Nordic Innovation

Reinventing aviation in the Nordics

The state of electric aviation and the case for enhanced industry-government collaboration.

November 2024

Executive summary

Accelerating the Uptake of Electric Aviation in the Nordics: A call to Action to align industry and governmental actions in the Nordics

"Policymakers can accelerate the uptake of battery-electric and hydrogen aircraft through framing strategic goals and forward-looking policies." [1]

The urgent need to reduce the climate impact of aviation is beyond dispute, demanding swift and extensive action. The global airline industry has already committed to achieving net-zero carbon emissions from their operations by 2050. However, achieving this goal demands action on many fronts, including the development of new aircraft and propulsion technology. The Nordic region is uniquely positioned to lead the global transition, particularly in regional electric aviation where the Nordic region is already a global leader. The Nordic Network for Electric Aviation (NEA) is committed to driving this transformation, enhancing Nordic competitiveness, and securing regional jobs, in collaboration with the Nordic governments.

The solutions needed are within reach, and the electric aviation ecosystem is set to commercialise by the end of this decade. Nordic governments and policymakers are important parts of the puzzle, i.e. in the ongoing systems change, and must play their part in supporting and enabling the transition to regional electric aviation.

NEA, an industry-driven collaboration and innovation project supported and co-funded by Nordic Innovation since its launch in 2019, was in 2024 tasked with assessing progress and identifying obstacles to the realisation of electric aviation in the Nordics. In response to a mandate from the Nordic Ministers for Transport and Infrastructure, NEA embarked on a Nordic Policy Tour starting in Denmark in April and ending in Iceland in May 2024. This tour brought together over 100 representatives from the aviation industry, policymakers, experts, and stakeholders in mobility and transport across all five Nordic countries. The goal was clear: to align industry and governmental actions to expedite the implementation of electric aviation in the Nordics, including cross-border flights.

The "Target True Zero: Government Policy Toolkit to Accelerate Uptake of Electric and Hydrogen Aircraft", prepared by the World Economic Forum with input from NEA and others, has been used as guidance in connection with the Policy Tour and as a structural basis for this report.

[1] https://www.weforum.org/publications/target-true-zero-govern- ment-policy-toolkit-o-accelerate-uptake-of-electric-and-hydrogen-aircraft/

The purpose of this report is to share the insights from the NEA Policy Tour 2024. The short-term goals of the tour were as follows:

1. **Map the current state of electric aviation**
   Establishing a baseline for joint action moving forward. This included country-specific reports and assessments as well as joint Nordic recommendations and activities.

2. **Identify obstacles and opportunities**
   Identifying obstacles to the realisation and commercialisation of Nordic electric aviation from 2028 onwards. Opportunities at societal, regional, and industry levels were explored, including benefits for the public.

3. **Provide grounds for decision-making**
   The tour, and hence this report, aimed to provide the Nordic governments with sufficient grounds for decision- making regarding the next steps at the Nordic and at the national level.

Reinventing aviation in the Nordics through Electric Aviation

The Nordic region includes all the partners needed in the ecosystem to pioneer new technologies for electric and hybrid-electric aviation. This presents a significant opportunity to lead in the drive to net- zero aviation, fostering both the net-zero transition and economic growth. To realise the potential, it is necessary to overcome engineering challenges, to develop new business models, and to implement policies that encourage adoption. In short, a collaborative effort among industry, governments, and politicians is urgently needed.

[2] https://www.iata.org/en/programs/sustainability/flynetzero/

Although the Nordic countries are small, collectively they form the world's 11 largest economy, capable of making a significant impact. By integrating aviation, energy, and industrial strategies, the Nordics can establish themselves as leaders in sustainable aviation also in a long-term perspective.

"Not so long ago, the perceived wisdom suggested that demand for sub-50-seat regional airliners would remain limited for a foreseeable future. But the pressure to bring reduced or zero carbon propulsion technology to market is changing the outlook and opening new possibilities to connect thousands of smaller communities that benefit from little or no scheduled airline service."

Quote from Charles Alcock, Farnborough Airshow 2024

Electric aviation will shape a new form of transportation, in between the commercial aviation of today and public transportation. It will increase availability, not only with new routes, but also with increased frequency. As noted in the NEA report, "Business models for Nordic electric aviation"[3]:

"Businesses that are located in rural areas can get much better connections to regional and national markets and capitals, as well as the rest of the world, which can be translated into economic growth for these businesses".

Regional and national governments may see themselves at the centre of a new and blooming global industry. When electric aviation becomes available to customers, the increased flexibility may shift the trend of urbanisation by offering ways of commuting that are flexible, affordable and sustainable. Regions may become more attractive to young people, and they may be seen as more lucrative places to establish business. Greater connectivity will result in increased welfare for many by providing better access to essential services and opportunities.

This report shares findings and provides recommendations that aim to deliver a technology transition where the Nordics are setting the global standard.

[3] https://www.nordicinnovation.org/2022/business-models-nordic-electric-aviation

Nordic Goals

There is already a Nordic framework in place upon which targeted, joint Nordic goals and priorities for electric aviation and the way forward can be built:

- The Nordic Prime Ministers' vision (Nordic Vision 2030) says that the Nordic region will become the most sustainable and integrated region in the world by 2030.
- One of three innovation missions under the Nordic Vision 2030 states that the Nordic region should become a pioneering region for green mobility. The Fredrikstad declaration concretises this ambition.
- A study commissioned by Nordic Innovation, "The next stages of Nordic Innovation and Cooperation for sustainable mobility and transport | Nordic Innovation", concluded that the transition to green aviation should be a top priority for collaboration in mobility and transport going forward.

Task 1 Key Findings

Net-zero Aviation Strategy

All Nordic countries are committed to achieving net-zero aviation by 2050, in line with ICAO and EU goals. However, the national goals vary in terms of scale, timeline, and terminology - such as "net-zero", "CO2 neutral", "fossil-free", "green" and "carbon neutrality".

	Scope	Year	target
Denmark	One domestic route	2025	Green route
	All domestic routes	2030	Green route
	Aligned with ICAO	2050	Net-zero
Finland	Aligned with ICAO	2050	Net-zero
Iceland	Aligned with ICAO	2050	Net-zero
Norway	Accelerate the transition towards zero and low emission aviation	As soon as technologically possible	Zero and low emission
	Aligned with ICAO	2050	Net-zero
Sweden	All departing domestic flights	2030 (domestic)	Fossil-free
	All departing international flights	2045 (all aviation)	Fossil-free
	Aligned with ICAO	2050	Net-zero

Create Enabling Environment

While there is support for innovation, research and development in place, more is needed to accelerate progress. Electric aviation often competes with other mobility solutions for grants. In many cases the selection criteria are not relevant or targeted enough for electric aviation. Furthermore, electric aviation bridges public and commercial transport, offering unique benefits that current frameworks sometimes overlook.

The Policy Tour confirms that regulatory bodies appreciate the opportunity to discuss aviation at a systemic level, recognising its potential for transformative impact. Nordic regulatory bodies face challenges in developing and deploying updated regulatory frameworks through ICAO, the EU, and EASA before the technology exists and is available in the market. This is a chicken and egg dilemma. It is vital to avoid delays in the innovation and implementation process to reach the 2030 climate targets and to foster a viable new aviation industry.

Cross-border support and collaboration within the Nordic region can accelerate the realisation of electric aviation. On the Policy Tour country meetings were held, and all reported back that clarifications are needed as regards which laws and regulations apply to electric aviation.

Only road and water transportation can be regarded as public transportation, according to EU-legislation. This is a barrier to the development of electric aviation and to the development of multimodality and new business models.

Accelerate Uptake with Incentives and Targets

Currently no Nordic country has specific incentives or targets for electric or hybrid- electric aviation in place. However, Norway and Denmark have published plans that include electric aviation. Norway's National Transport Plan allocates NOK 1 billion to support zero and low-emission aviation from 2025 to 2036. Denmark has agreed to establish a public fund to support the transition through tenders for green domestic routes, as well as funding to support smaller regional airports, and other initiatives - in total 2.85 billion between 2027 to 2033.

Task 2 Identifying obstacles and opportunities

During the Policy Tour the NEA ecosystem identified the obstacles that may prevent a technology transition, and turned them into recommendations:

- **Set Nordic Goals:** The Nordic countries should define a set of goals for 2040 with subgoals and intermediate milestones to attract investors and spur governmental and industry action. These goals should also be supported with state funding mechanisms. A first goal could be to agree, on the Nordic level, on where the first electric routes should be and support the realisation with funding.

- **Allocate more state funding:** There should be a joint Nordic investment strategy to help fund the agreed goals. This should cover all parts of the ecosystem, including airports (grid, charging, energy storage, loans), airlines (routes, pilot training, loans), OEMs (innovation, R&D, testing, scaling, loans, production investment), government (CAA empowered). Delivering a new generation of electric aircraft will require considerable state financial support.

  All the incumbent OEMs are the global leaders they are because they have the support and backing of host states that provide bridging loans and other financial mechanisms to compensate for the long R&D lead times that the private sector cannot support. It is a fact that no modern-day aircraft programme has come to market without some form of government funding, up to and including the most recent airframe and engines we see flying today. In the Nordics, there is also precedent. The Swedish government supported the development of the SF340 and 2000 programmes in the 1980s with funding solutions. Unless the Nordic countries, individually or collectively, are prepared to do the same with Nordic OEMs, there is a risk that the technology will scale in other countries and regions that are prepared to invest. This is not a question of providing direct state aid in the form of grants, but rather financial instruments (loans, guarantees) that are more favourable than what is available in the open market.

  - **Agree key policy priority areas:** The Nordic states should identify and establish priority areas for policy development and create blueprints for implementation. An example could be to prioritise infrastructure development in good time before aircraft enter into service.

  - **Ensure infrastructure is delivered in parallel:** All Nordic airports are currently working on their implementation plans. However, without the timely development of infrastructure (charging infrastructure, grid capacity, energy forecasts), there is a risk that new electric aircraft technology will not be able to be fully utilised when ready for take-off. Collaboration within the ecosystem is crucial.

- **Strengthen regulatory agency collaboration:** The cooperation between the CAAs in the Nordics and the entire ecosystem of electric aviation should be strengthened. This would ensure that preparatory work on new laws and regulations are ready and in step with the timelines of new aircraft delivery. There is a need for closer cooperation and focus on electric aviation within EASA, the EU and ICAO to set international standards in Europe and globally.

The Swedish Minister of Infrastructure emphasised the importance of preparatory work on future laws and regulations to avoid regulatory conflicts once the aircrafts are ready. (First meeting in February 2024 between NEA and the Nordic ministers)

The Nordic states should collaborate to maintain their leading position, accelerate the implementation of international and EU regulatory frameworks, support the scaling up the industry, and position the Nordics as a test arena for electric/hybrid-electric aviation. Avinor and the Norwegian Civil Aviation Authority have entered into a cooperation agreement on the establishment of Norway as an international test arena for zero- and low-emission aircraft. There is also test arenas in Sweden and Finland. We should assure that they learn from each other and collaborate to enhance the work even more. Airports need comprehensive forecasts to start planning, to set up grid for an airport takes time. There is also a need for a stronger electric grid in the Nordics with more capacity/production to support airports with the electricity needed.

- **Review EU PSO rules to drive technology uptake:** The Nordic region is a pioneer and significant user of PSO networks. The current EU level rules on PSO could be adapted to drive a faster uptake of new electric technology by prioritising new technology and driving funding to ground infrastructure.

In making these recommendations, NEA partners emphasise the importance of supporting all technologies and pathways that contribute to sustainable aviation. Electric and hybrid-electric technologies offer clear pathways to decarbonisation for regional flights, and they can alleviate the demand for sustainable aviation fuels (SAF) which is urgently needed for longer flights.

Overall, it is essential that all aviation actors, industry and government must focus on both SAF and new technologies, ensuring a comprehensive strategy for sustainable aviation. The industry will only achieve its net-zero targets using a basket of measures and no industry roadmap to net-zero gets beyond 70% with SAF alone.

Task 3

Providing ground for decision-making

Next Steps for Accelerating Electric Aviation in the Nordics

To build on the momentum generated by the Nordic Policy Tour and the findings from the recent assessment, the following next steps are recommended to further accelerate the adoption of electric aircraft in the Nordics:

Proposal: Establish a Nordic Working Group

To debate, develop and implement these findings and recommendations, it is crucial that a forum is urgently established that will allow a holistic approach, but also that the fine details can be discussed and agreed. As an example, it should be agreed what could be done collectively at the Nordic level and what should be done at the national level. Even if the overall goals are shared, there may be differences as regards the approach to implementation. A Nordic working group could provide a platform for sharing best practices, harmonising regulations, and coordinating infrastructure development and preparations for the implementation of electric aviation before the end of the decade. Moreover, it would give the Nordics a united front when working with global partners, such as EU, EASA and ICAO.

Possible tasks of the Nordic Working group

The findings in this report of the NEA Policy tour 2024 was presented at the Nordic Transport Ministers meeting in Gothenburg, August 14th, 2024. At the meeting a declaration for electric aviation was signed.

"When we, the Nordic transport ministers, convened in Fredrikstad on 8 November 2022, we agreed to pave the way for the establishment of Nordic fossil-free air routes by 2030. This commitment involves promoting a fossil- free aviation sector worldwide and encouraging future collaboration between the Nordic countries.

Electric aviation is pivotal in the shift towards a fossil-free aviation sector, not least in the more sparsely populated parts of the Nordic regions. The Nordic countries have the potential to become pioneers for the establishment of commercial electric aviation on a larger scale. However, to fulfil the goals set forth in the Fredrikstad declaration, we must intensify our efforts.

We will do so by:

- COLLABORATING on the requisite regulatory frameworks and permit processes to introduce electric aviation, while ENCOURAGING close dialogue between the Nordic authorities concerned.
- ADVOCATING COLLECTIVELY in global platforms such as the European Union and the International Civil Aviation Organization for a seamless and harmonized introduction of electric aviation.
- PROMOTING and ACCELERATING the establishment of commercial electric aviation in the Nordic countries, while SUPPORTING opportunities for our industries to become world leaders in important technologies related to electric aviation."

The Nordic Network for Electric Aviation (NEA) invites the Nordic ministers to embrace a collaborative approach that aligns with the goals of fostering electric aviation within the region, as expressed by the declaration. The summery of our work, so far, outlines how our shared efforts can not only meet your objectives but also position the Nordics as a global hub for electric aviation technology.

1. Collaborating on Regulatory Frameworks:
   - There is a need for coherent regulatory frameworks to facilitate the introduction of electric aviation. Collaboration can enable streamlined permit processes, ensuring a supportive environment for innovation.
   - By establishing a Nordic Working Group, we can create a platform for close dialogue between Nordic authorities, industry stakeholders, and policymakers to discuss the unique regulatory needs of electric aviation, thus enabling faster adoption and implementation.

2. Advocating Collectively on Global Platforms:
   - Together we can be advocating for harmonised regulations and standards in international forums, including the European Union and the International Civil Aviation Organization (ICAO).
   - Through a united Nordic front, we can push for policies that recognise electric aviation as a critical pathway to achieving net-zero emissions, enhancing our influence in shaping global standards.

3. Promoting and Accelerating Commercial Electric Aviation:
   - Our initiative aims to accelerate the establishment of commercial electric aviation in the Nordics. By setting joint Nordic goals for electric aviation, we can create a cohesive strategy that includes necessary funding mechanisms and infrastructure development.
   - Establishing, on a Nordic level, where the first electric routes could be and support it with funding, will not only demonstrate feasibility but also attract investment and bolster public confidence in electric aviation.

More recommendations can be found in chapter 7.

The Nordic region stands at the forefront of electric aviation innovation, with the potential to set global standards in sustainable aviation. By collaborating closely, we can overcome obstacles, harness opportunities and ensure that the Nordic countries not only meet their climate commitments but also secure a prosperous future in electric aviation.

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Introduction

List of Abbreviations

ACI: Airports Council International

AFIR: Alternative Fuels Infrastructure Regulation

BESS: Battery energy storage

BEV: Battery electric

CAA: Civil aviation authority

EASA: European Union Aviation Safety Agency

EVSE: Electric vehicle supply equipment

FAA: Federal Aviation Administration

IATA: The International Air Transport Association

ICAO: International Civil Aviation Organization

MCS: Megawatt charging system

NEA: Nordic Network for Electric Aviation

NISA: Nordic Initiative for Sustainable Aviation

PHEV: Plug-in hybrid vehicle

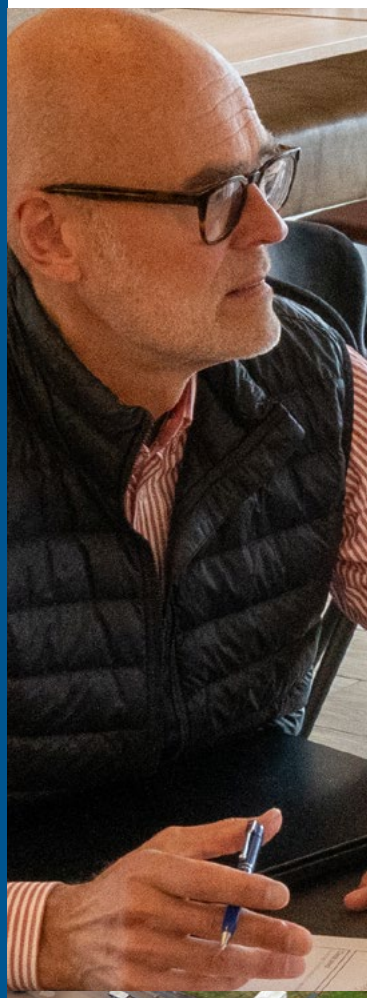
PSO: Public Service Obligations

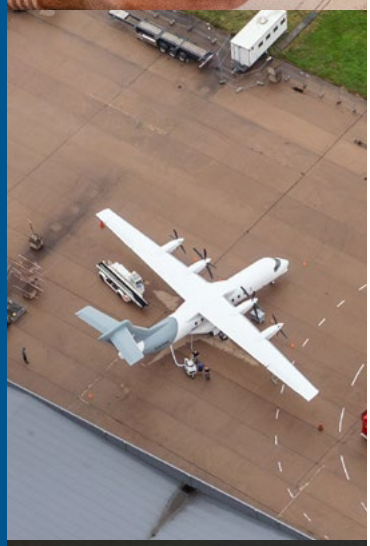
AF: Sustainable Aviation Fuel

WEF: World Economic Forum

Chapter 1:

Introducing NEA and the outlook for electric aviation in the Nordic region





The Nordic Network for Electric Aviation (NEA)

The overall aim of the Nordic Network for Electric Aviation, NEA, is to speed up the transition to a sustainable future where Nordic citizens can benefit from innovative mobility and connectivity solutions.

The Nordic countries are frontrunners when it comes to electric aviation. However, before NEA these were stand-alone efforts. The idea behind NEA was that by combining and coordinating individual efforts, the Nordic countries could take a leading position in the transition to electric regional air travel worldwide. This development presents an important opportunity for Nordic business and innovation. Individually, the Nordic countries are small, and to have a truly global impact NEA plays a vital role, bringing the countries and aviation industry together in a cross-border ecosystem collaboration. When working together, the Nordic countries represent the world's 11th largest economy, which significantly strengthens the region's influence and capabilities.

The Nordic countries have all set ambitious sustainability goals. In January 2019, the Nordic Prime ministers signed the "Declaration on Nordic Carbon Neutrality", committing their countries to strengthening cooperation to attain carbon neutrality domestically. The declaration emphasises the importance of decarbonisation of the transport sector. NEA is a contribution to this work.

NEA's mission: To accelerate the shift to electric regional aviation through collaboration.

NEA's vision: A connected and vibrant Nordic region empowered by electric aviation.

Background

Electric aviation is one of many important contributions to the transition toward zero and low-emission aviation.

During the NEA project, the Nordic region has witnessed the emergence of an entirely new aviation industry. The ball started rolling in 2018 when Avinor shared the vision that all domestic short-haul flights should be electric by 2040 . Around the same time, the start-up companies Heart Aerospace (Sweden) and Elfly Group (Norway) were founded. The Nordics have been trailblazers in setting national targets for sustainable development. Several specific conditions have made the Nordic countries attractive to the growing electric aviation industry. These conditions include:

1. **Geography**: The geography encourages the development of air transport, as it presents natural obstacles to the construction of road and rail networks. Notable geographic features include the long coastlines of Norway, the abundance of lakes in Finland and Sweden, and the long-stretched archipelagos, mountains, and harsh winter climate in the Northern region, including the islands of Iceland, Åland, Greenland and the Faroe Islands.

2. **Energy Infrastructure**: The existing energy infrastructure includes access to hydropower, geothermal energy, wind, and solar power plants, creating the cleanest energy mix in the world. Benefitting from this, electric aviation will leave close to zero climate footprint from use in the Nordics.

3. **Innovative Industries**: Nordic industries are innovative, focused on export markets, and able to attract highly skilled talent for research, development and innovation.

4. **Shared Values:** The shared Nordic values encompass openness and willingness to share, as well as traditions for collaboration and progress, making the Nordics a shared platform for innovation.

All these circumstances have propelled the Nordic Network for Electric Aviation and have provided the Nordics with a unique industry collaboration.

[1]Norsk luftfart skal bli elektrisk i 2040 – NRK Norge – Oversikt over nyheter fra ulike deler av landet

Climate, Cost and Connectivity – the 3 Cs

From the very start, in the first project description submitted to Nordic Innovation, NEA used the 3Cs as explanatory model. The 3 Cs describe both the reasoning behind electric and hybrid-electric aviation, as well as the solutions that electric and hybrid-electric aviation can bring.

Let us start with the reasoning behind the need for a change in regional aviation. Climate: Aviation accounts for 2,7% of the global CO2 emissions today, but emissions will grow exponentially if nothing is done (see more details in the table below). Cost: Both regional airliners and airports in the Nordics are burdened by high costs that give low profitability. Airliners also have high maintenance costs, and in some parts of the Nordics there is a decreasing number of travellers. Connectivity: Aviation is growing in major hubs, which leads to underuse of regional airports.

