



# International comparisons of energy and environmental efficiency in the road transport sector



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## ABSTRACT

The present work provides an international comparison of the energy intensity and the carbon dioxide intensity in road transport for a group of 90 countries over the period 1980–2012. This paper attempts to perform a comparative analysis to find the most appropriate mapping of the energy performance in road transport taking into account the three dimensions of sustainable energy development, namely road transport-related energy consumption, economic growth and carbon dioxide emissions. An important result of the study is the inverse relationship between energy efficiency and environmental efficiency. Through the calculated Theil coefficient, our empirical findings highlight the existence of spatial and temporal disparities between countries. In 2012, Tunisia occupies the 48th and the 38th rank respectively in terms of energy and environmental efficiency. Based on a general index of energy performance in the road transport sector, it is deemed to have a medium–high energy performance by occupying the 34th rank. The study shows the importance of enhancing a number of policies for the road transport system through the joint improvement of the fuel price policy, of the road infrastructure policy and of the fuel-efficient road vehicles policy, in order to maintain sustainable energy road transport.

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## 1. Introduction

Researches about the development topic at both national and international levels focus mainly on the energy consumption in the road transport sector, especially in the current context of environmental urgency and of instability of oil prices. The key question is: Should we replace fossil energies with less-carbon energies that can possibly be more damaging, or should we use energy more efficiently and in harmony with the legitimate needs?

The investigation of the relationship between the triplet energy-sustainable development-road transport deserves some rigor in terms of conceptualization. By exploring the literature, the convergence of problematic and theoretical issues between the concept of sustainable energy development [1] and the concept of

sustainable transportation [2] is justified mainly by the existence of common roots and a strong interaction between the two concepts.

The convergence between these two concepts aims to develop, in parallel, the importance of energy sustainability and transport sustainability by promoting the capacity of joint action in order to maintain the double sustainability approaches. We must find the optimal combination between less and/or better consumption as a purpose of sustainable energy development on the one hand, and less and/or better transportation as a purpose of sustainable transportation on the other hand.

Thus, sustainable transportation is too complex an issue to identify which sustainable energy development can be introduced easily within its organization. In this sense, it is relevant to know which of them should adapt to the organizational principles of the other. Sustainable energy development is both a strong challenge to the sustainable mobility strategy and a framework governing the performance of this strategy. The sustainable energy development questions mainly the growth of traffic flow in order to achieve sustainable transportation, which may currently be qualified as unsustainable, given the very high levels of energy consumption

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caused by this sector. The adoption of a consensual and integrated approach consists of the retention of sustainable energy development as both the cause and the consequence of sustainable transportation. In this perception, the sustainable energy transport presents a way of doing, a development philosophy and a purpose in itself.

The role of the fuel consumption in the transition to sustainable energy road transport is still important. The challenge is to define a model which not just minimizes the negative impacts of energy consumption of the road transport sector, but which maximizes the positive effects on the economic, social and environmental dimension. This transition consists of finding a model that seeks to balance between the “consuming better/consuming less” road fuel on the one hand, and the “driving better/driving less” on the other hand.

Over the last ten years, several initiatives have focused on the characterization of the sustainability of road transport system considering the close link with the sustainable energy development problematic. The main consensus is the affirmation that the treatment of sustainable transportation passes through the establishment of efficient strategies incorporating energy sustainability.

Our investigation is inspired from two main studies: the first is the thesis of [3] who carried out an international comparison to rank Turkey compared to 130 other countries based on energy and environmental efficiency during the period 1990–2005. The second is the study of [4], whose objective is to classify 133 countries according to the energy intensity over the period 1960–2010. In our study, we use the same approach but for a disaggregated sector which is the road transport one. The choice of the road transport sector is guided by its strong implication and its specificity on the economic and environmental dimension of sustainable development.

The purpose of this paper is thus to extend the discussion about the problematic of energy performance in the road transport sector through an international comparison based on energy efficiency measured by the energy intensity, and the environmental efficiency measured by the carbon dioxide (CO<sub>2</sub>) emissions intensity for a group of 90 countries during the period 1980–2012. The ranking of countries in terms of the general energy performance index in the road transport sector provides an insight for makers, and allows them to identify the difficulties of the energy transition towards sustainable road transport energy and the implementation of efficient energy system that ensures both environmental sustainability and economic growth, as well as reducing road transport-related energy consumption.

