CAPITAL AREA TRANSPORT PACT SOCIOECONOMIC ANALYSIS

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PROJECT NO.		DOCUMENT NO.
COWI: A270805	MANNVIT: 1.110.262	001

VERSION	DATE OF ISSUE	DESCRIPTION	PREPARED	CHECKED	APPROVED
1.0	January 2024	Final report	COWI: ADPD MANNVIT: AS, ÓK	COWI: JEE MANNVIT: ÓK	ÓK

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GLOSSARY

Term	Explanation
CO_2	Carbon-dioxide
DT	Delivery Trucks
HGV	Heavy Goods Vehicle
IRR	Internal Rate of Return
ISK	Icelandic Króna
NO_x	Nitrous-oxides
NPV	Net Present Value
Pkm	Person km
$PM_{2.5}$	Particle Matter smaller than 2.5 micro-meter
PPP	Purchasing Power Parity
SLH	Transport Model for the Capital area (Icelandic: Samgöngulíkan höfuðborgarsvæðisins)
VAT	Value Added Tax
Vkm	Vehicle km

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1 Executive summary

1.1 Summary in Icelandic – Samantekt á íslensku

Hér er farið yfir niðurstöður félagshagfræðilegrar greiningar á Samgöngusáttmála höfuðborgarsvæðisins. Verkefni er sagt vera samfélagslega hagkvæmt ef núvirtur nettóábati er jákvæður, þ.e. ábati fyrir samfélagið er meiri en kostnaður. Þessi greining metur sameinuð áhrif allra verkefnanna í Samgöngusáttmála höfuðborgarsvæðisins, sem eru m.a. Sæbrautarstokkur, Miklubrautargöng, nokkur stofnvegaverkefni og Borgarlínan sem er hraðvagnakerfi (Bus Rapid Transit). Viðbótarsviðsmynd er einnig greind sem eru verkefni Samgöngusáttmálans og Sundabraut. Sundabraut er ekki hluti af Samgöngusáttmálanum en í samræmi við áætlanir er hér gert ráð fyrir að hún opni fyrir umferð árið 2031.

Innviðaverkefni eins og verkefni Samgöngusáttmálans og Sundabraut geta leitt til lækkunar á ferðakostnaði á áhrifasvæðum sínum. Sparnaðurinn felst í virði tímasparnaðar (tímavirði), minni aksturskostnaði og sparnaði í ytri kostnaði vegna áhrifa á öryggi og umhverfi yfir líftíma verkefnis. En verkefnum fylgir einnig kostnaður vegna framkvæmda, reksturs og viðhalds á líftíma þeirra. Félagshagfræðileg greining getur auðveldað stjórnvöldum að meta ávinning af verkefni á líftíma þess og vega á móti stofn- og rekstrarkostnaði. Félagshagfræðilegar greiningar, með leiðbeiningum sem settar eru m.a. af framkvæmdastjórn Evrópusambandsins, Alþjóðabankanum, IFC og stjórnvöldum Danmerkur, Noregs, Bretlands og Hollands o.fl., eru víða notaðar erlendis.

Niðurstöður þessarar félagshagfræðilegu greiningar eru að Samgöngusáttmáli höfuðborgarsvæðisins er metinn þjóðhagslega hagkvæm fjárfesting. Það þýðir að núvirtur ábati, á verðlagi ársins 2023, er meiri en núvirtur kostnaður. Samfélagslegur ábati af Samgöngusáttmála höfuðborgarsvæðisins er hér metinn um 1.140 ma.kr., núvirt á verðlagi ársins 2023 yfir 50 ára tímabil greiningarinnar. Innri raunvextir eru metnir 9,2%. Sviðsmyndin þar sem Sundabraut hefur verið bætt við hefur örlítið lægri innri vexti en er samt sem áður álíka þjóðhagslega hagkvæm.

Framkvæmdakostnaðarliðurinn í greiningunni samanstendur af framkvæmdakostnaði verkefnanna og virði eignanna í lok greiningartímabilsins, núvirt aftur til ársins 2023, þ.e. hrakvirðið. Rekstrarkostnaðarliðurinn samanstendur af kostnaði vegna viðhalds innviðanna (gatna, gangna, brúa) og auknum rekstrarkostnaði vegna Borgarlínukerfisins og ábata vegna aukinna fargjaldatekna almenningssamgangna.

Notendaáhrif eru ábati vegna styttri ferðatíma notenda allra ferðamátanna sem greindir eru auk aksturskostnaðar bílnotenda og áhrifa á heilsu notenda (vegna breytinga í ferðum hjólandi). Mestur ábatinn er vegna tímasparnaðar notenda almenningssamgangna og bílnotenda. Þessi tímasparnaður er vegna aukinna afkasta samgöngukerfisins og minni umferðartafa.

Mesti ábati notenda almenningssamgangna er vegna Samgöngusáttmálans þar sem Borgarlínan er hluti af honum. Sviðsmynd með Sundabraut hefur ekki mikil áhrif á notendur almenningssamgangna en hefur jákvæð áhrif á bílnotendur.

Table 1-1 Niðurstöður félagshagfræðilegrar greiningar á Samgöngusáttmála höfuðborgarsvæðisins, milljónir króna á verðlagi ársins 2023.

Milljónir ISK	Samgöngusáttmálinn Núvirði	Samgöngusáttmálinn og Sundabraut Núvirði
Framkvæmdakostnaður:	-215.575	-276.528
Rekstrarkostnaður:	-96.423	-107.401
Notendaáhrif:	1.422.451	1.674.142
Ytri áhrif:	14.619	32.252
Önnur áhrif:	16.743	5.994
Núvirtur ábati	**1.141.815**	**1.328.458**
Innri vextir	**9,2%**	**8,9%**
Ábata/kostnaðarhlutfall	**3,49**	**3,23**

Heimild: COWI og Mannvit

Vegna óvissu í undirliggjandi breytum hefur niðurstaða félagshagfræðilegu greiningarinnar gengist undir næmnigreiningu þar sem frumforsendum hennar er breytt til að kanna áhrif þeirra á samfélagslega hagkvæmni Samgöngusáttmálans og Sundabrautar. Á heildina litið breytir næmnigreiningin ekki því að Samgöngsáttmálinn og Samgöngusáttmálinn með Sundabraut sé samfélagslega hagkvæmur. Í gegnum allar breyturnar eru báðar sviðsmyndir með hæstu innri vexti yfir 3,5%, sem er viðmiðið til að verkefni teljist samfélagslega hagkvæmt.

1.2 Summary in English

This report presents the socioeconomic analysis of the Capital Area Transport Pact (Samgöngusáttmáli höfuðborgarsvæðisins). The socioeconomic analysis addresses the combined impacts of all projects included in the Transport Pact, which includes for example Sæbraut cut and cover, Miklabraut tunnel, a few highway projects and Borgarlínan which is a Bus Rapid Transit system. In an alternative scenario the Sundabraut bridge and highway project is also analysed in combination with the Transport Pact. The Sundabraut project is not a part of the Transport Pact but here it is assumed that Sundabraut will open for traffic in 2031.

Infrastructure projects like the projects in the Capital Area Transport Pact and Sundabraut have the potential to result in less kilometres driven, travel time

savings and reductions in external costs of transport such as noise, air pollution and accidents. However it also imposes costs from construction, operation and maintenance during its lifetime. A socioeconomic study of the proposed projects helps policymakers evaluate the aforementioned benefits arising from the project and compare it to the project costs. The socioeconomic analysis is therefore a management tool for policy makers in order to make more informed decisions for large public investments in transport infrastructure. Socioeconomic studies are widely used in the planning of infrastructure investments worldwide with guidelines set by e.g. the European Commission, World Bank, IFC, and the governmental bodies of among others Denmark, Norway, UK and the Netherlands.

The socioeconomic analysis shows that the Capital Area Transport Pact has a socioeconomic net benefit of about 1,140 billion ISK over the entire analysis period of 50 years and an internal rate of return of 9.2%. Adding the Sundabraut project to the project portfolio slightly decreases the internal rate of return but remains a positive socioeconomic business case. This means that the discounted socioeconomic benefits are higher than the socioeconomic costs related to the projects and the Transport Pact is therefore deemed socioeconomically feasible.

The construction costs consist of the construction costs of the projects in the construction period discounted to present value, as well as the benefit of the assets at the end of the analysis period discounted back to 2023, named the scrap value. The change in operational costs is twofold. Firstly, an increase in cost of maintenance of the road infrastructure and in the operational costs for buses in the Borgalínan system. Secondly, an increase in revenue from public transport tickets.

The user impacts cover the travel time benefits for all analysed travel modes as well as the vehicle operating costs and the user health impacts (due to changes in biking). The main benefits accrue from time savings for the public transport users and the motorists. These time savings arise from a more efficient traffic system and less congestion.

Most gains to public transport users come from the Capital Area Transport Pact as it includes the Borgarlínan system. Adding Sundabraut does not cause significant changes to public transport users but has high positive impact on cars and motorist.

Table 1-2 The Capital Area Transport Pact socioeconomic summary results 2040, 2023 prices

Million ISK	Transport Treaty NPV	Transport Treaty and Sundabraut NPV
Construction costs:	-215,575	-276,528
Operational costs:	-96,423	-107,401

User impacts:	1,422,451	1,674,142
External impacts:	14,619	32,252
Other consequences:	16,743	5,994
Net present value	**1,141,815**	**1,328,458**
Internal rate of return	**9.2%**	**8.9%**
Net benefit to cost ratio	**3.49**	**3.23**

Note: *All benefits are with a positive sign whereas all costs are denominated with a negative sign.*

Source: *COWI and Mannvit*

The result of the socioeconomic analysis has undergone a sensitivity analysis where the primary assumptions are altered in order to investigate the impact on the socioeconomic feasibility of the Transport Pact. The sensitivity analysis shows that the result of the study is robust towards changes in all the primary assumptions. Overall, the sensitivity analysis does not change the economic feasibility of the project, and it doesn't change the relative difference between the scenarios with and without Sundabraut. Through all the parameters the Capital Area Transport Pact maintain an internal rate of return above 3.5%.

2 Introduction

The state, Reykjavík City, Kópavogsbær, Hafnarfjarðarkaupstaður, Garðabær, Mosfellsbær and Seltjarnarnesbær signed an agreement on transport projects in the capital area on September 26, 2019. This agreement is called the Capital Area Transport Pact (Samgöngusáttmáli höfuðborgarsvæðisins) and outlines a shared vision and comprehensive transportation strategy for the capital area, with the objective of enhancing traffic safety, optimizing transportation for all modes of travel, minimizing congestion, significantly improving public transport and other active modes, and mitigating pollution from particle matter emissions and greenhouse gas emissions.

This report presents the socioeconomic analysis of the Capital Area Transport Pact (Samgöngusáttmáli höfuðborgarsvæðisins). The socioeconomic analysis addresses the combined impacts of all projects included in the Transport Pact, which includes for example Sæbraut cut and cover, Miklabraut tunnel and Borgarlínan which is a Bus Rapid Transit system. The projects are further described in chapter 3.

In an alternative scenario the Sundabraut bridge and highway project is also analysed in combination with the Transport Pact. The Sundabraut project is not a part of the Transport Pact. The purpose of Sundabraut is to improve the flow of transportation in the Reykjavík capital area and improve connections both in the capital area and to/from it to north and northeast. Sundabraut is one of six transportation projects that the Icelandic government has approved in its Transportation Plan 2020-2034 to be worked on as a PPP (Public Private Partnership) project.

Measuring the impacts of the Capital Area Transport Pact

In order to analyse the impact of the Transport Pact the transport model for the capital area was used (SLH). Information on the transport model can be found in its documentations[1].

Based on the transport model as well as cost estimates for constructing and operating the project, the socioeconomic analysis (often referred to as cost benefit analysis or CBA) provides a quantitative measure of the effects of the project. It seeks to answer whether a new project or initiative will bring the community benefits that exceed the costs of construction and operation.

[1] (Cowi & Mannvit, Transport Model for the Capitol area of Iceland - Documentation 3.0, 2021)

The European Commission has heavily promoted the use of socioeconomic analysis for major infrastructure projects and has introduced legislation for its members outlining basic rules for conducting CBA[2].

In OECD´s economic survey of Iceland one of the key recommendations for improving public spending is applying a more comprehensive cost-benefit analysis to infrastructure projects.[3]

In all Scandinavian countries, the UK and the Netherlands, a cost benefit analysis must be performed on all major infrastructural projects.

Socioeconomic studies have been performed sporadically in Iceland in recent years:

1 "Hagræn úttekt á sex valkostum fyrir framtíðarstaðsetningu Reykjavíkurflugvallar"[4]

2 2014: "Svæðisskipulag höfuðborgarsvæðisins"[5]

3 2015: "Kostnaðar- ábatagreining á alhliða flugvelli í Hvassahrauni"[6]

4 2017: "Ásvallabraut - Hagræn greining"[7]

5 2020: "Borgarlína Socioeconomic Analysis"[8]

6 2021: "Sundabraut Socioecenomic Analysis[9]

The aforementioned analyses were conducted using the Danish socioeconomic model for transport projects, TERESA[10]. Allowing the impacts of alternative transport projects to be compared using a consistent methodology. This project is carried out in TERESA as well.

2.1 Purpose

The purpose of this report is to present the socioeconomic impacts and document the analysis of the Capital Area Transport Pact.

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[2] (European Commision, 2014)
[3] (OECD, 2019), page 10, key policy insights.
[4] (ParX, 2007)
[5] (Various, 2015)
[6] (Hagfræðistofnun, 2015)
[7] (Mannvit, 2017)
[8] (Mannvit C. &., 2020)
[9] (Cowi & Mannvit, Sundabraut Socioecenomic study, 2021)
[10] Transport- og Energiministeriets Regneark for Samfundsøkonomisk Analyse (DTU, TERESA 6.0, 2022)

As a part of this analysis, a set of transport economic unit values for Iceland were developed specifically (see appendix A) for the unit values necessary in order to analyse the socioeconomic impacts of the Transport Pact.

2.2 Structure of the report

The remainder of the report is structured as follows:

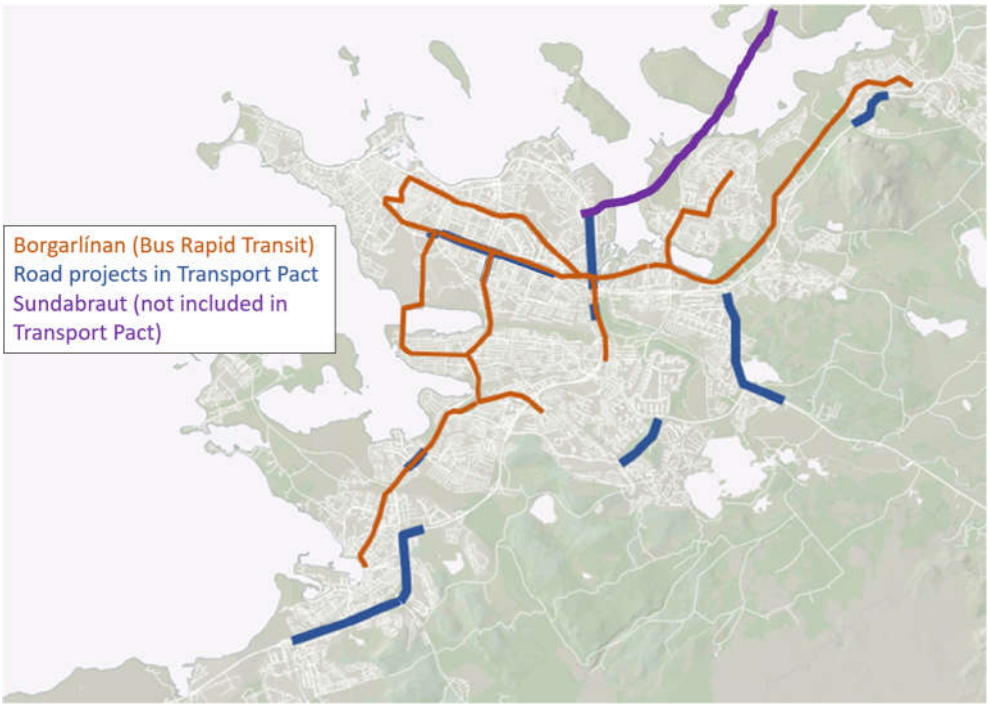
- Chapter 3 describes the Capital Area Transport Pact projects and the Sundabraut project.
- Chapter 3 shortly summarises the main aspects, the principles of socioeconomic analysis and the impacts included in the analysis of the Transport Pact and Sundabraut
- In Chapter 5, all input and assumptions of the analysis are described in detail
- Chapter 6 presents the results of the socioeconomic analysis
- In Chapter 7, the robustness of the results presented in chapter 6 are investigated by changing the main input parameters. This is a so-called sensitivity analysis
- Chapter **Error! Reference source not found.** looks into the wider economic impacts of infrastructure projects and aspects of BRT as an enabler for green transition and urban development
- Chapter 9 concludes on the entire socioeconomic analysis

The subsequent chapters 10 and 11 list the studies used in the analysis and the appendices.

3 The Capital Area Transport Pact – projects

Several projects are included in the Capital Area Transport Pact and they can be categorized into three groups; road projects, public transport projects (Borgarlínan) and other projects. The following figure gives an overview of the road projects and the public transport projects included in economic calculations. One of the road projects, the Sundabraut bridge and highway project, is not a part of the Transport Pact but is included in an alternative scenario in the socioecenomic calculations.

Figure 1 Overview of projects included in the Capital Area Transport Pact and the Sundabraut project.



For the socioecenomic study a future scenario is investigated for the year 2040 when all these projects are planned to be finished. The projected population for the capital area is estimated to reach 314,000 in this future scenario.

Below is a further description of the projects included in the future scenario.

3.1 Description of road projects

For the socioecenomic study ten projects included in the Transport Pact were evaluated in a future scenario. Furthermore a separate future scenario was also calculated which additionally includes Sundabraut. The Transport Pact projects can be categorized into major and minor projects. Following is a description of all the projects.

3.1.1 Major road projects

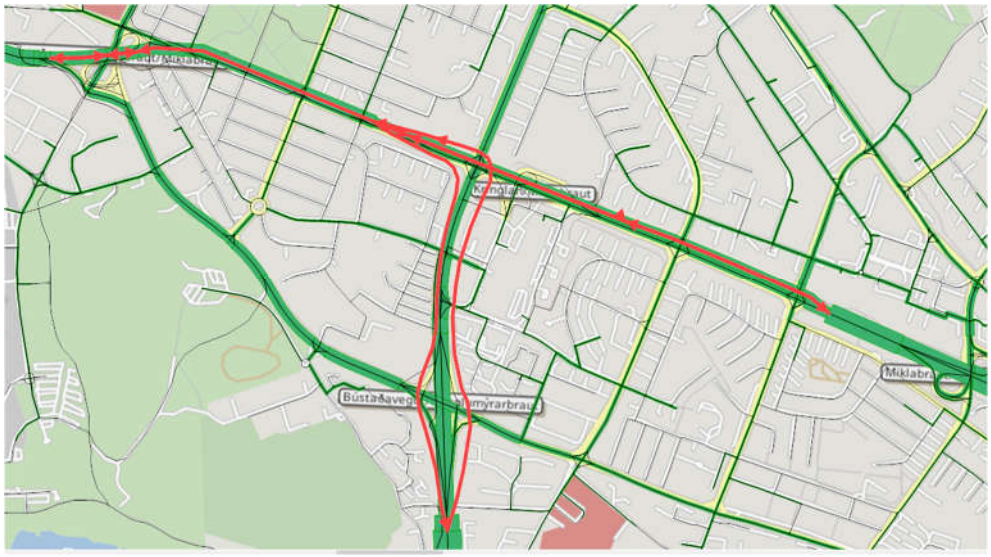
Four of the projects might be considered as a major project considering both cost and complexity. Prerequisites for these projects used in this socioeconomic analysis are further described here below.

