</b>	<b>M€</b>	<b>5 099</b>				<b>200</b>	<b>224</b>	<b>268</b>	<b>293</b>	<b>324</b>	<b>355</b>	<b>386</b>
<b>EXISTING USERS</b>	<b>M€</b>	<b>2 139</b>				<b>84</b>	<b>94</b>	<b>112</b>	<b>123</b>	<b>136</b>	<b>149</b>	<b>162</b>
Value of time savings	M€	1 986				78	87	104	114	126	138	150
Value of level of service change (convenience)	M€	153				6	7	8	9	10	11	12
<b>NEW USERS</b>	<b>M€</b>	<b>2 960</b>				<b>116</b>	<b>130</b>	<b>155</b>	<b>170</b>	<b>188</b>	<b>206</b>	<b>224</b>
Generalized users cost surplus (rule of half)	M€	2 960				116	130	155	170	188	206	224
<b>BENEFITS OF FREIGHT TRANSPORT</b>	<b>M€</b>	<b>437</b>				<b>19</b>	<b>21</b>	<b>23</b>	<b>25</b>	<b>27</b>	<b>28</b>	<b>30</b>
<b>PRODUCERS SURPLUS (PASSENGERS)</b>	<b>M€</b>	<b>2 894</b>				<b>128</b>	<b>137</b>	<b>154</b>	<b>163</b>	<b>175</b>	<b>187</b>	<b>198</b>
Passenger train operating costs	M€	-1 000				-42	-46	-53	-57	-62	-66	-71
Rail fare revenues (passengers)	M€	4 271				181	197	226	242	263	283	304
Ferry operating costs	M€	442				24	24	24	24	24	24	24
Ferry fare revenues	M€	-819				-35	-38	-43	-46	-50	-54	-58
<b>EXTERNALITIES</b>	<b>M€</b>	<b>12</b>				<b>0</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>
Emissions	M€	12				0	1	1	1	1	1	1
<b>Total economic benefits</b>	<b>M€</b>	<b>8 442</b>				<b>347</b>	<b>383</b>	<b>446</b>	<b>481</b>	<b>526</b>	<b>570</b>	<b>615</b>
<b>ENPV / Net benefits</b>	<b>M€</b>	<b>-10 386</b>	<b>-735</b>	<b>-1 892</b>	<b>-533</b>	<b>290</b>	<b>325</b>	<b>388</b>	<b>423</b>	<b>468</b>	<b>513</b>	<b>8 088</b>
<b>ERR</b>		<b>0.8 %</b>	Economic Net Present Value (ENPV)									
<b>B/C RATIO</b>		<b>0.45</b>	<ul style="list-style-type: none"> <li>The difference between the discounted total social benefits and costs</li> </ul> Economic Rate of Return (ERR) <ul style="list-style-type: none"> <li>The rate that produces a zero value for the ENPV</li> </ul> Benefit/Cost Ratio <ul style="list-style-type: none"> <li>The ratio between discounted economic benefits and costs</li> </ul>									

# Summary of the benefits



- Most important benefits originate from the new users that start to travel between Tallinn and Helsinki:
  - They are the source of fare revenues for train operator
  - They also get user benefits because the generalized cost of travel is reduced
- Passenger volumes are based on rapid growth scenario, which can be seen as one result of the fixed link

# Sensitivity Analysis

1. Investment cost: low (−14 %) and high estimate (+25 %)
  2. Life cycle of the tunnel structures from 100 years down to 50 years
  3. Infrastructure project life cycle from 30 years up to 60 years
  4. Socio-economic discount rate from 3.5 % up to 5.0 %
  5. Calculations base year to the opening year of the tunnel according to Finnish guidelines
  6. Uncertainty of maintenance and operating costs: these costs have been doubled
  7. Travel time of fixed link up 5 minutes, as the timetables are only drafts
  8. The fares revenues maybe lower due to e.g. competition:  
30-day card revenues from 480 euros down to 240 euros
  9. Number of new daily commuters up 25 %
  10. Number of new daily commuters down 25 %
  11. Unit values of time savings for the Estonian travelers to be the same as Finnish travelers in all trip purposes
  12. The growth of GDP in Finland and Estonia is 30 percentage unit higher than in base scenario
- All positives factors and all negative factors together

# Sensitivity Analysis

