Fossil-free airplanes with liquid hydrogen - experiences from Umeå Airport

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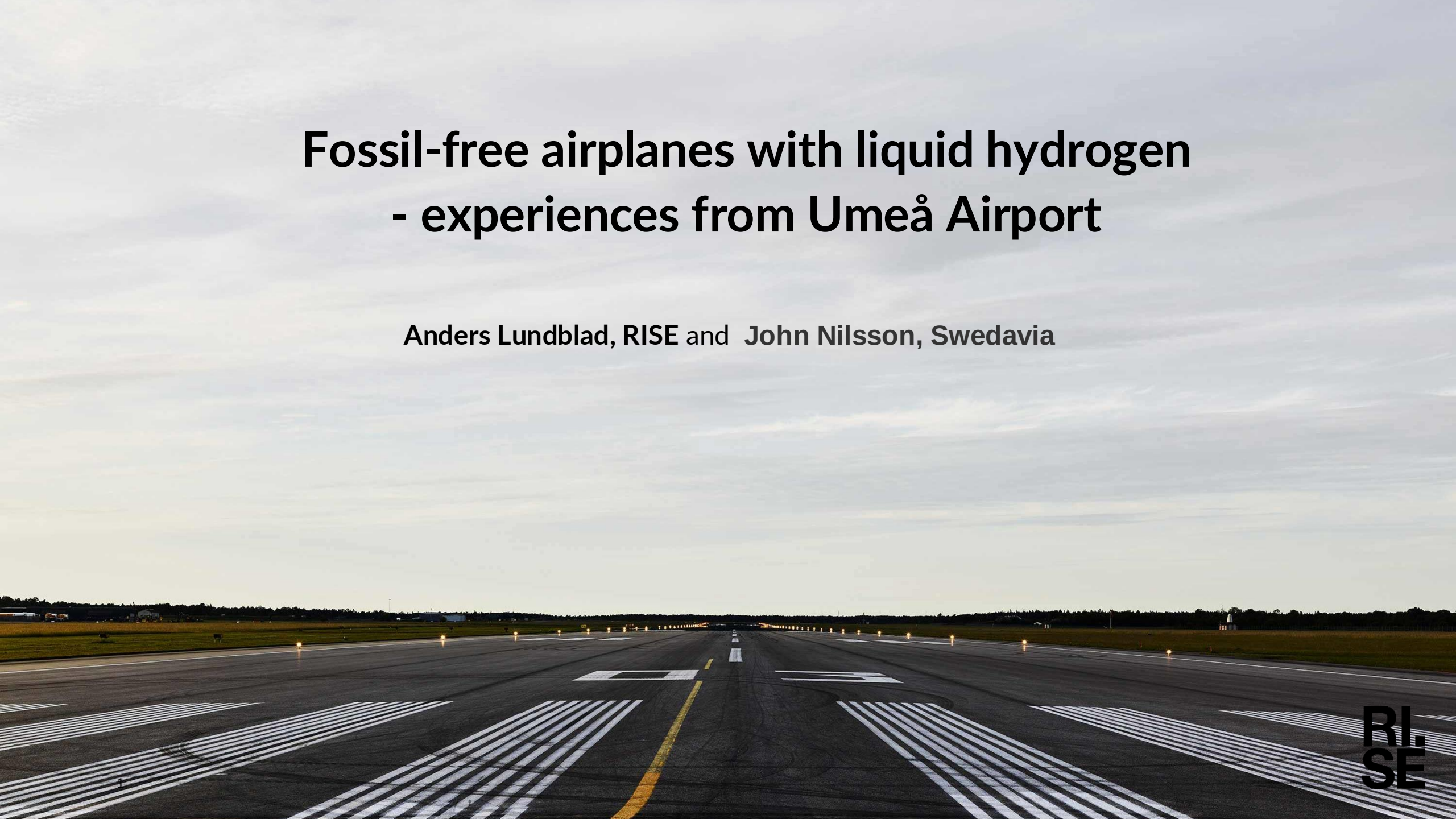


Outline

- Swedavia – its airports and fossil free mission
- The airport – a complex environment
- Previous and ongoing projects
- FLYH2UME – preparing for hydrogen aviation

Swedavia operates and develops ten airports in Sweden, from Kiruna in the north to Malmö in the south

Swedavia Airports

Mission

Swedavia’s mission is to own, operate and develop Sweden’s national basic infrastructure of airports.

