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## LIVRO DE RESUMOS

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# A DEA Approach to Evaluate the Electric Mobility Deployment in European Countries

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The European green deal embodies an ambitious plan to fight the climate change, aiming to achieve carbon neutrality, by 2050. Transportation is the remaining sector where emissions are still above the 1990 emissions level, being the road transportation the biggest emitter and the main share of transport energy demand. Main elements of the strategy are the increasing efficiency of the transport system and the use of low-emission energy sources for transport, which can be accomplished by the deployment of the electric mobility. This work aims to assess the performance of European countries on the deployment of low-emission alternative energies and vehicles in road transportation. In order to achieve this aim, a model based on Data Envelopment Analysis (DEA) is used to calculate a composite indicator for several European countries, that aggregates several sub-indicators built from a dataset for the 2019 year. Results obtained indicate that most European countries have potential to improve their practices towards on better road transport sustainability, by emulating the best practices observed on the benchmarks. Additionally, the relative strengths and weaknesses of each country in terms of road sustainability are further explored.

**Keywords:** DEA, Performance, Electric mobility

## A DEA Approach to Evaluate the Electric Mobility Deployment in European Countries

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### Introduction

The European green deal embodies an ambitious plan to fight the climate change, aiming to achieve carbon neutrality, by 2050. Transportation is the remaining sector where emissions are still above the 1990 emissions level, being the road transportation the biggest emitter and the main share of transport energy demand.

Main elements of the strategy plan are the **increasing efficiency of the transport system** and the use of **low-emission energy sources** for transport, which can be accomplished by the deployment of the battery electric vehicles and plug-in hybrid electric vehicles (PEV).

This work aims to assess the performance of European countries (27 EU and United Kingdom) on the deployment of low-emission alternative energies and vehicles in road transportation. A Benefit-of-the-doubt (BoD) model based on Data Envelopment Analysis is used to calculate a composite indicator (CI) for several European countries, aggregating several sub-indicators built from a dataset for the 2019 year.

### Methodology and Results

#### Data and Model

Set  $M=8$  the selected sub-indicators  $i$ , being  $m=5$  isotonic and  $M-m=3$  reverse, to assess the road sustainability performance of EU countries:

	Renewable energy	Public transport length	PEV market share	Industrial Prod. Index (IPI)	GHG Emissions Intensity	Energy Intensity	New car registrations
Mean	0.088	0.023	17.727	1.105	2.100	130.200	122.237
St.dev.	0.003	0.002	4.277	0.029	0.019	7.040	15.713
Max	0.203	0.121	28.400	0.140	1.210	193.031	157.600
Min	0.033	0.013	9.400	0.004	0.973	0.355	50.400

using the BoD model proposed by [1] with proportional virtual weight restrictions [2] for a constant  $k \in ]0, 1[$  to assess the CI for each country  $j_0$ :

$$CI_{j_0} = \max \sum_{i=1}^m w_i y_{ij_0} - \sum_{i=m+1}^M w_i y_{ij_0}$$

s.t.

$$\sum_{i=1}^m w_i y_{ij} - \sum_{i=m+1}^M w_i y_{ij} \leq 1 \quad \forall j = 1, \dots, s$$

$$\frac{1}{M} (1-k) \leq \sum_{i=1}^m w_i y_{ij_0} \leq \frac{1}{M} (1+k) \quad w_i = 1, \dots, M$$

$$w_i \geq 0 \quad \forall i = 1, \dots, M$$

If no reverse sub-indicators, this model is equivalent to the BoD model [3]

#### Results

Analysis of the CI achieved in 5 scenarios with BoD model for each country using  $k=0.5, 0.6, 0.7, 0.8$  and  $0.5$  (mean):

Performance assessment of EU countries in the selected scenario with  $k=0.8$ :

Optimal weight structures for each country using  $k=0.8$ :

### Conclusions

- CI results are robust for variations of  $k$ , except with  $k=0.9$ , where higher variations were observed. Scenarios with  $k=0.8$  is adopted as a trade off between robustness and flexibility.
- 6 benchmarks are identified (AUS, DEN, IRE, LUX, NET, SWE), the mean of CI is 0.66 and St.dev. is 3.27. Most countries have potential to improve road transport sustainability following the best practices adopted mainly by NET and SWE.
- The model allocates more weight to the isotonic sub-indicators (average share=79%) than to the reverse ones (average share=21%) in which the lowest average share is attributed to the electric mobility (4%).
- The performance assessment for each country tends to attribute high proportion to the sub-indicators with higher relative performance and a low proportion to the sub-indicators with poor relative performance, being relevant to identify its strengths and weaknesses.

### Main References

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