



Electric regional aviation – a fast and clean transport mode for the needs of Kvarken region



EUROPEAN UNION

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European Regional Development Fund

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The aim of this report is to act as an information package of the possibilities of electric regional aviation in the Kvarken region.

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BACKGROUND FOR ELECTRIC REGIONAL AVIATION

*Why is now the right time to develop
electric and regional aviation?*

Changing world of aviation

A turning point in aviation business is at hand – a start to a new era of aviation

Kvarken electric regional aviation project suits well to this time when aviation business is in its worst crisis in the history of commercial aviation. On spring 2020 the global covid-19 pandemic led to a big collapse in the demand and supply of aviation. Up to 90% of the aircraft were grounded and many airlines bankrupted. Many airlines are trying to survive with the help of state aids. During summer 2020 some airlines re-started few of their routes, but already on autumn the pandemic situation became worse, and the supply of flight routes was reduced.

Aircraft manufacturers have also met the crisis as the orders of aircraft have been cancelled. Pandemic has increased uncertainty among airlines and passengers. International Air Transport Association (IATA) has estimated that recovering of the aviation market takes many years, perhaps until 2024.

Markets after pandemic are to be changed

After the pandemic, the aviation market is not the same as it was before the crisis. Both the demand and the supply of aviation will be renewed. It will open an unseen opportunity to develop new aviation services and markets. The consolidation of airlines will continue also in Europe according to the same model as in the USA. In the USA, the four biggest airlines make up 80 % of the markets, while the market share in Europe is only 40 %, respectively. The constellation will be influenced strongly by the bankruptcies of many airlines and the survival of airlines by the state financial aids. The new demand will be shared between the survived airlines and there will be a new balance between the demand and the supply. After all, there will be space for new kind of aviation services. Especially regional demand, like in the Kvarken region, can be served better than before.

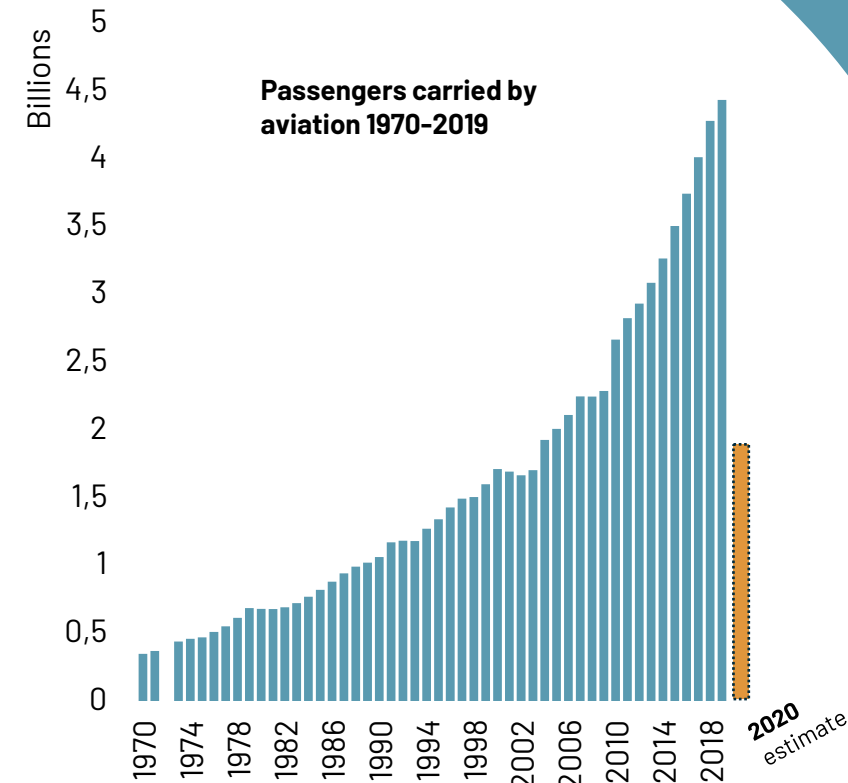
Some of the business trips will be substituted by digital communication and the selection of leisure trips are dependent e.g. on the health security. The passenger volumes are estimated to remain lower than earlier, which will be a great challenge for the volume business. The flight distances will become shorter. The biggest aviation markets are in Asian countries. It is too early to estimate how fast the recovering of aviation will happen there and how the demand will focus on the European destinations.

When the overcapacity in aviation markets decreases, the balance between the demand and the supply will be better and the ticket price level will set at a sound level. The low price of raw oil has helped airlines during the crisis, but when the global economy is gradually recovering, the situation will change.

New technology and new business models are the basis for the future of aviation

Crises give always an opportunity to build something new. Aviation has been touched already before pandemic by the pressure from climate change and from the strict competition in the markets. New technology has been implemented constantly. Engine technology, lighter materials in aircraft and alternative fuels are more and more under research and testing. Electric aviation will be one very essential solution for the areas of small passenger flows and rather short distances. Also, the new technology in airports will reduce the cost level and enable possibilities to develop new kinds of aviation services.

European Union Aviation Safety Agency (EASA) gave in May 2020 instructions to airports and airlines of the actions to guarantee health safety. It means competitive advantage to smaller airports without congestion and where it is easier to organize the safety actions. There are many of this kind of airports in the Kvarken region. Technology, new operation models and versatile supply are the key areas in renewing the aviation market for the future.



Source: International Civil Aviation Organization

Now is a crucial time to develop new operating models in aviation

What is electric regional aviation?

A NEW FAST AND CLEAN MODE OF TRANSPORT

Electric regional aviation is a new mode of transport which can be seen as a complimentary element between public and private transport. It is suitable for small passenger flows and can operate shorter distances profitably compared to traditional commercial aviation. It doesn't directly replace any of the current transport modes.

ZERO EMISSION ALTERNATIVE

A very essential advantage of the electric regional aviation is its zero emissions during operations. Electric power in Nordic countries is produced in a sustainable way. That is why the climate effect and emissions from regional flights will reduce significantly.

OPTIMAL FOR SMALL VOLUMES

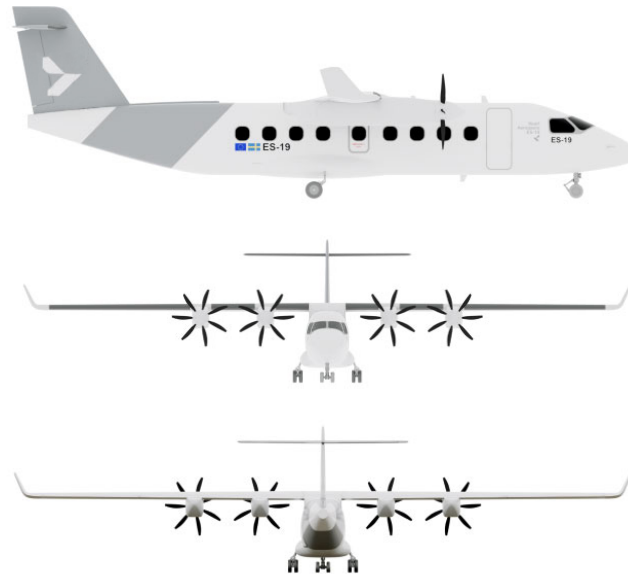
Typical to electric regional aviation is its ability to serve rather small passenger flows, between 10 and 20 persons, in distances up to 400 km. It will be a solution to fill the gap between demand and supply caused by current volume-based business model in aviation.

A TOOL FOR REGIONAL ACCESSIBILITY

Finland and Sweden both are countries of big surfaces and low population densities. Both also have strong export industry widely located in various parts of the countries. That creates important needs to business travel, but the current supply of aviation is not giving sufficient service level to meet the demand. That is why electric regional aviation is needed.

Focus area in the next years

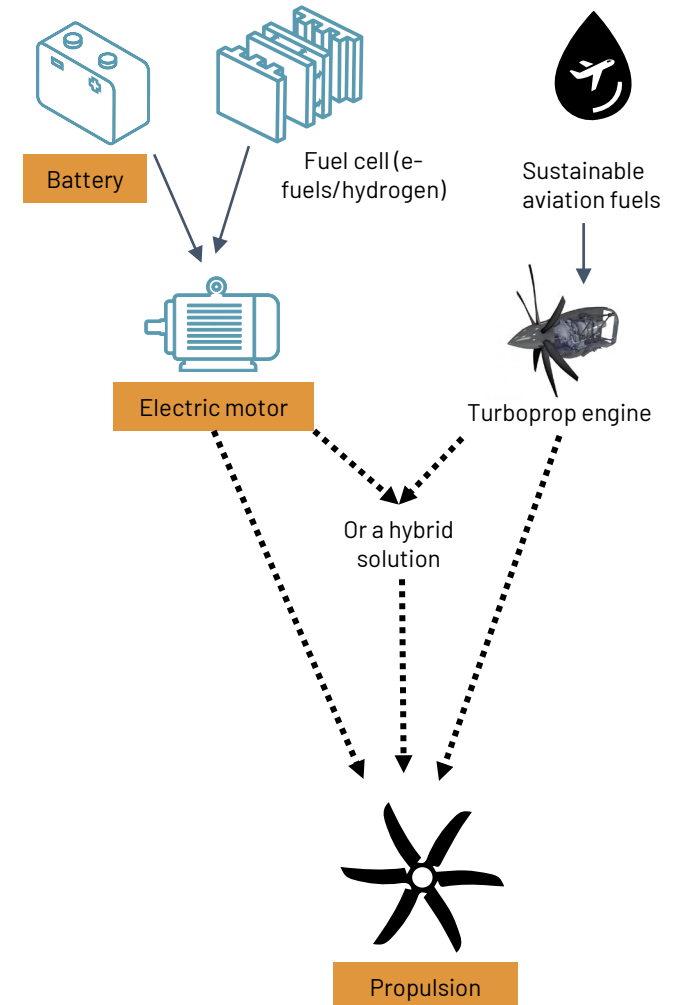
NATION TO NATION
REGION TO REGION
WITHIN REGION



An example of an electric airplane is the ES19 of Heart Aerospace. A nineteen-passenger airliner with an operating range of 400 km. The ES-19 is a fully electric aircraft, and the goal is to have the aircraft certified for commercial operation by 2026.

Source: Heart Aerospace

New propulsion powers in aviation



Changing the transport system with electric regional aviation

The development of every system needs vision for the future

Without visions the mankind would have remained at stone age. For many reasons transport system also needs renewal and for that visions are required. There is always a gap between the future state and the current state. The gap can be seen in demand, supply and the whole transport system. The gap illustrates the desire of a better future where demand will be fulfilled in a smart way and supply meets demand. The gap also illustrates that in the current state there are many problems in the transport system.

This report provides a vision: what could be if electric aviation and the whole aviation system with it is improved. What possibilities and synergies could this provide?

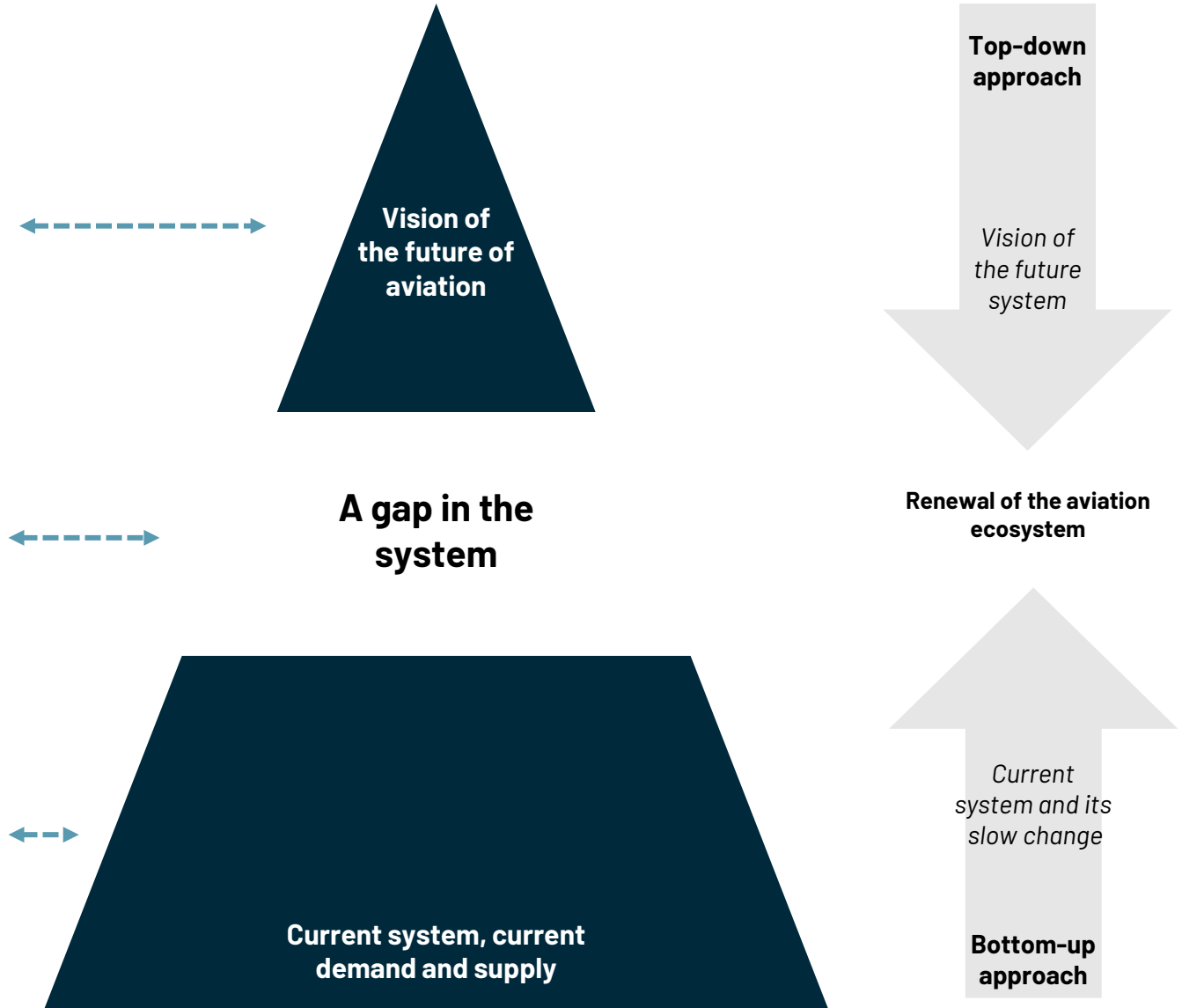
Electric regional aviation – filling the gap between the present and the future

Electric regional aviation will replace some transport modes in some trips but more often it will be part of new trip chains. The basic nature of aviation will be constant – aviation is aviation – but electric aviation will be clean and cost-effective. Regional aviation will provide new supply that has been earlier very limited.

Changing the current transport system requires time

In transport system there is the same phenomenon as in physics: the slowness of the mass, i.e. inertia. The slowness of the mass means the ability of the mass to resist the change of the movement.

The transport system contains a huge amount of factors and they are dependent on each other in many relations. Many factors are changing slowly: vehicle fleet, infrastructure, technology, energy distribution systems, policies and regulations and last but not least, the habits and attitudes of customers.



