

OSeMOSYS: Open Source Modeling System

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This is an edited extract from the following Compendium contribution: Managing the fiscal impacts of electric vehicles, public transportation, and biking

OSeMOSYS is a bottom-up energy system model, initially developed to assess the costs and benefits of net zero strategies for the energy sector (Howells et al., 2011; Godinez et al., 2020), but also recently applied to decarbonizing road transportation. In the latter context, the OSeMOSYS model starts by projecting demand for mobility (in passenger-kilometers per year) and freight (in tonne-kilometers per year), typically by 2050, estimated from assumed GDP and population scenarios. It then calculates the cost of satisfying these demands using different means of transportation, such as buses, bikes, walking, or private cars (distinguishing, in particular, between electric, diesel, and gasoline-fueled vehicles). The model accounts for capital costs, maintenance, and fuel expenses by multiplying the number of vehicles, the kilometers traveled, and fuel consumption by unit energy costs, which are taken as a given. It also estimates the cost to deploy the necessary infrastructure (such as bus lanes or charging stations).

The model then computes the costs and benefits of choosing a decarbonization scenario instead of a business-as-usual scenario. Finally, it computes the incidence of these costs and benefits on households, grouped by income quintile or region of residence. It also computes the costs for different types of firms, such as taxis, bus companies, or firms that use vehicles for their operations (think, for example, of a sales agent visiting clients using a company vehicle). To do this, it uses surveys that reveal the means of transportation typically used by different households. Other data sources include vehicle registration data, typically available to Ministries of Finance (MoFs), and energy balances, available in most countries.

Victor-Gallardo et al. (2024) assess the financial, fiscal, and distributional impacts of road decarbonization in a single framework, using OSeMOSYS, to which they add a tax and a distributional impact module. They have applied the model to Costa Rica, which was among the first developing countries to issue a National Decarbonization Plan (Costa Rica, 2019) and aims to reach net zero emissions by 2050. Key targets include electrifying 95% of its light vehicle fleet and 85% of its buses, increasing journeys by bike and on foot by 10%, and deploying liquefied petroleum gas and hydrogen vehicles in the cargo sector. However, today the Government heavily relies on road transportation for funding, with taxes on gasoline, diesel, vehicle ownership, and import duties making up 20% of its fiscal revenues (Ministry of Finance, Costa Rica, 2021).

The model findings show that between 2023 and 2050, decarbonizing transportation brings financial benefits worth 1.49% of GDP to households and firms (Victor-Gallardo et al., 2024). Financial benefits include, for instance, lower energy expenses that more than offset the higher upfront cost of buying an electric vehicle (EV) but exclude nonfinancial benefits such as a reduction in congestion or accidents (see Groves et al., 2020 for an estimation of these benefits). Absent tax adjustments, however, the Government of Costa Rica faces a fiscal loss of 0.41% of GDP. This is primarily due to reduced fuel tax revenue, which is only partially offset by increased revenue from property taxes and import duties (EVs are costlier to buy than petrol vehicles), and VAT on electricity. Finally, since the decarbonization plan reduces the total number of vehicles on the road, revenue from import and property taxes is lower than in the business-as-usual scenario by the end of the period.

The OSeMOSYS model is fully documented¹ and available for free.² It can easily be applied to other countries: for instance, it was recently used to investigate the same issue in Peru (World Bank Group, 2022).

¹ <https://osemosys-cr-v2.readthedocs.io/en/latest/>

² <https://github.com/EPERLab/osemosys-cr-v2>

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