ANNUAL AUTUMN CONFERENCE
30th of November, 2023, Mannheim

GREENING AVIATION & AIRPORTS
THE REGIONAL PERSPECTIVE

organised by

STADTMANNHEIM²

ANNUAL AUTUMN CONFERENCE
30th of November, 2023, Mannheim
WELCOME TO MANNHEIM

Dr. Volker Proffen
Deputy Mayor
City of Mannheim
MANNHEIM
AS AN URBAN NODE

CONNECTED TO 6 NATIONAL HIGHWAYS

EUROPE’S SECOND BIGGEST RAILWAY YARD

CENTRAL RAIL NODE IN PASSENGER TRANSPORT: 658 TRAINS / 100,000 PAX PER DAY

EUROPE’S SECOND BIGGEST INLAND PORT

CONFLUENCE OF RIVERS RHINE & NECKAR

325,000 INHABITANTS CENTRE OF THE METROPOLITAN REGION

CITY-AIRPORT FOR BUSINESS JETS & SCHEDULED FLIGHTS

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CITY-AIRPORT FOR BUSINESS JETS & SCHEDULED FLIGHTS
MANNHEIM AS A CITY OF INNOVATION IN MOBILITY IN HISTORY

**CARL BENZ-MOTORCAR**
1885 – FIRST PRACTICAL MODERN AUTOMOBILE

**DANDY HORSE**
1817 – PREDECESSOR OF THE BICYCLE

**SCHÜTTE-LANZ AIRSHIPS**
1911-1919

**LANZ-BULLDOG**
1921 - FIRST OIL-POWERED TRACTOR

**OPEL-SANDER RAK.1**
1929 – FIRST ROCKETPLANE
MANNHEIM AS A CITY OF INNOVATION IN MOBILITY TODAY

DAIMLER BUSSSES E-CITARO

H2-FUELING & APPLICATION

CropEnergies SUPER E20-FUEL

rmv - RABus AUTONOMOUS SHUTTLE
AIR MOBILITY IN THE URBAN CONTEXT
Thank you for your attention!

Dr. Volker Proffen
Deputy Mayor
City of Mannheim
Department I – Finance, Investment Asset Management, IT and Public Safety
Rathaus E5, 68159 Mannheim
volker.proffen@mannheim.de
+49 621 293 9310
Rhine-Neckar Metropolitan Region

Progressive, committed and livable
Agenda
What to expect

Regional planning and development

• Who we are and what we do
• How we work (together)
• Our roles

11 European Metropolitan Regions in Germany
Rhine-Neckar Metropolitan Region

Home to 2.4 million people
Developing the region together
Joining forces in an alliance of strong partners

Our role: To position our region in the competitive locations market and to develop its economic, social and ecological assets in effective partnerships.

Forging alliances.
Being a driving force. Promoting the region. Supporting regional initiatives.
Strong Partners for Regional Development
Governance & financing of regional development

<table>
<thead>
<tr>
<th>Strategic level</th>
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<tr>
<td>Association assembly, local politics</td>
</tr>
<tr>
<td>Board Zukunft Metropolregion Rhein-Neckar e.V. office</td>
</tr>
<tr>
<td>Chambers of Crafts and Industry, Chambers of crafts</td>
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</table>

<table>
<thead>
<tr>
<th>Operational level</th>
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<tr>
<td>Verband Region Rhein-Neckar office</td>
</tr>
<tr>
<td>Metropolregion Rhein-Neckar GmbH</td>
</tr>
<tr>
<td>Zukunft Metropolregion Rhein-Neckar e.V. office</td>
</tr>
</tbody>
</table>

Shareholders

Sponsors

2023 Rhine-Neckar Metropolitan Region
Action areas for collaborative regional development

Future-oriented and pioneering

- Energy transition
- Mobility
- eGovernment
- Urban and open space development
- Cultural region
- European cooperation
- Labour market / professionals
- Health region
- Region of excellence in education
- Promoting innovation
- Civic engagement
Rhine-Neckar metropolitan region in Europe

Networked with strong partners across Europe
Rhine-Neckar – a location for business and innovation

Economic indicators

- GDP (2022): €79,000 per capita (Germany: €46,000 per capita)  
  Source: statista

- GVA (2020): €90 billion  
  Source: Statistisches Bundesamt (2022), own calculations

- Employees paying social security contributions (2022): around 980,000  
  Source: Bundesagentur für Arbeit

- Unemployment rate (as of January 2023): 5.2 % (Germany: 5.7 %)  
  Source: IHK Rhein-Neckar, Bundesagentur für Arbeit

- 150,000 businesses represented by Chambers of Commerce and Industry  
  Source: IHK (2022)

- Exports from manufacturing industry (2021)  
  Source: IHK-MRN, Statistisches Bundesamt
  - Rhine-Neckar Metropolitan Region: 63.4 %
  - CCI, Palatinate District (whole district): 66.0 %
  - CCI, Rhine-Neckar District: 60.2 %
  - CCI, Darmstadt District: 50.0 %
  - CCI, Rhinehessen District: 65.0 %
  - Germany: 48.4 %
Rhine-Neckar Metropolitan Region

Excellent accessibility

- Nine motorways
- High-speed passenger and freight hub
- Frankfurt Airport Mannheim City Airport
- Harbour Centre Mannheim / Ludwigshafen
Particularly due to its proximity to the largest Central European airport Frankfurt Main - MRN is well served by scheduled services.