Electric regional aviation – a tool for meeting the mobility demand and supply

Why flight connections are important to areas?

Aviation is necessary for the versatile export industry in the Kvarken region on both sides of the Gulf Bothnia. There are also many other strong export industry and tourism centers in the Nordic countries requiring good flight connections. The service level of domestic aviation especially in Finland and Sweden needs to be improved. There is a need to create new operating models in aviation. The basic principle is to provide optimal supply of flights to meet the needs of business life, tourism and other actors including public sector.

All the regions in Finland and Sweden need a connection to global economy and markets. Export industry and tourism are business branches producing billions of euros annually and they need good accessibility. It is necessary that a company in international business can be located wherever in the Nordic countries. That is why domestic and especially regional aviation must be developed.

After the pandemic, the digital communication will strengthen its position and it will substitute some physical trips. Certain basic need for flights will remain. Business deals will be made face to face also in the future, and e.g. the installation, service and repairing work of industrial equipment will require travelling abroad. Tourism will be a growing branch and it needs a good accessibility. Flight connections have a close connection to tourism business prosperity in the Nordic countries.

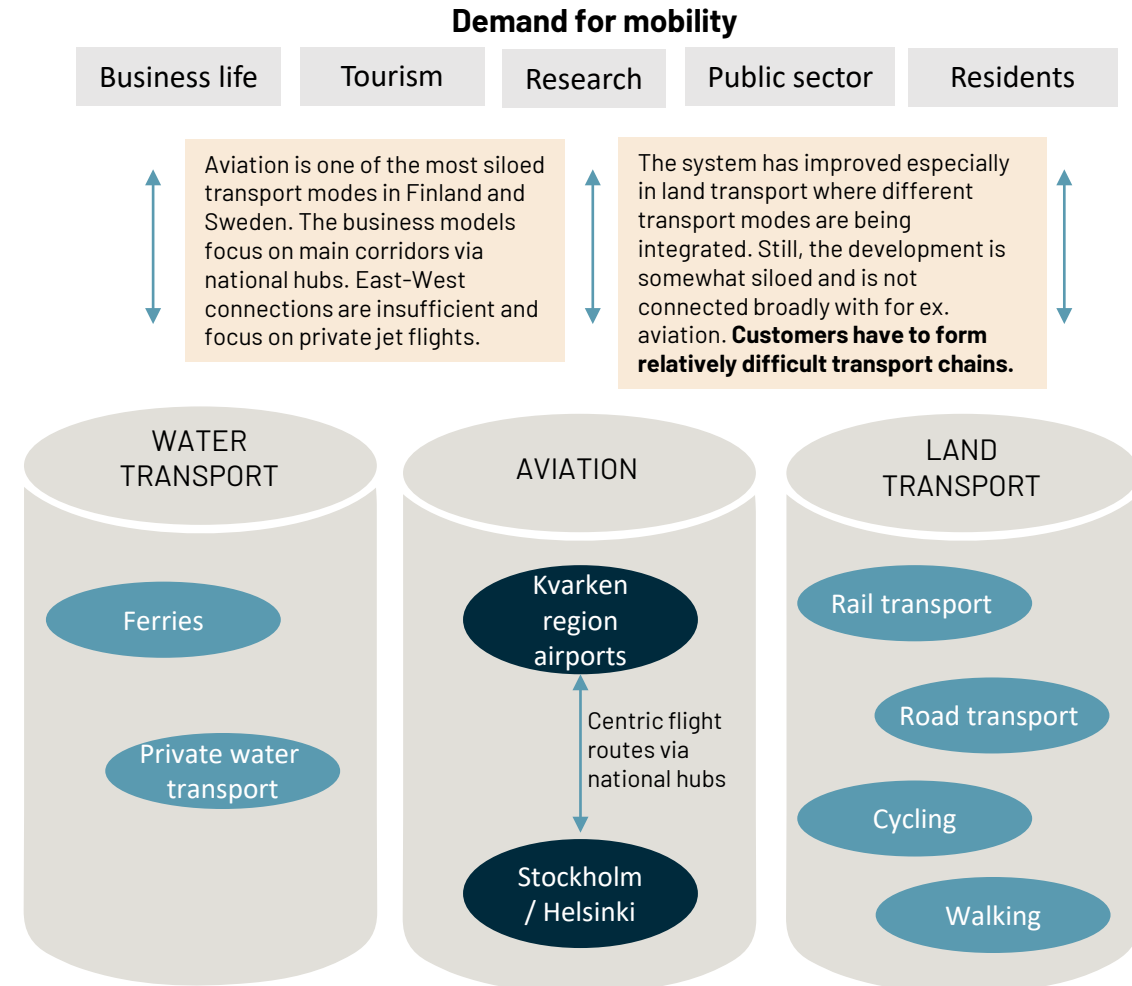
Current aviation business model does not serve areas in the best way

The aviation market has been favoring big airlines and large passenger volumes. Many airlines have an interest to concentrate to big volumes. The routes generating strong passenger flows are profitable. Lower passenger volumes do not fit to this business model.

The state can give temporary subsidiaries to areas generating lower volumes or it can directly buy flight routes from airlines. This has been an attempt to answer the demand of important travel needs in regions. A very essential problem has been the aircraft fleet in the use of airlines. Many routes have been operated with too big aircraft which has led to low passenger load factor and low profitability of flights. Further, the continuity of many routes has been uncertain, which is very severe factor to industrial enterprises – to fly or not to fly next week. In Sweden, the situation is slightly better than in Finland.

Electric aviation provides an opportunity to develop trip chains especially in a regional context

CURRENT TRANSPORT SYSTEM FROM CUSTOMER PERSPECTIVE



Electric regional aviation – a tool for meeting the mobility demand and supply

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An advanced aviation market and new operation models are needed

An advanced aviation market will be one key factor for the accessibility and prosperity of areas. In Finland, the aviation market is undeveloped. In route traffic the market has been based mainly on one airline or its subcontractors. In Sweden, the situation is to some extent better. When there is lack of competition, the price level is high, and the supply limited. The demand in many low volume areas has not been fulfilled.

Where there is supply, there will be new demand, too. Of course, the basic potential for the demand must exist. One good example of the aviation market from Finland is the route between Helsinki and Oulu that has been functioning according to the principles of the market economy. When there were three airlines flying the route, the ticket prices were low and the passenger volumes high. When the number of airlines decreased, the ticket prices became higher and the passenger volumes lower. The low cost carriers (LCC) have been creating a new market when they have been increasing their route supply.

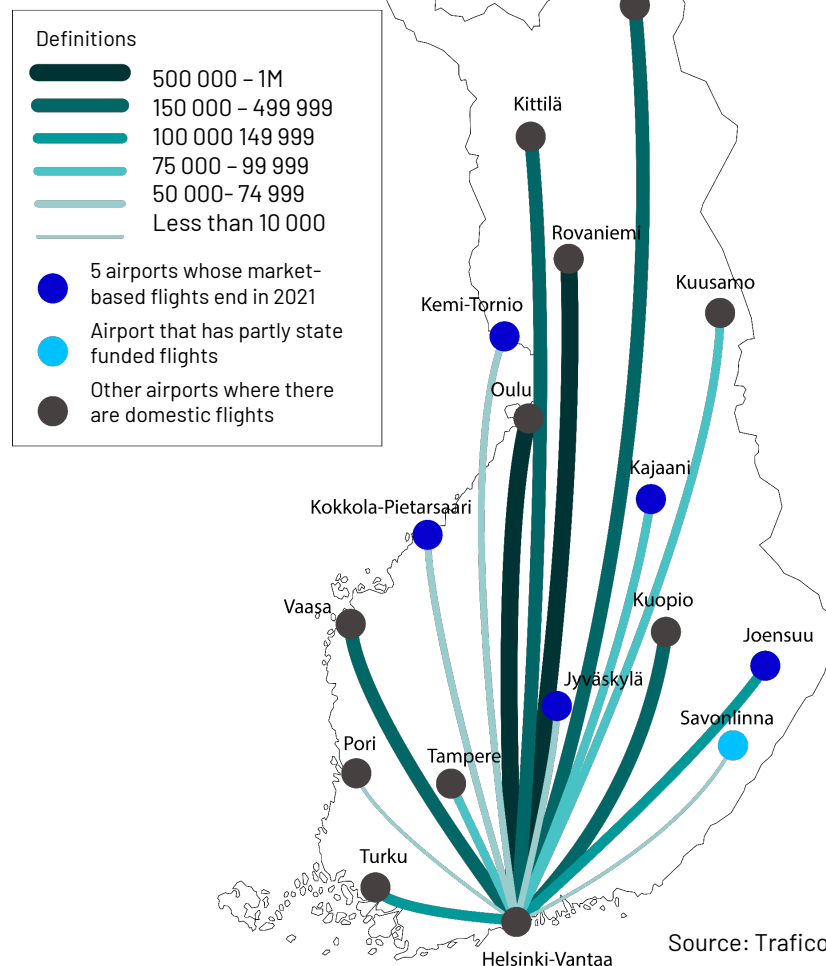
What is the role of the Kvarken electric regional aviation in solving the problem?

The Kvarken electric regional aviation will be a solution to many current problems including the imbalance between aviation demand and supply. The aviation business model based on large passenger volumes has not been able to serve the important low volume demand from business life and other actors in Kvarken area.

The global turning point caused by pandemic should be utilized carefully. Now is the right time to enhance electric regional aviation and the new business model for aviation that will be especially useful for regional mobility needs.

The new technology will be the most important enabler for the renewal of the aviation. Electric aircraft will be usable in this decade, and they will also have a strong contribution to reduce aviation carbon emissions.

The Finnish domestic aviation system is currently based on hub and spoke connections from Helsinki-Vantaa airport. Passenger volumes 2019



With electric aviation there is a possibility to provide direct flights complementing the hub and spoke system

Electric aviation is an efficient tool in reducing aviation emissions

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EU Green Deal will increase fossil fuel-based aviation costs – competitive edge for electric aviation

EU Green Deal is the EU's strategic growth agenda for 2021-2027 - the most significant reconstruction program since World War II. The reform of the emissions trading system (ETS) is one of the EU's first major EU Green Deal actions.

- Currently commercial aviation within the EU borders is included in the ETS

The reform contents

- Reduction of emissions allowances
- Inclusion of ship and long-distance flights in the emissions trading scheme
- Allowance prices are projected to rise sharply compared to the long-term average (approx. 7€/CO₂t.) Already now the markets have anticipated forthcoming changes and the price is on the rise. In 2021, the price has increased from 35€ per CO₂t to 52€ per CO₂t. (**Nearly a 50% increase**)



Figure ES-1. CO₂ emissions by operations and aircraft class in the three analyzed years.

Source: ICCT 2020

Approximately 1/3 passenger CO₂ emissions occurred on short-haul flights of less than 1,500 km
Carbon footprint of regional aviation is considerable on shorter than 500 km flights.

→ Electric aviation can reduce the emissions at shorter distances and will thus **be an efficient tool to reduce emissions and at the same time provide better service.**

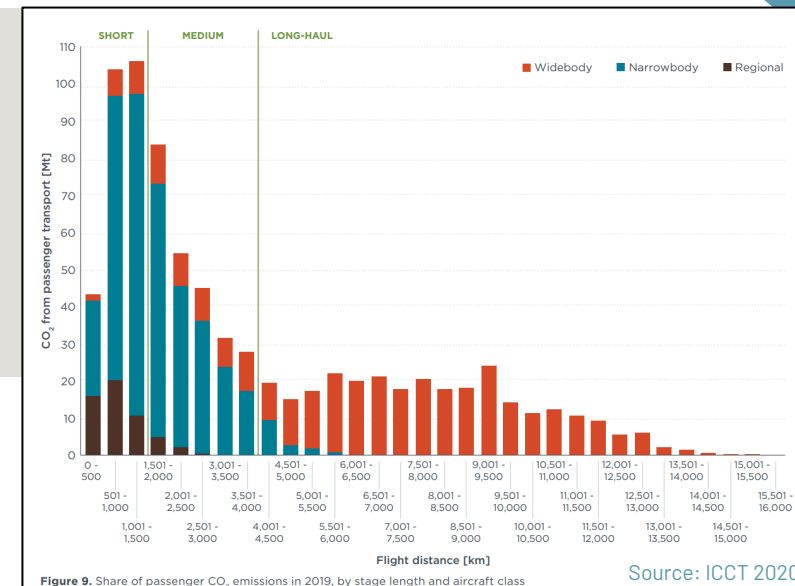


Figure 9. Share of passenger CO₂ emissions in 2019, by stage length and aircraft class

Source: ICCT 2020

Aviation produces globally around 2 % of all the CO₂-emissions. Aviation's carbon footprint is even higher because flying high intensifies the effect of emissions. Before the pandemic aviation demand doubled within 15 years. The exponential growth has eaten the benefits of technological development. Aviation is facing immense pressure to reduce emissions to control climate change.

Short-haul flights are more CO₂ intensive per RPK (revenue passenger kilometers) than long haul flights. Thus, it is efficient to reduce the emissions in these shorter flights. **Electric aviation provides a sustainable solution for this.**

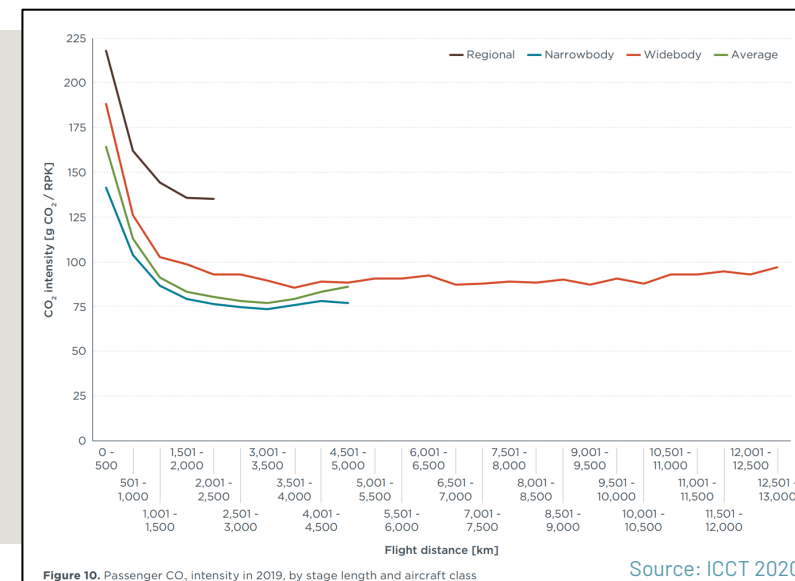


Figure 10. Passenger CO₂ intensity in 2019, by stage length and aircraft class

Source: ICCT 2020

Evolving aviation technology

– improvements to infrastructure, fleet and booking systems

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Electric airplanes

Aviation, as transport in general, is being electrified. Electric plane can be powered with battery electricity or electricity produced in a fuel cell. At first, shorter routes will be ideal to serve small volumes and improve regional accessibility. Electric aviation's key benefits are zero emissions and reduced operational costs.

