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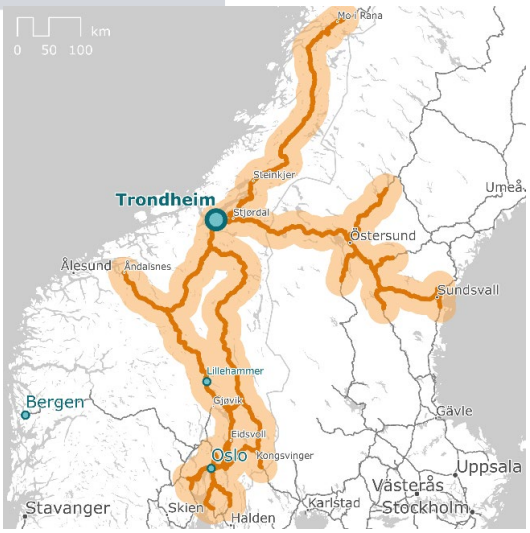
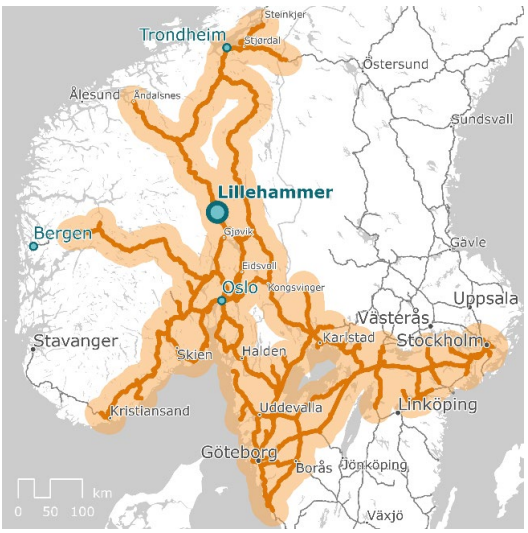
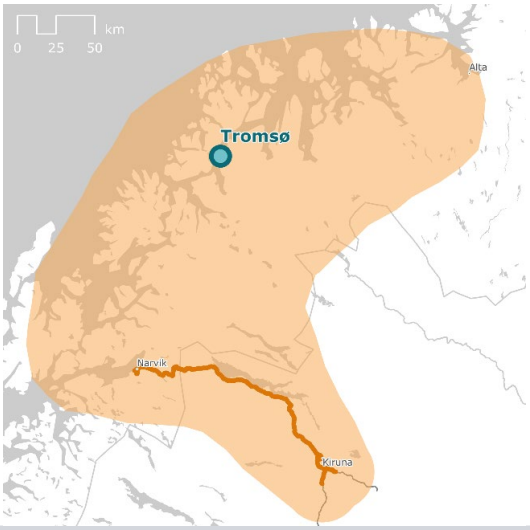
NINA Report

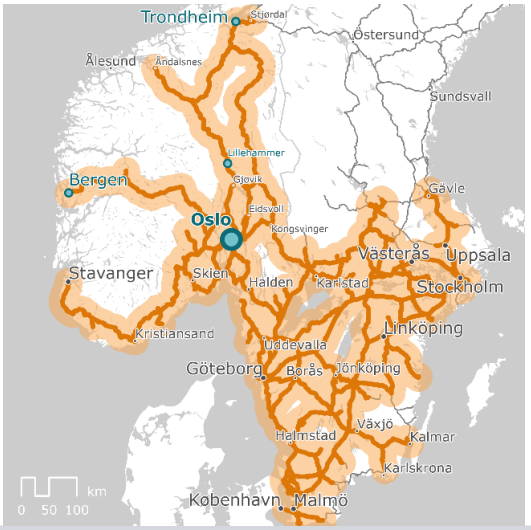
NINA's guidelines on environmentally responsible travel

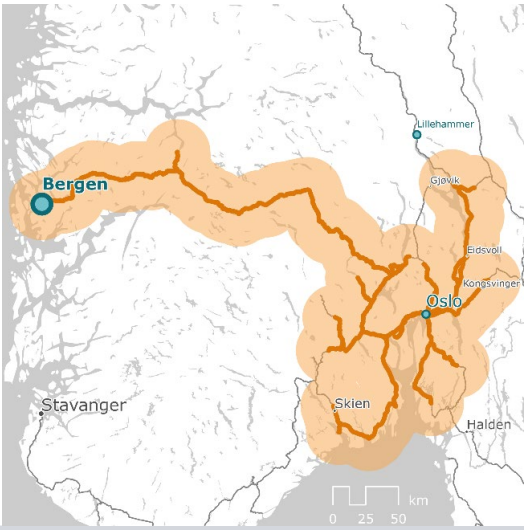
Zofie Cimburova, Nina Dehnhard, Hanno Sandvik











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NINA's guidelines on environmentally responsible travel

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Norwegian Institute for Nature Research

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COVER PICTURE
The cover picture combines **Figure 4** of this report (maps indicating the destinations accessible from NINA offices by train or bus within eight hours) with a cropped version of a photograph of a Norwegian train (photographer: Espen Franck-Nielsen, Wikimedia, CC BY-SA 4.0, see https://commons.wikimedia.org/wiki/File:10tveter_el18_b3.jpg).

KEY WORDS
Bus, car, carbon dioxide, carbon footprint, CO_2 emission, corporate travel policy, environmental footprint, green-house gas, plane, train, transport, video conference

NØKKELORD
Bil, buss, CO_2-utslipp, drivhusgass, fly, karbondioksid, klimafotavtrykk, miljøfotavtrykk, reiseråd, tog, transport, videokonferanse

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Abstract

Cimburova, Z., Dehnhard, N. & Sandvik, H. 2021. NINA's guidelines on environmentally responsible travel. NINA Report 1882. Norwegian Institute for Nature Research.

As an institute focussing on "cooperation and expertise for a sustainable future", the Norwegian Institute for Nature Research (NINA) has decided to implement measures that reduce NINA's environmental footprint. This commitment encompasses the obligation to reduce the emissions of carbon dioxide (CO_2) and other greenhouse gases. The greatest potential for cutting NINA's CO_2 emissions is by (1) reducing the volume of travels and by (2) changing the means of transportation for the remaining travels. With this background, NINA has adopted guidelines on environmentally responsible travel, which are described in this report.

The guidelines make explicit that a journey only should be undertaken if it can be shown to create sufficient added value compared to arranging a video conference. Importantly, the further one intends to travel, the higher the added value of the journey needs to be. The guidelines provide specific examples of what constitutes an added value. For instance, listening to a conference does not create sufficient added value to justify travelling outside Europe. However, it might do so for travelling within Scandinavia.

