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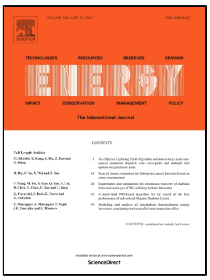

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Project-level multi-modal energy system design - Novel approach for considering detailed component models and example case study for airports

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Abstract

The current situation, which is driven by environmental concerns and increased air traffic, forces airport operators to examine their energy systems in an integrated approach. In order to optimize total expenditures, demands of energy in all forms must be considered. This paper introduces a novel method for the optimal design of multi-modal energy systems, which will be put to further use in the European Union Horizon 2020 MODER project. The optimization problem was formulated as mixed-integer linear programming based on a superstructure approach, including all feasible state-of-the-art technologies. Part-load efficiencies as well as the influence of ambient conditions on available output capacities were considered. The model took into account several types of energy storages, i.e., electrochemical, thermal and water storages. For fifteen locations, the optimal set of technologies, their capacity and operation was identified. Results showed that for this load range, combined heat and power plants were economically very attractive. Furthermore, photovoltaic energy was a viable option, even without designated feed-in tariff. Last but not least, compression chillers with chilled water storages offered an attractive option for enhanced flexibility. Combined total cost savings by using both the described method and on-site generation of up to 61% were achieved.

Keywords

Multi-modal energy systems; Distributed energy systems; Energy system design; Optimal design; MILP; Airports

Highlights

- Optimal design of airport energy systems
- Optimization of installation, capacity and operation considering detailed models
- Multi-modal energy systems including electric, heat, cold and water demand
- Evaporative and active turbine inlet air cooling
- Evaluation for fifteen different locations

Nomenclature

Abbreviations

AC	Absorption chiller
AC0	Absorption chiller with normal cooling supply temperature (8 °C)
ACi	Absorption chiller in ice mode (-5 °C supply temperature)
BOM	Mumbai
CAPEX	Capital expenditures