

Electric mobility investment in developing countries: emerging regional patterns from cross-country analyses.

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Abstract

On paper, many developing countries have made pledges to decarbonise and reduce GHG emissions. Nevertheless, decarbonisation is barely happening in many of them. Among other reasons, transport electrification with electric mobility, which is pivotal in the decarbonisation strategy of many developing countries, is beset by investment challenges on the demand and supply side. On the demand side, the lingering 'where will the money come from' challenge remains critical because the governments are financially constrained. On the supply side, investors remain unsure of which country to make electric mobility investments. This paper contributes to this academic and policy debate from the transport and power sector coupling context. We apply our conceptual framework to analyse some developing countries with wholesale power markets and wholesale and retail power markets. Then, we conduct cross-country analyses of fifteen countries to assess the possibility of emerging patterns in electric mobility investment solutions in these countries. We argue that regional or continental patterns may be emerging among some countries. We found that Latin American countries (Chile, Colombia, Argentina) appear to follow a pattern of investment in public transport electrification with electric buses, although the countries are at different stages of development. Romania, Poland, and Türkiye appear to follow an investment pattern in private electric vehicles. We found a pattern with low-cost two and three-wheelers in Central American countries (Nicaragua, Guatemala, and El Salvador). We recommend policies on electric mobility investment issues in developing countries.

Introduction and Motivation

Road transport electrification with electric mobility is one of the promising ways to reduce transport sector emissions. Electric mobility could also improve public transport service, urban mobility, and quality of life in urban areas (Viscidi, 2021). Besides, electric mobility could also offer the power sector a decentralised, clean power supply source, digitally connected, and flexible energy storage solutions. Increased investment in transport electrification is crucial for decarbonisation (Cantarero, 2019) in developing countries to mitigate climate change impacts. However, governments in developing countries often have limited budgetary allocations required for capital-intensive transport electrification investments. The economic problem of scarce resource allocation to alternative needs requires complex decision-making processes on what should be the priority investment decision (Bhattacharyya, 2011). The de facto reliance on multilateral and bilateral institutions' conditional debt financing and international aid is unsustainable and insufficient to meet many developing countries' investment needs. Moreover, it brings an associated risk of increased aid dependency and the difficulty of tackling complex, country-specific issues, in addition to the conditionalities to which recipient developing countries are subjected (Trotter and Abdullah, 2018). Developing countries also have high investment needs that could continue to increase with increasing power demand.

On the demand side, decarbonising the transport sector has implications for developing countries. These policies may reduce government revenues from fuel tax (Emodi et al., 2022). Moreover, developing countries need a lot of investments to cope with increasing power demand as their economies grow. On the supply side, what technology or electric mobility solution to invest in and which country remains critical for investors. We contribute to this debate with insight into what could be the emerging patterns of electric mobility investment technology solutions in developing countries with wholesale power markets and wholesale and retail power markets from the power and transport sector coupling context. We focus on developing countries with wholesale power markets and wholesale and retail power markets to identify emerging patterns that could support policy

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and investment decision-making. We attempt to answer the following research question: Is there a regional or continental pattern for electric mobility investment in developing countries with wholesale and retail power markets?

Applied Method

Building upon insight from the theoretical framework of the industrial organisation of electric utilities ex-post market reforms (Hunt, 2002), we extend the model to discuss the contemporary state of the electric utilities industrial model in developing countries, hypothesising the integration of electric mobility in the context of decarbonisation and digitalisation. Our hypotheses are full vertical integration plus peer-to-peer innovation with electric mobility (Model 1+), single buyer plus peer-to-peer innovation with electric mobility (Model 4+), wholesale market plus peer-to-peer innovation with electric mobility (Model 2+), and wholesale and retail market plus peer-to-peer innovation with electric mobility (Model 3+).

Then, we conduct case study analyses of the interaction of electric utilities and electric mobility in five developing countries (Ecuador, Peru, Nicaragua, Guatemala and El Salvador) with wholesale market power or wholesale and retail power markets to test our hypotheses. We use the framework to identify and classify developing countries. Then, building upon our previous works, Arowolo and Perez (2024a; 2024b), we conduct cross-country analyses of 15 countries in this paper.

Results

The case studies of the five countries in Model 3+ and Model 2+ analysed in this paper reveal insightful findings. First, electric mobility investments spurred by government policy support schemes to develop the market are in their infancy in these countries. Policy support is relatively nascent in Nicaragua, Ecuador, El Salvador, Peru, and Guatemala; most policy support schemes to incentivise electric mobility acquisition and charging infrastructure deployment were enacted between 2020 and 2022. Also, these markets appear to embrace low-capital-cost solutions such as electric motorcycles and electric tuk-tuks. This situation is despite their liberalised power sector for decades. It is worth noting that the small size of the power and transport sectors characterise the Central American countries (Nicaragua, Guatemala and El Salvador). The extant literature explains the ineffectiveness of competition in small power systems with small operational or installed generation capacity (Besant-Jones, 2006). In many small power systems, energy demand is often too low to allow the benefits of greater competition to manifest. The effectiveness of competition is hampered by the threshold effect or limited size of an electricity generation system below which competition will not produce the expected outcomes. Small power systems have characteristics which imply that the economic rationale for large electricity systems reform is not easily applicable to them because there are limited benefits from increased competition (Nepal et al., 2018; Rudnick and Velasquez, 2018).