NEA believes that electrification can positively impact the 3 Cs. Not only in bringing down emissions, alongside SAF and hydrogen, but also in making flying and sustainable mobility accessible to more people. Electric planes are cheaper to operate and can therefore unlock convenient and effective regional travelling, and help regional airliners and airports make a sustainable profit. A value proposition for regional aviation can be based on the 3 Cs:

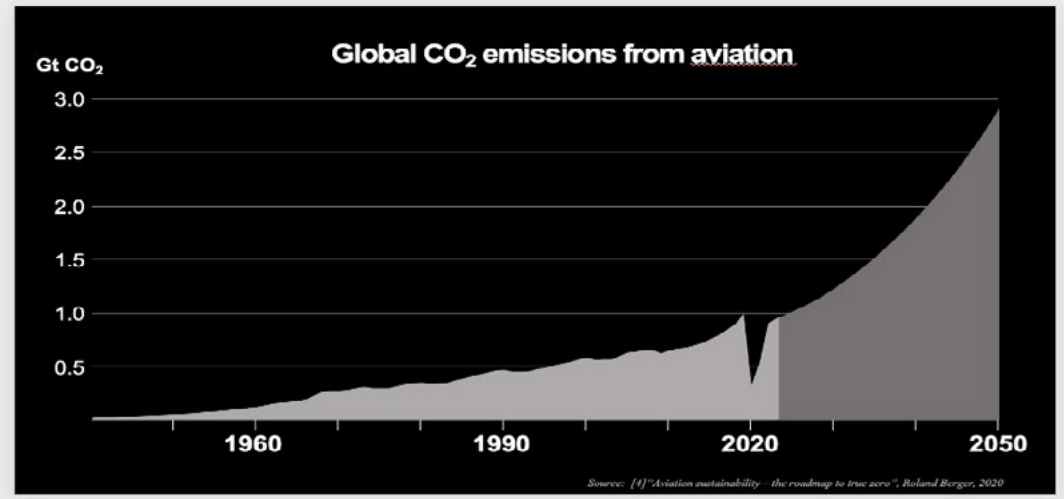
1. **Climate** relates to the climate footprint of electric aviation. Operations with close to true zero carbon emissions are possible due to the clean Nordic energy mix.

2. **Cost** relates to the reduced direct operating cost made possible due to the lower maintenance requirements and increased energy efficiency.

3. **Connectivity** relates to benefits for people and businesses from a distributed aviation route system. It includes the rebirth of old regional routes and new regional routes, while enabling faster door-to-door travel times.

The world looks different today than in 2019. A fourth bullet point should be added in our reasoning: Resilience. One example of ensuring resilience could be to produce electricity by solar and wind close to the airport instead of using fossil aviation fuel imported from other countries.

We have seen evidence that Nordic airliners are struggling. Norwegian Air Shuttle ASA have bought Widerø, and Braathens Regional Airlines will fly on contract for Scandinavian Airlines, which in turn was recently bought by KLM and Air France.



Aviation, with the engines and energy it runs on today, is a threat to a sustainable future. Aviation accounts for 2,7% of the CO2 emissions globally. One could argue that there are other areas we should start with to stay on the path towards 1,5 -2 degrees warming, according to the carbon law that was behind the Paris agreement. As can be seen from the table above, air travel has grown in the last decades. Consequently, emissions have increased, even though aircraft themselves have become more fuel efficient. The development came to an abrupt stop during the lockdown, but today the emissions are back to where they were before the pandemic.

By 2050, the emissions from aviation are expected to triple. Today only 20% of the world's population has set foot on an airplane. This will increase as more people can afford flying, as have already started happening in China and India. As other industries are decarbonising, the share of emissions from aviation will increase even more rapidly.

Aviation in the Nordic countries towards 2030

This section gives an overview of the state of play in Nordic aviation, highlighting recent developments in each country and trends towards 2030 relevant for electric aviation.

	Number of airports 2023	ACI netzero	Passengers 2019	Passengers 2023	PSO routers 2023	SAF 2023	Pipistrels 2024
Denmark	14[a]+20[b]	2030	36.900.000	33.500.000	0	<0,1%	0 (airforce 2 2021-23)
Finland	20+4	2025	26 000 000	18 300 000	7	*	1
Iceland	1+12	2030	8.000.000	8.500.000	6	0	1
Norway	43+5	2030	54 099 000	49 015 000	25 (route areas)	0.5%	4
Sweden	10+32	2020	51 870 000 **	34 474 000 **	11	1,8%***	5

* Fueling options are provided by fuel companies in Finland.
** All Swedish Airports
*** SAF used on all Swedish airports as proportion of total Jet-A1
a Commercial airports
b Airfields (private)

Note on Norwegian numbers:
Avinor operates 43 airports in Norway. In addition, there are five other airports with commercial flights. The number of passengers reported is passengers in Avinor's airports. SAF 2023 shows the percentage of sold fuel at Avinor's airports which is SAF.
PSO routes: https://transport.ec.europa.eu/document/download/9168af3e-67c7-430f-b46c- 61b76236d8cb_en?filename=pso_inventory_table_2023-02.pdf (17/2-23 for EU countries)

Note on Danish numbers:
SAF 2023 shows the approx. percentage of sold SAF in CPH Airport and AAL (Aalborg lufthavn).

Note on Swedish numbers:
Swedavia operates ten airports and 32 are operated by municipalities and regions (two additional privately owned airports exist, not included here). Figures for flown passengers include the 42 (10+32) airports mentioned.

Denmark

Overview of Aviation in Denmark 2024 - Airports and Infrastructure

Denmark's aviation sector consists of 14 commercial airports and 20 private airfields, which include helicopter landing sites for various purposes. Copenhagen Airport (CPH), the largest, is co-owned by private investors and the Danish state and manages Roskilde Airport. Many public airports are operated by municipalities or regions, while smaller airports are privately owned.

- Major Airports: Copenhagen Airport (CPH), Roskilde Airport (RKE), Billund Airport (BLL), Aarhus Airport (AAR), Aalborg Airport (AAL), Odense Airport (ODE), Sønderborg Airport (SGD).
- Regional Airports: Esbjerg Airport (EBJ), Karup Airport (KRP), Bornholm Airport (RNN).
- Private Airports: Sindal Airport (CNL), Skive Airport (SQW), Lolland Falster Airport (MRW).
- Military Use: Airports like Karup and Aalborg serve both civil and military purposes.

Airlines

Scandinavian Airlines (SAS) is the largest Danish airline, offering both domestic and international routes. Low-cost carriers such as Ryanair and Norwegian are also prominent, alongside regional airlines like DAT and Alsie Express, which serve Denmark's internal connections. Nordic Seaplanes offers seaplane services between Copenhagen and Aarhus ports.

Passenger Traffic and Trends

As the aviation industry recovers from the pandemic, both leisure and business travel are seeing a steady increase. The government and industry players are focusing on reducing the environmental impact of air travel through investments in sustainable aviation fuel (SAF) and the development of electric and hydrogen-powered aircraft.

Environmental and Regulatory Initiatives

Denmark has set ambitious targets to reduce aviation emissions, with Copenhagen Airport leading efforts towards energy-efficient operations, renewable energy use, and becoming CO2-neutral. In line with national policy, the focus is on promoting safe, efficient, and environmentally sustainable air travel.

The government has committed to achieving green domestic flights by 2030, and a passenger tax will be introduced in 2025, starting at DKK 70 per trip and rising to DKK 100 by 2030. Revenue from this tax will support social initiatives and fund sustainable aviation solutions, such as establishing green domestic routes.

Technological Advancements and Infrastructure Development

The Danish aviation sector is advancing on several fronts:

Expansion Projects: Copenhagen Airport is undergoing expansion to accommodate future growth and further strengthen its position as a European hub.
Sustainable Aviation Projects: There are multiple projects focused on integrating SAF and preparing for electric aviation. Copenhagen Airport is leading the EU-funded Smart Airport project, ALIGHT, to promote sustainable aviation.
Economic Contributions: Aviation plays a vital role in Denmark's economy, supporting employment, tourism, and trade, and serving as a crucial enabler for global business connections.

Electric Aviation

Denmark is preparing for the introduction of electric aircraft, with projects such as the collaboration between Væridion and Copenhagen Helicopter to establish an electric route between Roskilde and Læsø. Nordic Seaplanes is also exploring opportunities to introduce electric aircraft on its routes between Copenhagen and Aarhus.

Finland

Overview of Aviation in Finland 2024 - Airports and Infrastructure

Finland's aviation network consists of 24 airports, with 20 managed by the state-owned company Finavia. Helsinki-Vantaa Airport is the country's largest hub, with Finavia also operating regional airports across Finland, including key locations in Lapland which are vital for tourism. As tourism in Lapland continues to grow, Finavia has invested heavily in upgrading the region's airports.
Major Airports

Major Airports

- Helsinki-Vantaa Airport (HEL): Finland's central hub for both domestic and international flights.
- Regional Airports: Airports in Lapland, including Rovaniemi, Ivalo, and Kittilä, play an increasingly important role in Finland's growing tourism sector.

Sustainability Initiatives

Finavia is at the forefront of sustainability efforts, having achieved net-zero emissions at its airports in Lapland in 2023. It aims to achieve carbon neutrality across all Finnish airports by 2025, ahead of the global target of 2030 set by the Airports Council International (ACI).

Airlines and Geopolitical Challenges

Finnair, Finland's national airline, has historically focused on routes to Asia via Russian airspace. Due to geopolitical tensions, these routes have been restructured, leading to longer flight times and higher fuel consumption. Nonetheless, Finnair is committed to reaching carbon neutrality by 2045 and is investing in SAF, research, and new technologies to reduce emissions.

Electric and Sustainable Aviation

While Finland has no commercial electric flights currently, electric and hybrid aviation could offer a sustainable alternative for short domestic routes. Routes connecting Lapland's regional airports or the Helsinki-Tallinn route (approx. 90 km) are under consideration for future electric aviation. Hydrogen is also seen as a potential solution for long-haul flights, and Finland's government is positioning the country to become a leader in the hydrogen economy.

EU Regulations and National Infrastructure

Finland is aligning with the EU's AFIR Regulation, which requires the exploration of electricity and hydrogen in aviation. A national programme to develop the necessary infrastructure for alternative fuels and technologies, including electric aviation, is being prepared and will be submitted to the European Commission in 2024.

Iceland

Overview of Aviation in Iceland 2024 - Airports and Infrastructure

Iceland's aviation sector consists of 13 airports, with Keflavik Airport (KEF) serving as the primary international gateway. In 2023, KEF handled 7.8 million passengers, reinforcing its importance as a central hub for international connections and transcontinental flights. KEF is operated by Isavia ohf., a public limited liability company owned by the Icelandic state. The airport is committed to the ACI Net Zero 2030 target.

A study on Future Fuel Readiness was conducted at KEF to evaluate the steps necessary to prepare the airport for future energy needs. While electric flights will have limited use at KEF, the long-term focus is on hydrogen as a sustainable solution, with sustainable aviation fuel (SAF) acting as a bridge in the short term. Significant expansion of the electric grid will be required to support the energy transition for ground operations.

Isavia Regional Airports, a subsidiary of Isavia ohf., operates under a service agreement with the state and does not receive funding from the parent company. It manages 12 regional airports, including three international airports in Reykjavík, Akureyri, and Egilsstaðir. In 2023, there were six Public Service Obligation (PSO)

routes, with two additional PSO routes funded during winter months. Passenger numbers on these routes represent 3-4% of total passengers, with pre-pandemic levels near 800,000 passengers, now reduced to below 700,000 post-2019.

Electric Aviation Preparations

By 2025, Iceland expects the arrival of its first electric training aircraft, which will use small portable charging stations. The country is preparing to establish electric charging infrastructure, starting with sites near Reykjavik. Over the next five years, airport development projects will focus on collaborating with airlines to assess energy needs and update staff training for the changing aircraft fleet.

Infrastructure Development

Currently, electric infrastructure for aircraft is limited to Reykjavík Airport, where a charging station is used for Pipistrel aircraft. This small electric aircraft can reach Selfoss airfield (49 km) and requires about 30 minutes to recharge.

Expanding charging infrastructure at domestic airports is essential, especially outside Reykjavík. Isavia Regional Airports will conduct an analysis to assess the energy infrastructure and distribution grid's capacity to meet the needs of both small and large aircraft. This development will be crucial for both operational and potential future airports likely to serve electric aviation near urban centres.

Icelandair and Future Plans

In 2021, Icelandair signed a Letter of Intent (LOI) with Heart Aerospace for the hybrid-electric 30-seater ES-30.

Iceland's National Transportation Plan (2024-2038) emphasizes the importance of using advanced technology to connect communities and link Iceland to the rest of the world in an environmentally sustainable way.

Norway

Overview of Aviation in Norway 2024 - Airports and Infrastructure

Norway's aviation network comprises 43 airports, managed by Avinor, with additional privately owned airports supporting domestic route traffic. The country's domestic air traffic is primarily served by SAS, Norwegian, Widerøe, and Danish Air Transport (DAT). SAS and Norwegian operate routes between major Norwegian airports, while Widerøe and DAT serve smaller airports, including PSO routes subsidized by the Ministry of Transport.

There are 25 PSO route areas in Norway, some covering multiple routes, contributing to a higher total number of PSO routes. In 2023, these PSO routes served close to 1.2 million passengers, representing 8% of all domestic air travel in Norway. Widerøe's fleet consists primarily of Dash8 aircraft with capacities ranging between 39 and 78 seats.

New Airport Development

Norway is constructing its first new airport since Oslo Gardermoen opened in 1998. The new Mo i Rana Airport is scheduled to open in 2027. In addition, a new airport in Bodø, replacing the existing facility, is expected to be completed by 2029/2030. This project is a collaboration between Avinor, Bodø Municipality, and the Norwegian Armed Forces.

Transition to Fossil-Free Fuels

Norway is committed to phasing in fossil-free fuels for aviation, requiring significant infrastructure updates at airports. This includes ensuring the availability of electricity, hydrogen, and other alternative energy carriers. Establishing this infrastructure will demand substantial investment, and Avinor has already begun assessing the power needs at its airports to support future electrification.

Avinor's traffic light map identifies the costs and timeline for grid connections at different airports, with some projects requiring up to eight years from request to completion.

National Transport Plan (2025-2036)

The Norwegian Ministry of Transport has established a collaborative forum with the Confederation of Norwegian Enterprise (NHO) and the Norwegian Confederation of Trade Unions (LO) to guide the green transition in aviation. The development of infrastructure is key to ensuring Norway becomes a test arena for low-emission aviation technologies.

Avinor estimates that investments in charging infrastructure and network connection for new aircraft could total NOK 1.6 to 2 billion by 2040, with NOK 740 million required by 2030. Piloting hydrogen technology will incur additional costs, estimated at NOK 250 to 400 million for testing and developing hydrogen refuelling at selected airports.

Sweden

Overview of Aviation in Sweden 2024 - Airports and Infrastructure

Sweden's aviation network includes 42 airports, of which 10 are state-owned and managed by Swedavia, while the remaining 32 are owned by municipalities and regions. The state-owned airports do not cover all of Sweden's geographical needs, making municipally owned airports crucial for the country's crisis preparedness, defence, and ensuring regional growth.

National Transport Plan (2026-2037)

The Swedish Transport Administrati on is currently working on the National Transport Plan for the 2026-2037 period. This plan will guide the development and management of Sweden's aviation infrastructure. Early indications suggest that electric aviation will play a key role in improving the profitability and availability of short-range routes, though airport design and charging infrastructure challenges remain to be addressed.

Airlines and Sustainability

In 2024, Scandinavian Airlines (SAS) and Braathens Regional Airways (BRA) entered into a wet lease agreement, with BRA operating aircraft on key domestic routes in Sweden on behalf of SAS. Both airlines are committed to reducing the environmental impact of air travel and working towards sustainability goals.

Fossil-Free Aviation Outlook

Swedavia is heavily involved in electric aviation projects, exploring battery and fuel cell-driven aircraft, as well as using hydrogen as a sustainable fuel for jets. These initiatives are part of a broader strategy to promote fossil-free aviation. Swedavia is also assessing the infrastructure needs for future electrification, including ground equipment, vehicles, and hydrogen production on-site.

Infrastructure Development

Swedish Regional Airports (SRF) is studying the power needs for their airports and has begun planning to increase capacity through the installation of solar panels. SRF has organized electric flight tours, together with NEA, across Sweden (southern, central, and northern regions) to demonstrate the feasibility of electric aviation. Skellefteå Airport is a leader in this space, with a 1MW power supply for charging electric aircraft and plans for a fuel cell hydrogen-powered flight system.

Heart Aerospace: A Swedish Pioneer

Sweden's Heart Aerospace is pioneering the development of hybrid-electric regional aircraft, having raised $145 million to develop the ES-30, a 30-seat hybrid aircraft capable of all-electric flight up to 200 km. With over 550 orders, options, and Letters of Intent (LOIs) from major airlines such as United, Air Canada, SAS, and Braathens, the demand for the ES-30 highlights Sweden's potential leadership in the field of sustainable aviation.

Nordic initiatives

Airbus, Vattenfall, Swedavia, Avinor, Stakraft and SAS, have signed cooperation agreements which include mapping of value chains and prerequisites for the introduction of zero-emission aircraft, based on hydrogen in Norway and Sweden.

The **Nordic Network for Electric Aviation (NEA)** is accelerating the transition to sustainable aviation across Denmark, Finland, Iceland, Norway, and Sweden. By focusing on electric and hybrid-electric aviation, each country is contributing to the region's leadership in carbon-neutral transport, driving both technological innovation and regional connectivity. Policymakers should continue to support these initiatives to ensure that the Nordics remain at the forefront of global green aviation.

Chapter 2:

Technical development

The transition to fossil-free aviation affects several areas within aviation, both on the airport and aircraft side. Reduced climate impact and increased sustainability efforts are crucial drivers. New technical solutions are needed.

Infrastructure development

This transition also includes climate adaptation for infrastructure, such as:

- More efficient airspace and air traffic services
- Operations and maintenance of airports

The development of new types of fuels, including electricity, may mean that airports will take on a new role as energy hubs for the management and distribution of fossil-free fuels. This evolution is evident as airports begin to establish facilities such as solar parks and battery storage. Future airports may thus be energy self-sufficient and also serve as energy suppliers to other sectors, such as transportation. In Sweden Borlänge and Örnsköldsvik are planning the establishment of battery storage near the airports, and solar energy facilities are under planning at many other airports. However, it is crucial that this development is carried out without disrupting vital technical equipment at the airports.

This report is focusing on electric and hybrid electric aviation but in the future it is clear that there is a huge transition of the infrastructure surrounding airports, both physically and digitally. New fuel types, such as electricity and hydrogen, require changes to be delivered to airports safely and efficiently. Additionally, planning is beginning for smaller airports, known as vertiports, to facilitate future transportation with drones and eVTOL. Measures being implemented at airports include:

- Expansion of electric infrastructure (charging stations) to enable the charging of future electric and hybrid aircraft.
- Hydrogen infrastructure at airports.
- Electrification of airport operations.
- ntegration of eVTOL at airports.

Batteries and electric aviation development

Electric aviation began to take shape in the late 20th century, primarily with small aircraft and drones. The 2000s saw the emergence of experimental electric aircraft, like the Pipistrel Alpha Electro, which demonstrated the feasibility of electric flight on a small scale.

You can divide electric aviation into:

- **Electric aircraft**

These include light aircraft like the Pipistrel Alpha Electro, which are powered entirely by electric motors and are primarily used for training and leisure flying.

- **Electric Seaplanes**

Are usually smaller aircraft. They can be amphibious, landing both on water and land. Examples include NOEMI by Elfly.

[2]The Swedish aviation authority (Luftfartsverket) states that approximately 6% of aviation emissions can be influenced by the design of the airspace, i.e., the ATM system.

- **Hybrid Electric aircraft**

These aircraft combine electric motors with conventional engines, enhancing fuel efficiency and reducing emissions. Examples include the Heart ES-30. Usually used for bigger aircraft for regional aviation.

- **Electric Vertical Takeoff and Landing (eVTOL)**

eVTOL aircraft are designed for urban air mobility, allowing for short, efficient flights in congested areas.

In this report we will cover electric, hybrid-electric and electric seaplanes.

Resilience in Future Aviation

A clear trend affecting aviation is the occurrence of disruptions that directly or indirectly impact the system, such as cyberattacks, terorist threats, natural disasters, and pandemics. The development of resilience, the ability to withstand external disturbances, becomes increasingly important and is prioritised moving forward. This is affecting both the airports, but also the need to be self-efficient when it comes to fuel/energy of the aircraft.

Airport infrastructure considerations

Battery-electric aircrafts will demand new types of standardised infrastructure on airports. Design regulations are based on international standards owned by the UN division ICAO (International Civil Aviation Organization). Regulations should be incorporated in the national regulations owned by a Civil Aviation Authority. In Sweden, for example, it is Transportstyrelsen (the Swedish Transport Authority). National regulations need to be according to the base line in the ICAO regulation but can also be stricter. In the European Union there exists EU-standards for airport regulations that is common for all EU-member states. National authorities need to adhere to these regulations but can have more strict interpretations than the EU directive.

1. **Charging development**: To sustain profitability, airlines need to keep their quick turn-around times at the airport. With large batteries needing charging, this puts high requirements on the charging infrastructure. Some significant milestones have been achieved for the charging of electric aviation. The Megawatt Charging System (MCS) standard being developed, there will be a cross-sector standard for high power charging, catering to heavy duty vehicles, off-road work vehicles, ships, and aeroplanes. As airports scale up their charging infrastructure, several solutions are made available, from mobile charging trucks with batteries, to fixed charging stations at the stands. Developments show that even airports with low power grid connections can scale up their infrastructure by installing Battery Energy Storage Systems (BESS) and sustainable energy production at the airport to accommodate the increased demand from electric busses, electric trucks and electric aeroplanes with one harmonised solution, without the need for expensive grid connections.

The fast-charging systems for electric cars are a good benchmark for the rapid growth of charging infrastructure. The publicly available fast charging points has seen an exponential growth since 2015. Public charging grew by over 40% in 2023, with fast chargers growing 55%, surpassing slow chargers. By the end of 2023, fast chargers made up over 35% of public charging stock. China leads in EV charging infrastructure, with more than 85% of the world's fast chargers and around 60% of slow chargers. With over 35% of electric car sales, China focuses on full urban and highway coverage by 2030, including rural areas, aiming for 60% off-peak charging by 2025 in five pilot cities. The European Union's AFIR will mandate public fast chargers every 60 km along main transport routes, ensuring sufficient charging capacity for registered BEVs and PHEVs. Other developed markets, like the UK and Korea, also enhance EVSE support while reducing vehicle incentives, with significant installations and private investment bolstering the sector. EVSE targets are set alongside vehicle targets elsewhere. New Zealand aims for a charging hub every 150-200 km on highways and 600 rural stations by 2028. The United States announced funding to achieve 500,000 chargers by 2030 and ensure existing chargers' maintenance. Canada is on track for 33,500 ports by 2026, while India funded over 7,000 fast chargers in 2023.

