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Public Service Obligation as a tool for implementing flight routes operated by electric aircrafts

Gisle Solvoll
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Interreg Botnia-Atlantica
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Sammendrag

Hovedformålet med denne rapporten er å undersøke hvilke erfaringer myndighetene kan ta med seg fra prosessen med innføring av nullutslippsfartøy i fergedriften i Norge når de gjennom kjøp av flyruter (FOT-ruter) skal legge til rette for at fly som får energien fra batterier eller andre nullutslippskilder skal kunne erstatte fly som benytter fossilt drivstoff.
For å tilrettelegge for bruk av elektriske fly på disse rutene er det, basert på erfaringene fra fergeanbudene, viktig at Samferdsels-departementet, foretar en kartlegging av strømforsyning og strømbehovet for alle flyplassene, involverer Avinor, Luftfartstilsynet og sikkerhetsmyndighetene, innleder en dialog med leverandører og underleverandører til luftfartsnæringen og starter arbeidet med utforming av nye anbudskontrakter.

Emneord

Luftfart
Elektriske fly
Null-utslippsferger
Offentlig tjenesteyting
Anbud

Summary

The main aim of this report is to investigate what experiences the authorities can draw from the recent process of introducing zero-emission vessels in ferry operations in Norway when, in purchasing air routes (PSO routes), they facilitate the replacement of aircraft powered by fossil fuels with ones that receive their energy from batteries or other zero-emission sources.
In order to facilitate the use of electric aircraft on these routes, it is important that the Ministry of Transport, conducts a survey of power supply and power requirements for the airports, involves the airport owner and the safety authorities, initiates a dialogue with airlines, suppliers and subcontractors to the aviation industry and starts working on the design of new tender contracts.

Keywords

Aviation
Electric planes
Zero-emission ferries
Public service obligation
Tenders

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PREFACE

This report forms part of the FAIR (Finding Innovations to Accelerate Implementation of Electric Regional Aviation) project. FAIR has developed methods and insights to support an early and efficient commercialisation of electric-powered regional flights in the Botnia Atlantica region.

FAIR has had a broad partnership of participants. The Kvarken Council has been the owner and coordinator of the project. FAIR has been financed by Interreg Botnia Atlantica, Region Västerbotten, Regional Council of Ostrobothnia, City of Vaasa, FAB Kronoby Flyghangar, Into Seinäjoki Oy, Lycksele Flygplats AB, MidtSkandia, Ostrobothnia Chamber of Commerce, Skellefteå City Airport AB, Skellefteå Kraft AB, South Ostrobothnia Chamber of Commerce, Storumans Kommunföretag AB, Swedavia Umeå Airport, Umeå Municipality, Vaasan Sähkö Oy, Vaasa Region Development Company (VASEK), Västerbotten Chamber of Commerce, Örnsköldsvik Airport AB, Alstahaug Municipality, Brønnøy Municipality, Helgeland Regional Council, Inner Helgeland Regional Council, Nordland County Council and Rana Utvikling.

Beneficiaries have been the Kvarken Council (Lead part), BioFuel Region (BFR AB), Region Västerbotten, RISE (Research Institutes of Sweden), Umeå University, Nord University and University of Vaasa.

The daily management of FAIR, on behalf of the Kvarken Council, has been carried out by Tyréns in Umeå, under the excellent guidance of Andreas Forsgren and Isak Brändström.

Bodø, July 2022

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SUMMARY

The main aim of this report is to investigate what experiences the authorities can draw from the recent process of introducing zero-emission vessels in ferry operations in Norway when, in purchasing air routes (PSO routes), they facilitate the replacement of aircraft powered by fossil fuels with ones that receive their energy from batteries or other zero-emission sources.

Airports and flight route purchases in Norway

The state-owned company Avinor owns and operates 44 airports in Norway. In addition, there is scheduled traffic at two airports that are not owned by Avinor. The airports' runways have very different lengths; 53% of them have runways that are shorter than 1,000 metres. The largest of Avinor's airports made a profit in 2019, and part of this profit is used to cover the deficit at their small regional airports. This cross-subsidisation system is referred to as the Avinor model.

Norway is a country that is well suited to the introduction of first-generation electric aircraft, which will have up to 19 seats. The country has many airports with short runways, good flight connections between the airports and a strong public commitment in respect of the purchase of regional flights.

The Norwegian Ministry of Transport purchases flight route services in areas where the quality of transport is poor and an appropriate flight route service cannot be established on commercial terms. The airline that wins the tender competition will have the exclusive right to operate the routes for a period of 4 years in southern Norway and 5 years in northern Norway.

Since the first tenders in the late 1990s, Widerøe has been the dominant service provider for the PSO routes in Norway. For the period 1 April 2022 to 31 March 2023, the Ministry of Transport will purchase air routes to a value of NOK 893 million. About 80% of the financial compensation is given to scheduled operations in northern Norway. The PSO routes are of great importance for the quality of transport in the rural areas and are considered by many to be an important regional policy instrument.

Airports and flight route purchases in Sweden

In Sweden, there are 39 airports with scheduled or charter traffic. 10 of these airports are owned and operated by the state-owned company Swedavia. The airports in Sweden are divided into the categories of strategic national airports, strategic regional airports and other airports. Like Avinor, Swedavia also practises cross-subsidisation between its profitable and unprofitable airports. The Swedish state provides financial support to airports that are not owned by Swedavia. Strategic national airports have their entire deficit covered, strategic regional airports have 75% of their deficit covered. The other airports do not receive government support.

The Swedish Transport Administration is responsible for governmental purchases of flight route services in areas where other public transport services are considered to be insufficient. The purchases amounted to an annual average of SEK 95 million in the period 2008–2018. From 2019 to 2023, the procurement includes 11 PSO routes, of which 9 are routes to/from Arlanda.

Tendering in Norwegian domestic ferry operations

Purchases of ferry routes in Norway began back in 1994. The tender regime led to a consolidation of the shipping companies, such that in 2022 there are 4 dominant ferry companies in Norway: Torghatten, Fjord1, Norled and Boreal.

The process of electrifying ferry operations started in 2010 as an initiative of the Norwegian Public Roads Administration (NPRA) and NHO Sjøfart. NPRA and NHO, together with their members, discussed the possibilities of requiring more environmentally friendly ferry designs in the tenders to achieve energy and environmental benefits. NPRA realised that tender contracts where the shipping companies competed only on price failed to achieve the implementation of new "green" technologies in the industry.

The politicians took this idea on board, and in the state budget for 2011 it was decided that the Lavik – Oppedal connection should be announced as a development contract, where the industry should be invited to compete for the delivery of the most energy and environmentally efficient ferry. The procurement was organised under the "competitive dialogue" procurement procedure. All four ferry companies in Norway participated in the competition, each proposing 3-4 concepts for how the connection could be operated.

In the dialogue phase, NPRA was very concerned that the providers (shipping companies) should be able to document that they had collaborated with potential suppliers on the management, build and approval of the development ferry and the associated charging infrastructure. The Norled shipping company won the tender competition with the battery-electric ferry Ampere, which was built at Fjellstrand shipyard in Hardanger.

After this first environmental tender, the focus increased on reducing emissions from ferry operations, and in the state budget for 2015, the Storting (the Norwegian Parliament) asked the Government to ensure that all new ferry tenders had low-emission technology or zero-emission technology when this became available.

In 2015, NPRA expected that, by 2030, two thirds of the energy needed to operate the ferries would come from the electricity grid. The remaining energy sources should be

biodiesel, natural gas and hydrogen. In 2022, NPRA stated that this forecast was too pessimistic, but they have not published any new estimates.

The transfer value of ferry services to the electrification of aviation

Although ferry operations and aviation are very different in terms of both the means of transport itself and the requirements for necessary terminal facilities, there is much that aviation can learn from the reorganisation of the ferry services.

Most regional airports in Norway have short runways, where only small aircraft with STOL capability can land and take off. Since the initial alternatives to fossil fuel planes will only be appropriate for small aircraft (up to 19 seats), the short-haul network in Norway will be well suited to the introduction and use of first-generation electric aircraft.

The suitability of the regional air routes in Norway, the PSO routes, for the introduction of electric aircraft is also underpinned by the fact that the airports are owned by the same owner, Avinor, which will probably make it easier to establish the necessary energy solutions (charging infrastructure), as well as the broad political support that exists for efforts to make aviation more environmentally friendly. Thus, future tenders can be one of a number of instruments for testing new aircraft types.

In order to facilitate the use of electric aircraft on the regional flight route network in Norway, based on experiences from the ferry tenders, it will be important for the Ministry of Transport to: (1) conduct a survey of power supply and power requirements for all airports in Norway, (2) involve Avinor and the safety authorities, (3) initiate a dialogue with suppliers and subcontractors to the aviation industry and (4) start working on the design of new tender contracts.

SAMMENDRAG

Hovedformålet med denne rapporten er å undersøke hvilke erfaringer myndighetene kan ta med seg fra prosessen med innføring av nullutslippsfartøy i fergedriften i Norge når de gjennom kjøp av flyruter (FOT-ruter) skal legge til rette for at fly som får energien fra batterier eller andre nullutslippskilder skal kunne erstatte fly som benytter fossilt drivstoff.

Lufthavner og flyrutekjøp i Norge

Det statseide selskapet Avinor eier og driver 44 lufthavner i Norge. I tillegg er det flyrutedrift på to lufthavner som ikke er eid av Avinor. Rullebanene har svært ulik lengde. 53 % av lufthavnene har rullebaner som er kortere enn 1 000 meter. De største lufthavnene gikk i 2019 med overskudd, og deler av dette overskuddet brukes til å dekke underskuddet på små regionale lufthavnene. Dette systemet omtales som Avinor-modellen.

Norge er et land som egner seg godt for innføring av førstegenerasjons elektriske fly. Dette vil være fly med inntil 19 seter. Landet har mange lufthavner med korte rullebaner, gode flyruteforbindelser mellom lufthavnene og et sterkt offentlig engasjement knyttet til kjøp av regionale flyruter.

Samferdselsdepartementet i Norge kjøper flyrutetjenester i områder hvor transportstandarden er dårlig og et hensiktsmessig flyrutetilbud ikke kan etableres på kommersielle vilkår. Flyselskapet som vinner anbudskonkurransen får enerett til å operere rutene i en periode på 4 år i Sør-Norge og 5 år i Nord-Norge.

Widerøe har siden de første anbudene på slutten av 1990-tallet vært den dominerende aktøren på FOT-rutene i Norge. For perioden 1. april 2022 til 31. mars 2023 kjøper

Samferdselsdepartementet flyruter for NOK 893 millioner kroner. Om lag 80 % av den økonomiske kompensasjonen gis til rutedriften i Nord-Norge. FOT-rutene har stor betydning for transportstandarden i distriktene og anses av mange som et viktig distriktspolitisk virkemiddel.

Lufthavner og flyrutekjøp i Sverige

I Sverige er det 39 lufthavner med rute- eller chartertrafikk. 10 av disse lufthavnene eies og drives av det statseide selskapet Swedavia. Lufthavnene i Sverige deles inn i kategoriene strategiske nasjonale lufthavner, strategiske regionale lufthavner og andre lufthavner. Som Avinor, praktiserer også Swedavia kryssubsidiering mellom sine lønnsomme og ulønnsomme lufthavner. Den svenske stat gir økonomisk støtte til lufthavnene som ikke eies av Swedavia. Strategiske nasjonale lufthavner får dekket hele sitt underskudd, strategiske regionale lufthavner får dekket 75 % av sitt underskudd. De andre lufthavnene mottar ikke statlige tilskudd.

Trafikverket i Sverige er ansvarlig for statlige kjøp av flyrutetjenester i områder der annet kollektivtilbud vurderes å ikke gi et tilstrekkelig tilbud. Kjøpene utgjorde i gjennomsnitt SEK 95 millioner per år i perioden 2008 – 2018. Fra 2019 til 2023 omfatter anskaffelsen 11 FOT-ruter, hvorav 9 er ruter til/fra Arlanda.

Anbud i norsk innenlandsk fergedrift

Kjøp av fergeruter i Norge startet i 1994. Anbudsregimet førte til en konsolidering av rederiene slik at det i 2022 er 4 dominerende fergerederier i Norge. Dette er Torghatten, Fjord1, Norled og Boreal.

Prosessen med å elektrifisere fergedriften startet i 2010 som et initiativ fra Statens vegvesen og NHO Sjøfart. Statens vegvesen og NHO sammen med sine medlemmer diskuterte mulighetene for å kreve mer miljøvennlige ferjedesign i anbudene for å oppnå

energi- og miljøgevinster. Statens vegvesen innså at anbudskontrakter der rederiene kun konkurrerte på pris, ikke klarte å oppnå implementering av nye «grønne» teknologier i næringen.

Politikerne mente dette var en god idé, og i statsbudsjettet for 2011 ble det vedtatt at sambandet Lavik–Oppedal skulle lyses ut som en utviklingskontrakt, der næringen skulle inviteres til å konkurrere om leveransen av den mest energi- og miljøeffektive fergen. Anskaffelsen ble organisert i henhold til innkjøpsprosedyren «konkurransepreget dialog». Alle de fire fergerederiene i Norge deltok i konkurransen, der hver av dem kom med 3-4 skisser for hvordan sambandet kunne driftes.

I dialogfasen var Statens vegvesen svært opptatt av at tilbyderne (rederiene) kunne dokumentere at de samarbeidet med selskaper som gjorde at de kunne klare og få bygget og godkjent utviklingsfergen med tilhørende ladeinfrastruktur. Rederiet Norled vant anbudskonkurransen med den batterielektriske fergen Ampere som ble bygget ved Fjellstrand verft i Hardanger.

Etter det første miljøanbudet økte fokuset på å redusere utslippene fra fergedriften, og i statsbudsjettet for 2015 ba Stortinget Regjeringen sørge for at alle nye ferjeanbud hadde lavutslippsteknologi eller nullutslippsteknologi når denne teknologien er tilgjengelig.

I 2015 forventet Statens vegvesen at innen 2030 skulle to tredjedeler av energien som trengs til å drifte fergene komme fra det elektrisitetsnettet. De resterende energikildene bør være biodiesel, naturgass og hydrogen. I 2022 uttalte Statens vegvesen at denne prognosen var for pessimistisk, men de har ikke gjort noe nytt anslag.

Fergeanbudenes overføringsverdi til elektrifiseringen av luftfarten

Selv om fergedrift og luftfart er svært forskjellig både med hensyn til selve transportmidlene og krav til nødvendige terminalfasiliteter, er det mye luftfarten kan lære fra omleggingen av fergeanbudene.

De fleste regionale flyplassene i Norge har korte rullebaner, hvor kun små fly med STOL-egenskaper kan lande på og ta av. Siden alternativer til fossilt brensel vil først bli aktuelle på små fly (opp til 19 seter) vil kortbanenettet i Norge egne seg godt for bruk av førstegenerasjons elektriske fly.

At flyplassene eies av Avinor vil sannsynligvis gjøre det enklere å etablere nødvendige energiløsninger (ladeinfrastruktur) på lufthavnene. Når vi også tar i betraktning at det er bred politisk støtte knyttet til arbeidet med å gjøre luftfarten mer miljøvennlig, bør de regionale flyrutene i Norge, FOT-rutene, være godt egnet for innføring av elektriske fly. Dermed kan fremtidige anbudsutlysninger bli ett av flere virkemidler for å teste ut nye flytyper.

For å tilrettelegge for bruk av elektriske fly på det regionale flyrutenettverket i Norge er det, basert på erfaringene fra fergeanbudene, viktig at Samferdselsdepartementet, (1) foretar en kartlegging av strømforsyning og strømbehovet for alle flyplasser i Norge, (2) involverer Avinor, Luftfartstilsynet og sikkerhetsmyndighetene, (3) innleder en dialog med leverandører og underleverandører til luftfartsnæringen og (4) starter arbeidet med utforming av nye anbudskontrakter.