“Aviation favour”

Flight offer

Through:
- Terminal 3 in Frankfurt
- NBS Rhine-Main - Rhine-Neckar brings FRA Frankfurt Main even closer to the MRN

Grafik: www.gc-map.com
Flugangebot, Stand: November 2014
Roles of the various air traffic locations to ensure the development of the MRN in air traffic

- **Frankfurt/Main**: Above-average scheduled air transport service
- **Worms**: Important for flight school operations and a small part of business aviation
- **Speyer**: IFR upgrade with the greatest potential benefit, business aviation
- **Mannheim City**: Ideal location within the MRN, mainly business jets
- **Stuttgart**: Scheduled air transport service

*Quelle: Regionalluftverkehr in der Metropolregion Rhein-Neckar, März 2015*
Thank you for your attention.

Thank you for being our guests today.

We wish you a successful conference and a pleasant stay in Mannheim.
A green Aviation: The EU and German perspectives – 
The Regional Perspective from Baden-Wuerttemberg

Dr. Monika Herrmann, 
Ministry of Transport Baden-Württemberg, 
Department 55 Aviation and Climate Neutral Fuels, Head of e-fuels 
ARC – Rhein Neckar Metropolitan Region Conference, 30th November 2023

Mobility and quality of life. 
In our cities and rural areas.
Outline

- Challenges
- Role and responsibility of the regional level
- Definition reFuels
- Roadmap reFuels for BW
- Projects and Activities
- The influence of regulation
- Demands on politics at EU and federal level
Challenges
Climate protection goals, CO2 reduction and the role of reFuels

- Climate neutrality goals: EU – 2050, Germany – 2045, Baden-Württemberg – 2040, ...
- The ambition is growing, the measures are not enough.
- Consistent and rapid implementation of existing options for action is required.
- Aviation is a major emitter of CO2.
- reFuels or Sustainable Aviation Fuels (SAF) can help or make unavoidable aviation more sustainable.
- So far, SAF are almost the only solution.
Challenges

How can aviation become climate neutral? What can regions do?

A strong statement for green aviation in the Coalition agreement BW:

“Start an initiative for more climate-friendly flying through innovations and sustainable aviation fuels. Conversion of Stuttgart Airport to STR Zero. Support for other airports and landing sites in pilot projects. Shifting more flight connections to rail.”

- Climate Protection Act BW and
- Climate Measures Register for the monitoring of measures.
Role and responsibility of the regional level for green aviation

- The Ministry of Transport is responsible for aviation, airports and climate-neutral fuels.
- Close links with other Ministries in the state and responsibilities within the Aerospace Strategy BW.
- BW is currently developing a State Mobility Law.
- This is also about the higher use of SAF.
  - So far on state level there is no legal basis.
STRzero: How can an airport become climate neutral?

- Destination STRzero: Stuttgart Airport aims to reduce its direct greenhouse gas emissions to net zero by 2040.
- Emissions in Scope 1 (direct emissions) and 2 (indirect e. from purchased energy) according to the Greenhouse Gas Protocol are expected to fall by 85% by 2030 compared to 1990.
- The handling fleet is planned to be climate-neutral from 2030.
- Strategy includes buildings, parking, handling, vehicles, apron, planes, etc.
Baden-Wuerttemberg started to work intensively on renewable energy fuels in 2017. The first steps were a project with the car industrie and KIT.
Definition of reFuels

reFuels – definition and areas of application

"reFuels = overarching term for fuels that are produced based on renewable energies, such as hydrogen, synthetically produced hydrocarbons, sustainable biofuels (advanced biofuels) within the meaning of the EU's RED II."

We need reFuels as a measure to achieve the sector goals in the transport sector.

- Areas of application include aviation (SAF), shipping, heavy goods traffic and parts of existing car fleets.
- They are important to ensure resilience.
- Use of SAF in Aviation has the highest impact due to additional non-CO2 effects.
- In the political discussion, the use of SAF in aviation is undisputed - in contrast to the use in cars.
- Therefore our team started an intensive cooperation with Stuttgart Airport for the discussion around SAF production.
Roadmap for reFuels for Baden-Württemberg
From one project to state strategy

BW is the only federal state with a reFuels roadmap:
- Main goal: initiate or ramp up production and increase the climate-friendly share in fuels.

Other goals:
- Research & Development
- Economic opportunities
- Workplaces and
- Country cooperations.

Three focus areas for action (demand, supply and policy framework).

Measures to SHAPE THE POLITICAL FRAMEWORK

Measures to increase the OFFER
Projects
SAF@STR - Technology Investigation

- Stuttgart Airport plans to use Sustainable Aviation Fuels (SAF).
- There are incentives for landing fees (EntgeltVO).
- Technology study with Stuttgart Airport and SkyNRG 2022.
- Advantages of SAF:
  - CO2 reduction,
  - better air quality,
  - higher energy density of the fuel and
  - less contrails (double CO2 effect!).
Stuttgart Airport is working with SkyNRG and Schwenk Zement to develop a **feasibility study for the production of PtL-Kerosene** at Schwenk in Mergelstetten.