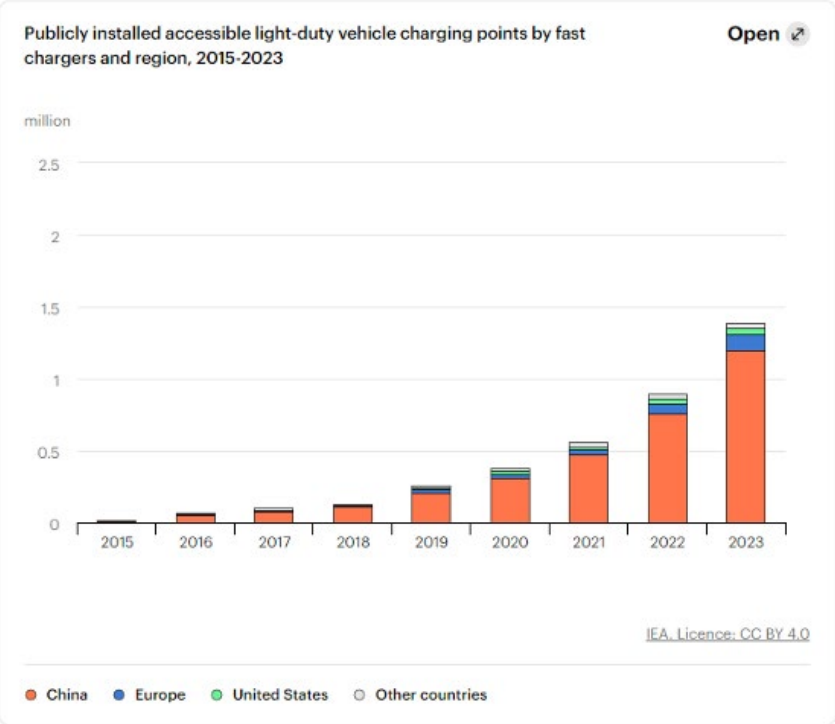


Figure 1: Publicly installed accessible light-duty vehicle charging points by fast chargers and region.
Source: https://www.iea.org/reports/global-ev-outlook-2024/trends-in-electric-vehicle-charging

Megawatt Charging at Airports

The MCS charging standard will be released for commercial use no later than 2025. The standard is developed by Charging Interface Initiative (CharIN), which is an organisation consisting of representatives from manufacturers of charging stations, the automobile industry, grid operators and energy providers. (CharIN, CharIN Whitepaper Megawatt Charging System, 2022)

CharIN has previously developed the Combined Charging System (CCS) standard, which is the fast-charging standard for electric vehicles, capable of delivering charging power up to 350 kilowatts (kW). This is now the charging standard in Europe.

Owing to increased requirements for extended vehicle range, faster charging times, and the adoption of electric buses and trucks, the need for a new high-power charging standard has emerged. Consequently, in 2018, CharIN established a working group dedicated to developing a cutting-edge Megawatt charging standard

The MCS-standard will consist of three different power levels, see table below:

MCS Level	Current [Ampere]	Power [MW]	Cooling of handle
1	350	0.35	No
2	1000	1	Yes
3	3000	3.75	Yes

For regional electric aircraft, MCS-level 3 will be necessary to enable a turnaround time of 30 minutes.

Electrical hardware - Fixed charging station

Megawatt charging can be carried out using either a fixed or mobile charging station. The more extensively investigated approach within the EV industry is the fixed charging solution, which is commonly deployed at gas stations, truck stops, and supermarket parking lots.

Fixed MCS charging will be similar to today's EV-charging stations. On the airport premises, the essential equipment consists of a transformer, strategically positioned on the land or airside, designed to handle anticipated peak power demands for charging purposes. This transformer is linked to a switchgear, serving the dual purposes of safeguarding the electrical system against surges and facilitating maintenance of downstream equipment (ASCO Power Technologies, 2023).

The equipment closest to or on the apron consists of MCS supply equipment and a dispenser. MCS supply equipment are power cabinets that convert AC power from the grid to DC power needed for fast charging. The supply equipment also regulates charging voltage DC/DC. To make power cabinets suitable for Megawatt charging, in comparison to EV fast charging cabinets, it is a matter of scaling power cabinets linearly by size, and dimension cables according to anticipated electrical currents.

The dispenser will house the connector and communication system, necessitating its placement near the apron to facilitate efficient charging.

Mobile Charging

A mobile charger equipped with batteries may accommodate the MCS supply equipment, dispenser, and stored charging energy in the form of batteries. Given the substantial space required for all these components, a truck serves as the most practical and convenient platform for this purpose.

A mobile charger with batteries will charge its onboard batteries slower than it will discharge. This means that the grid connection will be less affected by peak power demands compared to a fixed charging station. An additional advantage is that this charging solution provides flexibility to airports, allowing both conventional and battery electric aircraft to coexist on the same apron.

Challenges associated with this solution includes the requirement for a substantial battery capacity installed in the truck to charge the aircraft, the overall weight of the truck, and the certification of the charger dispenser and power cabinets.

Another concept for mobile charging involves using a movable truck without onboard batteries. Instead of batteries, this concept relies on a direct connection to the grid via an underground AC or DC supply. In this case, the truck would house the charging dispenser, power cabinets, and, for AC systems, a transformer that converts medium voltage to low voltage inside the truck.

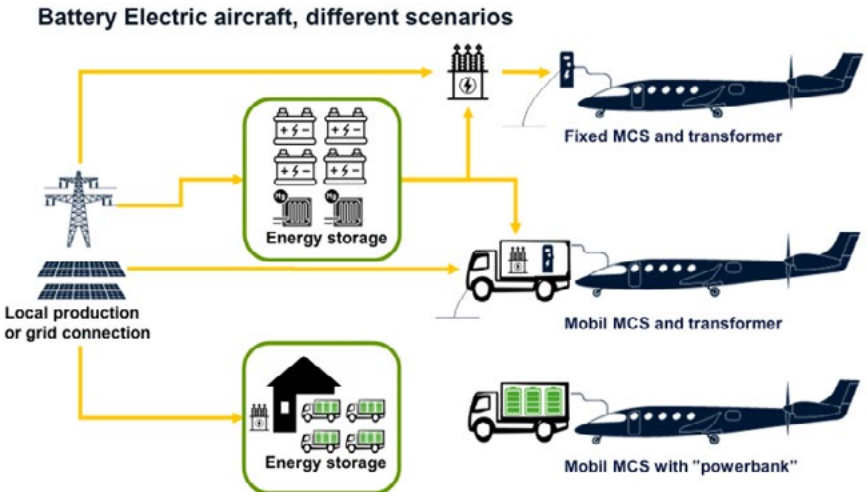


Figure 2: Conceptual visualisation of a fixed, semi-mobile and mobile charging solutions, with energy storage (Source: Swedavia)

Technical advancements in Aircraft Development

Electric motors: Over the past decade, the development of electric motors has seen a remarkable transformation, transitioning from lower power outputs to the ability to produce over 2 megawatts (MW) of power for electric aviation. Initially, electric motors were limited by their power output and efficiency, making them viable mostly for small-scale applications and short-distance travel. However, continuous research and development efforts have led to substantial breakthroughs in materials, design, and cooling technologies. These advancements have enabled the creation of high-power electric motors capable of supporting larger aircraft and longer flight durations. Notably, cutting-edge programmes such as those funded by the Advanced Research Projects Agency-Energy (ARPA-E) have been instrumental in pushing the boundaries of electric motor capabilities, paving the way for their implementation in the burgeoning field of electric aviation.

Electric motors and batteries have shown considerable promise in terms of efficiency when compared to combustion engines. The efficiency of fossil fuel combustion engines typically ranges from 30% to 40%, while electric motors boast a much higher efficiency range of 90%. In terms of actual propulsion power, this means an increase by almost 4 times . This significant difference underscores the potential for electric aviation to outperform traditional methods in terms of energy utilization.

One of the notable advantages of electric aviation is the substantial reduction in noise levels. Electric motors operate much more quietly than combustion engines, leading to a quieter cabin environment and reduced noise pollution around airports and flight paths. Electric motors provide superior torque control, which translates into smoother and more precise handling of aircraft. This enhanced control can improve safety and

[3] https://arpa-e.energy.gov/sites/default/files/2023-02/3.%20Debock_ASCEND%20PHASE%20II%20Program%20Kickoff%20and%20Tech2market%20meeting%20feb2nd_public.pdf

performance, making electric aviation a more attractive option for both pilots and passengers.

Electric motors are inherently simpler in design compared to complex combustion engines, resulting in fewer moving parts. This simplicity means less wear and tear, leading to lower maintenance requirements and costs over the aircraft's operational life.

Modern advancements in battery technology have led to batteries that are not only lightweight, reducing the aircraft's weight by approximately 20%, but also highly efficient, increasing flight ranges by up to 30% and reducing charging cycles to just 1-2 hours. One of the key factors driving these improvements is the significant increase in gravimetric energy density.

Historic Battery Evolution: Over the past 20 years, gravimetric energy density has seen remarkable progress, increasing from around 100 Wh/kg in the early 2000s to over 300 Wh/kg today. This tripling of energy density means that modern batteries can store three times more energy per unit of mass than their predecessors. Consequently, this efficiency makes electric aviation more practical and convenient for regular use, enabling longer flights.

Looking ahead to 2050, experts predict that continued innovations in materials science and battery design could push gravimetric energy densities beyond 600 Wh/kg. Such advancements would further revolutionize electric aviation, extending flight ranges by an additional 50% to 100%, working towards fully electric routes up to 1500 km by 2050. This future outlook underscores the transformative potential of ongoing research and development in battery technology.

Figure 3 shows the historical evolution of cell level energy density from the major battery cell manufacturers. For reference, the targets from different national initiatives are also presented. The data demonstrates the recent trend of a substantial increase in the battery energy density improvement rate as a result of the increased demand for improved battery technology for electric transportation.

From 1990 to 2010 the gravimetric energy density improved approximately 5% per year. Since 2010 and the scaling of EVs, there has been a significant acceleration in this trend, with energy density improving more than 10% per year.

Figure 4 shows the historical trend of lithium-ion battery annual cost reductions across the period 2010-2018 was -18%. Battery manufacturers and battery pricing are highly dependent on commodity material prices and in 2022, due to global events such as the Russia-Ukraine war, metal commodities including lithium and nickel increased by 20%. Together with supply chain disruptions, this resulted in a 7% increase in battery pricing in 2022 (Figure 5).

[4] Sources: https://pubs.rsc.org/en/content/articlepdf/2021/ee/d0ee02681f before 2018; BNEF Long-term Electric Vehicle outlook after 2018; https://rmi.org/the-rise-of-batteries-in-six-charts-and-not-too-many-numbers/#:~:text=RMI%20forecasts%20that%20in%202030,5.5%E2%80%938%20TWh%20per%20year .

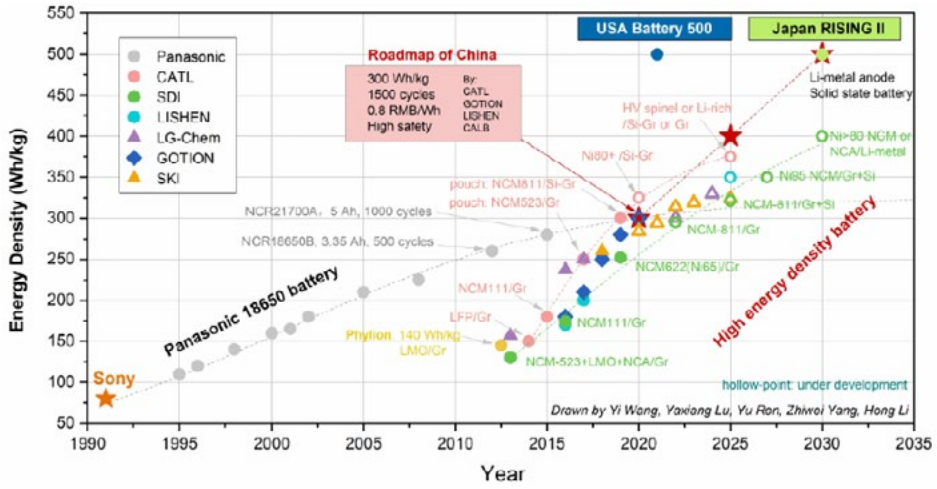


Figure 3 - Battery gravimetric performance, 1990-2030

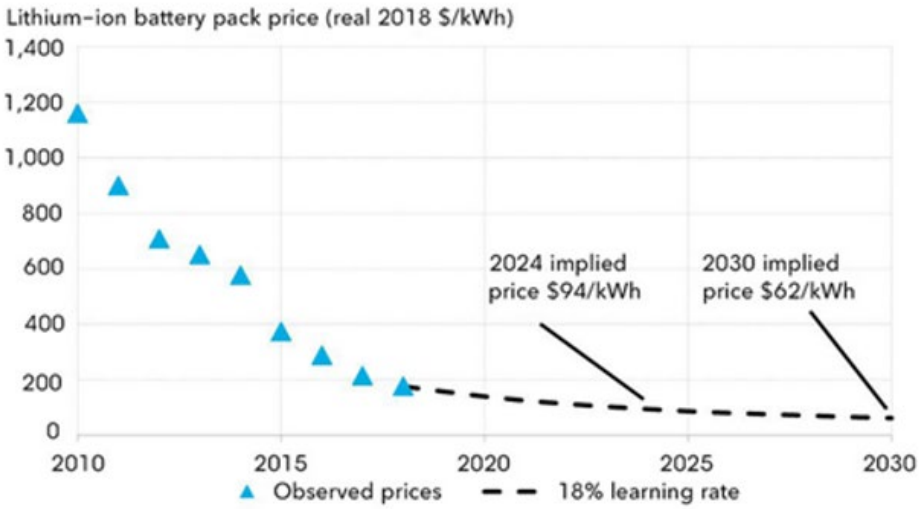


Figure 4: Lithium-ion battery price outlook, 2010-2030

Lithium-ion battery price outlook indicating technology improvement and significant price reduction over time. Source: BloombergNEF (https://about.bnef.com/blog/behind-scenes-take-lithium-ion-battery-prices/)

Figure 5: Historical volume-weighted average battery pack prices, 2010-2022

Forecast Battery Evolution: Bloomberg New Energy Finance (BNEF) expects battery prices to start falling again in 2024, when lithium prices are expected to ease as more extraction and refining capacity comes online. Based on the updated observed learning rate, BNEF's 2022 Battery Price Survey predicts that average pack prices for automotive and stationary storage applications should fall below $100/kWh by 2026. Although cost drivers, including cell costs will follow the same trend, aerospace packs will include a premium to account for certification costs and lower production volume.

Figure 6 presents a summary of the gravimetric energy density (Wh/kg) of the current and next generation battery technologies in production or development, as well as targets set by Japan and China for similar programs as those supported by the European Commission. The horizontal axis plots the fundamental battery cell energy density, and the vertical axis plots the battery pack energy density which accounts for the additional weight required to create a functioning pack, such as the BMS, cooling system, mechanical and electrical integration. The energy density at the pack level is strongly linked to the cells selected, with the battery packing efficiency typically between 60% to 80% by mass.

Although some of the programs differ in the expected time to market, they are rather consistent in the achievable performance. Considering 60% to 80% packing efficiency:

- Current technology (blue column) cells vary between energy densities of 160 to 360 Wh/kg, which achieves 128 to 288 Wh/kg at the pack level.
- Next Gen <2030 technology (green column) project cell energy density between 360 to 580 Wh/kg, which achieves 288 to 464 Wh/kg for the pack.
- Next Gen 2030+ technology (orange column) project cell energy density of up to 750 Wh/kg, and 450 to 600 Wh/kg for the pack.

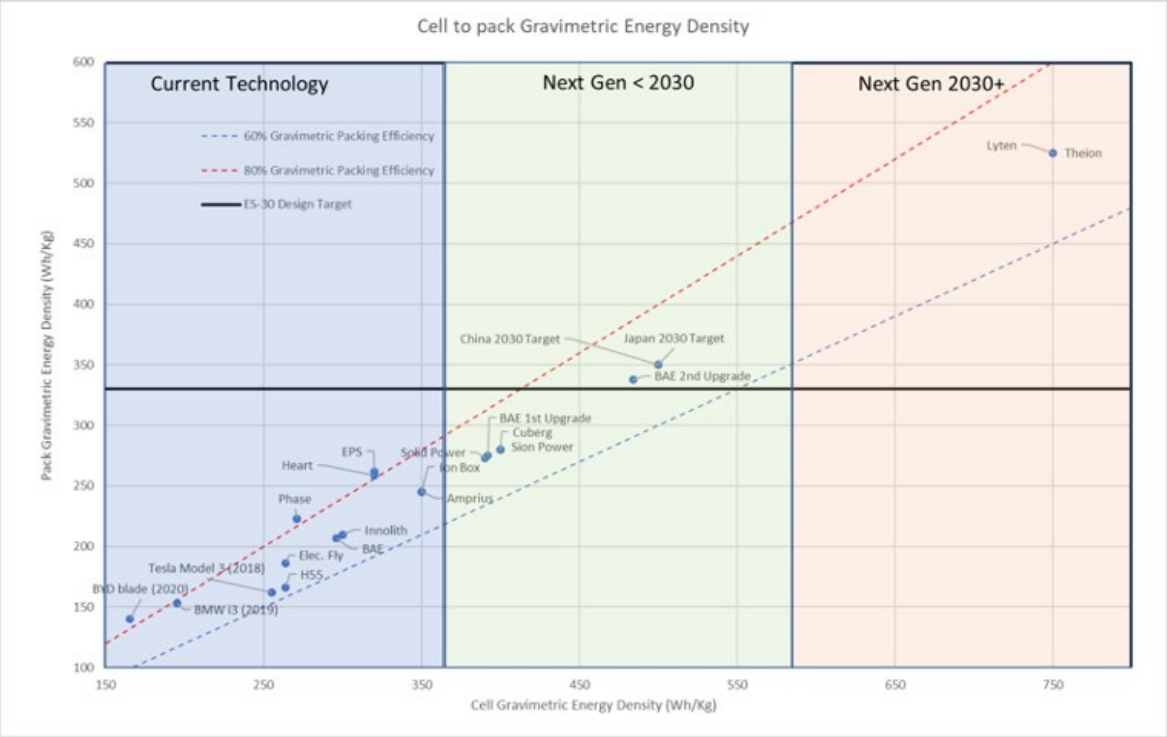


Figure 6 - Battery cell vs pack gravimetric energy density, Current – Next Gen.

Cell vs Pack gravimetric Energy Density of different supplier/products. The dotted lines represent the packing efficiency with regards to the weight added to the pack.[1]

Summary

The transition to fossil-free aviation necessitates significant advancements across various sectors of the industry, including airports and aircraft operations, with a focus on reducing climate impact and enhancing sustainability. This transition will involve:

1. Infrastructure Development:
   - Airports must adapt to climate impacts by enhancing air traffic services and improving operations.
   - The shift to new fuel types, particularly electricity and hydrogen, will transform airports into energy hubs, integrating solar parks and battery storage to manage and distribute fossil-free fuels effectively.

2. Electric and Hybrid Aviation:
   - The report emphasises the importance of electric and electric hybrid aircraft, as well as electric seaplanes.
   - Future airports will need expanded electric infrastructure, including charging stations to accommodate electric aviation demands.

3. Resilience against Disruptions:
   - As the aviation industry faces potential disruptions from various external threats (cyberattacks, natural disasters), building resilience will be essential. This includes ensuring self-sufficiency in energy supply for aircraft operations.

4. Charging Infrastructure:
   - The upcoming Megawatt Charging System (MCS) standard will be pivotal in establishing a robust charging network for electric aircraft by 2025. This infrastructure will support quick turnaround times essential for airline profitability.

5. Battery and Electric Aircraft Development:
   - Significant advancements in electric motor and battery technologies are crucial, allowing for greater efficiency and longer flight durations. Innovations may see gravimetric energy density exceed 600 Wh/kg by 2050, greatly enhancing the feasibility of electric aviation.

Proactive planning and investment in these areas are vital for a sustainable and resilient future in aviation, positioning airports not only as transport hubs but as pivotal energy providers in the broader transportation ecosystem.

Chapter 3:

Market Development

Mega Trends

In the last 20 years, Europe has seen a 50% decline in the regional aircraft fleet of less than 100 seats The operating economics of regional jets has pushed airlines to move to larger gauge aircraft that offer lower unit costs. However, te demand for thin routes still exists. If the industry can bring to market a sustainable regional aircraft with compelling unit economics, the potential for route re-growth is significant - this is where electric aviation has the edge.

The sustainability driven reindustrialisation that currently is taking place in the Nordic countries demands increased access to competence. This development will increase the demand for sustainable regional cross-border as well as domestic regional point-to-point routes.

The regional air travel market, which has been in decline for the past 30 years, is showing signs of revitalisation due to four significant global megatrends. In an article published by McKinsey in May 2023 , the four megatrends that could contribute to stimulate demand for regional flights were summarised as follows:

1. Technological Advances: Innovations in aircraft propulsion, design, and navigation are driving down operating costs for small aircraft, making them more competitive. Future advancements may enable autonomous aircraft, significantly reducing labour costs. Retrofitting existing aircraft with new propulsion systems presents a quicker market entry. Enhanced flight planning and precision GPS are also lowering operational costs, enabling smaller airports to provide reliable services without costly infrastructure.

2. Sustainability Focus: Growing public and governmental emphasis on sustainability is reshaping aviation. With the sector contributing about 4% to global warming in the Nordics, new regulations for emissions reductions and sustainable fuel blending present opportunities for growth in regional air travel. Surveys show that nearly half of the travellers desire more sustainable options, and 87% wish to travel sustainably, with one-third prioritizing emissions concerns.

3. Congestion Issues: Traffic congestion and airport delays are significant challenges, with drivers in the U.S. and U.K. losing 51 and 80 hours annually, respectively. Major airports are operating at capacity, leading to frequent delays and cancellations. This highlights an unmet demand for efficient transportation alternatives that bypass congested roads and airports.

[5] https://www.researchgate.net/publication/330329361_Trends_in_development_of_air-Craft for_regional routes impact on the european air transportation system

[6] https://www.mckinsey.com/industries/aerospace-and-defense/ ur-insights/short-haul-flying-redefined-the-promise-of-regional-air-mobility

4. Mobility as a Service: The rise of integrated mobility solutions allows consumers to book multiple transport modes easily, reducing vehicle ownership. The shared mobility market is expected to grow to $500 billion to $1 trillion by 2030, reflecting consumer willingness to explore convenient and accessible transportation options. This shift is likely to enhance regional air travel's appeal as part of a comprehensive transportation network.

The four megatrends—technological advances, sustainability focus, congestion issues, and the rise of mobility as a service—collectively position regional electric aviation for growth. By capitalizing on these trends, regional electric aircraft can not only meet current market demands but also play a crucial role in reshaping the future of air travel.

Technological Advances:

- **Cost Efficiency:** Innovations in aircraft design and propulsion, including electric engines, can significantly lower operating costs. For regional airlines, this means enhanced competitiveness as electric aircraft can provide cost-effective solutions for thin routes.
- **Operational Improvements:** Advancements in navigation and control systems can streamline operations for regional flights. This includes the potential for autonomous flight, reducing labour costs and increasing scheduling flexibility. The ability to retrofit existing aircraft with new technologies also enables a smoother transition to electric aviation.

Sustainability Focus:

- **Market Demand:** As public and governmental pressure for sustainable travel options increases, regional electric aviation can fulfil this demand. Electric aircraft are inherently greener, making them attractive to environmentally conscious travellers. This focus on sustainability can drive growth in regional markets, particularly as regulations mandate lower emissions.
- **Government Incentives:** Many governments are implementing policies to support sustainable aviation initiatives, which may include funding and infrastructure development for electric regional aircraft. These policies can incentivise airlines to invest in electric solutions and expand regional air services.

