Sustainable Development and Competition: new evidence from EU countries

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Abstract. In this paper we present energy efficiency targets indicators of sustainable development and we discuss the role of competition, on promoting and enhancing sustainability and pricing issues. For this purpose, we present statistical evidence of energy efficiency targets indicators, we highlight the degree of competition of electrical markets in various member states and we present the effect of the degree of competition on electrical prices and energy efficiency targets. The empirical results indicate that the higher the degree of competition in electrical markets, the lower the electrical prices. Furthermore, less concentrated electrical markets exhibit higher rates of greenhouse gas emissions and share of renewable energy in total energy consumption than in the less competitive markets. Even though the empirical results do not reveal a clear-cut picture in regard with the effect of competition on energy efficiency indicator, EU28 countries have a primary energy consumption of almost 1.526 Mtoe in 2019 and they are quite close to achieve the energy efficiency target of Europe 2020 strategy implemented by Directive 2012/27/EU on energy efficiency.

1 Introduction

The European Green Deal focuses on sustainable growth through smart, inclusive and competitive low-carbon economy. Also, the Circular Action Plan, “focuses on the entire life of products …… that the resources used are kept in the EU economy for as long as possible” (See particularly https://ec.europa.eu/environment/circular-economy/index_en.htm.) Green Growth fosters economic development and natural assets must continue to provide the necessary resources in favor of humanity (Fotis Karkalakos & Asteriou 2017; Fotis & Pekka 2017). Environmental sustainability seems to provide economic opportunities rather than challenges through the implementation of innovation and investments (OECD, 2011).

The European Green Growth Agenda focuses on the transformation of the EU into a competitive economy with no net emissions of greenhouse gas emissions in 2050 and it is part of Commission’s policy to implement the United Nations 2030 Agenda and Sustainable Development Goals (SDGs). The SDGs, adopted in September 2015 by the General Assembly of the UN, cover all sectors of the economy by defining 17 goals for both developed and developing countries, encompassing economic, financial, institutional,
social and environmental dimensions (Fotis 2020). On 30 November 2016, the European Commission, among others, proposed a new 30% energy efficiency target for 2030 (Polemis & Fotis 2019). See also Fotis & Polemis (2018).

The European Union (EU) has in recent years made significant efforts to incorporate green growth issues to a concrete framework that enables the implementation of green growth objectives in EU strategic policies, in favor of public and private sectors.

The objective of this paper is to present energy efficiency targets indicators of sustainable development and to discuss the role of competition, on promoting and enhancing sustainability and pricing issues in EU countries. For this purpose, section 2 presents statistical evidence of energy efficiency targets indicators. Section 3 highlights the degree of competition of electrical markets in various member states and section 4 presents the effect of competition on electrical prices and energy efficiency targets. Lastly, section 5 concludes.

2 Energy efficiency indicators within European Union

Energy efficiency dataset covers indicators for monitoring progress towards energy efficiency targets of Europe 2020 strategy implemented by Directive 2012/27/EU on energy efficiency. In 2007, the EU leaders set the 3 key targets for 2020, that is, 20% cut in greenhouse gas emissions (from 1990 levels), 20% of EU energy from renewables, 20% improvement in energy efficiency. See particularly https://ec.europa.eu/energy/topics/energy-efficiency/targets-directive-and-rules/eu-targets-energy-efficiency_en. The EU28 member countries have committed themselves to have a primary energy consumption of no more than 1.483 million tons of oil equivalent (Mtoe) and a final energy consumption of no more than 1.086 Mtoe in 2020. For 2030 the binding target is at least 32.5% reduction. That is, a primary energy consumption of no more than 1.273 Mtoe and a final energy consumption of no more than 956 Mtoe in 2030.

Fotis (2019) presents energy efficiency indicators as the share of renewable energy in gross final energy consumption, the electricity generated from renewable sources of gross electricity consumption and energy saving from primary energy consumption. The empirical results indicate that the share of electricity produced from renewable energy sources to the national electricity consumption contributes to the elimination of emissions, but a more pronounced effect is revealed by the contribution of the share of renewable energy in gross final energy consumption.

Fotis (2019) also points out that the empirical results derived from the indicator of energy saving indicator suggest that EU energy policy should be also strengthened towards a more efficient use of energy at all stages of the energy chain from its production to its final consumption.