1. INTRODUCTION

This chapter presents the background, purpose and structure of the report.

1.1 Background

Recent years have seen an increasing focus on climate change, to which greenhouse gas emissions from human activities have contributed. To reduce these emissions, the Paris Agreement was adopted on 12 December 2015, and was ratified by Norway on 22 April 2016. Through this agreement, Norway has committed to reducing greenhouse gas emissions. The agreement will underpin increased efforts on emission reductions, and strengthen the work on climate adaptation. It provides a clear direction for future climate work and contains obligations to increase efforts over time.

Norway has undertaken a conditional commitment of a reduction in greenhouse gas emissions (CO_2 equivalents) of at least 40% in 2030 compared with 1990, Meld. St. 13 (2014–2015). Transport is one of the sectors where CO_2 emissions are to be cut, and some of the emission cuts are expected to come from within aviation.

In 2019, the transport sector accounted for about 1/3 of Norway's greenhouse gas emissions. Aviation contributed 5.5% of greenhouse gas emissions, divided into 2.2% and 3.3% for domestic and international traffic, respectively. Avinor, which owns and operates 44 airports in Norway, aims to ensure that their airport operations are fossil-free by 2030. They will achieve this through various measures; see Figure 1-1.

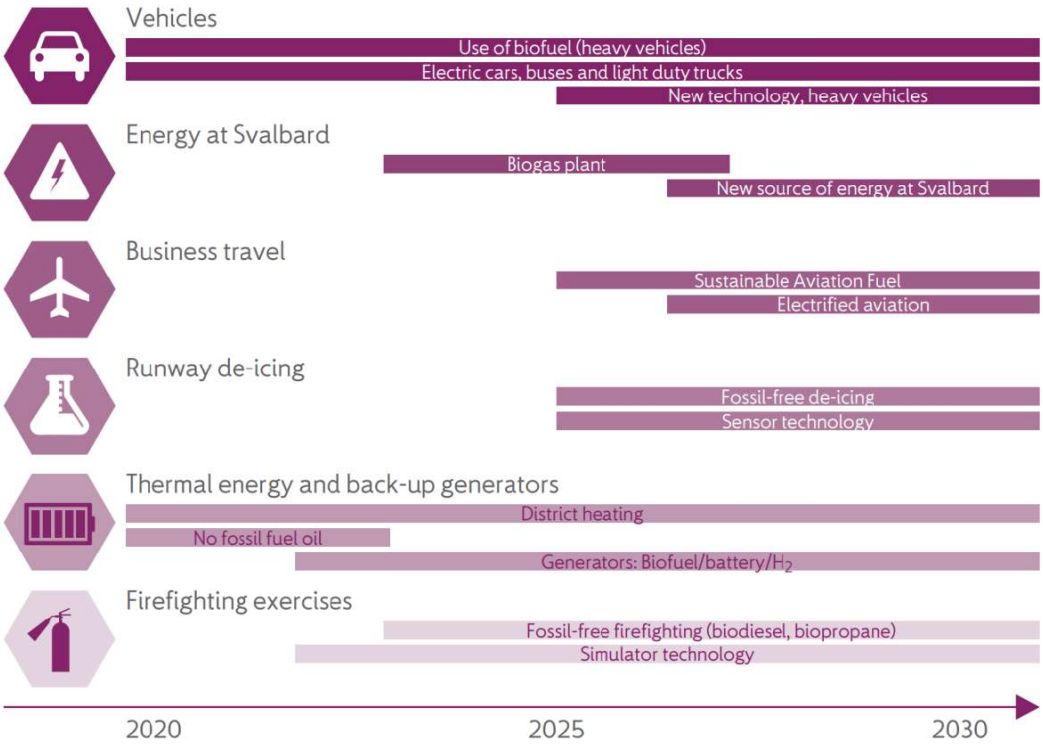

Figure 1-1: Roadmap to fossil-free airport operations. (Source: Olav Mosvold Larsen, Avinor).

Norwegian aviation aims to be fossil-free by 2050. This goal, and a roadmap for its achievement, has been agreed on by SAS, Widerøe, Norwegian, Avinor, LO and NHO-aviation (Avinor et al., 2021). This means that, by 2050, fossil fuels will not be used on flights to and from Norway. This will be a demanding task for an industry characterised by fierce international competition (Avinor & Luftfartstilsynet, 2020).

There are various measures that must be implemented to achieve the goal of fossil-free aviation (Wangsness et al., 2021). Many of these require the use of technological solutions that already exist. This applies to the introduction of more energy-efficient aircraft, the use of more sustainable fuel (biofuel), the use of hydrogen as an energy carrier, the efficiency of the individual flights and the use of the airspace and, last but

not least, the development of electric aircraft. To succeed, the authorities and the industry must work together towards common goals (Ydersbond & Amundsen, 2020).

The problems of introducing fossil-free aviation on routes in the Botnia Atlantica region are discussed by Westin (2021). Among other things, he has studied the possibility of establishing regional commuter flights over the Kvarken Strait (between Vaasa and Umeå/Skellefteå/Örnsköldsvik) with aircraft based on an electric powertrain.

Norway is in many ways well suited for the use of electric aircraft (Ydersbond & Amundsen, 2019). The country has a large network of airports, see Figure 2-1, with many short flight routes. 85% of the flights are less than 500 km and 75% of the flight routes of the dominant player on the regional routes, Widerøe, are shorter than 300 km. Through long-term and strong government involvement in the purchase of flight services through a public service obligation (PSO) and competitive tendering of flight routes, a market for short flights with small aircraft has been established, especially in the northern and western parts of Norway. Most of the aircraft that operate the PSO routes must be approved for STOL operations, since many of the regional airports in the rural areas of Norway have runways shorter than 1,000 metres; see Figure 2-2.

For these reasons, Norway would be well suited as a first market and an innovation arena for the introduction and use of first-generation electric aircraft. These will be aircraft with up to 19 seats. Many of the routes serve places with few inhabitants and thus few travellers, which makes the use of small aircraft appropriate. In addition to their STOL requirements, the airports also have the same owner, Avinor, which makes it easier to establish necessary energy solutions (charging infrastructure and hydrogen logistics). Furthermore, electric energy production in Norway is based on 99.8% renewable energy (hydropower and wind power). Finally, it can be mentioned that there is broad political support for efforts to make aviation more environmentally friendly.

1.2 Purpose

The main aim of this report is to examine what experiences the authorities can draw on from the recent transition to zero-emission vessels in ferry operations in Norway when, through the purchase of air routes (PSO routes), they provide support to the shift from fossil-fuelled aircraft to aircraft powered from batteries or other zero-emission sources.

We will first explain how the purchase of flight routes (PSO routes) in Norway takes place and what criteria the authorities use to assess the scope of such purchases. Secondly, we will describe how the authorities have proceeded in the work of implementing zero-emission vessels in ferry operations in Norway.

Both of these points are important to examine in relation to issues concerning the commercial use of electric aircraft. It is reasonable to believe that the authorities' strategy for purchasing flight route services could be of great importance for the introduction of electric aircraft to Norway. At the same time, it is important to draw lessons from the introduction of environmentally friendly means of transport in a sector, i.e. ferry services, that has historically produced significant emissions of greenhouse gases, and where the “green shift” has come a long way.

The following questions will be addressed:

1. Which criteria are used in Norway when deciding whether a flight route should be put out to tender or not?
2. How is the PSO-route network in Norway structured?
3. How has the implementation of zero-emission ferries in Norway proceeded?
4. What can we learn from the experience of moving from diesel vessels to zero-emission vessels in the ferry sector that may bear on the introduction of electric aircraft?

1.3 Structure of the report

The remainder of this report is structured as follows. Initially, in Chapter 2, we provide a general description of aviation in Norway in terms of organisation, airport structure, the regional airline network and Avinor's role as airport owner. Chapter 3 gives a short description of the history of the tendering of regional flight routes (PSO routes) in Norway, and of the process and criteria used by the Ministry of Transport in purchasing PSO routes. Chapter 4 presents a short description of aviation in Sweden covering airports, their organisation and financing, and the purchase of flight routes. Chapter 5 investigates experiences of the environmental tendering of the Norwegian ferry services. In Chapter 6, we discuss, on the basis of experiences drawn from the ferry sector, implications for the purchase of flight routes using electric aircraft. Finally, in Chapter 7, we summarise the findings and draw some conclusions.

2. THE ORGANISATION OF AVIATION IN NORWAY

In this chapter, we provide a general description of aviation in Norway in terms of organisation, airport structure, the regional airline network and Avinor's role as airport owner.

2.1 Introduction

In Norway, the state-owned company Avinor operates 44 airports, 12 of them in collaboration with the Armed Forces. In addition, in 2022, there is scheduled traffic at two privately owned airports, of which Sandefjord Airport, Torp (TRF) is the largest measured by the number of passengers. See Figure 2-1.

In 2019, 12 of the airports had direct international routes. Oslo Airport Gardermoen (OSL) is the hub of the Norwegian airport system, with about 50% of the number of terminal passengers. The domestic routes in Norway are mainly operated by SAS, Norwegian, Flyr and Widerøe. SAS and Norwegian are the dominant players on the routes between the largest airports, while Widerøe is dominant on the regional routes, several of which are operated on contract with the Ministry of Transport and Communications (i.e. PSO routes). When it comes to international routes, several foreign airlines operate from Norwegian airports, in addition to pure charter operators. KLM, Lufthansa, British Airways, Wizz Air and Ryanair are the foreign airlines operating most of the routes.

2.2 The infrastructure

The locations of the 48 Norwegian airports with scheduled route traffic are shown in Figure 2-1.[1]

[1] Ørland airport is owned and operated by Ørland municipality.

The airports in Norway differ greatly both in terms of the size of the terminal buildings and runway lengths. The runways lengths are important because different types of aircraft require different runway lengths for take-off and landing. Runway lengths for the various airports are shown in Figure 2-2. The overview is based on the announced runway length, so-called TORA (Take off Run Available), from which the airlines operate. However, the physical runway length may be longer than the numbers given.

Figure 2-1: Airports in Norway. (Source: NOU 2019:22).

At airports with runway lengths of less than 1,000 metres, only small aircraft can land and take off. The largest commercial aircraft that can operate on these short runways is the Dash-8 100 / Q200 with 39 seats that Widerøe uses. Runway lengths of 1,199 metres can also accept the Dash-8 300 with 50 seats. On runways of about 2,000 metres or

longer, the jets that SAS, Norwegian and Flyr use domestically (primarily Boeing 737) can mostly take off and land without weight restrictions. A total of 23 of the airports meet this requirement.

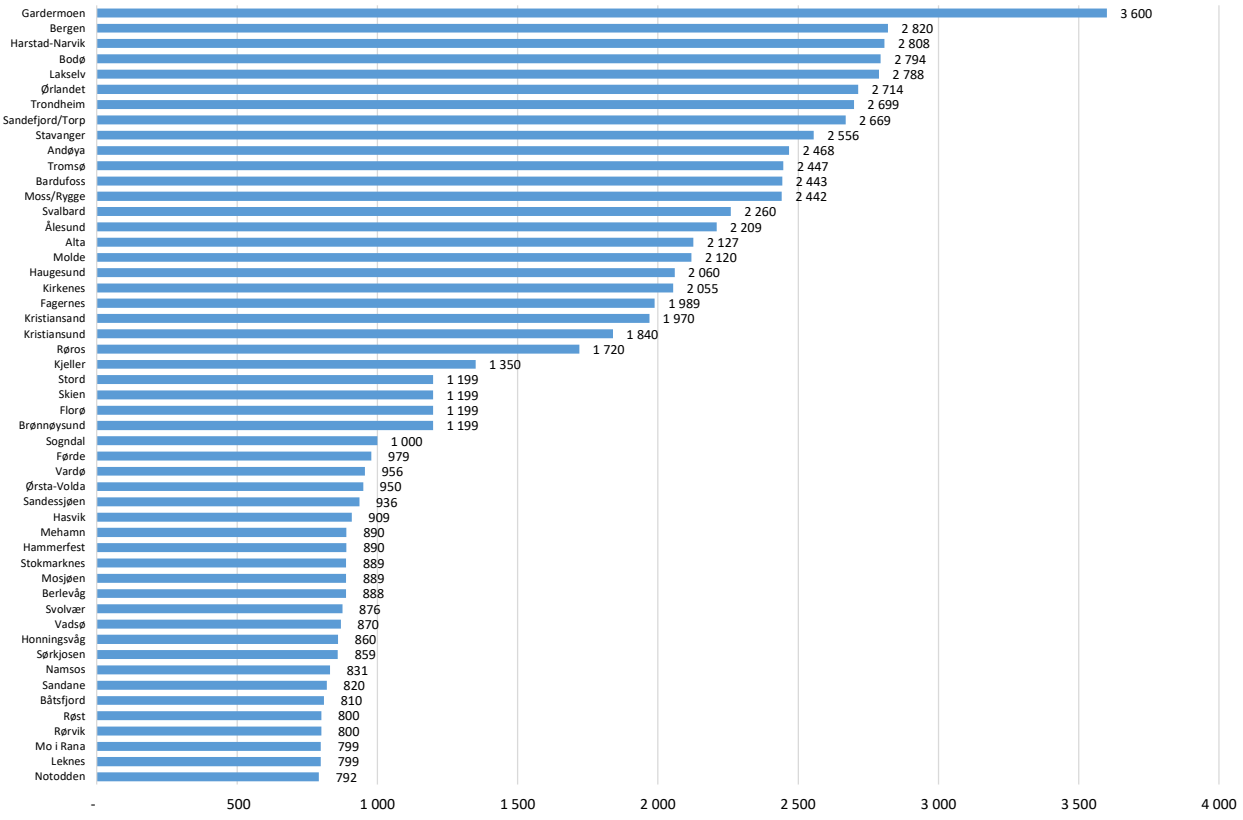

Figure 2-2: Runway length at Norwegian airports. Metres (Source: Avinor, AIP Norway).

2.3 The Avinor model

Most of the airports owned and operated by Avinor are not profitable. Normally, only at the four largest airports, Oslo, Stavanger, Bergen and Trondheim, do the aeronautical and non-aeronautical revenues exceed the operational costs. In 2019, the operating revenues from the airport operations at Avinor's airports were 10.4 billion NOK and the operating costs (incl. depreciation and financial costs) 7.4 billion NOK. This generated an operating profit of 3.0 billion NOK. However, the operating profit at the four largest airports was 4 billion NOK, while the net operating deficit at the regional airports was 1

billion NOK. There is thus significant cross-subsidisation in Avinor, but the infrastructure network as a whole is self-financed. Having profitable airports finance the loss-making ones is referred to in Norway as the Avinor model.

However, today there are two exceptions to the self-financing rule. The state, in partnership with local stakeholders, is financing the construction of two completely new airports – one in Mo i Rana which is to replace the existing airport at Røssvoll and one in Bodø, which is to replace the current city airport as a part of an urban development project. Once the airports receive operational approval, they will be a part of the Avinor system. This financial partnership is partly a consequence of the fact that the host municipalities of the two airports wish to accelerate work on the new airports and that Avinor is currently in difficult financial straits due to significant traffic reduction, and hence revenue, decline, resulting from the covid pandemic.

Non-state owned airports can apply to the Ministry of Transport for a subsidy for a five-year period based on the following criteria:

- The airport must have scheduled and/or charter traffic with at least one daily departure five days a week or equivalent traffic level on a monthly or annual basis.
- The budget must be in balance after public support and any contributions from the owners.
- Subsidies from the state must be critical for the operation of the airport.
- The airport must have a certain regional importance.
- Passengers must be at least one hour's travel distance from a state airport or another, unsubsidised, non-state airport.

The airports in Ørland, Stord and Notodden, see Figure 2-1, received operating support in 2022.