Congestion Issues:

- **Alternative Transportation Solutions:** With major airports facing capacity constraints and increasing delays, regional electric aviation offers a timely alternative for travellers. By utilizing smaller regional airports, electric aircraft can bypass congested hubs, providing more direct and efficient travel options.
- **Enhancing Accessibility:** Electric regional flights can connect remote areas, reducing reliance on overburdened road networks. This not only addresses congestion but also meets the transportation needs of underserved communities, enhancing regional connectivity.

Rise of Mobility as a Service (MaaS):

- **Integrated Travel Options:** The shift toward MaaS creates opportunities for regional electric aviation to be part of a comprehensive transport network. By integrating with other modes of transport, such as buses, trains, and shared mobility services, regional electric flights can offer seamless travel experiences.
- **Consumer Acceptance:** The growing consumer preference for shared and efficient transportation solutions supports the adoption of regional electric aviation. As people increasingly look for convenient ways to travel, electric flights can become a key component of multi-modal travel options, particularly for short-haul routes.

Market commitments from regions in the Nordics

As pointed out, the Nordics provide favourable conditions for electric and regional aviation. Even more so for regions and local communities not easily accessed by roads or trains, like highlands and islands.

In March 2023, Swedish electric aircraft manufacturer Heart Aerospace and the Government of Åland announced a collaboration to explore the use of Heart's ES-30 electric regional aircraft for developing sustainable air services in the Baltic Sea archipelago. Åland's capital, Mariehamn, is ideally situated for this initiative, being less than 150 km from Stockholm and Turku, and under 300 km from Helsinki and Tampere, Finland's second-largest city. Currently, Mariehamn is connected by air to Stockholm, Turku, and Helsinki [7].

In December 2023, Norwegian electric seaplane manufacturer Elfly Group and the Lofoten (Green Islands) signed an LoI [8]. The organisations agreed to pursue the development of zero-emission regional aviation together. The contract was signed in Lofoten by contributing parties Lofotkraft, Destination Lofoten and the Lofoten Council, on behalf of the six Lofoten municipalities - Røst, Værøy, Moskenes, Flakstad, Vestvågøy and Vågan.

In June 2024, Region Gotland, the largest island in the Baltic Sea, signed a collaboration agreement with both Heart Aerospace and Elfly Group, to accelerate the introduction of sustainable air travel. The partnership with Heart Aerospace will explore operational needs, technical requirements, ground infrastructure and maintenance, and business models for implementing hybrid-electric aviation [9]. The partnership between Elfly Group and Region Gotland involves plans to launch zero-emission commercial seaplane flights to the island by 2027 [10].

[7] https://heartaerospace.com/newsroom/heart-aerospace-to-explore-early-use-case-for-electric-es-30-airplane-with-aland-islands/
[8] https://newsroom.aviator.aero/elfly-signs-an-loi-with-lofoten-green-islands-to-pursue-zero-emission-aviation-together-with-noemi/
[9] https://heartaerospace.com/newsroom/swedish-region-gotland-partners-with-heart-aerospace-for-sustainable-aviation/).
[10] https://www.revolution.aero/news/2024/07/12/elfly-and-gotland-government-partner-on-potential-seaplane-flights/

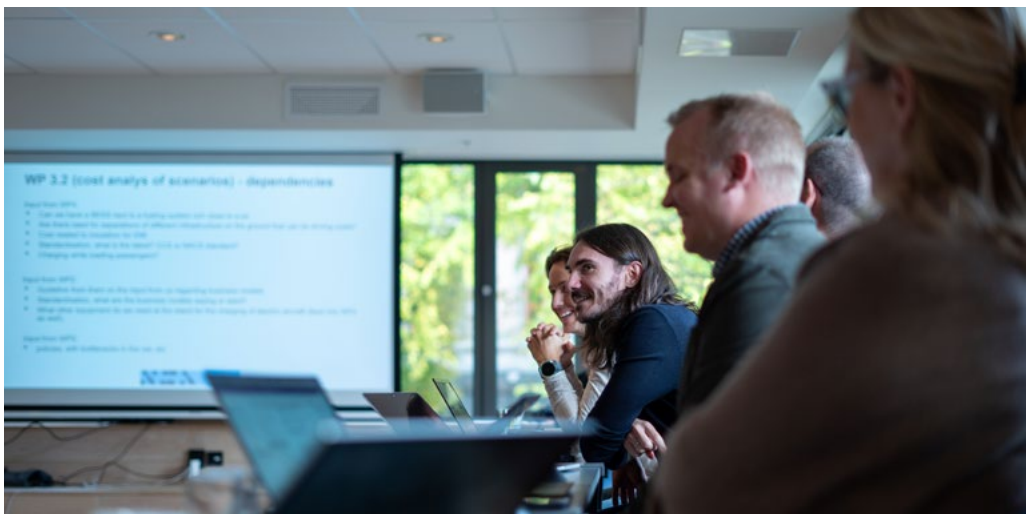
Summary

There has been a decline in regional aviation worldwide over the last decades due to the cost factor that has led airlines to favour larger aircraft that offer lower operating costs, despite persistent demand for thin routes. The advent of sustainable regional aircraft, particularly electric aviation, holds significant promise for revitalising these routes. The four key trends driving market development are technological advances, increased focus on sustainability, congestion issues and the emergence of the Mobility-as-a-Service concept.

The Nordic countries have emerged as leaders in electric and regional aviation, particularly in areas with challenging access. Notable initiatives include:

- Heart Aerospace and Åland: A collaboration to explore sustainable air services using Heart's ES-30 electric aircraft in the Baltic Sea archipelago, improving connections between Mariehamn and major cities like Stockholm and Helsinki.
- Elfly and Lofoten Green Islands: A partnership aimed at developing zero-emission regional aviation, with commitments from local municipalities to support this initiative.
- Region Gotland: A collaboration with Heart Aerospace and Elfly to accelerate sustainable air travel, including plans for hybrid-electric aviation and zero-emission seaplane flights by 2027.

Electric aviation presents a compelling opportunity to address current market demands and reshape the future of regional air travel. Policymakers should recognise and support the convergence of technological advances, sustainability initiatives, congestion solutions, and integrated mobility trends to fully leverage this potential. By investing in electric aviation, particularly in underserved regions, decision-makers can facilitate a sustainable transportation network that meets both economic, regional development, and environmental goals.



Chapter 4:

Net-zero Aviation Strategy

As recommended by the World Economic Forum in the report "Target True Zero: Government Policy Toolkit to Accelerate Uptake of Electric and Hydrogen Aircraft" (2023) "all countries should develop a net-zero aviation strategy and understand the role that battery- electric and hydrogen aircraft can play within this strategy."

Global and Nordic goals

The negative impact of climate change must be drastically reduced. This also applies to aviation, although it is often claimed that this is an especially difficult industry to change.

The Paris agreement was in 2022 followed by an ICAO initiative. ICAO Member States adopted a collective long-term global aspirational goal (LTAG) of net-zero carbon emissions by 2050. Many individual countries and regions have defined their own plans and goals fin line with the 2050 target. These include the EU's 2021 Fit for 55 package. ICAO states in its agreement that all Nordic countries are signatories to a "long-term global aspirational goal" (LTAG) for international aviation. The LTAG is described as follows on the ICAO website:

"The LTAG does not attribute specific obligations or commitments in the form of emissions reduction goals to individual States. Instead, it recognizes that each State's special circumstances and respective capabilities (e.g., the level of development, maturity of aviation markets, sustainable growth of its international aviation, just transition, and national priorities of air transport development) will inform the ability of each State to contribute to the LTAG within its own national timeframe. Each State will contribute to achieving the goal in a socially, economically and environmentally sustainable manner and in accordance with its national circumstances."

ICAO does not classify itself as a regulator, and most ICAO decisions need to be incorporated by states into national legislation to have legal effect. ICAO provides a global framework for decarbonising international aviation, but the Nordic countries also need to decarbonise domestic aviation to reach the overall goals of the Paris-agreement. Moreover, transitioning to sustainable mobility and transport is part of the joint Nordic Vision 2030. The Nordic countries need to establish policies and support mechanisms that build on ICAO's recommendations and clarify how and when to reduce emissions from aviation.

[11]https://www.icao.int/environmental-protection/Pages/LTAG.aspx

Some Nordic countries have set their own national aviation targets and seek action by an earlier date than what follows from ICAO´s LTAG commitment, while others align with the ICAO LTAG goal.

	Scope	Year	target
Denmark	One domestic routes	2025	Green route
	All domestic routes	2030	Green route
	Aligned with ICAO	2050	Net-zero
Finland	Aligned with ICAO	2050	Net-zero
Iceland	Aligned with ICAO	2050	Net-zero
Norway	Accelerate the transition towards zero and low emission aviation	As soon as technologically possible	Zero and low emission
	Aligned with ICAO	2050	Net zero
Sweden	All departing domestic flights	2030 (domestic)	Fossil-free
	All departing international	2045 (all aviation)	Fossil-free
	flights Aligned with ICAO	2050	Net-zero

The rate of progress will determine which and how different technologies can support the goals. For example, Denmark's goal to introduce a green route in 2025 can only be accomplished with a Sustainable Aviation Fuel (SAF) pathway.

Reporting on Nordic goals

Progress towards achieving ICAO´s LTAG is reported through the submission of national action plans. These plans require countries to establish their long-term strategy on climate change for the international aviation sector, define a quantified baseline scenario, choose appropriate emissions mitigation measures, and calculate the expected results of implementing those measures. This is done by the CAA in each country and is not coordinated in a structured way at the Nordic level today.

All technology options are needed to decarbonise Nordic aviation

Various pathways to reach net-zero on an international level have been defined. Sustainable Aviation Fuel (SAF) is set to provide the bulk of global decarbonisation from the industry, but to achieve net- zero it is vital to use all available options, including battery-electric, hybrid-electric and hydrogen powered options.

The aviation sector is committed to achieving net-zero carbon by 2050 globally. This commitment stems from the 2021 IATA resolution on behalf of the global airline industry which requires airline members to collectively achieve net-zero carbon emissions from their operations by 2050. This pledge brings air transport in line with the objectives of the Paris Agreement to limit global warming to well below 2ºC.

The challenge ahead is significant. To quote IATA when it agreed on its resolution: "to succeed, it will require the coordinated efforts of the entire industry (airlines, airports, air navigation service providers, manufacturers) and significant government support."[13] [17]

Roadmaps to 2050

In setting a 2050 goal, both industry and government have been working on roadmaps to meet the targets. Broadly speaking the main levers that will be used by the sector are:

- Sustainable aviation fuel (SAF)
- New technology (electric and hydrogen)
- Infrastructure and operational efficiencies
- Residuals (Offsets and carbon capture)

As can be seen in the analysis of these different roadmaps below, no single option will get the industry to net-zero. To date, the sector and governments, including ICAO, have been heavily focused on SAF. However, even under the most optimistic scenarios, SAF will only deliver around 70% of the decarbonisation needed.

[12] https://www.iata.org/en/programs/environment/flynetzero/
[13] https://www.iata.org/en/programs/sustainability/flynetzero/

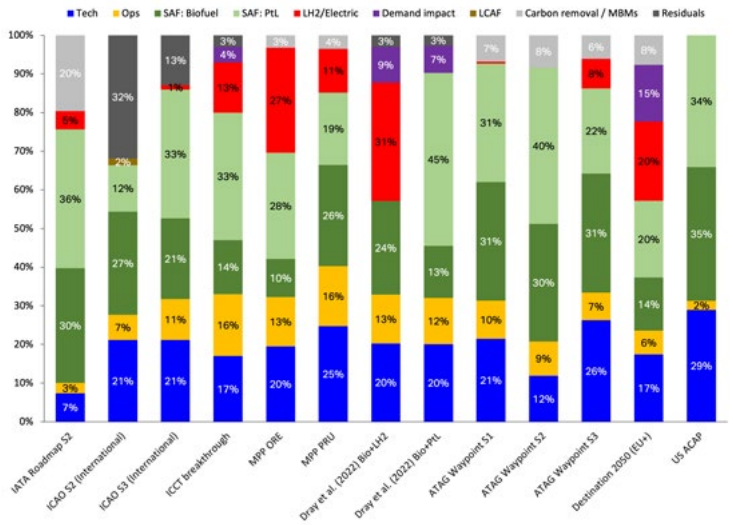


Figure 7: IATA (2024), "Aviation Net-Zero CO2 Transition Pathways: Comparative Review": https://www.iata.org/contentassets/8d19e716636a47c184e7221c77563c93/nz-roadmaps.pdf

The role of SAF and new technology in meeting net-zero emission

A closer look at the various roadmaps prepared by ATAG in its industry leading Waypoint 2050 report shows that the second biggest contributor after SAF is new technology, and within this lies electric and hybrid-electric, together with hydrogen. Under scenarios where these technologies are rolled out aggressively, new technology will contribute as much as 34% of the decarbonisation needed.

Figure 8: ATAG. Source: Waypoint 2050 (www.aviationbenefits.org)

Based on these scenarios, SAF is expected to deliver the majority of the decarbonisation needed, and all the available SAF will need to be prioritised for medium and long-haul flights where no current viable alternative technology exists.

[14] https://aviationbenefits.org/media/167417/w2050_v2021_27sept_full.pdf

New technology needed alongside SAF

With this backdrop, it is more important than ever that the sector develops alternative pathways to SAF, with the same sense of urgency. Electric and hybrid-electric technologies offer pathways to decarbonise regional aviation, which will reduce the demand for SAF. SAF can then be reserved for longer flights where no other solution exists in the short term. In the longer term, as new technology matures, it will also have a role to play in short and medium haul flights. To conclude, industry and government need to focus on SAF and new technology with equal focus.

New technology will also include the following:

- Airframe (aerodynamics, lightweight materials and structures, equipment and systems, new configurations, energy management and electrification)
- Propulsion systems (engine architecture, thermal and propulsive efficiency, combustor technologies, advanced materials, electrification)

The role of NEA in this regard is to promote electric and hybrid-electric technologies their adoption as a complementary solution alongside SAF.

Joint government and industry engagement necessary to tailor strategies to Nordic needs and resources

"At the state level, governments should engage with their stakeholders to understand the specific needs of their industries and find an appropriate balance between technologies that are closer to market today and those disruptive technologies that may deliver over a longer timescale".

NEA has seen how the work has accelerated, and results have been achieved since the beginning of the collaboration in 2019. It would have taken much longer to reach the current state without coordination, between partners in the value chain and between countries. To speed up even more and to reach the stage where electric and hybrid-electric aviation is realised, the involvement of Nordic governments is needed. To move forward, a broader perspective should be taken. Policymakers need to understand where aviation fits into the wider Nordic decarbonisation roadmap and what the availability of different energy resources will be.

[15] World Economic Forum (WEF): Government Policy Toolkit to Accelerate Uptake of Electric and Hydrogen Aircraft", WHITE PAPER., JULY 2023. Page 12.

Already in the NEA 1.0 report "Accelerating the development of electric aviation in the Nordic countries" (2023) , the following was stated:

During the NEA project, the Nordics have witnessed the emergence of an entirely new electric aviation industry. In 2018, Avinor shared the vision that all domestic short-haul flights should be electric by 2040 . Around the same time, the start-up companies Heart Aerospace (Sweden) and Elfly Group (Norway) were founded. The Nordics have been trailblazers in setting national targets for sustainable development targets. There are several specific conditions that have made the Nordic countries attractive to the growing electric aviation industry. These conditions include:

1. The geography encourages the development of air transport, as it presents natural obstacles to the construction of road and rail networks. Notable geographic features include the long coastlines in Norway, the abundance of lakes in Finland and Sweden, and the long-stretched archipelagos, mountains and harsh winter climate in the Northern region, the islands of Iceland, Åland, Greenland and the Faroe Islands.

2. The existing energy infrastructure includes access to hydro power, wind, and solar plants, creating the cleanest energy mix in the world. Benefitting from this, electric aviation will leave close to zero climate footprint in the Nordics.

3. The Nordic industries are innovative and focused on export markets and can attract highly skilled talents for research and development.

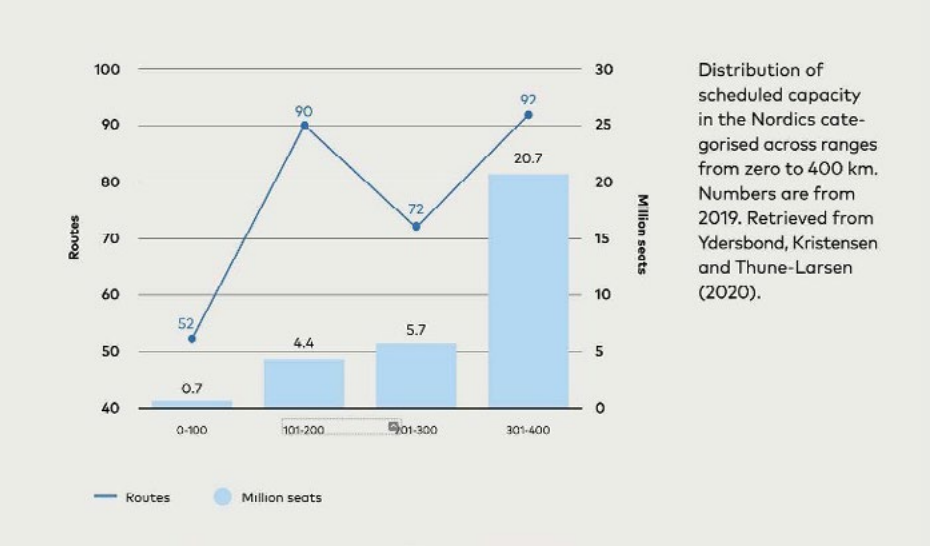
4. The shared Nordic values encompass language, collaboration, and progress, making the Nordics a shared platform for innovation. All these circumstances have propelled the Nordic Network for Electric Aviation and have provided the Nordics with a unique industry collaboration.

A fifth condition is that the Nordic governments through Nordic Innovation, an organisation under the Nordic Council of Ministers, have supported and co-funded NEA and the entire ecosystem since 2019 when launching NEA as the first project under the Nordic Smart Mobility and Connectivity programme. This has given the industry in the Nordics a good start.

The Nordic region is ideal for electric aviation

A key consideration when determining the role of different technologies is the structure of aviation in the Nordics. Insights from the NEA report "Business models for Nordic Electric Aviation" (2022) showed that "the share of today´s market that could become subject to competition from electric aviation in the next ten years are likely to include routes with relatively short distances (50-300 km)." The following insight in this section is drawn from this report.

[16] NEA (2023). Accelerating the development of electric aviation in the Nordic countries.
Project report from the Nordic Network for Electric Aviation (NEA) project 1.0 (2019-2022). A. Lundkvist.
[17] https://www.nrk.no/norge/norsk-luftfart-skal-bli-elektrisk-i-2040-1.13864654



Distribution of scheduled capacity in the Nordics categorised across ranges from zero to 400 km. Numbers are from 2019. Retrieved from Ydersbond, Kristensen and Thune-Larsen (2020).

Figure 9: Distribution of scheduled capacity in the Nordics categorised across ranges from zero to 400 km.

Smaller aircraft with room for fewer passengers will entail those aircraft serving a part of the market that is very small today, for example in aviation operations among archipelagos or fjords.

New service offerings that are not available in today's air transport market, will also be possible if operating costs becomes lower and will benefit passengers with increased flexibility, both in where to fly and how often.

Businesses are also expected to get benefits from point-to-point travel if there is increased traffic outside of the hub-and-spoke travel pattern that dominates today. Businesses located in rural areas can get much better connections to regional and national markets and capitals.

The Nordic governments can benefit from the shift in many ways. To realise electric aviation, a huge amount of innovation is needed, involving OEMs, Heart Aerospace and Elfly Group, Nordic airports and others. There is a shift away from working with known concepts to an innovative work process where new ideas are being prototyped and tested. This is done in NEA, but also in projects outside of NEA. Knowledge is shared in the networks. Talent is attracted to the region and valuable knowledge is being accumulated.

[18] Hellesund, Stina "Business models for Nordic Electric Aviation" NEA project report. December 2022. Business models for Nordic electric aviation | Nordic Innovation
[19] https://www.norden.org/en/declaration/declaration-nordic-transport-ministerial-meeting#:~:text=The%20Nordic%20transport%20ministers%20from,discussed%20topics%20of%20mutual%20interest.

Nordic Declarations

The Nordic declaration , signed by the Nordic ministers of Transport and Infrastructure in 2022, states:

"The Ministers agree to strengthen co-operation on transport and infrastructure in order to follow up Vision 2030: The Nordic region as the world's most sustainable and integrated region. Our countries are at the forefront of developing sustainable transport, but the transition needs to be improved. Nordic cooperation is important in order to reconcile interests and positions among the Nordic countries, which share so many common features and challenges. The inhabitants of the Nordic region benefit from a highly integrated transport system, where roads, railways, aviation and maritime transport bind us together.

All modes of transport are important, and they must be developed in cooperation. There is still a great need for improvements, especially on the development of green transport solutions and on border crossing connections. This requires a closer Nordic co-operation on transport. It is our shared responsibility to reduce greenhouse gas emissions from transport. Developing smart and seamless transport solutions is important for reducing emissions and will also support Nordic integration."

*The declaration included goals concerning aviation directly. This was a guiding star for the NEA Policy tour 2024:
his:

"Pave the way for the establishment of Nordic fossil-free air routes by latest 2030 - by promoting a fossil-free aviation sector as a whole and encourage future collaboration between the Nordic countries."

The 2022 Fredrikstad declaration was followed-up at a Nordic Transport Ministers meeting in Gothenburg, 14 August 2024. The findings from the NEA Policy tour were presented at the meeting and a new declaration for electric aviation was signed.

"When we, the Nordic transport ministers, convened in Fredrikstad on 8 November 2022, we agreed to pave the way for the establishment of Nordic fossil-free air routes by 2030. This commitment involves promoting a fossil- free aviation sector worldwide and encouraging future collaboration between the Nordic countries.

Electric aviation is pivotal in the shift towards a fossil-free aviation sector, not least in the more sparsely populated parts of the Nordic regions. The Nordic countries have the potential to become pioneers for the establishment of commercial electric aviation on a larger scale. However, to fulfil the goals set forth in the Fredrikstad declaration, we must intensify our efforts.

[20] government.se/contentassets/5dd4be170c364cf68efc501609a7ba3d/declaration-from-the-nordic-transport-ministerial-meeting-in-gothenburg-14-august-2024/

Against this background and our shared vision, we, the Nordic transport ministers, agree to further strengthen Nordic cooperation to promote the development of air routes operated by electric aircraft.

We will do so by:
- COLLABORATING on the requisite regulatory frameworks and permit processes to introduce electric aviation, while ENCOURAGING close dialogue between the Nordic authorities concerned.
- ADVOCATING COLLECTIVELY in global platforms such as the European Union and the International Civil Aviation Organization for a seamless and harmonized introduction of electric aviation.
- PROMOTING and ACCELERATING the establishment of commercial electric aviation in the Nordic countries, while SUPPORTING opportunities for our industries to become world leaders in important technologies related to electric aviation."