Given that a journey creates sufficient added value, the next question to be addressed is the means of transportation. Whenever possible and convenient, travels should be undertaken by train or bus, as these are the alternatives with the smallest environmental footprint by far. Train journeys of up to eight hours, and bus journeys of up to five hours, are defined as convenient in this sense. Only when travel by train or bus is unavailable or inconvenient, one may consider other means of transportation, namely car, boat or plane, in this order.

The guidelines give further advice on each of the alternatives. For instance, when travelling by car, one should whenever possible share a car with other passengers. When travelling by plane, direct flights and economy class should be preferred to stopover flights and business class. Finally, the greenhouse gas emissions of car, boat and plane travels should be compensated for.

The report also provides detailed information on travels between NINA's offices (in Trondheim, Oslo, Tromsø, Lillehammer and Bergen) in terms of prices, durations and CO_2 emissions. Finally, one map per NINA office illustrates the destinations that can be reached within an eight-hour train travel (or bus travel). For example, the train connections Trondheim–Oslo and Oslo–Bergen take less than eight hours, and should thus normally be preferred to air travels between these destinations. Replacing air travels by train travels along these distances reduces the CO_2 emissions by 96% (or c. 120 kg per passenger). Likewise, a train travel from Oslo to Stockholm or Copenhagen takes roughly eight hours and should thus normally be preferred to a plane travel.

The guidelines cover all work travels of all NINA employees beyond their hometown. Project leaders should also consult the decision tree during the early project planning stage, so as to minimise the total kilometres travelled by the project participants during the project. Ideally, the monetary costs of environmentally responsible travel should be included in the project budgets.

There is no one-size-fits-all standard for travels, and it is therefore not obligatory to follow the guidelines. Rather, they form recommendations with the aim to inform and to raise awareness. Choices about travel destination and means of travel should be made consciously, since they have substantial effects on NINA's environmental footprint.

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Sammendrag

Cimburova, Z., Dehnhard, N. & Sandvik, H. 2021. NINAs veileder for miljøvennlige arbeidsreiser. NINA Rapport 1882. Norsk institutt for naturforskning.

I tråd med instituttets motto – «samarbeid og kunnskap for framtidas miljøløsninger» – har Norsk institutt for naturforskning (NINA) besluttet å gjennomføre tiltak som reduserer NINAs miljøfotavtrykk. Denne målsettinga forplikter oss til å redusere våre utslipp av karbondioksid (CO_2) og andre drivhusgasser. NINAs største potensial for utslippskutt består i å (1) redusere antall reiser og (2) endre fremkomstmiddelet for de øvrige reisene. På denne bakgrunn har NINA utarbeidet en «reis bevisst»-plakat for miljøvennlige arbeidsreiser, som beskrives i denne rapporten.

Ifølge «reis bevisst»-plakaten bør en reise bare gjennomføres hvis den genererer tilstrekkelig merverdi, sammenlignet med å gjennomføre et videomøte. Reisens merverdi bør være høyere, jo lenger man planlegger å reise. Veilederen inneholder noen konkrete kriterier for hva som regnes som merverdi. Å være tilhører på en konferanse genererer eksempelvis ikke nok merverdi til å rettferdiggjøre en reise utenfor Europa, men kan være god nok grunn til en reise i Norden.

Gitt at en reise gir nok merverdi, er fremkomstmiddelet det neste spørsmålet man må ta stilling til. Så sant det er mulig og praktisk gjennomførbart, bør man reise per tog eller buss, fordi disse har det desidert laveste miljøfotavtrykket. Togreiser på opptil åtte timer og bussreiser på opptil fem timer regnes i denne sammenheng som «praktisk gjennomførbare». Bare hvis tog- eller bussreiser ikke er tilgjengelige eller praktisk gjennomførbare, bør man vurdere andre reisemåter. Disse er – i prioritert rekkefølge – bil, båt og fly.

Veilederen gir utdypende råd for hver reisemåte. Når man bruker bil, bør man for eksempel, om mulig, samkjøre med andre. Tar man fly, bør man foretrekke flyruter uten mellomlanding og kjøpe økonomi- fremfor business-billetter. Ved reiser med bil, båt eller fly bør man kjøpe kompensasjon for drivhusgassutslippene.

Rapporten sammenstiller detaljert informasjon om reiser mellom NINAs kontor (i Trondheim, Oslo, Tromsø, Lillehammer og Bergen) når det gjelder priser, varighet og CO_2-utslipp. Ved hjelp av kart vises alle reisemål som ligger innenfor en åtte timers togreise (eller bussreise) fra de ulike NINA-kontorene. Togreisene Trondheim–Oslo og Oslo–Bergen tar eksempelvis mindre enn åtte timer. På disse strekningene bør man derfor reise med tog istedenfor fly, noe som reduserer CO_2-utslippene med 96 % (eller ca. 120 kg per passasjer). På samme måte bør reiser mellom Oslo og Stockholm eller København vanligvis foretas med tog, siden de tar rundt åtte timer.

«Reis bevisst»-plakaten gjelder for alle arbeidsreiser som NINAs ansatte gjør utover sine hjemsteder. Prosjektledere bør dessuten bruke «reis bevisst»-plakaten tidlig i prosjektplanlegginga, slik at prosjektdeltagernes totale reiselengde kan minimeres. Helst bør også prisen for miljøvennlige arbeidsreiser inkluderes i prosjektenes budsjetter.

Det fins ikke én reisemåte som passer for alle anledninger, og veilederens anbefalinger er derfor ikke bindende. Dens mål er heller å informere og skape bevissthet. Valg av reisemål og -måter bør tas bevisst, fordi de har en enorm påvirkning på NINAs miljøfotavtrykk.

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Contents

Foreword

The idea for NINA's guidelines on environmentally responsible travel arose in conversations among a wider group of NINA employees and in the NINA-internal group "Et grønnere NINA", which has the aim to make NINA an even more sustainable organization. Originating from the idea of presenting these guidelines through a decision tree in the form of a "Vær bevisst-plakat", we realized soon that apart from the decision tree, we also needed to provide background information about sustainable travel, as well as document the decisions made when designing the tree and how the different values, numbers and figures were derived. This NINA Report therefore presents a comprehensive documentation of the work we have conducted. We acknowledge that the process of making NINA a more sustainable organization is a continuous project, and the guidelines on environmentally responsible travel may therefore be adjusted or improved in the future.

