

Article

Decarbonizing Urban Mobility: A Methodology for Shifting Modal Shares to Achieve CO₂ Reduction Targets

Paulo J. G. Ribeiro ^{*}, Gabriel Dias  and José F. G. Mendes 

CTAC—Centre for Territory Ambient and Construction, School of Engineering, University of Minho, 4800-058 Guimarães, Portugal; id8651@alunos.uminho.pt (G.D.); jfgmendes@civil.uminho.pt (J.F.G.M.)

^{*} Correspondence: pauloribeiro@civil.uminho.pt

Abstract: In most urban areas, mobility is predominantly reliant on automobiles, leading to significant negative environmental impacts, such as noise pollution, air pollution, and greenhouse gas emissions. To meet the objectives of the Paris Agreement, urgent action is required to decarbonize the mobility sector. This necessitates the development of assessment and planning tools to create effective decarbonization scenarios. Urban mobility must evolve to reduce dependency on fossil fuels by increasing public transport options and promoting active modes of transportation. This research presents a methodology to estimate the modal share required to shift car users to active modes and public transport, thereby achieving future CO₂ emission reduction targets in the road transport sector. A case study in Braga, Portugal, demonstrates that to meet the 2040 target of 59,150 tons of CO₂, 63% of trips must be made using active modes (e.g., walking and cycling) and 32% by public transport.

Keywords: urban mobility decarbonization; modal shift; active modes of transport; public transport; CO₂ reduction



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1. Introduction

In 2022 alone, the domestic transport sector was responsible for deploying more than 800,000 kt CO₂ eq in the European Union [1]. Yet, greenhouse gas (GHG) emissions, after dropping during the COVID-19 pandemic, experienced growth in 2021 and 2022 [1]. To stop climate change from becoming worse, actions must be taken to cut GHG significantly, to adapt to the changes happening now, and, in the future, to limit the damage [2]. Therefore, to achieve the goal of reducing 90% of the greenhouse gas emissions from transport and for the European Union to become a climate-neutral economy by 2050, transport modes need to be more sustainable. Sustainable transport alternatives must be made widely available, and incentives to drive the transition should be put in place [3].

The car is still the most common transport mode used for everyday mobility and for long-distance trips, with local car trips being longer than local trips made with alternative modes of transport [4]. Diesel is still the fuel used for the largest share of urban displacements in countries such as Greece (86%) and Portugal (63%) [5]. Therefore, it is of utmost importance to evaluate urban mobility while taking into consideration the reduction in fossil energy consumption in the transport sector [6].

The widespread use of fossil fuels to power transport options also contributes to the increase in various respiratory diseases and allergies in drivers and the general inhabitants of any location [7–9], which jeopardizes the well-being of the population, the competitiveness of urban areas, and the level of sustainability.

Hence, the re-establishment of sustainable mobility plans needs to thrive in the opposite direction so that society can move towards a low-carbon emission scenario. Urban mobility needs to thrive in different directions to reduce the dependency on fossil fuels, allowing the implementation of new sources of power for vehicles, such as the introduction of electric and hydrogen-powered cars and public transport [10]. Despite the shift in the