Table 1 here presents the energy efficiency in 30 EU countries. The indicator of energy efficiency is based on primary energy consumption. It is evident from Table1 that a lot of progress has been made during the period from 2010 to 2019 on EU level towards Europe 2020 target for energy efficiency.

Energy efficiency on primary energy consumption has decreased 8.24% during the period from 2010 to 2019 in EU28 countries. In absolute terms, EU28 countries have a primary energy consumption of almost 1.526 Mtoe in 2019 and they are quite close to achieve the energy efficiency target of Europe 2020 strategy implemented by Directive 2012/27/EU on energy efficiency.
energy efficiency. It is evident from Table 1 that a lot of improvement in energy efficiency. See particularly Fotis (2019) that highlights the energy consumption is the energy used by end-consumers (final energy consumption) plus energy produced from renewable energy. The empirical results derived from the indicator of energy saving suggest that EU energy policy should be also strengthened towards a more efficient use of energy at all stages of the energy chain from its production to its final consumption.

In 2007, the EU leaders set the 3 key targets for 2020, that is, 20% cut in greenhouse gas emissions (in EU countries), 30% cut in energy consumption and a final energy consumption of no more than 1 primary energy consumption of no more than 1.273 Mtoe and a final energy consumption of no more than 956 Mtoe in 2030. The EU28 energy consumption is the energy used by end-consumers (final energy consumption) plus energy produced from renewable energy. The empirical results derived from the indicator of energy saving suggest that EU energy policy should be also strengthened towards a more efficient use of energy at all stages of the energy chain from its production to its final consumption.

The European Union (EU) has in recent years made significant efforts to incorporate energy efficiency. The share of renewable energy in gross final energy consumption is the energy used by end-consumers (final energy consumption) plus energy produced from renewable energy. The empirical results derived from the indicator of energy saving suggest that EU energy policy should be also strengthened towards a more efficient use of energy at all stages of the energy chain from its production to its final consumption.

Lastly, section 3 of the article presents also points out that t...
### Table 2. Share of renewable energy (RE) in gross final energy consumption in EU countries: 2004, 2019 (%)

| Regions                                      | 2004  | 2019  |
|----------------------------------------------|-------|-------|
| European Union - 27 countries (from 2020)    | 9,633 | 19,729|
| European Union - 28 countries (2013-2020)    | 8,559 | 18,876|
| Euro area - 19 countries (from 2015)         | 8,400 | 18,576|
| Belgium                                      | 1,890 | 9,924 |
| Bulgaria                                     | 9,231 | 21,564|
| Czechia                                      | 6,774 | 16,244|
| Denmark                                      | 14,840| 37,204|
| Germany                                      | 6,207 | 17,354|
| Estonia                                      | 18,389| 31,889|
| Ireland                                      | 2,378 | 11,984|
| Greece                                       | 7,161 | 19,677|
| Spain                                        | 8,339 | 18,356|
| France                                       | 9,508 | 17,216|
| Croatia                                      | 23,404| 28,466|
| Italy                                        | 6,316 | 18,181|
| Cyprus                                       | 3,071 | 13,800|
| Latvia                                       | 32,794| 40,975|
| Lithuania                                    | 17,223| 25,461|
| Luxembourg                                   | 0,899 | 7,047 |
| Hungary                                      | 4,364 | 12,614|
| Malta                                        | 0,102 | 8,488 |
| Netherlands                                  | 2,030 | 8,768 |
| Austria                                      | 22,554| 33,626|
| Poland                                       | 6,914 | 12,164|
| Portugal                                     | 19,209| 30,619|
| Romania                                      | 16,811| 24,290|
| Slovenia                                     | 18,397| 21,974|
| Slovakia                                     | 6,391 | 16,894|
| Finland                                      | 29,232| 43,081|
| Sweden                                       | 38,677| 56,391|
| Iceland                                      | 58,841| 78,196|
| Norway                                       | 57,101| 74,625|
| United Kingdom                               | 1,096 | 12,336|

Source: Eurostat (https://ec.europa.eu/eurostat/databrowser/view/SDG_07_40/default/table?lang=en)

Table 3 depicts greenhouse gas emissions intensity of energy consumption in 29 EU countries, in EU27, EU28 and Eurozone (EU19) countries.

