Sustainable Development and Competition: new evidence from EU countries

Panagiotis Fotis

Hellenic Competition Commission; Commissioner, 10345, Patision Str. & Kotsika, 1A, Athens, Greece

Hellenic Open University, Patra, Greece

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 Table 1 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.

Table 1. Energy Efficiency (EE) in EU countries: 2010, 2019 (Mtoe - %) – 2005: 100

Regions	2010 (%)	2010 (Mtoe)	2019 (%)	2019 (Mtoe)
European Union - 27 countries (from 2020)	97,37	1.458,06	90,28	1.351,93
European Union - 28 countries (2013-2020)	96,64	1.663,15	88,68	1.526,12
Euro area - 19 countries (from 2015)	96,60	1.166,77	88,46	1.068,42
Belgium	105,10	54,19	95,24	49,11
Bulgaria	90,55	17,40	94,81	18,22
Czechia	100,06	42,54	94,36	40,11
Denmark	102,94	20,02	86,52	16,83
Germany	97,99	315,15	87,90	282,71
Estonia	110,41	5,56	93,50	4,71
Ireland	98,39	14,71	98,12	14,66
Greece	89,92	27,24	80,09	24,26
Spain	90,32	122,88	88,76	120,75
France	97,52	254,45	90,16	235,26
Croatia	96,96	8,86	89,86	8,21
Italy	92,51	167,28	80,68	145,89
Cyprus	108,07	2,68	102,66	2,54
Latvia	101,43	4,56	101,50	4,56
Lithuania	76,63	6,17	77,99	6,28
Luxembourg	96,63	4,61	94,27	4,50
Hungary	93,46	24,62	93,29	24,57
Malta	101,52	0,93	95,50	0,87
Netherlands	102,30	71,72	90,52	63,46
Austria	100,45	32,86	98,43	32,20
Poland	109,79	96,56	111,57	98,13
Portugal	91,16	22,65	88,84	22,08
Romania	91,37	32,95	88,66	31,97
Slovenia	97,02	7,03	89,97	6,52
Slovakia	95,66	16,66	91,79	15,98
Finland	105,61	35,44	95,52	32,06
Sweden	98,67	48,34	93,43	45,78
Iceland	172,08	5,53	193,17	6,20
Norway	113,37	30,78	93,02	25,25
United Kingdom	91,77	205,09	77,94	174,18

Source: Eurostat
https://ec.europa.eu/eurostat/databrowser/view/NRG_IND_EFF__custom_1076111/default/table?lang=en

Table 2 presents the share of renewable energy in gross final energy consumption in 30 EU countries, in EU27, EU28 and Eurozone (EU19) countries. The indicator measures the share of renewable energy consumption in gross final energy consumption. The gross final energy consumption is the energy used by end-consumers (final energy consumption) plus grid losses and self-consumption of power plants.

It is evident from Table 2 that the majority of EU28 countries move towards to achieve the EU level of Europe 2020 target for the share of renewable energy in gross final energy consumption. However, countries such as Belgium, Luxembourg, Malta, Netherlands, Ireland, Poland, Hungary and Cyprus, must strengthen their efforts to meet the said target.

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.

Table 3. 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	100,00
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	80,9	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](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
<u>Czechia</u>	0,1057	0,0646
Denmark	0,0610	0,0635
Germany	0,0975	0,0855
<u>Estonia</u>	0,0587	0,0768
Ireland	0,1206	0,1294
Greece	0,0948	0,0810
Spain	0,1098	0,0925
<u>France</u>	0,0667	0,0812
<u>Croatia</u>	0,0853	0,0887
Italy	-	0,0952
<u>Cyprus</u>	0,1164	0,1291
<u>Latvia</u>	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 ($\Delta\%$) 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 a quite modest 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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