Moreover, the limited size of market participants for small countries can further reduce the number of potential investors (Jamashb, 2006), not only in the power sector but also in electric mobility. We corroborate the existing literature by Grütter and Kim (2019), Rajper and Abrecht, 2020, and Dioha et al. 2022 that small power system size could be a challenge for electric mobility investment and deployment. Therefore, to effectively spur the electric mobility market in these countries, specially designed measures beyond enacting policy documents could spur electric mobility growth and create a conducive investment climate for private sector investors. Specific or tailor-made policies could further be required to develop these countries' electric mobility market. Despite reforms, it is noteworthy that these countries' power and transport sectors are not as advanced as other countries in our Model 2+ and Model 3+ classification, arguably due to the size of their power and transport sectors. Thus, distinct policy solutions are required to attract investments (Nepal et al., 2018). Furthermore, the level of reliability of the regulatory framework remains unclear. Nonetheless, the situation may improve in the future (Balza et al., 2020; Foster and Rana, 2020).

Our cross-country analyses for 15 countries combined the results from this paper and our previous works on the Philippines, Argentina, Romania, Poland, China, India, Brazil, Chile, Colombia and Türkiye. We find that the Latin American countries (Chile, Colombia, Brazil and Peru) appear to follow a pattern of attracting investment in public transport electrification with electric buses. However, the countries are at different stages of development. We could not substantially validate an emerging pattern for developing countries in Asia, Central America or Eastern European countries with wholesale power markets and wholesale and retail power markets. The countries

are implementing diverse solutions, including two- to three-wheelers, electric buses, electric jeeps, electric tuk-tuks, and private electric vehicles.

Conclusions

Many developing countries that made pledges to decarbonise and reduce GHG emissions are barely scratching the surface of their set goals. Transport electrification with electric mobility, which remains crucial in the decarbonisation strategy of many developing countries, is beset by investment challenges on the demand and supply side. On the demand side, the governments are financially constrained to implement the solutions. On the supply side, investors remain unsure of which country to make electric mobility invest in. This paper contributes to this debate from the power and transport sector coupling context, focusing on developing countries with wholesale power markets and wholesale and retail power markets. We attempt to answer the central research question of identifying if there is a regional or continental pattern to electric mobility investment technology solutions in developing countries.

We apply our conceptual framework to offer insights on electric mobility investment in developing countries to case studies of Peru, Ecuador, Nicaragua, Guatemala, and El Salvador. We find that there is existing government policy support for the electric mobility market in these countries. The markets could also attract electric mobility investments, albeit low-cost investment solutions such as electric motorcycles, electric tuk-tuks, and refurbished or second-hand electric vehicles. These could provide some promising decarbonisation potential, but the potential for digitalisation is still in its infancy in these countries. Then, we conduct a cross-country analysis for fifteen developing countries, including ten countries from our previous works. We find the following emerging pattern of electric mobility investments. Three Latin American countries - Chile, Colombia, and Argentina- appear to follow a pattern of attracting investment in public transport electrification with electric buses. The private electric vehicle market is developing in Eastern European countries - Poland, Romania, and Türkiye. In Central America, El Salvador, Guatemala, and Nicaragua are developing electric motorcycles and electric tuk-tuks.

We contribute to the extant literature in three significant ways. First, we argue that the threshold size effect of small power systems could also be influential in small transport systems. Second, with a cross-country analysis of fifteen countries with wholesale power markets and wholesale and retail power markets, we establish a notable investment pattern in some regions or continents. Third, we provide in-depth insights on electric mobility investment in developing countries in the power and transport sector coupling context. We offer the following policy recommendations for policymakers and potential investors interested in electric mobility investment issues in developing countries:

- Policymakers (demand-side)

Developing countries with wholesale and wholesale and retail power markets but small power and transport sectors may struggle to attract electric mobility investment without tailor-made policy interventions. Our analysis shows that Central American countries (Nicaragua, Guatemala, and El Salvador) have small power systems, buttressing the threshold size constraint in the literature. This effect means that competition will not produce the expected outcomes in fostering competition because of high transaction costs. This situation also influences the transport system and requires specific policy responses to attract investments. Therefore, policymakers could focus on carefully designed and context-specific solutions to spur electric mobility investments and market development in these countries.

A robust regulatory framework is required to implement public policy support schemes: In addition to the well-known government policy support schemes that are present in countries with wholesale and wholesale and retail power markets, robust regulatory frameworks are crucial to implement (on paper) policy schemes, and to facilitate an enabling investment climate for potential investors.

- Potential investors (supply-side)

Emerging pattern of low-cost electric mobility solutions in countries with small power and transport sectors: These countries with wholesale power markets in Central America, such as Guatemala, El Salvador, and Nicaragua, seem to be growing in the two- and three-wheeled electric vehicle and second-hand private electric vehicle markets.

Emerging pattern of private electric vehicles in Eastern Europe: Romania, Poland and Türkiye may follow the pattern with private electric vehicles and the deployment of charging infrastructure as observed in developed countries in Western Europe.

Emerging pattern of public electric bus electrification in Latin American countries with wholesale and retail power markets: There seems to be some emerging trend towards public electric buses in some Latin American countries (Chile, Colombia, and Argentina), although they are at different stages in their market development.

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