The guidelines presented in this NINA Report were thoroughly discussed and reviewed within the "Et grønnere NINA" group, and we would like to thank our colleagues Kjetil Hindar, Jiska van Dijk, Audun Ruud, Annette Taugbøl, David Barton, Arnaud Tarroux, Rakel Blaalid, Elisabet Forsgren and Norunn S. Myklebust for their constructive feedback in this process. Eva Katrine Hagen kindly provided the data about NINA employees' air travels.

25th of August 2020, Zofie Cimburova, Nina Dehnhard and Hanno Sandvik

1 Introduction

If dangerous and irreversible impacts of global warming are to be avoided, global anthropogenic emissions of carbon dioxide (CO_2) and other greenhouse gases need to be approximately halved by 2030 compared to 2010 levels, and to reach "net zero around 2050" (IPCC 2018: C.1). These challenging goals cannot be reached unless emissions are reduced in all relevant sectors. Worldwide, transport accounts for roughly 23% of CO_2 emissions (IPCC 2014). The contribution of scientists to travel-related CO_2 emissions is not negligible and is increasingly discussed self-critically (e.g. Caset et al. 2018, Sonne et al. 2019, Haage 2020). Clearly, if scientists are part of the problem, they should also be part of the solution. As Nathans and Sterling (2016) put it: "If scientists do not lead by example, then who else will?"

As a research institute focussing on "cooperation and expertise for a sustainable future" (NINA 2015), it would be ironic if NINA does not contribute to reducing the emissions that threaten this very sustainable future. As a consequence, NINA has recently adopted the objective of "implementing measures that contribute to reducing NINA's environmental footprint" (unpublished). Based on experience from similar research institutions (e.g. NTNU 2018), it is likely that transportation accounts for a major part of NINA's CO_2 emissions. It can, therefore, be assumed that the greatest potential for reducing NINA's emissions is by

(1) reducing the volume of travels,

(2) changing the means of transportation for the remaining travels.

For instance, travelling from Trondheim to Oslo by plane emits 25 times more CO_2 than travelling the same distance by train (see chapter 3 for comparison of different means of transport between NINA offices). Yet, despite having a well-functioning train connection, at least 445 flights between Trondheim and Oslo were booked by NINA employees in 2019, generating emissions of nearly 60 tonnes of CO_2-equivalents (see chapter 5.1 for details).

Who should use these guidelines
The guidelines should be used by any NINA employee who intends to travel in connection with her/his work. This includes researchers, engineers, administrative staff, IT advisors, leaders – in summary everyone. The guidelines cover all work travels beyond one's hometown. This includes, but is not necessarily restricted to, meetings, conferences, fieldwork, consultations, supervision and the like. The guidelines should obviously be applied when intending to travel in the near future. However, the guidelines should also be used at an earlier stage, e.g. when planning a new project. Project leaders should consult the decision tree during the early project planning stage, so as to minimise (or at least to keep as low as reasonably possible) the total kilometres travelled by the project participants. In addition, the costs of environmentally responsible travel should be included into project budgets.

The aim of these guidelines
The suggested guidelines have two main goals: to inform and to raise awareness. The choices we make on how to travel have substantial effects on our environmental footprint. We ought to make these choices consciously. These guidelines will hopefully help in this process.

It is *not* the aim of the suggested guidelines to tell what is right or wrong. There are a number of potential reasons to deviate from the recommendations provided by these guidelines. Firstly, we wanted to keep them simple. Secondly, there is no one-size-fits-all standard for travels. If you are able to work efficiently during a day train journey, you may get the tasks done while travelling. However, if you use to get sick on a train, the situation is quite different. A travel by night train might not be a feasible alternative if you can't sleep in a train; if you can, however, you may find it far more comfortable than a flight. For these and many other reasons, you are welcome to make your personal adjustments to the suggested decision tree which is reflecting NINA's guidelines. You may even consider using them as an inspiration for private travels. Good luck!

2 The guidelines through a decision tree

NINA's guidelines on environmentally responsible travel take the form of a flow chart or decision tree as shown in **Figure 1**, which is intended as a help in making travel choices. The first two questions in the decision tree are the most crucial ones:

(1) **Does a physical meeting have sufficient added value?** Unless a journey creates sufficient added value, it should simply not be undertaken. Importantly, the further one intends to travel, the higher the added value of the journey needs to be. For example, what qualifies as a good reason for travelling to Stavanger, might not be a sufficiently good reason for travelling to New Zealand. The meaning of "sufficient added value" is further elaborated in chapter 2.1.

(2) **Is it possible and convenient to reach the destination by train or bus?** Whenever possible and convenient, a travel should be undertaken by train or bus, as these by far are the alternatives with the smallest environmental footprint. Train journeys of up to eight hours should normally be considered as convenient in this sense. See chapter 2.2 for further explanations.

