Analyzing Morocco's Electricity Consumption Changes with an LMDI Decomposition Model: A Global and Sectoral Perspective

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Abstract. Over the past decade, Morocco has experienced a surge in electricity demand, driven by economic growth and population expansion. This study aims to delve into the factors influencing electricity consumption in Morocco from 2000 to 2020, examining both the overall national trends and sector-specific dynamics. Indeed, we employ the logarithmic mean Divisia index (LMDI) to assess changes in electricity consumption, considering various components like electricity's share, energy intensity, economic structure, economic activity, and population. At the national level, our findings indicate that economic growth has been the primary driver, contributing 66.22% to the total change in electricity consumption, followed by electricity's share effect (39.15%), population scale (29.44%), and the sectorial structure effect (10.85%). Conversely, energy intensity exhibited a declining trend, acting as a restraining factor. Among the analysed sectors, we observed distinct patterns that exhibited some degree of variation. While the agricultural, transport, and residential sectors were primarily affected by the production-per-capita effect, the industrial and commercial sectors were mainly influenced by the intensity effect. The results mentioned above highlight the significance of recent efforts to improve energy efficiency within the Moroccan economy. They also emphasize the necessity of further developing these strategies and introducing novel approaches to rationalize electricity consumption.

Keywords: LMDI; Electricity; Energy sector; Morocco

1 Introduction

Morocco still heavily relies on the importation of fossil fuels and a private sector that controls 84% of electricity production and nearly all energy distribution [1]. Despite an ambitious program and billions of dirhams invested in the development of renewable energies, particularly solar power, including one of the world's largest Concentrated Solar Power (CSP) plants, Morocco's energy mix in 2021 is still dominated by hydrocarbons, accounting for

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These hydrocarbons are mainly used for transportation, while coal continues to dominate electricity production at 33% [2].

The transportation sector remains the largest energy consumer in Morocco, accounting for 35% of the country's total consumption in 2020 [3]. Almost entirely reliant on fossil fuels, it is responsible for around 50% of the national energy bill, which amounted to over 4 billion euros in 2018, and contributes to 20% of the trade deficit. Then comes the residential sector, which ranks second in terms of final energy consumption (28%), followed by the industrial (19%), agricultural (9%), and commercial sectors (8%) [3].

In terms of electricity production, coal remains the primary source of electricity to this day, accounting for 65% in 2020. In this regard, Morocco has set several objectives, including increasing the share of renewable energy in installed capacity to 42% in 2020, 52% by 2030, 70% by 2040, and 80% by 2050 [1]. However, despite all the efforts made, it only reached 38% by the end of 2022 [3]. With this rate, renewable energy sources accounted only for 19% of the national production in 2019, with wind power contributing 11%, hydroelectric power 4%, and solar power 4%, while the rest was derived from fossil fuels. The second objective is to reduce energy consumption by at least 20% in the Kingdom by 2030 [1]. This reflects the pressure that Morocco faces in terms of energy and electricity supply, particularly for sustaining economic growth and the development of various sectors.

Several studies have claimed an upward trend in electric power consumption in Morocco by the end of 2030. The report published by the IEA [4] predicts that the demand for electricity in Morocco will increase at an annual rate average of 2% between 2023 and 2025. Jamii and Maaroufi [5] expected that by 2030 electricity consumption will continue to grow and be between 39639.09 GWh and 53589 GWh. Haouraji et al. [6] also reported that residential electricity is expected to experience a significant increase between 2016 and 2030 (approximately 115%). Considering the current situation and the forecast provided, there is a growing importance in studying the historical patterns and future prospects of electricity, along with the factors that influence their fluctuations. This research aims to achieve two main objectives: firstly, to examine the changes in electricity in Morocco over the past decade, and secondly, to comprehend the underlying driving forces behind these changes. To accomplish this, we will utilize the Divisia methodology, known for its advantageous characteristics which will be further elucidated. Indeed, we conducted an analysis that decomposed the electricity consumption into five key factors: share of electricity, energy intensity, economic structure, economic activity, and population effects. We conducted the analysis at both global and sectoral levels of disaggregation. The findings from this study will be valuable in developing targeted actions and measures for each sector, with the aim of rationalizing electricity consumption.