- Synergies between CO2 capture and fuel production.
- The CO2 should be used in the power-to-liquid process for SAF at the site.
- At the moment this seems uneconomically unless EU regulations change.
One of our most interdisciplinary projects is Platform Innofuels:

- **KIT has applied for a joint research project** with the support of the ministries in BW and Hessen.
- The aims are networking, further development and framework conditions for the ramp-up of electricity-based fuels and advanced biofuels.
- The project started in March 2023 funded by the Federal Ministry of Transport.
- SAF is one of eight Innovation focal points.
- All federal states should be involved in the further process.
BW has started an **Aerospace Strategy in July**: 
- It combines excellent research and innovative companies.
- Around 42 million euros are available for the implementation of the strategy.
- reFuels are part of the strategy with SAF and the Hydrogen Aviation Center.
- In aviation future technologies are examined: study on potential of the future field of **urban air mobility** with electrically powered air taxis.
German PtL roadmap for Aviation:
- Electricity-based kerosene (power-to-liquid = PtL) is essential for climate-friendly flying.
- Politics and business have jointly agreed on specific requirements and measures that are necessary to establish and expand the production of PtL kerosene in the next few years.

PtL quota
A quota of two percent for PtL-Kerosene is anchored in the German Climate Protection Act (2030).
- 2 percent PtL Kerosene would correspond to up to 250,000 tons per year for Germany.
ReFuelEU Aviation has come into force:

- The aims are ambitious but urgently needed. But are they reachable?
- So far the PtL-production in Germany is on a research plant level.
- Details of the implementation at the airports still need to be clarified.
- BW would like to create incentives to deploy more SAF at airports than the EU-quota requires.

ReFuel-Demand BW:
- 2030: 0,60 Mio. t (min. 0,35 Mio. t)
- 2031: 0,60 Mio. t (min. 0,35 Mio. t)
- 2032: 1,02 Mio. t (min. 0,61 Mio. t)
- 2033: 1,03 Mio. t (min. 0,62 Mio. t)
- 2034: 1,04 Mio. t
Further EU regulations influence business cases for SAF and production facilities worldwide:

- **Delegated act on hydrogen** sets too strict criteria for production of H2, e.g. operating time, renewable energy production.
- **Delegated act for the calculation of greenhouse gas reduction**: Industrial CO2 from point sources is not allowed after 2040.

Conclusion: Production in Germany is too expensive due to regulation, lack of renewables and infrastructure, high construction prices and slow permits.

- Imports are necessary!
The illustration shows the required scaling up of production:

- Own production in Germany and BW is not economically - due to the delegated legal acts. Therefore, the import of green crude oil products would be better pursued than complete production at the BW location.
- BW is in discussions with producers to initiate the import of green methanol to BW and further processing into premium fuels.
- The importance of imports is increasing.
The EU regulation effects that plants in Baden-Württemberg cannot be operated economically.

Imports from countries without an efficient CO2 pricing mechanism are also not possible:

- EU regulations impose also stricter standards on production in these countries.
- CO2 from DAC or biogenic CO2 has to be used. In EU, CO2 from point sources is allowed till 2040.
- Clear regulation for imports is lacking.
- Consequences: Many announced plants will not be realized.
- Other regions of the world will buy the fuel.
- EU might come away empty-handed!
Demands on politics at EU and federal level
Conclusions, recommendations for action and political demands

- reFuels could make an important contribution to climate protection. There is a risk of delivery bottlenecks!

- Germany and Baden-Württemberg have a high level of **technical expertise** in research and plant engineering.

- So far only a few **research level production plants** for PtL-Kerosene are realized.

- **Innovation in SAF needs more speed** and above all **investment security for industrialization**.

- **International legal production certainty must be created immediately** for the import of green crude products.

- The unequal treatment of non-EU countries must end.

- Large production facilities are more likely to be built in sunny and windy locations (Southern Europe, South America, North Africa). For this purpose, country cooperation must be established.

- For hydrogen, transport issues need to be clarified promptly and **infrastructure expansion strategies** developed.

- **A Carbon Management Strategy** must be created to deal with CO2.
Thank you very much for your attention!

Ministry of Transport Baden-Wuerttemberg

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Transition scenarios for climate-neutral flight

Ram Kamath
Transition to climate-neutral flight

- Intro to Bauhaus Luftfahrt

- The Airline Decarbonisation Model

- Transition scenarios - ReFuelEU vs. Aspirational technology scenario
Bauhaus Luftfahrt - The Aviation Think Tank

Interdisciplinary research institution
- Founded in 2005 as independent research organization.
- Members:

Our Mission
- Identification of long-term options for sustainable and climate-neutral air transport
- Chart the future of aviation by combining a high level of technical expertise with a systems approach

30.11.2023
Conference on Greening Aviation & Airports: The Regional Perspective
A systems approach to climate-neutral flight

Transition Finance
- Input: KPIs, financing structures
- Outputs: Green-loan income in different scenarios, effect of different technologies

Production and Operations
- Input: Effect of Hydrogen aircraft on landing charges
- Outputs: effect of ReFelEU, costs of SAF subsidies

Think Tanks, consultancies, research centers
- Input: evolution of emerging technologies, demand evolution
- Outputs: fleet composition, airport charges, hydrogen consumption

Policymakers
- Input: policy action schedule
- Outputs: Green-loan income in different scenarios, effect of different technologies
The Airline Decarbonisation Model

Objective

- To explore possible transition-scenarios for aviation (from the airline perspective)
- Scenarios are described through the evolution of various metrics

A web-app

- Planned to be available for access through the BHL website
The Airline Decarbonisation Model

Capabilities

- Project transition scenarios from 2020 to 2075, for an airline with aircraft for the short-haul, medium-haul, and long-haul market segments