Nordic Routes

We have created a simulation tool in NEA that will be released at the end of 2024. It will help simulate and analyse which Nordic routes could be viable.

In the first simulations NEA has investigated how many routes that can be used for electric aviation according to distance. With the expected technological maturity and battery range, 25 % of all routes in the Nordics could be electrified in 2030, in theory. It is necessary, however, to also look at both market and technology logic. This is a mere simulation of already existing routes that could be electrified. The technology of electrification allows for substantial emission reductions across the Nordics. The commercial aspect will be the enabling or limiting factor to what can be achieved with electric aviation.

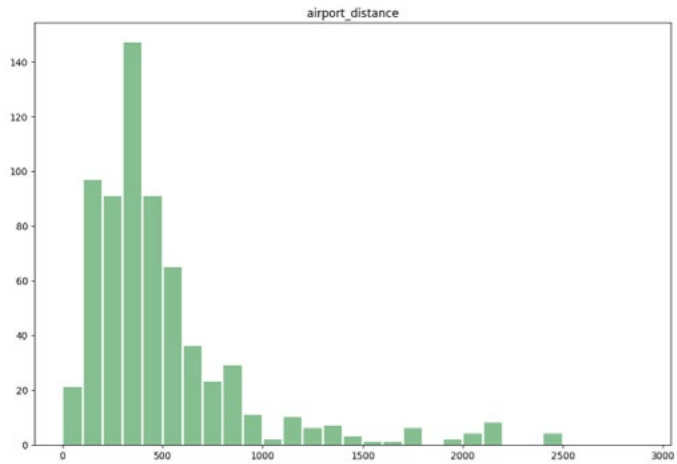


Figure 10: Existing routes in the Nordics shown as number of routes per distance.

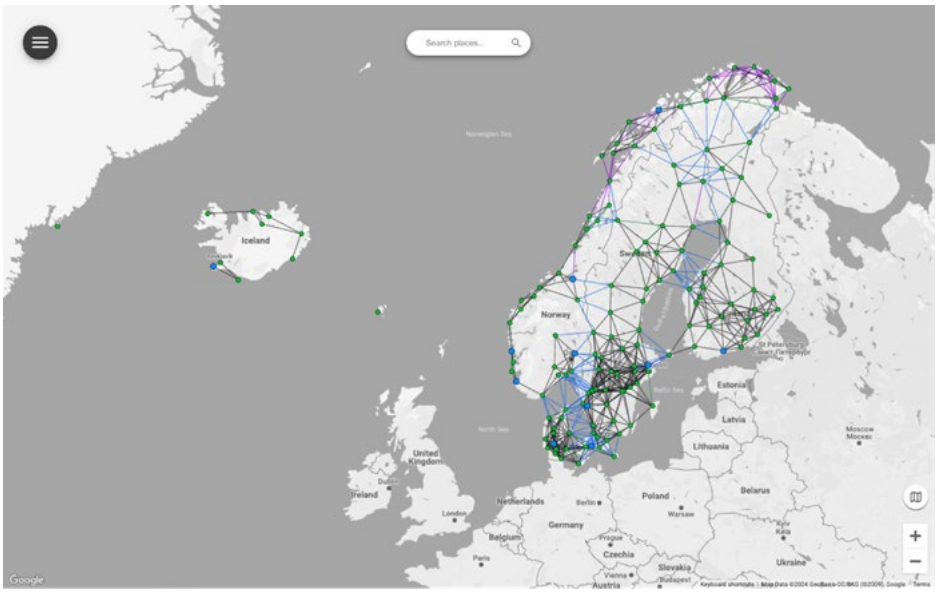
25% of today's cross-country and domestic routes in the Nordic region are under 400 km. Routes under 200 km counts for 7,5% of today's routes.

No decision has been made yet, neither at the national nor at the Nordic level, on which electric cross-border routes should be introduced when in the Nordics. However, several regions are preparing for both national and cross-border routes.

Examples:

- A green domestic route in Denmark is being planned through a collaboration between Copenhagen Helicopters, Væridion, and Copenhagen AirTaxi. The goal is to establish an electric aircraft route between Roskilde and Læsø from 2030.
- The Region of Gotland has aim to have at least one commercial electric aviation route by 2028. They have also initiated, together with the ecosystem and business at Gotland, a roadmap that describes the steps needed between 2024 and 2028 to have an electric route in place, including both the supply and demand side.
- Kvarken region is preparing for electric aviation between Sweden and Finland in their FAIR projects. They are preparing routes between Örnsköldsvik, Vaasa, Umeå, Kokkola, Pietarsaari and Skellefteå.
- Green Fly Way is connecting Sweden and Norway and preparing for electric aviation flights, between Trondheim, Östersund and Sundsvall.
- Avinor and the Norwegian Civil Aviation Authority have entered into a cooperation agreement on the establishment of Norway as an international test arena for zero- and low-emission aircraft.
- In their city council platform, the Oslo city government has included working towards achieving a zero-emission route between Oslo and the city of Kristiansand by the end of their term of office in the autumn of 2027.

Can we simulate tomorrow already today?



The NEA Vision Tool is built to visualize both the feasibility and potential of electric aviation in and between the Nordic countries. It is a map-based tool that enables you to see all airports and seaplane bases in the Nordic countries as well as potential and existing routes that connect to the airports. With aircraft being built with different characteristics and requirements. The simulation took can take this into account and simulate which routes could be replaced by electric aviation and which potential routes are feasible.

The potential routes on the map are all possible direct route connections between the airports on the map within a set distance (400 km limit). We have added a data point that can indicate the commercial feasibility of these, with data for both car and public transport available as a route comparison tool for time saving potential. The existing routes on the map are scheduled routes currently in operation as of 2024. These are currently split into two types, regular scheduled routes and public service obligation routes (PSO).

The tool comes with a dynamic filter menu that allows you to filter impact and feasibility in real time by applying various filters such as for example time you would like to save on a route, time that passengers spend at the airport, and number of passengers (pax) on a route or airport.

The tool is being developed with the demand we see needed to make decisions for Nordic routes. Differrent partners in the electric aviation ecosystem see different demands, e.g what is needed for an airport, airline, region or country. In the future there will also be a policy simulation part of the tool.

What is important for a system change?

Transitioning to sustainable aviation and mobility as such requires systemic change. NEA Vision Tool draws inspiration from Nordic Innovation's "System Innovation Compass"– a systemic design methodology in mobility that NEA Vision Tool has been involved in developing. Systems change requires a change of mindset and it is necessary to think differently about how to prioritise, fund and govern innovation across the Nordics.

- Purpose-driven innovation is key – aiming for social, environmental and economic impact. NEA Vision Tool and the implementation of electric aviation covers all these aspects.

- The complexity of the mobility sector must be acknowledged, including how the layers in the mobility system (aviation system) are interwoven and how change in one part will impact others. NEA Vision Tool is in itself a proof that this is working.

[21] https://www.nordicinnovation.org/2024/systemic-innovation-compass

- A common understanding of where we are and what we aim for must be in place. NEA has defined a joint mission and joint vision to set a direction, but concrete Nordic targets at the governmental level are not yet in place.

- Collaboration and co-production are key leverage points to tackle systemic change, and a multitude of actors from the system must be brought together. NEA is an example of a platform for systemic change that lean and adapt continuously, incorporate new resources and deliver tangible results. However, closer interaction with decision-makers and regulators at national and Nordic levels is a vital next step.

Efforts for Sustainable Aviation Across Nordic Countries

Building partnerships with key stakeholders can accelerate progress by providing a forum for decision-makers, industry and other stakeholders to meet, align plans and policies, share information and exchange experiences – and to innovate.

Some Nordic countries and regions have established forums for engaging with stakeholder groups, but not necessarily covering the complete ecosystem. NEA is often mentioned in this context. NEA is supporting the joint vision and goals of the Nordic governments and the Nordic Council of Ministers. Hence, NEA can be seen as a promoter of joint Nordic interests and priorities. However, thus far we have not worked closely with the Nordic governments as a Nordic group, in the same way that individual NEA partners work together with their respective governments.

An example of a partnership between industry and government from outside the Nordic region, was the UK Jet Zero Council. This is an example of a working group, where ministers and high-level representatives from the industry oversee technical work streams on SAF and zero-emission aircraft (ZEA) and work together. This allowed industry to advise governments, and industry to see the constraints that governments face in developing enabling policies.

As part of a collective commitment to combat climate change, Nordic countries are implementing strategic frameworks to transition the aviation sectors toward sustainable practices. The focus is on reducing greenhouse gas emissions, fostering innovation, and enhancing the infrastructure necessary for the adoption of environmentally friendly technologies.

[22] https://www.weforum.org/publications/target-true-zero-government policy-toolkit-to-accelerate-uptake-of-electric-and-hydrogen-aircraft/

Denmark

In 2021, Denmark established a **Climate Partnership for Aviation**, uniting key stakeholders including airlines, airports, NGOs, and governmental bodies. This partnership aims to achieve a 30% reduction in aviation emissions by 2030.

In the agreement '**Green aviation in Denmark**', the passenger tax on air travel was introduced. The passenger tax increases from DKK 70 on average per travel in 2025 to DKK 100 on average per travel in 2030.
The fee is differentiated according to how long the flight is: DKK 50 for domestic journeys and journeys within Europe, and DKK 310 and DKK 410 on medium- and long-distance routes when the tax is fully phased in in 2030.

Transfer and transit passengers are exempt from the tax. The passenger tax is estimated to generate an annual revenue of DKK 0.9 billion by 2025, rising to DKK 1.2 billion in 2032. Approximately half of the revenue will be returned to aviation's green transformation. Approximately half of the total passenger tax must finance an increased seniority contribution, and thus will not be returned to aviation.

During the period 2025-2029, 0.8 billion is allocated for the establishment of a Danish domestic route. Attempts are being made to establish a tender process for this.

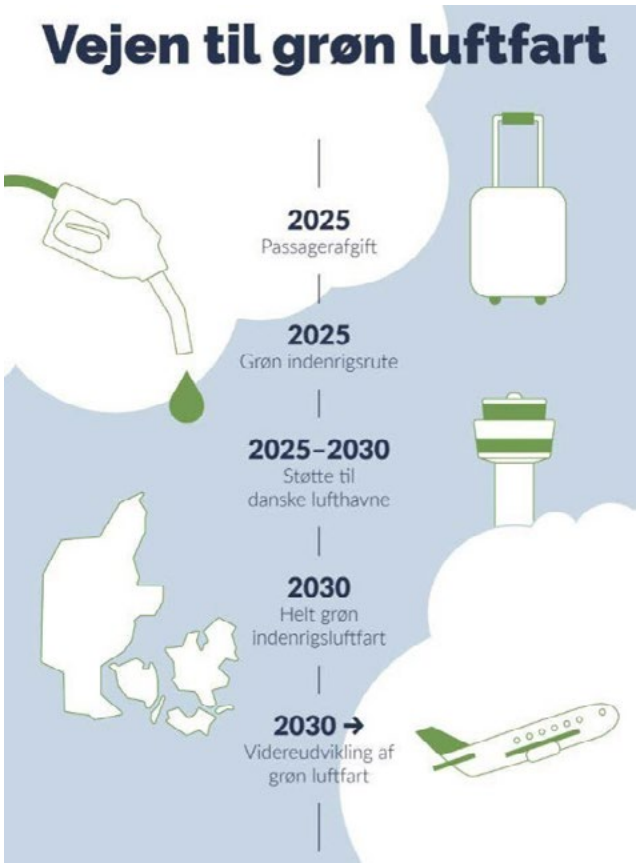
The parties behind the agreement agree to use approximately DKK 1.5 billion in the period 2027-2033 to support the development of green domestic aviation. The amount is estimated to be able to cover the costs of reducing aviation's CO2 emissions, - in addition to other upcoming measures, including the EU requirement for SAF blend-in. The goal is for Danish domestic to be completely green by 2030. In addition, 0.55 billion is allocated to other areas, for example:

- Support for smaller regional airports
- The route development program Global Connect
- Other initiatives for Danish airports and the aviation sector

The support for the establishment of a green route (or the equivalent of a Danish route) will be awarded after a tender process. This is expected to be initiated in the autumn 2024 with implementation in Q3 2025. As no other options exist yet, it is expected to be support for additional cost for SAF in the period 2025-27.

In 2027, the concept will be reassessed, and a new round of tenders will be planned. The next stage may include new fuels, other routes or sustainable propellants for electric or hydrogen aircraft, depending on what is available 2028-30. The process, scope and allocations to individual projects such as e-fuels, electric planes, etc. is not known yet.

[22] https://www.weforum.org/publications/target-true-zero-government policy-toolkit-to-accelerate-uptake-of-electric-and-hydrogen-aircraft/



Source: Danish Government, Nov 2023, Vejen til grøn luftfart

Finland

Finland has in place a **National Transport System Plan** (Liikenne 12), currently covering the period 2021-2032. The Transport 12 Plan is updated every government term, and the update for the ongoing term is currently underway. The National Transport System Plan first published in 2021 describes air transport at a rather general level and does not go into detail when it comes to aviation fuels or electric aviation.
The National Transport System Plan provides an overview of the role of air transport and the structure of the airport network in Finland. Air transport is identified as playing a particularly important role in terms of international and internal accessibility. (Prime Minister's Office 2021a.).

In 2021, the Government published a government resolution on reducing greenhouse gas emissions from aviation. One of the measures of the resolution outlined the need for a study on the electrification of aviation and the development of charging infrastructure at airports (Prime Minister's Office 2021b.) The Finnish Transport and Communications Agency, Traficom, has carried out a study on electric aviation in Finland in 2022 (Traficom, 2022). For aviation, the roadmap specifically identifies hydrogen and downstream electric fuels as important options for promoting sustainable aviation. (Prime Minister's Office 2021c.).

The government programme initially outlined the creation of a separate national air traffic strategy (in Finnish lentoliikennestrategia) focusing solely on the development of aviation. However, a separate strategy will likely not be created, and instead aviation will be assessed as part of the National Transport System Plan.

Iceland

In the **Transportation Plan** for 2024-2038 it is stated that Iceland's vision for the future involves technology connecting the country's communities and Iceland to the world in an environmentally balanced manner. It is stated that the main objectives of the Ministry of Infrastructure's plans for sustainable communities and municipalities across the country are reflected in the goals, priorities, and actions of the Transportation Plan. Among other things, the key issues in transportation in Iceland over the coming years will be to focus on reducing greenhouse gas emissions from transportation, reducing local environmental and public health impacts of transportation, changing travel habits, and fostering innovation and technological development in transportation. These issues will be addressed with defined goals and actions.

One of the actions is to analyse ways to reduce fuel consumption at and around airports where focus will be on the energy transition for aircrafts as well as cars and equipment. Transportation to and from the airport will also be examined. An analysis will be conducted on the state of electricity access at airports and landing sites to meet the needs of electric aircraft. The project is under the responsibility of Isavia Regional Airports.

In an **Aviation Plan for Iceland** that was published in 2020 it was stated as key objective to: Reduce the negative environmental impact of aviation and aviation-related operations and facilitate the energy transition in the field of air transport in conjunction with technological development and promote the development of necessary infrastructure for it.

In an updated **Climate Policy Action Plan** for Iceland published in 2024 there are a number of actions regarding aviation. Firstly, the improvements of alternate airports in Iceland in order to lower the fuel carrying of aircrafts and by that lowering the environmental impacts and costs. Improving aeronautical processes f.x departure and approach paths to lower energy costs. Installing A-CDM, TBS and CADM at KEF airport.

Regarding aircrafts, Iceland will continue participation in ETS and CORSIA and amend the regulatory framework accordingly. Iceland will install the EU directive regarding SAF. The state will consider supporting the investment for passenger aircraft to be used in regional flights. And lastly the state will provide a strategy regarding the production of SAF in Iceland. An initial analysis on the business case has been done, but no decision has been made so far.

No flight routes have been planned domestically or to other Nordic countries, neither by the government as part of the transportation plan 2024-2038 nor by other parties. The Road Administration which is responsible for the tender of PSO routes is looking into this matter and follows the development of aircrafts with alternative fuels closely and how the PSO tender could incentivise energy transition in aviation.

Norway

The Norwegian government aims to accelerate the transition to zero and low emission aviation. This includes phasing in zero and low emission aircrafts on domestic routes as soon as technology permits. At the latest the goal is to include zero and low emission aircraft in the renewal of most of the PSO routes with contracts starting in 2028/2029, if technology development allows.

The Norwegian aviation strategy (Bærekraftig og sikker luftfart) and the **National Transport Plan** (Nasjonal transportplan 2025-2036, NTP) represent pivotal elements in the nation's efforts to transition towards sustainable transport solutions. A key focus within these strategies is the advancement of zero and low-emission aviation, aimed at reducing the environmental impact of air travel. The Norwegian aviation strategy outlines the country's commitment to fostering innovation in zero and low emission aviation technologies and integrating them into the existing aviation framework. Complementing this, the NTP provides a comprehensive roadmap for the development and implementation of infrastructure and policies to support zero- and low-emission transport across all sectors, including aviation. Together, these two documents lay the groundwork for a more sustainable future in Norwegian air travel.

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The National Aviation Strategy outlines the Norwegian government's strategy to promote sustainable and safe aviation. It emphasises the importance of accelerating the transition to zero and low emission aviation, focusing on technological advancements such as hydrogen and batteries as energy carriers in aircraft. The document highlights the need for sustainable aviation fuel (SAF) as an interim solution and details plans for adapting infrastructure to support new energy carriers. The strategy was put forward by the Norwegian Ministry of Transport and approved by the Council of State in the beginning of 2023.

The National Transport Plan sets out the strategic framework for Norway's transport policy over a twelve-year period, starting from 2025. This comprehensive plan addresses the need for substantial investments in infrastructure, emphasising sustainability and the reduction of greenhouse gas emissions. Through the transport plan the Norwegian government commits to putting forward 1 billion NOK to establish Norway as a test ground for low and zero emission aviation. It is, however, not stated how the funds will be allocated over the twelve-year period.

Sweden

The 2023 **Swedish Government Climate Action Plan** highlights the transport sector, emphasizing fossil-free and electric aviation as priorities. The government advocates for technology and electrification over punitive measures, aiming to facilitate the market introduction of electric aircraft.

The industry stakeholders, in Swedish Air Transport Society, together with experts and the governmental organization Fossil Free Sweden, have written a **Roadmap for fossil free aviation**. The first version came out in 2019 and have since then been updated yearly.

Targets in the roadmap are:
2030: Domestic flights to be fossil free (CO2 emissions from aviation equivalent to domestic flights to be eliminated).
2045: Domestic and foreign flights to be fossil free (all flights starting at Swedish airports to be fossil free and thus not refuel with fossil fuel).

The Swedish Air Transport Society is responsible for the process of following up the roadmap. Which has also given rise to several collaborative projects. One such project is the innovation cluster Fossil Free Aviation 2045, which has produced the report The route to fossil free aviation 2045, a more detailed and broader analysis of how the targets in the roadmap are to be attained.

In January 2024, the Swedish Transport Administration submitted the proposed long term planning orientation which serves as basis for the government infrastructure proposition expected to be presented this fall, and the future national plan for transport infrastructure 2026–2037, Inriktningsunderlag - Bransch (trafikverket.se).

In the sub-report Luftfart, the Swedish Transport Administration highlight 4 areas of development where there is identified needs for measures. One area addresses the electrification and digitalisation of the aviation sector, Luftfart, Underlagsrapport till Inriktningsunderlag för 2026 - 2037 (diva-portal.org).

In February 2024, the Swedish National Road and Transport Research Institute (Statens väg- och transportforskningsinstitut, VTI), produced a report that explores the concept of the airport as an energy hub in the decarbonizing transportation and energy systems, The airport as an energy hub (diva-portal.org) . In the report, VTI claims that the airport, transitioning from petroleum-based fuels to carbon-free alternatives like electricity, hydrogen, or biofuels, could help reduce the aviation sector's carbon footprint and that incorporating renewable energy and storage systems and potentially producing fossil-free fuels positions the airport as a two-way hub in both the transportation and energy systems, the airport can help to balance multiple objectives in achieving economy-wide sustainability targets.

Nordics

The collective initiatives undertaken by Denmark, Finland, Iceland, Norway, and Sweden exemplify a robust regional commitment to sustainable aviation. By fostering collaboration among governments, industry stakeholders, and research institutions, these countries are paving the way for a greener aviation future. Policymakers are encouraged to leverage these frameworks to support further innovation, investment, and infrastructure development, ultimately contributing to global climate goals.

Summary

The aviation sector faces significant pressure to reduce its climate impact, necessitating a robust net-zero aviation strategy. The World Economic Forum's "Target True Zero" toolkit emphasizes the critical role of electric and hydrogen aircraft in achieving this aim. Countries are urged to formulate comprehensive strategies that align with international goals while addressing unique national circumstances.

Global and Nordic Commitments

The adoption of the Paris Agreement and the International Civil Aviation Organization's (ICAO) goals establishes a collective aim for net-zero carbon emissions in aviation by 2050. The Nordic countries, while adhering to this global target, are also setting ambitious national goals, with some aiming for fossil-free domestic aviation by 2030. Each country must tailor its strategies based on local capabilities and priorities, utilising Sustainable Aviation Fuels (SAF) and innovative technologies like battery-electric and hydrogen-powered aircraft.

Strategic Pathways to Decarbonisation

The aviation industry recognises that achieving net-zero emissions by 2050 will require a multi-faceted approach. Key strategies include:

- **Sustainable Aviation Fuels (SAF)**: Expected to deliver 70% of necessary decarbonisation, particularly for medium and long-haul flights.
- **New Technologies**: Battery-electric and hydrogen-powered aircraft could contribute up to 34% of the required reductions, particularly in regional aviation.
- **Infrastructure Improvements**: Investments in infrastructure and operational efficiencies are essential to support these technologies.

Implementation Framework

To effectively transition to sustainable aviation, Nordic countries must establish clear policies and supportive mechanisms that align with ICAO's framework. This involves:

- Coordinated Nordic Policies: Work together and align our Nordic work, especially on EU and global levels.
- Stakeholder Engagement: Nordic Governments should actively collaborate with the Nordic ecosystem, industry stakeholders, to ensure the strategies are pragmatic and contextually relevant.
- Nordic Cooperation: Enhanced cooperation among Nordic nations is vital to reconciling differing national strategies and achieving collective goals. Align our national plans outlining emissions reduction commitments, technological pathways, and timelines.

Investment in Innovation

Investing in innovation will be crucial for the electric aviation sector's growth. Policymakers should:

- Support NEA as the leading partnership in joint innovation, development and realisation of electric and hybrid-electric aviation.
- Support startups and established companies in advancing electric aviation technologies.
- Recognize the unique geographical advantages of the Nordics, such as abundant renewable energy sources and innovative industries.