Based on solid business principles, Swedavia shall help to achieve the transport policy goals adopted by the Swedish parliament. **Swedavia is a self-financed public company.**

Swedavia is a world leader – fossil-free in its own airport operations

Some of the most important measures

- All vehicles (about 800), both large and small, run on fossil-free fuel.
- All heating and cooling of buildings is fossil-free.
- We use green electricity.
- We use SAF for our own travels (200 ton SAF in 2023)

Since 2020, the airport operations that Swedavia runs under the company's own management at our 10 airports are totally fossil-free.

We were the first airport group in the world to achieve this goal!

Kiruna Airport

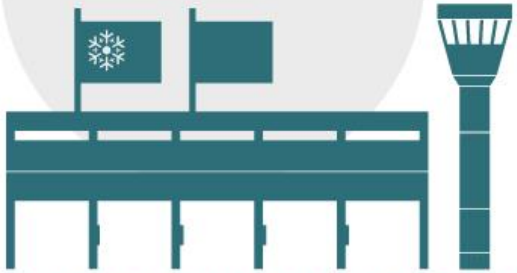
Hydrogen

Battery-driven electric aircraft

SAF (bio-jet/E-jet)

Goal, 2020

Swedavia's own airport operations became fossil-free.



Goal, 2025

Fossil-free airports – airport operations run by Swedavia's partners are also to be fossil-free.

5 per cent of all jet fuel used at Swedish airports is to be sustainable aviation fuel (SAF).

Goal, 2030

All domestic flights are to be fossil-free.

Transport to and from the airport is to be fossil-free.

Goal, 2040

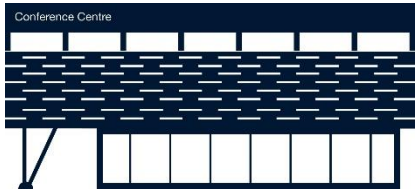
Net zero emissions from construction activities.

Goal, 2045

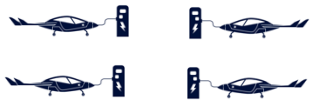
All international flights that take off from Swedish airports are to be fossil-free.

Swedavia Airports

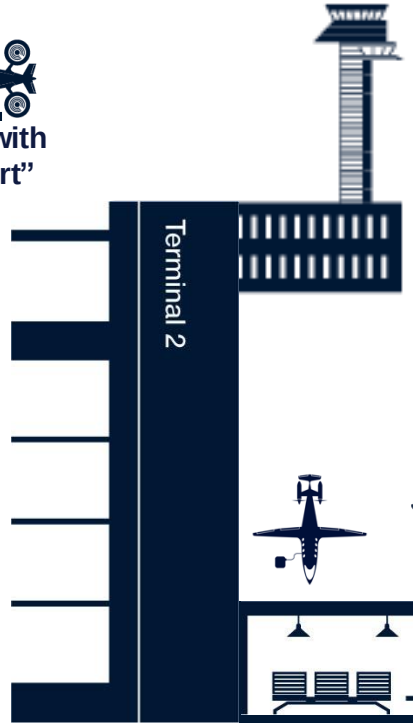
Conference and hotel



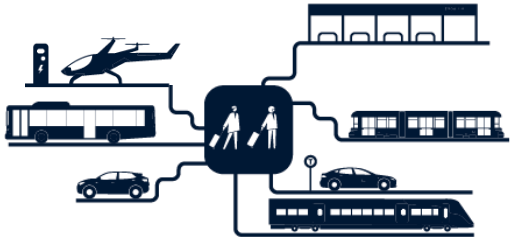
eVTOL with ”vertiport”



General Aviation



Multimodal transport point

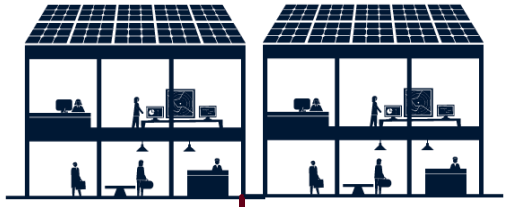


Refueling of SAF

Fast charging

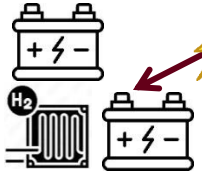
Liquid H_2 refueling

”Airport city”