Miklabraut tunnel

Miklabraut is currently being investigated in a conceptual design, where the advantages and disadvantages of adopting either a cut-and-cover or a tunnel approach are weighed.

In this socioecenomic study only the tunnel solution is evaluated. The eastern entrance to the tunnel is between Réttarholtsvegur and Grensásvegur and the western entrance is between Nauthólsvegur and Bústaðavegur. The tunnel has access tunnels to and from Kringlumýrarbraut. The entrance on Kringlumýrarbraut is south of Bústaðavegur and the entrance under Miklabraut is between Stakkahlíð and Kringlumýrarbraut.

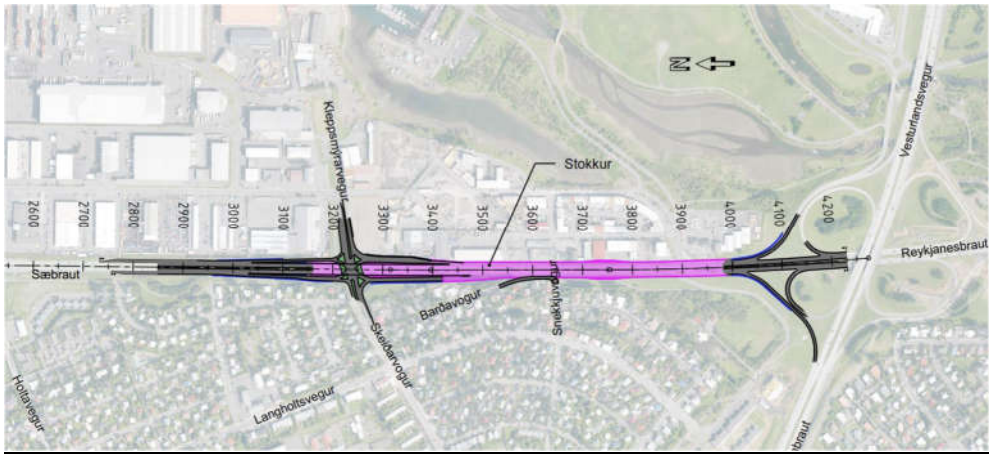
Figure 2 Overview of the Miklabraut project included in the Transport Pact as a tunnel with access tunnels to and from Kringlumýrarbraut.



Sæbraut cut and cover

Sæbraut will be placed in a 1 km long cut and cover between Kleppsmýrarvegur and Súðarvogur. The current junction of Súðarvogur and Sæbraut will be closed and the junction Kleppsmýrarvegur/Sæbraut will be grade seperated.

Figure 3 Overview of the Sæbraut project included in the Transport Pact. The purple area will be covered by the cut and cover.



Hafnarfjarðarvegur cut and cover
Hafnarfjarðarvegur will be placed in a 0.4 km long cut and cover between Lyngásvegur and Vífilsstaðavegur. This will make the junctions Lyngás/ Hafnarfjarðarvegur and Vífilsstaðavegur/Hafnarfjarðarvegur grade seperated.

Reykjanesbraut cut and cover
Reykjanesbraut is a highway in Hafnarfjörður between Lækjargata and Álftanesvegur and it is currently being investigated as either a cut and cover or a tunnel.

For the socioecenomic study only the cut and cover approach is evaluated. The project will change three current signal junctions into grade seperated junctions. The junction Hamraberg/Reykjanesbraut will be closed and Hamraberg will be connected to Reykjanesbraut through the Álftanesvegur/Reykjanesbraut junction.

3.1.2 Other road projects

Four road widening projects are included in the Transport Pact, one new road and one grade seperation of a junction. Although some of these projects have already been executed the cost and benefits are evaluated in this socioecenomic study. These are the projects:

- Arnarnesvegur: Rjúpnavegur – Breiðholtsbraut (new 1+1 road)
- Reykjanesbraut: Gatnamót við Bústaðaveg (grade separation of a signal junction)
- Vesturlandsvegur: Skarhólabraut – Hafravatnsvegur (widening to 2+2 lanes)
- Reykjanesbraut: Kaldárselsvegur – Krýsuvíkurvegur (widening to 2+2 lanes)
- Suðurlandsvegur: Norðlingavað – Bæjarháls (widening to 2+2 lanes)
- Suðurlandsvegur: Bæjarháls – Vesturlandsvegur (widening to 2+2 lanes)

3.1.3 The Sundabraut connection

Sundabraut is a new bridge and highway connection in the northeast part of the Reykjavik capital area. It creates a new connection from the northern part of Reykjavík City, through the Grafarvogur neighbourhood in Reykjavík, and to the highway system north of Reykjavík that further connects to the western part of Iceland. It is estimated that Sundabraut will be opened for traffic in 2031.

The Sundabraut project is split into two phases. Phase 1 is the crossing over the port area and the Kleppsvík bay, over to Gufunes in the Grafarvogur neighbourhood. Phase 2 continues from Grafarvogur and north to Kjalarnes where it connects to the Vesturlandsvegur highway. For phase 1 there are two options being evaluated, a bridge and a tunnel. For phase 2 only one option is evaluated.

Figure 4 Overview of the Sundabraut project. Phase 1 with bridge in orange, phase 1 with tunnel in blue and phase 2 with yellow

For the socioecenomic study the whole Sundabraut project (phase 1 and phase 2) was evaluated. In phase 1 only the bridge option was included, with two accesses

to Grafarvogur through grade seperated junctions, to Hallsvegur and to Borgarvegur.

3.2 Description of Borgarlínan

Borgarlínan is a Bus Rapid Transit project (BRT). It is a high-quality bus-based transit system that delivers fast, comfortable, and cost-effective services with high passenger capacity. It does this through a system of dedicated lanes, with busways and iconic stations typically aligned to the centre of the road, off-board ticketing, and fast and frequent operations.

Because BRT has features similar to a light rail or metro system, it is much more reliable, convenient and faster than regular bus services. With the right features, BRT is able to avoid the causes of delay that typically slow regular bus services, like being stuck in traffic and queuing to pay on board.

In a screening report from 2017[11], the following five principles were established to guide the vision of the Borgarlínan system:

- Simple and direct network structure
- High frequency and extended service hours
- Low travel time and high regularity
- Coordinated and convenient transfers to other forms of transport
- High comfort and quality for buses and stations

Borgarlínan is intended to have rapid, high quality services and its stations will provide a safe and comfortable experience for waiting passengers under any weather conditions. The new system's stations, buses and service maps are to form an immediately recognisable brand. Borgarlínan will:

- Include fully dedicated lanes, designed in a way that minimizes delay to passengers
- Include off-board fare collection, so that passengers can board quickly, and platform-level boarding so that passengers can board easily
- Be accessible to everyone
- Buses will run on clean, domestic fuels (electricity, methane or hydrogen)
- Cycle and pedestrian lanes will be integrated with Borgarlínan stations and corridors, providing an option for first or last mile connectivity

The majority of Borgarlínan will use existing streets but new infrastructure will be built in several places. Most notably a bike, pedestrian and transit-only bridge

[11] (Cowi, Borgarlína recommendations, screening report, September 2017)

between Reykjavík and Kópavogur (Fossvogur Bay) and a new transit-only bridge at Elliðaárvogur (Elliðaá Bay) will be constructed for Borgarlínan.

There are 5 BRT routs planned that will serve all municipalities in the capital area. The majority of the routes are planned to run on designated bus lanes, covering 50 to 90% of the overall route length. Where BRT routes run without bus lanes, measures are planned to mitigate delays and ensure passenger comfort such as with signal priority.

In this socioeconomic analysis, the complete Borgarlínan system included in the Capital Area Transport Pact from 2019 was analysed. Below is a list of projects associated with Borgarlina that are included in socioeconomic calculations:

- Borgarlínan Lota 1: Ártún – Hlemmur – Hamraborg (bus lanes and signal priority)
- Borgarlínan Lota 2: Hamraborg – Lindir (bus lanes and signal priority)
- Borgarlínan Lota 3: Mjódd – BSÍ (bus lanes and signal priority)
- Borgarlínan Lota 4: Fjörður – Miklabraut (bus lanes and signal priority)
- Borgarlínan Lota 5: Ártún – Spöng (bus lanes and signal priority)
- Borgarlínan Lota 6: Ártún – Mosfellsbær (bus lanes and signal priority)
- Measures to ensure right of way and passenger comfort outside bus lanes.

3.3 Description of other projects

Other projects included in the Transport Pact are dedicated bike paths, various safety measures such as pedestrian bridges or tunnels and redesign and optimization of traffic signals.

The following projects are included in the socioeconomic calculations:

- Bike paths along Borgarlina corridors
- Bike paths outside of Borgarlina corridors

A few projects in the category of other projects were excluded from the socioeconomic calculations due to the absence of assessments on calculated impacts, such as travel time savings or the reduction of accidents. While the construction costs of these projects are currently known, the benefits are not, making it impossible to analyze the net benefit-to-cost ratio for these specific projects at this time. These are the projects included in the Transport Pact but not included in the sociecenomic calculation:

- Pedestrian bridges and tunnels
- Redesign and optimization of traffic signals
- Other projects to increase road safety

4 Methodology

Infrastructure projects like the projects in the Capital Area Transport Pact have the potential to result in less kilometres driven, travel time savings and reductions in external costs of transport such as noise, air pollution and accidents. However it also imposes costs from construction, operation and maintenance during its lifetime. A socioeconomic study of the proposed projects helps policymakers evaluate the aforementioned benefits arising from the project and compare it to the project costs. The socioeconomic analysis is therefore a management tool for policy makers in order to make more informed decisions for large public investments in e.g. transport infrastructure.

The socioeconomic analysis can indicate whether a project is economically feasible, meaning that the present value of benefits over a project's lifetime outweigh its costs. The analysis can also (if used consistently) help policy makers prioritize projects or project alternatives by ranking economic feasibility.

A socioeconomic analysis is used to capture the benefits and costs for both the public and private sector such as neighbours or bus operators. Where possible the analysis includes impacts that are external to the project. These externalities include environmental effects, effects on traffic safety, road maintenance effects etc.

To be included in the calculations, all benefits and costs are monetized. This means that they are stated in monetary values. When using the same unit of measurement – ISK - it becomes possible to compare the benefits of e.g. reduced travel times of the commuters to the costs of building and maintaining the road. The socioeconomic analysis also makes it possible to compare the benefits and costs that are realised in different years.

The steps in a socioeconomic analysis are:

- Identify all relevant costs and benefits of the project
- Quantify and monetize the costs of the project
- Quantify and monetize the benefits of the project
- Compare the costs and benefits of the project in order to analyse the feasibility of the project

The socioeconomic analysis of the Transport Treaty is carried out in accordance with international guidelines for assessment of transport infrastructure investments[12].

The socioeconomic analysis results in three key indicators:

- Net present value. Since the costs and benefits of a new road connection accrue over several years, all the benefits and costs over the project life are

[12] The quantitative analysis is performed in a version of the Danish official model TERESA modified to Icelandic conditions. The Danish guidelines are comparable with the Norwegian and EU guidelines though there are minor differences.

discounted[13] to an estimated net present value (NPV). The NPV is therefore the value of all future benefits and costs should they have occurred today. Hereby, it is possible to compare costs and benefits that are realised in different years.

- Internal rate of return is the discount rate at which the discounted benefits equals the discounted costs. The internal rate of return (IRR) therefore demonstrates the attractiveness of a project. The internal rate of return should at least exceed the social discount rate, which is 3.5 % in real terms.

- Benefit-cost ratio. The ratio of discounted net benefits to the discounted public costs indicates the relationship between the net benefits of the project and public costs. A ratio higher than one indicates that the net benefits exceed the public cost of construction.

For a project to be socioeconomically feasible, the net present value should be positive, and the internal rate of return should exceed the social discount rate.[14] The net present value equals zero when the internal rate of return equals the social discount rate.

Net present value and internal rate of return

The formula for calculation of the net present value of the entire cost and benefit flow of a project is

$$NPV = \sum_{t=0}^{n} \frac{R_t}{(1+i)^t}$$

Where n is the total number of time periods, R is the net revenue per period, *i* is the discounting rate and t is the time period.

The internal rate of return is the discount rate that will return a net present value of 0. Therefore, we know that if the net present value is positive the internal rate of return is higher than the specified discounting rate. The internal rate of return is resolved in an iterative process.

[13] Discounting of a future value corrects it to its current value. The social discount rate is therefore an expression of the rate of which society is willing to give up benefits today in order to receive additionally in the future.

[14] The socioeconomic analysis does not by itself determine whether a project should be implemented or not. It solely presents the analysed social return on investment. It can still be a political priority to implement projects with low or negative results.

The economic impacts of the projects under the Transport Pact that are included in the analysis are described in **Error! Reference source not found.**. Each of the impacts are then further explained in detail in chapter 5.

Table 4-1 Impacts considered in the socioeconomic analysis of the Transport Pact

IMPACTS MONETISED IN THE ANALYSIS			
Subject	Description	Quantification	Monetisation
Construction costs	The construction of various projects in the Transport Pact, such as roads, bridges and tunnels/cut'n covers imposes a cost on society up front.	The construction cost of all the projects included in the Transport Pact (as described in Chapter 3).	Cost of constructing the projects.
Operational costs	The infrastructure must be maintained due to wear and tear of vehicles and nature. Also increased operational costs of the bus network.	Driven kilometres by car users, and regular cleaning and maintenance of the construction. Further operational cost increase to the bus network as a result of Borgarlínan is included.	Cost per kilometre driven by cars, and a fixed cost due to natures wear and tear and resulting maintenance. Also adding the difference between operational costs of an unchanged bus network and a public transport network with Borgarlínan.
Travel time savings	Travel time savings is usually the primary benefit of infrastructure projects, and relates to less time spent going from A to B.	The travel time savings is quantified using a transport model for the Capital Area.	Calculated unit prices for free travel time and congestion, and if public transport is affected also for time in transit, waiting time, and number of transfers.
Travel costs	Travel costs is a part of the cost of transport that the transport users take into account when deciding whether or not to perform a trip.	Change in km driven based on the transport model.	The average cost of driving for each transport mode incl. fuel, depreciation and taxes.
Accidents	Accidents come at a high cost for both the parties involved and the society. Changes in risk of accidents is therefore included and monetised in the analysis. The change in the risk of accidents stem from i.e. a reduction in vehicle kilometres and improvements of roads.	Number of avoided accidents based on reduction in vehicle km in the influence area. Sometimes a more detailed accident anaylsis is performed, based on accident history in the specific analysis area. But that has not been done for this analysis.	The cost of an accident regarding material damage, personal damage and cost to society due to health care services and loss of future productivity.
CO_2 emissions	The reduction in vehicle km as cars travel less kilometres and in less time due to the new road and less congestion time.	Change in vehicle km driven and emission factor.	Unit value for cost of CO_2 emission based on vehicle km.

IMPACTS MONETISED IN THE ANALYSIS			
Subject	Description	Quantification	Monetisation
Pollution	The reduction in overall vehicle km's driven lower the emissions of ambient air pollutants citywide.	Change in vehicle km driven.	Unit value for cost of pollution based per vehicle km.
Noise	Traffic noise imposes both nuisance and health related costs to society why there is a benefit of reduced kilometers driven.	Change in vehicle km driven, and changes in the noise annoyance factor calculated for the Sæbraut cut and cover.	Unit value for cost of noise based per vehicle km, combined with the value of a reduction in the noise annoyance factor.

Source: COWI and Mannvit

The socioeconomic analysis quantifies and monetizes the impacts for every year in the analysis period of 50 years. This allows for investigation of the feasibility of the project over time dependent on e.g. expected developments in traffic.

The cost of transport is often referred to as a generalized cost of transport consisting of e.g. driving costs and time spent in traffic for private cars, and ticket costs, walking time, in vehicle travel time, waiting time and shift when using public transport.

Transport users decide to travel as the cost of transport is lower than the benefit they receive from realising the trip. This net benefit is called the consumer surplus. Socioeconomic analysis of infrastructure projects, therefore analyses and monetises the change in consumer surplus for all transport modes. The methodology of quantification of changes in consumer surplus is elaborated in detail in Appendix 3.

5 Description of Data and Assumptions

In this chapter, the data and assumptions for the socioeconomic analysis is described.

5.1 Constructions Costs

Total investment of Transport Pact of 335 billion ISK incl. contingency

The Transport Pact encompasses numerous projects, which can be classified into three categories: Road projects, public transport projects (Borgarlínan), and other projects. The cost of each of these projects and the Sundabraut project is displayed below in Table 5-1 with all numbers in 2023 prices. Furthermore, a contingency[15] has been added to the construction costs and they are a P85 value, meaning that it is estimated that there is a 85% probability that the cost will be within this value. The total cost of the Transport Pact is thereby 335 billion ISK and the total cost of Sundabraut is 90 billion ISK, all in 2023 prices.

The total construction cost of road projects in the Transport Pact with contingency is 163 billion ISK and with the addition of Sundabraut the total construction cost is 253 billion ISK. The total construction cost with contingency of Borgarlínan is 135 billion ISK. The total construction cost with contingency of bicycle paths outside and inside Borgarlina sections is 38 billion ISK. All prices are in 2023 prices.

Table 5-1 Constructions costs incl. VAT, billion ISK

Project	Transport Treaty (P85 values)	Transport Treaty and Sundabraut (P85 values)
Bæjarháls - Vesturlandsvegur	590	590
Skarhólabraut - Hafravatnsvegur	950	950
Grade seperated intersection at Bústaðavegur	5,000	5,000
Kaldárselsvegur - Krýsuvíkurvegur	3,070	3,070
Norðingavað - Bæjarháls	5,300	5,300
Reykjanesbraut/Sæbraut - Holtavegur - Stekkjabakki (Sæbrautarstokkur)	26,000	26,000
Reykjanesbraut - Álftanesvegur - Lækjargata	21,000	21,000
Arnarnesvegur - Rjúpnavegur - Breiðholtsbraut	7,000	7,000
Miklabraut - Tunnel and connections to hospital	65,000	65,000
Hafnarfjarðarvegur - cut and cover tunnel in Garðabær	13,200	13,200
Other construction related cost and contingency	15,900	15,900
Sundabraut	0	90,000
Road projects total construction cost	**163,010**	**253,010**
Ártún - Hlemmur - Hamraborg	50,000	50,000

[15] During the initial stages of a project, contingency is incorporated into the construction cost to accommodate uncertainties. The extent of this contingency varies depending on the project's position within the planning stages.

Mjódd - BSÍ	18,200	18,200
Fjörður - Miklabraut	20,900	20,900
Ártún - Spöng	12,500	12,500
Hamraborg - Lindir	8,000	8,000
Ártún Háholt	17,300	17,300
Borgarlína through Keldur and Blikastaðaland	0	0
Harpa turnaround	1,200	1,200
Projects outside Borgarlina sections	3,000	3,000
Borgarlina stops outside Borgarlina sections	3,700	3,700
Borgarlina total construction cost	**134,800**	**134,800**
Bicycle paths along Borgarlina sections	22,000	22,000
Bicycle paths outside Borgarlina sections	15,800	15,800
Bicycle paths total construction cost	**37,800**	**37,800**
Total construction costs	**335,610**	**425,610**

Note: The estimate is including VAT and has been validated by Betri Samgöngur and the Icelandic Road and Coastal Administration. Projects such as pedestrian tunnels and bridges and traffic signal improvements were excluded from the socioeconomic calculations due to the absence of assessments on calculated impacts, such as travel time savings or the reduction of accidents. The total construction cost of these projects in the Transport Pact is 11.800 billion ISK.

Source: Betri Samgöngur and Efla (Sundabraut), updated construction costs for 2023

The construction of the Borgarlínan project is scheduled to occur between 2024 and 2040, with the initial phase targeted for completion by 2030. Road projects construction was already initiated in 2019, including the completion of certain segments like Skarhólabraut – Hafravatnsvegur, and are planned to continue until 2040. The construction of Sæbrautarstokkur is anticipated to conclude in 2029, while the completion of Miklabraut tunnel is projected for 2040. The construction timeline for Sundabraut is envisioned over a five-year span, spanning from 2026 to 2031, including both years.