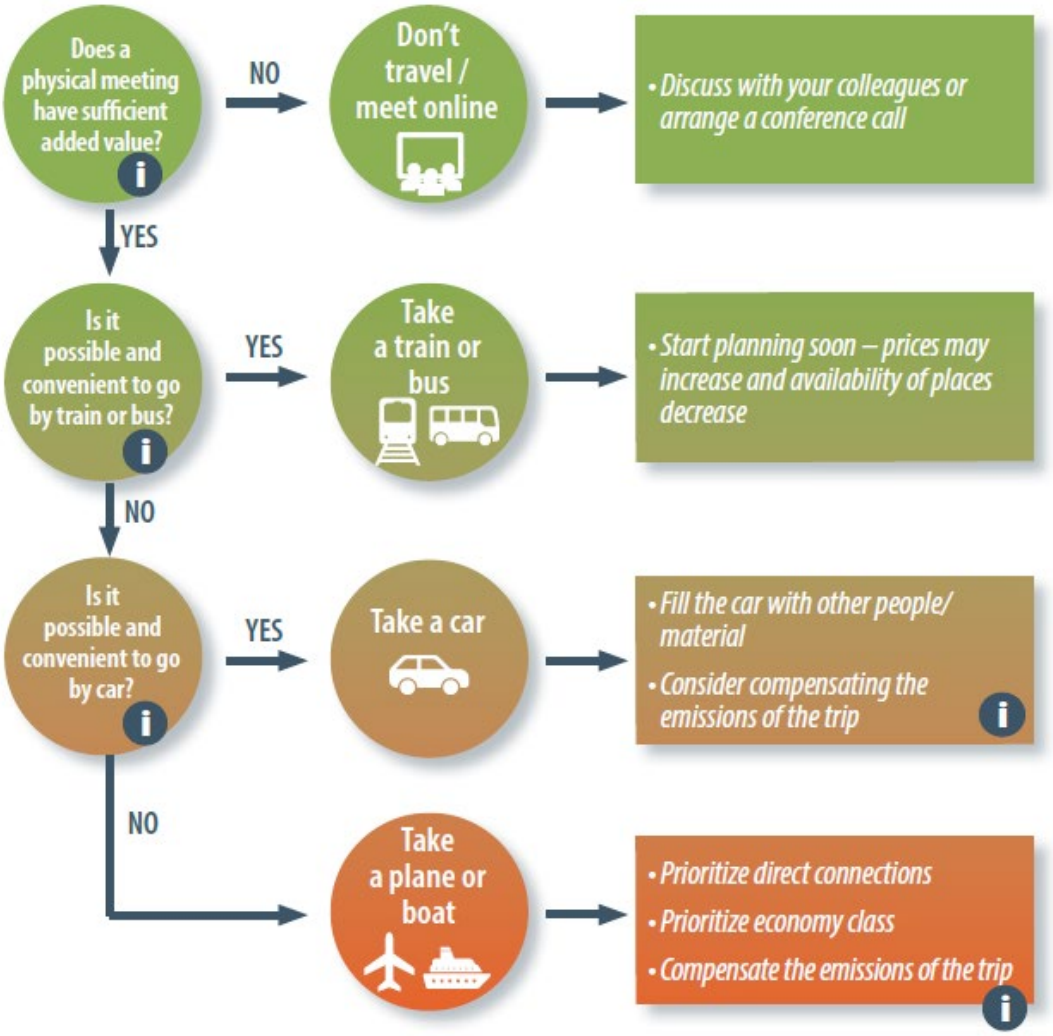

Figure 1. *Decision tree for environmentally responsible travel at NINA.*
** "Added value" is defined in section 2.1.*
*** "Convenient" is defined in section 2.2.*
**** Emission compensation is explained in section 2.3.*

The main sorting criterion in the decision tree are the CO_2 emissions of the different means of transportation (see section 5.2). Transportation with lower emissions is generally preferred to that with higher emissions. See chapter 4 for examples of CO_2 emissions for travels between NINA offices.

Given a choice, there are still further options to reduce the environmental footprint. These are summarised as bullet points in the decision tree, and explained here:

- Emissions should be compensated for. See section 2.3 for details.
- If more people are heading for the same destination by car, sharing a car obviously halves the emissions compared to travelling in several cars.
- Likewise, direct flights have considerably lower emissions than stopover flights. Air travels should thus be done with as few stopovers as possible. In addition, travelling by economy class maximises the number of passengers that each flight can carry, because business class seats take up more room compared to economy class seats. Thus, travelling by economy class produces less emissions compared to business class.
- An option that applies to all means of transportation is the possibility to reduce the number of travels by combining two or more meetings that take place in the same destination. By timing meetings (or moving them, when possible) they can be combined and realized during only one travel. Staying one night at a hotel in order to participate in different meetings on two consecutive days has lower CO_2 emissions than travelling back and forth twice.

2.1 What is “added value”?

According to the guidelines, one should not travel unless a physical meeting has a “sufficient added value” compared to an online meeting. **Table 1** outlines a non-exhaustive list of possible reasons which may count as “added value” in a NINA context.

As emissions increase with increasing distances travelled, the added value needs to be higher the longer one intends to travel. In order to qualify as having *sufficient* added value, it is therefore recommended that:

- to travel *within the Nordic countries*, one should answer “yes” to *at least one* of the questions in **Table 1**,
- to travel *within Europe* (beyond Scandinavia), one should answer “yes” to *at least two* of the questions in **Table 1**,
- to travel *beyond Europe*, one should answer “yes” to *at least three* of the questions in **Table 1**.

The principle that a travel should contribute with more added value the further one travels, is illustrated in **Figure 2**. The horizontal axis represents the travel distance. Scandinavia, European countries and non-European countries are the three main destination groups. The vertical axis represents the number of positive answers to the questions in **Table 1**. The green-yellow-red gradient then represents the added value of a travel from insufficient (red) through sufficient (yellow) to high (green), given travel distance and reasons to travel. While travels located in the upper left (green) triangle are considered to have high added value (because of short travel distance or several good reasons to travel), travels located in the bottom right (red) triangle are considered to have insufficient added value (because of long travel distance or insufficient reasons to travel).

Table 1. *List of reasons (non-exhaustive) that contribute to added value of a travel. When planning a travel, you are invited to ask yourself these questions to estimate the added value of your travel.*

Does the travel contribute to NINA on a scientific level? (For example by contributing to the professional development of NINA employees, fostering scientific exchange, or for fieldwork.)
Does your attendance contribute to the conference, meeting or project? (For example by giving a talk, heading a conference session, participating in a panel discussion, contributing to a workshop, or presenting a poster.)
Does the travel contribute to NINA on a strategic level? (For example by positioning NINA in important topics/networks/collaborations/advisory groups.)
Does the travel contribute to the personal development of the person travelling? (For example by networking or gaining experience. This is mainly relevant for early career researchers.)
Does your attendance at the destination contribute to the local community? (For example by competence transfer to developing countries.)
Does the travel combine several meetings in one destination, nearby destinations or on the way?
Is the number of people travelling appropriate? The general recommendation is to travel with fewer people the further the distance. (For example, reconsider if it is necessary that 5 researchers from NINA attend the same conference in New Zealand.)

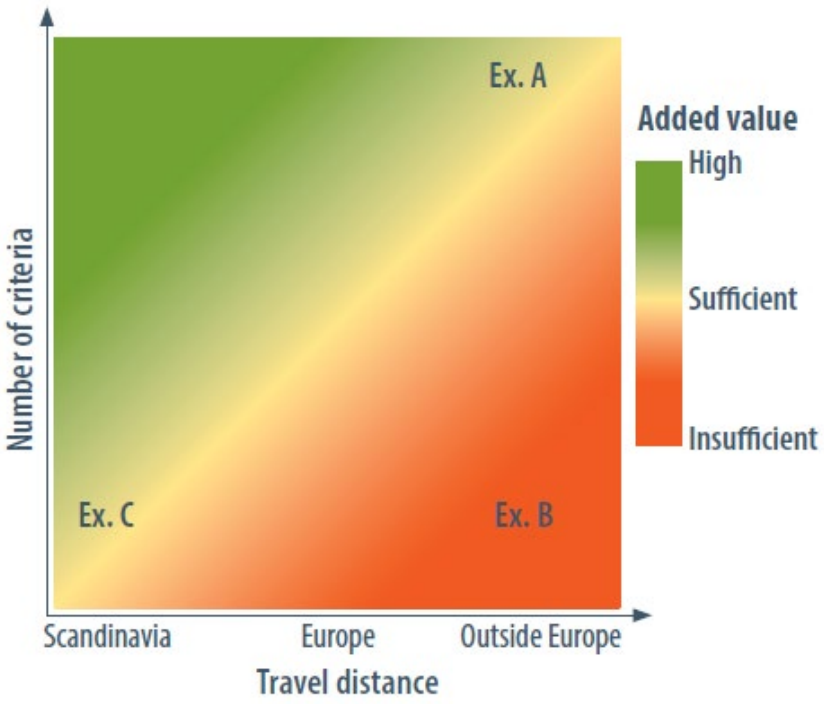

Figure 2. *Added value (scored from red to green) of travels as a function of travel distance and reasons to travel.*