The indicator is calculated as the ratio between energy related greenhouse gas emissions and gross inland consumption of energy. It expresses how many tones CO2 equivalents of energy related greenhouse gas emissions are being emitted in a certain economy per unit of energy that is being consumed. Table 3 reveals that Iceland, Malta and Denmark are the champions towards to achieve the EU level of Europe 2020 target for the greenhouse gas emissions intensity of energy consumption. Moreover, the majority of EU28 countries have made substantial progress towards the accomplishment of the said target during the period from 2000 to 2019.
from 2000 to 2019. It made substantial progress towards emissions intensity of energy consumption champions towards energy that is being consumed. It expresses how many tonnes CO2 equivalents of countries, in EU27, EU28 and Eurozone (EU19) countries.

Source: Table 2.

Table 3 depicts greenhouse gas emissions (GGE) intensity of energy consumption in EU countries: 2000, 2019 (%) – 2000: 100

| Regions | 2001 | 2019 |
|---------|------|------|
| European Union - 27 countries (from 2020) | 99,4 | 82,8 |
| European Union - 28 countries (2013-2020) | 99,7 | 82,6 |
| Belgium | 101,3 | 84,6 |
| Bulgaria | 103,9 | 97,1 |
| Czechia | 97,7 | 73,6 |
| Denmark | 100,1 | 63,1 |
| Germany | 99,5 | 87,2 |
| Estonia | 98,4 | 79,7 |
| Ireland | 99,6 | 79,6 |
| Greece | 99,4 | 74,9 |
| Spain | 97,8 | 79,7 |
| France | 98,4 | 79,5 |
| Croatia | 101,8 | 86,6 |
| Italy | 99,5 | 82,2 |
| Cyprus | 97,3 | 94,9 |
| Latvia | 98,7 | 83,8 |
| Lithuania | 93,0 | 102,6 |
| Luxembourg | 101,3 | 92,4 |
| Hungary | 100,9 | 77,3 |
| Malta | 95,2 | 58,7 |
| Netherlands | 100,8 | 92,6 |
| Austria | 102,0 | 83,9 |
| Poland | 99,6 | 85,9 |
| Portugal | 99,8 | 78,6 |
| Romania | 102,9 | 85,7 |
| Slovenia | 101,8 | 89,8 |
| Slovakia | 101,1 | 77,7 |
| Finland | 107,3 | 69,6 |
| Sweden | 95,8 | 68,3 |
| Iceland | 98,2 | 44,8 |
| United Kingdom | 101,4 | 81,8 |

Source: Eurostat (https://ec.europa.eu/eurostat/databrowser/view/SDG_13_20/default/table?lang=en)

3 Degree of Competition in European electrical markets

Table 4 presents the market share of the largest generator in the electricity market among 26 EU countries. This indicator measures the degree of competition in the member states’ electrical markets. The lower the market share of the largest generator in the electricity market, the higher (lower) the degree of its competition (concentration).

Cyprus exhibits a monopoly electrical market in 2019. Some EU countries exhibit quite concentrated electrical markets (Latvia, Croatia, Estonia, France, Czechia), that is, the market share of the largest generator in the electricity market is higher than 60% in 2019. Moreover, in 3 countries the electrical markets are less concentrated (Slovenia, Slovakia and Greece), that is, the market share of the largest generator in the electricity market is between 50% - 60% in 2019. In all the other EU countries of Table 4, the market share of the largest generator in the electricity market is lower than 50% in 2019, indicating more
competitive electrical markets. Particularly, the largest generator in the Polish and Luxembourgian electricity market is 11.82% and 18.10% respectively.

**Table 4.** Market share of the largest generator in the electricity market in EU countries: 2010, 2019 (%)

| Regions  | 2010  | 2019  |
|----------|-------|-------|
| Belgium  | 79.1  | 39.55 |
| Czechia  | 73.0  | 60.55 |
| Denmark  | 46.0  | 32.40 |
| Germany  | 28.4  | 22.40 |
| Estonia  | 89.0  | 76.36 |
| Ireland  | 34.0  | 44.00 |
| Greece   | 85.1  | 51.26 |
| Spain    | 24.0  | 22.79 |
| France   | 86.5  | 65.59 |
| Croatia  | 88.0  | 80.01 |
| Italy    | 28.0  | 23.00 |
| Cyprus   | 100.0 | 100.0 |
| Latvia   | 88.0  | 86.35 |
| Lithuania| 35.4  | 31.26 |
| Luxembourg| 85.4 | 18.10 |
| Hungary  | 42.1  | 39.91 |
| Malta    | 100.0 | 37.41 |
| Poland   | 17.4  | 11.82 |
| Portugal | 47.2  | 46.83 |
| Romania  | 33.6  | 31.80 |
| Slovenia | 56.3  | 53.04 |
| Slovakia | 89.9  | 52.83 |
| Finland  | 26.6  | 15.77 |
| Sweden   | 42.0  | 32.00 |
| Norway   | 29.8  | 29.90 |
| United Kingdom | 21.0 | - |

