Electric Cars in Jordan: Opportunities and Challenges

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Abstract: **The transition to electric vehicles (EVs) in Jordan is influenced by several key factors and presents opportunities and challenges. Factors influencing EV adoption include advancements in battery technology, government policies promoting EVs, the availability of charging infrastructure, and evolving consumer preferences. The shift towards EVs offers numerous opportunities for Jordan, including reduced fuel costs, enhanced energy security, job creation, tourism promotion, and improved air quality. However, challenges such as the impact on the traditional fuel sector, electricity grid limitations, limited charging infrastructure, and consumer awareness need to be addressed. One major challenge is the potential loss of government revenue from fuel and electric car taxes, which requires strategic planning and alternative revenue generation approaches. By implementing targeted policies, fostering public awareness, engaging in international cooperation, and investing in charging infrastructure and green businesses, Jordan can maximize the economic opportunities and societal benefits of EV adoption while mitigating the challenges. Balancing long-term sustainability with immediate financial considerations is essential for a successful and equitable transition towards a cleaner transportation future in Jordan.**

Keywords: **Electric vehicles (EVs), Jordan, Transition, Challenges, Climate change mitigation.**

I. INTRODUCTION

The widespread adoption of electric cars as a climate change mitigation strategy faces several formidable barriers that necessitate multifaceted solutions and policy interventions. Foremost among these challenges is the carbon-intensive manufacturing process inherent in battery electric vehicles (BEVs), which incurs a significant greenhouse gas (GHG) debt that must be gradually offset over time [1]. Furthermore, the adoption of electric vehicles is hampered by infrastructure limitations, including inadequate charging infrastructure and a scarcity of public charging stations, which undermine consumer confidence and convenience [2] [3]. Technological barriers, such as battery performance and durability in high temperatures and desert conditions, exacerbate adoption challenges, highlighting the need for robust technological advancements and innovations to address these concerns [4-5]. Moreover, the high initial purchase prices of electric vehicles, limited availability of EV dealerships, and apprehensions regarding the resale value of EVs pose significant financial hurdles for prospective buyers, inhibiting widespread adoption.

Additionally, insufficient awareness and understanding of EVs among consumers, coupled with safety concerns and apprehensions about the impact of EV adoption on the oil-based economy, further compound adoption barriers. These multifaceted challenges underscore the imperative for comprehensive policy support, targeted incentives, and concerted efforts to enhance infrastructure and technological capabilities, fostering an enabling environment conducive to the widespread adoption of electric cars for climate change mitigation. By addressing these barriers holistically and implementing a suite of coordinated strategies, policymakers can accelerate the transition towards sustainable transportation solutions while mitigating the adverse effects of climate change.

The adoption of electric cars contributes to climate change mitigation by reducing greenhouse gas emissions caused by road transport. Electric vehicles (EVs) have the potential to reduce CO_2 emissions and limit global warming substantially. Studies have shown that adopting battery electric vehicles (BEVs) can lead to exponential growth trends in EV adoption, with estimates suggesting that most passenger cars in Europe could be electric by 2031. The transition to electric mobility can be supported by delayed home charging and workplace charging, which can reduce peak electricity demand and optimize the use of renewable energy sources. However, the shift towards electric mobility faces roadblocks, including uncertainty in demand and production scalability, job losses, and the lack of charging infrastructure. Overall, adopting electric cars is crucial for achieving climate goals and transitioning towards a net-zero emission economy. Electric cars (EVs) have the potential to mitigate climate change by reducing carbon emissions and air pollution. They produce no tailpipe emissions, helping to reduce local air pollution [6].

Additionally, EVs can contribute to reducing carbon emissions by eliminating the greenhouse gases associated with the combustion of fossil fuels in traditional vehicles [7]. However, there are challenges to the widespread adoption of EVs. These include the high cost of infrastructure, limited range or range anxiety, and the performance of batteries [8]. To overcome these challenges, potential solutions include enhancing the charging infrastructure, increasing the number of charging stations, using battery swapping techniques, and improving battery technology [9]. Governments can incentivize consumers to purchase EVs through tax credits or subsidies and invest in building a robust charging infrastructure [10]. Overall, while EVs offer benefits for climate change mitigation, addressing these challenges is crucial for their widespread adoption and maximum impact.