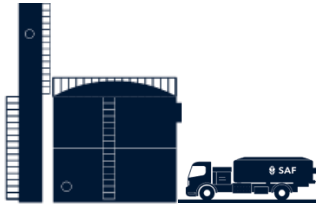
”Smart Grid”

Renewable electricity



Energy storage

Local production and Storage of H_2

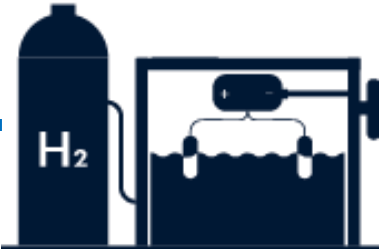


Storage of SAF (bio-jet and E-jet)

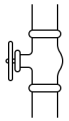
Imported SAF transported by ship

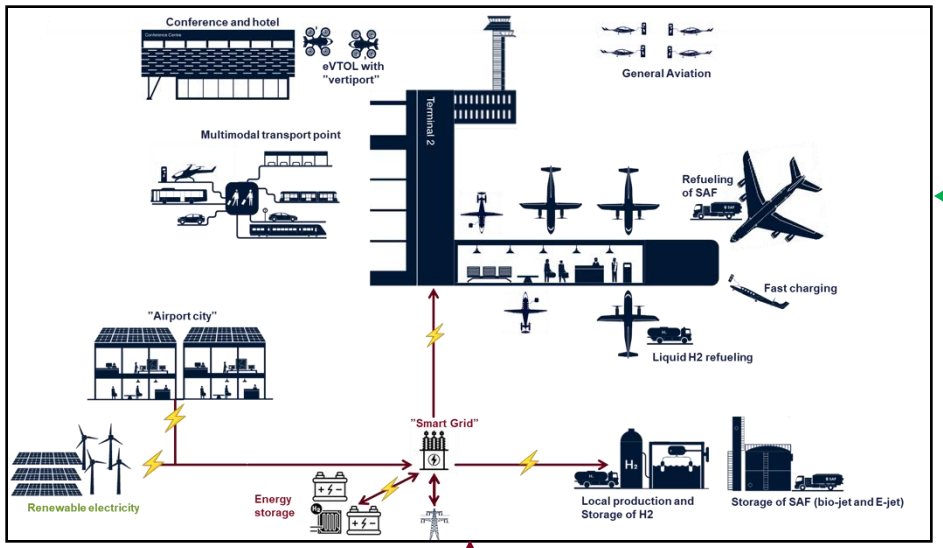
Trans-national H_2-pipeline

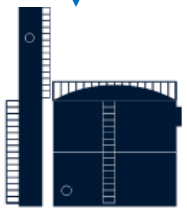
Imported H_2 transported by ship



Hydrogen production and liquification



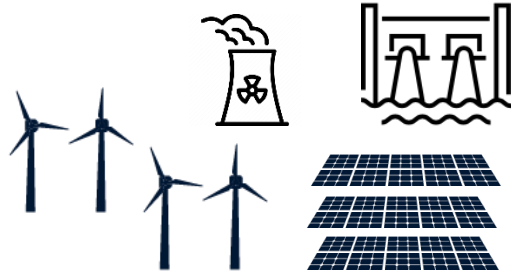




Biomass SAF and ”Power-to-Liquid” (eJet-A1)