The distribution of total construction cost between projects is shown in the following pie chart.

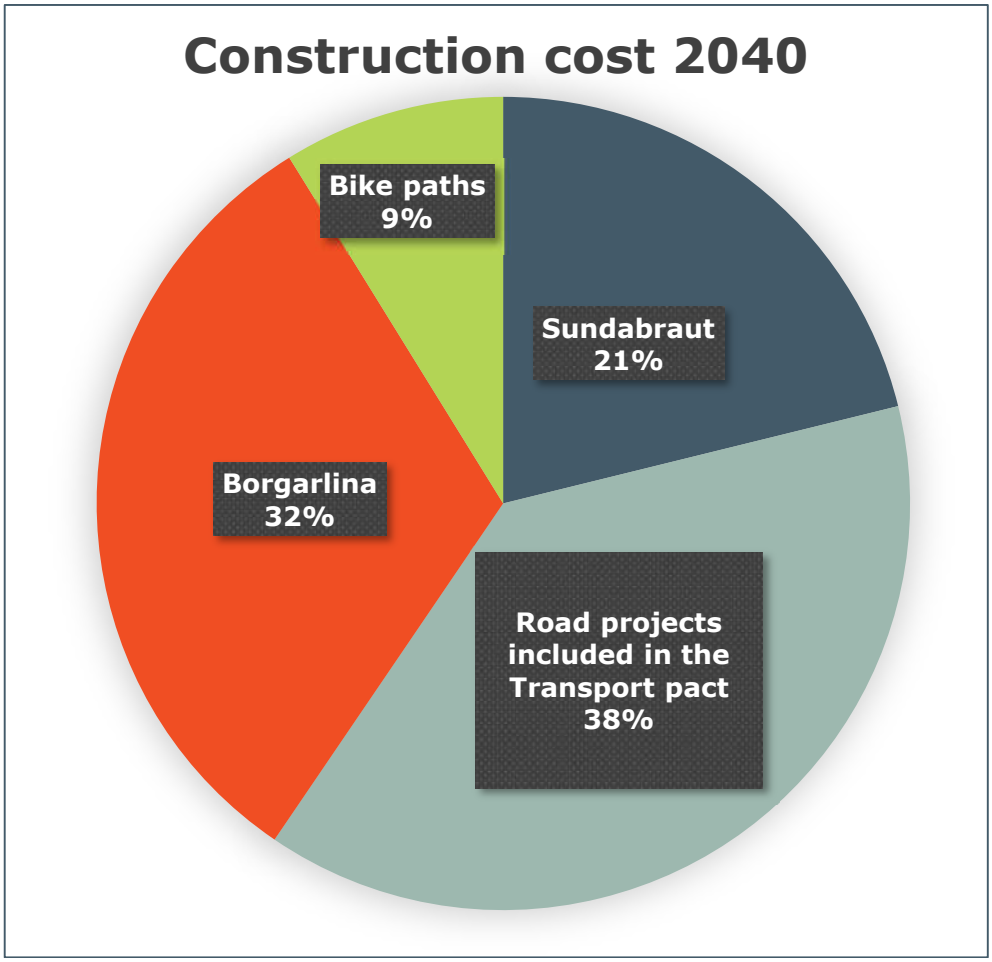


Figure 5 Distribution of constructions costs between project categories in socioeconomic scenario "Transport Pact and Sundabraut"

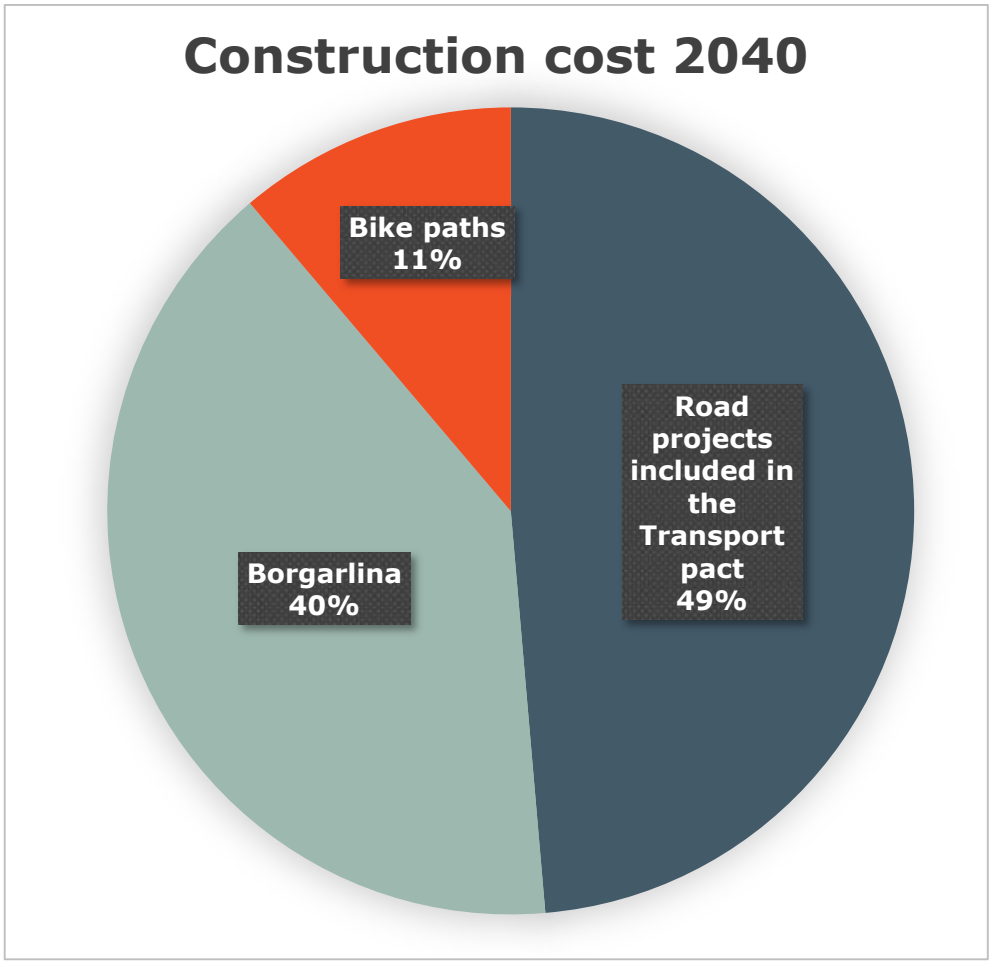


Figure 6 Distribution of constructions costs between project categories in socioeconomic scenario "Transport Pact"

5.2 Operational Costs

The operational costs include the costs and expenses related to maintenance of the construction in question. In this case the operational costs are related to maintenance of the highway infrastructure including bridges and tunnels. Additionally, they cover the maintenance of infrastructure for Borgarlina, incorporating elements such as priority lanes, priority systems, and bridges and the operation of the Borgarlínan system.

It has been assumed that the operational costs are 0,8 % of the total construction costs for all projects. The same is assumed for the Miklabraut tunnel and other three cut and cover projects. However, for tunnels an additional 96 million ISK per kilometre per year is added yearly to account for the tunnel's higher maintenance requirements[16]. This additional cost amounts to

[16] This estimate was conducted for the Sundabraut tunnel as part of its socioeconomic study in 2021. In this study, Sundabraut is treated as a bridge, incurring no additional costs.

700 million per year for all four underground projects (tunnel and cut and covers).

The introduction of Borgarlínan and the new route network with improved bus services is a significant improvement of the Capital Area public transport service level and will increase service kilometres from 30,550 to 46,000 km which is a 50% increase. The increase is mainly due to an increase in frequency. This will impose additional operational costs on Strætó. The total operational costs (without overhead) for the public transport system in the year 2040 is estimated 16.7 billion ISK per year with Borgarlínan and improved services. Without Borgarlínan and improved services the total operational costs of running a public transport system in 2040 is estimated to be 11.1 billion ISK per year. Therefore, the additional operational cost because of Borgarlínan and improved services is estimated to be 5.6 billion ISK per year in 2023 prices. This is 34% of the total operational cost of the public transport system and is based on additional vehicle kilometres mainly due to extra frequency.

Table 5-1 Operational costs bio. ISK per year when opening in 2040

	Transport Pact (Annual cost)	Transport Pact and Sundabraut (Annual cost)
Maintenance cost of new infrastructure	3.4	4.1
Operational cost of Borgarlina and improved services	5.6	5.6
Total operational cost	9.0	9.7

Source: *Operational cost of public transport is based on calculations by Strætó and maintenance assumptions are from the Icelandic Road and Coastal Administration (Vegagerðin).*

5.3 Traffic Impacts

The traffic related consequences of the construction of the projects in the Capital Area Transport Pact and the Sundabraut project have been estimated in the Transport model for the capital area (Samgöngulíkan höfuðborgarsvæðisins, SLH). The transport model was developed for the purpose of analysing the traffic related impacts of infrastructure investments in the Capital Area under the government's Transportation Plan. The transport model includes several travel modes;

- cars – private cars, delivery trucks and HGV,
- bicycles,
- public transport

Based on the transport model, a forecast is made for the traffic flow and levels in a baseline scenario in the year 2040 where neither the Transport Pact projects nor the Sundabraut project are realised. For comparison, two scenarios are introduced in the traffic model:

- The projects of the Transport Pact are realised in 2040.
- The projects of the Transport Pact and the Sundabraut projects are realised in 2040.

See also descriptions in chapter 3. The impact of the Transport Pact and Sundabraut is therefore the total changes in traffic flows from the baseline forecast to the forecast for 2040 for each of the two scenarios. For detailed information on the SLH traffic model see the description and documentation in Appendix D.

The SLH transport model is a network model which is an advanced model that allows for detailed study of the traffic impact in the modelled network.

Network transport models

Network models describe a defined impact area and are generally more advanced since they can involve 'feedback loops', where the resulting state of the network can impact user decisions. These complex models incorporate significant volumes of information on the demand structure, the transport network and its dynamics (e.g. timetables, interconnections, etc.) to describe large numbers of transport movements over a specified period. Data is typically coded in the form of attributes for each transport link in the network, including speed, quality, and the travel modes that use each link.

Source: *Guide to Cost-Benefit Analysis of Investment Projects, European Commission December 2014*

The transport model therefore allows the changes in travel times and distances to be valued. All benefits are shown with a positive sign whereas all costs are shown with a negative sign. For the valuation of the traffic consequences Icelandic unit values are applied.

In the following sections, we will first describe the overall estimated traffic impacts and then we will describe the estimated impacts on travel time savings for each traffic mode. For each traffic mode, we will also present the unit value used in order to monetise the impact. We conclude with the net present value of that traffic mode.

5.3.1 Overall traffic consequences

Fewer cars and less congestion

The implementation of the Transport Pact projects will help with the increasing congestion in the capital area. The projects will decrease both time spent travelling, and kilometres driven by cars in the area. The decrease is a combined effect of capacity improvements with new road projects and fewer cars due to shift to other modes such as public transport and bicycling. With the faster and

better public transport service that Borgarlínan will provide, and upgraded bike paths, more people will shift from cars.

The addition of Sundabraut offers a faster alternative for specific trip connections, mitigating the extent of the shift to other modes from cars in that scenario. As a result more trips are expected to be taken by car in the scenario with Sundabraut.

The number of trips in private cars in 2040 is estimated to decrease from appr. 1,419,000 daily trips to appr. 1,330,000 in the scenario with the Transport Pact and 1,334,000 in the scenario with the Transport Pact and Sundabraut. These trips are expected to be taken by public transport, by bike or as a passenger in a car instead of being individual car trips before. The reduction in hours in congestion in 2040 due to the shift away from cars and road improvements is estimated to go from 40,800 hours daily down to 27,200 hours with the Transport Pact and 26,000 hours if Sundabraut is added. For more details on the traffic model, network effects and change maps see Appendix D.

With fewer cars, mostly due to shift to other modes, daily kilometres driven will also decrease. In total there is 201,000 less kilometres driven on a daily basis in 2040 with the Transport Pact projects and 348,400 less kilometres if Sundabraut is added.

Increase in public transport service and usage

The introduction of Borgarlínan and the new route network is a significant improvement of the capital area public transport service level with an increase in vehicle km of 50 %. The increase in vehicle km is mainly due to an increase in frequency.

The increase in the service level of the public transport system with Borgarlínan is estimated to lead to an increase in passenger trips by 50%. With daily trips increasing from an estimated level of appr. 67,800 daily trips to appr. 97,300 daily trips. In the baseline 2040 forecast, the average trip length is 12,2 minutes whereas in the 2040 with Borgarlínan the average trip length is 10,7 minutes. The average trip length in the baseline forecast is 5,5 km whereas in the Transport Pact forecast it is 5,2 km. Thereby, the passengers on average travel shorter distances and spend less time travelling.

With the addition of Sundabraut to the scenario with the Transport Pact, a little less increase of passengers in public transport is expected, or 96,300 daily trips compared to 67,800 in baseline 2040 forecast.

A trip can consist of more than one boarding if there is a transfer between buses. Currently boardings are 29% higher than the number of trips per year. In the new bus network including Borgarlínan the estimated number of boardings are 22% higher than the number of trips per year.

Increase in bicycling

The Transport Pact is estimated to lead to an increase in bicycling traffic. The number of trips by bike is estimated to increase from appr. 148,400 daily trips to appr. 151,000. This is due to better bike paths and more direct paths provided by for example Fossvogur bridge. Higher travel time benefits with

Public transport is shifting both car users and bicycle users over to Borgarlínan. Improvements in paths is additionally shifting car users over to bicycling causing the net change to be a small increase in bicycling.

With the addition of Sundabraut to the scenario with the Transport Pact, less increase of trips with bicycle is expected, or 149,600 daily trips compared to 148,400 in baseline 2040 forecast.

Unchanged number of trips for DT and HGV

Delivery trucks and heavy good vehicles are estimated to have a constant level of trips across scenarios. However, with the shorter travel distances the total amount of kilometres driven will decrease slightly.

Table 5-2 Projected traffic impact per day in 2040.

Transport mode	Unit	Baseline	Transport Treaty	Transport Treaty and Sundabraut
Public transport	Passenger km	374,770	509,413	497,706
	Vehicle km	30,547	46,038	46,038
	Passenger hours	13,885	17,314	16,931
	# trips	67,788	97,310	96,333
	# shifts	22,405	25,169	24,677
Bicycles	km	205,723	204,291	202,982
	Hours	11,932	11,436	11,364
	# trips	148,432	151,020	149,632
Private cars	km	6,825,982	6,625,076	6,477,604
	Hours free flow	180,112	170,948	169,925
	Hours congestion	40,784	27,158	25,994
	# trips	1,419,160	1,330,182	1,333,932
Delivery trucks	km	607,188	617,144	604,577
	Hours free flow	14,815	14,827	14,703
	Hours congestion	3,219	2,285	2,159
	# trips	128,898	128,898	128,898
HGV	km	306,289	311,601	305,042
	hours free flow	7,525	7,556	7,487
	hours congestion	1,690	1,194	1,134
	# Trips	64,725	64,725	64,725

Source: SLH Transport Model

5.4 Travel Time Savings

The following sections present the results from the transport model regarding the impact on travel time savings for all travel modes. Benefits are shown with a positive sign and costs with a negative sign.

Note that the presented travel time savings are for two scenarios in future year (2040) first where all the Transport Pact projects have been realised and the second where in addition Sundabraut is also open for traffic. In the socioeconomic analysis, the traffic impacts are forecasted with an annual growth of 1,8% from year 2040. The number is based on the average car traffic growth in the transport model between the years 2019 and 2040.

The traffic impacts are reported for existing, diverted and induced travellers where:

- Existing travellers are the travellers that perform a trip with the same transport mode both with and without the Transport Pact projects.
- Diverted travellers are travellers that shift transport mode due to the realisation of all the Transport Pact projects. If this has a negative value, there are less travellers than before. If there is a positive value more trips are performed by travellers that were previously using another mode of transport.
- Induced travellers represent new and additional trips when positive. These are caused by a reduction in the cost of transport leading to more trips. If negative they represent a reduction in overall number of trips by the specific transport mode.

5.4.1 Traffic Impacts for Cars

There is a positive effect on the driving time for car users, when both scenarios are realised. The abiding drivers are estimated to experience a little longer travelling times when going to and from the same places as today in the scenario with Transport Pact but faster when Sundabraut is added. This happens because there will be a faster connection in general, but also because there is less time spent in congested traffic.

Table 5-3 Changes from baseline in annual travel times for cars, hours

Type	Travel time	Transport Pact	Transport Pact and Sundabraut
Existing	Free flow travel time	-110,914	404,687
	Congestion	3,000,248	3,494,008
Diverted/induced	Free flow travel time	-107,060	55,243
	Congestion	1,020,924	1,127,983

Total	3,803,197	5,081,921

Note: *The values in the table are the net changes. Thereby, they represent the changes in the consumer surplus which can be monetised using unit values. The impacts in this table are therefore not directly comparable with the gross impacts listed in Table 5-2.*
Benefits are with positive sign and costs with negative sign.
Source: *SLH Transport Model*

The traffic consequences for the road traffic are monetised based on the value per hour of less or extra time spent in traffic. To reflect that time spent on business trips is more costly than time spent off work, a set of unit prices are applied depending on the purpose. The unit value for time spent commuting and other travel purposes are valued at 3,356 ISK per hour whereas the time for business purposes is valued at 7,881 ISK per hour.

Time in congestion is valued higher than travel in free flow (approximately by a factor 1.5). This is due to the nuisance the driver experiences when travelling on congested roads.

Table 5-4 *Price per hour in traffic, ISK/hour*

Subject	Commute	Business	Other
Free flow travel time	3,356	7,881	3,356
Congestion time	5,043	11,821	5,043

Note: *2023 price level and in market prices*
Source: *See Appendix A*

By combining the time savings from Table 5-3 and the unit prices from Table 5-4, the net present value of the consequences for the car drivers is calculated. It amounts to the gains reported in Table 5-5 below, over the entire analysis period of 50 years.

Table 5-5 *NPV of the socioeconomic benefits for cars, billion ISK*

Subject	Transport Pact	Transport Pact and Sundabraut
Free flow travel time	-25.0	52.8
Congestion	692.4	795.8
Total	**667.4**	**848.6**

Source: *Calculations performed in TERESA by Mannvit and COWI*

5.4.2 Impact for Public Transport Passengers

The opening of Borgarlínan that is a part of the Transport Pact will result in increased service levels for public transport passengers and their travel time will be reduced. The travel time will be reduced since the frequency of departures

increases and the BRT will have right of way at selected sections and therefore will not be affected by congestion.

Public transport passengers are estimated to experience an overall improvement in all service factors i.e. travel time, waiting time, access time to and from stations, hidden waiting time and number of transfers. There may be some passengers that will experience increased number of transfers or travel time, but these are outnumbered by passengers experiencing improvements.

The service improvement is estimated to lead to more (induced) public transport passengers. The change in the service level is causing the shift towards public transport.

With addition of Sundabraut to a scenario with the Transport Pact fewer trips with public transport is expected that explains less gains in that scenario.

Table 5-6 Changes from baseline in annual travel times for public transport users, hours and number of shifts

Type	Travel time	Transport Treaty	Transport Treaty and Sundabraut
Existing	Travel time	438,480	437,535
	Delay		
	Waiting time	513,450	510,930
	Origin/Dest. Time	998,550	990,360
	Transfer time	56,385	57,015
	Hidden waiting time	261,765	260,505
	Number of shifts	941,850	953,190
Diverted/induced	Travel time	357,840	352,485
	Delay	0	0
	Waiting time	243,495	244,125
	Origin/Dest. Time	1,222,200	1,203,300
	Transfer time	70,245	68,040
	Hidden waiting time	87,255	87,255
	Number of shifts	1,396,080	1,340,010

Note: *The values in the table are the net changes. Thereby, they represent the changes in the consumer surplus which can be monetised using unit values. The impacts in this table are therefore not directly comparable with the gross impacts listed in Table 5-2.*
Benefits are with positive sign and costs with negative sign.
Source: *SLH Transport Model*

Travel time in public transport is valued at the same unit value as for private car. However, a trip with public transport also includes access time and waiting time. Furthermore, there may be transfer time in case the journey includes a shift. The access time is valued the same as in vehicle travel time whereas delays are valued at a factor three higher and waiting time as a factor of two higher than regular travel time. Transfer time is valued at a factor of one and a half. Shifts are valued at 336 ISK per shift.