Fleet evolution

Decarbonisation

DOC evolution

- Expenses (Million $)

- Annual carbon emissions

- Annual RPK
The Airline Decarbonisation Model

**Capabilities**

- Design transition pathways by controlling the development of evolutionary and revolutionary technologies, SAF production, different policy-instruments, and macro-conditions

**Technological levers**

- Year of introduction of greener aircraft
- Cost of greener aircraft

**SAF**

- Supply evolution for different types of SAF
- Price evolution for different types of SAF

**Macro-Economic conditions**

- Demand growth
- Evolution of kerosene prices, hydrogen prices
- Carbon offsetting cost
Comparing scenarios - ATS vs. ReFuelEU

- Describe ReFuelEU

- Compare two scenarios: ReFuelEU & Aspirational technology scenario (ATS)

Description + Comparison on the basis of

- Decarbonising year, cumulative emissions

- Number of Hydrogen aircraft >> airport charges

- Hydrogen consumption >> revenue from storage and refueling
Before we go to the scenarios...

- Scenario-projections are for the European aviation system

- We are at the refining stage (e.g. for improving quality of assumptions and inputs) – results are preliminary

- We welcome any collaboration, suggestions, inputs that can help with the refining process
  - ram.kamath@bauhaus-luftfahrt.net
## Scenario narratives

<table>
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<th>Characteristic</th>
<th>ReFuelEU SAF Quota scenario</th>
<th>Aspirational Technology</th>
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</thead>
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<tr>
<td>Introduction of greener aircraft</td>
<td>Slow</td>
<td>Aggressive</td>
</tr>
<tr>
<td>Efficiency jump of evolutionary aircraft, first gen to third gen</td>
<td>10% &gt;&gt; 30%</td>
<td>30% &gt;&gt; 50%</td>
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<tr>
<td>Introduction of Hydrogen Aircraft</td>
<td>2050</td>
<td>2038</td>
</tr>
<tr>
<td>SAF quotas</td>
<td>ReFuelEU schedule</td>
<td>No SAF quotas</td>
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</table>
Scenario narratives

ReFuelEU SAF Quota scenario

<table>
<thead>
<tr>
<th>Aircraft/Route</th>
<th>Short-haul</th>
<th>Medium-haul</th>
<th>Long-haul</th>
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<tbody>
<tr>
<td>Evolutionary</td>
<td>2038</td>
<td>2048</td>
<td>2058</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>2050</td>
<td>2060</td>
<td>2070</td>
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</table>

Aspirational Tech Scenario

<table>
<thead>
<tr>
<th>Aircraft/Route</th>
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<th>Medium-haul</th>
<th>Long-haul</th>
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<td>Evolutionary</td>
<td>2030</td>
<td>2035</td>
<td>2040</td>
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<tr>
<td>Hydrogen</td>
<td>2038</td>
<td>2043</td>
<td>2048</td>
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</table>
## Scenario narratives

### ReFuelEU SAF Quota scenario

<table>
<thead>
<tr>
<th>Year</th>
<th>Overall SAF quota</th>
<th>1st gen share of quota</th>
<th>2nd gen share of quota</th>
<th>PS-PTL share of quota</th>
<th>DAC-PTL share of quota</th>
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<tbody>
<tr>
<td>2030</td>
<td>6%</td>
<td>65 %</td>
<td>15 %</td>
<td>19 %</td>
<td>1 %</td>
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<tr>
<td>2035</td>
<td>20%</td>
<td>55 %</td>
<td>20 %</td>
<td>21 %</td>
<td>4 %</td>
</tr>
<tr>
<td>2040</td>
<td>34 %</td>
<td>45 %</td>
<td>25 %</td>
<td>18 %</td>
<td>12 %</td>
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<tr>
<td>2045</td>
<td>42 %</td>
<td>30 %</td>
<td>30 %</td>
<td>17 %</td>
<td>23 %</td>
</tr>
<tr>
<td>2050</td>
<td>70 %</td>
<td>17 %</td>
<td>33 %</td>
<td>16 %</td>
<td>34 %</td>
</tr>
<tr>
<td>2070</td>
<td>100 %</td>
<td>11 %</td>
<td>29 %</td>
<td>15 %</td>
<td>45 %</td>
</tr>
</tbody>
</table>
ReFuelEU – Number of hydrogen aircraft

- 122 aircraft in 2050 (1% of fleet)
- 6300 aircraft in 2065 (31% of fleet)
- 16000 aircraft in 2065 (58% of fleet)
Assumption - landing fees component will jump by 30% (expert input) when hydrogen aircraft are introduced (in 2050). **Increment applied to all aircraft.**

- Airport charges: 29 Billion $ in 2049, 72 Billion $ in 2075
ReFuelEU - Hydrogen fuel consumption & Share of block energy

- 0.07 Mt in 2050, 0.07% of block energy
- 11 Mt in 2065, 19% of block energy
- 41 Mt in 2075, 52% of block energy
ReFuelEU - Annual hydrogen storage and refueling revenue

![Graph showing annual hydrogen storage and refueling revenue from 2050 to 2075.]

