ESTABLISHMENT AND DEVELOPMENT OF CALIFORNIA'S FUEL CELL ELECTRIC VEHICLE MARKET - LESSONS LEARNED FOR THE EU MEMBER STATES

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Overview

As countries and regions pursue climate change mitigation, the importance of decarbonizing the transportation sector through green hydrogen utilization, produced via renewable energy sources, becomes evident [1,2]. This shift necessitates modifications to public policies and strategies enacted by regional and central/federal authorities [3]. Simultaneously, the drive for transportation decarbonization has prompted innovation in the automotive sector, resulting in an array of zero- or low-emission vehicles like Plug-in Hybrid Electric Vehicles (PHEVs), Battery Electric Vehicles (BEVs), and Fuel Cell Electric Vehicles (FCEVs). Examining each vehicle type individually is crucial, given their diverse and competitive markets. Despite PHEVs and BEVs dominating the electric car market [4], FCEVs hold significant potential for transportation decarbonization. Various countries and regions have adopted differing public policy incentives and strategies to promote FCEVs with mixed success [5]. Over the past decade, California has displayed diverse strategies [6,7] and a growing FCEV market potential in light-duty passenger vehicles, buses, and medium- and heavy-duty vehicles [8,9]. This expansion has coincided with the development of publicly accessible hydrogen refueling infrastructure and increased green hydrogen production, transportation, and storage. Given this context, the research problem can be framed as follows: **How have state policy instruments impacted California's fuel cell electric vehicle market development from 1990 to 2022, and what lessons can be drawn for the EU member states?**

Methods

In this study, I employed a mixed-method approach to investigate the public policy instruments used in shaping California's fuel cell electric vehicle (FCEV) market development over the past decades. First, I conducted a critical review and analysis of the existing scientific literature to synthesize state-of-the-art research on the topic. To supplement these findings, I analyzed recent secondary data, including statistics, reports, and market publications related to the research problem, through desk research. This analysis of key FCEV market indicators provided a comprehensive overview of the changes from 1990 to 2022. Furthermore, a comparative analysis of state-level public policy statements, bills, and directives was carried out to gain a deeper understanding of the adopted assumptions and review the implemented instruments. Lastly, I conducted highly structured interviews with various FCEV market stakeholders, such as policymakers, researchers, and representatives from companies and organizations involved in sustainable and low-carbon hydrogen production, hydrogen refueling infrastructure operation, and supply- and demand-side market actors. These 46 interviews were transcribed and evaluated using NVivo software to generate insightful results.

Results

The research results allow the evaluation of public policy instruments implemented in California from 1990 to 2022. The fundamentally effective instruments were those implemented on the state level. I identified four strategic objectives and matching policy instruments which are as follows: **(1) sustainable and low-cost production of hydrogen** (most effective policy instruments were: *Hydrogen Fuel Specifications and the 33% Green Hydrogen Requirement* as regulations and standards*; Low Carbon Fuel Standard* as tradebale permits), **(2) developing accessible and reliable refuelling infrastructure** (most effective policy instruments were: *AFV and Fuelling Infrastructure Grants* as subsidies; *Station Building Standards and Safety Codes* as regulations and standards; and *ZEV Infrastructure Support, Hydrogen Fuelling Station Evaluation* as the information policies), **(3) growth of market supply for FCEV** (most effective policy instruments were: *Light-, Medium-, and Heavy-Duty ZEV Requirements* as regulations and standards, *and ZEV Production Requirements* as tradeble credits), and last but no least objective **(4) growth of market demand for FCEV** (most effective policy instruments were: *Advanced Transportation Tax Exclusion, Zero Emission Transit Bus Tax Exemption, and ZEV Fee* as tax incentives, *Purchase requirements for Zero-Emission Transit Bus, Airport Shuttle, and Public Fleet Vehicles* as regulations and standards, *Bus Replacement Grants, LD-ZEV Rebates, HVIP Vouchers, and Emissions Reductions Grants* as subsidies, and *High Occupancy Vehicle and High Occupancy Toll Lane Exemption* as information policies). The strength of impact and effectiveness of these individual policy instruments were also evaluated with the quantitative approach during the interviews by assigning the weights of impact to present the overall road map for FCEV market growth in these four critical strategic development areas.

The research also discusses and demonstrates the essential role of demonstration projects, such as the example of the Port of Los Angeles, where heavy-duty FCEVs are operating. The research results contribute to a better understanding of the applied public policy instruments' effectiveness in deploying hydrogen and fuel cell technologies in California's transportation sector.

Conclusions

In conclusion, this analysis of California's successful fuel cell electric vehicle (FCEV) market development offers valuable insights for EU member states seeking to promote their own FCEV markets. First, adopting a technology-neutral policy approach with ambitious goals ensures fair competition and innovation across various vehicle technologies. Second, fostering synergy across FCEV market segments can lead to a more cohesive and robust market. Third, prioritizing the development of reliable, accessible, and high-capacity refueling stations is essential for encouraging FCEV adoption. Fourth, demonstrating a long-term commitment to supporting FCEVs can help circumvent the "valley of death" faced by emerging technologies. Fifth, promoting the scalability potential of FCEVs, particularly within transit agencies and medium- to heavy-duty fleets, can further drive market growth. Sixth, implementing policies based on tradable credits, subsidies, and purchase requirements can incentivize both supply and demand for FCEVs. Finally, establishing a self-sustaining regional hydrogen ecosystem, such as a hydrogen hub or hydrogen valley, can contribute to a comprehensive and effective infrastructure. By embracing these lessons learned from California's experience, EU member states can create a conducive environment for FCEV market development, fostering sustainable transportation and contributing to a greener future.

IAEE Codes:

10.6. Transportation – Policy Issues.
10.3. Transportation - Electric vehicles & systems.

References

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