Table 5-7 *Price per hour and shift for public transport users, ISK/hour and ISK/shift*

Travel time	Unit	Commute	Business	Other
Travel time	ISK/hour	3,356	7,881	3,356
Delay	ISK/hour	10,069	23,642	10,069
Waiting time	ISK/hour	6,713	15,761	6,713
Origin/Dest. Time	ISK/hour	3,356	7,881	3,356
Transfer time	ISK/hour	5,034	11,821	5,034
Hidden waiting time	ISK/hour	2,685	6,304	2,685
Shifts	ISK/shift	336	788	336

Note: *2023 price level and in market prices*
Source: *See Appendix A*

The net present value of the benefit for the public transport passengers is 624.5 billion ISK from the Transport Pact projects over the entire analysis period of 50 years. The main benefits stem from reduced waiting time and reduced time from origin to destination with respectively 180.6 billion ISK and 265.0 billion ISK. Adding the Sundabraut project to the Transport Pact scenario doesn't affect the benefit from public transport passengers.

Table 5-8 *NPV of socioeconomic benefits for public transport passengers, billion ISK*

Travel time	Transport Pact	Transport Pact and Sundabraut
Travel time	95.0	94.5
Delay	0	0
Waiting time	180.6	180.2

Travel time	Transport Pact	Transport Pact and Sundabraut
Origin/Dest. Time	265.0	261.7
Transfer time	22.7	22.4
Hidden waiting time	33.3	33.2
Shifts	27.9	27.4
Total	624.5	619.1

Source: Calculations performed in TERESA by Mannvit and COWI

5.4.3 Traffic Impacts for Delivery Trucks and HGV

Delivery trucks and heavy goods vehicles are, like the cars, estimated to experience improvements in travel time and congestion time. A time gain is experienced in both scenarios. Most in the scenario with Transport Pact and Sundabraut, where a bit more than 500.000 hours are gained every year.

Table 5-9 Changes from baseline in travel times for DTV and HGV, hours

Type	Travel time	Transport Pact	Transport Pact and Sundabraut
Existing	Free flow travel time	12,562	66,188
	Congestion	281,345	331,846
Diverted/induced	Free flow travel time	-3,931	13,986
	Congestion	99,490	112,770
Total		389,466	524,790

Note: The values in the table are the net changes. Thereby they represent the changes in the consumer surplus which can be monetized using unit values. The consequences in this table are therefore not directly comparable with the gross consequences listed in Table 5-2. Benefits are with positive sign and costs with negative sign.

Source: SLH Transport Model

The traffic consequences for the commercial road traffic are monetised based on the value per hour gained or lost in traffic. The value per hour can be seen in Table 5-10 below. The trip purpose for DTV and HGV are defined as business trips, and therefore the unit values are higher for these kinds of vehicles than for commuting private cars. As with the private cars the cost of time spent in congestion is higher than the cost of driving in free flow traffic due to the nuisance for the driver experience.

Table 5-10 Price per hour in traffic, ISK/hour

Travel time	DTV	HGV

Free flow travel time	7,497	9,177
Congestion	10,496	12,847

Note: *2023 price level and in market prices*
Source: *See Appendix A*

The gain of the decreased travel time for DTV and HGV amount to 126.0 bio. ISK. over the analysis period for the Transport Pact and 163.3 bio. ISK. for the scenario with Sundabraut added.

Table 5-11 *NPV of the socioeconomic impact for DT and HGV, billion ISK*

Travel time	Transport Treaty	Transport Treaty and Sundabraut
Free flow travel time	2.0	18.6
Congestion	124.0	144.7
Total	126.0	163.3

Source: *Calculations performed in TERESA by Mannvit and COWI*

5.4.4 Traffic Impacts for Bicycles

Bicycle riders are estimated to experience an improvement in travel time. Similar gains are experienced in both scenarios.

Table 5-12 *Changes from baseline in annual travel times for bicycles, hours*

Type	Transport Pact	Transport Pact and Sundabraut
Existing	129,780	127,890
Diverted/induced	82,845	83,160
Total	212,625	211,050

Note: *The values in the table are the net changes. Thereby they represent the changes in the consumer surplus which can be monetized using unit values. The consequences in this table are therefore not directly comparable with the gross consequences listed in Table 5-2. Benefits are with positive sign and costs with negative sign.*
Source: *SLH Transport Model*

The travel time for bicycles is monetised at the same value per hour as private cars and public transport. It is assumed that bicycles do not experience congestion.

Table 5-13 Price per hour in traffic for bicycles, ISK/hour

Travel time	Commute	Business	Other
Free travelling time	3,356	7,881	3,356

Note: 2023 price level and in market prices
Source: See Appendix A

The net present value of the consequences for the bicycles are 25,4 bio. ISK over the entire analysis period of 50 years. Incorporating the Sundabraut project results in a reduced value, caused by a shift in users from bicycles to cars.

Table 5-14 NPV of the socioeconomic impact for bicycles, billion ISK

	Transport Pact	Transport Pact and Sundabraut
Total	25.4	25.2

Source: Calculations performed in TERESA by Mannvit and COWI

5.4.5 Travel time savings from projects

The net present value of the consequences for all the Transport Pact projects and the Sundabraut project is about 1,670,000 million ISK over the period of 50 years. A comparative analysis of scenarios with and without Sundabraut enables the isolation of Sundabraut's impact on travel time savings. The TERESA model computes the travel time savings between different modes, this allows the differentiation of each project category's contribution to the overall travel time savings.

The distribution of total travel time savings between projects is shown in following pie chart.

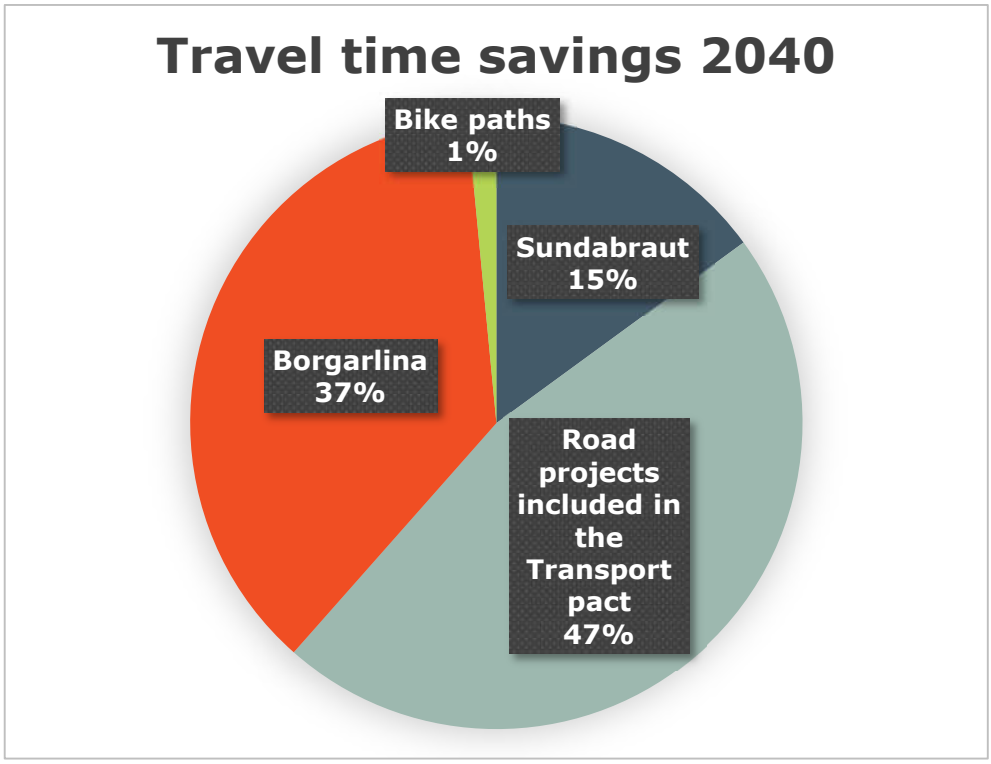


Figure 7 Distribution of travel time savings between project categories in the socioeconomic analysis (scenario with Sundabraut)

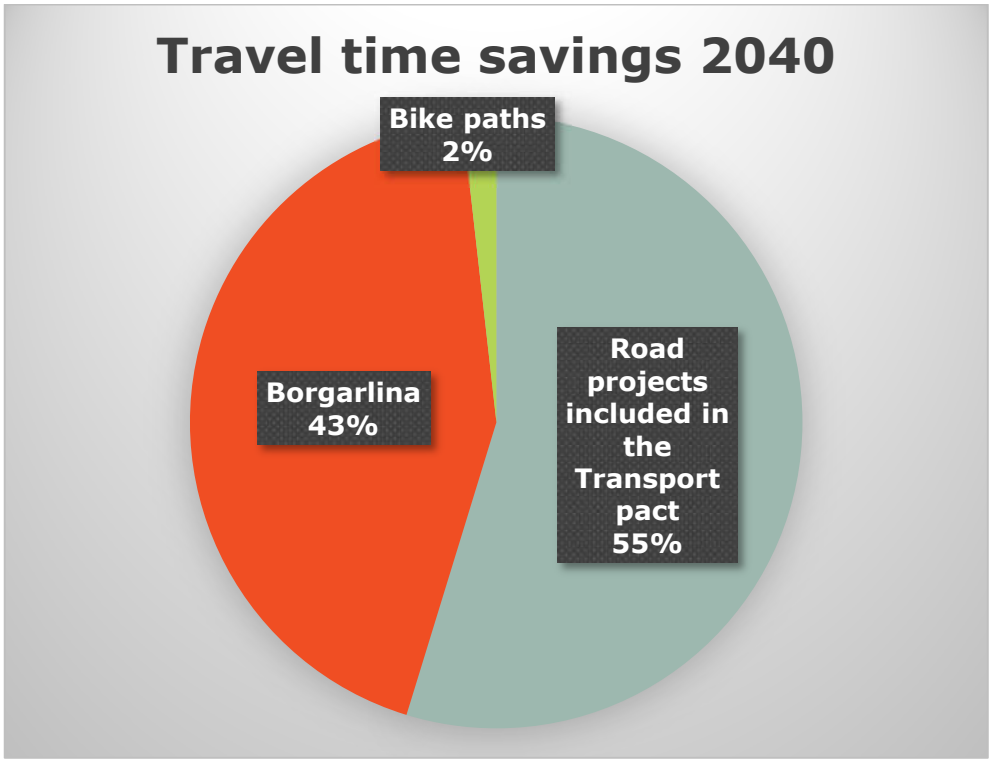


Figure 8 Distribution of travel time savings between project categories in the socioeconomic analysis (scenario without Sundabraut)

5.5 Vehicle Operating Costs

Cars, delivery trucks and heavy goods vehicles are estimated to have an increase in total vehicle operating costs with the implementation of the Transport Pact. With the addition of Sundabraut fewer kilometres will be driven and therefore the total vehicle operating cost will decrease.

Table 5-15 Change in annual net kilometres for cars, DT and HGV, km

Type	Transport Treaty	Transport Treaty and Sundabraut
Existing travellers	-11,623,200	31,498,400
New travellers	-1,852,200	7,788,100
Total	-13,475,400	39,286,500

Note: The values in the table are the net changes. Thereby they represent the changes in the consumer surplus which can be monetized using unit values. The consequences in this table are therefore not directly comparable with the gross consequences listed in Table 5-2 and Table 5-17.

Source: SLH Transport Model

The cost of driving is 49.07 ISK per km for commuting and for other purposes, whereas the cost is 45.99 ISK per km for business purposes. The cost of driving is 45.68 and 110.39 ISK per km for delivery trucks and heavy goods vehicles respectively.

Table 5-16 Price per km, ISK/km

Subject	Commute	Business	Other	DTV	HGV
Vehicle km	49.07	45.99	49.07	45.68	110.39

Note: 2023 price level and in market prices

Source: See Appendix A

This results in a decrease in net present value of around 9.6 bio ISK when the projects of the Transport Pact are fully introduced. Adding the Sundabraut leads to a total increase of 28.4 bio. ISK over the analysis period of 50 years._Hence the Sundabraut closes the negative net benefit.

5.6 Revenues

Increased revenue from additional passengers

The revenue stream to Strætó will increase as more people will use public transport.

The average bus fare today is 217 ISK per trip in 2023 price.[17] Although the Borgarlinan project will provide better service there are no plans to increase the fare prises accordingly. The same average fare is therefore used in the future system. With anticipated daily passengers of just over 97,000 for public transport in 2040, the net present value of the increased revenues from Borgarlina and bus passengers is projected to be 31 billion ISK over the entire 50 year analysis period. In the scenario including Sundabraut, an expected 96,000 passengers may result in a net present value of revenues amounting to 30 billion ISK.

5.7 Environmental impact

The project causes external effects to the environment, neighbours and others. These so called externalities result from the change in modal split and kilometres driven by vehicles. The expected future shift towards a car fleet running on renewable energy is incorporated in the unit values for noise, air pollution and climate.

The monetisation of externalities is based on the change in gross km for the different traffic modes. This is the common method for valuation of externalities.

The vehicle km of cars, busses, delivery trucks and heavy goods vehicles is estimated to decrease by approximately 352,300 kilometres and 185,700 kilometres per day, respectively, with the Capital Area Transport Pact and the Pact with Sundabraut added. This is shown in Table 5-17.

Table 5-17 Changes in gross km per project scenario per day in 2040, km

	Transport Pact	Transport Pact and Sundabraut
Basis	7,739,500	7,739,500
With projects	7,387,200	7,553,800
Change in km	-352,300	-185,700

Note: Change in gross kilometres.
Source: SLH Transport Model

The unit values for externalities are based on the average air pollution, climate impact and noise impact per vehicle km driven per transport mode.

[17] Strætó conducted the fare calculation, resulting in a charge of 163 ISK per boarding. Since passengers may switch lines during their journey, the fare price was adjusted accordingly. Utilizing the base year in the transport model, it was determined that an average of 1.33 boardings occurred per trip. Using this data, the fare was scaled to 217 ISK per trip.

Table 5-18 Unit prices for externalities per km in 2023, ISK/km

Subject	Cars	DT	HGV
Air pollution	0.26	0.83	0.71
Climate	2.01	2.99	11.19
Noise	2.74	3.85	5.66
Accidents	7.14	5.63	42.60

Note: 2023 price level and in market prices. For busses the change in km is solely from the BRT and is therefore based on electric busses.
Source: See Appendix A

As shown in Table 5-19 the net present value of externalities incurred by the Transport Pact is around 14.6 billion ISK over the entire period of analysis of 50 years. Adding the Sundabraut project this number will increase to 32.3 bio ISK. The primary benefit stems from the decrease in km driven by cars due to shorter distances and thereby a reduction in accidents and noise.

Table 5-19 Socioeconomic benefit of externalities, billion ISK

Subject	Transport Treaty	Transport Treaty and Sundabraut
Pollution	0.078	0.2
Climate	0.038	0.7
Noise	4.2	8.5
Accidents	10.3	22.9
Total	14.6	32.3

Note: 2023 price level and in market prices
Source: See Appendix A

5.8 Additional noise reduction benefit

The default calculation method to assess externalities in the socioeconomic model is by applying a price on the externality per km driven. This is the methodology applied to noise in the previous section. However, two of the projects in the Capital Area Transport Pact (the Sæbraut cut and cover and the Miklabraut tunnel) are noise reduction projects with no actual change in kilometres driven but a significant reduction in the noise in the surroundings. The benefit of the noise reduction has been calculated separately and added to the calculation model.

By using actual noise data from before and expected noise data from after the project is finished, an aggregate noise load factor (NLF) is calculated before and after the project, and the decrease in this factor has an externality price as described above.

Table 5-20 NLF-calculation and change in the Sæbraut cut and cover

Noise intervals	Number of dwellings affected before project	Number of dwellings affected after project	Annoyance factor	NLF-components before	NLF-components after	Change
<55 db	1	42	N/A	N/A	N/A	N/A
55-60 dB	19	38	0.11	2.04	409	2.05
60-65 dB	44	7	0.22	9.72	1.55	-8.17
65-70 dB	23	0	0.45	10.44	0.00	-10.44
>70 dB	0	0	0.93	0	0	0
NLF-total				**22.2**	**5.6**	**-16.56**

The component is calculated for each noise interval that exceeds 55 db. Each interval has an annoyance factor that is multiplied by the number of affected dwellings in the noise interval. This results in the intervals contribution to the aggregate NLF.

When having a NLF-before and NLF-after the difference is multiplied by the unit price and discounted throughout the evaluation period of the project (50 years). The results per year and over the entire period is presented in table 5-21.

Table 5-21 NPV of benefit from reduced noise from Sæbraut cut and cover

	Number
Yearly change in Noise Load Factor	-16.56
Unit price per unit change in Noise Load Factor (mio. ISK 2023-price)	1.2
Socioeconomic benefit in 2040 (mio ISK 2023-price)	20.6
NPV of benefit from noise reduction (mio ISK 2023-price)	689.1

The result is included in the socioeconomic result reported in chapter 6.

It has not been possible to do a similar calculation for the Miklabraut tunnel project as the noise data for affected dwellings are not available yet. However, it

is fair to assume that there is a minor socioeconomic benefit to gain from that as well.

5.9 Health benefits according to WHO tool (HEAT)

There is a clear health benefit and lower incidence of various common diseases such as diabetes and heart and vascular diseases with increased use of active modes such as walking to and from bus. The socioeconomic analysis carried out within the TERESA methodology does not consider these health benefits. These benefits were therefore calculated here with the help of the HEAT calculator (Health Economic Assessment Tool) from the World Health Organization (WHO) to show the impact although the numbers are not taken into the final result shown in chapter 6.

The transport model for the capital area (SLH) predicts that 30,000 more passengers per day will use public transportation compared to the baseline because of Borgarlínan. With this increase in additional passengers the total time spent walking by passengers to, from and between bus stops will increase. With these numbers, the Heat tool estimates how much individuals reduce their chances of premature death, due to the increased exercise they do during their travels. The number of statistical lives saved can be estimated using numbers of deaths per 100,000 for population in Iceland. Human lives are then valued with the value of a statistical human life, VSL. Same value is used as in other accident calculations in TERESA.

The travel time of passengers is estimated to increase by approximately 7,500 hours with the Transport Pact. This is shown in Table 5-17.

Table 5-22 Changes in hours per project scenario per day in 2040, hours

	Transport Pact	Transport Pact and Sundabraut
Change in hours walking	7,500	7,400

Note: *Change in hours.*

Source: *SLH Transport Model*

The unit values for externalities are based on the average time spent by all inhabitants in the capital area in the year 2040. In the forecast in SLH it is estimated to be 314,000 inhabitants living in the capital area. On average inhabitants spend 1.42 minutes more per day "exercising" in the scenario without Sundabraut and 1.41 minutes per day in the scenario with Sundabraut.

As shown in Table 5-19 the net present value of externalities according to the HEAT tool lies between 23.8 and 23.7 billion ISK over the entire period of analysis of 50 years, with the Sundabraut scenario having the smaller value. The primary benefit stems from the increase in walking by passengers of Borgarlínan and thereby an increase in statistical life expectancy due to increased exercise.