Grid expansion and consolidation

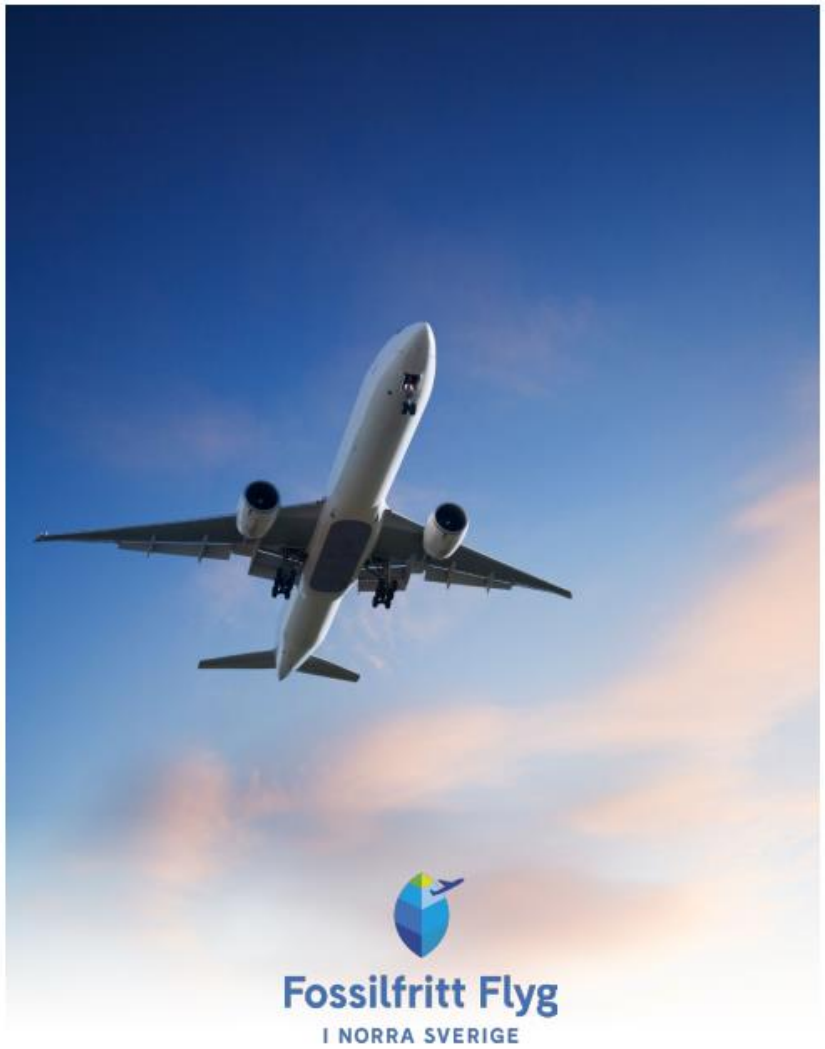
Grid expansion and consolidation



Sustainable and/or carbon neutral electricity

Some of Swedavia's involvement in hydrogen projects

Fossil Free Flying in Northern Sweden (2021-2023)



Feasibility for fossil free aviation in 2030 and 2045:

- Sustainable Aviation fuel, SAF (WP1)
- Electrified flying with batteries (WP2)
- Hydrogen (WP3)

Major findings of WP3 Hydrogen:

- Demonstrations of aviation with compressed hydrogen in 2023, but liquid hydrogen from 2035.
- Hydrogen produced locally or in the region requires large amounts of electricity power.
- Liquid hydrogen is best produced centrally in large quantities and distributed to the airport by truck or by ship.
- Aircraft refuelling by truck is best on small airports.

New project: FLYH2UME (2024-2026)

Preparing for the Introduction of Hydrogen Aviation by 2035

Umeå Municipality, Swedavia, RISE and Umeå Energy are preparing for establishment of scalable hydrogen facilities at airports and in particular Umeå (UME) airport.

Key results of the project will be:

- A comprehensive analysis of infrastructure requirements for Umeå Airport.
- Recommendations for handling liquid and gaseous hydrogen, focusing on safety and regulatory compliance.
- “Blueprint” of scalable hydrogen refuelling facilities at regional airports.