- **Truck refueling**
  - S&R revenue 2065: 1700 Million $
  - S&R revenue 2075: 6450 Million $
  - 2075: 7000 Million $

- **Pipeline refueling**
  - S&R revenue 2065: 1800 Million $
  - S&R revenue 2075: 6950 Million $
  - 2075: 7500 Million $

**Legend:**
- Blue: Truck refueling
- Orange: Pipeline refueling
ReFuelEU - storage and refueling revenue, truck vs pipeline delta

- 2050 ≈ 4 Million $
- 2065 ≈ 100 Million $
- 2075 ≈ 400 Million $

Graph showing the comparison of truck vs pipeline revenue from 2050 to 2075.
Comparing ATS & ReFuelEU - Annual carbon emissions

<table>
<thead>
<tr>
<th>Year of Decarbonisation</th>
<th>ATS</th>
<th>ReFuelEU</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2061</td>
<td>2070</td>
</tr>
<tr>
<td>Cumulative emissions</td>
<td>5800</td>
<td>7300</td>
</tr>
</tbody>
</table>
Comparing ATS & ReFuelEU - Number of Hydrogen aircraft

2059: ATS - ReFuelEU delta = 9000

2075: ATS - ReFuelEU delta = 6500
Comparing ATS & ReFuelEU - Airport charges

- ReFuelEU: Airport charges/Aircraft: 2.25 > 2.61 Million $ from 2050
- ATS: Airport charges/Aircraft: 2.25 > 2.61 Million $ from 2038
Comparing ATS & ReFuelEU - Hydrogen fuel consumption

2069: ATS - ReFuelEU delta = 25 Mt

2075: ATS - ReFuelEU delta = 9 Mt
Comparing ATS & ReFuelEU - Storage and refueling revenue pipeline

<table>
<thead>
<tr>
<th></th>
<th>Pipeline</th>
<th>Truck</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATS - ReFuelEU delta 2069</td>
<td>4000 Million $</td>
<td>4300 Million $</td>
</tr>
<tr>
<td>ATS - ReFuelEU delta 2075</td>
<td>1600 Million $</td>
<td>1700 Million $</td>
</tr>
</tbody>
</table>

2070: Long-haul Hydrogen Aircraft ReFuelEU
Comparing ATS & ReFuelEU - Conclusions

- ATS is more sustainable - faster decarbonisation, with lower cumulative emissions
- ATS also seems to bring in more revenue from hydrogen storage and refueling, airport charges

How can airports help in achieving the ATS scenario?
- Ramp up investments in infrastructure required for storing and distributing hydrogen
- More efficient aircraft will possibly have to larger wingspans) are key → ramp up investments in infrastructure to support these aircraft
- Airport charges are linked to take-off weight (also in the model) → can it be linked to emissions (lower emissions mean lower airport charges)?
Please participate in our Interview on the Feasibility of Regional Air Mobility at Your Airport

Thank you!
This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 957824

ALIGHT

CPH: a Lighthouse for the introduction of sustainable aviation solutions for the future

Dr. Benedict Enderle
DLR Institute of Combustion Technology
The ALIGHT approach

demonstrate

validate

replicate
This project has received funding from the European Union’s Horizon 2020 research and innovation program under grant agreement No 957824

Partners

Airports – Technology providers – Knowledge institutions
Airports

CPH, Copenhagen 30.3 Mio PAX

FCO, Rome 49.4 Mio PAX

VNO, Vilnius 6.5 Mio PAX

CPK, Warsaw greenfield
This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 957824.

Workstreams

Smart use of SAF

Smart use of energy
Smart use of SAF

- Foster the uptake of SAF
- Digital platform for SAF
- Field performance monitoring: SAF and local air quality
- SAF and non-CO₂ emissions
- SAF usage scenarios and cost-benefit analysis
- Aircraft stand of the future
Smart use of energy

- Vehicle charging infrastructure
- Greening of GSE
- V2G integration
- Smart energy management: real time AI powered energy control system
- Integration into the energy community
Demo: SAF and local air quality

- 3 week SAF measurement campaign at CPH
- HEFA SAF blend supplied at ARN
- **34% SAF blend** flying ARN – CPH (SAS A320N)
- 30 flights with Jet A-1, 84 with SAF blend
- Involved 6 out of 17 partners

- Focus on local air quality
Demo: SAF and local air quality
Demo: SAF and local air quality

- Complex data analysis
- Reduction of both total and non-volatile particle number using SAF
- A clear reduction in soot emissions in the order of about 30 percent
Demo: BESS for smart energy system

- Optimize CO2 footprint from electricity, costs of electricity, self-consumption from PV
- Deliver ancillary services to support the grid and reduce return of investment
- AI-powered energy consumption forecasting
- Battery electric storage system
Demo: BESS

- BESS with 1200kWh to be installed in Maglebylille service area
- Development of safety protocols
- Water filling test performed to reduce development of smoke from a potential battery fire.
- Each rack has a standard fire hose connector
Outlook

- reFuelEU aviation – implications?
- Bold Vision 2050 workshop
- Demonstration of the smart energy system
- Further SAF measurement campaigns
- ... ➔ Stay tuned!

https://www.linkedin.com/company/alight-aviation/
Thank you for your attention

https://www.linkedin.com/company/alight-aviation/
About

Marcus Weber Dipl. Des.(FH)

Green Aviation Hub UG (haftungsbeschränkt)
Member of the Management Board
Public Relations and Corporate Communications

**Profession**  Managing Director of a Creative Agency in Mannheim/Berlin
**Aviation**   PPL(A) since 2005, Board Member of Flying Club in Mannheim
The Green Aviation Hub UG

- Former workgroup (estd. 2019) of a traditional Flight-Club in Mannheim
  Goal: Sustainable Aviation through optimization, innovation, compensation

- Achievements to date
  - Reduction of CO₂ emissions by approx. 47%
  - 30% reduction of noise generated during operation
  - Compensation of yet unavoidable emissions

- Difficulties in approaching big/interntl. companies and institutions

⇒ Foundation of the Green Aviation Hub UG (haftungsbeschränkt)
GAH | Products and Services

Aircraft Sales & Leasing (certif.)