Table 5-23 Socioeconomic benefit of externalities, billion ISK

Subject	Transport Treaty	Transport Treaty and Sundabraut
Health benefits	23.8	23.7

Note: 2022 price level and in market prices

Source: Health economic assessment tool from World health organization, see Appendix A

6 Results of the Socioeconomic Analysis

The aggregate Net present value of the costs and benefits imposed by the projects under the Capital Area Transport Pact yields a socioeconomic benefit. Adding the Sundabraut project to the project portfolio slightly decreases the aggregate result but remains a positive socioeconomic business case. Table 6-1 presents the detailed socioeconomic results arising from the traffic effects and derived effects from externalities.

Table 6-1 Transport Pact socioeconomic results 2040 (2023 prices)

Million ISK	Transport Pact NPV	Transport Pact and Sundabraut NPV
Construction costs:	**-215,575**	**-276,528**
Construction costs	-260,824	-333,922
Scrap value	45,249	57,394
Operational costs:	**-96,423**	**-107,401**
Operational costs	-127,801	-137,741
Fare revenue in public transport	31,378	30,340
User impacts:	**1,422,451**	**1,674,142**
Time value, Road (Cars, vans and trucks)	793,297	1,011,946
Time value, Road (Bikes)	25,369	25,181
Time value, Public transport	624,478	619,107
Time value, cargo	1,595	2,153
Driving costs, road (Cars, vans and trucks)	-9,635	28,351
Driving costs, Road (Bikes)	263	261
Internal health effects (Bikes)	-12,916	-12,857
External impacts:	**14,619**	**32,252**
Accidents	10,309	22,859
Noise	4,195	8,507
Air pollution	78	205
Emissions (CO2)	38	680
Other consequences:	**16,743**	**5,994**
Tax impact	-12,502	-22,858
External health effects, bikes	-2,323	-4,446
Distortion of labour supply	-29,766	-37,490
Increased labour supply	60,645	70,099
Additional noise decrease	689	689

Million ISK	Transport Pact NPV	Transport Pact and Sundabraut NPV
Net present value	**1,141,815**	**1,328,458**
Internal rate of return	**9.2%**	**8.9%**
Net benefit to cost ratio	**3.49**	**3.23**

Note: *All benefits are with a positive sign whereas all costs are denominated with a negative sign.*

Source: *COWI and Mannvit*

The net present value of the construction costs consists of the construction costs of the projects in the construction period as presented in section 5.1 (but discounted back to present value (2023) from the years they are realized), as well as the benefit of the assets at the end of the analysis period discounted back to 2023, named the scrap value. The scrap value is included in the socioeconomic analysis as it is assumed that the asset is still of value when given an adequate level of maintenance and rehabilitation.

The change in operational costs is divided into two. One giving a negative impact to the socioeconomic calculations, and the other contributing positively:

- The decrease in socioeconomic calculations comes from an increase in cost of maintenance of the general road infrastructure that is expanded, as well as an increase in the operational costs for busses in the Borgalinan-system.

- The increase in socioeconomic calculations comes from an increase in revenue from public transport tickets as the number of passengers increase significantly.

The user impacts cover the travel time benefits for all analysed travel modes as well as the vehicle operating costs and the user health impacts (due to changes in biking). As mentioned earlier the main benefits accrue from time savings for the public transport users and the cars and motorists. These time savings arise from more efficient traffic system and less congestion.

Most gains to public transport users come from the Capital Area Transport Pact as it includes the Borgarlinan-system. Adding Sundabraut does not cause significant changes to public transport users but has high positive impact on cars and motorist.

Externalities have an overall positive impact on the socioeconomic result. The projects under the Capital Area Transport Pact implies that less kilometres are travelled by car, which leads to less emissions of pollution and green house gasses, and at the same time reducing noise and risk of accidents. Adding Sundabraut only enhances this effect as even less kilometres are travelled.

Other consequences cover the impact on public funds and GDP due to funding of the infrastructure with public funds and productivity improvements due to lower travel times that can partly be used productively for society. In this category

you also find the additional positive effect from less noise in the cut and cover project of Sæbraut.

7 Sensitivity analysis

The socioeconomic analysis of the Transport Treaty shows that the projects as an entity are economically feasible. However, the result of the socioeconomic analysis is based on several underlying assumptions with regards to e.g. construction costs, traffic growth, time values etc. Hence, it is customary to perform a sensitivity analysis to see how robust the results are to changes in some of the central assumptions.

7.1 Results of the Sensitivity Analysis

In this case where the project is economically feasible there will be special attention on the sensitivities towards higher costs as lower costs will only make the projects even more feasible.

Overall, the sensitivity analysis does not change the economic feasibility of the project, and it doesn't change the relative difference between the projects with and without Sundabraut. Through all the parameters the Capital Area Transport Pact maintain an IRR above 3,5 %.

The following describes each sensitivity parameter's possible influence on the result, and the actual result when changing the parameter. The results of the sensitivity analysis regarding the Internal Rate of Return are summarized in Table 7-1.

Labour supply distortion: In the sensitivity analysis it is assumed that there is no distortion on labour supply when financing projects with public funds, accruing from increased taxes. The basic assumption is 8 % distortionary effect.

In this analysis, changing the distortionary effect decreases the IRR for both scenarios, however it does not change the conclusion that the projects are economically feasible both with and without Sundabraut.

Construction costs: Higher construction costs can make the socioeconomic business case less positive. The sensitivity analysis investigates what happens if the construction costs are 25 % higher or 25 % lower than the basic assumption.

Changing the construction costs does not affect the overall results of this analysis. Both scenarios are economically feasible both with and without Sundabraut, even if construction costs should be 25 % higher than expected in this analysis.

Driving costs: Higher costs of driving a vehicle can make the socioeconomic business case less positive. The sensitivity analysis investigates what happens if the driving costs are 25 % higher or 25 % lower than the basic assumption.

Changing the driving costs does not affect the overall results of this analysis. Both scenarios are economically feasible both with and without Sundabraut, even if driving costs should be 25 % higher than expected in this analysis.

Operational costs: Higher costs of maintenance or lower revenue on public transport tickets can make the socioeconomic business case less positive. The sensitivity analysis investigates what happens if the operational costs are 25 % higher or 25 % lower than the basic assumption.

Changing the operational costs does not affect the overall results of this analysis. Both scenarios are economically feasible both with and without Sundabraut, even if operational costs should be 25 % higher than expected in this analysis.

Personal time values: Lower time values for people in traffic can make the socioeconomic business case less positive. The sensitivity analysis investigates what happens if the time values are 25 % lower or 25 % higher than the basic assumption. Since one of the main drivers of economic benefits in the Capital Area Transport Pact is saved travel time for motorists and public transport users, this is an important factor to investigate.

Changing the value of time does not affect the overall results of this analysis. Both scenarios are economically feasible both with and without Sundabraut, even if personal time values were 25 % lower than expected in this analysis.

Time value for goods: Lower time values for transporting goods can make the socioeconomic business case less positive. The sensitivity analysis investigates what happens if the time values are 25 % lower or 25 % higher than the basic assumption.

Changing the time value for goods does not affect the overall results of this analysis. Both scenarios are economically feasible both with and without Sundabraut, even if time values for goods were 25 % lower than expected in this analysis.

Only benefit for existing users: Some of the benefits from saved travel time come from new users of transport. Thus, less travel time leads to more people using this mode of transportation, leading to even more people gaining from the new infrastructure, giving a better socioeconomic outcome. The sensitivity analysis investigates what happens if there were no new people choosing this mode of transport, but only existing users gained the benefits.

Although having a significant impact on the IRR in both scenarios, the assumption that only existing users experience the time gains does not affect the overall conclusions of this analysis. Hence both with and without Sundabraut

the Capital Area Transport Pact projects are economically feasible, even when gains are only attributed to existing users.

External costs: Higher external costs of emissions, pollution, etc., can make the socioeconomic business case less positive. The sensitivity analysis investigates what happens if the external costs are 50 % higher or 50 % lower than the basic assumption.

Changing the external costs does not affect the overall results of this analysis. However, increasing the external cost by 25% has a significant downward impact on the IRR, but both scenarios are still well within economic feasibility both with and without Sundabraut.

The results of the sensitivity analysis regarding the Internal Rate of Return are summarized in Table 7-1.

Table 7-1 – Summary of sensitivity analysis

Internal Rate of Return	Transport Pact	Transport Pact and Sundabraut
Basic assumptions	9.2%	8.9%
Labour supply distortion from public financing 0%	9.4%	9.0%
Low construction costs -25%	10.5%	10.2%
High construction costs 25%	8.2%	7.9%
Low driving costs -25%	9.2%	8.9%
High driving costs 25%	9.2%	8.9%
Low operational costs -50%	9.5%	9.1%
High operational costs 50%	8.9%	8.6%
Low unit prices for time values -25%	7.8%	7.5%
High unit prices for time values 25%	10.3%	9.9%
Only benefits for existing users	7.3%	7.1%
Low external costs -50%	9.2%	8.8%
High external costs 50%	9.2%	8.9%
Low time values for goods -100%	9.2%	8.8%
High time value for goods 400%	9.2%	8.9%

Early opening date:

The base scenario for the Transport Pact and the Pact with Sundabraut has 2040 as the opening year for all projects. In reality many of the projects have been finished and open to public use well before 2040. Only counting the benefits from 2040 when all projects are finished leads to an underestimation of the actual benefits because the time value of money will decrease the value of benefits in a distant future compared to benefits in the near future.

To assess the degree of underestimation a sensitivity analysis is carried out where the projects that are finished by 2031 are modelled in an intermediate scenario of the traffic model, so the socioeconomic benefits from these projects are counted from 2031 instead of 2040.

In the intermediate scenario all projects listed in chapter 3 are finished except for these projects;

- Miklabraut Tunnel
- Hafnarfjarðarvegur (cut and cover)
- Reykjanesbraut (cut and cover) - only 1/3 finished.
- Borgarlína Lota 3: Mjódd – BSÍ
- Borgarlína Lota 4: Fjörður – Miklabraut
- Borgarlína Lota 5: Ártún – Spöng

Table 7-2 Sensitivity analysis of early operation of finished projects

Million ISK	Transport Pact NPV	Transport Pact and Sundabraut NPV
Net present value	**1.134.245**	**1.351.114**
Internal rate of return	**12.2%**	**12.0%**
Net benefit to cost ratio	**3,27**	**3,14**

As the numbers in Table 7-2 indicates, the effect of counting early benefits, results in a higher internal rate of return, even though the Net Present Value has not changed significantly. This happens because benefits are moved closer to the price year (2023), when counting them in from 2031 instead of 2040.

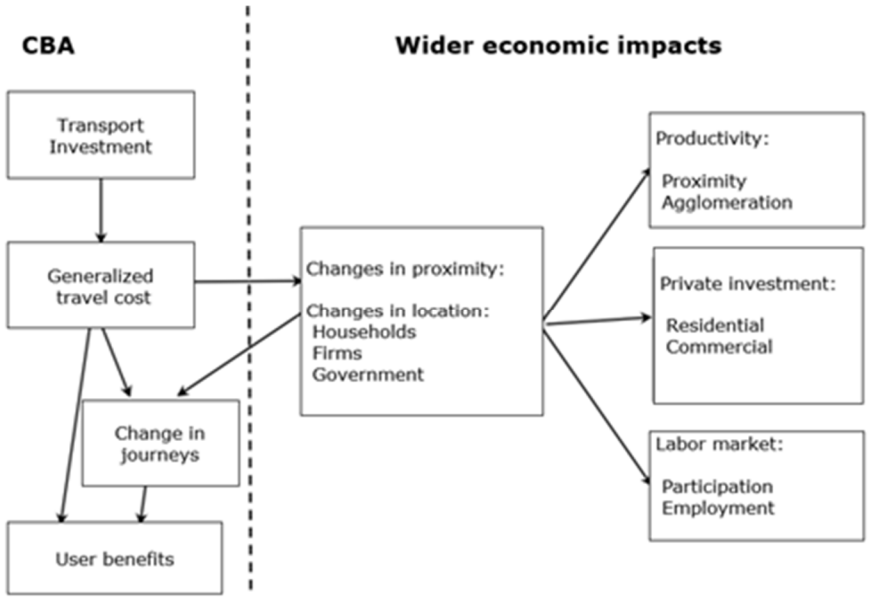
Thus, this sensitivity analysis also shows that the projects under the Capital Area Transport Pact are economically feasible.

8 Other economic impacts

8.1 Wider economic impacts

New transport investment brings time and cost savings to the users of the network. Moreover, transport improvements result in positive externalities (reduction in external costs) for safety and environment. Those factors are monetized and discounted over a set period of time. If the benefits outweigh the costs the project is deemed economically feasible according to the principles set out by CBA. The result presented in chapter 6 for the socioeconomic value of Sundabraut is calculated according to those principles.

The case for investment in transport improvements is frequently made in those terms solely. While they constitute the centre of any transport appraisal, there are other effects which cannot readily be assessed within the scope of CBA, so-called wider economic impacts. Wider economic impacts are illustrated in the figure below.



In the short term, infrastructure construction will stimulate economic growth but those effects are unlikely to be long lasting. In the long term however, they will bring areas closer together (the capital area and the western part of the country for example) and may trigger relocation of economic activity (relocation of firms and labor). Together these changes may provide benefit to affected areas such as induced private investment and positive effects in the labour market, on both the supply and demand side. This could result in added productivity in excess of the productivity gains that are represented by the user benefits that are calculated in chapter 6.

8.2 BRT as an enabler of green transition and urban development

A BRT ticks all three strategic elements of sustainable transport solutions as described in Dalkman et al. (2007) which aim at ensuring mobility while reducing the negative impacts of transport (e.g. congestion):

- Transport avoidance: Create sustainable (urban) infrastructure through proper urban development and transport planning, in turn increasing mobility and accessibility without creating excessive transport.
- Shifting to more sustainable modes: Promote use of more sustainable and low carbon transport modes such as walking, cycling and public transport as alternatives to cars – e.g. through better facilities and infrastructure such as a BRT line.
- Transport efficiency: Improve transport technologies and transport flows in order to provide the needed transport in the most efficient way.

A successful implementation of Borgalínan can push and inspire other green mobility initiatives and a wider implementation of BRT lines thus further helping the green transition. In many situations, a BRT is considered an attractive transport solution to create better mobility in cities around the world for the reasons mentioned above. A BRT solution can solve congestion challenges by offering an alternative to driving a car. A BRT should also be seen as an opportunity to facilitate urban development by boosting a city considerably by creating cohesion between urban development and public transport.

A literature review suggests that BRT lines can attract many passengers if travel time reductions are significantly high, which in turn will lead to attractive areas surrounding the BRT line with increasing property values in close proximity to stations (DTU, 2018). Literature concerning effects of metro and light rail lines suggest that a new line can act as a growth enabler for business. An international review on the effects of new bus and rail rapid transit systems finds that no significant deviations could be identified between effects on property values resulting from BRT, LRT, and metro systems, respectively (DTU, 2018). However, these effects are already at least partly included in the socioeconomic assessment through the monetised travel time savings[18].

Investment in reliable sustainable public transport benefits across all income groups and can be particularly important for households without other viable alternatives (e.g. households with no car ownership).

[18] In the socioeconomic analysis we assume a market in perfect competition why an increase in housing prices is caused by the accessibility created by the shorter travel times which is already monetized in the analysis.

9 Conclusion and Recommendations

This socioeconomic analysis of the Capital Area Transport Pact is carried out to support the decision on undertaking the projects enveloped by the project portfolio. To show that the projects are economically feasible when combined with each other and the Sundabraut project, two main scenarios have been run and a series of sensitivity analysis have been undertaken.

The socioeconomic analysis concludes that the projects under the Capital Area Transport Pact are economically feasible, meaning the costs of undertaking the project is outweighed by the gains for society from implementing the projects. Gains arise mainly from faster travel both with public transport and on the roads due to less congestion and a more direct line of travel for the daily users. Even more time savings on the roads are added when the Sundabraut projects are added to the portfolio.

Both without and with the Sundabraut project added, the project alternatives are economically feasible with a positive net present value of 1,142 and 1,328 billion ISK and an internal rate of return of 9.2% and 8.9% respectively.

Table 9-1 Summary of main results

Million ISK	Transport Pact NPV	Transport Pact and Sundabraut NPV
Net present value	**1,141,815**	**1,328,458**
Internal rate of return	**9.2%**	**8.9%**
Net benefit to cost ratio	**3.49**	**3.23**

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11 Appendices

Appendix A Unit prices methodology

The traffic impacts arising from the projects under the Capital Area Transport Pact are stated in time savings (hours) and kilometre savings in the traffic simulations underlying this analysis. In order to evaluate the traffic impacts in economic terms over the analysis period a set of *unit values/prices* need to be estimated. The unit values are entered into "Economic Transport Values" (Transportøkonomiske enhedspriser) to be used in TERESA (**T**ransport og **E**nergiministeriets **Re**gneark for **Sa**mfundsøkonomisk Analyse).

Table 1. Summary of unit values.

Traffic impact		Unit values	Modes	Type	Variations
1	Time-savings	ISK/hour	Private traffic	Leisure/work/other	Travel time/delays
			Public transport		Travel time /delays/waiting time/hidden waiting time/change time/change penalty
		ISK/ ton-hour	Freight	Average	
2	Vehicle operating costs	ISK/km	Private cars	Average/marginal	
			Bicycles	Average	
			Vans		
			Trucks		
		ISK/hour	Vans	Average	Travel time/delays
			Trucks		
3	External costs–emissions	ISK/kg	All	CO_2, $PM_{2.5}$, NO_x, SO2, CO, HC	Urban/rural
		ISK/km	Private	Gasoline, Diesel, Hybrid, Electric	
			Van	Gasoline, Diesel	
			Truck	Diesel	
			Bus	Electric	
	External costs-accidents	ISK/casualty	All	Killed/Severe injury/Minor injury	
		ISK/accident		Average	
		ISK/km	Private	Average	
			Van		
			Truck		
			Bus		
	External cost - noise	ISK/SBT	All	Average	
		ISK/km	Private	Gasoline, Diesel, Hybrid, Electric	
			Van	Gasoline, Diesel	
			Truck	Diesel	
			Bus	Electric	
	External cost - congestion	ISK/km	Private	Average	
			Van		
			Truck		
			Bus		

Varying methods need to be employed in the calculation of Icelandic unit values. This is partly due to the lack of Icelandic economic transport data and research as is to be expected for a small country. As a result, in some instances, conversion of Danish data is the preferred method. This "unit value transfer approach" is in line with international recommendations and is a common approach when applying TERESA in an international setting. The resulting uncertainty is taken into account in the sensitivity analysis of the CBA result.

The methodology for the calculations of Icelandic unit values which are adaptable into TERESA is explained in general in the relevant sections in this

memo. For a more detailed description of Danish research and methodology underlying TERESA please refer to [19] [20].

A.1 Price level calculations, present value calculations and deadweight loss

The unit values have to be stated in market prices, i.e. consumer prices, and are inflated from the base year to the price year selected in "Transportøkonomiske Enhedspriser" according to a set of rules. The monetized traffic impacts over the analysis period are then discounted with a real discount rate to the year chosen. Moreover, TERESA applies a socioeconomic markup on the use of public funds in the analysis wherein the deadweight loss of taxation is accounted for with a so-called "tax distortion" rate:

i. **Economic assumptions:** Projections for real GDP/capita are used to project values based on willingness to pay (WTP) i.e. the value of time to different years in the projection period as WTP is assumed to depend on real wealth. Projections for unit values not based on WTP are calculated with the consumer price index. The real GDP growth and inflation up until 2029 is provided by Statistics Iceland (economic forecast). The real GDP growth is assumed to be 2,5% for the remainder of the period as well as as the inflation (CBI inflation target). The population projections are provided by Iceland Statistics until 2073 and are used to convert real GDP growth into real GDP growth per capita. The so called „net tax factor" represents an average tax rate and is used throughout the analysis to convert factor prices to market prices. The average tax is calculated as 14% and is calculated as the ratio between GDP in market prices and gross factor income over a 5 year period.

ii. **Discounting with a social real rate:** No extensive research has been conducted on the social real discount rate in Iceland. Thus, the real discount rate in the analysis is chosen as 3,5% in line with Danish recommendations for CBA of transport infrastructure. This rate represents the real discount rate for the first 35 years of analysis period in Danish CBA. 2,5% is used for year 36 to 70 and 1,5% for year 70 onwards. The rate represents a societal time preference rate and thus cannot be compared to present market real rates.[21]

iii. **The tax distortion rate (Icelandic: "umframbyrði skattlagningar" or "allratap"):** The rate reflects the deadweight loss of taxes and is a markup applied to the draw on public funds i.e. construction costs in TERESA[22]. The distortion rate is calculated as 8% and is scaled down from the Danish value of 10% with a ratio of total general government revenue as a share of GDP between Iceland and Denmark. This is in line with recommendations for Greenland.[23]

[19] A unit value catalogue for use in Danish CBA's of infrastructure and transport related projects is accessible here: https://www.cta.man.dtu.dk/modelbibliotek/teresa/transportoekonomiske-enhedspriser.