Unmanned aircraft

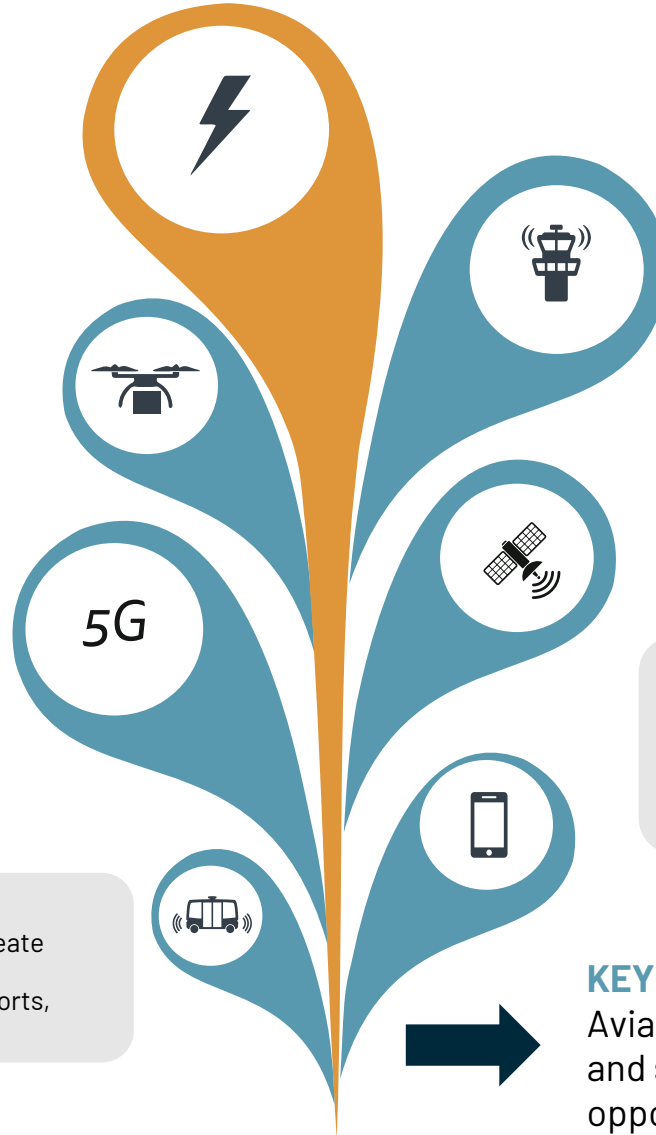
Especially in freight transport, unmanned aerial vehicles (UAVs) are being extensively piloted and soon different size of cargo aircraft can provide new options for goods delivery.

5G

Millions of devices can be connected to the 5G network, giving all airport actors, such as operators, airlines and air traffic control, a reliable, real-time, predictable and a common overview of the airport. Airports and airlines get the most out of their data and can streamline their operations when all activities can be monitored and optimized. IoT and 5G together make this possible.

Connecting transport modes and transport automation

Aviation can be connected to other transport modes to create door-to-door trip chains. Transport digitalization with automatization can provide increased accessibility to airports, thus improving the customer experience.



Remote Tower Services (RTS)

Multiple airports can be controlled from a single remote control center. Air navigation services in a small airport can account for 30... 40% of the operational costs. The service can be delivered just when there is a need.

Satellite Based Augmentation System (SBAS)

A Satellite Based Augmentation System (SBAS) is a navigation system that supplements the Global Navigation System (GNSS) providing a more accurate and reliable navigation service than GNSS alone. Reduces the need for physical infrastructure and provides reduced noise and emissions with curved approaches and continuous descent paths.

New mobility platforms

Enabling on-demand aviation and seamless trip chains for a customer-friendly transport system. Varying and small demand can be better served with the right supply. On-demand systems are being developed in land transport and the next step is to include aviation to these platforms.

KEY OUTCOME

Aviation is evolving in all aspects. Infrastructure, aircraft and supply models are changing, and this creates new opportunities for different stakeholders

ELECTRIC REGIONAL AVIATION IN THE KVARKEN TRANSPORT SYSTEM

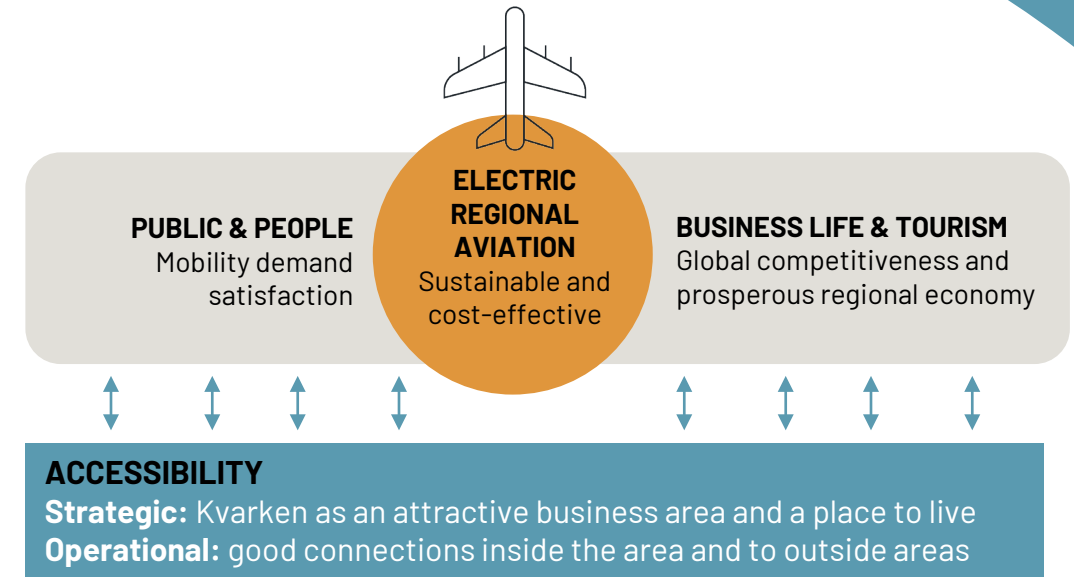
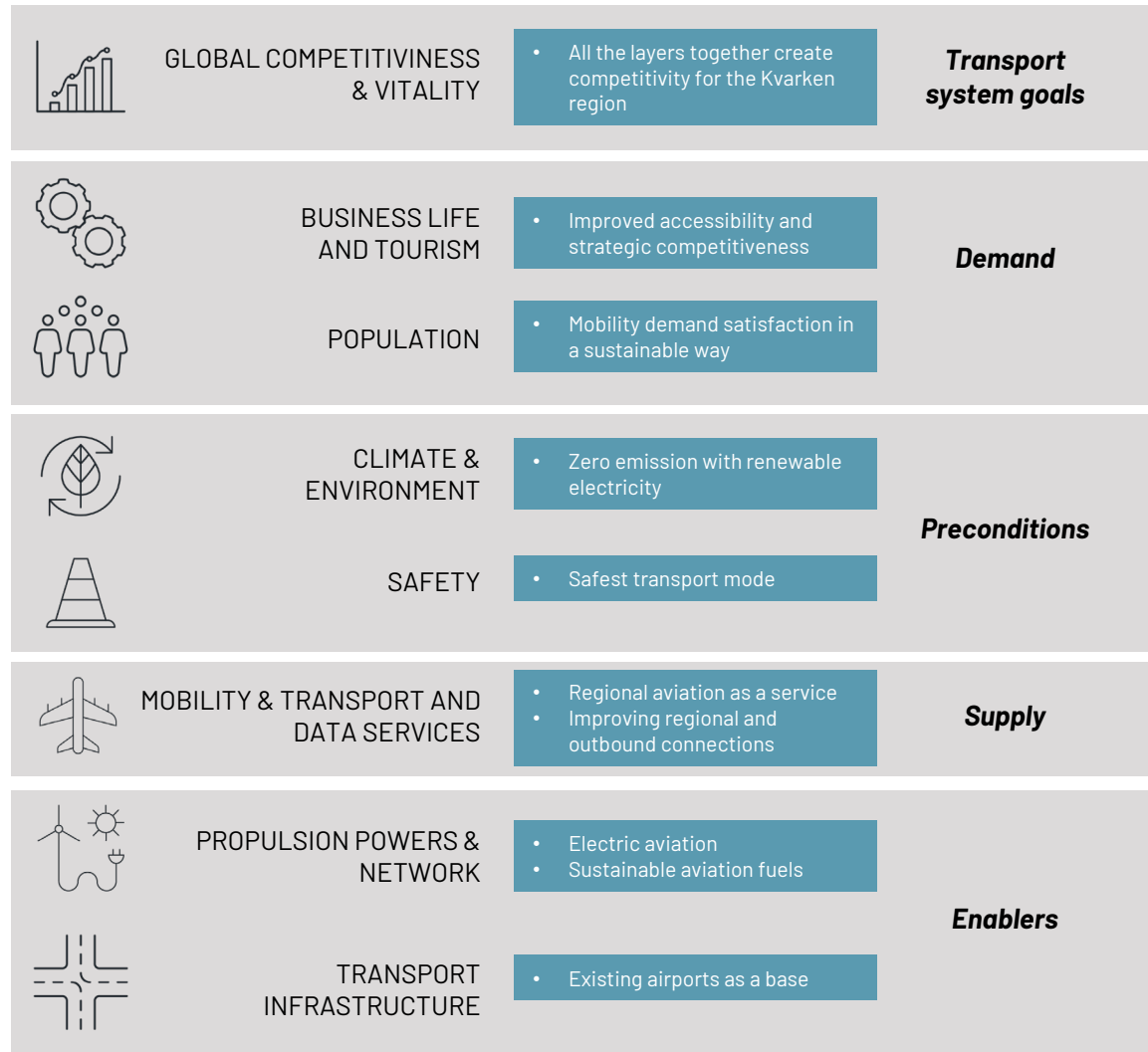
What added value does electric aviation bring to the transport system and where is its natural place?

What effects does electric aviation have on competitiveness and accessibility in the Kvarken region?



Improving the competitiveness and accessibility of Kvarken region

Electric aviation effects on transport system layers



The aim of FAIR-project is a rapid implementation of electric regional aviation in the Kvarken region to enhance the business life, tourism and the mobility needs of public authorities and citizens. The best way to reach the target is to integrate electric aviation as an essential part of the attraction factor of the area and a part of tourism product.

Current air transport services often force to make a trip via station-wide hubs Helsinki, Stockholm and Oslo. Electric aviation in Kvarken region enables to create flexible and high-level aviation services in a carbon-neutral way. It will also connect different parts of Kvarken region and connect them to important aviation nodes and other transport modes.

Infrastructure

There is a good basic infrastructure in the form of regional airports in Kvarken area. An operational system and a new business model for aviation are needed to meet the demand of business life, tourism and public sector mobility needs better than currently.

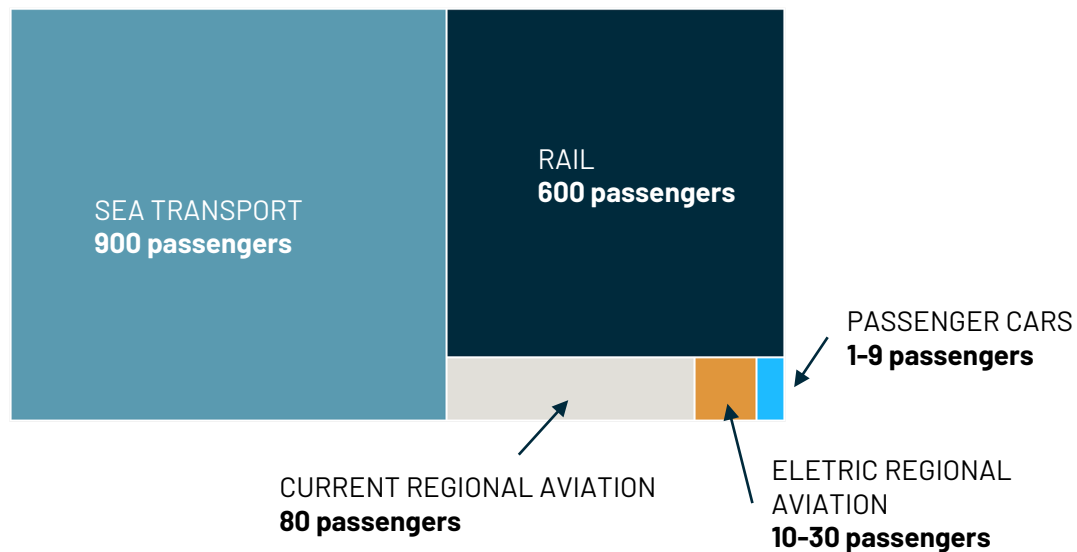
There are many industrial city areas on the both sides of Gulf of Bothnia. It creates a basis for demand of aviation. The area has also transport infrastructure for many kind of person transport and freight transport services.

Electric aviation's basic properties compared to other transport modes in the Kvarken region

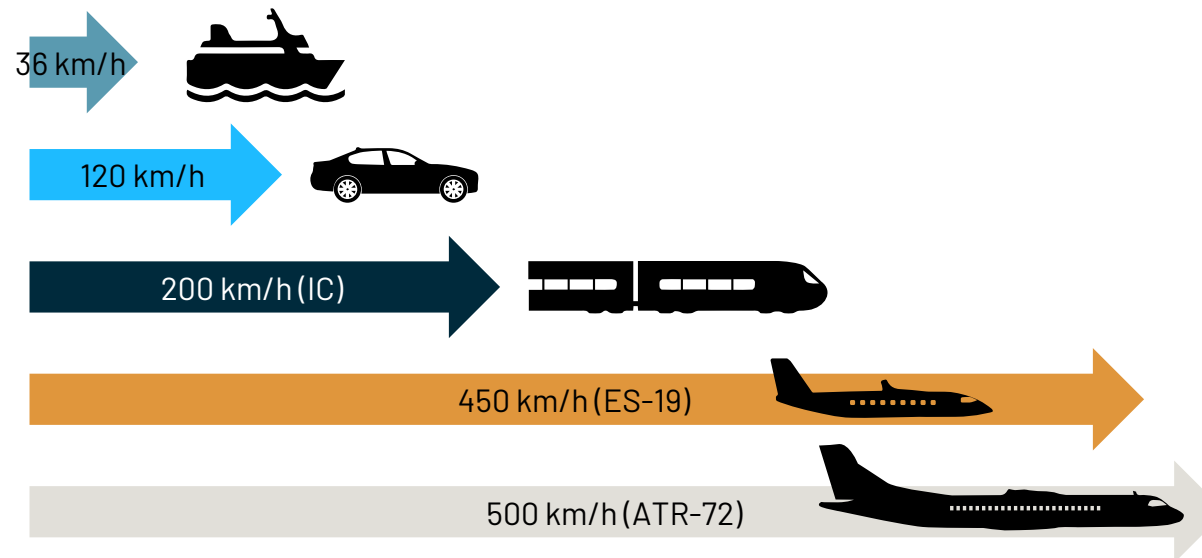
Each transport mode has its optimal operational area. The basic attributes are speed, capacity and infrastructure. These create the basis to understand electric aviation's role in the transport system.

