Masters Desertion Showcase
Year 2024

	Department: Electrical Engineering Programme: Masters in Engineering Specialization: Electrical Power System
1	**Title of the Thesis** An Uncertainty-Based Allocation and Scheduling Strategy For A Hybrid Charging and Refuelling Station
2	**Abstract** (300 to 500 words) The past decade has witnessed a surge in concern regarding the environmental impact of conventional vehicles. This has prompted a global shift towards alternative transportation solutions, with a particular focus on fuel cell electric vehicles (FCEVs) and battery electric vehicles (BEVs). However, widespread adoption faces a critical hurdle: the chicken-and-egg problem of infrastructure. Consumers hesitate to embrace electric vehicles due to the scarcity of charging/refuelling stations. This lack of infrastructure discourages investment, as stakeholders remain unsure of the market's profitability. Additionally, the unpredictable charging patterns of electric vehicles pose a significant challenge for utility companies. These intermittent surges in demand can disrupt power quality and strain existing infrastructure. This research aims to bridge this gap by promoting the proliferation of both FCEVs and BEVs. It strives to achieve a delicate balance – ensuring grid stability for utilities, maximizing profits for investors, and prioritizing customer satisfaction. To achieve this, the research proposes a methodology for optimally sizing and allocating a hybrid refuelling station within a designated distribution network. A key aspect of this research involves modelling the load profile of the proposed refuelling station using the Monte Carlo Simulation method. This method accounts for the inherent uncertainty in power demand caused by the unpredictable driving patterns of electric vehicle owners. The final stage of the research proposes a Time-of-Use (ToU) based optimal pricing strategy. This strategy aims to create a win-win scenario by balancing customer satisfaction with investor profit. By implementing dynamic pricing based on the time of day, the strategy encourages off-peak charging, reducing the strain on the grid during peak hours. This not only benefits utilities by optimizing power usage but also incentivizes customers to charge their vehicles at lower-cost times. In conclusion, this research proposes a comprehensive approach to foster the adoption of electric vehicles. By addressing the infrastructure gap, managing the impact on power grids, and implementing a customer-centric pricing strategy, this research can pave the way for a more sustainable transportation future.
3	**Impact on Sustainability of Urban Regions or SDG-11 "Sustainable Cities and Communities" (min 500 words)** The research presented in this thesis is closely aligned with the United Nations' Sustainable Development Goal (SDG) #11, Sustainable Cities and Communities, particularly Target 11.2. This target aims to provide access to safe, affordable, accessible, and sustainable transport systems for all by 2030, with a specific focus on vulnerable populations, such as women, children, persons with disabilities, and older persons. This work contributes to the goal by addressing the infrastructure needs for electric and hydrogen fuel cell vehicles, which are critical for the expansion of sustainable transport options. The core of this research revolves around the development and optimization of a hybrid charging and refuelling station for Battery Electric Vehicles (BEVs) and Fuel Cell Electric Vehicles (FCEVs). This directly supports the creation of sustainable transport systems by promoting the use of clean energy vehicles. By ensuring the strategic placement and efficient operation of these stations, this research helps reduce the reliance on internal combustion engine (ICE) vehicles, thus lowering greenhouse gas emissions and improving urban air quality.

	One of the significant contributions of this work is the emphasis on maintaining power quality and grid stability while integrating renewable energy sources. This is crucial for the sustainable operation of charging and refuelling stations. The developed pricing-based demand response scheme encourages the use of these stations, making them financially viable for both operators and users. This aligns with the affordability aspect of Target 11.2 by providing cost-effective solutions for vehicle owners, thus facilitating broader adoption of sustainable transportation methods. This research also considers the diverse needs of different population groups, including those in vulnerable situations. By ensuring that the charging and refuelling stations are optimally located and accessible, this work promotes inclusivity in the transportation network. This is particularly relevant for individuals with disabilities, older persons, and other vulnerable groups who rely heavily on public transport and need reliable and accessible infrastructure. Moreover, the project's indirect benefits, such as the improvement in the Air Quality Index and the reduction of greenhouse gas emissions, contribute to the broader objectives of SDG 11. Cleaner air and a healthier urban environment are essential components of sustainable cities and communities. The anticipated increase in BEV and FCEV sales due to the availability of adequate infrastructure will further propel the transition towards greener urban transport systems. In addition to addressing environmental concerns, this research fosters economic opportunities. By generating new income streams and attracting investments in the charging and refueling infrastructure, it supports economic growth and job creation within the sustainable transport sector. This economic dimension is integral to building resilient and sustainable communities, as envisioned by SDG 11. The methodologies employed in this work, including Monte Carlo simulations and optimization algorithms, ensure that the proposed solutions are both effective and practical. This scientific approach to solving real-world problems exemplifies how academic research can directly contribute to achieving global sustainability goals. By providing a robust framework for the deployment of sustainable transport infrastructure, this project offers a valuable blueprint for policymakers and urban planners aiming to meet the targets set out in SDG 11. In conclusion, this research work makes a substantial contribution to the United Nations' Sustainable Development Goal #11 by proposing innovative solutions for sustainable transport infrastructure. Through a comprehensive approach that includes economic, environmental, and social considerations, the research aligns with Target 11.2's objectives of improving road safety, expanding public transport, and ensuring that transport systems are accessible to all, particularly the vulnerable populations. This alignment not only underscores the relevance of this research to global sustainability efforts but also highlights its potential impact on creating more sustainable, inclusive, and resilient urban communities.
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