Source: Eurostat (https://ec.europa.eu/eurostat/databrowser/view/NRG_IND_331A$DEFAULTVIEW/default/table?lang=en)

Table 5 presents the electricity prices by type of user in 31 EU countries, in EU27 and in Euro area countries. This indicator presents electricity prices charged to non-household consumers (medium size industrial consumers), which are average national prices in euro per kWh without taxes applicable for the first semester of each year.

Table 5 reveals that in some EU countries the electricity prices fall from 2009 to 2020. However, there are some other countries in which the electricity prices increase from 2009 to 2020.

Particularly, the lowest prices among the 31 EU countries are found in Czechia, Denmark, Netherlands, Finland and Iceland. According to Table 5, Finland and Denmark are among the countries with competitive electrical markets (15.77% and 32.40% respectively), while Czechia presents higher degree of concentration (60.55%).

Moreover, Table 5 reveals that countries with high concentrated electrical markets (Cyprus, Latvia, Croatia, Estonia, France), except from Czechia, exhibit higher electrical prices than most of the countries with less concentrated or more competitive electrical markets.
Table 5. Electrical prices in EU countries: 2009, 2019 – 2020 (EUR per kWh)

| Regions | 2009 | 2019 |
|---------|------|------|
| European Union - 27 countries (from 2020) | 0.0895 | 0.0842 |
| Euro area (EA11-1999, EA12-2001, EA13-2007, EA15-2008, EA16-2009, EA17-2011, EA18-2014, EA19-2015) | 0.0913 | 0.0861 |
| Belgium | 0.1026 | 0.0807 |
| Bulgaria | 0.0639 | 0.0877 |
| Czechia | 0.1057 | 0.0646 |
| Denmark | 0.0610 | 0.0635 |
| Germany | 0.0975 | 0.0855 |
| Estonia | 0.0587 | 0.0768 |
| Ireland | 0.1206 | 0.1294 |
| Greece | 0.0948 | 0.0810 |
| Spain | 0.1098 | 0.0925 |
| France | 0.0667 | 0.0812 |
| Croatia | 0.0853 | 0.0887 |
| Italy | - | 0.0952 |
| Cyprus | 0.1164 | 0.1291 |
| Latvia | 0.0896 | 0.0837 |
| Lithuania | 0.0924 | 0.0833 |
| Luxembourg | 0.1096 | 0.0816 |
| Hungary | 0.1221 | 0.0861 |
| Malta | 0.1506 | 0.1330 |
| Netherlands | 0.0962 | 0.0679 |
| Austria | 0.0991 | 0.0805 |
| Poland | 0.0857 | 0.0795 |
| Portugal | 0.0919 | 0.0869 |
| Romania | 0.0811 | 0.0821 |
| Slovenia | 0.0987 | 0.0791 |
| Slovakia | 0.1416 | 0.0921 |
| Finland | 0.0663 | 0.0639 |
| Sweden | 0.0662 | 0.0733 |
| Iceland | - | 0.0558 |
| Liechtenstein | - | 0.0824 |
| Norway | 0.0669 | 0.0729 |
| United Kingdom | 0.1077 | 0.0998 |

Source: Eurostat (https://ec.europa.eu/eurostat/databrowser/view/TEN00117/default/table)

4 Competition in European electrical markets, electrical prices and Energy Efficiency Indicators

Tables 6 depicts the relationship between the percentage change (Δ%) of energy efficiency indicators and electrical prices in the most/less concentrated electrical markets of Table 4. The percentage change is calculated during the period from 2009 to 2019.