- **Commercial sea transport** has the largest capacity is often used on long distances. Its main attribute is not speed but capacity and activities that can be offered during the trip.
- **Rail transport** has also a large capacity and is most efficient between cities. The sparse railway network limits the possibilities and creates demand for last and first mile options.
- **Passenger cars**, whether self-owned vehicles, taxi service or autonomous in the future, have all capacity restraints and the speed reduces the operational distance. Although, the widest infrastructure makes road transport the best connecting transport mode and critical for many trip chains. Here, we have examined passenger cars, but local and regional bus transport has also a role to play but is less efficient with small demand.
- **Current regional aviation** provides a relatively large capacity and is used on main airports. Speed is the key attribute.
- **Electric aviation** has small capacity but because of the speed, can access many locations quickly. Opens possibilities to use the wide network of airports even more.

CAPACITY



TOP SPEED



INFRASTRUCTURE

ROAD

Widest network of all transport modes

SEA

Ports in coastal cities

RAIL

Rails between cities

AVIATION

Wide network of airports and aerodromes

Identifying the need for regional electric aviation

Demand factor	Demand for mobility
Tourism	<ul style="list-style-type: none"> Tourists and event visitors Tour operator visits
Processing industry (Forestry, metal, mining, chemical, plastic, rubber, grocery, circular economy)	<ul style="list-style-type: none"> Service and installation personnel (including retrofits) Critical expertise personnel Sales personnel Customer visits at factories/offices/worksites
Information society, design field, technology industry, R&D	<ul style="list-style-type: none"> Management and sales staff Experts and designers Service and installation personnel
Logistics	<ul style="list-style-type: none"> Management and operational managers International co-operation
Social and health services	<ul style="list-style-type: none"> Doctors (gig jobs) Special care patients
Public administration (municipalities, cities, governmental institutions etc.)	<ul style="list-style-type: none"> Personnel: conferences, study trips International co-operation
Research and education	<ul style="list-style-type: none"> Research and teaching staff (collaborative networks) International students Conferences
Residents	<ul style="list-style-type: none"> Leisure trips - meeting relatives, travelling Work trips and other trips - multilocality driven

Modified from source: Traficom 2020 - Lentoliikenteen julkisen palveluvelvoitteen oikeatasaisuuden arviointi

Questions to find out the need for aviation in a region

- Are the activities international?
- Is it useful to be connected to the metropolitan area?
- Is there a reliance on just in time deliveries such as spare parts or other goods?
- Is e-commerce an important for business?
- What is the need to travel farther regularly?
- What is the industry profile like?
- Share of high tech and manufacturing industry?
- Is the area dependent on exports or imports or both?
- Is logistics a significant competitive factor?

The significance of Kokkola-Pietarsaari airport for the business life -survey

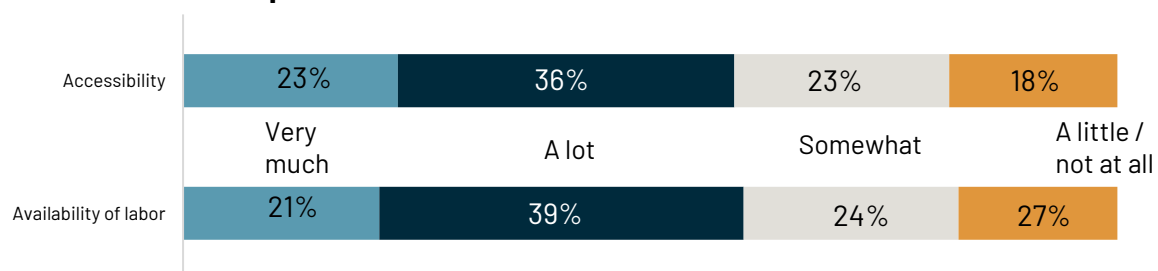
- 84 % of the companies consider the nearby airport to be important for the operations and image of the company
- 70 % of the companies that responded have business trips abroad
- 186 company responses to the survey

The survey also concluded that accessibility affects the

- regions image in international business
- investment conditions
- business location decisions
- availability of labor
- economy of the region and the whole of Finland

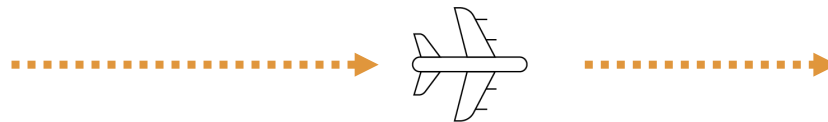
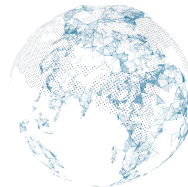
Source: WSP Finland 2018. The significance of Kokkola-Pietarsaari Airport for the business life

The most common factors influencing location and operating conditions of companies in Finland



Source: Chamber of Commerce 2016. Regional competitiveness

Driving forces supporting the use of electric regional aviation



TRANSPORT ELECTRIFICATION IS A GLOBAL MEGATREND

Electric power is a clean form of energy when it has been produced in a green way, using e.g. water, wind and solar energy. 85 % of electricity production of Finland is carbon neutral and 92 % of Sweden, respectively. That is a solid base to enhance electric aviation. Kvarken region is an important area in developing energy technology. That will give synergy advantages with development work in the aviation sector.

Energimyndigheten 2020, Energiateollisuus 2020

INTERNATIONAL TOURISM FAVORS NEW EXPERIENCES

The foreign visitors will most likely come back to the Nordic countries after the pandemic. Many factors support this such as increasing demand for space, peace and quiet, nature and new experiences. The aviation system will change compared to pre-pandemic time. The demand and supply are seeking a new balance. In this situation the big hubs like Stockholm, Helsinki and Oslo will survive, maybe serving smaller passenger volumes than earlier. Despite that, foreign tourists will arrive by bigger aircraft to these hub airports. The connecting trips to different domestic tourist destinations from the hubs could be served with smaller electric aircraft if suitable.

TIME BUDGETS ARE DECREASING – TRANSPORT NEEDS TO BE FAST

When people are choosing their tourism or other leisure time destination, they will count their time budget carefully. Because of mixing time use between work and leisure time, the activity patterns will be strongly different in the future than today or earlier. People may have a two-day trip to some destination in the middle of the week and after that they return to work. The short time budget does not allow to use old-fashioned trip chains, i.e. using nearly two days to travelling. People like to reach their destination quickly and use their limited leisure time to activities in their actual destination. For this kind of need the electric aviation is one good solution. By small electric aircraft small amounts of people can travel smoothly and according to a flexible timetable in domestic trips. Also, foreign travelers can reach many interesting destinations with connecting flights from hub airports by electric aircraft.

SUSTAINABLE TOURISM GIVES COMPETITIVE EDGE

Both Visit Sweden and Visit Finland give great emphasis on sustainable tourism and there are many eco programs and certificates such as Nature's best at place. A critical challenge is that many of the remote nature destinations are best accessed by air which is currently not very sustainable. Electric aviation is an important solution to improve the reputation of aviation and reduce environmental emissions and could be integrated to sustainable tourism concepts. During the pandemic time the domestic tourism has seen growth in some parts of Finland and Sweden. Domestic Visitors' share increased in Lapland by 7% from 2019 in 2020 in the summer season (Visit Finland 2020). 41% of the Finnish people would want to discover their homeland more and 34 % want to actively avoid congested destinations when traveling in the future. (Kauppalehti 2020) People are living more of their time in leisure accommodations. Working time and leisure time are being mixed more and more. Multi location habitation is gradually a more common phenomenon.

DESPITE DIGITALIZATION AND REMOTE WORK IMPORTANT BUSINESS TRIPS WILL REMAIN

During covid pandemic time the number of regular trips in passenger traffic has been reduced significantly. It has been predicted that this phenomenon will continue to some extent also after pandemic. It means that people are working partly outside their offices, and they do not need regular trips to and from workplace as much as earlier. Despite this phenomenon there will be trips which are compulsory. When a Nordic company is doing business abroad, negotiations will be carried out face to face. When an industrial equipment has been sold, there will be need to installation, maintaining and repairing work for many years. All this requires trips and especially flight trips. Kvarken area has many universities and research institutes and they have needs to collaborate in international networks. Conferences, seminars and working group meetings are partly physical after pandemic even if digital communication will substitute part of trips.

WEST-EAST -DIRECTIONS TRADITIONALLY UNDERSERVED – POTENTIAL FOR GROWTH

Both in Finland and Sweden trips are made to a great extent in south-north direction. The supply has been organized supporting these kind of trips. Many west-east -trips require extra kilometers because of lack of direct connections. Volumes in direct west-east trips are rather low and just for this reason the smaller electric aircraft would be a suitable solution for these trips. Increasing the supply between west-east axis could bring new business and tourism opportunities the area.

Kvarken region is a strong area of export industry

Västerbotten

Industry examples

- Industries are focused on machinery, for example Volvo Truck Corporation and Komatsu Forest. Also forest and mining industries, for example SCA and Boliden. Also dairy production.
- Growing battery cluster in Skellefteå: Northvolt and raw material production.

Tourism locations

- Wide variety of nature destinations (Gold of Lapland)

Research and education

- Umeå University

Örnsköldsvik

Industry examples

- Traditional industry area in forestry and metal industries, pulp and paper industries and machinery, 75 % of production to export markets, totally 3 % of Swedish total export (0,5 % of population).
- Biggest international companies for example Metsä Board, Bosch Rexroth Mellansel, Sanmina, Aditya Birla/Domsjö Fabriker and MacGregor Sweden.

Tourism locations

- High coast as an attractive travel destination.

Ostrobothnia

Industry examples

- Energy industry, for ex. Wärtsilä, ABB
- Battery cluster
- Wärtsilä research

Tourism locations

- Kvarken UNESCO World Heritage Site

Research and education

- Vaasa University
- Vaasa University of Applied Sciences

Export value of the region is 14 billion euros,

of which 8 in Sweden and 6 in Finland. Export industry creates a significant potential for electric regional flights. There is a current need for communication inside the Kvarken region and growth potential in the future.

(Finnish Customs 2019, Statistics Sweden 2018)

Central Ostrobothnia

Industry examples

- Battery material production
- Chemical, metal, forest and boat industry
- Boliden, Umicore, Rauanheimo, Keliber
- Fennovoima's nuclear powerplant project

Tourism locations

- Wide variety of nature destinations such as Salamajärvi national park and Kalajoki in the north

Research and education

- Centria University of Applied Sciences
- Kokkola University Consortium Chydenius

South Ostrobothnia

Industry examples

- Strongest food industry in Finland that has strong domestic market share and is also a growing export industry. For ex. Atria
- One of the largest commerce areas in Finland

Tourism locations

- Powerpark and Ähtäri Zoo
- Wide variety of nature destinations

Research and education

- University Consortium of Seinäjoki

Future aviation demand around Kvarken airports in Finland



- E-commerce logistics center development including drone logistics
- New green data center area with 200 MEUR investments. Various investors and global IT companies are involved
- Food industry is seeking growth in export to various markets
- The population on Seinäjoki commercial is estimated to quadruple and a lot of construction projects are ongoing.
- The commercial role of Seinäjoki area is increasing constantly
- There are over 6 000 SMEs in South Ostrobothnia with increasing export needs
- New tourism concepts are being developed



- One of the most important export centers in Finland
- Kokkola Industrial Park, KIP, The largest inorganic chemical industry ecosystem in Northern Europe, including leading battery chemistry and circular economy knowhow, is constantly growing
- Alholmen Industrial Park is known particularly as a wood processing, metal industry and shipbuilding cluster. The park is home to 10 industrial and 53 service companies. Almost 80% of the output in the area is exported.
- The city of Kokkola is part of BotH₂nia, an international network for building a large-scale hydrogen economy around the Gulf of Bothnia.



- EnergyVaasa, a global energy industry concentration of 140 companies with 11,000 employees. Exports account for up to 80%.
- Upcoming Battery Gigafactory is planned for 2024 next to the airport
- Vaasa region has strong focus on international co-operation and growth
- The Kvarken UNESCO world heritage site as an attraction for tourism
- International research and education facilities and R&D opportunities

The Finnish side of the Kvarken region is constantly growing in many aspects which creates new demand for sustainable aviation.
Communication between the region and international connections will greatly benefit from electric aviation.

How to take the greatest possible advantage of the existing infrastructure?

Small passenger volumes require a new approach

It is very recommendable to use the existing airport network in Finland and Sweden more effectively than currently. There is a wide network of airports and aerodromes both in Finland and Sweden. However, the system of volume business in aviation has left many of them to very limited use compared to their potential. There are no large volumes, but smaller and still important trip needs exist. Gathering small volumes to larger hubs is not optimal. A more customer friendly aviation system could be formed by using the network of airports and the electric regional aviation for the versatile needs of smaller volumes.

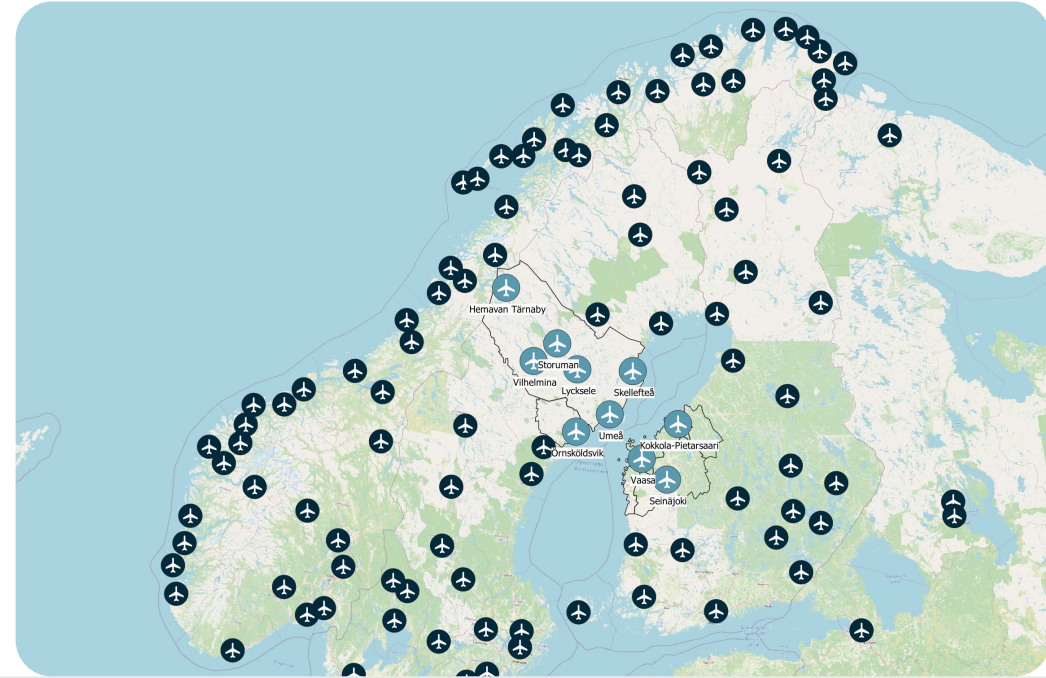
By comparison, aviation infrastructure is cheap to maintain

The runways are about 2 kilometers per airport which means that the basic airport infrastructure combined is not very long. In Finland there are about 60 kilometers of runways. It is a small amount compared to public roads, rails and waterway networks which have a total length of 100 000 km. The road network is the widest and most connecting transport network. In Finland there is about 80 000 km of public roads and about 400 000 km of private roads. The length of the railway network is nearly 6 000 km.