RI. SE

Swedavia Airports

UMEÅ KOMMUN

UMEÅ ENERGI

Energimyndigheten

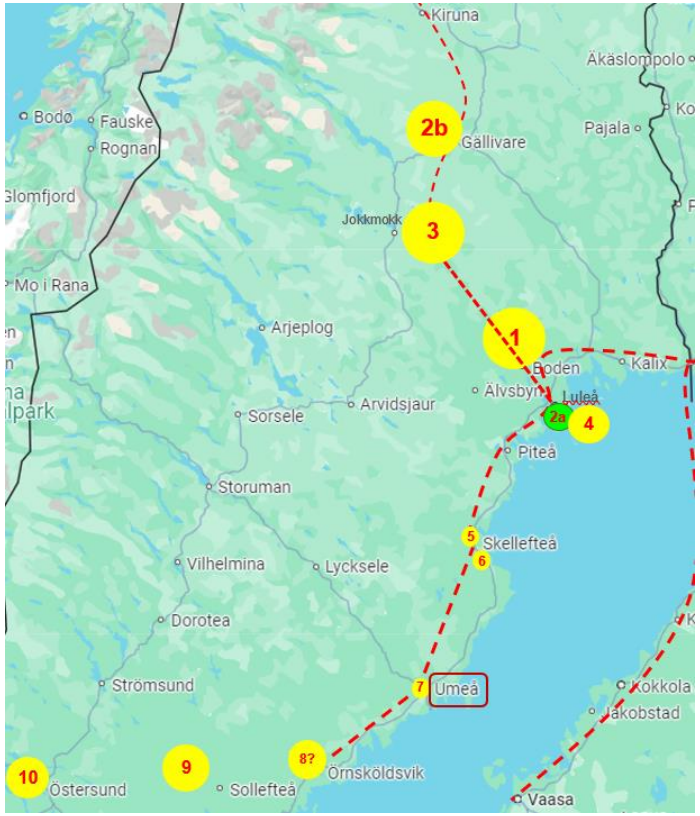
RI. SE

General plan for FLYH2UME

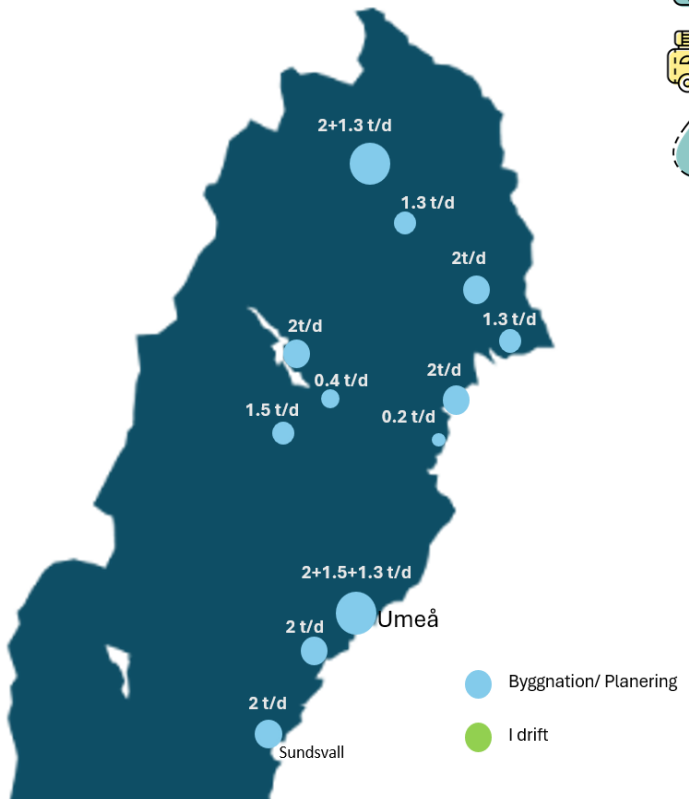
Description of activities	2024 Q1	2024 Q2	2024 Q3	2024 Q4	2025 Q1	2025 Q2	2025 Q3	2025 Q4	2026 Q1	2026 Q2	2026 Q3	2026 Q4
WP1 Production and logistics • General and local conditions for H2 • SoA review: liquid H2 production, distribution and storage • Technical challenges when increasing H2 volumes								Report				
WP2 Hydrogen market development • Regional • National/International								Report				
WP3a Hydrogen terminal – blue print • Define 3 development stages for H2 use at UME • Modelling of energy balance, dimensioning and techno-economical evaluation • Blue print for H2 facility at UME												Final Report
WP3b Hydrogen terminal – Safety • Regulations, safety and risks • Regulatory approval • Safety management & training												Final Public Conf.

Preliminary findings WP1 and WP2

- **GH2 production: electrolysis**



- **GH2 distribution: HRS**



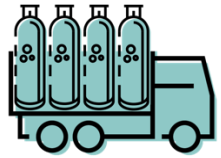
- **Production, compression, liquefaction**

Electrolysis: 50 -55 kWh/kg.