The challenges hindering the widespread adoption of electric cars in Jordan encompass multifaceted concerns ranging from infrastructure deficiencies to apprehensions

regarding vehicle reliability and the strain on the distribution system. Participants from Iraq underscored the absence of charging stations as a pivotal deterrent to the uptake of electric or hybrid vehicles, emphasizing the critical role of infrastructure development in fostering EV adoption [11]. Conversely, respondents from Jordan expressed reservations about the reliability of electric or hybrid vehicles, posing a significant barrier to their acceptance [12]. Moreover, the high penetration of EVs could precipitate challenges within the distribution system, including Undervoltage, overcurrent, and limitations in transformer capacity, thus necessitating comprehensive infrastructure upgrades to accommodate the burgeoning demand for electric mobility [13]. These complexities underscore the imperative for concerted efforts towards infrastructure development, particularly in establishing a robust charging station network, to facilitate the seamless integration of electric cars into Jordan's transportation landscape.

The adoption of electric vehicles (EVs) in Jordan signifies a transition towards sustainable mobility and unveils a spectrum of opportunities poised to reshape the country's energy landscape. Jordan's substantial renewable energy capacity, notably in wind energy, primarily presents a ripe opportunity to power EVs, mitigating energy curtailment issues and curbing emissions [14]. Moreover, the strategic implementation of an optimized EV charging infrastructure holds the potential to effectively manage the augmented electrical load, thereby mitigating adverse effects on the electric distribution network and ensuring grid stability [15]. Furthermore, a comprehensive evaluation of the EVs' impact on the distribution system offers valuable insights into determining the threshold of simultaneous EV charging that the system can sustainably accommodate without encountering operational constraints [16]. Additionally, delving into consumer behavior vis-a-vis EV adoption unveils critical insights into the determinants influencing individuals' intentions to embrace EVs, encompassing factors such as attitude, subjective norm, and perceived behavioral control [17]. By harnessing these opportunities and leveraging insights derived from research and analysis, Jordan can foster the growth and sustainability of its EV market, paving the way for a more environmentally conscious and energy-efficient transportation ecosystem.

Encouraging the widespread adoption of electric cars in Jordan necessitates a multifaceted approach that integrates innovative solutions and concerted efforts to reshape societal perceptions and infrastructure. Leveraging advanced techniques like Particle Swarm Optimization (PSO), Jordan can strategically position EV charging stations to optimize their placement, maximizing total charging capacity while minimizing transmission line congestion and power losses [18]. Moreover, fostering public awareness campaigns aimed at highlighting the myriad benefits of electric vehicles and reshaping societal attitudes towards sustainable transportation is paramount [19]. Addressing the pressing need for enhanced charging infrastructure in Iraq and Jordan by establishing more charging stations is a pivotal step toward bolstering EV adoption rates and overcoming existing barriers [20]. Furthermore, capitalizing on curtailed renewable energy, particularly wind energy, to power electric cars mitigates emissions and offers a sustainable solution to reduce energy costs and environmental impact [21]. In parallel, government-led initiatives aimed at incentivizing investments in clean energy and offering financial incentives and tax exemptions play a crucial role in facilitating the transition from fossil fuels to renewable energy sources, fostering a conducive environment for sustainable transportation initiatives to flourish [22]. By embracing these strategies and fostering collaborative partnerships between government agencies, private stakeholders, and communities, Jordan can pave the way for a greener, more sustainable transportation ecosystem while mitigating environmental impact and promoting economic growth.

II. GLOBAL ELECTRIC VEHICLE MARKET SHARE PREDICTIONS

2030: Several reputable organizations forecast a significant rise in electric vehicle (EV) market share by 2030. The International Energy Agency (IEA) predicts a 36% share in their Global Electric Vehicle Outlook 2023, with scenarios reaching 57% under ambitious climate action pathways. NEFs Electric Vehicle Outlook 2023 projects a 40% share by 2030, potentially reaching 52% under their accelerated transition scenario

2040: Forecasts diverge further for 2040, but all point towards continued Electric Vehicle dominance. The IEA scenarios range from 67% to 90% market share. NEFs predict a 73% share, with a potential high of 84% [23-24].