The structure of this paper is as follows. In Section 2, we present the literature review. In Section 3, we outline the methodology, employing the Logarithmic Mean Divisia Index (LMDI) decomposition method to analyse the evolution of electricity in Morocco from 2000 to 2020. In Section 4, we present and analyse our results, both on a global scale and within specific sectors. This analysis will enable us to assess the contribution of different determining factors to the overall variation. Finally, Section 5 summarizes the key findings and provides practical guidelines for energy policy-making.

2 Literature Review

This research paper utilizes the Index Decomposition Analysis (IDA) technique, which is widely utilized in the fields of energy and environmental analysis. IDA is recognized as one of the prominent index-based decomposition methods, offering a wide range of applications. It is favoured due to its beneficial characteristics, such as its ability to provide insightful results without necessitating extensive data requirements. For instance, in 2009, Achão and
Schaeffer [7] used the LMDI approach to assess the effects of economic activity, demographic structure, and intensity on energy consumption in Brazil. They reported that the number of consumers was the main catalyst for the rise in electricity consumption, followed by intensity effects, while the structure tended to reduce consumption. In 2012, Rogan et al. [8] employed the LMDI approach to analyse the factors contributing to the growth in gas consumption within the residential sector in Ireland. They concluded that the increase in the number of customers played a pivotal role in driving the growth of gas consumption. Yeo et al. [9] used the LMDI technique to identify the primary factors influencing CO2 emissions in two countries, China and India. The results showed that GDP growth significantly contributed to CO2 emissions, while energy intensity had the effect of reducing carbon dioxide emissions in the residential sectors of both countries. In China, Fan et al. [10] used the LMDI to study the impact of urbanization on energy consumption. Their findings indicated that 15.4% of the total fluctuations in energy consumption could be attributed to the impacts of urbanization. In 2020, Huang [11] employed the same method to explore residential energy consumption in Taiwan during the period 2014-2017. The investigation demonstrated that energy growth was predominantly influenced by climatic factors. Additionally, they found that imposing minimum energy performance standards could offer significant potential for consumption reduction. However, to our knowledge, only two studies applying decomposition analysis have been conducted in Morocco, and none of them have focused on electricity consumption. The initial study was conducted in 2017, Kharbach and Chfadi [12] aimed to identify the primary factors responsible for carbon emissions in the transportation sector in Morocco. Their analysis led them to the conclusion that vehicle ownership and population were the key drivers behind the overall changes in energy consumption in transportation. The second study was conducted by Engo [13] in 2021, who combined the LMDI approach with the Tapio method to analyse carbon emissions from industrial development in Egypt, Morocco, Algeria, and Tunisia. The results revealed that CO2 emissions and industrial growth moved in opposite directions over the period of 1990-2016, and the economic growth rate exceeded that of carbon emissions in Morocco.

3 Data and method

3.1 Data collection

Population, GDP, and household final expenditures data are collected from the World Bank [14], while sectoral value added in GDP data is obtained from the national accounts published by the national Haut Commissariat au Plan [15]. Additionally, data on electricity consumption, total final energy consumption, and energy consumption in various sectors (residential, transportation, agriculture, industrial and commercial) is sourced from the International Energy Agency [3]. The energy and electricity consumption are expressed in TJ, while the GDP and household final expenditures are expressed in constant 2015 dollars.