Compression: 3-6 kWh/kg.

Liquefaction: 10 -12 kWh/kg.

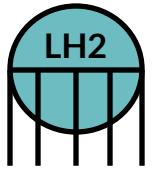
- **GH2 & LH2 transportation**



CH2 (350 b) =1 ton

LH2 = 4.5 ton

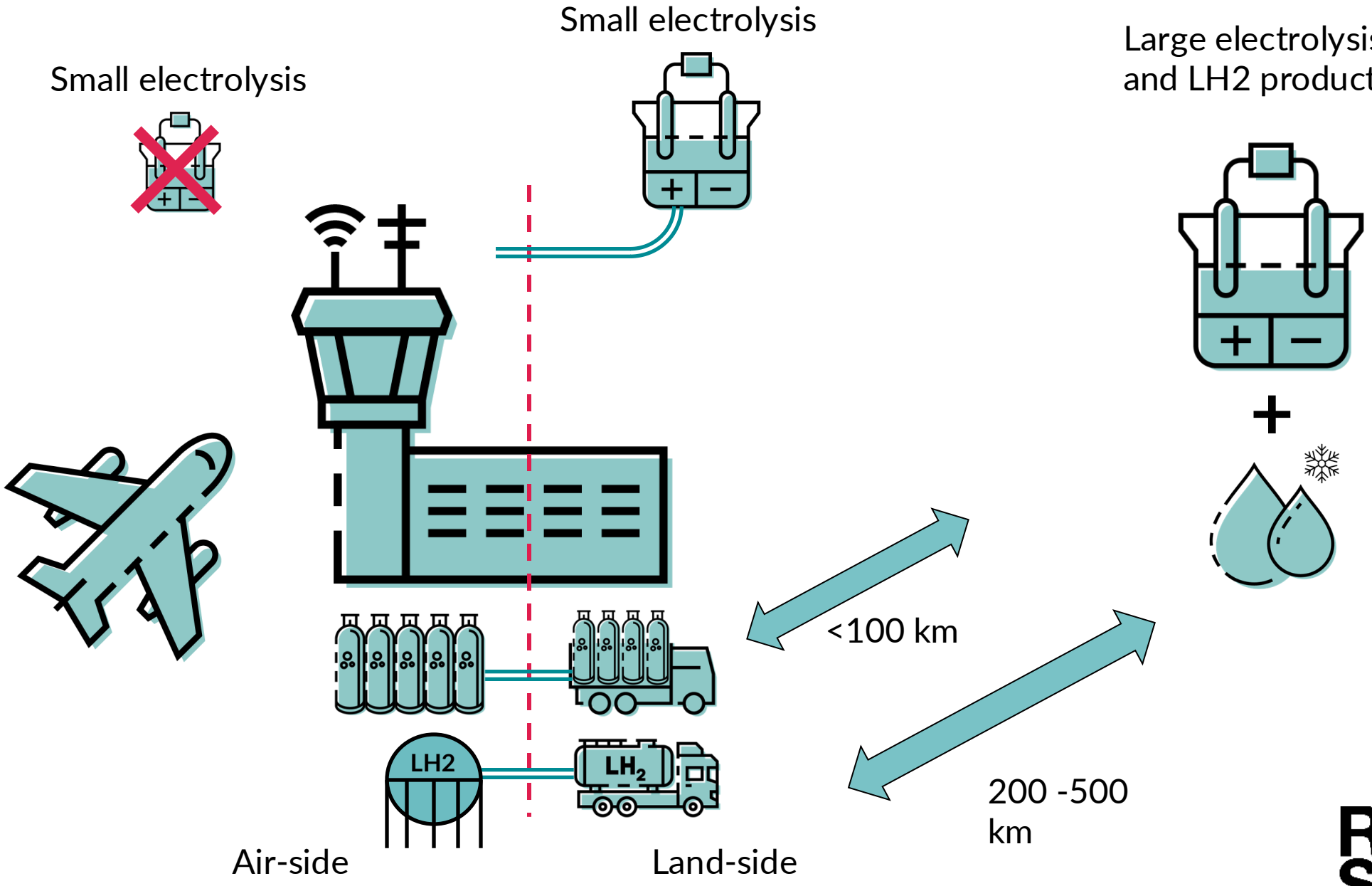
- **GH2 & LH2 storage**



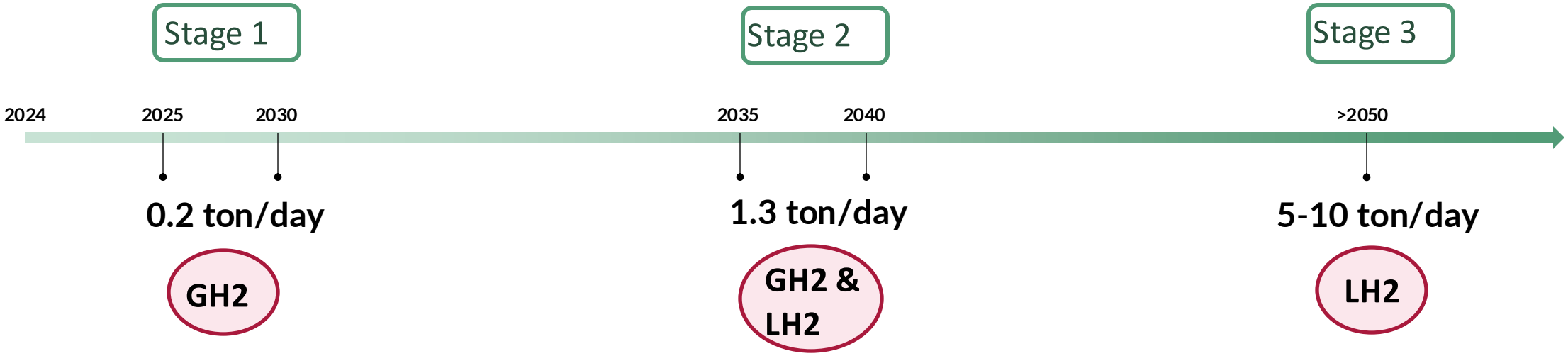
1-15 ton

5-50 ton

Production and distribution



Development stages WP 3a (prel.)



- Short-distance flights, small aircrafts (< 50 pax)
- Ground-handling equipment

DS1.1

GH2 production in Sweden (>100km)

GH2 long delivery to the airport by trailer

DS1.2

GH2 production near the airport (2-20km)

GH2 short delivery to the air-zone by trailer

- Early commercial flights, small & bigger aircrafts
- Ground-handling equipment

DS2.1

GH2 production in Sweden (>100km)

GH2 long delivery to the airport by trailer

DS2.2

GH2 production near the airport (2-20km)

GH2 short delivery to the air-zone by trailer

DS2.3

LH2 production in Sweden (>500km) or from abroad.

- Commercial use of hydrogen

DS3.1

Low penetration of LH2

DS3.2