An example of a travel with high added value is that of a young researcher who travels (alone) to hold a presentation of a large NINA project on a world-wide conference of experts in the field in New Zealand. Despite long travel distance, the answer to several questions in **Table 1** is "yes", and therefore the added value is relatively high (Example A in **Figure 2**). On the other hand, if the same conference is to be visited by a group of researchers who might establish important contacts there, but are not going to present their research, the added value of the travel is insufficient due to fewer positive answers in **Table 1** and long travel distance (Example B in **Figure 2**). However, if this conference rather were to happen in a nearby location, e.g. within Norway, the added value would be sufficient (Example C in **Figure 2**).

2.2 What is a "convenient" travel?

According to the decision tree (**Figure 1**), one should prefer travelling by train or bus when this is a "convenient alternative" to travelling by car, boat or plane. NINA's travel guidelines suggest to treat a train travel as convenient, when

- it takes no more than 8 hours and
- it costs no more than 1500 NOK for a day train or 2500 NOK for a night train (if it saves a night at a hotel).

NINA's travel guidelines suggest to treat a travel by bus, car or boat as convenient, when

- it takes no more than 5 hours.

The train connections Oslo–Trondheim and Bergen–Oslo take less than 8 hours, and should thus normally be preferred to plane travels between these destinations; see chapter 3 for detailed comparisons. In chapter 4 we show the "train/bus radii" around the different NINA offices, i.e. the destinations that can be reached by train and/or bus within 8 hours. For instance, a train travel from Oslo to Stockholm or Copenhagen takes approximately 8 hours (depending on the connections) and should thus normally be preferred to a plane travel.

What is convenient is ultimately subjective and depends on a number of circumstances. NINA's travel guidelines are not compulsory, but *suggest strongly* to follow the recommendations. However, anyone wanting to travel by train even when the duration is more than 8 hours, is free to make such a choice. We did not use the hourly wages as convenience criterion because it differs individually whether one can use the travelling time for working or not.

2.3 Compensation for emissions

When travelling by car, and especially when travelling by boat or plane, the greenhouse gas emissions should be compensated for. For the time being, employees are encouraged to offset their emissions individually, to submit the offset receipts with the travel expenses claim, and to include these expenses in budgets of future projects. We recommend compensation via www.myclimate.org (or www.atmosfair.de/en/). In the future, NINA will work for implementing a possibility for compensation via NINA's travel agency. In any case, compensation has to be paid via the respective project and thus needs to be taken into account during planning and budgeting.

Buying compensation for emissions, however, does not overrule the decision tree. If a travel does not have sufficient added value, it should not be undertaken. This applies especially to flights. We cannot compensate ourselves out of the fact that the overall volume of air travels has to be reduced.

3 Travels between NINA offices

In this chapter, we compare the different means of transportation between NINA offices. Variables compared are the costs in terms of money[1], time spent and CO_2-equivalents (CO_2-e) emitted. Comparisons are made for travels between Oslo and Trondheim (**Table 2**), Tromsø and Trondheim (**Table 3**), Lillehammer and Trondheim (**Table 4**), Bergen and Trondheim (**Table 5**), Lillehammer and Oslo (**Table 6**), Bergen and Oslo (**Table 7**), and Oslo and Tromsø (**Table 8**). **Figure 3** summarises the values presented in Tables 2–8 in a graph to allow for visual comparison of the magnitudes of the respective monetary, time and CO_2-e emission costs for different means of transportation. Details and sources for the calculations are provided in chapter 5.

Table 2. *Travels between* ***Oslo*** *and* ***Trondheim*** *(or vice versa, one way) with different means of transportation. Sorted by increasing CO_2-e emissions.*

Means of transportation	Price (NOK)	Time spent (h)	CO2-e emission (kg)
Staying at home	0	0	0
Bike	0	30	0
Video conference	0	0.2	0.2
Day train	250–1 100	6.5	5.5
Night train	1 200–2 200	7.5	5.5
Bus	900–1 200	9	15
Car (1 person)	450–600	7	130
Plane	1 000–2 600	4	130

Table 3. *Travels between* ***Tromsø*** *and* ***Trondheim*** *(or vice versa, one way) with different means of transportation. Sorted by increasing CO_2-e emissions.*

Means of transportation	Price (NOK)	Time spent (h)	CO_2-e emission (kg)
Staying at home	0	0	0
Bike	0	72	0
Video conference	0	0.2	0.2
Bus + night train	2 000–3 000	21	74
Plane[a]	1 000–3 600	4	180
Car (1 person)	1 200–1 500	17	270
Hurtigruten	> 3 000	50	410

[a] The values presented here are for direct flights Tromsø-Trondheim. For indirect flights (Tromsø–Oslo–Trondheim), please sum the values of the respective connections (**Table 2**, **Table 8**).

[1] Hourly wages are not included in the monetary cost as it differs individually whether one can use the travelling time for working or not.

Table 4. *Travels between* ***Lillehammer*** *and* ***Trondheim*** *(or vice versa, one way) with different means of transportation. Sorted by increasing CO_2-e emissions.*

Means of transportation	Price (NOK)	Time spent (h)	CO_2-e emission (kg)
Staying at home	0	0	0
Bike	0	20	0
Video conference	0	0.2	0.2
Day train	250–750	4.5	3.7
Night train	1 200–2 200	5	3.7
Night bus	250–750	6	10
Car (1 person)	310–520	5	85
Plane	1 200–2 900	5	130

Table 5. *Travels between* ***Bergen*** *and* ***Trondheim*** *(or vice versa, one way) with different means of transportation. Sorted by increasing CO_2-e emissions.*

Means of transportation	Price (NOK)	Time spent (h)	CO_2-e emission (kg)
Staying at home	0	0	0
Bike	0	48	0
Video conference	0	0.2	0.2
Day train	250–1 100	14	11
Night train	1 200–2 200	16	11
Bus	Not available	14	19
Plane	1 000–2 600	4	140
Car (1 person)	570–760	11	150
Hurtigruten	> 3 000	30	300

