Techno-Economic Optimization of Electrified Airports as Collaborative Energy Hubs

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1 Introduction

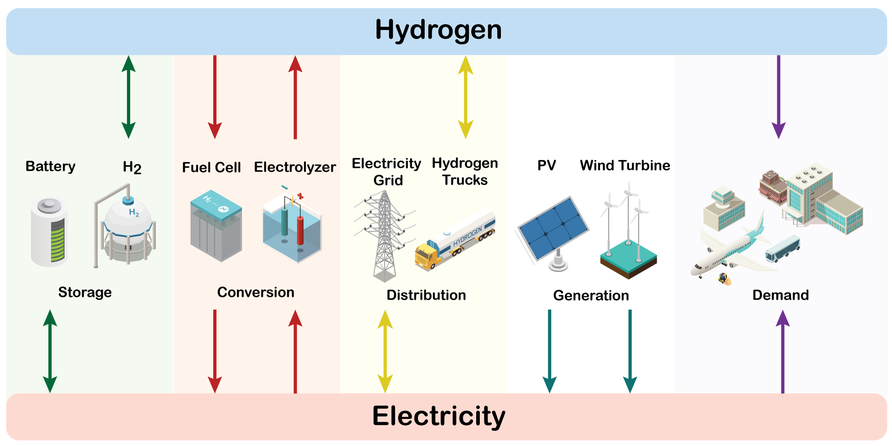
Regional aviation electrification requires airports to evolve into flexible energy hubs. Future battery electric and hydrogen electric aircraft will increase demand for electricity, hydrogen production, storage, and resilient grid interaction.

This study develops a scalable object-oriented techno-economic optimization framework for three airports operating as collaborative energy hubs.

Research Questions

- Can coordinated airport operation reduce total annual cost?
- How do dynamic pricing and PPAs affect system economics?
- What roles do batteries and hydrogen storage play in resilience?

2 Hybrid Airport Energy System



3 Methods

Create Airport Objects

Create System Connections

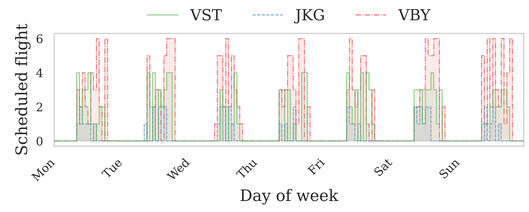
MILP Energy Network Formulation

GA-based Sizing & Dispatch Optimization

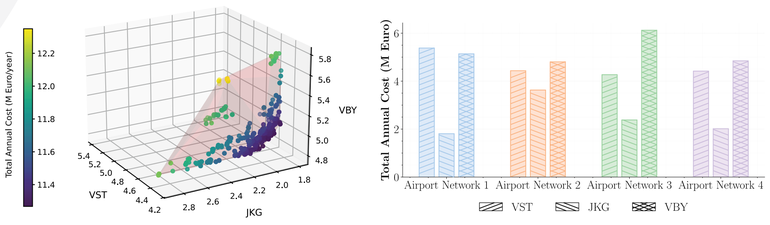
Object-oriented mixed-integer linear programming combined with genetic algorithm to find the optimal infrastructure design.

4 Case Study

Airport	Weekly Flights 2025	Weekly Flights 2035
Västerås (VST)	70	140
Jönköping (JKG)	18	58
Visby (VBY)	76	224



5 Design Optimization



5 Results

S_i	Sizing	Wind	Collab	Contract	Margin [%]	-ΔTAC* [%]
1	✓	-	-	-	-	-
2	-	✓	✓	PPA**	0, ±5, ±10	1.7 – 3.6
3	-	✓	-	PPA	0, ±5, ±10	1.2 – 2.1
4	-	✓	✓	DP***	0,5,10	2.6 – 3.4
5	-	✓	-	DP	0,5,10	0.8 – 1.2
6	✓	✓	-	DP	0,5,10	3.1 – 3.9
7	✓	✓	✓	DP	0,5,10	3.7 – 5
8	✓	✓	✓	PPA	0, ±5, ±10	2.7 – 4.7
9	✓	✓	-	PPA	0, ±5, ±10	2 – 3.4
10	-	✓	✓	PPA	0, ±5, ±10	2.2 – 4.6
11	-	✓	-	PPA	0, ±5, ±10	1.2 – 3.4

* Total annual cost compared to scenario 1
** PPA: Power purchase agreement
*** DP: Dynamic Pricing

6 Conclusion

1. The study reports reductions of up to 5% on TAC for the airports collaborating on a shared wind energy resources under dynamic pricing contract.
2. DP can lower operating cost and help the local grid to smoothing peaks.
3. While dynamic pricing increases market exposure, PPA offers more reliability on energy prices in long term which can result in lower operational costs in long term.
4. Batteries are best for short-term flexibility and peak shaving, but their high capital cost is a major economic driver. Hydrogen systems are better for larger demand spikes and longer outages, especially at larger airports such as VST and VBY.

References

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