2.3.1 Advantages and disadvantages of the Avinor model

An advantage of the Avinor model is that it provides predictable operation of the airports as long as the company manages to generate sufficient profits at the largest airports to cover the deficit at the smaller regional airports, while at the same time managing the necessary investments at the airports. In this way, the regional airports are not dependent on subsidies from the owners (the state) to maintain their operations. One disadvantage is that the co-financing model has increasingly made Avinor dependent on revenues from areas other than airports and air traffic control, such as parking, hotels, sales and rentals.

A significant source of income for Avinor is tax-free sales, especially at Oslo Airport Gardermoen (OSL). Based on alcohol policy assessments, some political parties wish to remove the tax-free scheme, reduce the tax-free quota or let Vinmonopolet take over the sales. A reduction in these revenues could affect cross-subsidisation and put the Avinor model under pressure. One consequence may be that the financing of the economically unprofitable regional airports will have to be achieved through annual grants from the state budget, which will create considerable uncertainty in the financing of an important part of the transport infrastructure in rural areas.

From an economic point of view, airport charges should be set on the basis of the marginal costs of servicing aircraft and passengers adjusted for the disadvantages of financing the deficit through taxation and/or user financing (Jørgensen & Solvoll, 2011). Today's cross-subsidisation is estimated to inflict on passengers and airlines a benefit loss that is 1 to 4 times greater than the amount used to cover the deficit at the economically unprofitable airports (Homleid et al., 2010). However, a charge-model based on marginal cost pricing, with a revenue constraint at about the current level, means that the equal treatment of airports is abandoned and that charges are set highest at airports where

demand is least price-elastic (Ramsey pricing). As these are often airports in rural areas with poor alternative travel options, such a pricing policy is considered by some to be in conflict with common regional policy objectives in Norway.

Even though the aeronautical charges, see Chapter 2.5, are not based on marginal cost pricing, some economists have suggested a financing model where Avinor owns and operates only the largest airports, where the income potential is so large that the operation will make a profit. In this model, Avinor will have the freedom to set aviation charges differently from the charges at the regional airports. The ownership of the regional airports, or more precisely the airports that will not be able to generate a profit, can be separated into a new publicly owned company, let us call it "Reginor", that puts the operation of the airports out to tender. See Figure 2-3. In the figure, we have divided the unprofitable airports into three groups, which might be on the basis of size (number of passengers) or location (region). This could result in three separate tenders for the operation of these airports.

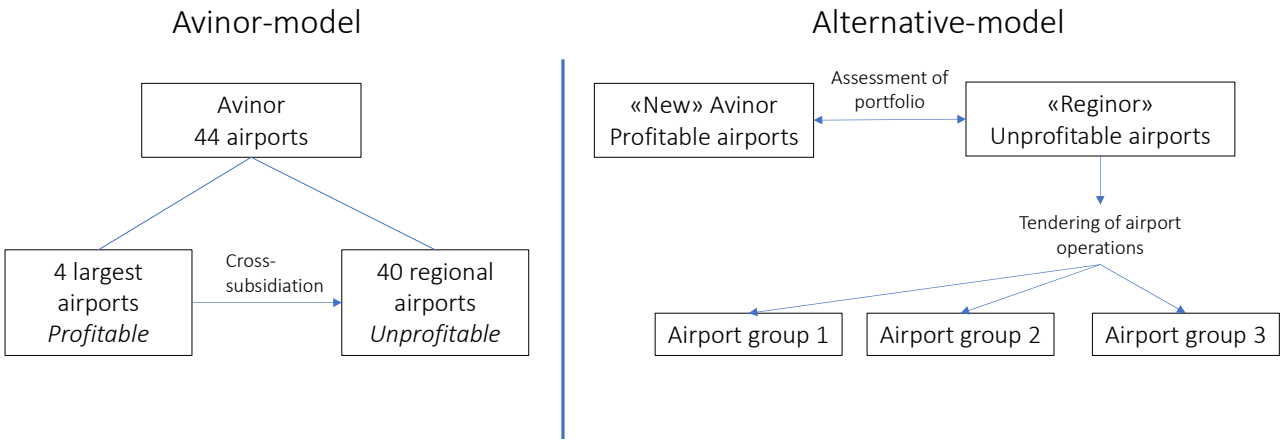

Figure 2-3: The Avinor model and a sketch of an alternative business model.

This alternative model represents a kind of analogy to the domestic aviation market in Norway, where the unprofitable regional air routes are put out to tender so that the airlines must compete for the exclusive right to operate them. The alternative model in

Figure 2-3 is a business model in which public procurement of services replaces cross-subsidisation. Avinor would then have to compete against other companies for the right to operate the regional airports on the basis of the operational requirements set by the authorities (Ministry of Transport). However, there is no direct link between the discussion of the Avinor model and the problems related to the electrification of aviation.

2.4 Aviation charges

The Avinor model also entails that the airport charges, with the exception of the terminal navigation charge (TNC) from 2020, are equal at all Avinor airports. The levels of the most important charges are shown in Table 2-1.

Table 2-1: Charges at Avinor airports in 2019 and 2022. (Source: www.avinor.no).

Type of charge	*2019*	*2022*
Take-off charge (6-75 ton) (NOK per ton)	62	69
Passenger charge (NOK)	48	50
Security charge (NOK)	60	64
TNC (NOK per service unit). 4 largest airports*	1891.55	1921.59
TNC (NOK per service unit). Regional airports.	1891.55	1152.95
En route charge**	421.61	546.33

* These are the airports in Oslo, Stavanger, Bergen and Trondheim.

** En route charges are invoiced and collected by Eurocontrol.

In 2020, the level of the take-off charge was raised, while a base allowance of 6 tonnes was implemented, so that aircraft under 6 tonnes do not have to pay a take-off charge. The charges are cost-based, and should reflect the average costs of managing a given aircraft and a passenger.

The charges do not differentiate between the environmental characteristics of different aircraft types. Today, when aircraft use fossil fuels, the weight of the aircraft is probably a good calculation criterion, but when electric aircraft come into operation, it will be natural to include environmental criteria in the fare system.

To stimulate the acquisition and use of electric aircraft, it may be useful for the authorities to use airport charges as one of several incentives, in the same way as tax exemptions and reductions have been used to achieve a rapid replacement of cars with internal combustion engines with electric cars in Norway.

A disadvantage of such tax exemptions and reductions is that Avinor's revenues from the charges will be reduced; see Table 2-2. This may present a challenge to the Avinor model, and pressure the company to further increase its non-aeronautical revenues if the charges on fossil fuel aircrafts are not increased.

2.5 Aviation revenues

The aeronautical charges, including the en route charge, and the non-aeronautical charges generated total revenue of 11.8 billion NOK for Avinor in 2019. Income by revenue source is presented in Table 2-2.

It can be seen from Table 2-2 that, in 2019, income from the aeronautical and non-aeronautical charges was 5.4 and 6.4 billion NOK, respectively. The non-aeronautical share of total revenues was therefore 54%. Avinor thus earns more from purely commercial activities at the airports than from the flight-related activities. For Oslo Airport Gardermoen (OSL), this share was 68% if we exclude the en route charge. These numbers show how heavily the Avinor model depends on revenues not directly related to aviation.

Table 2-2: Income by revenue type at Avinor airports in 2019. (Source: www.avinor.no) .

Revenues after source	*Income (Mill. NOK)*
Take-off charge	1 160
Passenger charge	1 240
Security charge	1 315
Terminal navigation charge (TNC)	595
En route charge	1 068
Sum aeronautical charges	5 379
Tax free sale	2 903
Parking	949
Other	2 554
Sum non-aeronautical charges	6 407
Sum operational revenue	11 785
Share aeronautical revenues	46%
Share non-aeronautical revenues	54%

2.6 The regional routes

The Ministry of Transport purchases air routes in accordance with the rules in EU Regulation 1008/2008 and regulations of 12 August 2011 no. 833 on the purchase of air transport services in the European Economic Area (EEA).[2] These routes are normally called Public Service Obligation routes (PSO routes).

PSO in aviation entails the government putting routes out to tender. The company that wins the tender is obliged to operate a specified transport service for a particular period of time in return for a grant. The winning company then has exclusive rights to operate the route for a period of 4 years in southern Norway and 5 years in northern Norway.

[2] Regulation (EC) No 1008/2008 of the European Parliament and of the Council of 24 September 2008 on common rules for the operation of air services in the Community. (https://www.legislation.gov.uk/eur/2008/1008/article/16)

PSOs are aimed at routes which are unprofitable for airlines to operate, but where it has been determined that an air transport service is socially desirable.

The purchases of air routes in Norway cover about 50 connections in 22 route areas. 36 airports had one or more PSO routes in 2019 and approximately 1.2 million passengers used these routes. This is about 4% of domestic passengers in Norway, but because PSO routes are operated by relatively small aircraft and the routes are short, PSO routes account for a significantly larger share of air transport movements. The PSO routes in 2019 are shown in Figure 2-4.

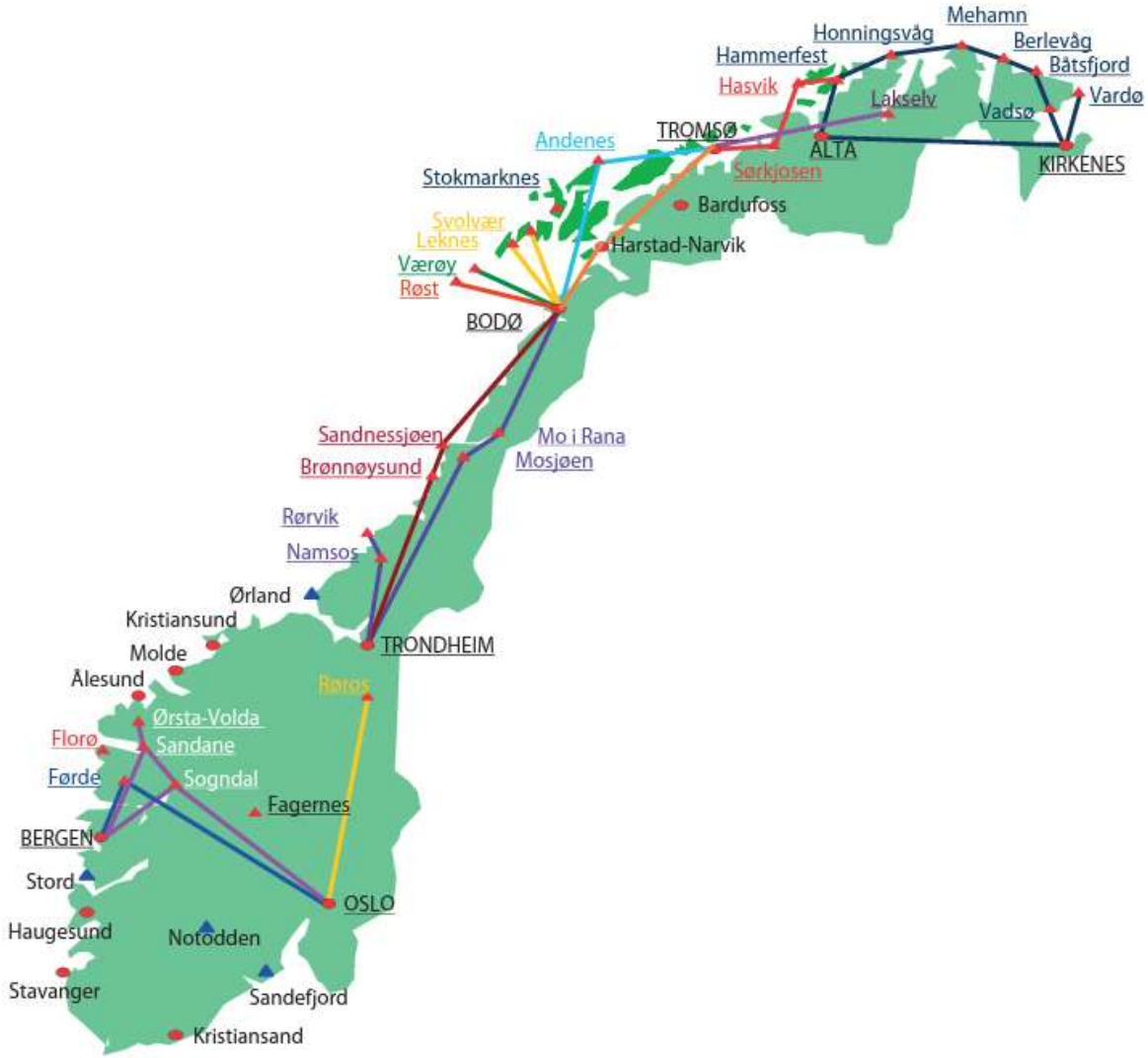

Figure 2-4: The PSO routes in Norway in 2019 (Source: NOU 2019:22).

As can be seen from Figure 2-4, the majority of the PSO routes are found in the northern part of Norway, where an important function is to connect smaller regional airports to hubs in Tromsø and Bodø. From these two airports, commercially operated routes to/from Oslo, Trondheim and Bergen are accessible, together with routes to some international destinations. In Finnmark, the PSO routes also have the important local function of connecting relatively small communities to Kirkenes, Hammerfest and Alta. The PSO routes in the southern part of Norway are primary designed to connect small regional airports on the west coast with Bergen and Oslo.

2.6.1 Responsibility for the purchases

A report from Oslo Economics (2016) investigated challenges in transferring the purchases of air transport services from the state to the county councils. The conclusion was that a regional model would make it easier to see and prioritise local needs, since the regions no longer have incentives to overstate the importance of the regional air routes in order to be allocated funds from the state. One identified disadvantage of transferring the purchases of PSO routes to the county councils was a risk to adequate maintenance of national interests.

How the purchasing of PSO routes should be structured depends on whether the benefits of regional prioritisation between air routes, bus routes, fast craft routes, county roads and other measures are greater than the gains obtained from national prioritisation between air routes, airports, national roads and other purposes.

If it is reasonable to assume that a regional model provides the most effective prioritisation, this must be assessed against an increase in public expenses. Oslo Economics (2016) estimates that, at a national level, a regional model will increase administrative costs by about eight man-years. The cost differences between a regional and a state model will increase if the regions are unable to cooperate on tender

announcements. Without cooperation, there is a risk that the tenders will be designed in a way that makes it impossible for the airlines to take advantage of economies of scale. Any gain in the form of better prioritisation may then disappear in increased costs.

In the spring of 2021, the Norwegian government suggested that the county councils (regions) should be responsible for purchasing airline services, but the Storting said no. It was Arbeiderpartiet, Senterpartiet, Sosialistisk Venstreparti and Fremskrittspartiet that secured the majority against transferring the purchases to the regions. Their argument was that they feared that regional responsibility would lead to a fragmentation of the aviation policy and poorer flight route services, since the government did not want to earmark the money that would accompany the delegation of flight route purchases. As a result, the purchases remain the responsibility of the state.

2.7 Summing up

This chapter provides a general description of aviation in Norway both in terms of organisation, airport structure, the regional airline network and Avinor's role as airport owner.

In Norway, the state-owned company Avinor operates 44 airports, 12 of them in collaboration with the Armed Forces. In addition, in 2022, there is scheduled traffic at two privately owned airports, of which Sandefjord Airport, Torp (TRF) is the largest measured by the number of passengers. The airports' runways have very different lengths; 53% of them have runways that are shorter than 1,000 metres.

Most of the airports owned and operated by Avinor are not profitable. In 2019 the operating profit at the four largest airports was NOK 4 billion, while the net operating deficit at the regional airports was NOK 1 billion. There is thus significant cross-subsidisation in Avinor, but the infrastructure network as a whole is self-financed. Having

profitable airports finance the loss-making ones is referred to in Norway as the Avinor model.