Photovoltaic & energy storage solutions

Airport Infrastructure and e-Charging systems

Pilot Training

CAMO Maintenance Part-145 Insurance

Green Aviation Consulting

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Installation and test operation of an electric flight and charging network in the Rhine-Neckar metropolitan region
Core objectives of the project:

1. Examination of possible areas of operation for an electric aircraft for flight-schools and flying clubs

2. Establishment of charging points at cooperating airports within operational range of the acft

3. Proof of the usefulness and importance of an airfield network for the establishment and development of electrified aviation
GAH | Pilot project 2023

1 x Velis Electro (VSW 128)  
3 x Chargers (Pipistrel)  
3 x Airports (MRN)
The Rhine-Neckar Metropolitan Region – one of many regions ideal for a charging network for electrified aviation!

In the operating area of Velis Electro*, there are over 25 potential network airports within a radius of approx. 50 NM!

*Without consideration of the wind
GAH | Pilot project 2023

City Airport Mannheim (EDFM)
Installed Charging Point

- Parking position aircraft
- E-charging station
- Electricity via photovoltaic system
GAH | Pilot project 2023

Charging Point 1: City Airport Mannheim (EDFM)
Charging Point 2: Speyer Airport (EDRY)
Charging Point 3: Worms Airfield (EDFV)
GAH | Pilot project 2023

Pipistrel Velis Electro over the Rhine-Neckar Metropolitan Region (MRN)
Pilot Training Briefings, Difference and Flight Training
Facts & Figures:

- **over 60 Missions flown** in the M-R-N
- **Velis Electro:** +32 flight-hours and more than 120 landings
- **Longest flights***
  - Mannheim < > Schweighofen (48 min/66 NM)
  - Speyer – Mosbach – Speyer (48 min/54 NM)

* without landing, due to lack of charging points at destination
Proof of Concept

- The range of the aircraft proves to be completely sufficient for the intended use (Flight times between 20 and 40 minutes)
- No direct CO2 emissions during flight operations
- Significantly perceptible noise reduction for local residents
- Energy price per hour (True Air Time) according to electricity meter: 11.87 Euros*

*Assuming a price of 0.48 €/kWh

Project was awarded an Innovation Prize!

From 2024, a Pipistrel Velis Electro will be permanently stationed in Mannheim and operate in the Rhine-Neckar metropolitan region's airfield network
A blooming idea...

With each new network partner, a new 50 NM radius is created, expanding the region's operational area for electric aircraft!
The Chicken-and-Egg Problem

Airfields and Local Authorities
"If there is an electric aircraft at our site or in the surrounding area, we are happy to provide charging infrastructure."

Flying Clubs & Flight Schools
"If there is charging infrastructure at our site or in the surrounding area, we are prepared to invest in an electric aircraft."
Standardization
Proprietary systems

- High acquisition costs due to small circulation
- No other aircraft/vehicles can be connected
- Limited output power & voltage
Standardization

Automotive standard

- Lower costs due to high quantities
- All standardized vehicles and aircraft can be charged at one station
Standardization

**ABB Terra Mobil 54HV**
- **Power:** 50 kW
- **Charging time:** approx. 1/2 hour to full
- **AC connected load:** 400 V, 78 A, 54 kVA
- **DC output power:** 200 - 920 V, 19 - 50 kW, max. 125 A
- **CCS2 connection**

*Currently subsidized in Germany with up to €14,000!*

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Innovation & Investment
Innovation & Investment
Battery Storage

- 20ft Container
- Capacity 1mWh
- KI integrated
Airport Solution

**ABB Wall/column charging point for vehicle and aircraft**

- Up to 4 charging points simultaneously, total 200 kW
- Mix of wall/column/field charging point possible (max. 4)
- AC connected load: 400 V 315 A, 218 kVA
- DC output power per charging point: 150 - 920 V, 19 - 50 kW, max. 125 A
- CCS2 connection
- Compliant with calibration law (optional)
GAH-Concept
Apron Charging Point

- Underfloor, suitable for apron, load class D400
- DC output power: 150 - 920 V, 19 - 50 kW
- CCS2 connection, 3.5 m
Innovation & Investment
Summary

Set the right course...

if possible, generate the energy you need independently and use it autonomously for the needs of your infrastructure.

Prepare yourself for future technologies such as H$_2$ production using electrolysers and create sustainable arguments for climate-friendly aviation in your communication, but also for your municipality and political representatives.
Create incentives...

For the users of your airport infrastructure!

**Best practice:** The cooperation partners Mannheim and Speyer of our pilot project have stipulated the free landing of electrified aircraft in their 2024 landing fee regulations and are also considering free charging power.
Exchange ideas...

Use forums such as this conference, agree on joint measures and standards and thus steer the developments of the respective providers towards a broad and marketable consensus!