3.2 Method

Based on the LMDI decomposition method introduced by Ang and Liu [16], energy consumption can be analyzed in terms of three distinct effects: the "economic aggregation effect," the "energy intensity effect," and the "energy structure effect." The LMDI method is specifically chosen for its strong theoretical foundation, high adaptability, and capability to achieve a complete decomposition, ensuring no unexplained residual terms in the outcomes [17] [18]. Consequently, the LMDI model, based on the Kaya identity [19], is employed to
break down the changes in electricity consumption in Morocco. The decomposition equation is presented below:

\[ E_{\text{elec}}^t = \sum_i E_{\text{elec}}^i t = \sum_i \frac{E_{\text{elec}}^i t}{E_{\text{elec}}^i t} \cdot \frac{E_{\text{GDPP}}^t}{E_{\text{GDPP}}^t} \cdot \frac{E_{\text{GDPP}}^t}{P^t} \]  

where \( E_{\text{elec}}^i t \), \( E_{\text{elec}}^i t \) and \( E_{\text{GDPP}}^t \) represent the electricity consumption, energy consumption and GDP of sector \( i \) in year \( t \). \( GDP^t \) and \( P^t \) refer to GDP and total population in year \( t \). 

\( SE_{\text{elec}}^i t \) shows the share of the sectorial electricity consumption to the total energy consumption of sector \( i \) in year \( t \); \( E_{\text{IL}}^i t \) and \( ES^t \) are, respectively, the energy intensity and the economic structure of sector \( i \) in year \( t \); \( GDP^t \) and \( P^t \) represent the per capita GDP output and the population in period \( t \), respectively.

The variations in electricity consumption (\( \Delta E_{\text{elec}}^t \)) within the time interval \([t-1; t]\) are then calculated using the LMDI method. \( \Delta E_{\text{elec}}^t \) is the sum of the change of electricity share effect (\( \Delta SE_{\text{elec}}^i t \)), the change in energy intensity (\( \Delta E_{\text{IL}}^i t \)), the variation of economic structure (\( \Delta ES^t \)), the change of economic activity effect (\( \Delta GDP^t \)), and the change of population effect (\( \Delta P^t \)). Thus, the expressions for the LMDI decomposition of electricity consumption in Morocco are as follows:

\[ \Delta E_{\text{elec}}^t = E_{\text{elec}}(t) - E_{\text{elec}}(t - 1) = \Delta SE_{\text{elec}}^i t + \Delta E_{\text{IL}}^i t + \Delta ES^t + \Delta GDP^t + \Delta P^t \]  

Through the LMDI technique, the effects of the five factors are shown in Eqs.(3)-(7).

\[ \Delta SE_{\text{elec}}^i t = L(E_{\text{elec}}^i t, E_{\text{elec}}^i t - 1) \cdot \ln \frac{E_{\text{elec}}^i t}{E_{\text{elec}}^i t - 1} \]  

\[ \Delta E_{\text{IL}}^i t = L(E_{\text{elec}}^i t, E_{\text{elec}}^i t - 1) \cdot \ln \frac{E_{\text{IL}}^i t}{E_{\text{IL}}^i t - 1} \]  

\[ \Delta ES^t = L(E_{\text{elec}}^i t, E_{\text{elec}}^i t - 1) \cdot \ln \frac{ES^t}{ES^t - 1} \]  

\[ \Delta GDP^t = L(E_{\text{elec}}^i t, E_{\text{elec}}^i t - 1) \cdot \ln \frac{GDPP^t}{GDPP^t - 1} \]  

\[ \Delta P^t = L(E_{\text{elec}}^i t, E_{\text{elec}}^i t - 1) \cdot \ln \frac{P^t}{P^t - 1} \]  

where the function \( L(a, b) \) is the logarithmic mean of two positive numbers "a" and "b." It is defined as follows:

\[ L(a, b) = \frac{a - b}{\ln a - \ln b} \]  

The electricity share (SElecC) represents the influence of electricity consumption on the overall change in energy consumption. Energy intensity (EI) measures the combined effect of energy and technological productivity enhancements. Sectorial structure adjustment (ES) reflects the impact of changes in sector composition on electricity utilization. Economic activity captures the economic growth impact across society. Population change highlights the consequences of population growth on electricity consumption.