The Avinor-model entails that the airport charges, with the exception of the terminal navigation charge (TNC), are equal at all Avinor airports. To stimulate the acquisition and use of electric aircraft, the authorities can remove or lower airport charges for such aircraft as one of several incentives. A disadvantage of such a policy is that Avinor's revenues from the charges will be reduced. This may present a challenge to the Avinor model, and pressure the company to further increase its non-aeronautical revenues, which in 2019 constituted about 54% of the company’s total revenues.

The Ministry of Transport in Norway purchases flight route services in areas where the quality of transport is poor and an appropriate flight route service cannot be established on commercial terms. The airline that wins the tender competition gets the exclusive right to operate the routes for a period of 4 years in southern Norway and 5 years in northern Norway. The purchases of air routes in Norway cover about 50 connections. 36 airports had one or more PSO routes in 2019 and approximately 1.2 million passengers used these routes. This is about 4% of domestic passengers in Norway, but accounts for a significantly larger share of air transport movements.

3. TENDERING OF FLIGHT ROUTES IN NORWAY

In this chapter, we provide a short description of the history of the tendering of regional flight routes (PSO routes) in Norway, and of the process and criteria used by the Ministry of Transport in purchasing PSO routes.

As mentioned in Chapter 2.6, the Norwegian Ministry of Transport purchases flight route services in areas where the quality of transport is poor and an appropriate flight route service cannot be established on commercial terms. The airline that wins the tender competition gets the exclusive right to operate the routes for a period of 4 years in southern Norway and 5 years in northern Norway.

3.1 The history

In Norway, the first call for tenders came in the autumn of 1996, with route production starting on 1 April 1997. The number of route areas was 10, and Widerøe won all routes. Until 2015 in southern Norway and 2016 in northern Norway the contract period was 3 years. Subsequently, the contract period was extended to 4 years in southern Norway and 5 years in the north. This was done, in agreement with the EU, so that the necessary investments could be depreciated over a longer period to reduce the risk to the operator. The last tendering for routes in northern Norway was launched in autumn 2021. Due to the pandemic and considerable uncertainty about demand for trips, the contract period was set to two years. Widerøe won all routes and started the operations on 1 April 2022.

Widerøe has historically operated the most PSO routes in Norway. The Ministry of Transport states that, for the period 01.04.2022 – 31.03.2023 (12 months), they purchased routes for NOK 893 million, divided between NOK 702 million in northern

Norway (incl. Trøndelag) and NOK 191 million in western Norway (incl. Røros-Oslo)[3]. Consequently, about 80% of the economic compensation is given to route operations in northern Norway. The PSO routes are of great importance for the quality of transport in the rural areas and are by many considered an important regional policy instrument.

In evaluating the tendering of regional flight routes, Lian et al. (2010) draw the following main conclusions:

- *Weak competition:* It is mainly Widerøe and Danish Air Transport (DAT) that have participated in the competitive tenders. There was competition only on routes where aircraft with less than 30 seats were allowed or where the runway was at least 1199 metres.
- *Flight distances:* Relatively short flight distances, 165 km on average, contribute to high unit costs. However, lower unit costs can only be achieved by setting significantly lower quality requirements or allowing poorer regularity.
- *Economies of scale:* There are economies of scale in flight operations, especially when it comes to utilisation of the aircraft fleet and crew and regarding the need for reserve capacity. Thus, there is a trade-off between tendering large route packages and single routes where small airlines can also participate in the competition.
- *Runway length:* Longer runways provide more competition. The longer the runway, the more types of aircraft that can be used, and the more operators that can participate in the tender competition.
- *Technology:* Requirements for installing the satellite-based approach system SCAT-1 and presence on a global distribution system (GDS) have been barriers to competition.

[3] For the period 01.04.2017 – 31.03.2018 they purchased routes for NOK 627 million, divided between NOK 494 million in northern Norway (incl. Trøndelag) and NOK 133 million in western Norway (incl. Røros-Oslo).

- *Time:* It was insufficient time from the announcement of the winner to the start of the contract. Five to six months is not enough time to prepare for complex short-haul operations.

3.2 Transport quality criteria

An issue that concerns local politicians as well as the business community and the population in the districts is the scope of PSO routes and what quality they should have. This question was last investigated for northern Norway in 2015.

At that time, Møreforsking, in collaboration with the Institute of Transport Economics (TØI), was asked by the Ministry of Transport to suggest how the tender for regional scheduled flights north of Trondheim (Bråthen et al., 2015) could be designed. In their report, Møreforsking and TØI suggested which criteria should be used to decide on the routes to include in the PSO tender system. A similar report was written the year before for flight routes in southern Norway (Thune-Larsen et al., 2014).

The suggestions in the report are partly based on how the Swedish Transport Administration (Trafikverket) assessed how to appraise accessibility for municipalities in Sweden (Trafikverket, 2013 & 2021)[4]. The criteria used by the Swedish Transport Administration are related to the municipalities' accessibility to and from the capital Stockholm, accessibility to international destinations, trips to larger cities, to regional hospitals, to universities and colleges and to other major cities.

Accessibility is measured from a relevant municipal centre, and is divided into three categories: green, good; yellow, satisfactory; and red, poor. The fulfilment of the criteria is then analysed with and without a given flight route connection.

[4] The accessibility model and accessibility criteria used are described in attachment 2 (bilaga 2) in the respective reports.

Based on the scheme in Sweden, and a discussion of other relevant criteria, Bråthen et al. (2015) point out that access to the regional capital and to a regional airport with direct routes to southern Norway and to medical treatment of at least the regional hospital level, appear to be relevant criteria. They propose that "access to universities and colleges" is to be replaced by "access to centres with county administration". This criterion is perhaps particularly relevant in northern Norway. Also, in many instances, county administration, higher education institutions and regional health services are often located in the same city, but this is not always the case. The transport quality criteria proposed by Bråthen et al. (2015) are outlined in Table 3-1.

Table 3-1: Proposed transport quality criteria in northern Norway. (Source: Bråthen et al., 2015).

Criteria *	**Green standard**	**Yellow standard**
1. Correspondence to capital and international routes	Arrival at regional airport no later than 08.30, after a total travel time of maximum 3 hours. Return from regional airport not earlier than 17.00	Arrival at regional airport no later than 10.00, after a total travel time of maximum 4 hours. Return from regional airport not earlier than 15.00
2. City with regional hospital	Arrival at hospital no later than 10.00 after a total travel time of maximum 3 hours, with earliest start 03.00. Return from airport at earliest 16.00. Applies throughout the week.	Arrival at hospital no later than 10.00 after a total travel time of maximum 4 hours, with earliest start 03.00. Return from airport at earliest 16.00. Applies for 5 working days.
3. Place with expanded health services	As for criterion 2	As for criterion 2
4. County administration	As for criterion 2, but requirements only for 5 working days.	As for criterion 2

* Regional airport is an airport with direct connection to Oslo. This could include airports such as Tromsø and Bodø and also large airports such as Trondheim.

As can be seen from the table, the authors describe a green standard and a yellow standard for the different criteria. The green standard must be regarded as a *good*

standard, whereas the yellow standard could be seen as a *satisfactory* or *acceptable* standard.

Given the criteria in Table 3-1, and the definition of the green and yellow transport standard, Table 3-2 gives an example of how the transport quality from a given place with a nearby airport and flight route service fulfils the standards for the present air transport service, land-based transport (car) and an alternative flight route service.

Table 3-2: Illustration of transport quality criteria for purchase of PSO services for a given airport in northern Norway. (Source: Bråthen et al., 2015).

	Criteria			
	1	2	3	4
	Correspondence to capital and inter-national routes	City with regional hospital	Place with expanded health services	County administration
Today's transport				
Land-based transport (could be = today's transport)				
Flight route service, alt. 1 (could be = today's transport)				

= good standard, = satisfactory standard, = not fulfilled

Table 3-2 also introduces a red standard (criteria not fulfilled) in addition to the green and yellow ones. In the example, land-based transport does not fulfil the transport quality criteria numbers 1, 2 and 4.

3.2.1 Relevant calculations

A methodology, with criteria determined on the basis of national conditions, combined with a rough economic calculation of differences in generalised travel costs between

aircraft and the most affordable alternative transport solution, can serve as a basis for political/ administrative decisions on whether flight route services should be included in the PSO system or not. Generalised travel costs (G) are the sum of all monetary costs (C) and time costs (TC) associated with the trip. See e.g. Jørgensen & Solvoll (2021). Thus, G can be written as:

(3.1) $G = C + TC = C + kT$

In (3.1), travel time T is measured in hours and k is the traveller's time value per hour. Then $TC = kT$. The value of k can be interpreted as a traveller's willingness to pay to avoid one hour of travel time. For example, if k is NOK 200, it means that the traveller is willing to pay a maximum of NOK 200 to avoid traveling another hour. If the traveller can choose between two travel options, she would choose the option with the lowest G value.

Let us denote the sum of passengers' total (generalised) travel costs when using air transport G_P. G_P can then be compared with the generalised travel cost for passengers when they use the most affordable alternative transport solution, which we can denote G_C. If generalised travel costs when using air transport are higher than generalised travel costs of using other transport solutions, that is $G_P > G_C$, the PSO service should be considered changed or terminated. If $G_P < G_C$, one should consider the disadvantage of using alternative transport against the current total grants to cover the deficit of the PSO route, by assessing whether reduced generalised costs per grant NOK (benefit/grant ratio) for air transport lies in the area of around 1 or higher. A very low benefit/grant ratio indicates that saved transport costs can be very low per passenger. A high benefit/grant ratio may signal that the service can be improved, if this provides a satisfactory load factor.

Table 3-3 shows how generalised travel costs of different transport solutions between two centres can be compared depending on the desired level of detail. In its simplest form, one can limit the presentation to show average values per passenger, regardless of travel purpose. However, in Table 3-3, the calculation is split between work-related and other travel purposes.

Table 3-3: Compilation of generalised travel costs, operating costs, ticket revenues and grants for a given route. (Source: Bråthen et al., 2015).

Time consumption and costs (NOK per one-way trip)				
	Plane (G_P)		Road/cheapest alternative (G_C)	
Travel time centre–centre				
Costs	Work-related	Other	Work-related	Other
Value of travel time (travel time x time value per trip centre–centre)				
Value of changed frequency (only by change in the flight route service)				
Travel expenses centre–centre				
• Airplane tickets				
• Toll charges, ferries				
• Distance costs by car				
• Travel costs to and from airports				
Sum G_P and G_C				
Costs and grants for flight route service (NOK per passenger per one-way trip)				
Operating costs per passenger				
PSO grant per passenger				
Key figures				
(G_C-G_P)/PSO grant per passenger				

The yellow fields in the table are calculated or obtained from various sources. For simplicity, the same time value can be used for all trips. The key figures “PSO grant per passenger” and “reduced generalised costs per grant NOK per passenger” (given a load

factor of around 60%) can be used to rank the PSO routes based on economic assessments.

3.3 Procedure for designing the quality of a PSO service

As explained earlier, the need for flight purchases from a local airport is made, at least in theory, primarily by comparing the generalised travel costs of using ground transportation, usually car (G_C), with the generalised travel cost of travelling by plane (G_P). The comparison is performed for trips to the nearest city with a regional hospital, a hospital with expanded health services, the county capital, as well as correspondence via regional airport to/from the capital Oslo, (Bråthen et al., 2015).

If the quality of transport, measured by generalised travel costs, with air transportation is estimated to be significantly better than road transportation, further analyses of the scope of government purchases are made. This can be illustrated as in Figure 3-1.

The model in Figure 3-1 tries to compare the accessibility criteria from Table 3-1 with assessments based on the calculation of generalised travel costs (G). Generalised travel costs are calculated for air transport (G_P) and a land-based transport solution (G_C). If it is unquestionable that $G_P < G_C$, i.e. that it is more expensive to use land-based transport, you can move straight to box 4, where you identify the flight route service that maximises user benefits/subsidy ratio given a load factor of e.g. 60%. This will typically be a trade-off between choice of aircraft type and size, departure frequency, fare and load factor that also satisfies the accessibility criteria. However, in practice, it is usually only a matter of simply adjusting departure and arrival times.

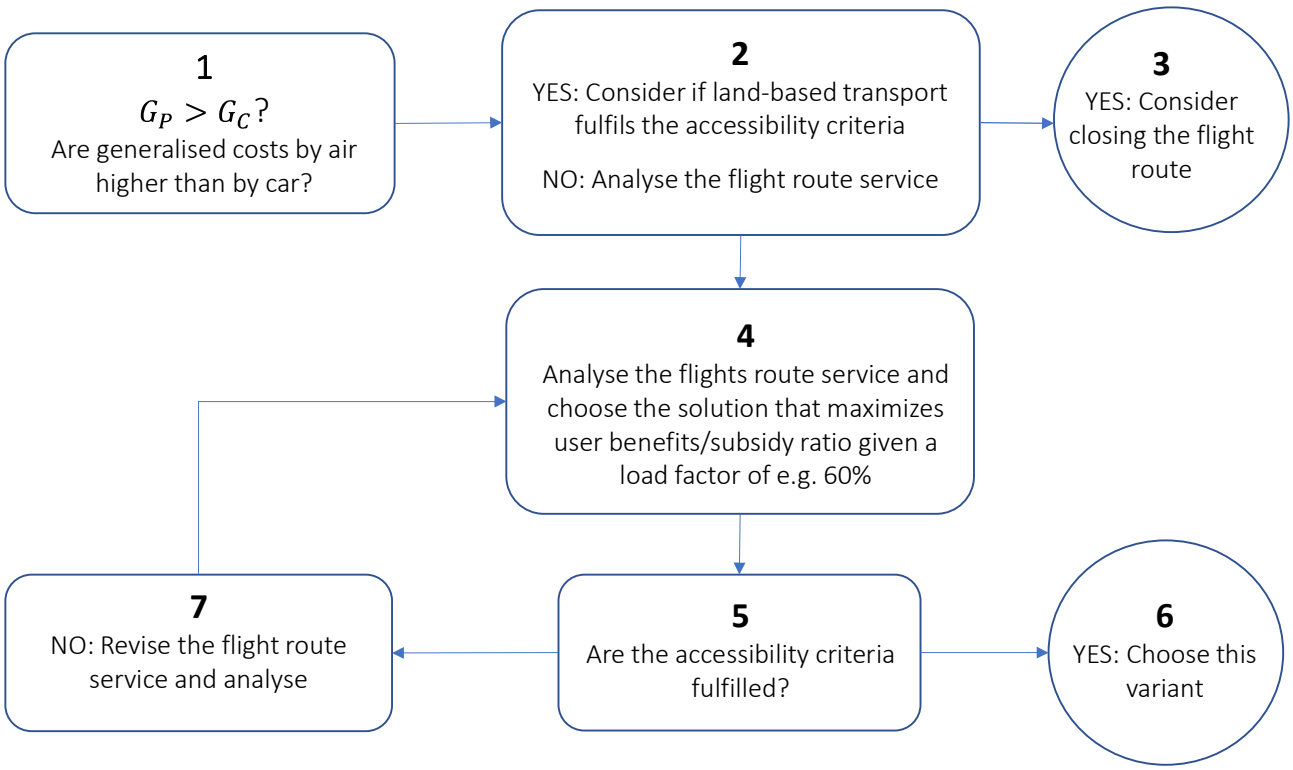

Figure 3-1: Conceptual model for designing a flight route service in Norway. (Source: Bråthen et al., 2015).

3.4 Calculation example

Let us now use the transport quality criteria from Table 3-1 and the template from Table 3-3 to assess the current transport quality between Mo i Rana and Bodø and Mo i Rana and Trondheim. This is done in Table 3-4 and Table 3-5. The example is from Bråthen et al. (2015).