Gasoline Cars Displacement Timelines: Europe: The European Union aims for a zero-emissions car fleet by 2050, effectively phasing out gasoline cars. Some countries have set even more ambitious targets, with Norway aiming for all new car sales to be electric by 2025. California aims for 100% zero-emission vehicle sales by 2035. Market forces and consumer preferences will also likely accelerate the transition [25-27].

III. FACTORS INFLUENCING ELECTRIC VEHICLE ADOPTION AND GASOLINE CARS DISPLACEMENT

- Battery technology advancements: Continued improvements in battery range, affordability, and charging speed will be crucial for wider Electric Vehicle adoption.
- Government policies: Stringent emission regulations, financial incentives for Electric Vehicles, and restrictions on ICE vehicles can significantly accelerate the transition.
- Charging infrastructure: Expanding and improving the availability of charging stations, particularly fast-charging options, is essential for overcoming range anxiety and attracting more consumers.
- Consumer preferences: As electric vehicles become more affordable, offer a wider range of options, and provide a premium driving experience, consumer preference will increasingly shift towards them.

IV. ELECTRIC VEHICLES IN JORDAN: OPPORTUNITIES AND CHALLENGES

Driven by technological advancements, environmental concerns, and changing consumer preferences, electric vehicles are poised to dominate the global automotive market rapidly within the next few decades. The transition to electric vehicles in Jordan presents both significant opportunities and challenges. By addressing these challenges through strategic planning, targeted policies, and public awareness campaigns, Jordan can harness the potential of EVs to achieve its economic growth, environmental sustainability, and energy security goals.

Opportunities:

- Reduced fuel costs: Electric cars can significantly reduce individual and national fuel expenses by replacing imported oil with domestically generated electricity.
- Enhanced energy security: Reduced reliance on imported oil translates to improved energy security and less vulnerability to global oil price fluctuations.
- New economic opportunities: The electric car industry can create new jobs in manufacturing, charging infrastructure development, maintenance, and battery recycling. Attracting investments: Electric car technology and infrastructure investments can entice foreign direct investment and boost Jordan's economic growth.
- Promoting tourism: By offering Electric car charging facilities and promoting eco-friendly travel options, Jordan can position itself as a leader in sustainable tourism. Tourism electrification: Developing electric car charging infrastructure and promoting eco-friendly tourism packages incorporating electric cars can attract environmentally conscious tourists.
- Cheaper transportation: Lower operating costs of electric cars can translate to cheaper ride-sharing and taxi services, improving mobility and affordability for citizens.
- Ride-hailing and car-sharing services: Promoting electric car-sharing apps and services can optimize vehicle usage, reduce traffic congestion, and create new business models.
- Renewable energy storage: Utilizing electric car batteries as distributed energy storage solutions can improve grid resilience, particularly in areas with intermittent renewable energy sources. Leveraging Jordan's renewable energy surplus: Incentivizing off-peak charging can generate excess solar energy.
- Vehicle-to-grid (V2G) technology: Exploring V2G technology, where parked electric cars feed excess stored energy back into the grid during peak demand periods, can enhance grid stability.
- Boosting rural development and job creation: Encouraging smaller, community-based charging stations in rural areas and along highways can offer additional services and create local employment opportunities.
- Entrepreneurship and innovation: Promoting innovation and entrepreneurship in areas like smart charging solutions, battery recycling, and electric car maintenance can foster economic diversification and job creation.
- Improved air quality: Widespread adoption of electric cars would drastically decrease transportation-related air pollution, leading to better public health and environmental conditions.
- Reduced greenhouse gas emissions: Electric cars contribute significantly less to greenhouse gas emissions than traditional gasoline-powered vehicles, aligning with Jordan's climate goals and international commitments.