The remainder of the paper is organized as follows: Section 2 presents a review of literature on sustainable energy for road transport. It outlines the interaction between sustainable energy development and sustainable transport. Moreover, it analyses the role of the improvement of energy and environmental efficiency on the implementation of energy conservation policy and climate-resilient strategies. In Section 3, we present the data and the methodology used. Section 4 presents the empirical results and their discussion. Special attention is devoted evaluating the energy sustainability degree of road transport sectors and defining an action plan to fulfill the challenge of energy performance in Tunisia. Finally, Section 5 concludes with the discussion of some policy implications.

## 2. Literature review

Energy consumption constitutes a challenge for sustainable road transport for two basic reasons. The first reason is linked to the environmental pressures. The second refers to the inadequacy of policies which essentially seek to influence the production modes given that the increase of the productivity of the resources is in part canceled by the modification of the consumer behavior.

In literature, a large majority of studies have discussed the question of relationship between economic growth, carbon dioxide emissions and energy consumption. Alam et al. [5] investigated the possible existence of a dynamic causality between energy consumption, electricity consumption, carbon emissions and economic growth in Bangladesh. The authors found an unidirectional causality running from energy consumption to economic growth both in the short and the long-run. Alshehry et al. [6] used the cointegration approach to evaluate the dynamic causal relationships between energy consumption, energy price and economic activity in Saudi Arabia. The general finding stipulates the existence of a long-run relationship between energy consumption, energy price, carbon dioxide emissions, and economic growth.

For the case of transport, the relationship between economic growth, transport energy consumption and CO<sub>2</sub> emissions has been investigated recently. Zhang et al. [7] identified the relationships between transportation energy consumption and its driving factors. The authors mentioned that transportation activity effect is the most important contributor to energy consumption increases in the transportation sector. They concluded that the energy intensity effect plays the dominant role in decreasing energy consumption. For the case of Tunisia, Mraïhi et al. [8] discussed the effects of economic, demographic and urban factors on the evolution of transport energy consumption over the period 1990–2006. Their results show that vehicle fuel intensity, vehicle intensity, GDP per capita, urbanized kilometers and national road network are considered as the main driving factors of energy consumption change in the road transport sector in Tunisia. Tiwari and Gulati [9] examined the causes for the change in energy consumption in the transport sector in India. They found that the changes in the energy consumption are attributed to growth in transport volume, structural change or modal shift, and energy intensity. Al-Ghandoor et al. [10] analyzed the gasoline consumption in Jordan's transportation sector and identified the main factors affecting its future demand. They concluded that registered vehicles, income level and gasoline price variables are strongly linked and must be coordinated to lead to sustainable energy development in transport sector.

A survey of the existing literature [11] shows that there are strong theoretical and managerial interests to mutually enrich and consolidate the two facets of sustainability-sustainable energy development and sustainable transport-under the concept of the sustainable energy transport. This links the triplet of sustainable development-energy-transport. Perhaps, this rapprochement can lead to more promising sustainable development and open the way for multiple empirical investigations.

Concerning sustainable energy development, most of the studies have discussed the theoretical framework such as the work of [12] and [13]. It remains a composite concept composed of two fundamental laws. The first relates to the physical world, the energy, and is governed by objective laws. However, the second, sustainable development returns to a society philosophy, necessarily non-normative.

Consequently, sustainable energy development requires development modes which provide reliable energy services at a lower cost, demand less energy and produce fewer polluting gases [14].

The key is to consume less and better and even produce otherwise if we consider the role of technology supply. In other words, we should develop and adopt a rigorous approach to an independent, secure, sustainable and fair energy future. This quadruple forms a complex equation to solve, the fundamental principle of which is the realization of political, economic, social and environmental security [15]. Each policy developed in this sense is at the crossroads of the social, environmental and green economics. All these theories have participated in achieving a sustainable energy future [16].

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