



Hydrogen Valley Airport – GRONINGEN (NL)

Project Goal

Evaluate the potential of hydrogen to decarbonize airport operations.

Hydrogen Production

Assess the feasibility of using on site solar power to power a 1-MW electrolyzer system for local hydrogen production.

Hydrogen Utilization

Hydrogen will be used refueling land and airside vehicles and ultimately Hydrogen Aircraft, and power generation.

Groningen Airport Eelde is positioning itself as Hydrogen Valley Airport, a hub for the development and implementation of hydrogen solutions in aviation. Situated in Europe's first Hydrogen Valley, the airport benefits from an active regional industrial ecosystem that helps accelerate the transition to clean aviation.



Microgrid Energy Sources

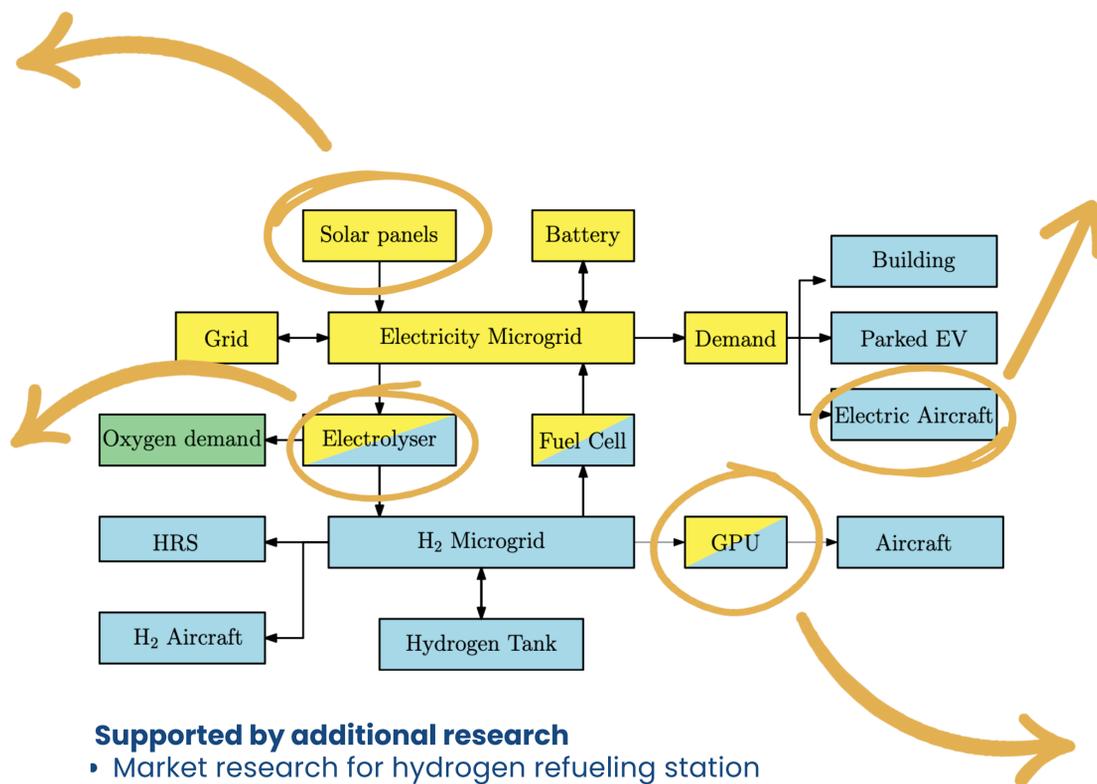
The model considers photovoltaic (PV) cells and grid-acquired electricity as energy sources.



Energy Storage and Trading

Battery storage is employed for electricity, while hydrogen storage systems (HSS) manage excess hydrogen, enabling trading with the central grid.

Regional Airport Microgrid Investment & Operations Planning



Hydrogen Utilization

Hydrogen, produced via electrolysis powered by the microgrid, is used for ground power units (GPU), hydrogen refueling stations (HRS), electric vehicles (EVs) and potentially future electric and/or hydrogen aircraft.



PROOF OF CONCEPT

Supported by additional research

- Market research for hydrogen refueling station
- Research into a hydrogen multitool combining ground handling functions
- Roadmap for hydrogen development

Objective

Design and operate a microgrid in a robustly profitable manner, even under worst-case scenarios

Challenge

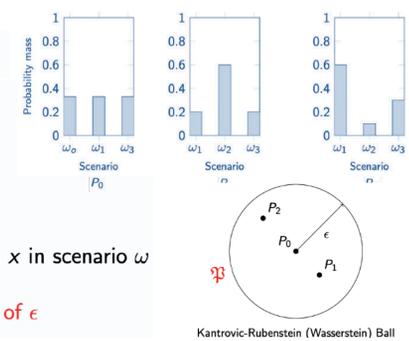
Maximizing profit is critical, but complex for real-world operations under deep uncertainty

Modelling Methodology



$$\min\{c^T x + \max_{P \in \mathfrak{P}} \mathbb{E}_{\xi_P}[Q_\omega(x)] \mid Ax \geq b, x \in \mathbb{R}\},$$

- where,
- c vector of cost of technologies
 - x decisions on technology investments
 - Ω set of scenarios
 - ω a scenario
 - P_0 reference distribution across Ω
 - $Q_\omega(x)$ second stage cost of investment decision x in scenario ω
 - A & b define feasible domain of x
 - \mathfrak{P} ambiguity set defined by P_0 and distance of ϵ



Uncertainty Challenge	Why DRO is Ideal
Mixed data quality (good temp data, poor hydrogen data)	Uses partial distribution info without requiring full probability densities
Correlated uncertainties (weather → demand → prices)	Handles dependencies through moment constraints or Wasserstein metrics
Multiple future scenarios	Ambiguity set naturally incorporates different distributional regimes
Long-term planning with hourly resolution	Computationally tractable without chance constraints
Rapidly evolving technologies and markets	Robust to distribution shifts and structural breaks

Base scenario	Middle-of-the-road condition based on current airport data; assuming a linear decline in the hydrogen prices from €10, gradually reaching €4.24 by year 2048. The demand for electric vehicles intricately linked to flight frequency.	Fossil fuel development	-50% green energy demand compared to the base scenario; focusing on local environment concerns, less regard for global issues.
Green Growth	+50% green energy demand compared to the base scenario. Improved management of local and global issues, tighter regulation of pollutants.	BSS capacity investment	The grid limit is set to 1MW per hour, (i.e., model can't sell more than 1MW to the grid per hour). Maximum battery investment capacity is set to 10MW and 20MW.
Fuel cell	The fuel cell efficiency is doubled (e.g., from 0.3 to 0.6).		