From Table 3-4 we can see that with respect to travel time, air transport achieves a green standard for trips both between Mo i Rana and Trondheim, and between Mo i Rana and Bodø. When it comes to arrival time in Bodø, air transport from Mo i Rana achieves a yellow standard. Car use can meet the arrival time criteria at yellow level for trips between Mo i Rana and Bodø, but achieves a red standard for trips between Mo i Rana and Trondheim.

Table 3-4: Quality of transport between Mo i Rana and Bodø and between Mo i Rana and Trondheim. (Source: Bråthen et al., 2015).

	Travel time		Arrival time	
	Plane	Car	Plane *	Car
Mo i Rana - Bodø (criterion 1)				
Mo i Rana - Bodø (criteria 2, 3, 4)				
Mo i Rana - Trondheim (criteria 1, 2, 3)				

* Based on requirements specified in the tender contract.

= good standard, = satisfactory standard, = not fulfilled

In Table 3-5, the calculation of generalised travel costs and the reduction in "generalised travel costs per grant NOK per passenger" is carried out for a trip between Mo i Rana and Bodø.

The key figures suggest that for each NOK given by the state in grants to the route, society gets 0.55 NOK back. However, there are uncertain figures for the load factor that may reduce the need for grants somewhat. It can also be seen from the numbers in the table that the difference in the total generalised travel costs between plane and car is only about NOK 100 for a trip between Mo i Rana and Bodø.

The flight route between Mo i Rana and Bodø may appear to be in a grey zone as a result of the level of the PSO grants, since the necessary transport quality is offered by car (i.e. car has yellow standard). This, together with the relatively low additional costs associated with total travel expenses, means that this particular route could be a candidate for removal from the PSO system.

Nevertheless, a removal of the PSO routes to/from Mo i Rana has not been an actual issue. However, when a new airport at Mo i Rana is expected to open for traffic in 2025, the need for a PSO service will probably disappear since the flight routes between Bodø and Mo i Rana and between Trondheim and Mo i Rana are expected to be commercially viable.

Table 3-5: Calculation of key figures for trips between Mo i Rana and Bodø. (Source: Bråthen et al., 2015).

Time consumption and costs (NOK per one-way trip)	**Mo i Rana – Bodø**	
	Plane (G_P)	Road/cheapest alternative (G_C)
Travel time centre–centre (hours)	1.68	3.82
Value of travel time (travel time x time value per trip centre–centre)	588	1 336
Value of changed frequency (only by change in the flight route service)		
Travel expenses centre–centre		
• Airline tickets	655	
• Toll charges, ferries		48
• Distance costs by car		321
• Travel costs to/from airports	350	
Sum generalised travel costs	1 593	1 704
Costs and grants for flight route service (NOK per passenger per one-way trip)		
Operating costs per passenger	856	
PSO grant per passenger	202	
Key figures		
(G_C-G_P)/PSO grant per passenger (NOK)	0.55	

3.5 The tendering process

In the competitive tendering for PSO routes, the airlines can choose to tender for either single routes or route packages. This ensures that both small and large companies can participate in the tender competition while economies of scale can also be realized.

The stipulations from the state in the competitive tendering are related to:

- Aircraft to be used (minimum number of seats, pressurised cabin, etc.).
- Annual seating capacity offered (total number of seats per route per year).
- Minimum number of daily departures (weekdays vs. weekends. There is no traffic obligation on Christmas Day and Good Friday. A reduced route programme is allowed on some red days during Christmas, Easter and Pentecost).
- Maximum number of stopovers on the routes.
- Timetable (time of first arrival and last departure).
- Maximum ticket prices. An upper limit (maximum price) for the most expensive ticket is set.
- Possibility of production changes (when load factor <35%, seating capacity can be reduced by 25%).
- Regularity requirements: minimum 98.5%. The regularity is calculated on the basis of factors under the company's control. (The company is, for example, not responsible for bad weather).

The tendering process is normally carried out in 8 steps:

1. An external analysis determines guidelines for which routes are to be put out to tender and which stipulations are made for operation of the routes.
2. The guidelines are distributed to stakeholders for consultation.

3. Based on steps 1 and 2, a route programme with frequencies and a timetable is determined.[5]
4. The Ministry of Transport decides on the new public service obligations (PSO) based on steps 1 and 3.
5. The final tender proposal is sent to the EFTA Surveillance Authority (ESA) for approval.
6. Tender announcements are published in the Doffin database and made searchable for companies throughout the European Union.
7. Tenders received before the deadline are processed by the Ministry of Transport and the Civil Aviation Authority.
8. The winners are announced by the Ministry of Transport and the tender protocol is made publicly available.

3.6 Transborder routes

Politicians, bureaucrats and business representatives in Norway's Nordland county and the northern parts of Sweden have on occasion called for flight services between airports in Nordland (e.g. Bodø and airports at Helgeland) and towns along the coast in Norrland and Västerbotten (e.g. Luleå and Umeå). As no airlines consider such routes to be commercially viable, it appears that the establishment of transborder routes between these regions will require public subsidies.

Regarding the possibilities for establishing transborder flight routes, Article 16 of Regulation (EC) No 1008/2008 states the following:

[5] Before 2016 the route-program were sent on hearing to relevant stakeholders.

"A Member State, following consultations with the other Member States concerned and after having informed the Commission, the airports concerned and air carriers operating on the route, may impose a public service obligation in respect of scheduled air services between an airport in the Community and an airport serving a peripheral or development region in its territory or on a thin route to any airport on its territory any such route being considered vital for the economic and social development of the region which the airport serves.

That obligation shall be imposed only to the extent necessary to ensure on that route the minimum provision of scheduled air services satisfying fixed standards of continuity, regularity, pricing or minimum capacity, which air carriers would not assume if they were solely considering their commercial interest".

The above indicates that there are no legal obstacles associated with establishing PSO routes between two regions in Norway and Sweden as long as it can be argued that this is important for the economic and social development of the regions. There must then be an agreement at governmental level in the two countries that an air route service is important to establish. In addition, a financing model must be agreed on and what proportion of the required grant is to be financed by Norway and Sweden respectively. Both the issue of importance and the financing model will be challenging to reach agreement on. However, if electric aircraft reduce the operating costs of such routes, the financing issue at least will be easier to solve. Of course, the best solution would be to find operating concepts that are economically profitable for the operators so no public intervention is necessary.

3.7 Summing up

Chapter 3 provides a short description of the history of the tendering of regional flight routes (PSO routes) in Norway, and of the process and criteria used by the Ministry of Transport in purchasing PSO routes.

In Norway, the first call for tenders was launched in the autumn of 1996, with route production starting on 1 April 1997. The number of route areas was 10, and Widerøe won all routes.

Widerøe has historically operated the most PSO routes in Norway. For the period 01.04.2022 – 31.03.2023, the Ministry of Transport purchased routes for NOK 893 million. About 80% of the economic compensation is given to route operations in northern Norway. The PSO routes are of great importance for the quality of transport in the rural areas and are by many considered as an important regional policy instrument.

The need for flight purchases from a local airport is made, at least in theory, primarily by comparing the generalised travel costs of using ground transportation, usually car, with the generalised travel cost of travelling by plane. The comparison is performed for trips to the nearest city with a regional hospital, a hospital with expanded health services, the county capital, as well as correspondence via regional airport to/from the capital Oslo. If the quality of transport, measured by generalised travel costs, with air transportation is estimated to be significantly better than road transportation, further analyses of the scope of government purchases are made.

In the competitive tendering for PSO routes, the airlines can choose to tender for either single routes or route packages. This ensures that both small and large companies can participate in the tender competition while economies of scale can also be realized. The stipulations from the state in the competitive tendering are related to minimum number

of seats, annual number of seats offered, minimum number of daily departures, maximum number of stopovers, timetable, maximum ticket prices and regularity requirements.

Politicians, bureaucrats and business representatives in Nordland county in Norway and the northern parts of Sweden have on occasion called for flight services between airports in Nordland (e.g. Bodø and airports at Helgeland) and towns along the coast in Norrland and Västerbotten (e.g. Luleå and Umeå).

There are no legal obstacles associated with establishing PSO routes between two regions in Norway and Sweden as long as it can be argued that this is important for the economic and social development of the regions. However, there must be an agreement at governmental level in the two countries that an air route service is important to establish and what proportion of the required grant is to be financed by Norway and Sweden respectively.

4. AVIATION IN SWEDEN

In this chapter we provide a short description of aviation in Sweden covering airports, their organisation and financing and the purchase of flight routes. The chapter is mainly based on Trafikanalys (2019).

4.1 The infrastructure

In 2021, there were 39 airports in Sweden where scheduled or charter services were operated. Of these, 10 were run by the state-owned company Swedavia, see *Figure 4-1* (situation in 2018). The other airports are owned by municipalities or county councils with the exception of Skavsta, Ängelholm and Hemavan which are wholly or partly owned by private stakeholders.

In 2005, there were 42 airports with scheduled or charter traffic in Sweden, of which 18 were operated by the state. There were a total of three more airports than in 2021 and eight more of them were state-operated. The biggest change has thus taken place in terms of ownership and not in the number of airports. It is worth noting that a new regional airport, Scandinavian Mountains Airport Sälen–Trysil, opened in December 2019. This airport is not included in the map in *Figure 4-1*.

Figure 4-1: Swedish airports with scheduled or charter traffic in 2018.

4.2 Organisation and financing

4.2.1 The history

In Flyplatsutredningen (FPU), published in 2007, we can read that the state, through the transport policy goals, has committed to providing an infrastructure that enables basic

accessibility throughout the country. With regard to aviation, this means that the state has a responsibility to contribute to the maintenance of the infrastructure. This responsibility is assumed through direct ownership or through operating support to airports owned by regions, municipalities or private actors.

One of the most important proposals in FPU was that the Swedish airports should be categorised on the basis of their contribution to the fulfilment of transport policy goals, regardless of ownership. According to the proposal, airports should be divided into the three categories of national strategic airports, regional strategic airports and other airports. The number of passengers and the airport's population base should determine which category an airport is placed in.

The FPU proposed that the compensation system for the non-state airports should be based on these categories, and that the level of compensation should be differentiated between nationally and regionally strategic airports, where the nationally strategic airports would receive full cost coverage. For the regionally strategic airports, a deficit coverage of up to 75% was proposed. The remaining deficit should be covered by the airports' regional owners. The purpose of leaving part of the deficit with the regional owners is that this would motivate them to develop and streamline operations. No compensation should be paid to the airports categorised as other airports.

The Government considered that, in the long run, the state would be responsible for a national basic supply of airports. The selection of airports should be based on the FPU's proposal. The Government proposed that the airports of Gothenburg/Landvetter, Kiruna, Luleå, Malmö, Ronneby, Arlanda, Bromma, Umeå, Visby and Åre/Östersund Airport should be defined as strategic airports and be part of the state airport group Swedavia. The Government's proposal deviated from the FPU's on two points. The airport in Arvidsjaur was excluded in the government's proposal, while the airport in

Ronneby was added on the grounds that it provides reasonable geographical coverage in the south-eastern part of Sweden. See Figure 4-1.

With regard to the state's economic support to airports, the government argued that a clearer link should be made to the need to ensure interregional accessibility in cases where there are no satisfactory public transport alternatives. The economic support from the state should be given to the airports at which the state procures air route services. The motive is that air routes and infrastructure should be seen in context. In cases where the state has assessed that there is a need to procure certain air route services, it follows as a logical consequence that grants can also be given to support the airport infrastructure. This implies that it is a requirement that the state procures flight routes at the airport for it to be eligible for economic support from the state.

4.2.2 The economy of the airports

There is an economic imbalance within the Swedish airport system which means that the major airports make a profit and the others make a loss. Thus, as with Avinor in Norway, Swedavia practises cross-subsidisation between the profitable airports and those that are not. The income from Swedavia's airports in 2019 was SEK 6.2 bill. and the operating costs SEK 5.5 bill. This generated a profit before taxes of SEK 0.7 bill.[6] The accounting figures shows that Swedavia's aeronautical income was SEK 3.9 bill. and non-aeronautical income was SEK 2.3 bill., meaning that the non-aeronautical income contributed 43% of total income. In Norway, the corresponding proportion is 58%.

The majority of non-governmental airports report operating deficits year after year, while the airport system as a whole shows a surplus. Consequently, many airports

[6] We have not been able to find information on the extent of cross-subsidisation between the profitable and non-profitable airports.

depend on economic support in some form to carry on. As in Norway, public economic support is compatible with EU state aid rules if it meets the need for coordination of transport services or compensation for public service obligations (PSO). This enables the Swedish Transport Administration to provide financial support to regional airports where the state or the county councils procure flight routes that are operated under PSO; see Chapter 4.3.

The economic support from the state to non-state-owned airports since 2009 has amounted to approximately SEK 103 mill. per annum. In 2017, this included 21 airports. Consequently, average annual governmental support per airport is barely SEK 5 mill. In addition to this, 15 of the non-state-owned airports received SEK 238 million in operating support from their host municipalities in 2017. In sum, the public support (state plus municipality) to these airports was about SEK 340 mill. in this year.

It should also be mentioned that the Swedish Transport Administration has agreements with 11 airports to maintain round-the-clock national preparedness for socially important air transport services. Specific support is provided to these emergency airports, which in 2019 came to SEK 9 mill.

4.3 Tendering of flight routes

The Swedish Transport Administration is responsible for the procurement of interregional public transport services where the traffic cannot be operated commercially. The procured traffic aims to ensure basic accessibility throughout the country in line with the transport policy goals. The costs of the procured air traffic routes (PSO routes) amounted to an average of SEK 95 mill. per year in the period 2008 – 2018.

4.3.1 Procedure for designing the quality of a PSO service

Prior to a decision on PSO and, if necessary, procurement of air route services, an investigation is made to justify whatever decision is taken. A decision is similarly made on any changes to the existing PSO routes.

A precondition for the Swedish Transport Administration to be engaged in a certain public transport service is that the service must provide measurable improvements in the interregional accessibility for a municipality that, without the transport service, would lack accessibility.

Whether a transport service provides improvements in interregional accessibility or not, what design it should have, whether there are conditions for operating the traffic commercially or in collaboration with other actors, what possible compensation is reasonable, etc., are assessed in line with conditions defined in different investigative steps (Trafikverket, 2021):

1. Analysis of the need for public transport services. Investigate what shortcomings exist in accessibility for municipalities where the accessibility shortcomings could be improved with air traffic.
2. Assessment of the possibilities for the establishment of commercial transport services, e.g. by estimating the share of the total operating costs covered by ticket revenues.
3. Assessment of the possibilities to create complementary transport services, e.g. use of bus transport to an airport for onward transport by plane.
4. Assessment of the different transport solutions' effectiveness in creating accessibility.
5. Assessment of the transport solutions against the Swedish Transport Administration's terms for traffic agreements, e.g. that the transport service is not maintained or shall not be maintained by regional public transport

authorities, that the trips do not comprise frequent commuting, that the passengers must bear at least 20% of the operating costs and that the costs for the service fall within the Swedish Transport Administration's budget for traffic agreements.

6. Assessment against national transport policy goals.
7. Assessment against regional transport policy goals.
8. Proposal for the design of the procurement of PSO routes.

4.3.2 The regional routes

From 2019 to 2023, the procurement of PSO routes included the following 11 connections (Trafikverket, 2021):

- Arvidsjaur – Arlanda
- Gällivare – Arlanda
- Hagfors – Arlanda
- Hemavan – Arlanda
- Kramfors – Arlanda
- Lycksele – Arlanda
- Pajala – Luleå
- Sveg – Arlanda
- Torsby – Arlanda
- Vilhelmina – Arlanda
- Östersund – Umeå

The flight routes are shown on the map in Figure 4-2.

The map in Figure 4-2 shows the routes where there was a PSO route in 2019. As can be seen from the map, certain lines are combined, i.e. the route is operated with a stopover. This is the case, for example, with the routes Arvidsjaur – Arlanda and Gällivare – Arlanda.

