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Doctoral School: MEGeP
First year registration: 2018
Funding: CONACyT

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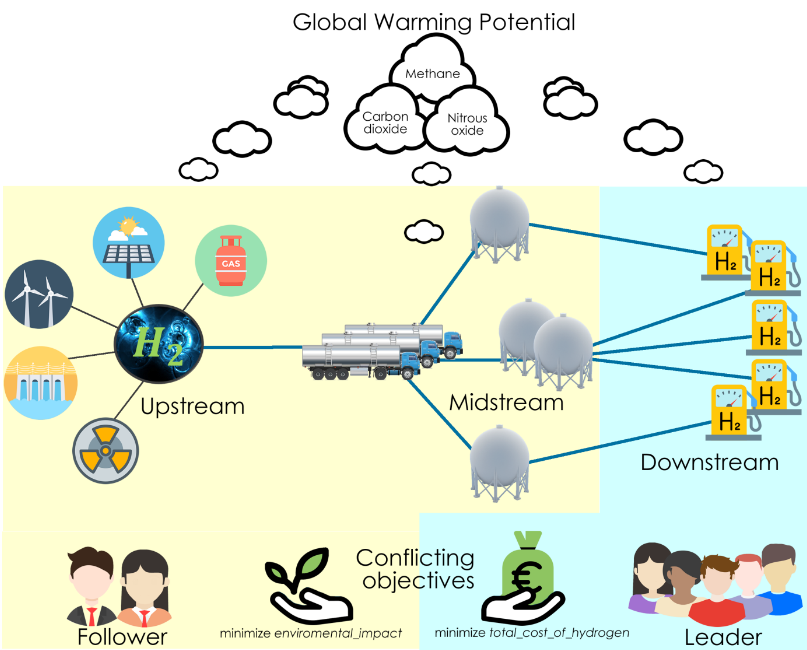
OPTIMAL DESIGN AND OPERATION OF POWER-TO-GAS (HYDROGEN) SUPPLY CHAIN : APPLICATION TO AIRPORT ECOSYSTEMS

Conception et fonctionnement optimaux de la chaîne d'approvisionnement énergie-gaz (hydrogène): application aux écosystèmes aéroportuaires

In this work, we follow a general modelling framework for non-cooperative supply chains adapted to the hydrogen supply chain (HSC) where different stakeholders with conflicting objectives exist (Figure). The used framework is based on an economic and environmental approach and the famous Stackelberg game structure to represent the non-cooperative relationships between the stakeholders across the supply chain.

In the field of game theory, Stackelberg games are used to represent an economic planning process involving interacting agents at two distinct levels: collectively called the leader and the follower. Stackelberg problems possess a hierarchical structure similar to that of Bilevel Programming Problems (BLPP), in fact the leader, who enjoys the priority of decision-making to optimize its objectives, represents the upper level and the follower, who react optimizing its own objective only after the leader makes a decision, represents the lower level problem. In these kind of problems, the optimal solutions to the lower level problem become possible feasible candidates to the upper level problem.



Hydrogen Supply Chain with noncooperative Stakeholders

The result of this modelling is a BLPP to take into account the different stakeholders and their respective objectives. Design decisions are based on the number, type, capacity, and location of production and storage facilities. More precisely, they involve the number and type of transport units required as well as the flow rate of hydrogen between locations.

According to the existing literature, BLPP is known to be strongly NP-hard and it has been proven that merely evaluating a solution for optimality is also a NP-hard task. To tackle the mentioned computational complexity we decided to incorporate an evolutionary programming approach since metaheuristics, like evolutionary algorithms, had proved efficiency solving this kind of problems.