The maintenance of rail network is more expensive per kilometer than road because of the technical equipment of railways. The maintenance costs of roads and rails are about 2 billion euros annually. The infrastructure of waterways in Finland consist of 8 000 km of seaways and of 8 000 km inland waterways. The maintenance costs of waterways and airports are rather cheap compared to the road and rail network.

Quick effects to be gained

Major rail investments are currently discussed in Finland. The rapid rail connections are expensive, together between 10 and 20 billion euros, and the planning and construction would take many decades. For that reason, even big rail investments are not the answer for the needs of business life today. Electric regional aviation will be in use already in this decade.



Using the existing infrastructure with electric regional aviation would be both cost- and climate-efficient

- There is a dense network of airports in the Nordics
- The maintenance of the airports is cheap compared to other transport mode infrastructures such as roads and rail
- There is no need to build new airports. No major infrastructure investments needed to improve mobility between regions
- The costs of airport maintenance can be reduced with Remote Tower Centers and Satellite Based Augmentation Systems that are being used on many airports already
- Infrastructure construction emissions are being investigated more and more and are considered in decision making. Emissions from airports are minimal in the Nordics and for ex. Helsinki-Vantaa has been carbon neutral since 2017. (Finavia 2020)
- For comparison, adding additional rail tracks to the Finnish main railway between Helsinki and Tampere would emit 947 Mkg CO2-e. **The emission reduction from improving the railway would offset the emissions from the construction of the additional tracks in 182 years.** (Ramboll 2020). This doesn't mean this investment isn't necessary. However, it shows building new infrastructure has a carbon footprint thus making the use of existing infrastructure more attractive.



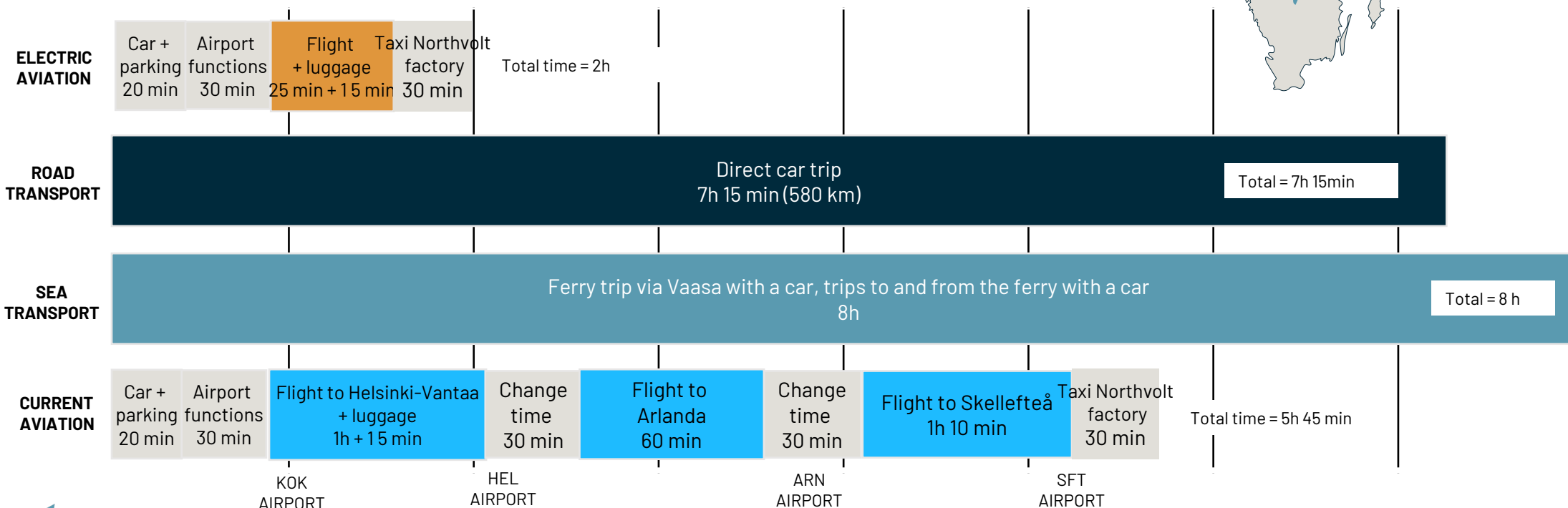
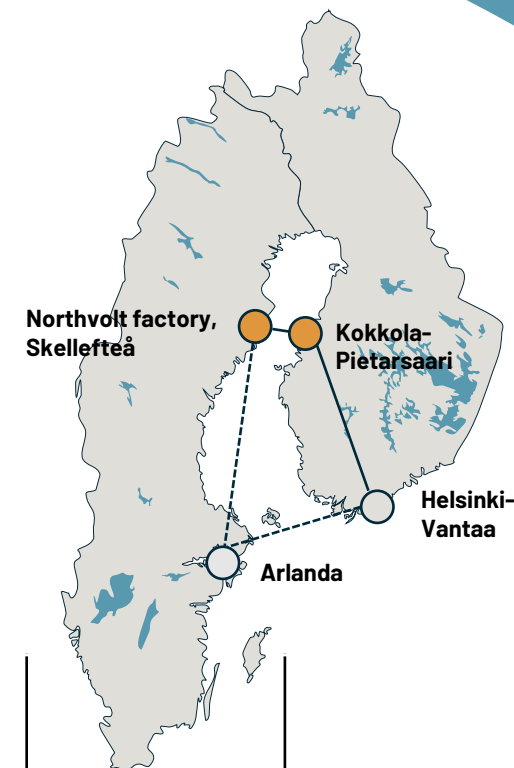
Fineweld weekly works trips Kokkola-Pietarsaari - Skellefteå

Fineweld selected as key supplier for Northvolt's battery plant project

Fineweld's long-term experience in large industrial investment projects and the company's unique semi-modular plant construction concept succeeded in convincing the Swedish battery manufacturer Northvolt. Fineweld was selected as one of the key suppliers for a massive battery plant project in Skellefteå. Fineweld's delivery and installations are a key part of Northvolt's active cathode material production process. There are weekly needs to travel between Kokkola and Skellefteå.

The duration of the already agreed project is more than two years. The project will be implemented in the form of an alliance together with Sweco and ABB. Sweco is responsible for project design and ABB electrical, instrumentation and process control delivery.

A direct flight between Kokkola and Skellefteå would be the most reasonable way to travel. Today it requires extra time and flight miles to reach Kokkola or Skellefteå via Helsinki-Vantaa and Stockholm. This wastes time, human resources, energy and increases the carbon footprint of the trip. Electric aviation would solve all these problems.



Nordic battery cluster

- case Vaasa - Skellefteå work trip

Northvolt One Gigafactory in Skellefteå

Main production site for battery cells, which includes active material preparation, cell assembly, recycling and auxiliaries. Will provide up to 3 000 jobs by 2025.

Northvolt's gigafactory will be further expanded to support a combined order worth more than \$ 14 billion over the next 10 years as Northvolt is selected by Volkswagen Group as a strategic lead supplier for premium battery cells in Europe.

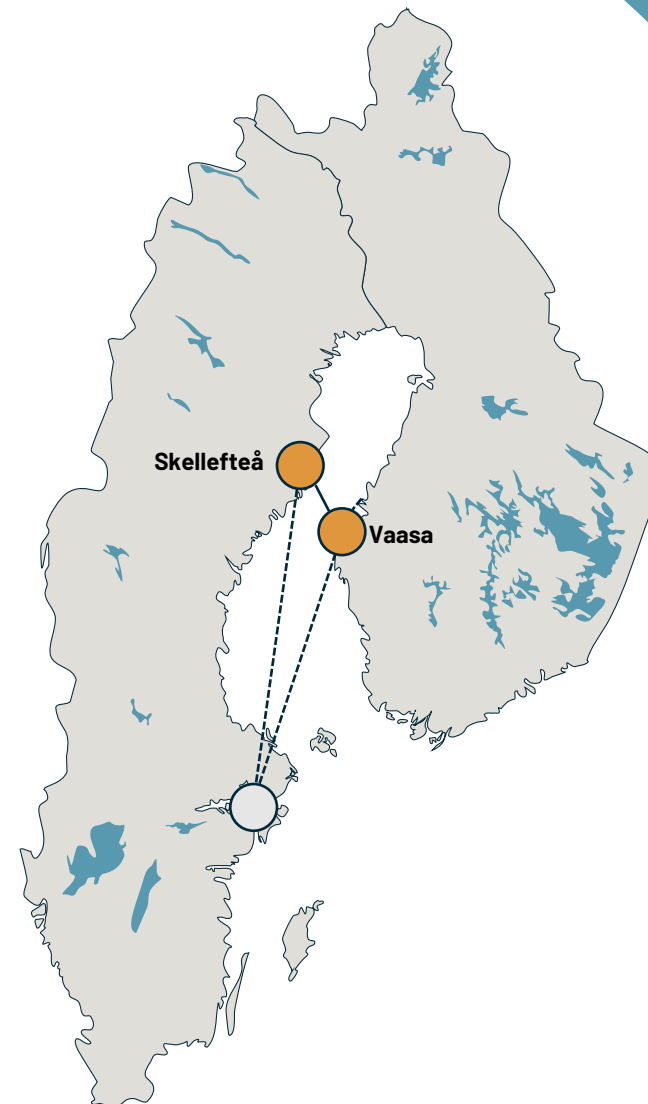
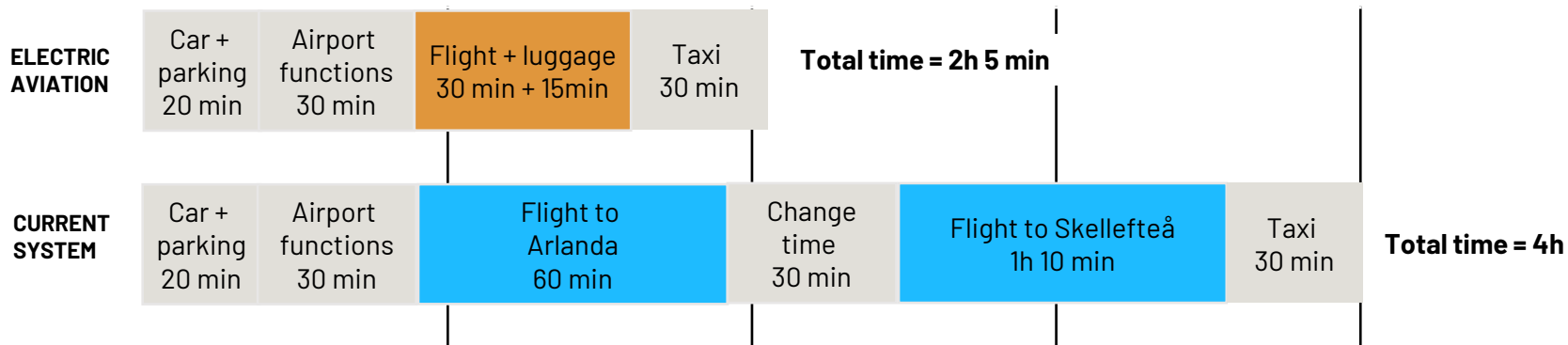
- Collaboration needs
- Workforce mobility between Vaasa and Skellefteå



Vaasa upcoming Gigafactory in 2024

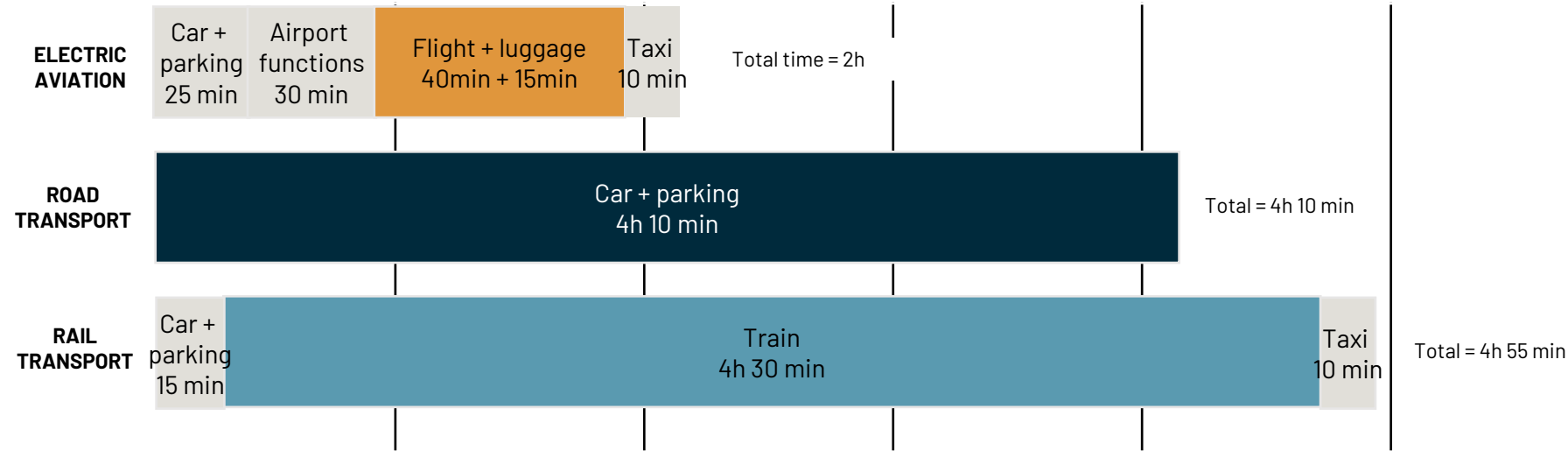
Suomen Malmijalostus has stated it is planning to invest in a cathode material plant planned for Vaasa. The British listed company Johnson Matthey is the partner and leader of the factory investment.

The factory would employ hundreds of people. The planning area is located next to the airport of Vaasa which provides excellent accessibility with electric airplanes.



Trip chain comparison

Case Wärtsilä Turku to Wärtsilä Vaasa



Aviation trip chain

- Fastest option and with an on-demand system a relatively flexible service
- Work can be done during the flight

Car trip

- No interchanges required and flexible timetable wise
- Transport safety is worst of the options – bad weather and darkness increase risks
- Not suitable for working; phone calls can be made
- Infrastructure costs are relatively high because maintaining the extensive road network requires a lot of capital
- Increases congestion

Train trip chain

- Longest transport time
- Work can be done during the trip, so the time doesn't necessarily go to waste
- Timetables limit the flexibility
- Rail stations are located in the city centers



Connecting South Ostrobothnia and Sweden

Potential to enhance tourism

Tourism is currently an underdeveloped sector in South Ostrobothnia. It could be enhanced by marketing tourism attractions to Kvarken areas in Sweden, i.e. Västerbotten and Örnsköldsvik. Tourism flows could move in both directions.