Talk to us, we will be happy to support you with our know-how!
clear skies

Thank you for your attention!

www.greenaviationhub.com
3541 Airports in Europe

100th airport in 2022, Billund, 3,7 Mpax
Fixed costs business
with a few profitable (but remarkable) cases
Energy costs
The issue of financing regional airports

COMMUNICATION FROM THE COMMISSION

extending the transitional period provided for in the Guidelines on State aid to airports and airlines concerning regional airports

Brussels, 7.7.2023
C(2023) 4494 final
Lleida-Alguaire airport – strategy

2010  now  2030
Lleida-Alguaire airport - layout
Lleida-Alguaire airport
Lleida-Alguaire airport
Lleida-Alguaire airport – key data

**Airport data and services**

- ILD/LEDA 4C
- Runway 31/13: 2.500x61m
- Apron: 36.100m²
- RWY center line lighting
- Airport elevation: 1,152ft/351m
- Fire category: HR AD: CAT 5/7
- Fueling: HR ATS (JetA-1/AVGAS 100LL)
- Handling: HRATS
- Security: H24
- Restaurant and bar
- Free parking
- Free wifi
- Business center
Lleida airport as a H2 energy lab

...delivering H2 powered solutions for air mobility & airport operations

...using H2 as a fuel for aviation and airport ground operations

- H2 as a fuel for mobility
- R+D
Scaling up – Stage 1 – aeroH2ub

Key data
• Production of green H2 from existing solar plant.
• 0,3 MWh solar plant.
• 100kwh – 200kwh Hydrolyser.
• Hydrogen station.
• H2 Retrofitting of handling equipment and airport ground vehicles.
• H2 powered logistics drone.
• Ground vehicles and handling equipment testing bench.
• Drone testing bench.
• Test bench and labs developed by technological institutes.

Budget
• Total: 3,2 MEUR.
• Nextgen financing: 1,8 MEUR.

Calendar
• Start of the project: May 2023.
• Start of H2 production: July 2024.
Lleida airport: autonomous energy airport

...combining solar and H2 energies

...using H2 fuel cells
Key data
• New 2,5 MWh solar plant.
• 1,0 – 1,2 MWh Hydrolyser.
• 400 kwh – 500 kwh fuel cell
• H2 powered logistics drone.

Budget
• Total: 3,7 MEUR.

Calendar
• Start of the project: Sept 2023.
• Start of H2 production: Nov 2024.
Catalyst of green energy industries
Availability of land with low aeronautical value
Renewable Energies

Decarbonizing airport management
Improving regional airports P&L
Building synergies between regions and airports
Hydrogen Valley in Košice Region

Department of Regional Development, Košice Self-governing Region, Slovakia
Košice Self-governing Region
Technology  Innovation  Environment
Hydrogen activities in Košice Self-governing Region
Innovation center of Košice Region

Regional Innovation Strategy of Košice Self-governing Region

The first hydrogen strategy in Slovakia
02 Hydrogen activities in Košice Self-governing Region

- Faculty of Aeronautics
- Faculty of Materials, Metallurgy and Recycling
- Faculty of Mining, Ecology, Process Control and Geotechnologies
- Moravian-Silesian Region
Considering the need for decarbonization, the goal of the Self-governing Region is to deploy more than 80 hydrogen buses. Therefore, there is a need to produce green hydrogen at a stable price and the need to build a sustainable hydrogen infrastructure.

Hydrogen consumption in the transport sector:

➔ City buses: 10 pcs.; 20 pcs (Valaliky Industrial Park- Volvo, Košice, Michalovce)
➔ Suburban buses: 70 pcs.; 130 pcs (Košice, Michalovce)
➔ Trucks, last-mile heavy-duty transport, regional supply: 50; 100 pcs
➔ Forklifts: 20; 80 pcs

➔ Forklifts: 20; 80 pcs
➔ Communal equipment (garbage trucks): 2; 6 pcs
➔ Regional FC trains: 2; 6 pcs
➔ Cruise ship: 1 small, 1 larger

KSR create new company focusing mostly on deployment of H2 buses: Autobusová doprava KSK, s. r. o.

Total hydrogen consumption in transport is estimated at 1 000 t H2 by 2027 and between 2 000 and 3 000 t H2 in 2030
Pilot projects using Hydrogen technology – Mobility
Emission-free public transport

Attractive long distance equipment for citizens and tourists

Future hydrogen powered boats
Hydrogen powered bicycles

- Electrical motor
  BROSE 36V

- Motor power
  ELECTRICAL ASSISTANCE UP TO 250 W

- Top speed
  ELECTRICAL ASSISTANCE UP TO 25 KM/H

- Fuel cell technology
  150 W PEM FUEL CELL

- Bridging energy
  150 WH LI-ION BATTERIES

- H2 storage
  2 L COMPRESSED H2 GAS CYLINDER
Hydrogen Aviation Valley in the Košice Self-governing Region
Cooperation with Aeronautic Faculty of TUKE, with Tomark.s.r.o. and Letisko Košice – Airport Košice, a.s.