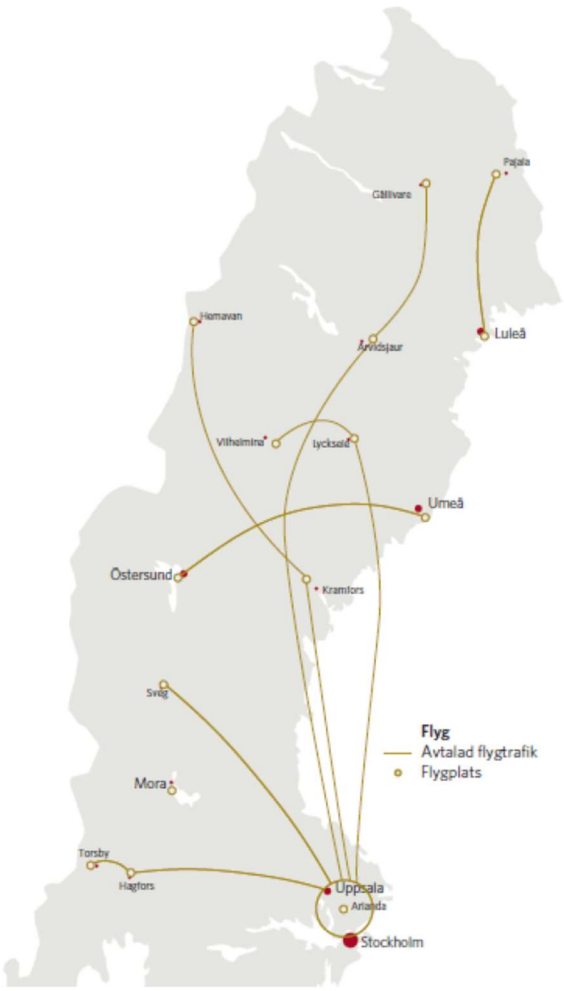

Figure 4-2: PSO routes in Sweden from 2019 – 2023. (Source: Trafikverket, 2021).

4.4 Summing up

This chapter provided a short description of aviation in Sweden covering airports, their organisation and financing and the purchase of flight routes.

In 2021, there were 39 airports in Sweden where scheduled or charter services were operated. Of these, 10 were run by the state-owned company Swedavia. The other airports are owned by municipalities or county councils with the exception of Skavsta, Ängelholm and Hemavan which are wholly or partly owned by private stakeholders.

In Sweden, the airports are divided into national strategic airports, regional strategic airports and other airports. The number of passengers and the airport's population base should determine which category an airport is placed in.

Also in the Swedish airport system, the major airports make a profit while the others make a loss. Thus, as with Avinor in Norway, Swedavia practises cross-subsidisation between the profitable airports and those that are not. The income from Swedavia's airports in 2019 was SEK 6.2 bill. and the operating costs SEK 5.5 bill. which generated a profit before taxes of SEK 0.7 bill. Swedavia's aeronautical income was SEK 3.9 bill. and non-aeronautical income was SEK 2.3 bill., meaning that the non-aeronautical income contributed 43% of total income.

The governmental compensation system for the non-state airports differentiates between three categories of airports. The nationally strategic airports receive full cost coverage. For the regionally strategic airports, there is deficit coverage of 75%. The remaining deficit is covered by the airports' regional owners. No compensation are given to the airports categorised as other airports.

The Swedish Transport Administration is responsible for the procurement of inter-regional public transport services where the traffic cannot be operated commercially. The procured traffic aims to ensure basic accessibility throughout the country in line with the transport policy goals. The costs of the procured air traffic routes (PSO routes) amounted to an average of SEK 95 mill. per year in the period 2008 – 2018. From 2019 to 2023 the procurement of PSO routes includes 11 connections, of which 9 are connections to/from Arlanda.

5. EXPERIENCES FROM TENDERING ON FERRY SERVICES IN NORWAY

In this chapter, we provide a short description of the tendering of ferry services in Norway, and especially investigate experiences of the transition from traditional tenders based on the use of diesel ferries to tenders that required the development of environmental friendly vessels.

5.1 Introduction

Ferry and air routes are very important for Norway's public transport system. Whereas ferries and ferry services are important for efficient land-based transport along the coast, airports and air transport services are important for connecting different regions of Norway and facilitating effective transport between the rural and urban parts of the country.

As of 2022, ferry operations in Norway are mainly electrified. It is therefore worth investigating the process by which the Norwegian authorities made ferry services a low or zero-emission activity. Lessons learned from the ferry industry can be useful when considering how to achieve a green shift in aviation. We will therefore, in this chapter, describe how the ferry tenders changed from being based on diesel-powered ferries to being based on zero-emission vessels.

In 2022 there are approximately 130 ferry services in Norway that are operated for all (or parts of the) year. For 16 of these the state are responsible for determining the quality of the service. With exception of 5 -10 ferry services for which the municipalities are responsible, the determination of the quality of the remaining services a county council responsibility. The services are operated by about 200 ferries. The cost of operating these ferries was approximately NOK 6 billion in 2018 and they generated about NOK 3 billion

in traffic revenues. The companies operating the ferries received an annual grant of about NOK 3 billion.

5.2 The history

Until 1990, the national road ferry operations had a grant system whereby the ferry companies were allowed to balance their accounts after a review by the authorities. This grant system did not give the shipping companies incentives for operating efficiently. From 1 January 1990, a fixed grant system was introduced. The size of the grant was now determined through negotiations between the ferry companies and the road administrations in each county. The ferry companies could then either earn or lose money on the contract, and thus received incentives for running the operations cost efficiently. Under both the balanced account system and the fixed grant system, the shipping companies which won the grant were given an exclusive right to operate the service for 10 years.

Later, that is from 15 April 1994, the Government issued test-tenders for ferry services, and on 1 December 1995, the first 4 connections were announced with contract periods ranging from 5 to 8 years. After the test period, the Storting decided there should be a full-scale implementation of tenders on the highway ferry services. The introduction of tenders led to a consolidation of the Norwegian ferry industry. That is, the number of ferry companies was significantly reduced (Oslo Economics, 2012). While there were 16 companies operating ferries in Norway in 1993, in 2022 just four shipping companies dominate domestic ferry operations: Torghatten, Fjord1, Norled and Boreal.

As a result of a regional reform in 2010, the responsibility for many highways, and with them highway ferry services, were transferred from the state to the county councils. Of the 130 ferry connections in Norway, the state is now only responsible for 17. There has also been a change in the division of responsibilities between the buyer of ferry services

(the state and county councils) and the operators (ferry companies) with a transition from net to gross grant contracts. Gross grant contracts mean that the state or the county municipalities have revenue responsibility, while the shipping companies only have risk related to the operations, i.e. operating costs.

When discussing the state budget for 2015, Prop. 1S (2015–2016), the Storting asked the Government to ensure that all new ferry tenders had low-emission technology or zero-emission technology when this technology had been fully developed. As a result, traditional diesel ferries were expected to be gradually replaced by more environmentally friendly ferries. It should be noted that ferries with gas turbines have been in operation in Norway since 2000, and that there were 21 gas ferries in operation in Norway in 2019. Today, however, electric ferries are sailing at “full speed” into Norwegian fjords. The first fully electric ferry, named "Ampere", was put into operation on the Lavik–Oppedal service in 2015.

In 2015, the Norwegian Public Roads Administration (NPRA) expected that, by 2030, two thirds of the energy used to run the ferries should come from the electrical grid. The remaining sources of energy should be biodiesel, natural gas and hydrogen. In 2022, NPRA stated that this forecast was too pessimistic, but they have not published any new estimates.

Autonomous vessels are also being developed. Autonomy is considered suitable for ferry services with a fixed operating pattern. In 2022, ferry operations are considered an important component of the technological, digital and green shift in Norway.

5.3 The tendering process

In this section, we describe how the NPRA and other stakeholders worked to implement electric ferries in Norway. [7]

The process of electrifying ferry operations began a few months before the ZERO organisation started to write a report on the electrical operation of ferries (Opdal, 2010). The initiators of this work were the management of NPRA, together with NHO Sjøfart (Rederienes landsforening, RLF, before 2012). The price of electricity in Norway has historically been very low compared to the price of diesel. At the beginning of the 2000s, battery technology developed at a rapid rate. But with a few exceptions, shipping companies remained largely passive when it came to exploring the benefits electrically operated vessels could provide.

The tender regime of the 2000s was characterised by shipping companies that wanted to reduce their risk in the offers they made. This resulted in little innovation and only incremental improvements in the technology used on the vessels. The shipping companies adapted to the minimum quality criteria that were required by NPRA, and largely competed solely on price. It was the great potential for energy saving and environmental improvements that made NPRA and RLF take action. NPRA realised that tender contracts where the shipping companies only competed on price failed to achieve an implementation of new green technologies in the industry.

5.3.1 Preparation of tender requirements

NPRA revises the requirements in the tender documents almost every year. In 2009, a number of county councils also began to set new requirements in their ferry tenders. In

[7] The information in this section is largely obtained from an interview with Edvard Sandvik, who, until 2022, was director of ferry operations at NPRA.

addition to the focus on new energy carriers on the ferries, there were also sharpened requirements related to:

- Use of contrasting colours in the interior.
- Control buttons marked in Braille.
- Elevator requirements: size, door width and sound advertising.
- Toilet adapted for the disabled.
- Opportunity to issue messages both visually and verbally.
- Telephone loop in all accommodation areas.
- Automatic door openers.
- Stepless access to all the ferry's passenger facilities.
- Stairs with handrails in two heights.

At this time, NPRA and RLF together with their members discussed the possibilities of developing the ferry tenders towards an environmentally friendly ferry design that would provide significant energy and environmental benefits. The politicians gradually came round to this idea, and in the state budget for 2011 (Prop. 1 S (2010–2011), we read the following about ferry operations (the authors' translation):

"The Ministry of Transport believes it is important that the state facilitates technical innovations on the material side. Therefore, it is planned that the connection Lavik–Oppedal in 2011 will be announced as a development contract, where the industry is invited to compete for the delivery of the most energy and environmentally efficient ferry for national highway ferry operations. An electrically powered ferry or a ferry using biofuel may be relevant in the competition for the operational contract".

In connection with the presentation of the state budget in October 2010, the Government, through the Ministry of Transport, asked NPRA to announce a so-called development contract in which the transport companies and the shipbuilding industry were to be invited to compete for the tender of the ferry connection Lavik–Oppedal based on who had the most energy efficient and environmentally friendly ferry to operate on the service. The connection crosses Sognefjorden in the county of Sogn og Fjordane.[8] The location of the ferry service is marked in Figure 5-1.

Figure 5-1: The ferry connection Lavik–Oppedal.

[8] Sogn og Fjordane county merged with Hordaland county in 2019. The new county was given the name Vestland.

The connection is relatively short, barely 6 km and was therefore considered well suited for experiment with a tender based, for example, on using a battery-electric ferry. The decision to announce the development contract was also a much discussed topic at the national ferry conference in 2010, which in many ways can be considered the start-up conference for the transition to more environmentally friendly tenders in ferry operations.

Considerations regarding energy consumption and emissions were to be emphasised so that both electricity and biofuels could be relevant in the competition for the contract. In addition to the tender competition being an important contribution to the development of technology to achieve the climate goals, the development contract would make an important contribution to the Norwegian shipyard and supplier industry.

5.3.2 The first "environmental tender" Lavik–Oppedal

Prior to the actual call for tenders, NPRA announced a tender in October 2010 with the aim of obtaining assistance in formulating the call for the development contract for the energy and environmentally efficient ferry. This tender was won by Det Norske Veritas (DNV). As such, DNV helped NPRA to formulate which energy criteria to use in the announcement and to assess and analyse the energy figures provided by the suppliers. In addition, a tender was announced for the actual implementation of the competitive dialogue.

The competition was organised in accordance with the "competitive dialogue"[9] procurement procedure, where the dialogue included the development ferry. The part of the competition that included the operation of the ferry connection was carried out

[9] Cf. Regulations on Public Procurements (FOA) of 12 August 2016 no. 974, § 23-8 (2).

In Sweden, competitive dialogue (konkurrenspräglad dialog) is described as a possible form of procurement in connection with procurement in the supply sectors, Act (2016:1146). https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/lag-20161146-om-upphandling-inom_sfs-2016-1146.

as normal in the ordinary assignment of an operating licence and contract for the operation of a highway ferry connection.

The operation of the national highway ferry connection Lavik–Oppedal was put out to tender in 2011, with the start of operations set to 1 January 2015 and with a contract period of 10 years. In addition to the operation of the connection, the competition also included the development and construction of the most energy and environmentally efficient ferry (the development ferry). It was assumed that the ferry connection should be operated by 3 ferries, one of which should be the development ferry.

5.3.3 Use of competitive dialogue

The competitive dialogue procurement form can be used when the conditions in FOA § 13-2 are met. The procedure shall be used for procurements above the EEA threshold values. It follows that the procedure can be used when:

- The client's[10] needs cannot be met unless adjustments are made to available solutions.
- Procurement includes design or innovative solutions.
- The nature, complexity, legal or financial composition of the procurement or associated risks make it necessary to negotiate.
- The technical specifications cannot be described with sufficient precision by reference to a standard, a European technical assessment, a common technical specification or a technical reference.

Based on the above, we can state that competitive dialogue as a procurement form was well suited to the purchase of the development ferry. The progress schedule for the purchase was as follows:

[10] NPRA in this case.

- Invitation to participate in competitive dialogue; 15 August 2011
- Submission of concept proposal; 7 October 2011
- Supplier's presentation; 11-12 October 2011
- Feedback from NPRA (in writing); 21 October, 2011
- Response from the suppliers (in written form); 28 October 2011
- Dialogue meetings; 1-2 November 2011
- The points above were completed in 2-3 phases within a 2 week cycle
- Invitation to tender competition; 23 December 2011

The NPRA's purpose with this announcement was for the development ferry to become a showcase for innovative ferry design. The client's goal was to achieve at least 15-20% energy and environmental improvement for the development ferry compared to "traditional" new ferries. To ensure that a battery-electric ferry could also be included as one of the solutions, it was mentioned in the tender documents that the ferry could sail at a speed as low as 10 knots (18.5 km/h) and have a terminal time (charging time) as long as 10 minutes. The suppliers who were pre-qualified for the tender competition and submitted tenders received NOK 3 million in compensation for their development work.

All four large ferry companies in Norway, Fjord1, Torghatten, Norled and Boreal[11], participated in the competition to develop an environmentally friendly ferry, with most of them producing 3-4 concepts for how the crossing could be operated. Technological solutions that were considered to not meet the requirement for a showcase and 15-20% energy and environmental improvement were rejected. The same happened to the concepts that NPRA believed were impossible to implement within the start-up time. In

[11] Until 2011 the name of the transport company was Veolia Transport.

addition to a concept with a battery-electric ferry, there were concepts without batteries and hybrid solutions in the final phase.

5.3.4 Criteria and how they were weighted

The focus for the development aspect of the competition was on energy efficiency, with reduced energy consumption, and environmental efficiency, with reduced emissions as a result of the chosen energy carrier or technical solution. Energy efficiency was set to be the most important factor, as reduced energy consumption also leads to lower emissions. The criteria used to select a winner in the final tender competition, that is to be given the opportunity to operate the ferry service, was a weighted combination of the development ferry's energy and environmental efficiency and the lowest total price for the operation of the ferry connection, where the ferry's energy and environmental efficiency counted 40% and the total price counted 60%. The evaluation criteria used, with their associated weights, are presented in Table 5-1.

Representatives from NPRA describe the work to prepare award criteria that provide sufficient scope to evaluate solutions that will later be invited to the tender phase, as important and time-consuming. A real challenge can arise if a participant develops a much better solution than other participants. However, the competitive dialogue procurement form gave NPRA the opportunity to work with the participants so that only concepts that fulfilled the client's objective were asked to submit tenders. It is generally difficult to establish good models that combine qualitative criteria related to technical development and commercial criteria related to general operations. According to NPRA, the biggest challenge with qualitative award criteria is that those who are not awarded the contract can appeal the decision due to disagreement about how the various criteria are assessed.