The Kvarken area in Sweden is an attractive and versatile tourism area to which tourist trips can be directed via Seinäjoki Airport. Tourism organizations on both sides of the Gulf of Bothnia could create functioning tourism markets in co-operation. Electric aviation would provide an added value for environmental reasons.

On-demand tourist flights could be provided from Seinäjoki to Umeå, Skellefteå and Örnsköldsvik and vice versa. Västerbotten area has a wide variety of nature destinations. High coast near Örnsköldsvik is a famous and attractive travel destination.

South Ostrobothnia has many interesting tourism attractions like Power Park, Ähtäri Zoo, Tuuri business center, Aalto center and many nature attractions. A fast and clean way to reach South Ostrobothnia is surely a competitive factor to enhance the marketing of tourism in the area.

Potential to enhance business relations

- South Ostrobothnia has two strong business sectors, food industry and machinery and metal product industry. Also Västerbotten and Örnsköldsvik have similar industries. Volvo Truck Corporation and Komatsu Forest represent machinery industries. There exist also forest and mining industries, for example SCA and Boliden. Dairy production is comparable to South Ostrobothnia.
- Örnsköldsvik is a traditional industry area in forestry and metal industries, pulp and paper industries and machinery. It is a strong area of export business.

Connections to Stockholm and other parts of Sweden

- Direct on-demand -based flights from Seinäjoki Airport to Kvarken area airports in Sweden would offer an alternative possibility to continue to Stockholm. Arlanda hub offers a wide variety of international flights. That might be an interesting alternative both to business and tourism trips.
- From Kvarken airports in Sweden there is also possible to continue to other Swedish tourism and ski centers outside Kvarken area, like Åre.



Examples of travel times with electric aviation across the border

Leg	Flight distance	Travel time between city centers with electric aviation First mile – flight mile– last mile
Seinäjoki-Skellefteå	230 km	15 min car drive + 45 min total airport time + 40 min flight + 20 min car drive = 2h
Seinäjoki-Örnsköldsvik	210 km	15 min car drive + 45 min airport time + 35 min flight + 25 min car drive = 2h
Seinäjoki-Umeå	180 km	15 min car drive + 45 min airport time + 30 min flight + 20 min bus trip = 1h 50min

Examples of today's co-operation

Fortaco Oy, Kurikka / Komatsu Forest Ab, Umeå

Co-operation for several years. In Kurikka, Fortaco manufactures cockpits for several Komatsu Forest AB forest machine models. The finished cockpits are delivered by ship from Vaasa to Umeå, where they are installed on the hulls of the machines. There is close research and development work, which also requires constant communication and meetings of design teams.

Campnou Oy, Ähtäri / Alukin Boats Sverige AB, Norrtälje

Campnou Oy is a Finnish contract manufacturer of aluminum boats, which manufactures boat hulls and other components for several different brands (e.g the aluminum hulls of Yamarin Cross boats are manufactured by Campnou). Campnou has been manufacturing boat hulls and other parts and components for the Swedish Alukin Boats Sweden Oy for several years, and in 2021 it was announced that Campnou will start manufacturing certain Alukin boat models completely, from start to finish. The co-operation has thus expanded to a new level, which promises to continue co-operation in the future as well.

Accelerating cross-border co-operation with electric aviation

Future Cleantech Solutions

A project that promotes cleantech companies' opportunities for concrete business- and cooperation in a manner that strengthens their prospects of **doing business on regional, national and international markets**.

The project focuses on **cross-border cooperation** in the Kvarken region. The upcoming need is large and includes raw materials, energy, infrastructure, sustainable technical solutions, ecosystems for business cooperation and skilled labour in the entire value chain from major establishments to its subcontractors, creating unique opportunities for the region's companies for cross-border collaborations and business within the areas of **energy, smart, sustainable cities, bioeconomics and chemistry**.

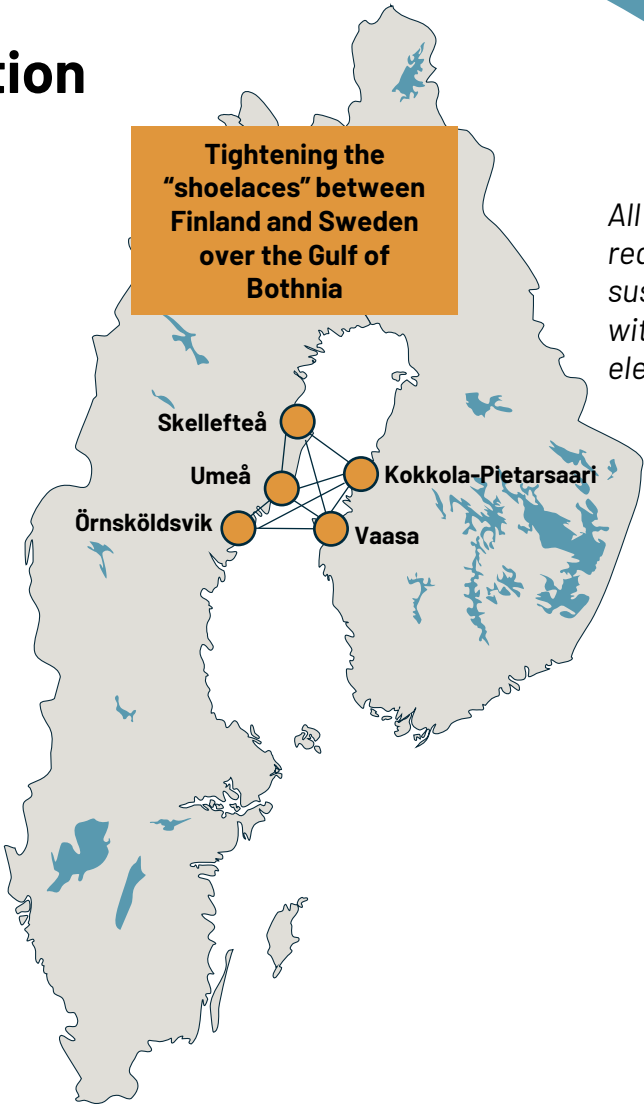
The project is being carried out until end of 2021 by

- Kompetensspridning in Umeå AB
- Skellefteå Science City
- Örnsköldsvik Municipality
- Teknologicenter Oy Merinova Ab
- Vaasa Region Development Company VASEK
- Development Company of Kokkola Region (KOSEK)

Close cooperation with the cities Umeå, Skellefteå, Örnsköldsvik, Vaasa and Karleby, and the energy companies Skellefteå Kraft and Umeå Energi, which, together with other parts of Västerbotten, Västernorrland, Ostrobothnia and Central Ostrobothnia, have assets, skills and resources that create a major growth and development potential within the cleantech area.

Examples of travel times with electric aviation across the border

Leg	Flight distance	Travel time between city centers with electric aviation First mile – flight mile- last mile
Kokkola-Skellefteå	142 km	20 min car drive + 30 min airport functions + 25 min flight + 15 min luggage + 20 min car drive = 1h 50 min
Vaasa-Örnsköldsvik	145 km	15 min car drive + 30 min airport functions + 25 min flight + 15 min luggage + 25 min car drive = 1h 50 min
Vaasa-Umeå	111 km	15 min car drive + 30 min airport functions + 20 min flight + 15 min luggage + 20 min bus trip= 1h 40 min



All project cities reachable in a sustainable way within 2 hours with electric aviation

KEY POINT

The Kvarken region is in constant collaboration, and co-operation is cross-border. Electric aviation could provide improved accessibility within the region and **promote such cross-border projects** as Future Cleantech Solutions.

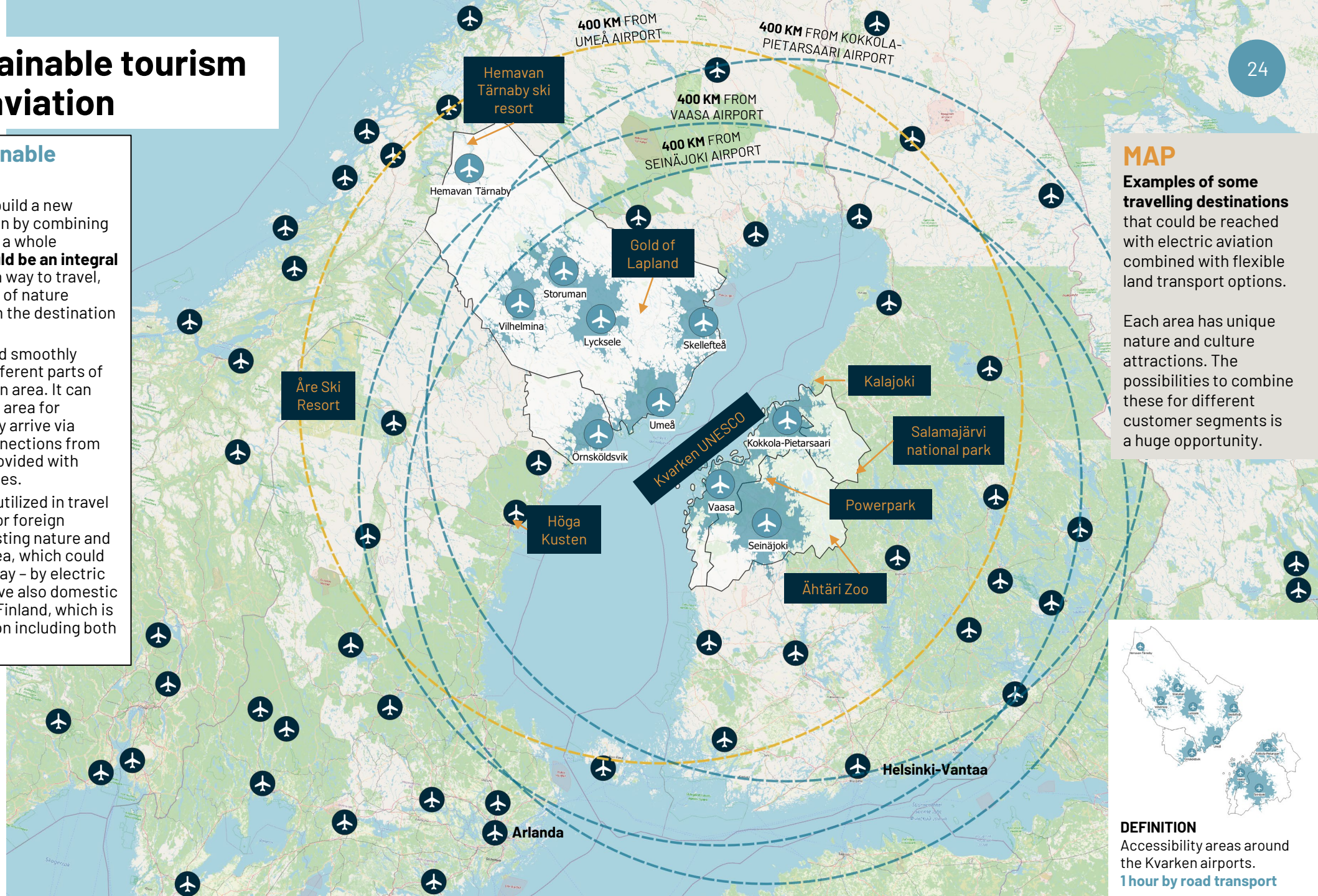
Boosting sustainable tourism with electric aviation

Possibility for a sustainable tourism concept

There is a unique possibility to build a new tourism brand for Kvarken region by combining interesting travel attractions as a whole package. **Electric aviation should be an integral part of the concept.** It is a clean way to travel, and it can strengthen the image of nature attractions, when one can reach the destination in a sustainable way.

People and freight can be moved smoothly according to needs between different parts of the area and outside the Kvarken area. It can strengthen the attraction of the area for tourism. Foreign tourist typically arrive via Helsinki-Vantaa or Arlanda. Connections from these national hubs could be provided with electric aviation for small volumes.

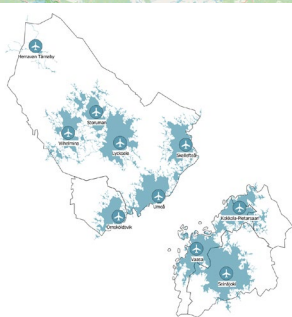
This concept thinking could be utilized in travel marketing directed especially for foreign tourists. There are many interesting nature and urban attractions in Kvarken area, which could be smoothly reached in a new way – by electric aviation. The concept could serve also domestic travel destinations, like Oulu in Finland, which is an example of a tourist attraction including both urban and nature activities.



MAP

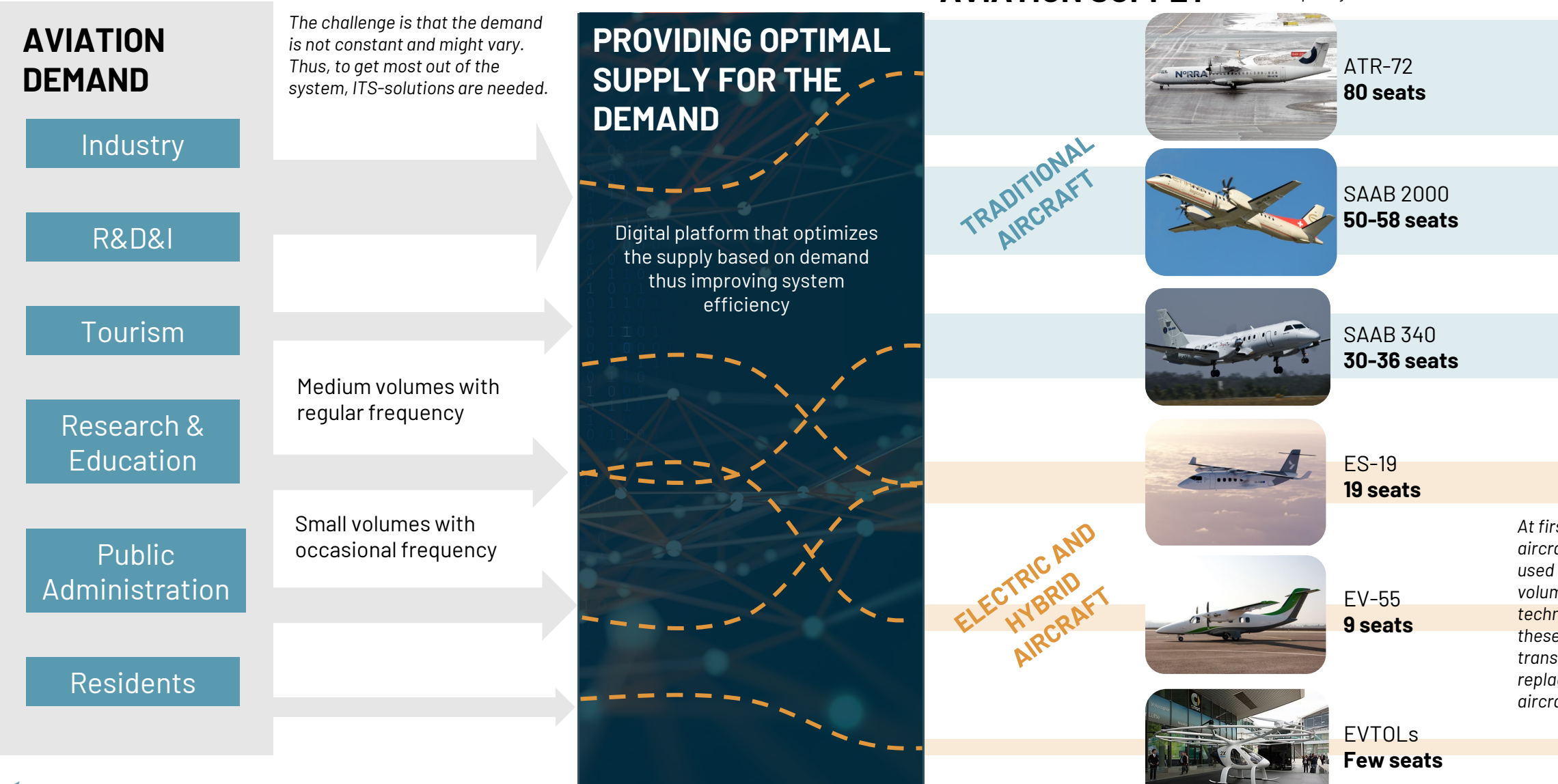
Examples of some travelling destinations that could be reached with electric aviation combined with flexible land transport options.