Challenges:

- Impact on the traditional fuel sector: The transition to electric cars could negatively impact the traditional fuel sector and related jobs, requiring new business models for the petrol stations, workforce training, and support programs.
- Electricity grid limitations: The Jordanian electricity grid may require upgrades to accommodate the increased demand from widespread electric car charging. Grid modernization: Investing in grid modernization and smart grid technologies is crucial to accommodate the increasing demand for electric cars and ensure efficient energy management.
- Limited charging infrastructure: The current charging infrastructure for electric cars in Jordan is limited, creating range anxiety for potential buyers.
- Used electric car market: The lack of a mature used electric car market in Jordan can deter potential buyers due to concerns about resale value and maintenance costs.
- Lack of consumer awareness: There is a need for increased public awareness and education about the benefits and functionalities of electric cars to encourage wider adoption.
- Loss of Government Revenue from Fuel Taxes and Electric Car Taxes: the potential loss of government revenue from fuel taxes and electric car taxes is a significant challenge to consider when transitioning to electric vehicles in Jordan. Fuel taxes: Currently, fuel taxes represent a substantial portion of Jordan's government revenue. As electric cars become more popular and fuel consumption declines, this revenue stream is expected to shrink significantly. Electric car taxes: Currently, electric cars in Jordan benefit from lower taxes than gasoline-powered vehicles. While this incentivizes adoption, the government also collects less tax revenue per electric car than gasoline.

While the potential loss of government revenue from fuel and electric car taxes poses a significant challenge, it can be mitigated through strategic planning, alternative revenue generation, and careful financial management. By proactively addressing this challenge, Jordan can navigate the transition to electric cars in a way that ensures both environmental sustainability and fiscal responsibility. By strategically addressing these challenges and capitalizing on the numerous opportunities, Jordan can harness the potential of electric cars to achieve its goals for economic growth, environmental sustainability, and energy security, ultimately

transforming its transportation sector and paving the way for a brighter future.

V. MAIN CHALLENGES FOR THE GOVERNMENT

Balancing the numerous benefits of electric car adoption with the potential loss of government revenue from fuel taxes and electric car taxes. Maximizing the societal and environmental benefits of electric cars might come at the expense of immediate government income, potentially impacting essential services and infrastructure development. The main two losses are.

- Reduced fuel tax revenue: As gasoline consumption declines, fuel tax revenue, a significant budgetary source, will shrink.
- Lower electric car tax revenue: Even with lower tax rates on electric cars, they generate less revenue per vehicle than gasoline-powered ones.

Potential Impacts:

- Reduced government budget: Reduced revenue could impact the government's ability to fund essential services like healthcare, education, and infrastructure development.
- Fiscal deficit: The loss of revenue might widen the government's budget deficit, potentially leading to increased borrowing and debt.
- Reduced investments in public transportation: If the funding gap widens, investments in public transportation electrification or other sustainable initiatives might be hampered.

VI. POSSIBLE SOLUTIONS

Targeted policies and incentives:

- Gradual transition: Implement a phased rollout of electric cars, allowing time for the government to adjust tax structures and minimize the immediate impact on revenue.
- Dynamic tax adjustments: Introduce flexible tax structures based on vehicle emissions, fuel consumption, or even driving patterns, ensuring fair revenue contributions while incentivizing cleaner transportation.
- Alternative revenue sources: Explore diversifying income streams beyond traditional fuel taxes. This could involve carbon pricing schemes, taxes on other environmentally harmful activities, or broadening existing tax bases.
- Smart charging incentives: Promote off-peak charging through dynamic pricing or rebates, utilizing excess renewable energy generation without burdening the grid during peak demand.

Maximizing economic opportunities:

- Invest in charging infrastructure: Develop a nationwide charging station network, attract private investment, and create new jobs in construction, maintenance, and related services.
- Foster domestic electric car manufacturing: Encourage local production of electric components or even complete vehicles, boosting the economy and creating further job opportunities.
- Support green businesses: Provide financial and regulatory support to startups and businesses involved in renewable energy, recycling, and innovative clean transportation solutions.