Table 5-1: Evaluation criteria with weights for the development ferry on the crossing Lavik–Oppedal. (Source: The Norwegian Public Roads Administration).

Category	Evaluation criteria	Weight	Description
Energy efficiency	kWh/PCE km *	45%	Calculated based on documentation from the shipping company.
	Energy consumption	15%	Fuel consumption. It is energy density - megajoules (MJ)/year that is evaluated.
Environmental efficiency	Tonne CO_2-equiv./year (CO_2/kWh) (CH4/kWh)	15%	Calculated on the basis of annual total energy consumption for the ferry, a determined CO_2 factor for the energy sources (marine gasoil, gas, biodiesel, battery operation, etc.) and documentation of methane emissions (CH4).
	kg NOx/year	10%	Calculated based on weighted NOx factor and total fuel consumption for the ferry for one year.
Innovation		15%	Innovative solutions that are important for energy and environmental efficiency must be documented by the provider.

* Definition of PCE (passenger car equivalents): Length: 4.30 m, width: 1.85 m, weight: 1.3 tonne

5.3.5 The dialogue phase

In the dialogue phase, NPRA focused on whether the providers (shipping companies) could document that they had cooperated with potential suppliers on the build and approval of the development ferry for use on the ferry service. It was important for NPRA that the chosen technical solution would work in practice. Therefore, a timetable was set out, see section 5.3.3, which was intended to ensure that the providers had sufficient time to prepare their proposals and to carry out economic calculations on their final tenders.

NPRA was very concerned about equal treatment of suppliers, including ensuring that all providers had equal access to information. It was also important that information about one supplier's solution did not leak to another supplier. For example, NPRA could not disclose to the other participants solutions or other confidential information that a

participant had provided to the client, without the participant's permission. At the same time, it should be mentioned that the tender documents and the dialogue were only prepared in Norwegian. This meant that foreign companies that wanted to participate had to hire employees who spoke Norwegian, or join a "Norwegian" consortium.

During the dialogue phase, NPRA had several meetings with the Norwegian Maritime Directorate and DNV, about issues related to classification, certification and inspection of the vessels that were to be built. In addition, there was also close dialogue between NPRA and the Norwegian Directorate for Civil Protection (DSB) in respect of fire and explosion protection, especially in connection with the tender for the Hjelmeland–Nesvik connection in 2017, where a hydrogen-electric ferry was to be developed.

From the perspective of NPRA, it was important to prepare functional requirements that did not limit the participants' solution proposals more than strictly necessary. Emphasis was also placed on avoiding specifications that led the participants towards special solutions, if this was not considered necessary to satisfy the functional requirement. It was also important to clarify the interface between development work and ordinary ferry operations with the providers before the final preparation of contract work and contract conditions.

NPRA emphasises that successful implementation of a competitive dialogue requires a basis of confidentiality and trust. If this is achieved, the competitive dialogue procurement form gives the client the opportunity to develop competence in the project organisation, obtain good market contact and market understanding, create good relations between the contracting parties and make the work on the actual contract design easier.

Experience also indicates that there should not be too many people from the client side involved in the dialogue meetings. NPRA was represented by 8 people in the meetings for the tender for the Hjelmeland–Nesvik connection, and 6 people in the meetings for the tender at Lavik–Oppedal. The experience from these meetings is that participation of 6 from the client side is sufficient. It is important that the provider side feels that they are the key players and that open dialogue is planned and facilitated.

5.3.6 The result of the first environmental tender

As mentioned in section 5.3.3, four shipping companies (consortia) participated in the dialogue phase and in the subsequent tender competition: Fjord1, Torghatten, Norled and Boreal. Norled won the tender competition with the battery-electric ferry Ampere that was built at Fjellstrand shipyard in Hardanger. Ampere has a capacity of 120 passenger cars and 350 passengers, and is scheduled to carry out 34 daily departures on weekdays in 2022.

5.4 The process after the first environmental tender

The process that resulted in the world's first battery-electric ferry Ampere was in many ways a game changer in tenders for ferry services in Norway. In the years that followed, the experience gained from that process was important for the implementation of the tenders for the ferry connections that were to be re-tendered.

5.4.1 Vendor conference

On the basis of the "statement" in the political debate regarding the state budget for 2015 that *"The Storting asks the government to ensure that all future ferry tenders have requirements for zero-emission technology (and low-emission technology) when this technology has been fully developed"*, NPRA held a supplier conference on zero and low-emission solutions for ferry operations in October 2015.

The purpose of the conference was to start a dialogue with the market (i.e. the shipbuilding industry, equipment suppliers and the shipping industry) to discuss how the decision made by the Storting could be implemented. In this way, NPRA could prepare the market for environmental requirements in future procurements and at the same time gain input from the market on what the industry thought was possible to achieve, and what evaluation criteria should be used for choosing the winner. In addition, NPRA wanted to establish new relationships to create the best environmental solutions, for example by bringing shipbuilders, equipment makers and shipping companies together. The conference was attended by suppliers with an interest in ferry procurement, relevant business associations and corporate networks, purchasers of ferry services, including the public transport association (Kollektivtrafikkforeningen; kollektivtrafikk.no) as well as R&D companies, interest organisations and business development associations.

5.4.2 A guide for future tenders

In September 2015, the operation of the highway ferry connection Anda–Lote was put out to tender, with a planned start-up on 1 January 2018 and a contract period of 10 years. This connection is 2 km long and was to be operated by two ferries with defined capacity requirements (vehicle and passenger capacity).

One of the ferries should be able to be operated fully electrically. For this ferry, all energy consumption, in normal route production or when at a ferry quay, should come from electricity from the electricity grid. The vessel should also be able to maintain route production even if unable to charge from one of the quays. In the event that the ability to charge was lost at both quays, the vessel should be able to maintain route production under electrical power for a minimum of 3 hours.

The other ferry could use electricity (from the electricity grid), biodiesel, biogas or an optional combination of these as its energy source. The vessel should be able to maintain route production even if it was unable to charge from one of the quays. If unable to charge from either quay, the vessel should be able to maintain route production for at least 12 hours.

The tender documents that were prepared for this tender, and the requirements that were used in this competition, in addition to the experiences from Lavik–Oppedal, have been used as a model/inspiration for later tenders.

5.4.3 Industry forum for ferry operations

In December 2015, NPRA invited the management of the ferry companies and the county councils to an industry forum for ferry operations to be held on 5 January 2016. The aim of the forum was to establish a meeting place for purchasers (NPRA and the county councils) and the industry that was not linked to specific contracts. The forum was intended to become an arena where stakeholders could work for a shared understanding of the overall objectives and strategies for ferry operations and highlight various issues related to the use of tenders in a sector aiming to adapt to the low-emission society. Forum activities included:

- Challenges related to the use of tenders in a sector with rapid technological development and a lifespan of ferry equipment of 30 years.
- Acceptable time consumption related to preparing tenders, as well as time from selection of winner to start of contract. Among other things, new technology means it takes longer to build the vessels and get them certified.
- Cooperation on tenders and announcements of tenders sequentially, so that several large connections are not announced at the same time.
- Design and coordination of contract terms and technical requirements for vessels.

- Deciding who should be responsible for the necessary infrastructure on the ferry quays, for example the charging infrastructure.

It was important to involve the county councils, since most ferry connections in Norway are part of a county road, and thus within the county councils' area of responsibility. The forum arranged a new conference in November 2018.

5.4.4 Use of hydrogen in ferry operations

The Storting's statement from 2015 that all future ferry tenders are required to have zero-emission technology (and low-emission technology) when the technology is available, provided important guidelines for further development of zero-emission solutions in the ferry sector. In addition to battery-electric ferries, ferries that use hydrogen are also relevant. In the state budget for 2015, it was announced that a government development contract, similar to the one that resulted in the world's first battery-powered ferry Ampere, could also be relevant in developing a hydrogen-powered ferry.

Accordingly, in May 2016, in collaboration with the ZERO environmental organisation, NPRA announced a dialogue conference/seminar on the use of hydrogen as an energy carrier in ferry operations. The purpose of the seminar was to identify opportunities, barriers, areas that require more innovation, and the risks associated with developing a hydrogen ferry.

In political discussion of the state budget for 2017, cf. Prop. 1 S (2016–2017), we read that *«The Storting asks the Government to consider the use of development contracts for hydrogen ferries»* (Decision no. 873, 13 June 2016). The decision was based on the so-called "energy report", Meld. St. 25 (2015–2016). To develop a zero-emission alternative to fossil-based energy systems in vessels, NPRA was asked by the politicians to establish

a development project for a ferry partially powered by hydrogen. The planned start of the operation was set to 1 January 2021. In addition to technical development, regulations for hydrogen-powered passenger ships should also form part of the development project. It was therefore important for NPRA to establish close cooperation with the Norwegian Maritime Directorate.

To follow up the Storting's decision of 2016, NPRA invited relevant stakeholders to a dialogue conference focused on the possibilities of using hydrogen technology in ferry operations. This was held in Stavanger on 29 March 2017. Here NPRA informed the participants that they wanted to design a tender competition for the Hjelmeland–Nesvik–Skipavik ferry service for the period 2021 to 2030, to include the development of a hydrogen-electric ferry for the crossing. NPRA believed that succeeding with this technology would help NPRA meet the requirement for zero-emission technology on ferry crossings that are not suitable for fully electric operation.

The Hjelmeland–Nesvik–Skipavik ferry crossing was put out to tender on 13 July 2017. The purpose of the procurement was to facilitate the development of a ferry where at least 50% of the energy needed to operate the ferry comes from hydrogen. Norled won the tender competition and the ferry Hydra was developed and put into operation. Hydra has three energy sources. In addition to two hydrogen-powered fuel cells, it also has a large battery package on board. The batteries are continuously charged by the fuel cells, but can also be charged at the quay in Hjelmeland and Nesvik. At least 50% of the time, Hydra is powered by fuel cells powered by liquid hydrogen. In addition, the ferry has two diesel generators installed, which can be used as a back-up energy source.

A separate supplier conference was also arranged in August 2019 focusing on the use of hydrogen as an energy carrier on the ferry connection Bodø – Røst / Værøy – Moskenes. NPRA wanted to establish a meeting place for potential shipping companies, sub-

contractors, research institutions, other potential hydrogen consumers in the area and public authorities with an interest in hydrogen as a zero-emission alternative.

The background for the supplier conference was that NPRA had recently signed a development contract for a hydrogen-electric ferry on the Hjelmeland–Nesvik–Skipavik ferry crossing and was considering signing a similar contract on the ferry crossing between Bodø and Lofoten (Bodø – Røst / Værøy – Moskenes). Therefore NPRA sought input from stakeholders regarding:

- Design of the procurement, contract length, requirements and evaluation criteria to achieve the best possible competition and outcome.
- Measures to reduce the risk for those participating in the competition.
- Cost estimates for the ferry and especially the expected hydrogen price when delivered to the quay.
- Design of vessels, infrastructure for electricity and hydrogen, land use and safety.

The results of the conference were used to prepare a recommendation note to the Government. This note contained proposals for financial frameworks, environmental requirements and procurement strategy.

5.4.5 Charging equipment and charging infrastructure

In October 2018, NPRA was involved in a supplier conference about charging equipment for ferries. The purpose of the conference was to facilitate the development and use of a wide range of technological solutions for the charging of ferries.

The background to the conference was that the introduction of zero- and low-emission technology in ferry operations had led to a high degree of electrification of the fleet. The ferry companies and the maritime supplier industry are constantly looking for new

concepts when it comes to the charging of ferries. New concepts for charging entail the need to install new equipment on the ferry quays, which has an impact on existing ferry quays and the other land-based facilities, how new ferry quays and other land-based facilities are designed and the design of the ferry contracts (e.g. distribution of responsibilities and risk).

Battery prices, technical developments in power electronics and charging systems will affect what is economically appropriate. Cooperation between the developer, local authorities and grid companies is important to ensure that the power grid is sufficiently upgraded. For example, battery banks on land can reduce the power requirement when upgrading the power grid, cf. Figure 5-2.

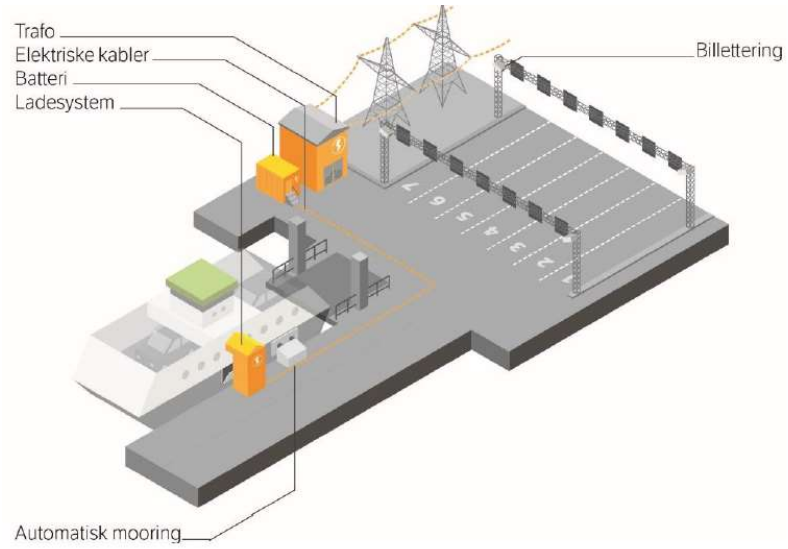

Figure 5-2: Possible solution of power requirements on ferry quay. (Source: PP presentation, Anita Bjørklund, NPRA).

With regard to the cost of upgrading the power grid when establishing charging infrastructure on ferry quays, the grid company shall determine a construction contribution to cover the costs of necessary grid investments and grid reinforcements.

This cost must be paid by the transport operator, whether a ferry company or airport owner.

The purpose of the construction contribution is twofold. First, it forces the customer who triggers the investment to contribute to the financing of a new power cable or any necessary reinforcement of an existing one. The power grid company may require the customer who triggers the need for investments in the power grid to cover up to 100% of the construction costs. How large a share the customer must cover depends on their power needs, and whether other customers will be connected to the power facilities or will demand increased capacity on an existing grid system. Second, the construction contribution allows for a distribution of the costs between the customer triggering the investment and the grid company's other customers. This is important since costs that are not covered by the customer who triggered the investment must be covered by the grid company's other customers through increased grid tax.

5.5 Summing up

This chapter provided a short description of the tendering of ferry services in Norway, and investigated experiences of the transition from traditional tenders based on the use of diesel ferries to tenders that required the development of environmental friendly vessels.

In 2022 there are approximately 130 ferry services in operation in Norway. For most of them, the county councils are responsible for determining the quality of the service. The services are operated by about 200 ferries. The cost of operating these ferries was approximately NOK 6 billion in 2018 and they generated about NOK 3 billion in traffic revenues. The companies operating the ferries received an annual grant of about NOK 3 billion.

The tendering of ferry services in Norway started back in 1994. The introduction of tenders led to a consolidation of the Norwegian ferry industry. While there were 16 companies operating ferries in Norway in 1993, in 2022 just four shipping companies dominate domestic ferry operations: Torghatten, Fjord1, Norled and Boreal.

The process of electrifying ferry operations started about 2010 as an initiative of the Norwegian Public Roads Administration (NPRA) and NHO Sjøfart. At this time, NPRA and NHO, together with their members, discussed the possibilities of developing the ferry tenders towards an environmentally friendly ferry design that would provide significant energy and environmental benefits. The tender regime of the 2000s was characterised by shipping companies that wanted to reduce their risk in the offers they made, implying a competition solely based on price. NPRA realised that tender contracts where the shipping companies only competed on price failed to achieve an implementation of new green technologies in the industry.