[20] The valuation in the catalogue is based on extensive research, for example: "Nøgletalskatalog 2004 - til brug for samfundsøkonomiske analyser på transportområdet." and Manual for samfundsokonomisk analyse: https://www.trm.dk/publikationer/2015/manual-for-samfundsoekonomisk-analyse-paa-transportomraadet/.

[21] See https://www.ft.dk/samling/20181/almdel/FIU/bilag/21/1967824.pdf

[22] PPP projects do not bear this markup.

[23] https://naalakkersuisut.gl/~/media/Nanoq/Files/Attached%20Files/Finans/DK/oekonomisk%20politik%202015/Vejledning%20i%20fremstilling%20af%20samfundsokonomiske%20konsekvensvurderinger%20-%20final%20-%20DK%20-%20april%202015.pdf

A.2 Time savings

The values of travel time savings are quantified with the so-called „value of time" and are split on travel purpose (commuting/other private = non business travel time, and business travel time) and types of travel time (ordinary travel time, delays, waiting time etc.):

i. **Commuting/other private time value (ISK/hr):** The methodology underlying the value of time for commuting/other private is based on the The Danish Value of Time Study[24]. The Icelandic value is calculated as 67% of disposable income per hour in line with the study.

ii. **Business time value (ISK/hr):** The value of travel time for business purposes is based on compensation of employees in the national accounts and total hours worked by employees in the base year according to Icelandic productivity statistics.

iii. **Travel purpose, time types and person per car (relative factors and percentages):** The relative factors used to calculate time values for ordinary travel time, delays, waiting time etc. are kept the same as in Denmark as no research has been conducted on relative time factors in Iceland (the value of delay-time savings for public transport is set at 3 times the value of ordinary travel time savings, for example). The travel purpose split and number of persons pr. car (according to purpose) is left unchanged from the Danish numbers as travel purpose surveys in Iceland do not provide a sufficiently detailed split so as to be adaptable into TERESA.

The value of time for person hours is displayed in table 2 below.

Table 2. Travel time values for person hours in 2023 in 2023-prices.

ISK per person-hour	Commuting	Business	Other private purposes
Public travellers			
Travel time	3.356	7.881	3.356
Delays	10.069	23.642	10.069
Waiting Time	6.713	15.761	6.713
Hidden waiting time (frequency)	2.685	6.304	2.685
Change time	5.034	11.821	5.034
Change penalty (ISK per change)	336	788	336
Car drivers			
Travel time	3.356	7.881	3.356
Delays	5.043	11.821	5.043
Cyclists			
Travel time	3.356	7.881	3.356
Delays	5.034	11.821	5.034

24 https://backend.orbit.dtu.dk/ws/portalfiles/portal/4046265/rap5_2007.pdf

A.3 Vehicle operating costs

Vehicle operating costs are estimated for private cars (leisure/business), vans, trucks and bicycles in average and marginal terms (for private cars) and fixed/variable terms for trucks and vans. The costs are split into propellant (gasoline, diesel, electricity), repair and maintenance, depreciation, battery (for hybrid and EV´s), salaries (for trucks and vans) and taxes. Icelandic data does not allow for exact calculation of driving costs in the Icelandic setting so a unit value transfer approach is applied in many cases as before:

i. **Average car/truck/van:** The Danish unit values are representative of an average vehicle which is based on a compilation of Danish transport data. Thus, the main cost components i.e. deprecation and maintenance is representative of that average car/truck/van/bicycle. The assumptions regarding the "average car" is left unchanged in the Icelandic unit values as no comparable data of similar quality has been compiled in Iceland thus far. The Icelandic tax of 6 ISK per kilometre driven in electrical car and 2 ISK per kilometre driven in hybrid, are also included in this unit price.

ii. **Cost components:** PPP price level indices for personal transport equipment is used to convert Danish data for depreciation into Icelandic unit values. PPP price level indices for GDP are used to convert repair and maintenance, tires and battery costs. Icelandic data is used for gasoline, diesel and electricity costs. The salary for van and truck drivers is calculated according to Icelandic data but average annual running hours for trucks and vans are left unchanged from Danish data.

iii. **Future projection of costs:** The future projection of real prices of propellant is left unchanged from the Danish projection i.e. Icelandic real prices are thought to fluctuate from the base year accordingly. The future projections for energy usage in the car fleet (car share split) is based on a memo compiled by „VSÓ ráðgjöf" for the Association of municipalities in the Capital area and the Road Administration. The wages for truck and van drivers are from Statistics Iceland and increase in line with real GDP/capita throughout the analysis period.

The main posts for vehicle operating costs are shown on the next page.

Table 4. Driving costs for private passenger cars in 2023 in 2023-prices.

ISK per km	Average excl. tax	Average incl. tax	Marginal excl. tax	Marginal incl. tax
Propellant	7.2	15.2	7.2	15.2
Battery (hybrids and EV's)	0.2	0.3	0.2	0.3
Tires	2.5	3.1	2.5	3.1
Repair and maintenance	9.5	11.8	3.0	3.8
Car taxes	-	1.7	-	-
Depreciation	11.9	17.1	2.8	4.0
Total	**31.3**	**49.1**	**15.6**	**26.1**

Table 5. Distance related driving costs for vans in 2023 in 2023-prices.

ISK per km	Prices	*Value*
Propellant	Factor price	11.2
Tires	Factor price	3.2
Repair and maintenance	Factor price	3.5
Depreciation	Factor price	3.4
Costs excl. taxes	**Factor price**	**21.2**
Taxes (not refundable)	Factor price	18.8
Costs incl. tax	**Factor price**	**40.1**
Costs incl. tax	**Market price**	**45.6**

Table 6. Time related driving costs for vans in 2023 in 2023-prices.

ISK per km	Prices	*Value*
Depreciation	Factor price	149
Salary	Factor price	5,358
Repair and maintenance	Factor price	76
Other costs (e.g. administrative)	Factor price	994
Costs excl. taxes	**Factor price**	**6,576**
Taxes (not refundable)	Factor price	-
Costs incl. tax	**Factor price**	**6,576**
Costs incl. tax	**Market price**	**7,497**

Table 7. Distance related driving costs for trucks in 2023 in 2023-prices.

ISK per km	Prices	*Value*
Propellant	Factor price	24.74
Tires	Factor price	9.93
Repair and maintenance	Factor price	13.86
Depreciation	Factor price	6.82
Costs excl. taxes	**Factor price**	**55.4**
Taxes (not refundable)	Factor price	36.4
Costs incl. tax	**Factor price**	**91.7**
Costs incl. tax	**Market price**	**104.5**

Table 8. Time related driving costs for trucks in 2023 in 2023-prices.

ISK per km	Prices	*Value*
Depreciation	Factor price	1,009
Salary	Factor price	5,347
Repair and maintenance	Factor price	385
Other costs (e.g. administrative)	Factor price	1,310
Costs excl. taxes	**Factor price**	**8,050**
Taxes (not refundable)	Factor price	-
Costs incl. tax	**Factor price**	**8,050**
Costs incl. tax	**Market price**	**9,177**

A.4 External costs

Traffic imposes negative externalities on society in the form of air pollution, noise, accidents, congestion and wear on the infrastructure. Those externalities need to be quantified in a standard CBA analysis.

Emissions, climate, noise and congestion

The values for air pollution, noise and congestion stated below have been converted from Danish unit values and are primarily linked to willingness to pay i.e. WTP for avoiding health damage[25]. The common approach for WTP unit transfers between countries recommended by the „Handbook on the external costs of transport"[26] consists of multiplying the unit values by the ratio of PPP income in the policy country to income in the study country with an income elasticity of 0,8 (see screenshot from the handbook below):

Recommended approach: unit value transfer with income adjustments

Transferring the unit value from the original country to the remaining Member States and countries considered in this Handbook requires the following adjustments which control for differences across locations:

- *Differences in prices*. Controlling for differences in prices is crucial to minimise errors when transferring values across locations. The recommended approach is to use *PPP-corrected exchange rates* to take into account the cost of living. If appropriate, adjustments can also be made in line with differences in living costs between regions within the same country.
- *Differences in income*. A central issue when converting values between countries is to consider differences in income. The common approach consists of multiplying the unit values by the ratio of income in the policy country to income in the study country as such:

$$WTP_{PS} = WTP_{SS}\left(\frac{I_{OS}}{I_{ss}}\right)^{\varepsilon},$$

Where WTP_{PS} is the WTP transferred to the study site, WTP_{SS} is the WTP at the study site, I_{OS} and I_{ss} are income at the other and study sites, and ε is income elasticity of WTP. Income is defined as PPP-adjusted GDP/capita in this Handbook[7]. For the income elasticity a value of 0.8 is recommended, indicating that environmental goods can be considered normal goods. This value of the income elasticity is based on an extensive meta-analysis of the OECD, which concludes that the income elasticity for the WTP of environmental and health related goods falls between 0.7 and 0.9.

Table 9. Marginal external costs for 2021 in 2021-prices.

ISK per km		Capacity	Total	Air pollution	Climate change	Noise	Congestion
Passenger car	Petrol	4 pers	28.94	0.15	2.14	2.79	15.08
	Diesel	4 pers	29.42	0.48	2.29	2.79	15.08
	Rech. Hybrid	4 pers	27.09	0.06	0.87	2.30	15.08
	Electricity	4 pers	26.20	0.05	0.01	2.28	15.08
Van	Petrol	1,5 t	28.93	0.27	2.45	3.87	15.39
	Diesel	1,5 t	30.17	0.88	3.08	3.87	15.39

[25] For a detailed explanations on the rationale underlying external costs see https://www.trm.dk/media/3738/1streport.pdf

[26] https://op.europa.eu/en/publication-detail/-/publication/9781f65f-8448-11ea-bf12-01aa75ed71a1

	Rech. Hybrid	1,5 t	26.79	0.08	1.18	3.18	15.39
	Electricity	1,5 t	25.58	0.07	0.01	3.17	15.39
Truck	Diesel	23.2 t	102.52	0.71	11.24	5.67	30.65
	Electricity	23.2 t	88.47	0.25	0.05	3.28	30.65
Buss	Diesel	40 pers	86.71	2.34	12.75	12.31	38.79

The climate change or CO_2 emission costs are based on market prices for CO_2 quotas. In the TERESA-model there are options to calculate using a high and a low CO_2-price. The reported costs are related to the low CO_2-price.

Accidents

Accidents costs can be divided into the following social cost categories:

i. Direct public expenditures i.e. police and rescue costs and medical treatment costs.

ii. Indirect costs for society i.e. net production loss associated with fatalities.

iii. Loss of ”human value”, more commonly known as “Value of statistical life”.

iv. Other direct costs such as property damage costs.

The various cost components are calculated separately for fatalities, severely and lightly injured in the Danish unit values following the official European classification of accident casualties and Danish research on relative costs. However, the value of statistical life in Iceland has been assessed in a report from 2023, where a comparative study between other countries were conducted. Taking values from other countries into account, the report found an Icelandic value of statistical life of 900,000,000 ISK.[27] Hence, the calcualtions in the of injured is still incorporating the conversion from Danish numbers, while the cost of fatalities include the Icelandic value of statistical life. The values are presented below.

Table 10. Accident costs for 2023 in 2023-prices.

ISK per	
Death	1,155,414,652
Seriously injured	182,809,325
Lightly injured	24,025,613
Average	**35,453,781**

[27] Hagfræðistofnun Háskóla Íslands. (Apríl 2023). Virði tölfræðilegs lífs og mat á tímavirði.

Appendix B Prerequisites for calculations

In order to calculate the socioeconomic value of Sundabraut and taking into account the effect on public budgets, a series of assumptions are necessary. These are summarised in Table 11-1 below.

Table 11-1 Additional assumptions

Subject	Assumption
Price level	2023 prices, market prices
Dead weight loss	8%
Factor for cost of public funds	1,14
Opening year	2040
Construction period	2023-2040
Year of NPV	2023
Social discount rate	3,5% for the first 35 years hereafter 2,5%
Annual traffic growth	1,8%

Source: COWI, Mannvit and Vegagerdin

Appendix C Methodology for Consumer surplus and Rule of a half

THE RULE OF HALF

The Rule of Half (RoH) relies on the consideration that, without the project, non-travelling users Willingness To Pay (WTP) is lower than the (prior) generalised cost of transport. After project implementation the (new) generalised cost of transport is lowered so that some previously non-travelling people decide to travel.

Although the absolute WTP is not known, the average change in consumer surplus of the generated traffic can be estimated as half of the difference between the original and the new generalised costs of transport on the improved mode for a given origin-destination (O-D) relation. It is half because a linear demand/cost graph is assumed where new users are spread evenly between two extremes: those requiring marginal motivation to start travelling (their WTP is already on the cusp between travelling and not travelling, so they get the full benefit of the change in generalised costs) and those requiring the full benefit of the change to the transport system to be motivated to travel (they get marginal net benefit). The RoH can be therefore expressed by the following formula:

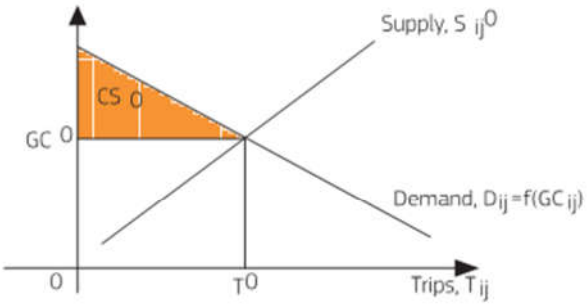
$$gc = p+z+v\tau$$

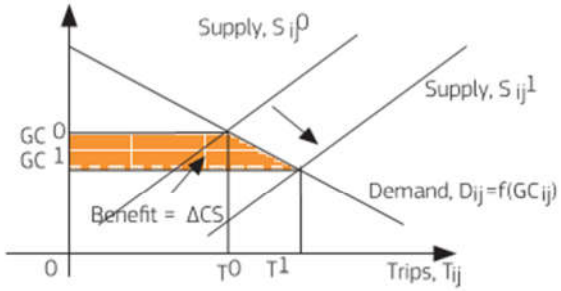
where: p is the amount paid for the trip by the user (tariff, toll); z is the perceived operating costs for road vehicles (for public transport is equal to zero);τ is the total time for the trip; v in the unit value of travel time.

Total consumer's surplus (CS^0) for a particular i and j in the Business As Usual (BAU) scenario is shown diagrammatically in the first figure. It is represented by the area beneath the demand curve and above the equilibrium generalised cost, area CS^0.

$$\text{User benefit} = \text{Consumer's surplus}_{ij}^{1} - \text{Consumer's surplus}_{ij}^{0}$$

where: 1 is the do-something scenario and 0 is the BAU scenario.





If there is an improvement in supply conditions the consumer's surplus will increase by an amount of ΔCS, due to a reduction in equilibrium generalised cost and the total user benefit (for existing and new users) can be approximated by the following function, known as the rule of a half:

$$\Delta CS = \int_{GC_1}^{GC_0} D(GC)\,dGC \approx \text{Rule of one Half (RoH)} = \frac{1}{2}(GC_0 - GC_1)(T_0 + T_1)$$

For the generated demand only (i.e. for new users), the benefits may be approximated by the following formula :

$$\Delta CS(\text{generated}) \approx 1/2*(GC0-GC1)*(T1-T0)'$$

In the case of a totally new infrastructure, the RoH will not be directly applicable and the measurement of the benefits depends on the nature of the new mode, its placement in the mode hierarchy and transport network, and will often need to be derived from the users' WTP or calculated with other approaches. For example see various integration and other methods suggested in World Bank Transport Note No. TRN-11 2005.

Source: Authors

Source: *Guide to Cost-Benefit Analysis of Investment Projects, European Commission December 2014*

Appendix D Traffic analysis memo and maps

Minnisblað

Tilvísun: 1110231-000-CMO-0001 26.01.2024
Til: Betri samgangna, Vegagerðarinnar og Innviðaráðuneytisins
Árni Freyr Stefánsson
Bryndís Friðriksdóttir
Þorsteinn Rúnar Hermannsson

Efni: **Samgöngusáttmáli, samgöngugreining 2040**

Samantekt

Þessi greinagerð inniheldur lýsingu á forsendum og niðurstöðum samgöngugreiningar sem unnin var með nýju Samgöngulíkani höfuðborgarsvæðisins (SLH). Nánar má lesa um líkanið í lokaskýrslu þess (A126792-001-3.0-Documentation-SLH). Úr samgöngugreiningunni koma svo upplýsingar um notendaábata í formi styttri ferðatíma eða ferðavegalengdar sem eru grunnforsendur samfélagslegrar arðsemisgreiningar á Samgöngusáttmálanum. Notendaábati er reiknaður fyrir einkaferðir með bíl, atvinnuferðir með bíl, ferðir með almenningssamgöngum og ferðir á hjóli.

Sviðsmyndir eru reiknaðar á grunni með framtíðarsamgöngukerfi sem inniheldur allar framkvæmdir samgöngusáttmála höfuðborgarsvæðisins ásamt Sundabraut. Framtíðarár sviðsmynda er 2040 og er gert ráð fyrir að íbúum á höfuðborgarsvæðinu hafi þá fjölgað um 100.000 íbúa frá árinu 2019.

Alls voru reiknaðar tvær framtíðarsviðsmyndir árið 2040, sú fyrri með öllum framkvæmdum Samgöngusáttmála og hin síðari með Sundabraut til viðbótar við framkvæmdir Samgöngusáttmála. Þá var einnig reiknuð grunnsviðsmynd þar sem lítið hefur verið framkvæmt af innviðum árið 2040 en samt 100.000 nýjum íbúum bætt við höfuðborgarsvæðið.

Eftirfarandi sviðsmyndir voru reiknaðar með samgöngulíkaninu:

- Grunnsviðsmynd 2040
- Framtíðarsviðsmynd 2040 með samgöngusáttmála
- Framtíðarsviðsmynd 2040 með samgöngusáttmála og Sundabraut

Niðurstöður er sýndar sem umferðarkort í viðauka 1 og sem samantekt á lykiltölum í töfluformi.

Ef horft er á vöxt umferðar frá 2019 til 2040 er ferðum með bíl að fjölga í öllum sviðsmyndum, mest í grunnsviðsmyndinni eða um 2,0% á ári og minnst í sviðsmynd með Samgöngusáttmála en án Sundabrautar eða 1,68%. Í sviðsmynd með Samgöngusáttmála og Sundabraut er vöxturinn 1,69% á ári.

Ef rýnt er í lykiltölur sést að bílferðum er að fækka í báðum sviðsmyndum samanborið við grunnsviðsmynd sem þýðir að almennt eru ferðir að flytjast frá því að vera farnar með einkabíl yfir í

almenningssamgöngur eða vera farnar á hjóli. Minni minnkun er í sviðsmynd með samgöngusáttmála og Sundabraut og munar þar um 3.700 bílferðir.