Table 6. *Travels between* ***Lillehammer*** *and* ***Oslo*** *(or vice versa, one way) with different means of transportation. Sorted by increasing CO_2-e emissions.*

Means of transportation	Price (NOK)	Time spent (h)	CO_2-e emission (kg)
Staying at home	0	0	0
Bike	0	10	0
Video conference	0	0.2	0.2
Day train	250–450	2.3	1.8
Bus	410	2.7	5.0
Car (1 person)	290–340	2.5	44

Table 7. *Travels between* ***Bergen*** *and* ***Oslo*** *(or vice versa, one way) with different means of transportation. Sorted by increasing CO_2-e emissions.*

Means of transportation	Price (NOK)	Time spent (h)	CO_2-e emission (kg)
Staying at home	0	0	0
Bike	0	36	0
Video conference	0	0.2	0.2
Day train	250–1 100	6.5	5.3
Night train	1 200–2 200	7.5	5.3
Bus	750–1 100	10	12
Car (1 person)	640–780	7	110
Plane	1 000–2 600	4	120

Table 8. *Travels between* ***Tromsø*** *and* ***Oslo*** *(or vice versa, one way) with different means of transportation. Sorted by increasing CO_2-e emissions.*

Means of transportation	Price (NOK)	Time spent (h)	CO_2-e emission (kg)
Staying at home	0	0	0
Bike	0	102	0
Video conference	0	0.2	0.2
Bus + (night) train	3 000–4 000	28	80
Plane	1 000–3 600	4	230
Car (1 person)	1 700–2 200	24	390

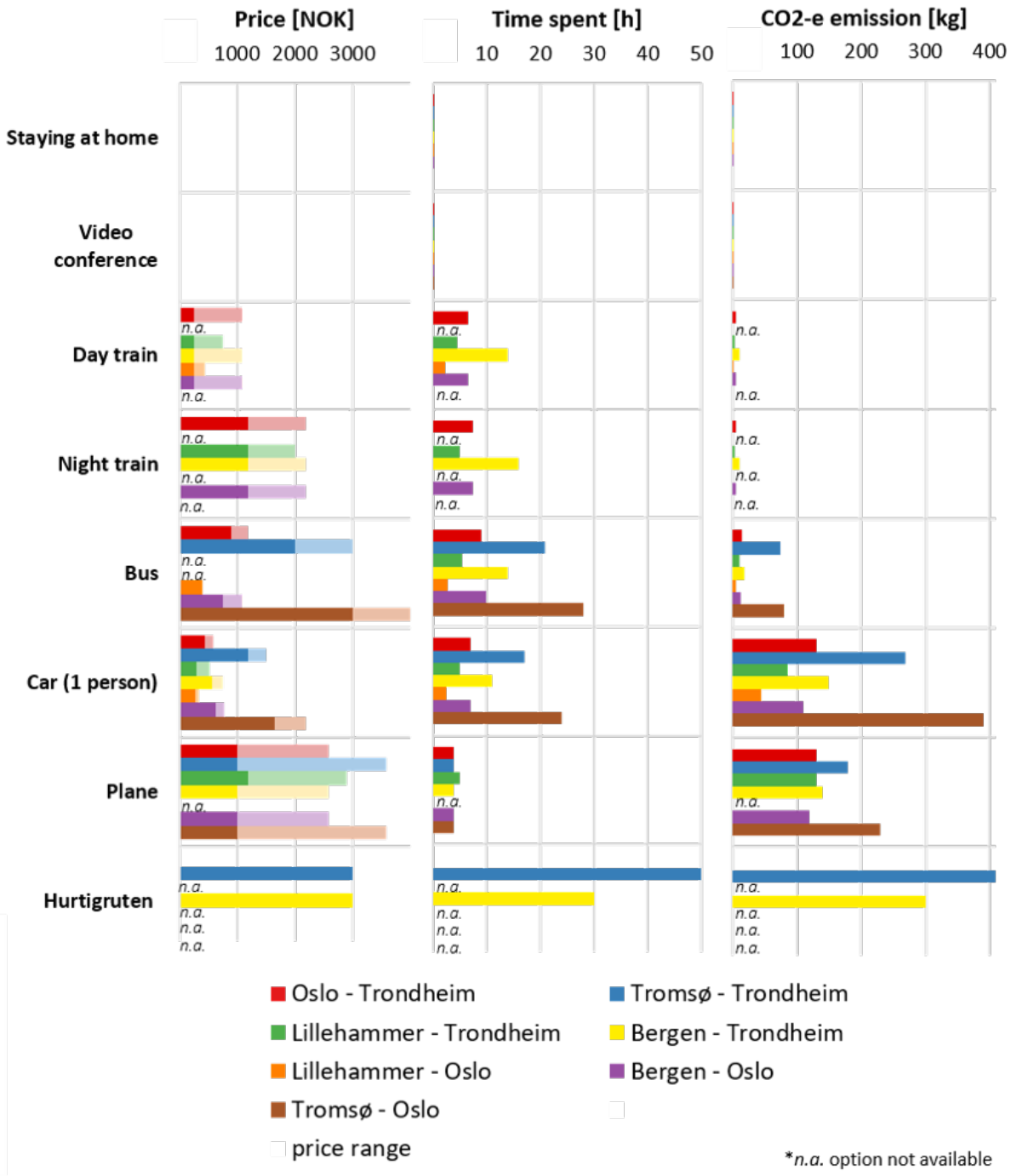

Figure 3. *Comparison of travels between NINA offices (one way) by different means of transportation and different travel costs.*

4 Train/bus radii around NINA offices

As mentioned in chapter 2.2, NINA's travel guidelines suggest an 8-hour train journey as a convenient alternative to car, boat or plane travels. We have therefore created maps to visualize areas which are accessible within an 8-hour train journey from the NINA offices in Trondheim, Oslo, Tromsø, Lillehammer and Bergen (**Figure 4**).

The underlying railway network is represented by Open Street Map dataset of railways (fclass = 'rail'). To select the segments of railways accessible within 8 hours by train, we used the Rail Planner App from Eurail[2] and manually searched for various connections to localities within 8 hours distance (at least one connection in two upcoming days) from the respective NINA office. This manual search was carried out in March 2020. To express uncertainty, as well as accessible areas in the vicinity of railways, we further included a 25 km buffer around the accessible railways. The maps further illustrate the location of all NINA offices as well as other major towns.

For the NINA office in Tromsø, we also included destinations accessible by bus, because Tromsø is not connected to the Scandinavian railway network. The accessible area was then manually delineated.