Public awareness and engagement:

- Transparency and communication: Communicate the economic implications of the transition to electric cars and the need for adjustments, building trust and public support for necessary measures.
- Social safety nets: Implement targeted programs to protect vulnerable populations disproportionately affected by any shifts in tax structures or fuel costs.
- Invest in public education: Increase awareness about the benefits of electric vehicles and address potential concerns like range anxiety, promoting wider adoption and fostering a culture of sustainable transportation.

International cooperation and knowledge sharing:

- Learn from best practices: Collaborate with other countries successfully transitioning to electric vehicles, adopting their strategies for balancing revenue considerations with environmental and social goals.
- Access technical assistance: Partner with international organizations and development partners for technical expertise and funding support, smoothing the transition and mitigating potential challenges.

VII. CONCLUSION

By proactively addressing the revenue challenges and capitalizing on the vast opportunities presented by electric vehicles, Jordan can navigate this transition to maximize benefits for its citizens, environment, and economy. Balancing long-term sustainability with immediate financial considerations is key to ensuring a successful and equitable transition toward a cleaner future.

Building on your existing research on electric vehicles in Jordan, future exploration should focus on three key areas. Firstly, the social and economic impacts of EV adoption need in-depth analysis. This includes understanding how EVs affect different income groups and regions, exploring the potential for job creation and economic growth, and addressing public concerns about affordability, range anxiety, and charging infrastructure. Surveys and focus groups can offer valuable insights to promote wider EV acceptance.

Secondly, optimizing EV integration with the electricity grid is crucial. Research should delve into developing efficient load management strategies and explore the potential of vehicle-to-grid technology to enhance grid stability and even contribute to power supply. Integrating renewable energy sources with charging infrastructure is essential for a sustainable future. By focusing on these areas, research can pave the way for a smooth and environmentally responsible transition to EVs in Jordan.

REFERENCES

[1] Y. Ren, X. Sun, P. Wolfram, X. Tang, D. Zhao and X. Zheng, "Hidden delays of climate mitigation benefits in the race for electric vehicle deployment," *Nature Communications*, vol. 14, 2023. DOI: 10.1038/s41467-023-38182-5.

[2] A. Pasura, W. Atthirawong and P. Luangpaiboon, "Fuzzy Analytical Hierarchy Process for Strategic Decision Making in Electric Vehicle Adoption," *Sustainability*, vol. 15, no. 8, 2023. DOI: 10.3390/su15087003.

[3] M. Murugan, S. Marisamynathan and P. Nair, "Investigating the Barriers for Electric Vehicle Adoption Using Analytical Hierarchy Process Approach," *Lecture Notes in Civil Engineering*, vol. 261, pp. 837-850, 2023. DOI:10.1007/978-981-19-2273-2_55.

[4] C. Corradi, E. Sica and P. Morone, "What drives electric vehicle adoption? Insights from a systematic review on European transport actors and behaviours," *Energy Research & Social Science*, vol. 95, 2023. DOI: 10.1016/j.erss.2022.102908.

[5] S. Alotaibi, O. Siddig and Y. Su, "Identification of Potential Barriers to Electric Vehicle Adoption in Oil-Producing Nations—The Case of Saudi Arabia," *Electricity*, vol. 3, no. 3, pp. 365-395, 2022. DOI: 10.3390/electricity3030020.

[6] X. Bi, W. Li and H. Zhang, "Transport Electrification: Opportunities and Future Challenges," *Highlights in Science, Engineering and Technology*, vol. 46, pp. 14-18, 2023. DOI: 10.54097/hset.v46i.7658.

[7] F. Alanazi, "Electric Vehicles: Benefits, Challenges, and Potential Solutions for Widespread Adaptation," *Applied Sciences*, vol. 13, no. 10, 2023. DOI: 10.3390/app13106016.

[8] E. J. Muehlegger and D. S. Rapson, "Correcting Estimates of Electric Vehicle Emissions Abatement: Implications for Climate Policy," *Journal of the Association of Environmental and Resource Economists*, vol. 10, no. 1, pp. 263-282, 2023. DOI: 10.1086/721374.

[9] P. Moriarty, "Electric vehicles can have only a minor role in reducing transport's energy and environmental challenges," *AIMS Energy*, vol. 10, no. 1, pp. 131-148, 2022. DOI: 10.3934/energy.2022008.