4 Results and discussion
Using the decomposition defined in Eq.2, we estimated the contribution of the determining factors to the total electricity consumption in Morocco during the survey period. The outcomes of the decomposition analysis (Fig.1 and Table 1) unveil three key findings:

(a) The overall effect of electricity share, sectorial structure, economic growth and population scale on electricity consumption is positive, while the overall effect of energy intensity is negative.

(b) The variations in per capita production significantly marked the evolution of electricity consumption throughout the study period except for 2016 and 2020. The cumulative effect of ΔGDPP is an increase of 47831 TJ over the period, which represents 66.22% of the total variation of electricity consumption. These findings strongly support the conclusions drawn by [20], emphasizing the significance of implementing alternative strategies that promote both economic growth and a rational use of electricity.

(c) Over the study period, the energy intensity plays the role of restrictive effect, contributing to the reduction in electricity consumption by 45.66%. At this stage, we cannot attribute this solely to the energy efficiency resulting from research and the promotion of greener electricity, the development of household appliance technologies, and the implementation of energy-saving policies, as there is another significant factor. In fact, the price per kilowatt-hour (KWH) is very high in Morocco compared to other countries with a similar income level (lower middle-income group). The proposed electrical energy for households in 2020 costs $0.04 per kWh in Algeria, $0.05 per kWh in Egypt and Turkey, and $0.07 per kWh in Tunisia [21]. In contrast, Morocco lags far behind these countries with a cost of $0.13 per kWh. This cost is very close to that of Bulgaria ($0.13) and Norway ($0.14) [21], despite Norway having a per capita income of $75,954 compared to $3,367 in Morocco [22]. This situation slows down the consumption of electricity in many sectors of Morocco.

![Graph showing total cumulative effects from 2000 and 2020](image_url)
Table 1. Results of the breakdown of Electricity Consumption in Morocco.