The journey toward sustainable aviation requires coordinated efforts among governments, industries, and stakeholders across the Nordic region. NEA could be a driver for this. By prioritising SAF and emerging technologies equally, leveraging existing capabilities, and fostering regional cooperation, the Nordics can position themselves as leaders in the transition to a net-zero aviation sector, contributing to both national and global climate goals.

Chapter 5:

Creating an Enabling Environment

Chapter 4 describes what is needed to create a Nordic strategy for electric and hybrid-electric aviation and what is already in place in the Nordics. This chapter, which builds upon the second step in the WEF Policy toolkit24, will discuss how to create an enabling environment to implement the strategy.

The WEF report, "Target True Zero: Government Policy Toolkit to Accelerate Uptake of Electric and Hydrogen Aircraft", highlights the need to focus on several key actions:

1. Support R&D and innovation: Invest in innovation, R&D and deployment of new technologies, and start to build a market for electric and hybrid electric aviation, as well as the building of pilot plants for production of aircraft.

2. Infrastructure Investment: Ensure that airports have the necessary infrastructure to accommodate new aircraft technologies.

3. Regulatory Review: Evaluate and update regulatory frameworks to be technology-neutral, removing any unintended barriers to alternative propulsion systems. This includes reviewing certification standards and airworthiness requirements.

4. Facilitate International Collaboration: In addition to working together in the Nordics, it is important to engage in international partnerships to accelerate progress, share best practices, and harmonise certification approaches, and where possible, to do so as a unified Nordic actor.

To create an enabling environment, there are various tools available that can be used at the Nordic level. The tools mentioned in the WEF report are used as inspiration in this chapter, supplemented with examples from the Nordic countries.

[24] World Economic Forum (WEF): "Target True Zero: Government Policy Toolkit to Accelerate Uptake of Electric and Hydrogen Aircraft", WHITE PAPER., JULY 2023.

R&D and innovation to accelerate battery-electric and hybrid-electric aviation

Direct R&D and innovation funding can take the form of grants, awards, or public-private partnership.

Governments can also:

- **Encourage private investment into new or existing firms working on key technologies.** NEA is an example of this, where Nordic Innovation has supported and provided co-funding to the project since 2019. This has given the ecosystem time to build trust and collaborative structures. All Nordic airliners were the first to sign LoIs with Heart Aerospace and Elfly Group.

"For Heart Aerospace, the support from the project partners has been incredibly important. The letters of intent that were given from the airlines have been a tangible asset to put on the table in front of venture capital investors. This support set us apart from other startups and made us succeed in a fiercely competitive environment",

- Anders Forslund, CEO, Heart Aerospace.

- **Consider providing regulatory sandboxes.** An approach that allows testing of innovations for a time-bound period, under a regulator´s oversight – to help accelerate learnings and iteration of new technologies. Green flyway and FAIR are two examples of test arenas in the Nordics.

Funding for academic research can help address areas where there are existing knowledge gaps.

WEF 202225 identified eight critical "technology unlocks". Three unlocks concern electric aviation:

a. Ensuring aviation batteries are charged with renewable energy

b. Improving battery lifecycles and management for aviation

c. Improving battery-electric aircraft energy density

In addition to these, NEA has also identified the following technology unlocks that we are working with:

d. Standardization
- In NEA 1.0 mainly Charging infrastructure
- In NEA 2.0 **Infrastructure and technology**: Prepare destinations for electric aircraft by mapping out necessary infrastructure changes

e. Nordic context
- In NEA 1.0 Nordic conditions, such as weather conditions, example de-icing
- In NEA 2.0 **Safety and security**: Evaluate safety and security

requirements, adapt and prepare requirements for electric aviation

f. Connectivity
- NEA 1.0 New Business models
- NEA 2.0 **Decision support system**: Create a decision support system for stakeholders to optimize infrastructure and operations for the future of electric aviation

g. Communication and Government Affairs: Increase political and public awareness around electric aviation through communication activities to enable both supply (technological), demand (market) and regulatory frameworks to develop.

[25] World Economic Forum (WEF): "Target True Zero: Unlocking sustainable battery and hydrogen-powered Flights", July 2022.

Innovation and development supported in the Nordics

The first electric aviation projects started back in 2018 and took off in 2019 in the Nordics. NEA was one of the very first projects in this domain. Today, there are electric and hybrid-electric aviation projects in all Nordic countries. However, the criteria for these kinds of projects are not in place, and they are assessed in the same categories as SAF and hydrogen projects, which sometimes gives electric and hybrid-electric aviation a disadvantage.

Denmark

The Danish government has not made concrete decisions on which technologies, methods or proposals are to be supported.
The possibilities for funding to be allocated to electric aircraft development are present in the legal text, which states: "It can be in the form of support for the blend-in of sustainable aviation fuel such as PtX fuels or other propellants such as hydrogen and electricity" and "Biofuels and PtX will compete with electric and hydrogen aircraft for the subsidies".

Example

Copenhagen Airport is the lead on the EU project ALIGHT, primarily financed by EU Horizon 2020. The focus is analysing and preparing a conceptual design manual for the aircraft's use of fuel and on all forms of energy use at the airport. The project has several work packages. One is a concept study on the future aircraft stand, in which they study the infrastructure needed for electric aircraft and other propellants, also testing electric and autonomous push back tractors.

Finland

In 2021, the Finnish Government published a government resolution on reducing greenhouse gas emissions from aviation. The government resolution states that Finland will use RDI funding to promote technology and production related to electric fuels. In Finland, there has not yet been extensive investment in electric aviation, however, there are increasing efforts to develop the operating environment for electric aviation. EU regulations, such as the ReFuel EU and AFIR regulations guide the development of sustainable aviation, and in Finland, the Finnish Transport and Communications Agency, Traficom, monitors compliance with international regulations. International cooperation is tight-knit, and Finland is actively involved in the exchange of information at EU level and participates in cross- border electric aviation projects such as FAIR 2. There is also an ongoing domestic-level project aiming at creating an electric aviation ecosystem in Finland.

Promoting electric aviation requires a wide range of skills and investment in research and development, as well as education. Finland has not yet invested extensively in the promotion of electric aviation at the national level, as Finland's general government deficit and growing international debt has forced the government to make severe cuts to government budget and supplementary budgets.

The development of battery technologies is key in advancing electric aviation. In the background discussions, one interviewee pointed out that the EU risks falling behind in battery technology development, especially compared to China, which is heavily investing in the battery industry. Several interviewees felt that Finland should be able to make better use of EU funding, especially in RDI activities, which would allow funding to be channelled to the development of electric aviation. However, one interviewee pointed out that applying for EU RDI funding is rather bureaucratic and challenging, which may lead companies to avoid applying for funding. One interviewee also pointed out that the lack of aircraft manufacturing industry in Finland is one potential reason for the relatively low amount of research in aviation technology in the country.

In Finland, there are currently no public financial incentives or subsidies for the development of electric aviation except for individual grants. Some of the interviewees underlined that the development of electric aviation and other forms of sustainable aviation should be mainly market driven. One interviewee also pointed out that public subsidies need to be carefully considered as they tend to become permanent structures that are not easily ceased at a later stage. Subsidies should therefore focus on the development phase of the technology, not on the provision of the service itself. Further, the current economic situation in Finland is not favourable to new, large-scale subsidies.

Example

An example of interest in promoting electric aviation is the recently established Smart Urban eFly project, which aims to create an electric aviation innovation ecosystem in Finland. The project aims to create a network bringing together companies of all sizes, RDI actors and public authorities at both national and international level. Through the network, the aim is to promote the know-how and operating environment for electric aviation, especially in the Uusimaa region. The project is funded by the European Regional Development Fund (ERDF) and will run from 2024 to 2027 (Haaga-Helia, n.d.).

Iceland

The Energy Fund is a competitive fun. The state governs the fund's commitments, and it is administered by the Energy Ministry. The goal of the Energy Fund is to support projects that aim to discontinue the use of fossil fuels and instead use renewable and environmentally friendly energy. The fund regularly allocates grants for energy transitions. It is worth noting that the Energy Fund is tasked with accelerating the energy transition using proven technology.

This technology can be new, provided it is a well-established market product. The total amount of funding through this scheme is 900.000.000 ISK (~ $6.5 million). All projects are evaluated based on their reduction in greenhouse gas emissions and how well they support the government's climate action plan. The Minister for the Environment, Energy, and Climate decided to expand the criteria for fund allocations for the year 2024.

will be awarded to projects that fall under one of three focus areas: infrastructure for electric vehicles, ships, and aircraft; production of electric and biofuels; and solutions that reduce the use of fossil fuels. Electric aviation falls under two of these three focus areas.

The Energy Fund allocated 5 million ISK (~ $36.000) to Rafmagnsflug, the initiative behind the acquisition of the country's first electric aircraft, the Pipistrel Velis Electro, which was used to purchase a portable charging station. Additionally, 41 million ISK was allocated to the Reykjavík Flight School to partly fund the purchase of three training aircraft, the Diamond eFlyer, which has a flight endurance of 3.5 hours. However, the production of eFlyer aircraft has been significantly delayed, with uncertainty in when production will be ramped up. The original plan was for the delivery of the aircraft in 2024, but it now appears that there will be a 2-3 year delay.

In 2019, the **Climate Fund** (Loftslagssjóður) was established. This fund, overseen by the Minister for the Environment, Energy, and Climate, awarded annual grants totalling 200.000.000 ISK (~ $1.4 million). The fund's purpose was to support innovation projects in the field of climate and educational projects on the impacts of climate change. Grants for innovation projects were intended, among other things, to support research and development related to the adaptation and implementation of new climate-friendly technological solutions and designs. Currently, a bill is under discussion in Parliament proposing changes to the laws governing the Energy Fund and climate legislation, involving the merger of these two funds. The main role of the new Climate and Energy Fund will be to support innovation and infrastructure projects in the fields of climate, energy utilisation, and the circular economy.

There is no formal platform for research or development work related to electric aviation in Iceland. The transition to electric aviation will require collaboration across stakeholder groups, and it will need sector wide incentives given the magnitude of transformation.

Example

Thus far, the actions taken have emerged from the grassroots of aviation in the country, leading to the initiative to purchase the Pipistrel aircraft. Although similar projects had not been undertaken before, the purchase of the first electric aircraft in Iceland has demonstrated that such projects are feasible. The company Rafmagnsflug was established around the purchase of the Pipistrel aircraft, and this company manages its operation. The founders of the company are Matthías Sveinbjörnsson and Friðrik Pálsson, but other entities have also invested in the company and are its owners. In addition to Matthías and Friðrik, the owners include Icelandair, Isavia, Landsvirkjun, Hotel Rangá, Landsbankinn, the flight school Geirfugl, Reykjavik Flight Academy, and the Icelandic Flight Academy.

Norway

The Norwegian Research Council (NRC) offers a range of different funding programmes for innovation projects in which there are fundamental research needs. Through their range, the NRC offers calls and programmes aimed towards specific industries or more general social challenges, such as sustainable transport.

Pilot-T is a collaboration between NRC and Innovation Norway, and it aims to accelerate the application of new, smart mobility solutions by developing and testing and/or piloting technologies, services and business models with the potential to influence the transport system of the future to make it efficient, safe and environmentally friendly. Pilot-T requires industry stakeholders to pair up with R&D providers.

SFI (Centre for Research- based Innovation) aims to strengthen the innovation capacity of Norwegian trade and industry through research that addresses long-term needs, challenges and future opportunities for value creation.

The **Innovation Project for the Industrial Sector** is aimed at companies engaged in business-led innovation projects where R&D is a critical part of the innovation process. It is aimed at projects in which multiple partners are working together to develop sustainable innovations.

The Green Platform Initiative aims to accelerate the green transition in the business sector by supporting projects that will reduce greenhouse gas emissions by 2030 going towards a low-emission society in 2050. Projects must be ambitious with significant environmental and climate benefits and great value creation potential. Projects must form links between activities such as research, development and testing, as well as specific plans for implementation, commercialisation and scaling. Projects are to generate new knowledge, technology and solutions.

SkatteFUNN is a tax deduction scheme alleviating 19 % of costs related to R&D. This scheme is open to businesses developing new services, products or production processes in which new knowledge or new ways of utilising existing knowledge is essential to its development.

Innovation Norway offers funding mainly to businesses that sell services or products that are more mature on the Technology Readiness Level (TRL) scale. Their schemes ensure developments on the business and market-side. They offer financing, consultancy, expertise, network-strengthening and profiling. Innovation Norway has offices spread across important export markets, enabling them to catalyse market establishment in targeted locations. Additionally, together with NRC, they fund Pilot-T and Green Platform.

Enova offers programmes for financing to reduce investment costs in green energy procurements in order to accelerate industrialisation and market introduction of technology using renewable energy sources.
Even though no specific programme exists for supporting green aviation, Elfly Group was granted funding through their Piloting of groundbreaking climate technology.

SIVA (Selskapet for industrivekst) facilitates innovation through their real estate ownerships, creating synergies by offering a hub structure surrounding innovative private companies. Through their consultancy, they aim to help businesses accomplish their business ideas, competitiveness, and growth both nationally and internationally.

Sweden

The transition to electric aviation will require collaboration across stakeholder groups and given the magnitude of transformation it will need sector wide incentives. As future fossil-free aviation incorporates several parallel pathways, the need for RDI to work in parallel and in synergy with SAF, hydrogen and battery-electric aviation is of paramount importance, and the RDI of one pathway should not impede nor steal the focus of other pathways for fossil free aviation.

Swedish Energy Authority grants for fossil free aviation. The Swedish Energy Agency has funded research and innovation projects that will accelerate the transition to fossil-free aviation over a longer period. Partly through government assignments, partly through their own research and innovation programs for biofuel and sustainable transport.

Fund for Research and Innovation within the aviation sector. The Swedish Transport Administration finances, coordinates and conducts research and development in the field of aviation. In many cases, the research is conducted by the Civil Aviation Authority or Swedavia in close collaboration with the Swedish Transport Administration and other actors. The total grant amount is at least 50 MSEK per year.

The Climate Leap is the investment support that makes it possible to invest in fossil-free future technology and green transition. It can be applied for by companies, municipalities, regions and organizations throughout Sweden. The climate step is partly financed by the EU's recovery fund, NextGenerationEU.

The Industrial Leap grants are given for preliminary studies, research, pilot and demonstration projects and investments in various areas. The Industrial Leap grants are handled by the Swedish Energy Authority. Achieving the climate goals will require extensive investments in new technology that is rarely commercialized. The road to net zero emissions requires investment in innovative and technology- changing solutions. Industry has a major role in the transition, both by reducing its own emissions and by contributing to the climate transition in society through its products and materials.

Examples

10-15 projects are ongoing in Sweden during 2024, some of them are presented below:

FAACE: The project studies how airport infrastructure could be designed to meet the requirements of future aviation and future propulsion technologies. The project focuses on concepts for the charging of battery-powered electric aircrafts. As there are currently major uncertainties regarding the technical, operational and business developments in electric aviation, it is desirable to design for flexibility in the airport infrastructure. A specific solution that will be studied in this project consists of stationary energy storage in combination with an automated vehicle.

Air-Charge: This project proposal describes an initial phase for contributing to accelerated introduction of electric aviation, by establishing the foundation for future implementation of high-power charging solutions (>1MW) for battery-electric aircraft. Gathering relevant stakeholders under a common umbrella is a fundamental prerequisite for success. This means that we need to collectively examine the current conditions, potential ways forward, and determine what is required to create a functional and scalable system from a variety of perspectives. These perspectives include technical, economic, safety- and security-related aspects of all components of the system.

ELISE3: The project involves the development and realization of an electric aircraft demonstrator, a full-scale 1:1 model of Heart's ES-30. In addition to building the aircraft, the project focuses on optimizing the turnaround process for electric aircraft. This includes the first-ever turnaround test for an electric aircraft of this size. The project will explore how to optimize various aspects of turnaround operations, including charging, battery thermal management, refuelling, passenger boarding, and luggage loading. Additionally, there is a strong emphasis on battery development for future electric aircraft, such as the ES-30.

ELFLYSVE: The overall aim of the ELFLYSVE project is to bring more clarity to the potential to realise electric flight in Sweden, both theoretically and practically, which alternative solutions exist, as well as how this might look by 2030. To meet the aim, consideration must be given to several critical aspects that all affect feasibility, where ELFLYSVE includes the system components, electric aircraft, the airspace and the airport.

RETAS: In the project, the potential societal and climate benefits of a sustainable regional air transport system in Sweden and surrounding neighbouring countries are being studied. A model will be developed to assess how new flight routes are affected by technology, the number of departures, and ticket prices. Different business models and the need for various regulatory measures will also be evaluated.

Roadmap for electric aviation - Gotland: The pre-study on electric aviation in Gotland is focused on promoting sustainable accessibility by air, with a particular emphasis on electric flight. The goal is to identify the steps required to integrate electric aviation in Gotland and create a roadmap for this purpose. The ecosystem, with Heart, Elfly, Swedavia/Visby Airport, Region Gotland, energy companies and local industry and businesses, is working together.

EU RDI relevant for the Nordics

CEF (Connecting Europe Facility) or the Fund for a Connected Europe is an important source of funding for projects connected to the Trans-European Networks for Transport (TEN-T). CEF provides support for the development of transport networks, for example. CEF could therefore be utilised for Nordic development of infrastructure required for electric aviation.

At the EU level, it is important that the revenues from the Emissions Trading System (ETS) are channelled towards advancing the green transition, including the promotion of sustainable aviation.
EU funding, which should be better utilised in the Nordics.

Infrastructure to support electric aviation

Ensuring access to infrastructure for electric and hybrid-electric aviation will need to be a key priority for governments and regions that own the airports in the Nordics, to ensure that electric aviation can be operated. This equation is not only about charging infrastructure and preparing for landing and take-off; also access to adequate amounts of clean and renewable electricity is a fundamental requirement. On a governmental, and Nordic, level it will be necessary to develop plans for how aviation fits into overall renewable energy plans. All airports in the Nordics are currently developing plans. This is being discussed and knowledge sharing is taking place in NEA.

The WEF (2023) white paper "Target True Zero: Delivering the infrastructure for Battery and Hydrogen-Powered Flight", identified that around 90% of the energy and investments required for enabling electric aviation will be required offsite. The ten key insights from this report are outlined below. In addition to upstream infrastructure, new on-airport infrastructure will also be required. The WEF insights can be seen as inspiration for the Nordics:

Target True Zero – 10 key infrastructure insights

1. Global demand for **alternative propulsion could require 600-1,700 TWh of clean energy** by 2050. This is equivalent to the energy generated by around 10-25 of the world's largest wind farms, or a solar farm half the size of Belgium.
2. **Large airports could consume 5-10 times more electricity by 2050** than they do today, to support alternative propulsion.
3. Alternative propulsion will require **two new infrastructure value chains** – one for battery-electric aviation and one for hydrogen – which may include a whole variety of new partners that are not currently part of the aviation ecosystem.
4. **Most airports have space for hydrogen liquefaction and storage infrastructure**, but not enough land to generate all of the clean energy needed to power battery-electric and hydrogen aircraft.
5. Shifting to alternative propulsion will require a **capital investment of between $700 billion and $1.7 trillion** across the value chain by 2050. Approximately 90% of this investment will be for off-airport infrastructure, primarily power generation and hydrogen electrolysis and liquefaction.
6. Investment needed for airport infrastructure will be significantly higher for large airports than for smaller airports, but of **similar magnitude to other major investments such as building a new terminal**.
7. Costs to operators of alternative propulsion are expected to be **around 76%-86% over the market price for green electricity** – reflecting additional aviation infrastructure operating costs.
8. The investments needed to meet 2050 goals must start now. The first elements of **on-airport infrastructure must be in place by 2025** to meet expected energy demand.
9. To harness the power of network effects and regional connectivity, **coordination of infrastructure investment** will be required to make alternative propulsion operations feasible.
10. The aviation industry will need to **partner with other industries to secure enough green electricity and hydrogen** in a supply-constrained environment and have a voice in shaping the future of the hydrogen ecosystem.

Source: World Economic Forum[17]

Nordic regulatory review

To date the Pipistrel is the only certified electric airplane. There are standards under development but there are still uncertainties to be solved. Nordic governmental transport agencies have identified a lack of standards and are not sure about their responsibilities. They need more resources to be able to speed up the work, build knowledge and work alongside the industry to meet our Nordic goals. One example mentioned is that according to EU-regulation it is not possible to demand zero-emission aviation on PSO routes, e.g. electric, in procurement processes. PSO traffic is neutral regarding technical solutions, and electric aviation is thus not explicitly excluded. There are no established rules in place for the operation of these aircraft in commercial markets.

The Nordics will work together to solve regulatory issues, in alignment with the Gothenburg declaration. The following issues must be solved:

1. Aviation regulators will need to consider areas where differences in these aircraft require modification of existing rules and formulas. For example, charging formulas used by airports and navigation service providers to calculate landing and navigation fees are currently based on an aircraft's maximum take-off weight (MTOW). But battery-electric aircraft will be heavier than traditional aircraft, leaving them at a disadvantage under current regulations. One solution to this may be to subtract a factor of the weight of the aircraft battery from its MTOW for the purposes of setting charges.

2. There may be a need to update regulations to recognise the existence of battery-electric and hydrogen aircraft. For instance, countries or regions with SAF mandates, sub-mandates for synthetic e-fuels or operating bans may want to update these rules or build in rules from the outset for new regulations, to include operators using battery-electric aircraft or allow these technologies to contribute to meeting the requirements.

3. Regulators should ensure that their organisations are prepared for the growing number of new types of aircraft expected in the coming years. Considerations include training sufficient numbers of employees in the skills and knowledge required to regulate aspects of hydrogen or battery-electric aircraft, especially those specialising in aircraft certification.

4. It will be important for regulators to determine how best to maintain the same levels of safety without slowing down innovation in the industry. Bilateral aviation safety agreements are one measure that could allow a state without its own rules to use another jurisdiction's rules to approve an aircraft for operation within its airspace – providing that aircraft has been certified by another regulator. This would avoid the adoption process for aircraft being slowed down by a lack of standards in some countries and in the absence of ICAO standards.

5. There are also non-aviation-specific regulations that may need updating. For instance, health and safety rules for handling hydrogen may need to be reviewed to permit safe use at airports or for refuelling aircraft, along with rules related to transportation of batteries and their recycling. As noted earlier, alternative propulsion technologies can support new aviation business models, such as those enabled by Advanced Air Mobility, to play a role in public transport and provide enhanced mobility options for communities. However, this may require changes to regulations. For example, the definition of public transport used in European Union policies is confined to surface transportation, which would make these aviation applications are ineligible for public transport subsidies.

Overview of regulatory organisations

All the Nordic countries are members of the International Civil Aviation Organisation (ICAO), the UN's aviation agency. ICAO was established as a result of the Chicago Convention in 1944 where 54 states agreed to promote international air travel. ICAO has 193 member states. ICAO offers guidelines through standards and recommended practices (SARPS).

NORDICAO is a joint delegation to ICAO working with the mission of working together for safe, secure and sustainable aviation. Denmark, Estonia, Finland, Iceland, Latvia, Norway, and Sweden are members. Nordic representation in ICAO is ensured with the mutually agreed rotation scheme, making sure we continually hold a seat in the ICAO Council. The current representative candidature is Iceland, led by Valdís Ásta Aðalsteinsdóttir.