Each area has unique nature and culture attractions. The possibilities to combine these for different customer segments is a huge opportunity.



DEFINITION
Accessibility areas around the Kvarken airports.
1 hour by road transport

How to provide supply for small and medium passenger volumes



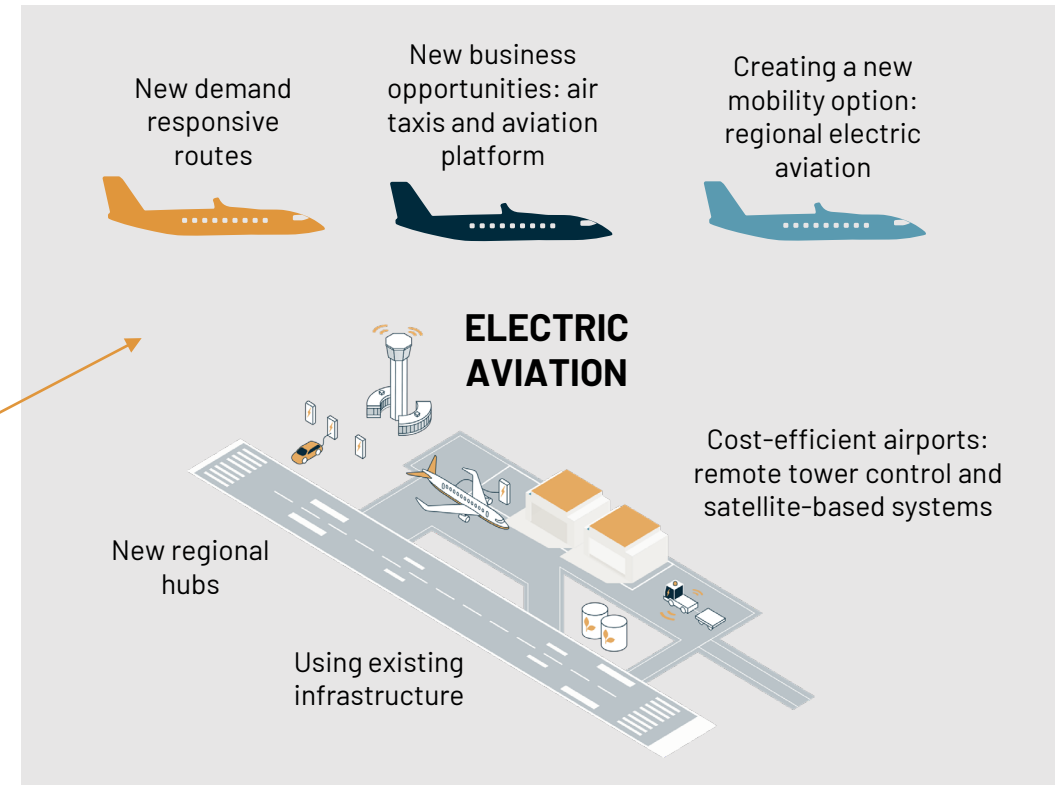
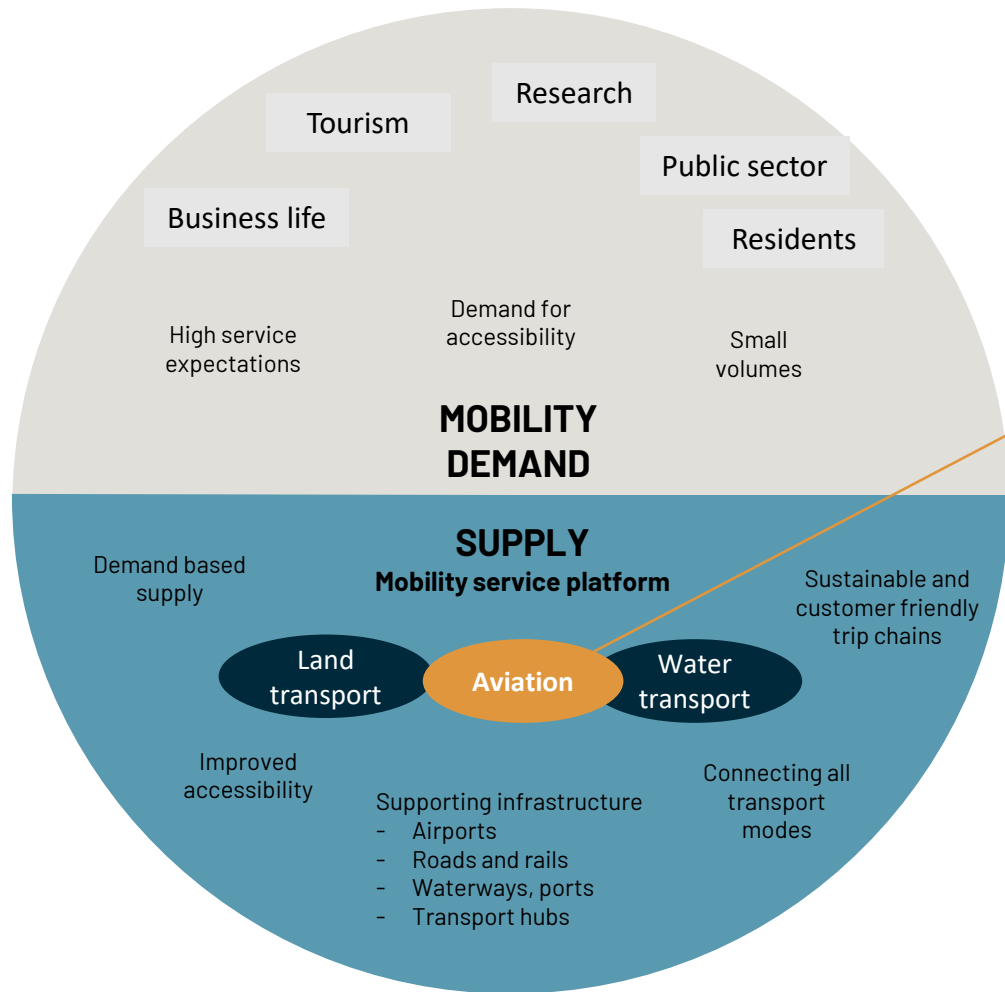
For operators, the platform would provide efficiency so that aircraft could be used with a high occupancy rate.

At first, traditional aircraft could be used for smaller volumes. As the technology evolves, these could be transformed or replaced by electric aircraft.

Vision of electric regional aviation in the Kvarken region

- renewing the current system

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Electric aviation in future trip chains

New era of aviation will be based on smart mobility, integrated mobility services and flexibility. Traditional high volume flight routes are not the case. It's about meeting customer travel needs and providing optimal mobility service by combining air, road, rail or water transport to form door-to-door trip chains. Electric regional aviation can enable better accessibility and provide a much needed alternative for region-to-region mobility in a fast and clean way.

FIRST MILE

FLIGHT MILE

LAST MILE

Effects of electric aviation on land use and business life near airports

Interesting location for business and R&D functions

The airports can be important centers for business life. Electric aviation gives new possibilities for companies to locate their R&D near airport. Also, high technology production fits well near airports.

Development and testing of new aviation technology is underway at Helsinki-East Aerodrome in Pyhtää municipality on the southern coast of Finland. The land use at the airport area has been directed to technology companies and logistics providers.

Finding the synergies

In a recent development project to Pori airport the focus was on location factors of business life. Activities were sought which have synergy with aviation in a way or another. Some companies have to travel a lot by flight and the location is easy to access for their customers, too. Negotiations can happen at the airport area, which is an advantage for the strict time budgets of business life.

Electric aviation will be to some extent less noisy than traditional aviation. Especially take off operations have typically been noisy and that is why it has limited the location of residential areas near airports. In the future electric aviation will improve the situation and enable the location of versatile activities nearer airport. Electric aviation requires a new type of infrastructure, technical equipment and new type of operation models. They all can have their contribution in reducing the noise level at airports and in their neighborhood.

Improving the attractiveness of the nearby cities

The development centers of technology are typical activities nearby airports. In Kvarken area there are many industrial branches which are in contact with each other over the Gulf of Bothnia. Electric aviation will be the **fast and clean** way in connecting Kvarken areas to each other. It will also bring the attractiveness to the cities near Kvarken airports. Fast and green transport is an important competitive factor in the future.

Industry near airports

Industry can directly benefit from the near airport location by good accessibility. Flights might be needed for work trips, collaboration, visitors and business meetings. The airport area can also provide optimal meeting locations. For cargo, the airport area can host warehouses, provide fast spare part logistics with drones and serve as a buffer if the supply chain resiliency is to be improved.

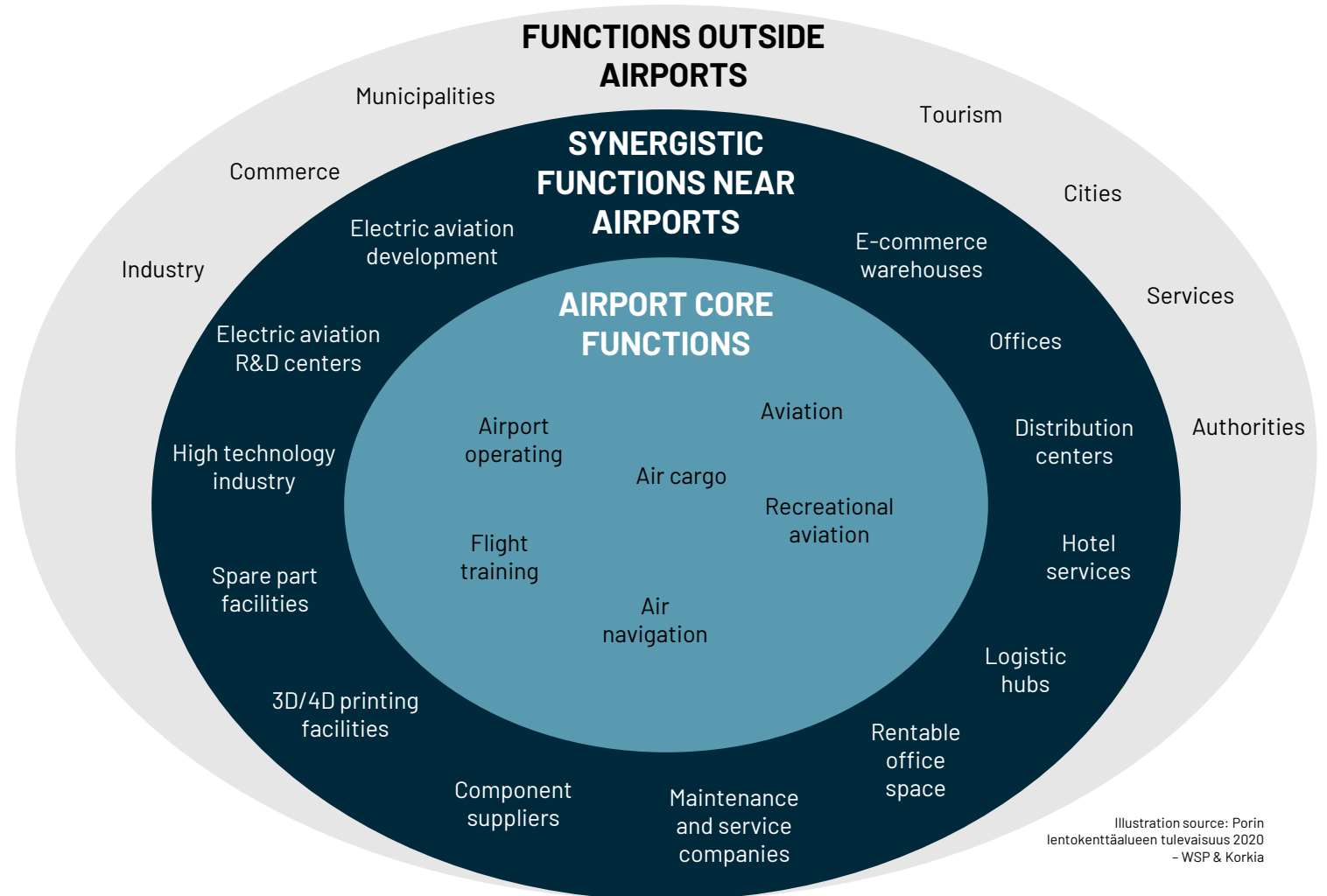
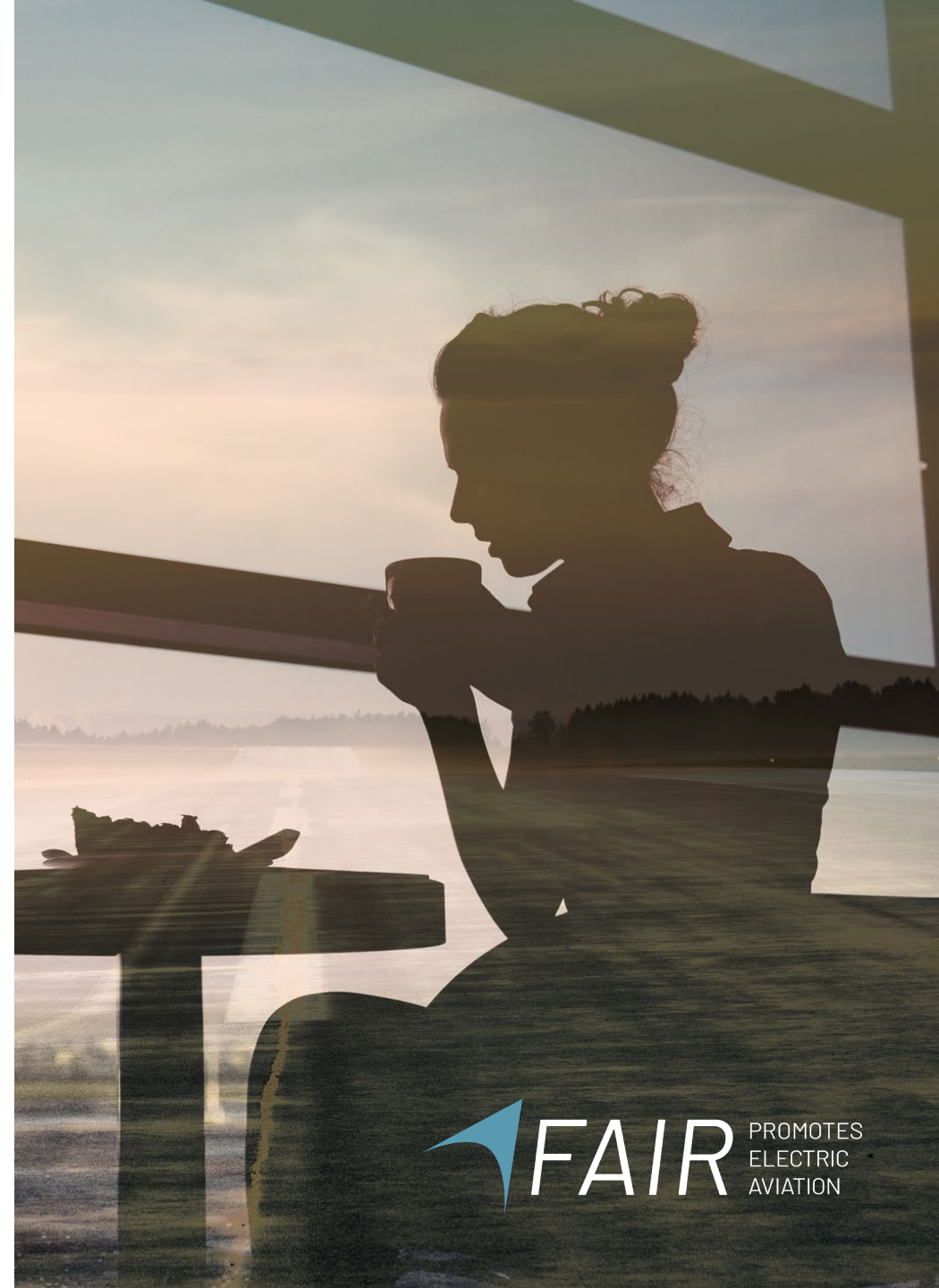