The politicians gradually came round to this idea, and in the state budget for 2011, it was decided that the connection Lavik–Oppedal should be announced as a development contract, where the industry was invited to compete for the delivery of the most energy and environmentally efficient ferry. The procurement was organised in accordance with the “competitive dialogue” procurement procedure. All four ferry companies in Norway participated in the competition, and most of them came up with 3-4 concepts for how the crossing could be operated.

In the dialogue phase, NPRA focused on whether the providers (shipping companies) could document that they had cooperated with potential suppliers on the build and approval of the development ferry and associated charging infrastructure. The shipping company Norled won the tender competition with the battery-electric ferry Ampere that was built at Fjellstrand shipyard in Hardanger.

After this first environmental tender, the focus on reducing emissions from ferry operations increased, and in the state budget for 2015 the Storting asked the Government to ensure that all new ferry tenders had low-emission technology or zero-emission technology when this technology had been fully developed.

In 2015 NPRA expected that, by 2030, two thirds of the energy used to run the ferries should come from the electrical grid. The remaining sources of energy would be biodiesel, natural gas and hydrogen. In 2022, NPRA stated that this forecast was too pessimistic, but they have not published any new estimates.

6. IMPLICATIONS FOR ELECTRIFICATION OF AVIATION

In Chapter 3, we described the procedure when the government purchases flight route services in Norway, while in Chapter 5 we described how the change to more environmentally friendly tenders in Norwegian ferry operations was achieved. Although aviation and ferry operations are very different, the lessons learned from how more environmentally friendly vessels were introduced in ferry operations, can be useful for the Ministry of Transport when aviation ceases using fossil fuel. Alternatives to fossil fuel will first become relevant on small aircraft because these require less energy, and the energy density of current lithium-ion battery packages is not sufficient for large aircraft. This means that the regional flight routes in Norway, the so-called PSO routes, are well suited to electric aircraft. Thus, future tender announcements could be an important tool for testing new aircraft types.

6.1 Purchase of flight routes with electric aircrafts

Based on the description in chapters 5.3 and 5.4 of the process of making the Norwegian ferry industry a low-emission sector and interviews with Edvard Sandvik in NPRA, it will be particularly important for the Ministry of Transport to initiate, at an early stage, the following activities in order to facilitate the use of electric aircraft on the regional flight route network in Norway:

- Carry out an investigation of the power supply and power requirements for all airports in Norway.
- Involve the airport owner (Avinor), the Civil Aviation Authority (Luftfartstilsynet) and the safety authorities.
- Initiate a dialogue with suppliers and subcontractors to the aviation industry.
- Start working on the design of new tender contracts.

The first three activities can start at about the same time. As such, the process can be outlined as shown in Figure 6-1.

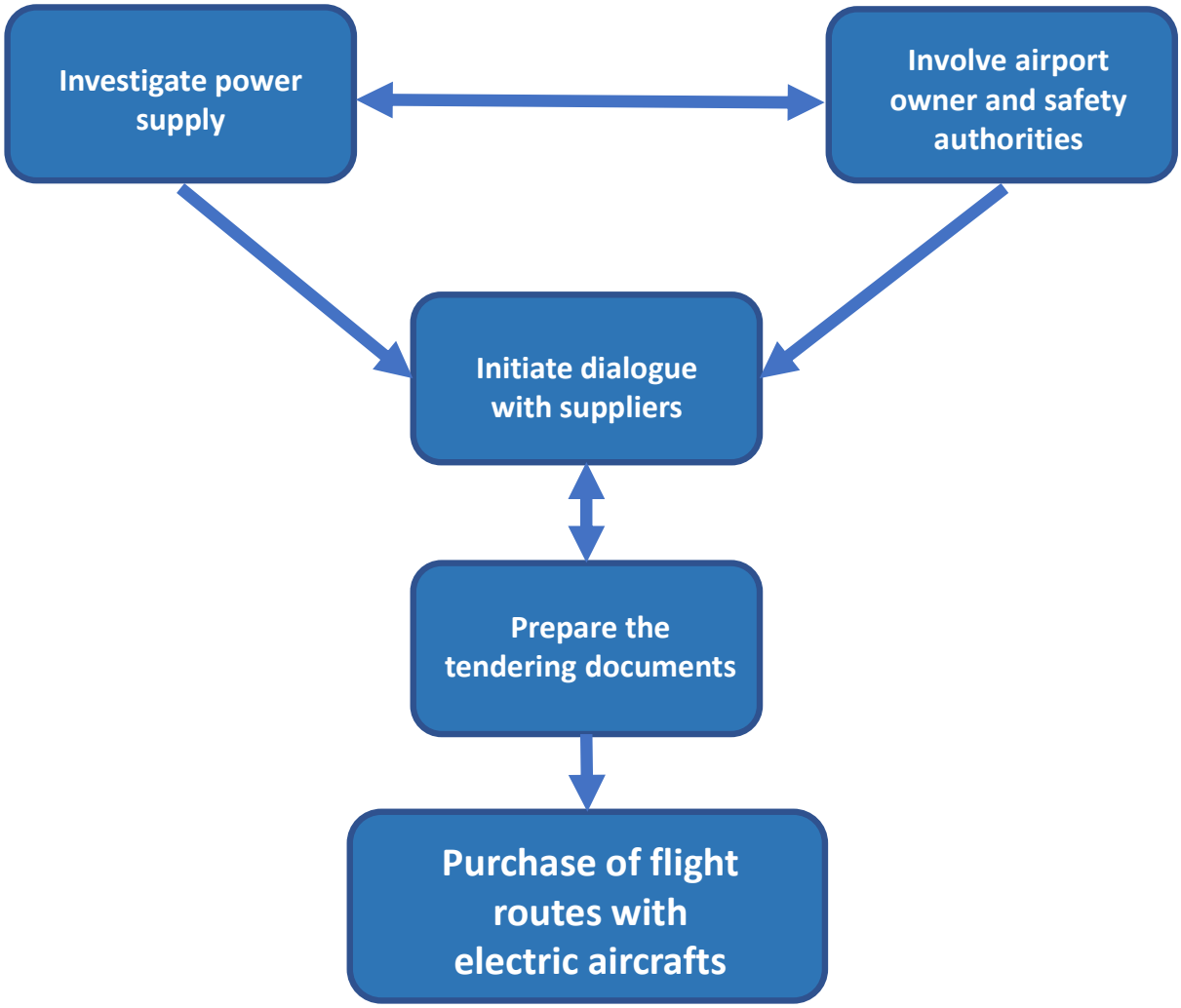

Figure 6-1: Suggested process for purchasing air route services operated by electric aircraft.

6.1.1 Investigate power supply

Electric aircraft will need to have their batteries charged while on the ground. It is therefore important to calculate how much power each airport will need if the current PSO routes are to be operated by electric aircraft. Here, forecasts must be made for electricity needs that take into account the predicted future number of aircraft

movements and today's capacity requirements (measured in the number of available seats), but also in a future scenario with increased route production.

If the current power supply at an airport is found to be insufficient, the power grid must be upgraded. In addition to being costly (cf. section 5.4.5), such upgrades also take time. There are examples from the ferry sector where it has taken up to five years from ordering the required capacity from grid companies until completion of the upgrade of the power grid. It will be especially important to estimate the power requirement during peak periods, that is when several electric aircraft are being charged simultaneously or when there are short intervals between each charge. A solution to the peak problem is to establish battery banks at each airport. Such battery banks have been established on the ferry connection Lavik–Oppedal. The fact that the state-owned company Avinor owns almost all airports in Norway should probably make such work easier than if there were several owners.

6.1.2 Involve airport owners and safety authorities

Early involvement of both airport owners, in Norway mainly Avinor, the regulatory authority (Norwegian Civil Aviation Authority, Luftfartstilsynet) and the safety authorities (in Norway mainly DSB) is also highly recommended. It is important to involve Avinor regarding the power supply, charging options, charging infrastructure and the facilitation of aircraft parking areas (airport apron) for both electric aircraft and others.

The Norwegian Civil Aviation Authority is the approval authority for airports and aircraft in Norway. Involving the Civil Aviation Authority early will therefore simplify the work of the suppliers involved. The Norwegian Directorate for Civil Protection (DSB) is important to involve in order to assess the risk and vulnerability related to the electrification of aviation. Among other things, DSB can provide stakeholders with important knowledge

on how to prevent accidents and other undesirable incidents in the implementation of electric aircraft.

6.1.3 Initiate a dialogue with suppliers

Experience from the ferry sector suggests that it is important to involve suppliers at an early stage. These suppliers will include aircraft manufacturers, airlines, battery manufacturers, manufacturers of battery banks, power grid companies and more. It is important to convey to these parties the goals that the authorities are working towards, the time perspective involved and the degrees of freedom that suppliers will have. The use of dialogue conferences/supplier conferences with group work produced good results in the ferry sector, and it is reasonable to assume that such conferences would work equally well in the aviation sector.

Perhaps the Aviation Conference in Bodø in 2024 could function as a start-up conference for the work of electrifying regional aviation in Norway, in the same way as the ferry conference in 2010 served as the start-up conference for the renewal of the ferry sector. Here, the Ministry of Transport could disclose that its goal in the tender for regional flights in northern Norway in 2030, is for requirements will include the use of aircrafts with zero CO_2 emissions, a minimum of 19 seats, STOL capabilities and a range of at least 250 km. This range is sufficient for operations on all PSO routes in Nordland county and also further north in the country, if charging facilities are available at the airports; Figure 6-2.

As such, early involvement will allow airlines, aircraft manufacturers, engine producers, battery builders and other suppliers to understand what they have to work towards.

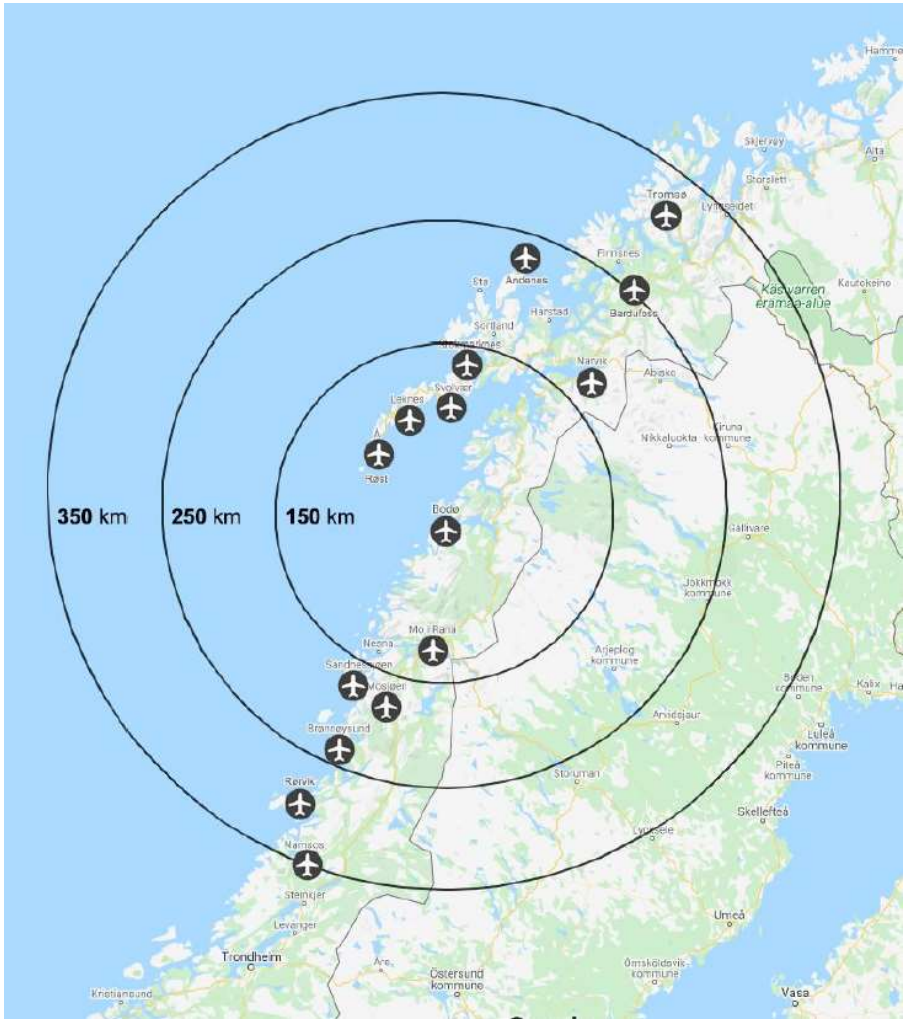

Figure 6-2: Airports within 150, 250 and 350 km distance from Bodø. (Source: Avinor and Luftfartstilsynet, 2020).

It is highly desirable that actors with different expertise and perspectives on the electrification of the aviation industry participate in the dialogue conferences. When it is time to start the procurement process, and the various suppliers have to outline how they intend to meet the objective of electrifying the aviation industry, it will be useful for permanent consortia working on different concepts to be established. This will produce insight into alternative solutions when it comes to making aviation less environmentally harmful. Another beneficial outcome is that the Civil Aviation Authority and the safety authorities gain increased knowledge about which technical solutions are under

consideration, and will be able to give the suppliers feedback on how to get their solution approved and certified. Finally, to make participation in this development phase more attractive, the authorities could, as was done for the two development contracts in the ferry sector, give participating consortia financial compensation.

6.1.4 Prepare the tendering documents

The experience gained by NPRA in the tenders for ferry operations is that the tenders that require new technology should be published much earlier than ordinary contracts. This is important to enable “maturation” on both sides of the table from publication of the tender documents, through dialogue and negotiation phases, until the final tender submission, as well as from the tender submission to the start of production. NPRA has spent up to twice as much time on the entire process as on an ordinary procurement contract.

Since it will be a fairly long time before electric aircraft can be used in ordinary scheduled operations, it is important for the Ministry of Transport to start the work on the competition documents and the contracts to be used in the tender competitions and in the work on a “development aircraft”, cf. the “development ferry” Ampere. In this regard, the competition documents and the contracts that were used on the Lavik–Oppedal and Hjelmeland–Nesvik–Skipavik connections may serve as inspiration.

One important decision is the length of the tender contract. Today, the maximum length of the tender period for airline purchases in northern Norway is 5 years. The development of and investment in electric aircraft and first-generation charging equipment requires significant capital. It is therefore important that the actors can use a depreciation period on the investments that is longer than 5 years. The tender contract for the development ferry on the Lavik–Oppedal connection was 10 years, while in the tender for a hydrogen-powered ferry between Bodø and Lofoten, a contract period of 15

years is planned. A development contract in aviation should probably have a time perspective of at least 10 years.

6.2 Summing up

This chapter focuses on the lessons to be learned from the electrification of the ferry operations in Norway when aviation ceases using fossil fuel.

Alternatives to fossil fuel will first become relevant on small aircraft. Most of the regional airports in Norway also short runways, where only small aircraft with STOL capabilities can land and take off. The fact that the airports are owned by Avinor should make it easier to establish necessary energy solutions (charging infrastructure and hydrogen logistics) at the airports. When we also take into account the broad political support for making aviation more environmentally friendly, the regional flight routes in Norway, the PSO routes, should be well suited to the introduction of electric aircraft. Thus, future tender announcements could be an important tool for testing new aircraft types.

To facilitate the use of electric aircraft on the regional flight route network in Norway, based on experiences from the ferry tenders, it is important for the Ministry of Transport to (1) carry out an investigation of the power supply and power requirements at all airports in Norway, (2) involve Avinor, the Civil Aviation Authority (Luftfartstilsynet) and the safety authorities, (3) initiate a dialogue with airlines, suppliers and subcontractors to the aviation industry and (4) start working on the design of new tender contracts.

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