<table>
<thead>
<tr>
<th>Year</th>
<th>ΔSElecC</th>
<th>ΔEI</th>
<th>ΔES</th>
<th>ΔGDPP</th>
<th>ΔP</th>
<th>ΔElecC</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000-2001</td>
<td>715,03</td>
<td>-364,85</td>
<td>-1479,93</td>
<td>2721,34</td>
<td>618,42</td>
<td>2210</td>
</tr>
<tr>
<td>2001-2002</td>
<td>20,20</td>
<td>320,44</td>
<td>416,31</td>
<td>889,36</td>
<td>632,69</td>
<td>2279</td>
</tr>
<tr>
<td>2002-2003</td>
<td>5613,77</td>
<td>-5775,53</td>
<td>1178,22</td>
<td>2406,85</td>
<td>642,70</td>
<td>4066</td>
</tr>
<tr>
<td>2003-2004</td>
<td>-6092,41</td>
<td>6769,77</td>
<td>528,39</td>
<td>1957,04</td>
<td>706,21</td>
<td>3869</td>
</tr>
<tr>
<td>2004-2005</td>
<td>1910,16</td>
<td>1072,57</td>
<td>-130,08</td>
<td>1163,49</td>
<td>804,87</td>
<td>4821</td>
</tr>
<tr>
<td>2005-2006</td>
<td>3711,60</td>
<td>-3107,37</td>
<td>418,94</td>
<td>3982,92</td>
<td>868,91</td>
<td>5875</td>
</tr>
<tr>
<td>2006-2007</td>
<td>2522,86</td>
<td>-2545,56</td>
<td>2150,37</td>
<td>1559,11</td>
<td>922,21</td>
<td>4609</td>
</tr>
<tr>
<td>2007-2008</td>
<td>852,92</td>
<td>-1942,65</td>
<td>533,84</td>
<td>3390,21</td>
<td>970,67</td>
<td>3805</td>
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<tr>
<td>2008-2009</td>
<td>1080,43</td>
<td>-3175,22</td>
<td>1439,14</td>
<td>2277,80</td>
<td>1012,84</td>
<td>2635</td>
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<tr>
<td>2009-2010</td>
<td>1439,38</td>
<td>-450,36</td>
<td>595,94</td>
<td>2012,01</td>
<td>1082,04</td>
<td>4679</td>
</tr>
<tr>
<td>2010-2011</td>
<td>1664,12</td>
<td>-189,76</td>
<td>752,89</td>
<td>3338,86</td>
<td>1186,88</td>
<td>6753</td>
</tr>
<tr>
<td>2011-2012</td>
<td>3753,12</td>
<td>-1851,77</td>
<td>1908,96</td>
<td>1527,38</td>
<td>1287,32</td>
<td>6625</td>
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<tr>
<td>2012-2013</td>
<td>725,31</td>
<td>-2452,47</td>
<td>-218,05</td>
<td>3085,32</td>
<td>1339,89</td>
<td>2480</td>
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<tr>
<td>2013-2014</td>
<td>4288,38</td>
<td>11738,23</td>
<td>-6129,35</td>
<td>16626,54</td>
<td>1348,67</td>
<td>4396</td>
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<tr>
<td>2014-2015</td>
<td>-450,06</td>
<td>-364,56</td>
<td>-1247,37</td>
<td>3188,93</td>
<td>1335,06</td>
<td>2462</td>
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<tr>
<td>2015-2016</td>
<td>1860,65</td>
<td>979,03</td>
<td>631,08</td>
<td>-767,69</td>
<td>1342,93</td>
<td>4046</td>
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<tr>
<td>2016-2017</td>
<td>-637,75</td>
<td>398,75</td>
<td>-393,52</td>
<td>4274,37</td>
<td>1362,15</td>
<td>5004</td>
</tr>
<tr>
<td>2017-2018</td>
<td>-1792,71</td>
<td>-7112,14</td>
<td>5029,02</td>
<td>2223,74</td>
<td>1304,09</td>
<td>-348</td>
</tr>
<tr>
<td>2018-2019</td>
<td>916,67</td>
<td>-861,69</td>
<td>606,34</td>
<td>2136,16</td>
<td>1236,52</td>
<td>4034</td>
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<tr>
<td>2019-2020</td>
<td>6180,56</td>
<td>-589,62</td>
<td>1248,33</td>
<td>10162,59</td>
<td>1258,32</td>
<td>-2065</td>
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<tr>
<td>2020-2021</td>
<td>28282,22</td>
<td>-32981,23</td>
<td>7839,49</td>
<td>47831,13</td>
<td>21263,39</td>
<td>72235</td>
</tr>
</tbody>
</table>

In % 39,15 -45,66 10,85 66,22 29,44 100
Upon examining the findings across various economic sectors (refer to Figures 2 to 5), it became evident that per capita income played a prominent role in most sectors, with the exception of the industrial and commercial sectors. In these sectors, the main determining factor was the intensity of energy usage.

Concerning the agricultural sector (Fig. 2), a very significant increase in electricity usage was observed throughout the examined timeframe. This mainly due to the per capita production effect and the electricity share effect, with a contribution of 5259 TJ (47.82%) and 3764 TJ (34.22%), respectively. This clearly suggests the need to examine the analysis of opportunities for deploying renewable energy technologies and energy efficiency practices in agriculture (solar pumping, efficient lighting etc...). The energy intensity effect was marginally positive, albeit without significant influence on the outcome. On the other hand, the sectorial sector effect was negative, representing the sole factor that partially countered the upsurge in electricity consumption.