[2] https://www.eurail.com/en/plan-your-trip/rail-planner-app

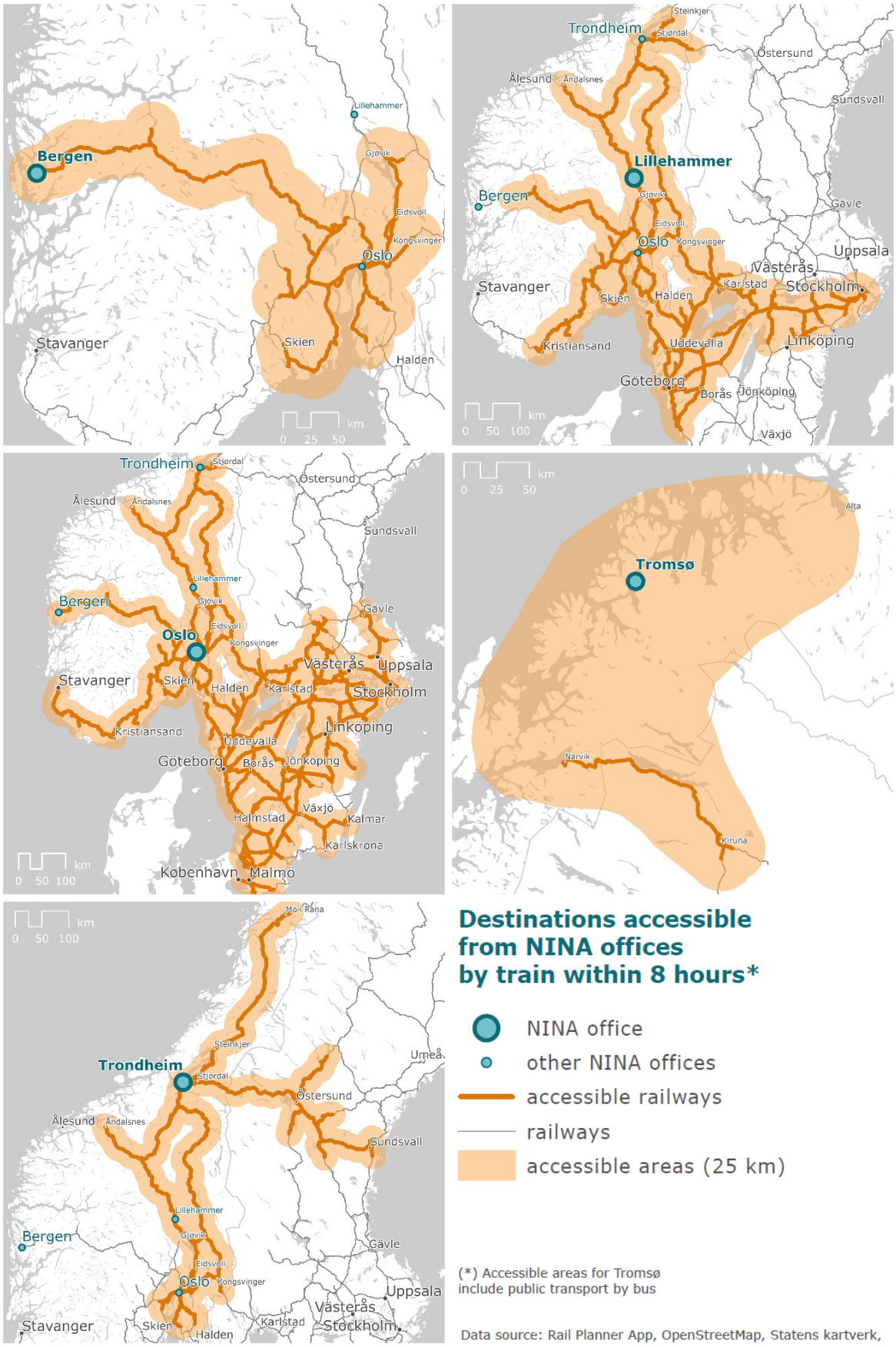

Figure 4. *Destinations accessible from NINA offices by train (or bus) within eight hours.*

5 Background

5.1 Air travels by NINA employees in 2019

As a description of the status quo and the potential and need for change, one can consider the flights travelled by NINA employees in 2019, which are summarised in **Table 9**. At least two interesting observations can be made:

- The single most flown distance (Oslo–Trondheim and vice versa) is between two cities that have a well-functioning train connection.
- A few flights to/from Southern Africa or South America have emissions comparable to 100 domestic flights.

Table 9. *Top 10 flights at NINA in 2019, sorted by decreasing cumulative CO_2-e emissions. Flights in both directions are counted, the number of flights is for one way (only flights booked through G-Travel are included; data provided by G-Travel). Emissions of CO_2-equivalents (CO_2-e) are estimated according to chapter 5.3.5.*

Flights	CO_2-e emissions (t)	Number of travels
Oslo–Trondheim	57.4	445
Tromsø–Trondheim	24.5	133
Bergen–Trondheim	21.0	148
Oslo–Tromsø	14.4	63
Kilimanjaro–Trondheim	13.9	10
Brussel–Trondheim	13.6	38
Windhoek–Trondheim	13.3	8
Astana–Trondheim	13.2	12
Cape Town–Trondheim	12.0	6
San José–Trondheim	10.8	6
...		
Total	**462.1**	**1666**

5.2 Decision tree

NINA's decision tree was inspired by the "Guide to responsible travel" developed at the University of Antwerp and "De Groene Locomotief" of the University of Ghent (see Universiteit Antwerpen 2018, Universiteit Gent 2020). Included means of transport are train, bus, car and plane. We also include long-distance passenger boats – i.e. we consider only Hurtigbåt/Hurtigruten and other boats which represent an actual alternative to other travel options.

The main sorting criterion is the CO_2 emissions of the different means of transportation. Transportation with lower emissions is generally preferred to transportation with higher emissions. Because emissions from passenger boats are comparable to, or even higher than the emissions from planes, while rarely being available for the same distances, in the decision tree we placed boat alongside plane.

5.3 Calculations

We here provide the details behind the tables in chapter 3, i.e. the sources of prices, travels durations and carbon footprints (all rounded to max. two significant digits). Estimates of CO_2-e emissions for means of transportation vary widely among sources. This is due to a number of reasons: The most important are the technological variability within each means of transportation (e.g. between different car brands), the kinds of emissions considered (transportation, production, maintenance etc.) and the greenhouse gases included. Beyond CO_2, other gases are incorporated after converting them to "CO_2-equivalents" (CO_2-e), according to their global warming potential. We have used Larson and Kamb (2019) as our main source, but see e.g. Simonsen (2010, Simonsen & Walnum 2011) for a different approach. Figures provided in chapter 3 should thus be considered as merely rough averages.