The evidence from Table 6 show that in the less competitive electrical markets (Estonia, France, Croatia, Cyprus), except from Latvia, electrical prices have increased during the period from 2009 to 2019. On the contrary, in the less concentrated or more competitive electrical markets (Czechia, Greece, Slovenia, Slovakia), electrical prices have decreased during the same period.
Table 6. Percentage change of Electrical prices and Energy Efficiency Indicators in the concentrated electrical markets of EU countries: 2019

| Regions   | Market Share | Prices Δ%  | GGE Δ%  | RE Δ%  | EE † Δ% |
|-----------|--------------|------------|---------|--------|---------|
| Czechia   | 60.55%       | -43.52%    | -24.67% | 139.8% | -5.71%  |
| Estonia   | 76.36%       | 30.84%     | 9%      | 73.41% | -15.29% |
| Greece    | 51.26%       | -14.55%    | -25%    | 174.78%| -10.93% |
| France    | 65.59%       | 21.74%     | -19%    | 81.07% | -7.54%  |
| Croatia   | 80.01%       | 4%         | -15%    | 21.63% | -7.34%  |
| Cyprus    | 100.00%      | 10.91%     | -2.5%   | 349%   | -5.22%  |
| Latvia    | 86.35%       | -6.38%     | -15.1%  | 24.95% | -    |
| Slovenia  | 53.04%       | -19.86%    | -11.89% | 16.04% | -7.25%  |
| Slovakia  | 52.83%       | -35.19%    | -23.10% | 164.34%| -4.08%  |

Notes: GGE: Greenhouse Gas Emissions; RE: Share of Renewable Energy; EE: Energy Efficiency
†According to Table 2, the percentage change of EE is calculated during the period from 2010 to 2019.
Source: Author’s elaboration of data.

In regard with greenhouse gas emissions, Table 6 presents that in the less concentrated electrical markets (Czechia, Greece, Slovakia), GGE have decreased more than in the less competitive markets (Estonia, France, Croatia, Cyprus). Even though Slovenia exhibits a less concentrated electrical market, it shows a lower rate of decrease of greenhouse gas emissions during the period from 2009 to 2019 (-11.89%) than in the less competitive electrical markets, such as, Latvia, Croatia and France.

The less concentrated electrical markets (Czechia, Greece, Slovakia) exhibit also a higher degree of share of renewable energy than in the less competitive electrical markets (Estonia, France, Croatia, Latvia). Even though the monopolistic electrical market in Cyprus, the share of RE in the total energy consumption in Cyprus has increased dramatically from 2009 to 2019. However, according to Table 2, Cyprus exhibits one of the lowest shares of RE among the 30 EU countries (13.8%). Moreover, Slovenia exhibits the highest share of RE (16.04%) among the less concentrated EU electrical markets (Greece, Slovakia, Slovenia).

In terms of Energy Efficiency indicators, Table 6 reveals that Estonia and Greece exhibit the highest rates of EE, among the less competitive and less concentrated EU electrical markets respectively. However, Cyprus and Slovakia exhibit the lowest rates of EE among the less competitive and less concentrated EU electrical markets respectively.

5 Conclusion

In this paper we present energy efficiency targets indicators of sustainable development and we discuss the role of Competition, on promoting and enhancing sustainability and pricing issues.

The statistical results reveal that in less competitive electrical markets prices have increased, while in less concentrated electrical markets prices have decreased, during the period from 2009 to 2019. These results indicate that the higher the degree of competition in electrical markets, the lower the electrical prices.

In regard with greenhouse gas emissions, in the less concentrated electrical markets greenhouse gas emissions have decreased more than in the less competitive markets, during the same period. The less concentrated electrical markets also exhibit a higher degree of share of renewable energy in total energy consumption than in the less competitive electrical markets, during the period from 2009 to 2019. Therefore, these results also
indicate that the higher the degree of competition in electrical markets, the lower the greenhouse gas emissions and the higher share of renewable energy in total energy consumption.

In terms of energy efficiency indicator, the statistical results are mixed. Less competitive EU electrical markets indicate higher rates of energy efficiency than less concentrated markets and vice versa. Therefore, one cannot get a clear-cut picture in regard with the effect of competition and energy efficiency. However, EU28 countries have a primary energy consumption of almost 1.526 Mtoe in 2019 and they are quite close to achieve the energy efficiency target of Europe 2020 strategy implemented by Directive 2012/27/EU on energy efficiency.

Further research on the effect (if any) of competition on the share of renewable energy in total energy consumption and greenhouse gas emissions, should be conducted with respect to Slovenia. Even though Slovenia exhibits a less concentrated electrical market among the EU electrical markets, the said relationship is quite puzzled.

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