Modelling Singapore's Green Plan Policies on Electric Vehicle Adoption and Transport Emissions

Hugo Khaou[1], Bellam Sreenivasulu[2*]

[1] College of Design and Engineering, National University of Singapore, Singapore, 117576
Email: hugo.khaou@u.nus.edu

[2*] Residential College 4, National University of Singapore, Singapore, 138614
Email: rc4bs@nus.edu.sg. *Corresponding author: (Bellam Sreenivasulu)

This study examines how Singapore's policies promote electric vehicle (EV) adoption to support long-term sustainability goals. With transport contributing 12.01% of national GHG emissions in 2022, EV-focused measures under the Green Plan 2030—particularly subsidies and charging infrastructure investments—have driven early uptake (National Environment Agency [NEA], 2024a, p. 8). Applying a systems thinking and system dynamics (ST&SD) approach, a model was developed to capture interactions among six key subsystems, including government, electric vehicles, and the environment. By analysing the various initiatives and policies enacted under the Green Plan 2030, both causal loop diagram (CLD) and stock-flow diagram (SFD) were constructed to analyse policy impacts and system behaviour and explore the long-term effectiveness of these policies. An SFD (Figure 1) shows the interdependent relationships among the various subsystems.

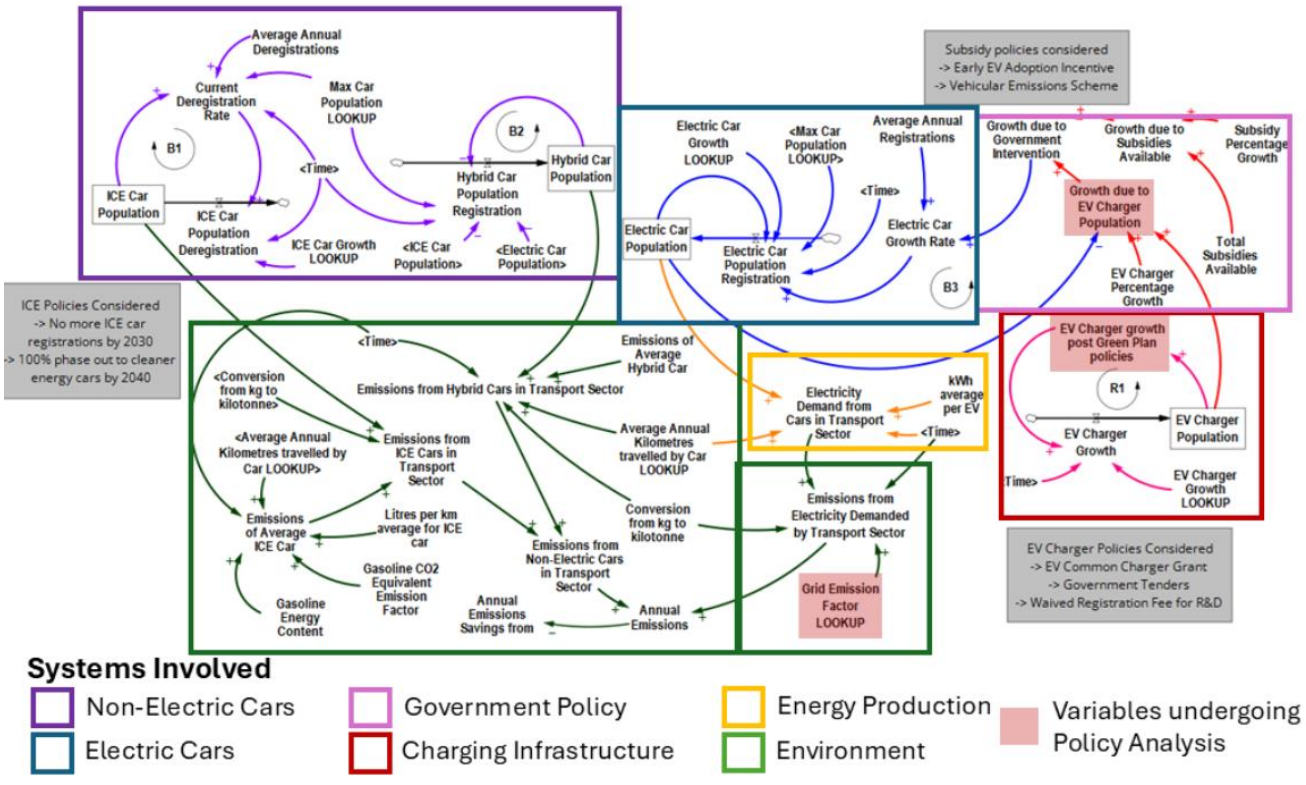

Figure 1. SFD (quantitative model) with policy insertions derived based on the CLD

Analysing the government interventions in electric car adoption and objectives outlined under the Green Plan, the impacts of current and future interventions on environmental targets and electric car populations are forecasted using Vensim PLE.

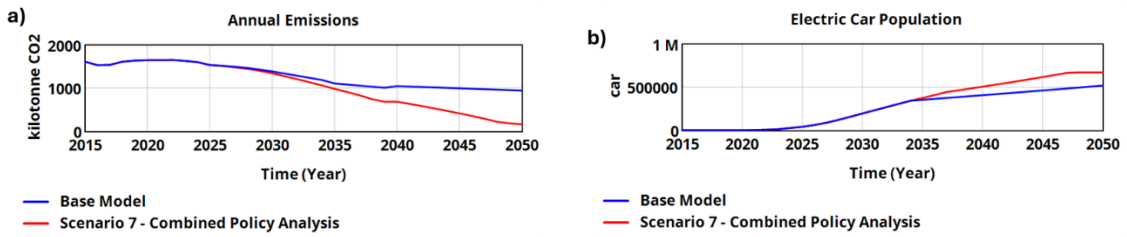

Figure 2. Policy simulation results

Under a combined policy scenario, simulation results (Figure 2) consider sustained government intervention impacting EVs and a reduction of Singapore's grid emission factor for energy production to 0.086 kg CO2/kWh by 2050. The model projects a potential for up to 1.45 million tonnes of emission savings by 2050 and the potential to attain 100% electrification by 2048. Model validity was assessed using both structural and behavioural validation conducted using available government data and projections, such as vehicle population data from 2015 to 2024. These findings suggest that whilst EV adoption will help to reduce emissions, achieving long-term sustainability goals requires policies implemented in the energy generation sector. Demonstrating the interlinked nature of Singapore's land transport sector with other key systems and the critical role that effective policy decisions play in reducing emissions. Additionally, whilst government intervention may promote EV adoption, the financial burden of these policies is an important consideration due to the high cost of subsidies and charging infrastructure investment.

This report provides relevant considerations for future decision making in the policies implemented to decarbonize Singapore's transport industry. Additionally, this report considers some of the future policies that have been announced by the Singaporean government targeting Heavy Electric Vehicles. The feasibility of attaining Singapore's sustainability goals is supported by the developed model, while highlighting the necessity of sustained intervention to achieve the desired outcomes.

References:

National Environment Agency. (2024a). *Singapore's First Biennial Transparency Report 2024* (Biennial Transparency Reports). https://www.nea.gov.sg/docs/default-source/cmd-documents/ghg-documents/singapore's-first-biennial-transparency-report-2024.pdf