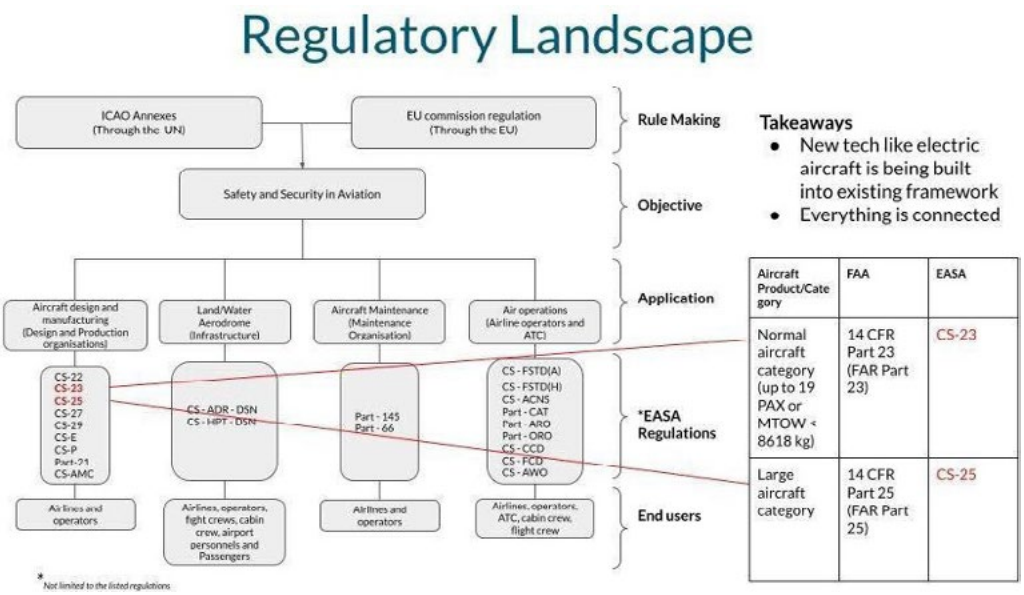
Founded in 1955 as an intergovernmental organisation, the **European Civil Aviation Conference (ECAC)** seeks to harmonise civil aviation policies and practices amongst its Member States and, at the same time, promote understanding on policy matters between its Member States and other parts of the world. It has particularly valuable links with industry and organisations representing all parts of the air transport industry. ECAC works closely and cooperatively with other regional organisations and individual Partner States on a range of civil aviation issues of common interest, including safety, security, facilitation and the environment.

EUROCONTROL is a pan-European civil-military organisation with 41 member states focusing on air traffic management. EUROCONTROL is one of the founding members of the Single European Sky ATM Research (SESAR) project, a research and innovation programme working towards integrating European airspace in order to become more sustainable, time- and cost efficient.

European Union Aviation Safety Agency (EASA) is the EU's flight safety agency with 31 member states. The Management Board brings together representatives of the Member States and the European Commission. The Management Board is responsible for the definition of the Agency's priorities, the establishment of the budget and for monitoring the Agency's operation. European Free Trade Association (EFTA) Member States (Norway, Iceland, Switzerland and Liechtenstein), do however not have voting rights. EASA issues laws and regulations, design certification, and is responsible for standardisation between countries and performs audits in this regard. An overview of the regulatory frameworks is part of NEA's work plan.

EASA is also coordinating efforts within several working groups. AZEA (Alliance for Zero-Emission Aviation) and the Sub Working Group 4 is specifically focused on the industry-wide structuring of standardization efforts. Its main objective is to identify standards required to support the certification of hydrogen and electric aircraft, associated air and ground operations and the infrastructure required to support them.

A forthcoming regulatory report from NEA includes the following overview of actors and responsibilities:

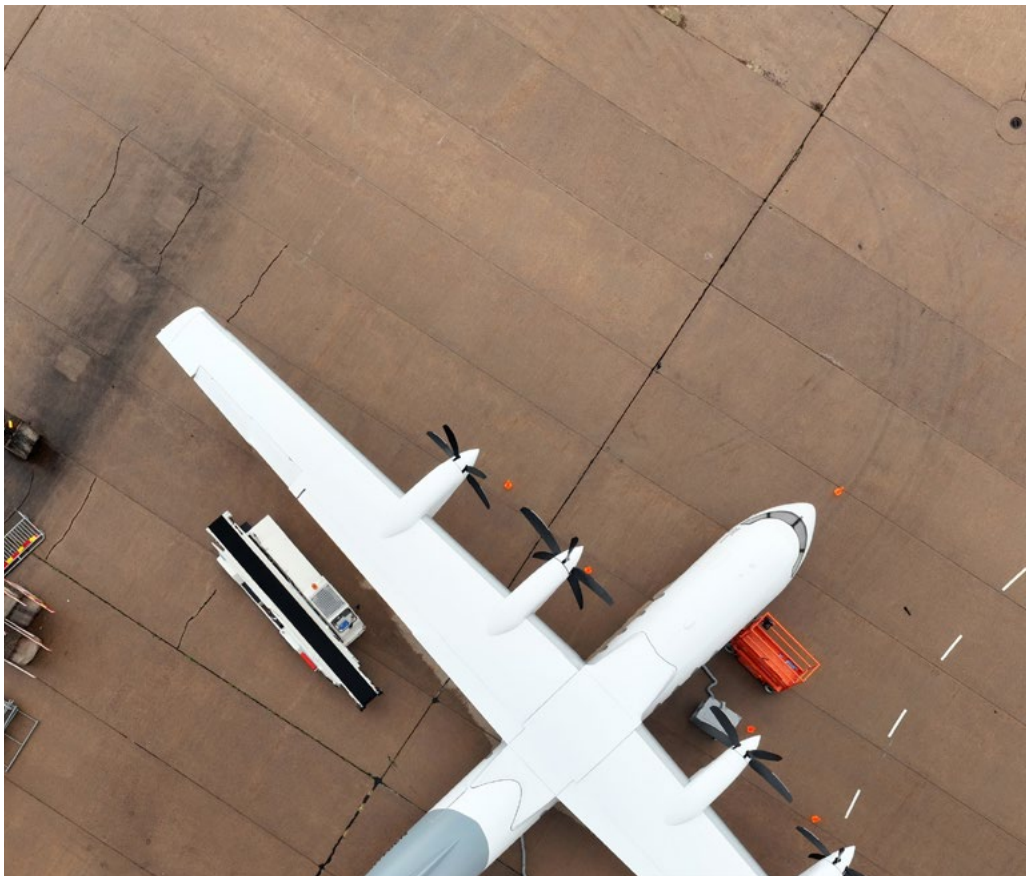


Denmark

The Danish parliament has decided to introduce a passenger tax starting in 2025. Half of the passenger tax is planned to be returned to the aviation industry as support for a transition to a more sustainable aviation sector in Denmark. It is now up to the regulatory authorities to ensure implementation of the agreed support. Initially, the authorities are tasked with establishing a tender process regarding a Danish domestic route. In the next phase, the regulatory authorities must establish a process over the next 5-6 years where the other support funds must go to development initiatives that will contribute to making all Danish domestic aviation independent of fossil fuels. Here it is possible that support can be allocated to the development or commissioning of, for example, electric aircraft.

The Danish authorities cooperate with all the Nordic countries regarding the work and representation in ICAO. As a member of the EU, the Danish regulators are currently working to ensure a correct implementation of RefielEU Aviation and RED III in Danish legislation.

In addition, the Danish Transport Agency is working on the State Action Plan task, which is a task that all countries must carry out in relation to ICAO. A task that must be carried out every three years.



Finland

Finland supports the ICAO and EASA objective to create a standardisation basis for electric aircrafts. EU regulation is the most important level of regulation for aviation. The background interviews highlighted the importance of EU legislation and international cooperation in promoting sustainable aviation, as international regulation steers the aviation sector at the national level. At the national level, the Finnish Transport and Communications Agency, Traficom, is responsible for air transport regulation in Finland and monitors compliance with international regulation.

At the EU level, a key regulatory tool is ReFuel EU Aviation which aims to reduce the carbon footprint of aviation as part of the EU's Fit for 55 package. The ReFuel EU Regulation focuses specifically on SAF, setting out minimum requirements for its distribution. However, in the regulation it is noted that ReFuel EU Aviation has the potential to contribute to the development of electric and hydrogen-powered aviation as well. (European Commission 2023).

Another central EU-level regulation is the AFIR Regulation, which obliges EU Member States to consider the role of electricity and hydrogen in aviation. Finland´s national implementation of ReFuel EU Aviation and AFIR Regulation is currently underway.

It should also be noted that EU legislation applies to airports used by commercial air traffic. If commercial electric aviation routes were to be opened at airports where there have been no commercial operations to date, they would also be covered by EU legislation. This would require significant investments in infrastructure, services, and personnel, among other things (Traficom 2022).

Iceland

The ministry of infrastructure and the Icelandic Transport Authority will develop regulations and standardise requirements for electric aviation. This work is entirely based on the approvals of international and European aviation authorities, such as the European Union Aviation Safety Agency (EASA), to utilise common certification.

Aircraft that fall under EASA airworthiness regulations shall be classified according to Commission Regulation (EC) No 748/2012 (EASA Part 21) on the airworthiness and environmental certification of aircraft. Icelandic aviation laws and safety regulations follow changes made to these laws and regulations. The registration of the first Pipistrel electric aircraft was possible because the authorities, the Icelandic Transport Authority, were able to follow the Norwegian model for airworthiness for that type.

To work on the implementation of new regulations, the government, Isavia, and the airlines need to cooperate on the electrification of domestic aviation. It is still unclear how the regular review of pilot licences will be conducted and how training for electric aviation will be managed.

Norway

The Norwegian aviation law regulates both civil and military aviation activities, in which there are requirements to environmental compliance.

Norway implemented a CO_2 tax on domestic aviation in 1999.[26] The CO2 tax aims to reduce the carbon footprint of domestic air travel by making it more costly to emit carbon dioxide. This financial incentive encourages airlines to adopt more efficient and sustainable technologies and practices. According to Norway's aviation strategy, the CO_2 tax will be progressively increased to NOK 2 000 per ton of CO_2 by 2030. Additionally, the passenger tax will be maintained, and the phasing in of SAF will proceed in line with EU plans. The Norwegian Institute of Transport Economics has projected that these combined measures will result in an 8,7 % reduction in emissions from domestic flights by 2030 compared to 2023, along with a 3 % decrease in passenger numbers during the same period. [27]

Sweden

It is suggested in the climate action plan to create a collaboration with the EU to ensure regulatory support for the transition to fossil-free aviation.

The upcoming national transport plan emphasises some of the hurdles that need to be tackled in order for electric aviation to be realised.
Whilst it acknowledges the decline in turboprop flights carrying less than 50 passengers and recognizes that new technologies can enhance profitability and availability by reducing noise levels and enabling the use of shorter runways, it points out that:

- Identifies the challenges with infrastructure to fast charge electric aircraft, the battery weight MTOW penalty and associated range penalty resulting in potential operating cost uncertainty.

- Highlights that the aviation industry may be hindered by regulations and a lack of financing which is reinforced by the fact that regional airports today are non-profitable.
- Mentions that an area where market conditions are weak is in the charging and hydrogen infrastructure on airports. For electric aircraft, there is a risk that the transition will be hindered by the profitability of the aviation industry not being sufficient to finance the necessary investments in charging infrastructure.

[26] Microsoft Word - VA -rapport nr. 2011-5 Utslippskutt i luftfart.docx (regjeringen.no)
[27] Luftfartsstrategiens klimatiltak: Hvordan påvirkes billettpriser, passasjertall og CO2-utslipp? (toi.no)

The Swedish Transport Administration had been tasked by the government of Sweden with analysing whether there are conditions to set up requirements for electric flights in the procurement of air traffic for lines with public service obligations according to applicable regulations and procurement process. If deemed necessary, The Swedish Transport Administration should also submit proposals for measures that can contribute to an early introduction of electric flights on these lines or some of the lines.

The Swedish Transport Administration had already carried out an investigation on behalf of the government in 2020 which would shed light on whether it was possible to set requirements for fossil-free flights in the procurements of air traffic. One conclusion from that investigation was that there is great uncertainty about today's EU rules provide scope for setting requirements for fossil-free alternatives, such as biofuel or electric aircraft. In the current investigation, the Swedish Transport Administration sees no reason to make a different assessment than in 2020 because the conditions are the same, that is, the EU Air Traffic Regulation has not been revised, and that it might be able to enable climate requirements in a procurement.

In this investigation, "Förutsättningar för elflyg i upphandlad flygtrafik", 28 the Swedish Transport Administration has focused on the practical conditions that need to be in place before any legal requirements are meaningful: electric flight must be fully developed and commercialised and available for sale on the market, airlines must be able to see business opportunities to invest in the technology in order to then offer them in the Swedish Transport Administration's procurements, and finally the airports must have adequate infrastructure that enables operations of such flights.

[28] https://trafikverket.diva-portal.org/smash/record.jsf?pid=diva2%3A1863566&dswid=4429

Collaboration beyond the Nordics

International collaboration can help accelerate progress through the sharing of knowledge, examples and lessons learned. Some challenges can only be resolved through international collaboration, such as the harmonisation of interoperability of charging and refuelling infrastructure.

ICAO promotes harmonisation for international aviation through its SARPs and states are encouraged to support ICAO in its work. In the event that the first battery-electric and hydrogen aircraft pre-date the finalisation of this work by ICAO, leading governments in this space could, as an interim measure, help shape future regulations by working together on a bilateral or multilateral basis. International collaboration can also help to ensure that investments in infrastructure are coordinated so they are delivered in different countries or regions at a similar time to allow international operations. Green corridors and similar initiatives can help develop international markets for these new technologies.

In terms of contributing to and receiving international knowledge, both NISA and ALIGHT have European and international partners, in which working together towards common goals is central.

A further example is the AZEA (Alliance of Zero Emission Aviation), the biggest European initiative whose main objective is to accelerate the development and deployment of zero-emission aircraft. AZEA was established by the EU commission in 2022. The alliance brings together stakeholders from across the aviation sector, including aircraft manufacturers, airlines, energy providers and airports, to work on the challenges and opportunities associated with zero-emission technologies such as electric and hydrogen-powered flight. Members of AZEA include both NISA and Heart Aerospace. The Alliance focuses on creating the necessary infrastructure, regulatory framework and industry standards to enable the widespread adoption of zero-emission aviation by 2050. This effort is part of the wider European Green Deal, which seeks to reduce aviation's environmental impact and support.

AZEA is split into six working groups focusing on the following issues:

WG1: Aircraft performance characteristics
Market forecast (traffic, aircraft entry-into-service, penetration rate, etc.) including potential changes to the network topology (e.g., new regional operations) Energy requirements for electric and hydrogen propulsion as applicable to the different aircraft categories
Breakdown of the number of flights per market segment
WG2: Electrical energy for battery recharging and green hydrogen

[23] AZEA members, organisation and reports can be found at: https://defence-industry-space.ec.europa.eu/eu-aeronautics-industry/alliance-zero-emission-aviation_en

production and corresponding required electricity generation
capacities for several low-carbon generation technologies
Distribution infrastructure to the aerodromes. Expected Capex Investment for generation (upstream) and distribution (downstream)
WG3: Operational considerations related to stand management, turnaround, taxiing operations, ground handling, passenger management, etc.
Ground logistics at the airport and impact of the infrastructure availability on the network
WG4: Hydrogen engine emission requirements and timeline for standardization / certification
WG5: This WG has the objective to enable the efficient and sustainable introduction and integration of electric, hybrid-electric and hydrogen-powered aircraft into the European network
WG6: Operational incentives as well as those related to the running costs of electric and hydrogen aircraft.

Denmark

Danish authorities as well as airlines and airports have a historic and well-developed collaboration with EASA and ICAO on a wide range of topics. The airlines have membership in various international industry organizations and Copenhagen Airport actively participates in ACI on, among other things, the green agenda.

As an initiative of the ALIGHT project and NISA, a Stakeholder Forum will be initiated which will initially bring together relevant actors with a view to preparing the airports to be able to handle electric aircraft, starting with assessing how the airports can adapt in terms of infrastructure.

The already mentioned Climate Partnership for Aviation with representatives from all airlines operating in Denmark, Danish airports, Danish Aviation, the Transport Agency, NGOs, NISA and other knowledge organizations has broadly united the industry in the efforts to make joint responses and proposals to the government.

Finland

Finnish aviation operators and public authorities are well-networked to international organisations and other international actors. These include, for example, the International Civil Aviation Organization (ICAO) and the European Union Aviation Safety Agency (EASA). Finland is also an active player in the EU and the exchange of information and dialogue at EU level is considered of great importance.

In the Nordic context, stakeholders from Finland, Sweden and Norway have participated in FAIR (Finding innovations to Accelerate the Implementation of electric Regional aviation) and FAIR 2 projects, which aim to promote cross-border electric aviation. The FAIR 2 project is currently ongoing and focuses on increasing knowledge on the demand for sustainable regional electric aviation.

The project will run from 1 June 2023 to 30 November 2024 with a budget of EUR 450,430 (Kvarken Council, n.d.). Thus, the FAIR 2 project plays a key role in supporting decision making on the development of electric and other forms of sustainable aviation.

Iceland

Until now, knowledge acquisition has been driven by individuals with a passionate interest in electric aviation, who have sought information through all possible means. In 2019, NEA was launched under Nordic Innovation's Nordic Smart Mobility and Connectivity programme. This demonstrated significant foresight and highlighted the importance of Nordic cooperation for knowledge transfer and information dissemination.

In 2022, Nordregio, the University of Akureyri and Austurbrú, a non-profit organisation in East Iceland operated by municipalities, universities, professional institutions, and other entities, participated in a collaborative project to map potential domestic flight routes for electric aviation: Electric Aviation and the Effects on the Nordic Regions[24].

Sweden

Swedish stakeholders in the aviation industry are well intertwined in many R&D projects related to electric aviation, some with regional approaches (FAIR and FAIR 2 as well as Green Flyway1 and 2), some with focus on a certain airport such as RESflyg and MODELflyg (Visby and Umeå airport) or broader studies with a national and international focus such as ELFLYSVE, FAACE, Air-Charge, ELISE 3, Fossilfritt Flyg i Norden and so on.

The drive from airport stakeholders, airline operators and the industry for cooperation and for solving the issues related to fossil free aviation is high. In certain areas our cooperation with airline manufacturers (Heart Aerospace), research institutes (RISE) and academia has led us to be front-runners in certain areas related to battery-electric aviation (such as electromagnetic interference, solutions for the turn-around process).

Collaboration with international stakeholders and actors has also helped the Swedish stakeholders push forward with new solution proposals and need for further investigations. However, now we see the need for concrete pilots in airports, with the need for financial support from the government or from other institutions in order to continue our strive towards net zero aviation.

Summary

To develop a comprehensive Nordic strategy for electric and hybrid aviation, it is essential to establish an enabling environment that fosters innovation, investment, and collaboration. The key actions for implementation recommended by WEF can guide our efforts in the Nordics:

1. Support R&D and Innovation
2. Infrastructure Development
3. Regulatory Framework Enhancement
4. Foster International Collaboration

Tools:
- Regulatory Sandboxes
- Financial Incentives

To create a successful and sustainable electric aviation market in the Nordics, it is imperative that politicians and decision-makers prioritise these strategic actions. By fostering an environment conducive to innovation, investing in necessary infrastructure, updating regulatory frameworks, and enhancing international collaboration, the Nordic region can continue to lead the way in electric aviation.

[24] https://nordregio.org/research/electric-aviation-and-the-effects-on-the-nordic-regions/

Chapter 6:

Accelerate Uptake with Incentives and Targets

Having outlined the necessary changes to create an enabling environment for electric aviation in chapter 5, chapter 6 will go on to explore how incentives and targets can be leveraged to achieve the Nordic goals. The World Economic Forum "Target True Zero Policy Toolkit" report30 highlights the following:

To expedite the adoption of alternative propulsion technologies in aviation, it is crucial to implement a strategic framework that includes targeted incentives, mandates, and public awareness campaigns.

Key measures for implementation:

1. **Incentives and Financial Support**:
- Subsidies: Provide financial assistance for renewable electricity initiatives to reduce operational costs for airlines.
- Low-Interest Loans: Offer favourable loan terms for purchasing or retrofitting aircraft with new technologies, facilitating quicker transitions.
- Market-Based Measures: Introduce levies on fossil fuel products to create a more competitive environment for sustainable options, making alternative technologies more appealing.

2. **Mandates and Regulatory Framework**:
- Technology Mandates: Consider establishing requirements for airlines to utilise specific low-emission technologies, which can drive the transition away from traditional, more polluting options.
- Ecolabelling Initiatives: Promote ecolabelling to enhance public awareness and consumer demand for greener alternatives, thereby encouraging airlines to invest in sustainable technologies.

3. **Assessment and Feasibility**:
- Before implementing any new policies, states should conduct a thorough assessment of the potential costs and benefits. This ensures that the requirements are feasible and proportionate, taking into account existing aircraft investments and the timelines for new orders.

To effectively accelerate the uptake of alternative propulsion technologies in aviation, a combination of financial incentives, regulatory mandates, and public engagement strategies must be employed. By setting clear targets and supporting operators in their transition, policymakers can significantly contribute to a more sustainable aviation sector

[30] https://www.weforum.org/publications/target-true-zero-government-policy-toolkit-to-accelerate-uptake-of-electric-and-hydrogen-aircraft/

Country contribution to accelerate uptake with incentives and targets

Denmark

The Danish Transport Agency and stakeholders within the field of green aviation have agreed upon the establishment of a public fund to contribute to finance the transition of the aviation industry through tenders of green domestic routes in 2025.

Denmark has formulated technology-agnostic goals for reaching their climate and environmental ambitions. Returning half of the passenger tax to the industry is in process, but this has not been implemented yet. The support for the establishment of a green route is awarded after a completed tender process. This is initiated in autumn 2024 with implementation in Q3 or Q4 2025. As no other options exist yet, it is expected to be a support for additional cost of SAF that is available in the period 2025-27. In 2027, the concept will be reassessed, and a new round of tenders will be planned. The new support may include new fuels, other routes or sustainable propellants for electric or hydrogen aircraft, depending on what may be available in the period 2028-30. The process, scope and amount to be allocated to individual projects such as e-fuels, electric planes, etc. is not yet known.

Finland

There are no large-scale public financial incentives for electric aviation in Finland, however individual projects have been supported by the state. EU funding for infrastructure development, research and development is central in developing sustainable aviation.

Public subsidies should be carefully considered and targeted at the development phase of the technology. Passengers can best be involved in the development of sustainable aviation by providing transparent information and looking at passenger demand and preferences.

Iceland

The success of a flight route is measured by the number of passengers or the load factor. A route that is established as carbon free must be valued by the passenger as such. In the first phase of the energy transition, it is anticipated that the price of electric flying could be somewhat higher compared to fossil flights. The traveller will then have to assess the value of carbon free transportation and choose between options.