Út frá lykiltölum sést að aksturskílómetrum ökutækja fækkar um 186.000 kílómetra á sólarhring í sviðsmynd með Samgöngusáttmála samanborið við grunnsviðsmynd og tafir eru að minnka um 14.000 klukkustundir á sólarhring. Meiri munur er í sviðsmynd með samgöngusáttmála og Sundabraut en í henni fækkar aksturskílómetrum með bíl um 352.000 kílómetra á sólarhring og tafir minnka um 15.000. Miðað við þessar lykiltölur eru báðar sviðmyndirnar skilvirkari en grunnsviðsmyndin.

Lykiltölur almenningssamgangna sýna að farþegakílómetrum fjölgar í báðum sviðsmyndum og ástæða þess er að farþegum fjölgar með tilkomu Borgarlínu. Meðalferðatími með almenningssamgöngum minnkar í báðum sviðsmyndunum eða úr 12,3 mínútum/ferð í grunnsviðsmynd í 10,6 mínútur/ferð í sviðsmyndum með Borgarlínu. Þá er skiptingum einnig að fækka í báðum sviðsmyndum eða úr því að vera skipting í þriðju hverri ferð í grunnsviðsmynd yfir í það að vera skipting í fjórðu hverri ferð í sviðsmyndum með Borgarlínu. Miðað við þessar lykiltölur eru báðar sviðmyndirnar skilvirkari fyrir almenningssamgöngur en grunnsviðsmyndin.

Lítilsháttar minnkun er í hjóluðum kílómetrum og hjóluðum klukkustundum í sviðsmyndunum en á sama tíma er heildarferðum á hjóli að fjölga. Þetta er aðallega vegna leiðarstyttinga með tilkomu nýrra brúarmannvirkja.

Inngangur

Þessi greinagerð inniheldur lýsingu á forsendum og niðurstöðum samgöngugreiningar sem unnin var samhliða samfélagslegri arðsemisgreiningu á Samgöngusáttmálanum. Samgöngugreiningin var unnin með nýju Samgöngulíkani höfuðborgarsvæðisins (SLH), nánar má lesa um líkanið í lokaskýrslu þess (A126792-001-3.0-Documentation-SLH). Úr samgöngugreiningunni koma upplýsingar um notendaábata í formi styttri ferðatíma eða ferðavegalengdar sem eru grunnforsendur samfélagslegrar arðsemisgreiningar á Samgöngusáttmálanum. Notendaábati er reiknaður fyrir einkaferðir með bíl, atvinnuferðir með bíl, ferðir með almenningssamgöngum og ferðir á hjóli.

Forsendur framtíðarsviðsmynda

Sviðsmyndir eru reiknaðar á grunni með framtíðarsamgöngukerfi sem inniheldur allar framkvæmdir samgöngusáttmála höfuðborgarsvæðisins ásamt Sundabraut (sjá mynd 1). Framtíðarár sviðsmynda er 2040 og er gert ráð fyrir að íbúar á höfuðborgarsvæðinu hafi þá fjölgað um 100.000 frá árinu 2019.

Mynd 1) Framkvæmdir samgöngusáttmála ásamt Sundabraut

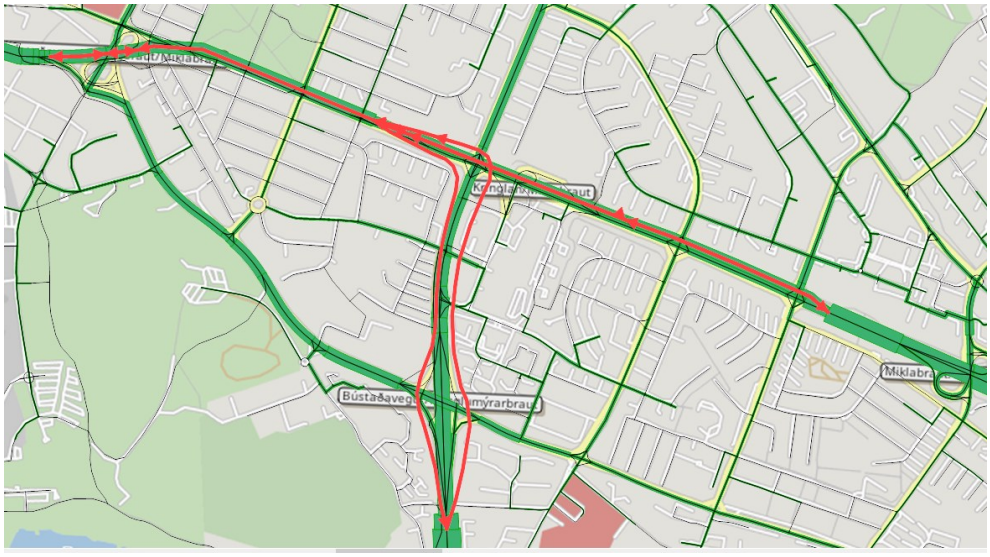
Framkvæmdir í sviðsmyndum

Af tíu vegaframkvæmdum samgöngusáttmálans má álykta að fjórar séu meiriháttar framkvæmdir, ef litið er til kostnaðar og flækjustigs. Þetta eru Miklubrautargöng, Sæbrautarstokkur, Garðabæjarstokkur og stokkur á Reykjanesbraut í Hafnarfirði. Forsendur þessara verkefna eins og þeim er stillt upp í samgöngulíkani í framtíðarspám er lýst hér að neðan.

<u>Miklubrautargöng</u>

Miklabraut er nú til skoðunar í frumdrögum sem Vegagerðin vinnur að. Í frumdrögunum eru til skoðunar kostir og gallar þess að setja Miklubraut í stokk eða jarðgöng.

Í sviðsmyndunum í líkaninu er gert ráð fyrir jarðgangnalausn. Gert er ráð fyrir að keyrt verði inn í göng að austanverðu áður en komið er að gatnamótum Réttarholtsvegar og Grensásvegar og gert er ráð fyrir vestari munnanum milli Nauthólsvegar og Bústaðavegar. Göngin eru með einbreiðum aðkomugöngum til og frá Kringlumýrarbraut. Munnar aðkomuganga eru sunnan Bústaðavegar og á Miklubraut milli Stakkahlíðar og Kringlumýrarbrautar.



Mynd 2) Yfirlitsmynd Miklubrautarganga eins og þeim er stillt upp í sviðsmyndum samgöngusáttmála

<u>Sæbrautarstokkur</u>

Sæbraut verður sett í 1 km langan stokk milli Kleppsmýrarvegs og Súðarvogs. Núverandi vegamót Súðarvogs og Sæbrautar verður lokuð og vegamótin Kleppsmýrarvegur/Sæbraut verða mislæg vegamót.

Mynd 3) Yfirlitsmynd Sæbrautarstokks eins og honum er stillt upp í sviðsmyndum Samgöngusáttmála. Fjólublá svæðið sýnir þakið á stokknum.

<u>Garðabæjarstokkur</u>

Hafnarfjarðarvegur verður settur í 0,4 km langan stokk milli Lyngásvegar og Vífilstaðavegar. Þetta mun gera vegamótin Lyngás-Hafnarfjarðarvegur og Vífilstaðavegur-Hafnarfjarðarvegur mislæg.

Reykjanesbraut milli Lækjargötu og Álftanesvegar

Verið er að skoða Reykjanesbraut í Hafnarfirði milli Lækjargötu og Álftanesvegar í frumdrögum sem annað hvort stuttan stokkan eða jarðgöng. Í báðum tilfellum verður Reykjanesbraut í frjálsu flæði á þessum kafla.

Í sviðsmyndum í samgöngulíkani er gert ráð fyrir stokkalausn en hún felur í sér stuttan stokk á vegamótum Reykjanesbrautar og Fjarðarhrauns sem gera vegamótin mislæg. Einnig verða vegamótin Lækjargata-Reykjanesbraut og Álftanesvegur-Reykjanesbraut mislæg. Vegamótum Hamrabergs og Reykjanesbrautar verður lokað og Hamraberg tengt við Álftanesveg.

Aðrar vegaframkvæmdir

Innifalið í Samgöngusáttmálanum er einnig fjölgun akreina á fjórum vegum, einn nýr vegur og ein mislæg vegamót. Sum þessara verkefna hafa þegar verið framkvæmd.

Eftirfarandi er upptalning á þessum verkefnum:

- Arnarnesvegur: Rjúpnavegur – Breiðholtsbraut (nýr 1+1 vegur)
- Suðurlandsvegur: Bæjarháls – Vesturlandsvegur (breikkun í 2+2 akreinar)
- Vesturlandsvegur: Skarhólabraut – Hafravatnsvegur (breikkun í 2+2 akreinar)
- Reykjanesbraut: Vegamót við Bústaðaveg (mislæg vegamót)
- Reykjanesbraut: Kaldárselsvegur – Krýsuvíkurvegur (breikkun í 2+2 akreinar)
- Suðurlandsvegur: Norðlingavað – Bæjarháls (breikkun í 2+2 akreinar)

Sérakreinar almenningssamgangna (Borgarlína):

Borgarlínan er hágæða almenningssamgöngukerfi (e. Bus Rapid Transit) sem mun aka að mestu á sérakreinum, hafa forgang á gatnamótum og aka með meiri tíðni. Þannig styttist ferðatími og áreiðanleiki eykst. Í samgönulíkaninu er gert ráð fyrir að sérakreinar verði byggðar á eftirfarandi köflum:

- Borgarlína: Ártún – Hlemmur - Hamraborg (sérakreinar og forgangur á ljósum)
- Borgarlína: Mjódd – BSÍ (sérakreinar og forgangur á ljósum)
- Borgarlína: Fjörður–Miklabraut (sérakreinar og forgangur á ljósum)
- Borgarlína: Ártún – Spöng (sérakreinar og forgangur á ljósum)
- Borgarlína: Hamraborg – Lindir (sérakreinar og forgangur á ljósum)
- Borgarlína um Keldnaland og Blikastaðaland
- Akstur utan sérrýmis á Borgarlínuleiðum
- Borgarlína: Ártún – Mosfellsbær (sérakreinar og forgangur á ljósum)

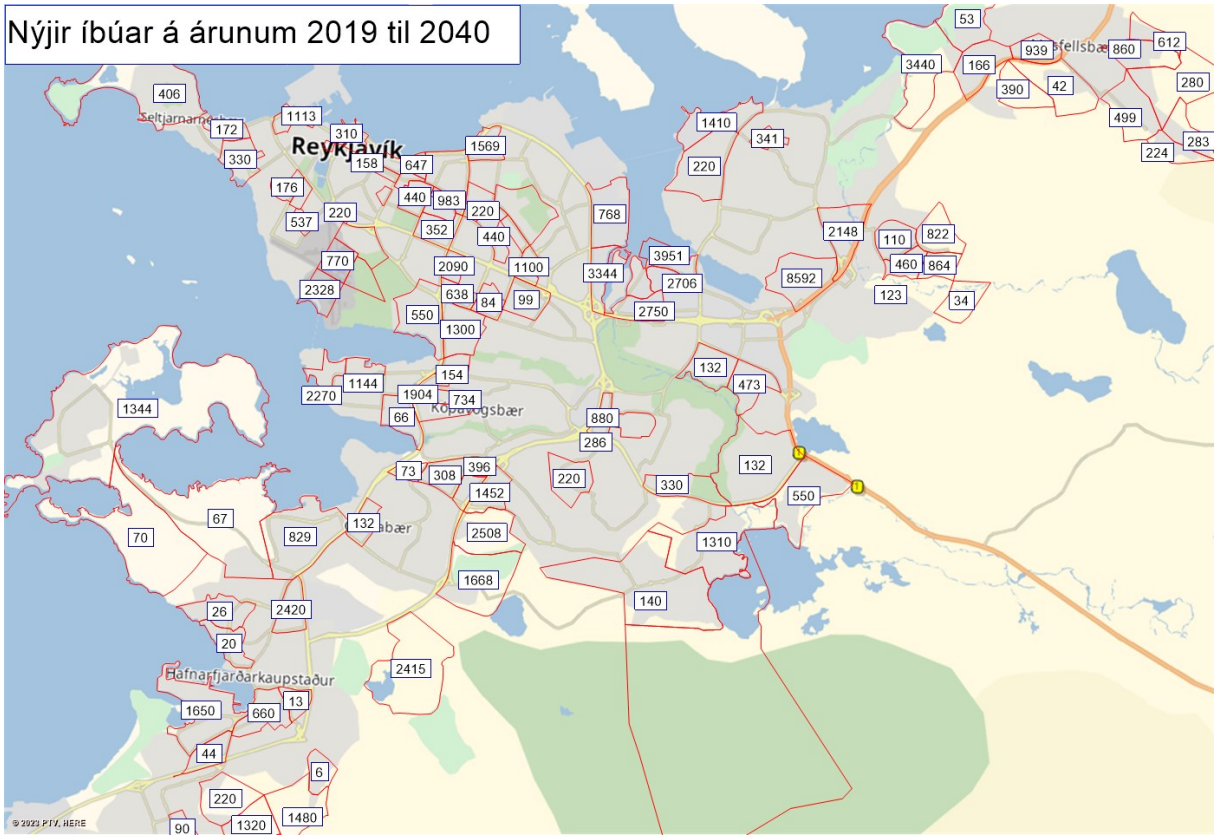
Önnur verkefni samgöngusáttmála:

Önnur verkefni sem innifalin eru í Samgöngusáttmálanum eru hjólastígar, ýmsar öryggisráðstafanir eins og göng eða brýr fyrir gangandi eða uppfærslur á ljósastýringum.

Af þessum verkefnum er einungis gert ráð fyrir hjólastígum í samgöngulíkani.

Fjölgun íbúa í sviðsmyndum

Unnin hefur verið ný mannfjöldaspá sem stuðst er við í samgöngusviðsmyndunum. Í grunninn er gert ráð fyrir að íbúum fjölgi um 100.000 á árunum 2019 til 2040. Tekið er mið af meðaltalsvexti á höfuðborgarsvæðinu síðustu 5 árin og árleg vaxtargildi mannfjöldaspár Hagstofunnar aukin sem því nemur.



Mynd 4) Á kortinu eru sýndir reitir samgöngulíkansins og hversu margir íbúar bætast þar við árið 2040 miðað við forsendur í samgöngulíkaninu.

Aðrar forsendur í samgöngulíkaninu

Alls voru greindar tvær framtíðarsviðsmyndir árið 2040, ein með Samgöngusáttmála og Sundabraut en hin með einungis Samgöngusáttmálanum.

- Áhrif vegna örferðamáta og rafhjóla hafa verið settar inn í samræmi við þróun undafarinna ára. Hefur það t.d. áhrif á hraða hjólandi ferða sem og hvernig notendur almenningssamgangna upplifa fjarlægð stöðva.
- Bílastæðakröfur hafa verið hertar á nýjum uppbyggingarsvæðum sem og að gjaldsvæði bílastæða hefur verið stækkað.
- Stórar framkvæmdir sem eru á undirbúningsstigi hafa verið uppfærðar í samræmi við þá vinnu, þ.e. að þær sviðsmyndir sem eru taldar líklegasta hafa verið settar inn í líkanið. Á það t.d. við um Sundabraut og Miklubrautarstokk sem er sett inn sem jarðgöng nú.

Sviðsmyndir

Alls voru reiknaðar tvær framtíðarsviðsmyndir árið 2040, ein með öllum framkvæmdum Samgöngusáttmála og hin með Sundabraut til viðbótar við allar framkvæmdir Samgöngusáttmála.

Þá var einnig reiknuð grunnsviðsmynd þar sem lítið hefur verið framkvæmt af innviðum árið 2040 en samt 100.000 nýjum íbúum bætt við höfuðborgarsvæðið.

Eftirfarandi sviðsmyndir voru reiknaðar með samgöngulíkaninu

- Grunnsviðsmynd 2040
- Framtíðarsviðsmynd 2040 með samgöngusáttmála
- Framtíðarsviðsmynd 2040 með samgöngusáttmála og Sundabraut

Niðurstöður

Alls voru greindar tvær framtíðarsviðsmyndir árið 2040, ein með Samgöngusáttmála og Sundabraut en hin með einungis Samgöngusáttmálanum. Þá var einnig reiknuð grunnsviðsmynd þar sem lítið hefur verið framkvæmt af innviðum árið 2040 en samt 100.000 nýjum íbúum bætt við höfuðborgarsvæðið. Með því að bera saman þessar sviðsmyndir er hægt að sjá áhrif framkvæmdanna á samgöngukerfi höfuðborgarsvæðisins.

Niðurstöður er sýndar sem umferðarkort í viðauka 1 og sem samantekt á lykiltölum í töfluformi hér á eftir. Í viðauka er hægt að sjá sólarhringsumferðarkort (HVDU) fyrir bílaumferð og almenningssamgöngur. Einnig er þar að finna mismunakort en með þeim er umferð í hverri sviðsmynd borin saman við grunnsviðsmynd og breytingar sýndar með rauðu og grænu. Þegar tölur eru rauðar er umferðaraukning í sviðsmynd samanborið við grunnsviðsmynd. Eftirfarandi kort eru sýnd í viðauka 1:

- Grunnár 2019 – Sólarhringsumferð ökutækja (HVDU)
- Grunnár 2019 – Sólarhringsumferð almenningssamgangna (HVDU)
- Grunnsviðsmynd 2040 – Sólarhringsumferð ökutækja (HVDU)
- Grunnsviðsmynd 2040 – Sólarhringsumferð almenningssamgangna
- Samgöngusáttmáli og Sundabraut – Sólarhringsumferð ökutækja (HVDU)
- Samgöngusáttmáli og Sundabraut– Sólarhringsumferð almenningssamgangna
- Samgöngusáttmáli án Sundabrautar – Sólarhringsumferð ökutækja
- Samgöngusáttmáli án Sundabrautar – Sólarhringsumferð almenningssamgangna

Til viðbótar við umferðarkortin eru lykiltölur sviðsmynda sýndar hér á töfluformi. Í fyrstu töflunni má sjá niðurstöðu ferðamátavals en eins og sést þá er fjöldi ferða sýndur eftir ferðamátum og hvernig hann breytist milli sviðsmynda.

Ef horft er á vöxt umferðar frá 2019 til 2040 er ferðum með bíl að fjölga í öllum sviðsmyndum, mest í grunnsviðsmyndinni eða um 2,0% á ári og minnst í sviðsmynd með Samgöngusáttmála en án Sundabrautar eða 1,68%. Í sviðsmynd með Samgöngusáttmála og Sundabraut er vöxturinn 1,69% á ári.

Eins og sést í töflunni þá er bílferðum að fækka í báðum sviðsmyndum samanborið við grunnsviðsmynd sem þýðir að almennt eru ferðir að flytjast frá því að vera farnar með einkabíl yfir í almenningssamgöngur eða vera farnar á hjóli. Minni minnkun er í sviðsmynd með Samgöngusáttmála og Sundabraut og munar þar um 3.700 bílferðir.