[10] A.A. Salah, M.M. Shalby and F.B. Ismail, "The status and potential of renewable energy development in Jordan: exploring challenges and opportunities," *Sustainability: Science, Practice and Policy*, vol. 19, no. 1, 2023. DOI: 10.1080/15487733.2023.2212517.

[11] L. Shalalfeh, A. AlShalalfeh, K. Alkaradsheh, M. Alhamarneh and A. Bashaireh. "Electric Vehicles in Jordan: Challenges and Limitations," *Sustainability*, vol. 13, no. 6, 2021. DOI: 10.3390/su13063199.

[12] F. Alhomaidat, R. A. Hasan, T. Eljufout and A. H. Abbas, "User's perceptions of electric, hybrid, and fuel-powered vehicles in Iraq and Jordan,", *Case Studies on Transport Policy*, vol. 12, 2023. DOI: 10.1016/j.cstp.2023.101004.

[13] A. Bashaireh, D. Obeidat, A. A. Almehizia and L. Shalalfeh, "Optimal Placement of Electric Vehicle Charging Stations: A Case Study in Jordan," *2023 IEEE Texas Power and Energy Conference*, USA, pp. 1-6, 2023. DOI: 10.1109/TPEC56611.2023.10078486.

[14] B. Eneizan, "The adoption of electric vehicles in Jordan based on theory of planned behavior," *American Journal of Economics and Business Management*, vol. 2, no. 2, 2019. DOI: 10.31150/AJEBM.VOL2.ISS2.64.

[15] M. Al-Omary, M. Kaltschmitt and C. Becker, "Electricity system in Jordan: Status & prospects," *Renewable & Sustainable Energy Reviews*, vol. 81, no. 2, pp. 2398-2409, 2018. DOI: 10.1016/J.RSER.2017.06.046.

[16] M. A. Momani and L. Alhmoud, "Statistical Modeling of the Determinants Driving the Electricity Demand in Jordan," *IEEE Open Access Journal of Power and Energy*, vol. 10, pp. 294-303, 2023. DOI: 10.1109/OAJPE.2023.3255100.

[17] A. Khandakar, A. Rizqullah, A. A. Berbar, M. R. Ahmed, A. Iqbal, M. E. H. Chowdhury and S. M. A. U. Zaman, "A Case Study to Identify the Hindrances to Widespread Adoption of Electric Vehicles in Qatar," *Energies*, vol.13, no.15, 2020. DOI:10.3390/EN13153994.

[18] A. A. Abu-ElSamen, M. N. Akroush, N. A. Asfour and H. I. Al Jabali, "Understanding contextual factors affecting the adoption of energy-efficient household products in Jordan," *Sustainability Accounting, Management and Policy Journal*, vol. 10, no. 2, pp. 314-332, 2019. DOI: 10.1108/SAMPJ-05-2018-0144.

[19] E.S. Hrayshat, "Analysis of Renewable Energy Situation in Jordan," *Energy Sources, Part B: Economics, Planning, and Policy*, vol. 3, no. 1, pp. 89–102. DOI: 10.1080/15567240600815000.

[20] A. Albatayneh, M. Assaf, M. Al-Qroum and D. Alterman, "Energy Saving and CO2 Mitigation as a Result of Reshaping Transportation in Jordan to Focus on the Use of Electric Passenger Cars," *Environmental and Climate Technologies*, vol. 25, no. 1, pp. 222-232, 2021. DOI: 10.2478/rtuect-2021-0015.

[21] International Energy Agency, Global EV Outlook 2023. Paris, France: IEA, 2023.

[22] BloombergNEF, Electric Vehicle Outlook 2023. New York, NY: BloombergNEF, 2023.

[23] European Commission, Fit for 55 package. 2021. [Online]. Available: https://www.consilium.europa.eu/en/policies/green-deal/fit-for-55-the-eu-plan-for-a-green-transition/

[24] State of California, California Air Resources Board, Advanced Clean Cars II regulation. 2022. [Online]. Available: https://ww2.arb.ca.gov/our-work/programs/zero-emission-vehicle-program.