Electric aviation opens a whole new world of possibilities in increasing frequency of flights and enhancing connectivity within Iceland. Today, there are scheduled flights to 12 destinations in the country, but in the nineties, there were 37 destinations. Will it be possible to move the transportation of cargo and passengers from the road system to the air? The development needs to be openly discussed, and the safety of electric aircraft needs to be verified for the travellers to trust them and feel safe on board.

Electric aircraft will have lower noise pollution, which might have a positive effect on the ongoing debate about the location of Reykjavík City Airport.

The governing body responsible for the tender of PSO routes, the Icelandic Road Administration, is following the development of aircraft technology closely, working towards incentivising aircraft service providers to transition to more environmentally friendly alternatives.

Norway

Norway operates a significant number of PSO routes compared to other countries, reflecting the high demand for subsidised air services to maintain accessibility across the country. All PSO routes in Norway, except the helicopter route between Bodø and Værøy, are due for renewal in 2027 or 2028. According to the National Aviation Strategy, this provides the Norwegian government the chance to include low and zero emission technologies when procuring the routes, if the technological development allows it.

The public sector in Norway purchases goods, services, and construction works amounting to approximately 740 billion NOK annually. According to the Norwegian law on public procurements (Anskaffelsesforskriften), public procurements must prioritise reducing climate and environmental impacts. At least thirty percent of the evaluation criteria should be focused on these considerations. Furthermore, climate and environmental criteria should be among the top three priorities in awarding contracts. Exceptions are only allowed if the procurement's climate footprint and environmental impact are negligible and justified in the procurement documents.

In Norway, all ferry routes that are part of the road network or public transport system are run by the public sector - either by county municipalities or by the Norwegian Public Roads Administration.
The procurement processes for these ferry routes have been used successfully to incentivize a technology shift for the ferries operating the routes: In 2021 the world's largest electric ferry came into operation on the Moss-Horten route in the Oslo fjord, and in 2023 the world's first hydrogen powered ferry started sailing in Rogaland in the west of Norway. By June 2024, 27,3 % of all ferry routes in Norway have at least one electric ferry 31. The procurement of the routes combined with grants from the state-owned innovation fund Enova have resulted in a technological shift in the ferry industry in Norway.

[31] https://www.tilnull.no/ferger

Sweden

There are currently many suggestions and investigations in Sweden looking closer into incentives and targets. However, the Swedish government climate action plan states that conditions need to be created to introduce electric aviation in Sweden. These conditions should include support for purchases or financial leasing of aircraft as the market for electric aviation develops. The government has already introduced similar support for other electric vehicles.

Suggestions have been put forward in the climate action plan to analyse existing incentives and propose new ones to stimulate the market for electric aircraft. Energimyndigheten has the main responsibility for this, and their conclusion is that electric aircraft can be an important cornerstone in reducing emissions from aviation. The climate action plan also states that the government intends to assess market introduction support as the electric aviation market evolves.

Trafikverket is tasked with analysing whether there should be an obligation to use electric aviation in Public Service Obligation (PSO) routes. They have also been specifically directed to work on a new research and innovation initiatives for the electric aviation sector.

The upcoming national transport plan suggests assessing what government investment support may be needed in the future.

Swedavia is continually working to accelerate the introduction of electric aviation, and this is clearly stated in their strategic framework. Their work includes encouraging initiatives and offering airports for testing electric flights, identifying basis for forecasts/scenarios to predict how electric aviation will develop and what market might exist, planning and preparing infrastructure for commercial electric aviation, and reviewing business models with new conditions such as completely new lines.

Swedavia has exempted fully electric aircraft powered by battery or fuel-cell from paying take-off charges.

Government financial measures

New technology implementations require investments and financial measures in a number of interrelated activities, including the manufacturing and operation of aircraft, airport infrastructure and operations, energy facilities and management, and travellers. Governments will need to undertake impact assessments to explore the potential effectiveness of different types of financial measures, as well as the appropriate timelines.

1. Supporting technology development and OEMs.

The Nordic governments should look at the financial support mechanisms they provide to technology development and seek to boost them. Delivering a new generation of electric and hybrid aircraft requires long technology lead times, extensive R&D&I, and considerable financial investment. The reality is that no modern-day aircraft programme has been successful without the financial support of a government. Today's leading incumbent OEMs owe their global success to the support of host states, which provided bridging loans and other financial mechanisms to offset the long R&D lead times that the private sector alone could not sustain.

In the Nordics, there is also precedent - the Swedish government supported the development of the SF340 and 2000 programmes in the 1980s with funding solutions. Unless the Nordic countries, individually or collectively, are prepared to do the same with Nordic OEMs, there is a risk that the technology scales in other countries and regions that are prepared to invest. It should be clarified that this is not a question of providing direct state aid in the form of grants, but rather financial instruments (loans, guarantees) that are more favourable than the open market.

2. Support with operator capital costs.

Governments could support operators with the capital costs of purchasing new alternative propulsion aircraft or retrofitting existing aircraft with new technologies. This could be in the form of direct subsidies, low-interest loans or other incentives, potentially drawing on the example of state incentives for the acquisition of EVs. However, while some large airlines do purchase aircraft, most operators now procure most equipment through long-term operating leases. This is especially true in the regional sector where smaller airlines seldom have the financial backing to purchase aircraft outright, even with bank loans.

There are other reasons than capital preservation for why airlines prefer leases, such as elimination of residual risk, flexibility in changing equipment, as well as availability and shorter lead times on specific models. Specialised aircraft leasing companies are now the OEMs' (such as Boeing and Airbus) largest customers, who then typically place the aircraft on 5–12-year operating leases. The leasing companies in turn depend on aviation banks or the public debt markets to finance their acquisitions.

These lenders rely heavily on the projected residual value of the assets, which of course is unknown in the case of groundbreaking new-technology equipment. Today, large aircraft manufacturers often provide residual value guarantees for new models, but that will be difficult to rely on when issued by a smaller, new OEM. Governments could, however, support or make the placement possible by providing a back-stop – either by guaranteeing the RVG, or providing credit enhancements to the aviation banks, or to the leasing companies themselves.

3. Add incentive schemes for low-carbon flying at airports.

Landing fees. Governments could regulate or encourage airports and air navigation service providers to set fee structures that incentivize lower-carbon flying. Some airports have offered to waive landing charges for a year for the first operators of zero-emissions aircraft. Manchester Airport in the UK has offered to waive landing fees for the first five years (an estimated saving of £1.3 million in current prices) to the airline that operates the first zero- emissions aircraft. Similarly, London Heathrow Airport has announced that it will waive landing fees for one vyear for the first battery-electric aircraft[26].

Review weight-based navigation fees. Operators of battery-electric aircraft can be disadvantaged by current fee structures. While these technologies are likely to benefit from the differentiated noise and emissions-related components of landing fees (where applied), core landing and navigation fees are usually based on maximum take-off weight (MTOW). This is because battery-electric aircraft are likely to weigh more than comparable conventional aircraft due to the weight of the batteries. Charging structures should consider subtracting the weight of the aircraft battery from the MTOW calculation to address this concern.

4. Support passenger levies.

Governments should consider whether existing aviation-related taxes could be used to help incentivise battery-electric propulsion. Passengers travelling with battery-electric aircraft could pay a lower rate of passenger departure tax or air passenger duty. Renewable electricity used for aviation could get the same tax benefits as electricity used for trains, for example. Additionally, revenues from new or existing aviation-based taxes could be earmarked to incentivise low emission technology.

An example is the 'Green aviation in Denmark' agreement introducing a passenger tax on air travel. The tax directly channels half of the recovered financial funds back to building a more sustainable aviation sector.

At the same time, Sweden has suggested removing their aviation-related tax with the rationale that the EU's Emissions Trading Scheme (ETS) covers carbon emissions from aviation.

[25] Manchester Airport Group (MAG) https://committees.parliament.uk/writtenevidence/38508/pdf/
[26] https://www.heathrow.com/latest-news/first-electric-aircraft-at-heathrow-airport-wont-pay-landing-fees-for-a-year

5. Carbon pricing.

Instead of offering incentives for alternative propulsion, states could look to reduce demand for fossil fuel by implementing measures to raise the price of kerosene-based fuel to encourage the uptake of more sustainable alternatives. Carbon pricing initiatives such as the EU-ETS is an example of how this could be introduced.

6. Carbon markets.

Governments could update existing market-based measures, such as carbon markets and emissions trading schemes, to recognise alternative propulsion within their frameworks. To help scale new technologies, market-based measures could incorporate additional benefits for early adopters of battery-electric or hydrogen aircraft, such as providing additional carbon credits for emissions avoided for a period of time.

Mandates, targets and restrictions

Mandates, targets and restrictions can help accelerate the transition towards zero-emission aviation by requiring the use of certain technologies or encouraging a shift away from more polluting technologies. Some examples are explored below.

Phase-outs. Phase-outs for certain types of aircraft have been used historically to accelerate fleet replacement of aircraft with less polluting alternatives. This approach was used by states in North America, Europe, Japan, Australia and New Zealand in the 1990s and 2000s to encourage the phase-out of noisier aircraft. Operators were given sufficient advance notice (10 years in the case of the Chapter 2 phase-out in Europe), with staged reductions and the granting of some limited exemptions based on economic criteria. A similar approach could be used for those aircraft with the lowest emissions performance to help accelerate the uptake of new, cleaner aircraft, including those using alternative propulsion systems.

Prescribed activities or routes. For Public Service Obligation routes, environmental performance could be added to existing criteria when selecting operators. As an alternative to prescribing the use of specific technologies, governments could consider basing requirements on net-zero or other environmental criteria that would provide operators with flexibility in how they meet these criteria.

Mandates. Governments could mandate targets that require operators or fuel suppliers to use a prescribed volume of a particular fuel or energy type, or to attain a defined level of reduction in overall emissions or emission intensities by a certain date.

Measures to encourage consumer awareness

Norway

Widerøe Zero, a subsidiary Widerøe company that is responsible for the strategy of the future greener airline, has an initiative, Air Mobility Lab, where they invite travellers and people from different regions in Norway to collaborate on the design and implementation of zero-emission aviation. The lab, which will be operational between 2023 and 2025, focuses on the customer experience through a living-lab methodology that allows participants to experience the proposals for future air mobility.

Finland

Access to information plays a key role in involving passengers in the development of more sustainable aviation. One interviewee pointed out that passengers should be provided with accurate and transparent information about aircraft and fuels as well as the environmental performance of airports. This would enable customers to make more sustainable choices based on the information available and steer development in a market-based manner. Thus, consumer decisions could encourage both airlines and airports to develop more sustainable solutions, including infrastructure development.

The development of electric aviation and the planning of routes should also consider passenger demand for different routes. This will involve looking at passengers' flying behaviour and preferences for air travel. One of the interviewees also noted that the availability of electric aviation does not increase customer demand per se, which is why demand mapping and analysing passenger preferences is key in developing electric aviation.

Chapter 7:

The way forward

Providing grounds for decision making

We want to build the demand for zero-emission aviation, or more specifically, for electric and hybrid-electric aviation, both to reduce our Nordic emissions from aviation, but also to build a new industry with regional electric aviation. The Nordic countries jointly, through the Nordic Councils of Ministers, each Nordic country by itself, and NEA all have the same goals.

Vision 2030: The Nordic Region will become the most sustainable and integrated region in the world by 2030.

As the Swedish Minister for Infrastructure and Housing, Andreas Carlson, stated in the first meeting with NEA in February 2024, where NEA presented the idea for the policy-tour 2024:

"We should not do double work, now that we have a project funded by Nordic Innovation (the Nordic Council of Ministers), it can tap into the very close Nordic cooperation that we have as ministers."
— Andreas Carlson

This message was repeated at the second meeting in Gothenburg in August 2024. NEA has compiled a list, a smorgasbord, highlighting findings from the Policy Tour as well as the work NEA partners are doing daily to get electric and hybrid-electric aviation to take-off. We know that it can be achieved by 2030, but we also know that we need all on-board to do so.

NEA supports the declaration signed in Gothenburg, which identifies the need to:

- COLLABORATING on the requisite regulatory frameworks and permit processes to introduce electric aviation, while ENCOURAGING close dialogue between the Nordic authorities concerned.
- ADVOCATING COLLECTIVELY in global platforms such as the European Union and the International Civil Aviation Organization for a seamless and harmonized introduction of electric aviation.
- PROMOTING and ACCELERATING the establishment of commercial electric aviation in the Nordic countries, while SUPPORTING opportunities for our industries to become world leaders in important technologies related to electric aviation.

The Nordic Network for Electric Aviation stands prepared to do its part and contribute to aligning industry and governmental efforts. There is now a momentum allowing us to stay in the forefront, through building on the work done in NEA, profiting from the renewable energy system and our ability to work together to achieve common goals. Now is the time to step up.

As a first step to further accelerate the adoption of electric and hybrid-electric aviation in the Nordics, we recommend:

Establish a Nordic Working group

NEA is a proof-of-concept that working together makes a different, for all companies and all Nordic countries. To succeed and to be able to take the next step we need Nordic governments to join. The first task would be to clarify what we can do together and what we need to do country-by-country. Let us not forget that together we are the 11th economy in the world. The Nordic Working group should share best practices, harmonise regulations, and coordinate infrastructure development and preparations for the implementation of electric aviation by the end of the decade.

We have used wordings from the declaration to present the smorgasbord, without prioritising at this point. Prioritising could make a great first task for the Nordic Working group. We end this chapter with some suggestions that would state to the world that the Nordics are an early mover in electric and hybrid-electric aviation.

1. Collaborating and Encouraging

Strengthen Regulatory Frameworks:

- Collaborate with ICAO, the EU, and EASA, to harmonise regulatory frameworks for electric aviation.
- Create a working group of Nordic Civil Aviation Authorities (CAAs) to address regulatory challenges and prepare for new technologies, alternatively include in the current N-ALM working group.
- Electric aviation is part of the regulatory frameworks for aviation in general, however we see more and more special conditions for the electric driveline. This needs to be monitored.
- Some areas that will have an impact on electric aviation are:
  I. Modification of Existing Aviation Rules
  II. Updating Regulations for New Technologies
  III. Preparing for New Aircraft Types
  IV. Balancing Safety with Innovation
  V. Updating Non-Aviation Regulations

Decision supportsystem:

- Utilise the NEA Vision Tool for evaluating regulatory and policy impacts.

Foster Industry Collaboration and Innovation:

- Support NEA Vision Tool and extend partnerships.
- Encourage collaboration between aviation and public transport sectors.
- REDIII initiative on credit mechanisms for renewable energy.

2. Advocating collectively

Create a Nordic Strategy, Monitor Progress and Adapt Strategies:

- Develop a comprehensive Nordic strategy aligned with ICAO and EU goals.
- Regularly update strategies based on technology and policy shifts.

Establish Nordic Goals and Milestones:

- Convene high-level meetings with Nordic representatives to set Nordic goals with funding streams for electric and hybrid-electric aviation.
- Monitor progress with intermediate milestones.

Expand International Collaboration:

- Use Nordic leadership to influence global aviation policies.
- Participate in international forums for sharing best Nordic practices and addressing common Nordic challenges.

3. Promoting and Accelerating Commercial Electric Aviation

Enhance Financial Incentives and Support:

- New technology implementations require investments and financial measures in a number of interrelated activities, including the manufacturing and operation of aircraft, airport infrastructure and operations, energy facilities and management, and travellers.
  I. Supporting technology development and OEMs
  II. Support with operator capital costs
  III. Add incentive schemes for low-carbon flying at airports
  IV. Support passenger levies
- Governments will need to undertake impact assessments to explore the potential effectiveness of different types of financial measures, as well as the appropriate timelines.
  I. Advocate for increased funding for electric aviation projects.
  II. Create a Nordic fund for Innovation and implementation of electric and hybrid-electric aviation.
  III. Implement incentives for zero-emission technology adoption.
  IV. NEA Decision support system could be used to determine how different proposals will affect the industry and/or the use of electric aviation
  V. Use the NEA Vision Tool for economic analyses for commercial routes.

Develop Infrastructure:

- Develop ground infrastructure at regional airports for electric and hybrid-electric aircraft.
- Integrate renewable energy sources into aviation infrastructure to align with Nordic renewable energy goals.
- Consider transforming regional airports into green hubs with EV infrastructure and sustainable practices.

Programs for First movers of Regional Routes:

- Initiate zero-emission flights on regional routes as pilots.
- Use data from pilot programs to adjust policies and guide investments.
- Support pilot projects and demonstration flights to gather data and validate technologies.

Lack of Workforce and Workforce Development:

- Create training programs to upskill the workforce for electric and hybrid-electric aviation.
- Partner with educational institutions to secure a skilled workforce.
- nitiatives to attract talent and assure availability of pilots.

Promote Public/Consumer Awareness and Engagement:

- Engage with the public to highlight zero-emission aviation benefits.
- Provide incentives for passengers choosing zero-emission flights.
- Encourage businesses to lower their emissions through electric aviation.

By taking these proactive steps, the Nordic region can solidify its position as a global leader in sustainable aviation, driving both environmental and economic benefits. This collaborative effort will ensure that the Nordics capitalise on their technological advancements and contribute to the global goal of net-zero aviation emissions.


Heart
Aerospace

Acknowledgements for participating in NEA Policy Tour 2024

The mapping of the current state of electric aviation presented in this report has been produced by NEA partners. They have gathered representatives from the aviation industry, policymakers, expert bodies, and stakeholders within mobility and transport from all five Nordic countries.

The result of the contribution from all participants in the NEA Policy Tour 2024 is what you see in this report. Thank you to all of you.

Denmark held a conference on electric aviation in the spring of 2024, a collaboration between CPH airports, ALIGHT, NISA and NEA. This was the second conference on the topic that they have invited Nordic and international stakeholders within the aviation industry to in just a few years.

This year's electric aviation conference was well attended, featuring contributions from four electric plane manufacturers, discussions on safety and regulation, airport infrastructure, and a panel discussion with the participation from the above partners as well as the Danish Ministry of Transport, an NGO and the Institute of Transport Economics from Norway.

Finland's representatives from NEA have interviewed key stakeholders to map the state of electric aviation in Finland. Key stakeholders included e.g: Ministry of Transport and Communications, Finnish Transport and Communications Agency Traficom, Confederation of Finnish Industries EK as well as VTT Technical Research Centre of Finland.

As part of the situation analysis, **Iceland's** representatives from NEA invited key stakeholders to a workshop to gather facts and map the state of electric aviation in Iceland. Attendees included the Ministry of Infrastructure, Icelandic Aeronautical Association, Norðlandair, Icelandair, Isavia Regional Airports, Isavia ohf., the Icelandic National Energy Authority, as well as a member of parliament.

Norway's representatives did a study of relevant documents and policy papers to gather information about the current situation in Norway and map out the country's plans for electrification of the aviation sector.

Sweden held a workshop with key representatives, including the Swedish Traffic Authority, the Swedish Transport Agency, the Swedish Confederation of Transport Enterprises, as well as the Ministry of Enterprise in the form of Fossil-free Sweden.

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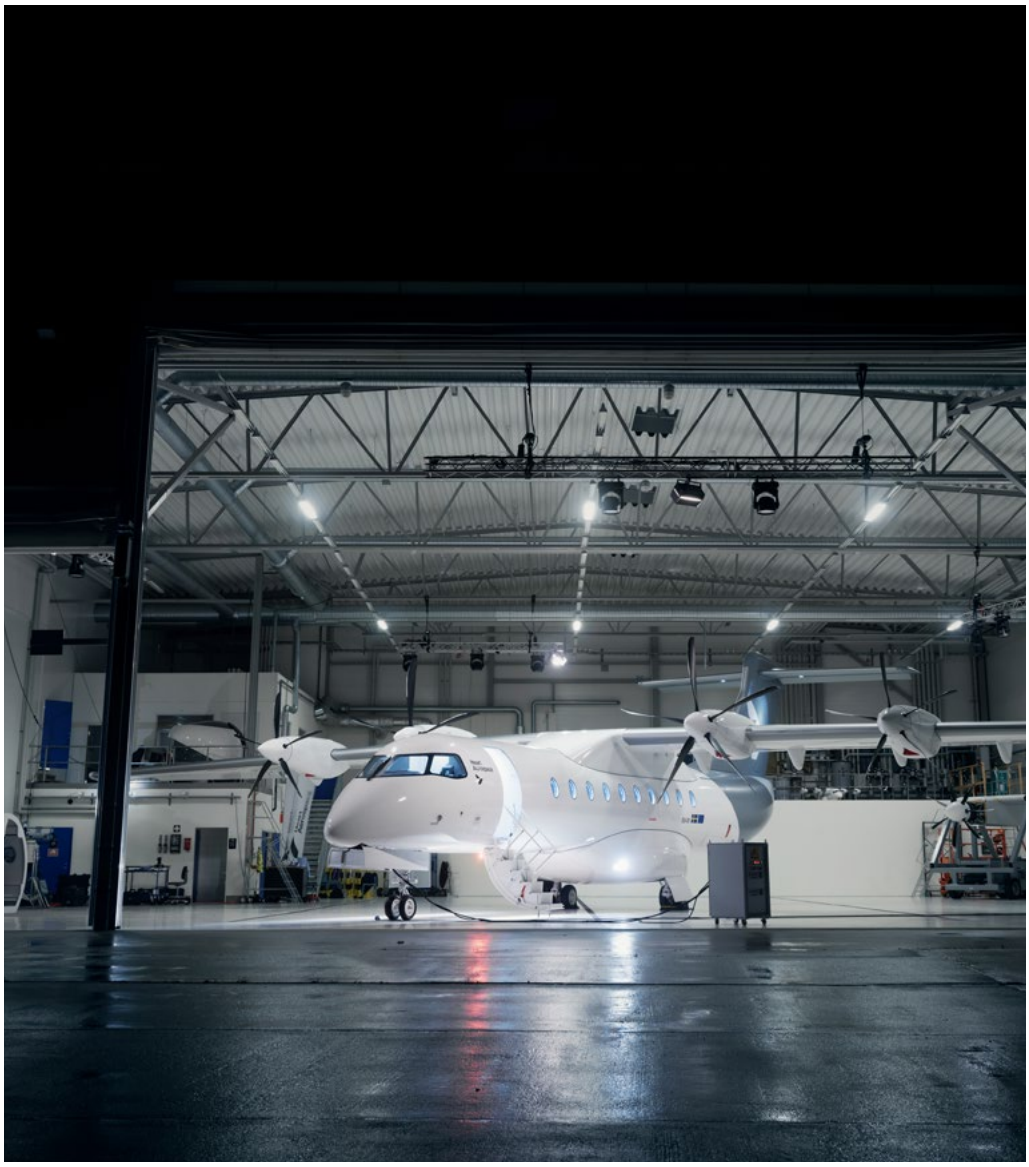


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Reinventing aviation in the Nordics

The state of electric aviation and the case for enhanced industry-government collaboration.

Nordic Innovation