In the case of the residential sector (Fig. 3), economic growth has been the primary driver of ElecC (contributing proportionally to 56.36%). This implies that economic growth in Morocco directly leads to annual increases in electricity consumption. The population effect has also had a significant influence on electricity growth (contributing proportionally to 25.52%). One main reason could be the increasing urbanization with population growth in Morocco, which have a relatively substantial impact on electricity consumption. As for energy intensity, considered the main inhibiting factor, it plays a restrictive role (contributing 20.40%). In fact, ΔEI maintained a negative sign in most years, except for 2001, 2004, 2019, and 2020, indicating energy consumption savings in residential areas. These improvements can be attributed, on the one hand, to Moroccan energy-saving policies [23], and on the other hand, to the technological advancements of household appliances.
As for the transport sector (Fig. 4), the per capita production and population effects are the main drivers of electricity consumption while the electricity share, energy intensity and sectorial effects have played a restrictive role. During this sampling period, it is difficult to assess the effectiveness of electricity usage in the transportation sector, as the sector relies on fossil fuels for 95% to supply its energy needs [3], and the adoption rate of electric vehicles does not exceed 3% in 2021 [15]. However, Morocco plans a series of measures aimed at boosting sales of electric vehicles and reaching 700,000 units in circulation by 2030 (which represents 10% of the total fleet with an average annual addition of 60,000 vehicles [24].

Regarding the commercial sector (Fig. 5), there was a substantial increase in electricity consumption, with an average annual growth rate of 6% between 2000 and 2020. All effects, except the energy intensity effect, contributed to this increase. In this case, electricity reduction came exclusively from the intensity effect. Indeed, the cumulative effect of ΔEI is a decrease of 10806 TJ over the period, which represents 79.95% of the total variation of electricity consumption. The negative intensity effect observed is encouraging, as it suggests that further innovation and the promotion of more efficient technologies could be highly beneficial.

For the industrial sector (Fig. 6), there was a gradual rise in electricity usage observed throughout the examined timeframe. The per capita production, population and electricity share effects were positive during almost the entire period while the intensity effect was negative almost half of the period. However, the intensity effect was unable to offset the
increase in electricity driven by the three effects. During times of crisis, industrial companies undergo a process of adjustment to adapt to the new circumstances. Initially, they may increase electricity consumption as they strive to ramp up production. However, as time progresses, they tend to invest in technology to enhance productivity and efficiency, enabling them to remain competitive in the market.

![Graph showing factor decomposition for electricity consumption changes in Industrial sector](https://doi.org/10.1051/e3sconf/202346900029)

**Fig. 6.** Factor decomposition for electricity consumption changes in Industrial sector

### 5 Policy implications

The above breakdown of the changes in electricity consumption by the Moroccan economy highlights the importance of focusing on electricity consumption efficiency in various sectors, particularly Transport, Residential, and Agriculture. One key aspect to consider is per capita income, which has been found to significantly influence electricity demand patterns. By understanding this correlation, policymakers and stakeholders can devise innovative strategies that prioritize energy efficiency measures. Among others, the following measures:

(a) In the residential sector: Encourage the use of energy-efficient appliances by providing clear energy consumption labels for consumers; Promote thermal insulation in homes to minimize energy losses and improve overall energy efficiency; and implement educational and awareness programs to encourage residents to adopt energy-saving practices.

(b) In the transport sector: Promote eco-friendly public transportation and develop suitable infrastructure to reduce individual vehicle usage; Incentivize the adoption of electric vehicles through tax incentives and subsidies; and implement policies to encourage carpooling and vehicle-sharing, reducing the number of vehicles on the road.

(c) In the agriculture sector: Introduce efficient irrigation technologies to reduce electricity consumption associated with irrigation; Encourage the use of renewable energy sources to power agricultural operations, such as solar or wind energy; and raise awareness among farmers about sustainable and energy-efficient agricultural practices to optimize electricity use in their activities.

Although the industrial and commercial sectors demonstrate more efficient energy usage, there is still room for further improvement. Implementing additional measures could lead to even greater reductions in their energy consumption. Some potential strategies include adopting advanced technologies to enhance energy efficiency in industrial processes and commercial operations, promoting energy audits and awareness programs to identify areas
for improvement, incentivizing the adoption of renewable energy sources, and encouraging the implementation of energy-saving practices across these sectors.

By implementing these combined measures, we can significantly rationalize electricity consumption in these sectors while promoting responsible and sustainable use of energy resources.

6 Conclusion

The efficient consumption of electricity remains a paramount concern for developing nations, including Morocco. As the demand for energy continues to grow in these regions, finding sustainable and effective approaches to optimize electricity consumption has become imperative. Throughout this study, we have explored various factors influencing electricity usage in Morocco during the period from 2000 to 2020, and identified the key elements to address this pressing issue.