Tafla 1) Lykiltölur umferðar á einum sólarhring

Grunnár 2019	Grunnsviðsmynd 2040	Samgöngusáttmáli og Sundabraut 2040	Samgöngusáttmáli án Sundabrautar 2040
938.400	1.419.200	1.333.900	1.330.200
36.100	67.800	96.300	97.300
59.200	148.400	149.600	151.000
84.900	128.900	128.900	128.900
42.700	64.700	64.700	64.700

Í eftirfarandi töflu eru sýndar niðurstöður fyrir lykiltölur umferðarkerfa. Þessar lykiltölur gefa til kynna hvaða áhrif mismunandi umferðarlausnir hafa á ferðatíma eða akstursmagn mismunandi ferðamáta. Þessar lykiltölur eru reiknaðar á mismunandi tímabilum í líkaninu og lagðar svo saman til að fá heildarsummur fyrir sólarhring. Hér eru skilgreiningar á þessum lykilstærðum:

- Aksturskílómetrar er heildarakstur viðkomandi ferðarmáta í líkaninu á sólarhring á virkum degi (heild fyrir höfuðborgarsvæðið). Þessi tala hækkar ef ferðum innan viðkomandi ferðamáta fjölgar eða ef ferðir lengjast vegna breytinga í umferðarkerfinu.
- Ferðatími í frjálsu flæði er sá tími sem tekur að ferðast milli staða ef engar tafir eru, t.d. ef ferðin væri farin um nótt. Lykiltalan er heildarferðartími á sólarhring á virkum degi fyrir allar ferðir á höfuðborgarsvæðinu ef mögulegt væri fyrir þær að ferðast án tafa. Þessi tala hækkar ef ferðum innan viðkomandi ferðamáta fjölgar. Talan getur lækkað ef meðalhraði á götum hækkar eða ef ný „tenging“ styttir ferðir.
- Tafir eru fundnar með því að draga frá „ferðatíma í frjálsu fræði“ frá reiknuðum raunferðatíma innan mismunandi ferðatímabila t.d. árdegisumferð eða utan háannatíma. Þessi tímabil eru lögð saman til að fá heildartafir fyrir sólarhring.
- Farþegatímar er ferðatími allra farþega milli stoppistöðva á einum sólarhring. Tekinn er með sá tími um borð í vagni og sá tími sem það tekur farþega að skipta um vagn. Ekki er tekinn með göngutími milli stoppa og áfangastaða og ekki er tekinn með biðtími á fyrstu stoppistöð. Þessi tala hækkar ef farþegum fjölgar en lækkar ef ferðatími milli áfangastaða lækkar.
- Ferþegakílómetrar er sami mælikvarði og aksturskílómetrar nema fyrir farþega almenningssamgangna. Þeim fjölgar ef farþegum fjölgar en fækkar ef breytt leiðarkerfi gefur farþegum möguleika á að stytta ferð sína.
- Skiptingar er heildarfjöldi tilfella þar sem farþegar þurf að skipta um vagn á leið sinni.
- Vagnkílómetrar er heildarakstur allra vagna í kerfinu á einum sólarhring.

Eins og sést í eftirfarandi töflu fækkar aksturskílómetrum ökutækja um 186.000 kílómetra á sólarhring í sviðsmynd með Samgöngusáttmála samanborið við grunnsviðsmynd og tafir eru að minnka um 14.000 klukkustundir á sólarhring. Meiri ábati er í sviðsmynd með Samgöngusáttmála og Sundabraut en í henni fækkar aksturskílómetrum með bíl um 352.000 kílómetra á sólarhring og tafir minnka um 15.000. Miðað við þessar lykiltölur eru allar sviðmyndir skilvirkari en grunnsviðsmyndin.

Lykiltölur almenningssamganga sýna að farþegakílómetrum fjölgar í öllum sviðsmyndum og þá vegna þess að farþegum fjölgar með tilkomu Borgarlínu. Meðalferðatími með almenningssamgöngum minnkar í báðum sviðsmyndunum eða úr 12,3 mínútum/ferð í grunnsviðsmynd í 10,6 mínútur/ferð í sviðsmyndum með Borgarlínu. Þá er skiptingum einnig að fækka í öllum sviðsmyndum eða úr því að vera skipting í þriðju hverri ferð í grunnsviðsmynd yfir í það að vera skipting í fjórðu hverri ferð í sviðsmyndum með Borgarlínu. Miðað við þessar lykiltölur eru báðar sviðmyndirnar skilvirkari en grunnsviðsmyndin fyrir almenningssamgöngur.

Lítilsháttar minnkun er í hjóluðum kílómetrum og hjóluðum klukkustundum í sviðsmyndum en á sama tíma er heildarferðum á hjóli að fjölga. Þetta er aðallega vegna leiðarstyttinga með tilkomu nýrra brúarmannvirkja.

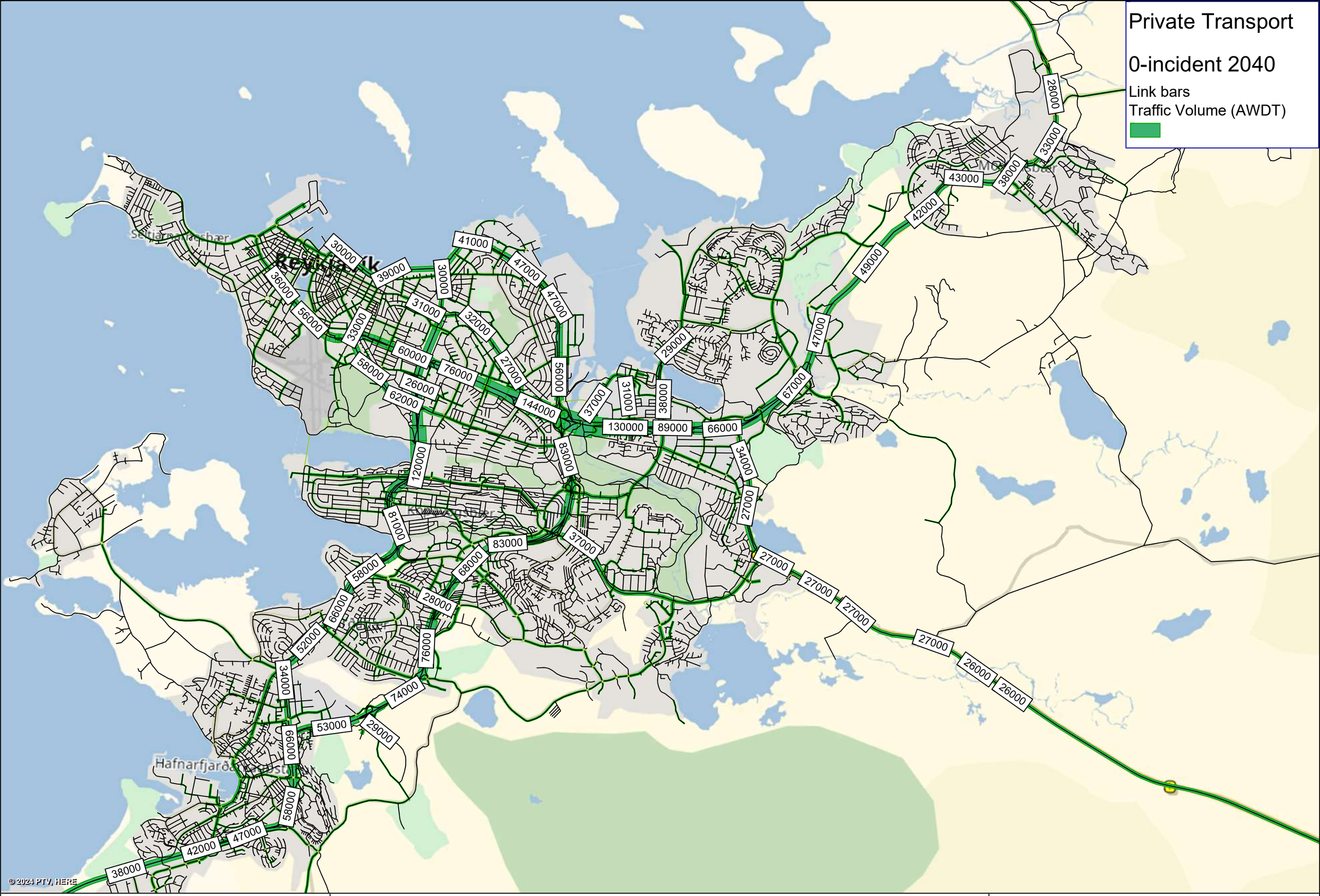
Tafla 2) Lykiltölur samgöngukerfa

		Grunnár 2019	Grunnsviðsmynd 2040	Samgöngusáttmáli og Sundabraut 2040	Samgöngusáttmáli án Sundabrautar 2040
Hjólandi	**Vegalengd (km)**	91.200	205.700	203.000	204.300
	Ferðatími (klst)	6.200	11.900	11.400	11.400
Ökutæki	**Akstur (km)**	4.773.400	6.826.000	6.477.600	6.625.100
	Tafir (klst.)	9.100	40.800	26.000	27.200
	Ferðatími í fjálsu flæði (klst.)	114.200	180.100	169.900	170.900
Sendi-bílar	**Akstur (km)**	433.300	607.200	604.600	617.100
	Tafir (klst.)	700	3.200	2.200	2.300
	Ferðatími í frjálsu flæði (klst.)	10.200	14.800	14.700	14.800
Þung umferð	**Akstur (km)**	219.000	306.300	305.000	311.600
	Tafir (klst.)	400	1.,700	1.100	1.200
	Ferðatími í frjálsu flæði (klst.)	5.200	7.500	7.500	7.600
Alm.-samg.	**Farþegatímar (klst.)**	7.600	13.900	16.900	17.300
	Farþegakílómetrar (km)	210.100	374.800	497.700	509.400
	Skiptingar	13.000	22.400	24.700	25.200
	Vagnkílómetrar (km)	30.500	30.500	46.000	46.000

Private Transport

0-incident 2040

Link bars
Traffic Volume (AWDT)



VISUM 2022.01 PTV AG	Author.: Mannvit & Cowi	A126792-SLH_v8.0_SB2040_0IncSCB_V4_Forecast4_P
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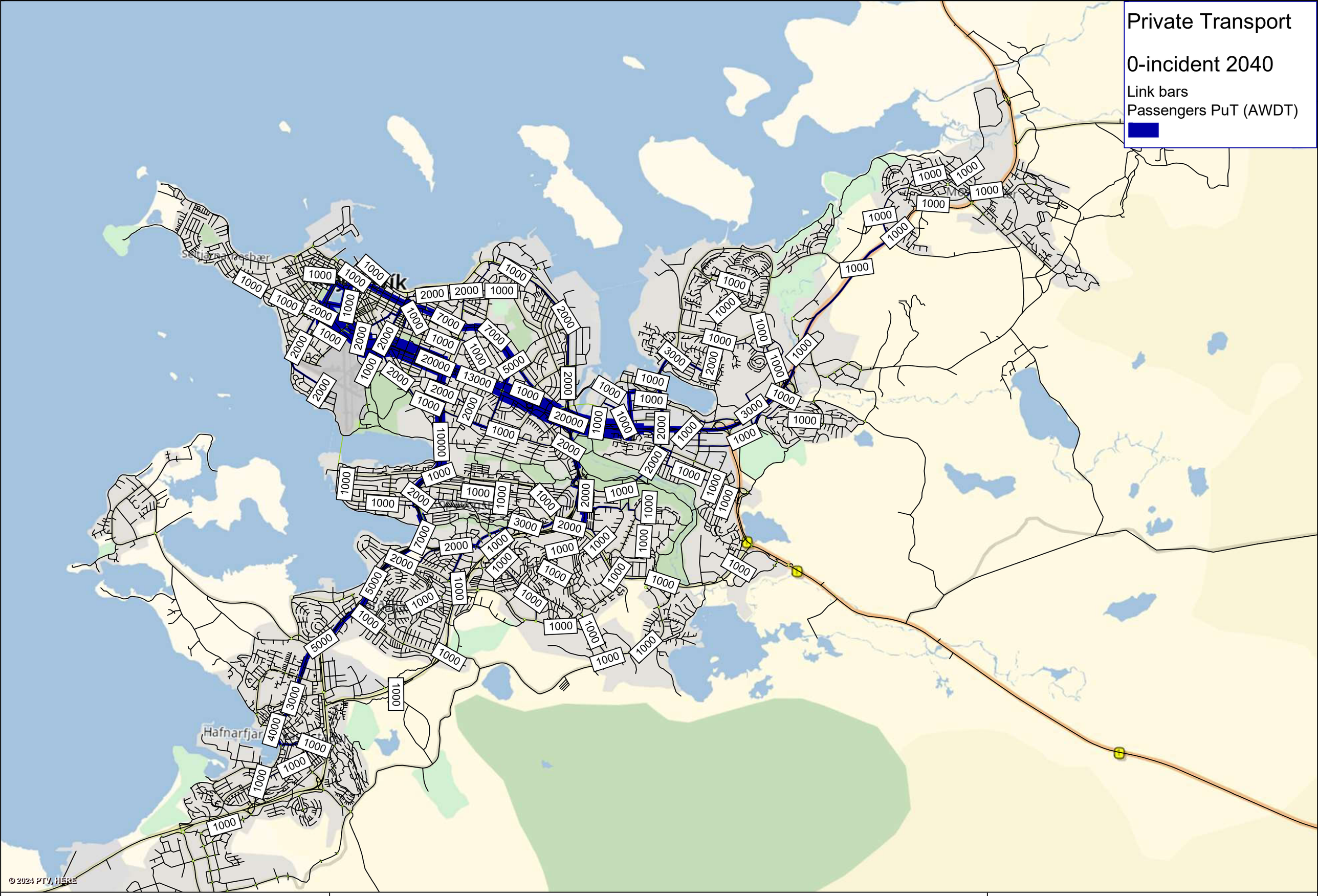
Private Transport

0-incident 2040

Link bars
Passengers PuT (AWDT)



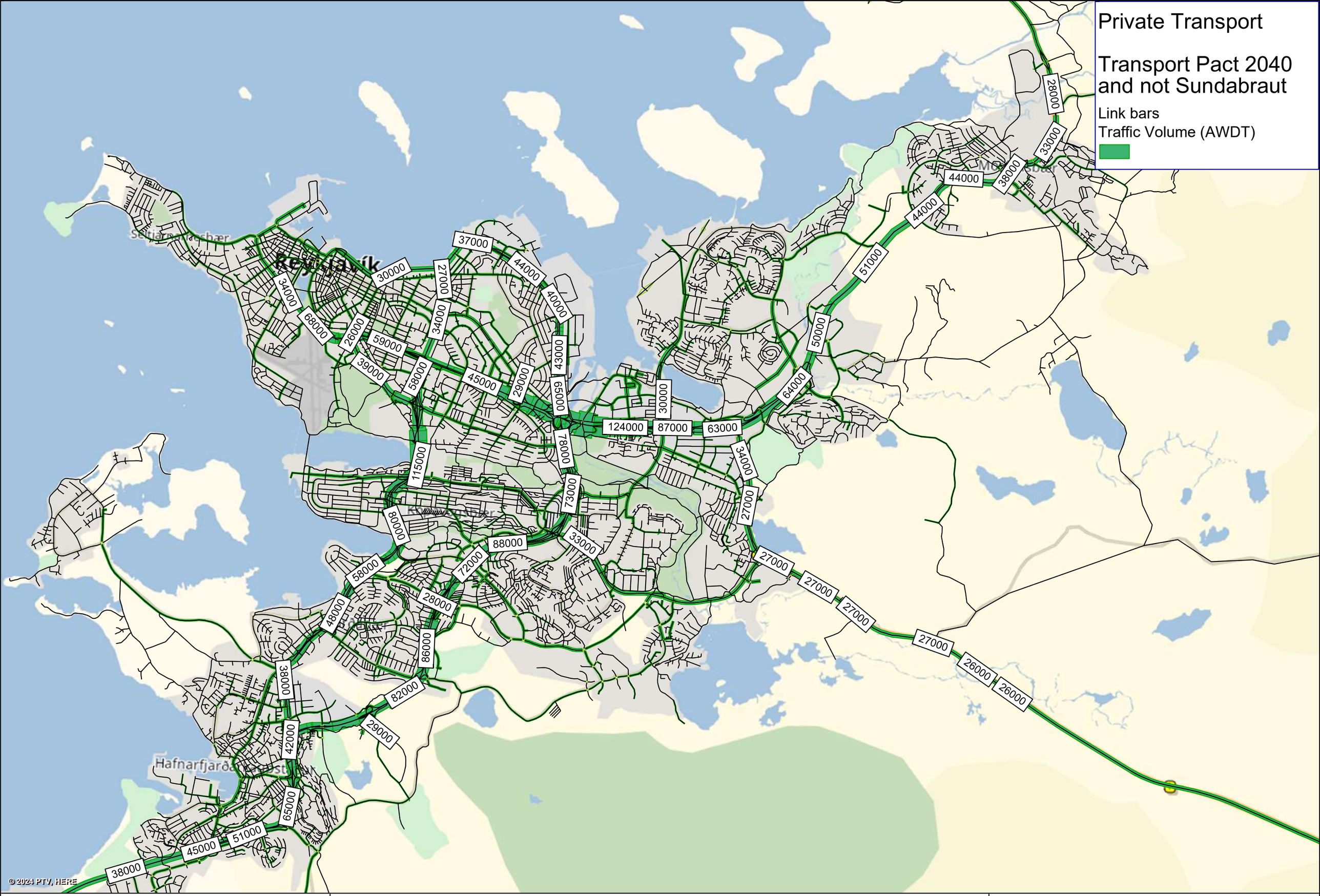
VISUM 2022.01 PTV AG	Author.: Mannvit & Cowi	A126792-SLH_v8.0_SB2040_0IncSCB_V4_Forecast4_P
Printed: 18.01.2024		1:60410

Private Transport

Transport Pact 2040 and not Sundabraut

Link bars

Traffic Volume (AWDT)



VISUM 2022.01 PTV AG	Author.: Mannvit & Cowi	A126792-SLH_v8.0_SB2040BgV4_NotSunda_Forecast3
Printed: 18.01.2024		1:54584

Private Transport

Transport Pact
and not Sundabraut

Link bars
Passengers PuT (AWDT)

VISUM 2022.01 PTV AG	Author.: Mannvit & Cowi	A126792-SLH_v8.0_SB2040BgV4_NotSunda_Forecast3
Printed: 18.01.2024		1:57424

Private Transport

Transport Pact 2040 and Sundabraut

Link bars
Traffic Volume (AWDT)

VISUM 2022.01 PTV AG	Author.: Mannvit & Cowi	A126792-SLH_v8.0_SB2040BgV4_Forecast3_PrT.ver
Printed: 18.01.2024		1:54584

Private Transport

Transport Pact and Sundabraut

Link bars
Volume PuT [Pers] (AP)

VISUM 2022.01 PTV AG	Author.: Mannvit & Cowi	A126792-SLH_v8.0_SB2040BgV4_Forecast3_PuT.ver
Printed: 18.01.2024		1:57424

Appendix E Health benefits with HEAT tool

Appendix x - Health benefits analysis with HEAT tool

Sourche: https://www.heatwalkingcycling.org/tool/

Summary of your input data

The volume data you have entered corresponds to 1 minute per person per day. Your assessed population is 213,520.

Summary of impacts for mortality

As a result, 4.5 premature deaths are prevented per year. Over the full assessment period of 50 years, 225 premature deaths are prevented.

Economic value of impacts

Mortality is monetized using a Value of Statistical Life (VSL) of 696,763,000 LCU per premature death. This corresponds to an economic value of LCU 3,140,000,000 per year.

Over the full assessment period of 50 years, the total economic impact is LCU 157,000,000,000.

Adjusted to 2022 value (i.e. discounted/inflated), the total economic impact is LCU 23,800,000,000.

Summary of your input data

The volume data you have entered corresponds to 1 minute per person per day. Your assessed population is 213,520.

Summary of impacts for mortality

As a result, 4.5 premature deaths are prevented per year. Over the full assessment period of 50 years, 224 premature deaths are prevented.

Economic value of impacts

Mortality is monetized using a Value of Statistical Life (VSL) of 696,763,000 LCU per premature death. This corresponds to an economic value of LCU 3,120,000,000 per year.

Over the full assessment period of 50 years, the total economic impact is LCU 156,000,000,000.

Adjusted to 2022 value (i.e. discounted/inflated), the total economic impact is LCU 23,700,000,000.

Disclaimer

Please bear in mind that HEAT does not calculate risk reductions for individual persons but an average across the population under study. The results should not be misunderstood to represent individual risk reductions. Also note that the "value of statistical life" does not assign a value to the life of one particular person but refers to an average value of a “statistical life”.

It is important to remember that many of the variables used within HEAT are estimates and therefore liable to some degree of uncertainty.

You are reminded that the HEAT tools provide you with an approximation of the order of magnitude of the impacts. To get a better sense for the robustness of the results, you are strongly advised to rerun the model, entering low and high values for variables where you have provided a “best guess”.