KSR together with Faculty Of Aeronautics (TUKE) are currently preparing a conceptual study of a strategic plan for the development of suburban air mobility, regional air transport and the integration of unmanned aerial systems (UAS) in KSR.
Clean Hydrogen Partnership
KSR received Project Development assistance (PDA)

Member of the European Hydrogen Valleys S3 partnership

KSR received Synergies with the Clean Hydrogen Partnership
Cooperation and good partnership as a key of success
06 Cooperation and good partnership as a key of success
Thank you for your attention
FUTURE FUELS READINESS: PREPARING INFRASTRUCTURE ACROSS AIRPORTS AND THEIR COMMUNITIES

30 NOVEMBER 2023
O U R  B U S I N E S S  A N D  G L O B A L  R E A C H

CONSULT

Business case and strategy development
Cost management
Commercial and procurement management
Portfolio, programme and project management
PMO services
Digital delivery and design
Security advice and management

CONSTRUCT

Contracting
Construction management
Fit out
Delivery
DfMA and MMC strategy and delivery

CONSULT

Business case and strategy development
Cost management
Commercial and procurement management
Portfolio, programme and project management
PMO services
Digital delivery and design
Security advice and management

292
294
5,263

Americas

Headcount

UK

Mainland Europe

Headcount

Asiа Pacific

Headcount

5,263
294
771

Total headcount

4 MOBILITY SECTORS

HIGHWAYS | AVIATION | RAIL | PORTS

LND

NYC

LIM

DXB

NRB

JHB

HKG

SYD

Total headcount

7,665
AIRPORTS: AT THE HEART OF DECARBONISATION

HEAT
- District Heat Network
- On-Site Heat Centre
- Local Industry & Residential Heat Consumers
- Terminal Building & Electric Vehicle Charging
- Microgrids & Private Wire
- Renewable Energy Generation

H₂ FUEL SWITCH
- On-Site Electrolysis & Liquefaction
- Storage
- Pipeline
- Local Industry
- H₂ Aircraft
- Airport Shuttles & Vehicles

ELECTRIFICATION

DECARBONISED AIRPORT

FUTURE CONSIDERATIONS
- Car Parking Canopies
- Drone Deliveries
- Autonomous Vehicle Fleet
- Circular Economy Hub
- FUTURE FUELS READINESS
**FUEL TRANSITION PLANNING PRESENTS THE MOST IMPORTANT CHALLENGE TO AVIATION TODAY**

Aviation is expected to become one of the highest carbon-emitting sectors by 2050, particularly if demand for flying continues to grow. To address this, both the US government and governments abroad are supporting airports in the fuel transition.

### 3 Drivers of Change

- **Aviation Fuel Transition**
  - **Emerging Legislation**: EU, EEA and UK airports must meet mandates to provide sustainable aviation fuel (SAF) by 2025 and ramp up supplies to 2050.
  - **Government Incentives**: EIB’s low carbon airport infrastructure investments, Horizon Europe grants, plus grants / tax breaks in the UK and US will grow supply and reduce prices.
  - **Technological Advances**: Advances in technology will make SAF more affordable and competitive over the next few years, boosting demand further.

### 4 Future Fuels – not one, but all

- **Biofuel SAF**: Drop-in fuel made from waste and fuel crops-based feedstocks.
- **Synthetic SAF**: Drop-in fuel made by synthesising hydrogen and captured carbon.
- **Hydrogen**: Propulsion by hydrogen combustion / hydrogen fuel-powered electric drive train.
- **Electricity**: Fully-electric / hybrid aircraft powered by on-board batteries with plug-in charging.
OUR FUTURE FUELS READINESS SOLUTION IS PROVEN TO PREPARE AIRPORTS FOR THE FUEL TRANSITION

Outcome: 4 infrastructure investment decisions

- LH2 storage and liquefaction: <64,000m² footprint estimated
- Electric network expansion:
  - 2.6x by 2030
  - 12x by 2050
- SAF blending facility: Area for leasing to fuel suppliers, if commercially feasible
- Hydrogen transport:
  - 1-12 cryogenic semitrailers per day; pipeline likely needed by 2045

Benefits: findings shared with 4 groups

- National government & multilateral bodies
  - National-level transport decarbonisation plans
  - Multilateral funding applications
- Local government
  - Municipal masterplan to crosscheck spatial requirements, grow local fuel supply base and electric grid capacity
- Electricity companies
  - Inform plans for new power plants through aggregating aircraft energy demands
  - Plans for transmission/distribution network expansion
- Airlines
  - Validate demand against fleet replacement plans
  - Shared implementation roadmap to build confidence in airport’s ability to fuel future fleets

SAF blending facility:

Electric network expansion:

Hydrogen transport:

LH2 storage and liquefaction:
Overview:

Working with Edinburgh Airport, we developed detailed plans to capitalise on its energy potential, including supplying heat to local residents. We defined investment opportunities and mapped the most suitable technologies for our Client.

Methodology:

- **Feasibility Study**: Assessing readiness, high-level funding streams and opportunities for collaboration.
- **Options Analysis**: Reviewing available technologies and supply chain against the characteristics of the airport.
- **Financial Modelling**: Assessing our best option, based on criteria including NPV, IRR and Payback Periods.
- **5 Case Business Model**: Defining the Strategic, Economic, Financial, Commercial and Management Cases to unlock future investment.
Energy transition planning projects can bring 4 key benefits to airports and hosting regions:

**Accelerating Net Zero goals:** Tackling local emissions, making airport regions front-runners in an economically viable green transition.

**Robust case for external funding:** Supporting applications for national, EU and multilateral funding – incl. EIB green airport grants.

**Start budgeting for change:** Building cost estimates for decarbonisation infrastructure for airports and their regions; shaping local supply chains, e.g. ‘hydrogen valley’ groups.

**Resilient infrastructure planning:** Identifying key investment decisions for infrastructure to produce, transport and store new fuels, heat and stored carbon.
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Read more about Mace’s aviation fuel transition service offer here:
Thank you!