To achieve this objective, we employed a methodology relying on logarithmic mean divisia index (LMDI). This approach effectively decomposes the variations observed in the aggregate into distinct predetermined factors. The identified factors are electricity's share effect, intensity effect, per capita production effect, sectorial structure effect and population effect.

Overall, according to the factor decomposition analysis, the results suggest that the combined effect of electricity's share, sectorial structure, per capita production, and population scale on electricity consumption is positive, while the overall effect of energy intensity is negative. Furthermore, our findings revealed that per capita production emerged as the predominant factor driving electricity consumption, constituting 66.22% of the total change in electricity usage. It was closely followed by electricity's share (39.15%), population scale (29.44%), and the effect of sectorial structure (10.85%). As for energy intensity, which is considered the main inhibiting factor, it plays a restrictive role (contributing at 5.99%).

Through our examination of the evolution of electricity consumption by sector of activity, we found that the per capita production serves as a leading determinant of electricity consumption across various sectors, exerting a significant influence in the realms of Transport, Residential, and Agriculture. The positive correlation between per capita income and electricity usage suggests that as individuals' income levels rise, there is an inclination towards increased energy consumption in these sectors. This phenomenon can be attributed to improved living standards, which often lead to higher demand for transportation services, greater residential energy needs, and increased agricultural activities to meet growing food requirements. Moreover, higher disposable incomes empower consumers to adopt modern technologies, appliances, and practices that rely on electricity, further driving up consumption rates. Consequently, acknowledging the pivotal role of per capita income in electricity demand patterns is crucial for formulating effective energy policies and sustainable development strategies that align with economic growth trajectories.

Our study also revealed that the intensity effect played a significant role, particularly during the later years of the study, coinciding with an economic recovery. This effect was particularly noticeable in the Industrial and Commercial sectors contributing to a reduction in electricity use by varying degrees. However, in the Agriculture sector, the intensity effect was found to be nearly neutral. This observation raises concerns about the potential insufficiency of measures aimed at promoting innovation, research and development of more efficient technologies, and the encouragement of farmers preferences towards renewable energy technologies. Finally, it is important to acknowledge that the different sectors hold
varying degrees of significance as electricity consumers. As a result, the impact of their functioning on reducing electricity consumption may vary in importance.

In conclusion, the findings above underscore the significance of recent energy efficiency measures implemented in the Moroccan economy. These results also emphasize the importance of further strengthening existing strategies and introducing novel approaches to enhance electricity consumption efficiency. To combat the challenges posed by increasing electricity demand, it is imperative to focus on innovation, research and development, the dissemination of eco-friendly technologies, and a broader adoption of renewable energy sources. By prioritizing these reduction actions, Morocco can effectively combat the impact of increased electricity consumption on the environment.

Nomenclature

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ElecC</td>
<td>Electricity Consumption</td>
</tr>
<tr>
<td>EC</td>
<td>Energy Consumption</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
</tr>
<tr>
<td>GDPP</td>
<td>GDP per Capita</td>
</tr>
<tr>
<td>IDA</td>
<td>Index Decomposition Analysis</td>
</tr>
<tr>
<td>LMDI</td>
<td>Logarithmic Mean Divisia Index</td>
</tr>
<tr>
<td>P</td>
<td>Population</td>
</tr>
<tr>
<td>TJ</td>
<td>Tonnes Joules</td>
</tr>
<tr>
<td>ΔElecC</td>
<td>Electricity share effect</td>
</tr>
<tr>
<td>ΔEI</td>
<td>Energy intensity effect</td>
</tr>
<tr>
<td>AES</td>
<td>variation of economic structure</td>
</tr>
<tr>
<td>ΔGDPP</td>
<td>Economic activity change</td>
</tr>
<tr>
<td>ΔP</td>
<td>Change of population effect</td>
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</table>

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