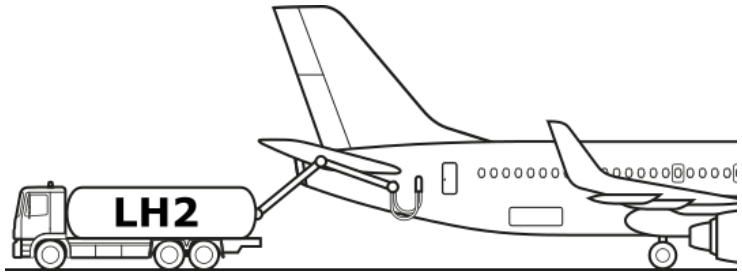
High penetration of LH2

Work Package 3b Safety

Includes:
- Landside & airside hydrogen infrastructure (WP 3a)
- Fuel transport to aircraft
- Aircraft refuelling
- Emergency response
- Ground handling

Excludes:
- Aircraft
- Aircraft flight operations

Airport



- **Regulatory Approval**
- **Safety Management & Training**

“Early” findings

- **There is a need for the aviation industry to prepare for a hydrogen future.**
- **FLYH2UME aims to facilitate future scalable hydrogen infrastructure at regional airports.**
- **Hydrogen at airports will require co-operation with other industries and stakeholders in the society.**
- **Practical introduction of hydrogen at airports will include small aircraft and ground handling operations.**
- **Due to limited quantities liquid hydrogen will be distributed by trailer to the airport .**

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”Fly lighter with hydrogen”

Thank you!

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