5.3.1 Video conference

The CO_2-e emissions of a video conference depend largely on the technical equipment at both ends, and in addition on the bandwidth used. Our estimates were based on a standard NINA meeting room, where the technical equipment has an effect of c. 340 W (2 screens at 135 W plus a video-conference unit at 70 W; NINA IT Dept., pers. comm.), at each end. We assumed an average bandwidth of 1.0 Mb s^{-1} ≈ 0.44 GB h^{-1} and an average electricity intensity for data transmission of 60 Wh GB^{-1} (Aslan et al. 2017), yielding an effect of 26 W. CO_2-emissions were based on the use of an average European energy mix (290 g CO_2 kWh^{-1}; EEA 2018). The emissions thus amount to ca. 100 g CO_2 per meeting-hour per endpoint. The numbers in Tables 2–8 in chapter 3 represent meetings between two endpoints and lasting one hour. We assumed the extra time for setting up the meeting in a conference room to be 6 min (0.1 h).

5.3.2 Train

Prices for train tickets and duration of connections were obtained from Vy (www.vy.no) in February 2020. Ticket prices started at 250 NOK (minipris) if tickets were purchased well in advance. Maximum ticket prices were last-minute purchases. For the night-train option, 980 NOK for the sleeping compartment was added. CO_2-e emissions were based on an average estimate of 10 g CO_2-e km^{-1} $passenger^{-1}$ for Nordic electric trains (Larson & Kamb 2019 and references therein). Railway distances are 527 km for Bergen–Oslo, 184 km for Oslo–Lillehammer, and 369 km for Lillehammer–Trondheim (www.banenor.no); estimates for Oslo–Trondheim apply to Dovrebanen. See below for Nordlandsbanen (Trondheim–Fauske).

5.3.3 Bus

Prices for and durations of bus connections were obtained from Nettbus, Vy and Nor-Way in February 2020. Emissions were based on an average estimate of 27 g CO_2-e km^{-1} $passenger^{-1}$ for diesel buses, assuming 60% passenger load (Larson & Kamb 2019 and references therein). Bus distances are 462 km for Bergen–Oslo, 185 km for Oslo–Lillehammer, and 355 km for Lillehammer–Trondheim (Google Maps); estimates for Oslo–Trondheim are made for the E6.

For the route between Trondheim and Tromsø with train and bus, the connection consists of three legs: from Trondheim to Fauske by train (Vy; 1230–2180 NOK, 9:11 h travel time), from Fauske to Narvik by bus (Nordlandsbuss; 457 NOK; 4:35 h travel time) and from Narvik to Tromsø by bus (Troms fylkestrafikk; 322 NOK; 4:18 h travel time). Waiting times of 2.5 hours have been added. Emissions were based on 91 g CO_2-e km^{-1} $passenger^{-1}$ for a diesel train (Larson & Kamb 2019 and references therein) on the distance of 674 km (BaneNor), and 27 g CO_2-e km^{-1} $passenger^{-1}$ for a diesel bus (see above) on the distance of 480 km (Google Maps).

5.3.4 Car

For car transport, we based our calculations on a medium-sized petrol car, filled with one person (the driver). For the prices, we provided the range between 0.8 NOK km^{-1} and 1.1 NOK km^{-1} (corresponding to e.g. petrol consumptions from 5.5 to 6.5 litres per 100 km and petrol prices of 14.5 to 17.0 NOK per litre). Distances and driving duration were extracted from Google Maps. Toll costs were extracted for each of the routes from www.fjellinjen.no. CO_2-e emissions were based on an average estimate of 239 g CO_2-e km^{-1} for a medium-sized petrol car with one person (Larson & Kamb 2019 and references therein). The estimate is very dependent on the type of car, e.g. larger cars have higher emissions (mainly proportional to the petrol consumption per kilometre), whereas other fuel types have lower emissions (e.g. diesel, 157 g CO_2-e km^{-1}; electric, 19 g CO_2-e km^{-1}; Larson & Kamb 2019 and references therein).

5.3.5 Plane

We obtained price ranges and durations of flights from G-Travel. In addition, prices and time for connections to and from the respective airports were added as obtained from Flytoget, Vy and AtB, viz. 1 hour for Trondheim-Værnes, 40 min for Oslo-Gardermoen, 1 hour for Bergen-Flesland and 30 min for Tromsø-Langnes. We added an additional waiting time of 1 hour at the airport pre-departure (based on our own experience with the time needed for check-in and security checks). CO_2-e emissions were based on the exact connections as calculated on www.myclimate.org. Greenhouse gas emissions from planes vary with a number of factors and are not a linear function of the distance flown (see e.g. Larson & Kamb 2019, Myclimate 2019). Emissions are highest during take-off, which is why short-distance flights and stop-over flights have higher relative emissions per kilometre. In addition, emissions vary with plane type, flight height, passenger load, seating class etc. Carbon emissions for transport to/from the airport were not considered in the calculations.

5.3.6 Hurtigruten

Prices and durations were obtained from Hurtigruten (www.hurtigruten.no). Prices vary grossly across seasons and cabin categories. Durations are provided as the averages for north- and southbound travels. Emissions were based on an estimate of 394 g CO_2-e km^{-1} $passenger^{-1}$ (Aas 2019), and distances of 753 km between Bergen and Trondheim (average for summer and winter route, which includes and excludes a 115 km detour, respectively) and 1043 km between Trondheim and Tromsø.

5.3.7 Bike

The connection by bicycle was added to give a perspective of the distances between different NINA offices and the duration in the form of travel many of us are very familiar with. The durations were obtained from Google Maps.

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NINA Report

The Norwegian Institute for Nature Research, NINA,
is as an independent foundation focusing on environmental research, emphasizing the interaction between human society, natural resources and biodiversity.

NINA was established in 1988. The headquarters are located in Trondheim, with branches in Tromsø, Lillehammer, Bergen and Oslo. In addition, NINA owns and runs the aquatic research station for wild fish at Ims in Rogaland and the arctic fox breeding center at Oppdal.

NINA's activities include research, environmental impact assessments, environmental monitoring, counselling and evaluation. NINA's scientists come from a wide range of disciplinary backgrounds that include biologists, geographers, geneticists, social scientists, sociologists and more. We have a broad-based expertise on the genetic, population, species, ecosystem and landscape level, in terrestrial, freshwater and coastal marine ecosystems.

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