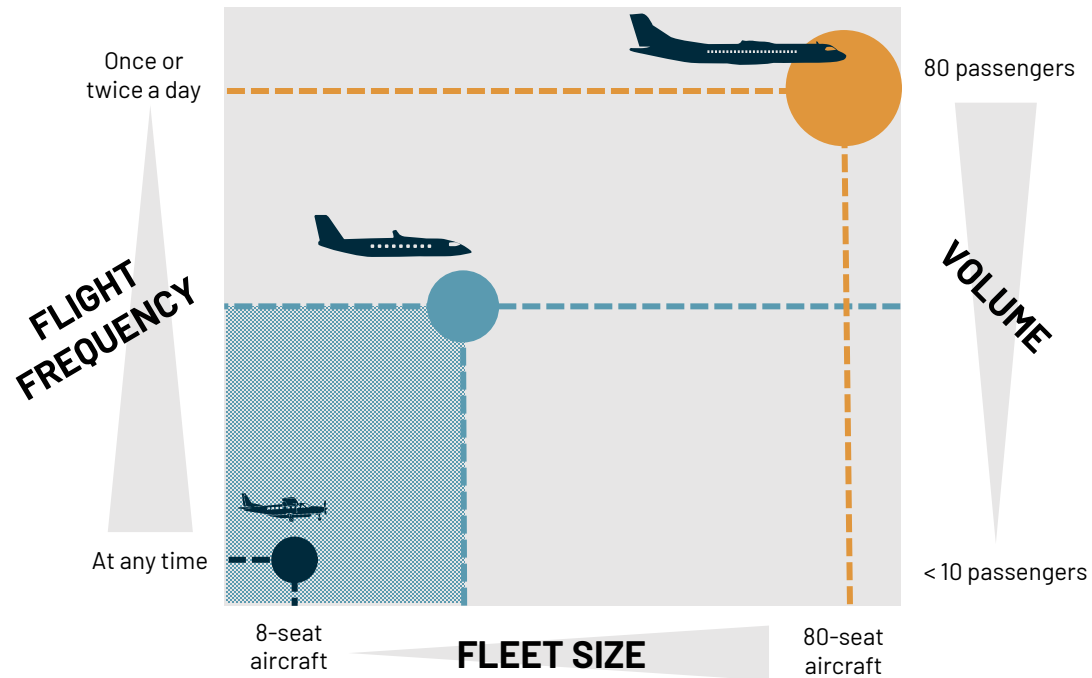
Illustration source: Porin lentokenttöalueen tulevaisuus 2020 – WSP & Korkia

ELECTRIC REGIONAL AVIATION BUSINESS MODEL

*What kind of business model would
be suitable to begin electric aviation
operations in the Kvarken region?*



Business model for an on-demand airline



BUSINESS AIRLINE

Private flights with small aircraft at any given time

ON-DEMAND AIRLINE

Variable fleet to serve variable volumes. Frequency depends on the demand.

REGIONAL AIRLINE

Operating with larger aircraft such as ATR-72 with 80-seats. Frequency is low, typically 1 or 2 flights per day. Serves larger volumes.

On-demand airline

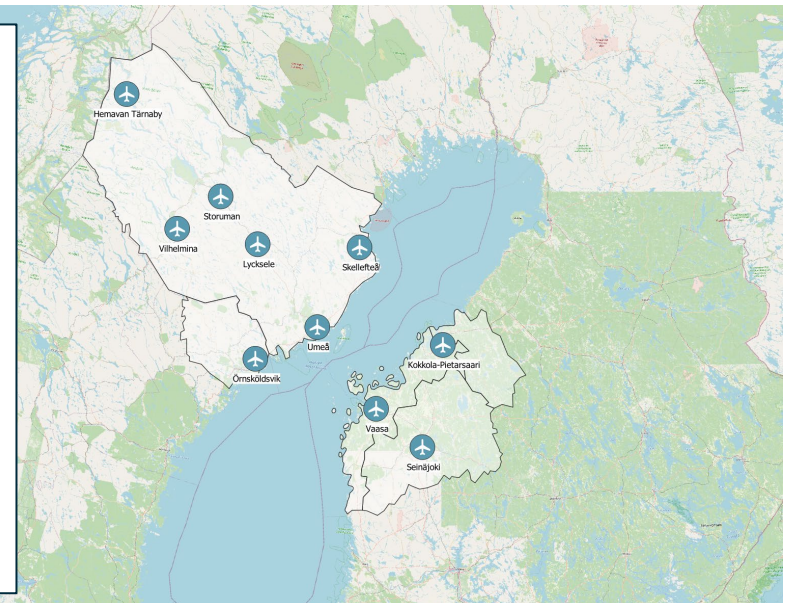
- Combination of traditional regional flights and business flights
- **Complementary flights** for route flights with electric aircraft from main hubs if the flight distance is under 400 km. In case route flight schedules are not optimal or the volumes are small.
- **Flexible feeder flights** from regional hubs for small passenger volumes with electric aircraft. Direct flights to destinations if range is sufficient.
- **Region to region flights** between connected airports (up to 400km) with electric aircraft. Improves regional accessibility and provides new flight routes.

Profitability and service level

- Smaller aircraft can provide more efficient operations and more frequent flights. Good service level will increase the demand and keep the prices competitive.

Operational area for an on-demand airline can be smaller than for traditional airlines. An on-demand airline could focus operations e.g. to the Kvarken region and try find competitive flights between the region's airports.

First and last mile connections are critical for success so a Mobility as a Service approach with a platform that combines land transport with flights, should be developed. The platform could be owned by a separate company.



Cost structure of traditional and electric aircraft

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Cost estimate of operating a Cessna Caravan 208 (9 seats)

Direct operating costs (DOC)

Fuel, maintenance and landing & handling fees

Fixed costs

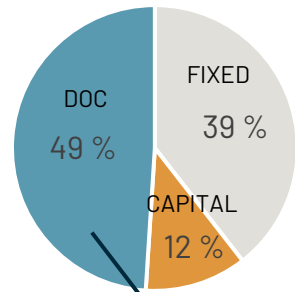
Crew, training, insurances, sales, marketing

Capital costs

Depreciation, interests

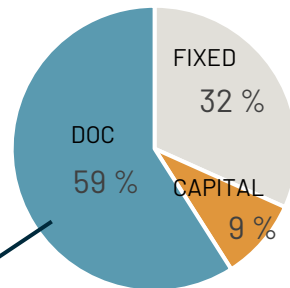
Cost structure

400 flight hours per year



Cost structure

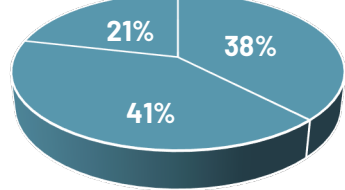
600 flight hours per year



Typically, the direct operating costs for a Cessna Caravan are 480 €/h (based on 400 flight hours per year)

Cost sources: LibertyJet, GuardianJet

AIRPORT COSTS



FUEL

Major cost component for smaller turboprops is the direct operation cost (DOC). As demonstrated, the more you fly, the larger the proportion of DOC becomes. Cost-wise, it is good to fly as much as possible.

MAINTENANCE, REPAIR AND OVERHAUL (MRO)

Estimates of costs to operate electric aircraft

DIRECT OPERATING COSTS OF ELECTRIC AIRCRAFT

FUEL

Heartstone Aero states that fuel costs would be reduced by 50-75 %. The costs of energy will most likely be reduced compared to the current situation but as the use of electricity increases in transport, industry and households, electricity prices might rise if the clean energy production can't keep up.

MAINTENANCE

Electric engines have less wearing parts which will translate to reduced maintenance costs. A large part of maintenance costs are the engine overhaul costs. Heartstone Aero states that maintenance costs could be reduced by 50 %.

LANDING AND HANDLING FEES

Electric aviation won't change these. However, as the fuel and maintenance costs are reduced, the share of landing and handling costs increases proportionally. Thus, reducing airport operational costs could even further increase the competitiveness of electric aviation.

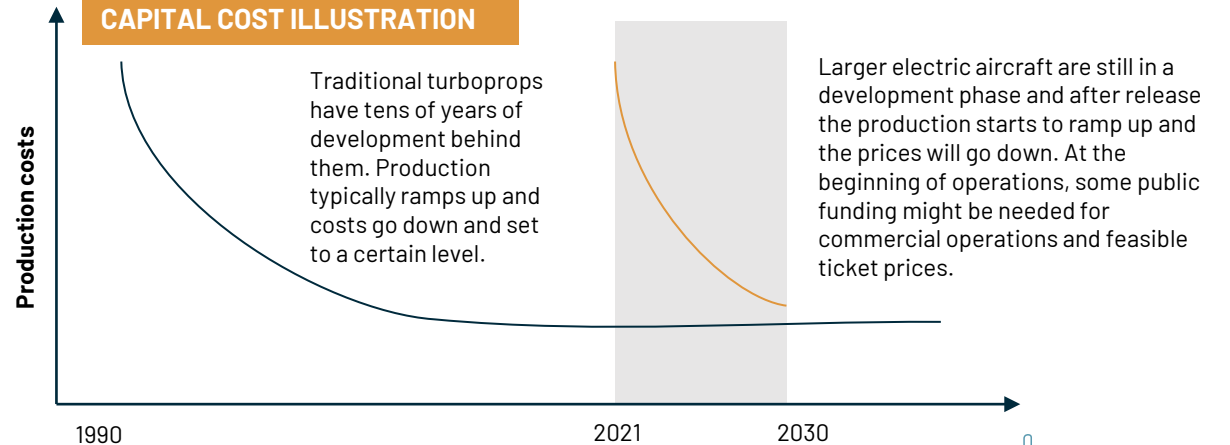
FIXED COSTS OF ELECTRIC AIRCRAFT

Electric aviation won't affect the fixed costs.

CAPITAL COSTS OF ELECTRIC AIRCRAFT

It is unclear what will the electric aircraft's purchase or rental cost be in the longer run. It is certain that before large-scale production, capital costs will be larger than with current turboprop aircraft. One interesting option would be to retrofit the current aircraft to fit electric motors. Thus, the capital costs could be possibly reduced.

CAPITAL COST ILLUSTRATION



Creating new business models for aviation – electric aviation plays a crucial role but the whole value chain must be changed

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Airlines

- On-demand, regional and private airlines
- Flexible services for different needs
- Efficiency and reduced emissions with electric aircraft
- Recommendation: begin on-demand aviation based on existing demand from companies on certain routes before electric aircraft commercialization

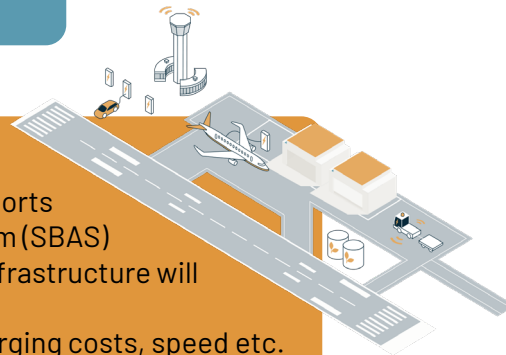


Airport operators

- Interests to lower costs and market the airport to operators and customers
- Synergies and cost-efficiency with remote tower services
- Increased service level: 24h operational time for all airports

Airport infrastructure

- Critical to lower costs at current airports
- Satellite Based Augmentation System (SBAS) and Remote Tower Services (RTS) infrastructure will provide low operating costs
- Charging infrastructure models: charging costs, speed etc.
- Infrastructure for first and last mile transport options



Mobility service providers

- MaaS-service that combines all transport modes into a user-friendly door-to-door package
- Booking, ticketing, trip tracking etc. included
- Includes first and last mile service providers: taxis, shared cars, public transport etc. that are connected to the “flight mile” on airports
- Close co-operation between local service providers

MOBILITY SERVICE PROVIDERS

AIRLINES

AIRPORT OPERATORS

AIRPORT INFRASTRUCTURE

PARTNERSHIP

FINANCIERS

Interreg Botnia Atlantica | Region Västerbotten | Regional Council of Ostrobothnia | Kvarken Council (Lead part) |

BioFuel Region BFR AB | City of Vaasa | FAB Kronoby Flyghangar | Into Seinäjoki Oy | Lycksele Flygplats AB | MidtSkandia |

Ostrobothnia Chamber of Commerce | RISE Research Institutes of Sweden | Skellefteå City Airport AB | Skellefteå Kraft AB |

South Ostrobothnia Chamber of Commerce | Storumans Kommunföretag AB | Swedavia Umeå Airport | Umeå Municipality |

Umeå University | University of Vaasa | Vaasan Sähkö Oy | Vaasa Region Development Company, VASEK |

Västerbotten Chamber of Commerce | Örnsköldsvik Airport AB

SUPPORTING PARTNERS

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NEA – Nordic Network for Electric Aviation | Umeå kommunföretag AB | Umeå Institute of Design |

The Swedish 2030-secretariat | Transportföretagen

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Thank you! flyfairkvarken.com



KVARKENRÅDET
MERENKURKUN
NEUVOSTO



Interreg
Botnia-Atlantica
European Regional Development Fund