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Development and Renewable Energy: An Examination of the Nordic Countries

Kalkınma ve Yenilenebilir Enerji: Nordik Ülkelerinin İncelenmesi

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ABSTRACT

The aim of this study is to graphically evaluate the development and renewable energy situation of the Nordic countries (Denmark, Sweden, Norway, Finland and Iceland) within the framework of total population, economic growth, GDP per capita, renewable energy consumption, human development index, and the Legatum Prosperity Index. Although the period 1990-2023 is wanted to be considered for evaluation, it should be noted that they cover different periods because the data started to be calculated at different times and the timing of their disclosure is different. According to the findings obtained as a result of the evaluation, GDP per capita, human development index and renewable energy use have increased over the years in the Nordic countries. It can be said that the Nordic countries rank high in terms of the Legatum Prosperity Index and have managed to maintain their positions. The same applies to the natural environment, which is one of the twelve pillars of the Legatum Prosperity Index. As a result, it is seen that there is a parallelism between the development levels and renewable energy use of the Nordic countries.

Keywords: *Energy, Renewable Energy, Development, Nordic Countries, Legatum Prosperity Index*

JEL codes: *O10, Q2, Q4, Q42*

ÖZET

Bu çalışmanın amacı; Nordik ülkelerinin (Danimarka, İsveç, Norveç, Finlandiya ve İzlanda) kalkınma ve yenilenebilir enerji durumunu, toplam nüfus, ekonomik büyüme, kişi başına GSYH, yenilenebilir enerji tüketimi, insani gelişme endeksi ve Legatum Refah Endeksi çerçevesinde grafiksel olarak değerlendirmektir. Değerlendirme için 1990-2023 dönemi ele alınmak istense de verilerin farklı zamanlarda hesaplanmaya başlanması ve açıklanma zamanlarının farklı olması sebebiyle farklı dönemleri kapsadıklarını belirtmek gerekir. Yapılan değerlendirme sonucunda elde edilen bulgulara göre, Nordik ülkelerinde kişi başına GSYH, insani gelişme endeksi ve yenilenebilir enerji kullanımı yıllar itibarıyla artış göstermiştir. Legatum Refah Endeksi açısından Nordik ülkelerinin üst sıralarda yer aldığı ve yerlerini korumayı başardıkları söylenebilir. Aynı durum Legatum Refah Endeksinin on iki sütundan biri olan doğal çevre için de geçerlidir. Sonuç olarak, Nordik ülkelerinin kalkınmışlık seviyeleri ile yenilenebilir enerji kullanımı arasında bir paralellik söz konusu olduğu görülmektedir.

Anahtar Kelimeler*: Enerji, Yenilenebilir Enerji, Kalkınma, Nordik Ülkeleri, Legatum Refah Endeksi*

JEL kodları: *O10, Q2, Q4, Q42*

INTRODUCTION

Industrialization, globalization, economic growth, technological developments, increase in production and consumption, rapid population growth and correspondingly the increasing needs and similar situations bring about a rise in energy consumption. It can be said that energy has become an important need, especially after the Industrial Revolution. Besides, the use of fossil energy sources has led to many environmental problems such as environmental pollution and global warming, as well as decreasing such resources and increasing foreign dependency. Such negative effects threaten nature and humanity. Therefore, today it is widely accepted that renewable energy sources, which are an alternative energy source, should be used.

The fact that renewable energy sources are less costly and have less negative influence on the environment causes the demand for renewable energy sources to increase. Main renewable energy sources include solar energy, wind energy, biomass energy etc. (Kayişoğlu and Diken, 2019: 62).

It can be said that energy is a measure of the economic and social development of countries. In point of fact, energy is a significant and an essential element in both economic activities and in meeting people's basic needs (Bayrak and Esen, 2014: 139). As a matter of fact, all societies need energy to meet basic human needs such as lighting, heating, cooking, communication, etc. to sustain their existence (Owusu and Asumadu-Sarkodie, 2016: 3). Energy, which is one of the main factors of development, is important as it enables investment and innovation as well as contributes to creating employment for economies (Babatunde et al., 2022: 70). In other words, energy is a necessary source for the development of economies and the societies' high quality of life. For this reason, the demand for energy is constantly rising. But this situation threatens the environment and the well-being of future generations (Miłek et al. 2022: 1). Accordingly, for the sustainability of development, it is essential to use clean energy sources instead of fossil fuels such as coal, oil and natural gas. In this context, this study aims to examine the relationship between development and renewable energy in the Nordic countries (Denmark, Sweden, Norway, Finland and Iceland), which are socio-economically developed. In the literature review on the subject, no studies examining the relationship between development and renewable energy were found for the Nordic countries. Therefore, it is thought and expected that this study will contribute to the literature in this respect. Accordingly, in the section after the introduction, the conceptual framework will be explained. Following this, a literature review will be included. Then, the relationship between development and renewable energy in the Nordic countries will be examined with graphs. The study will be completed with the conclusion part.

CONCEPTUAL FRAMEWORK

Development, which is accepted as an improvement and quality increase in the living standards of societies and people, is no longer associated with a single parameter today. One of the most important of these parameters is renewable energy. The increase in economic and technological development has begun to generate negative effects on the environment. In order to solve this problem, efforts are being made to increase the use of renewable energy, which is considered clean energy. In addition, due to the increasing population, it has become necessary to use renewable sources for energy production in the world, and thus energy production systems have developed and accelerated. Almost every country in the world has increased studies in this field, especially in recent years. Studies show that economies that are advanced in the field of renewable energy have high levels of development and as the use of renewable energy increases, their welfare levels increase even more.

The reason why the study was conducted on the basis of the Nordic countries is that these countries have an important place in the world in terms of renewable energy, as well as their development levels. These countries, which also have a common culture among themselves are among the happiest countries in the world. Nordic countries also rank high in the Human Development Index published by the United Nations Development Programme.

Energy is indispensable for today's societies. As a matter of fact, it is an important factor that determine the quality of life and economic factors. The scarcity of energy resources in the world and the increasing need for energy day by day further increases the importance of renewable energy sources. Renewable energy is the source of clean and abundant energy obtained from self-renewing sources such as sun, wind, soil, plants and water. No matter to what extent the renewable energy sources are used, it can renew itself without any problems

due to its structure. The goal in the world is to increase the percentage of energy obtained and used from renewable sources. Each of renewable energy technologies has a different stage of development. With this development, the differences in costs and applicability affect the usage rate of each renewable energy source.

One of the major features of renewable energy sources is that they help protect the environment by reducing carbon dioxide emissions. In addition, renewable energy sources are preferred because they are domestic resources and contribute to reducing foreign dependency on energy and increasing employment (Büyükyılmaz and Mert, 2015: 104). Currently, the majority of energy production is provided by fossil fuels, and these resources have both a negative impact on the environment and the possibility of depletion. Considering that the protection of the environment has become one of the most significant issues in the world in recent years, the importance of renewable energy sources is increasingly on the agenda. Failure to protect the environment primarily causes global warming and climate changes, and in this case, it negatively affects people's daily lives and becomes the most important factor that threatens future generations.

When the increase in energy demand due to rapid population growth is added to all these factors, the planning and implementation of renewable energy investments becomes an extremely sensitive issue. Moreover, it is our duty to humanity to leave a clean and healthy world to future generations. At this point, it would be useful to note the following: Extreme care should be taken when making renewable energy investments. In the end, these investments also have an influence on the environment. Therefore, the places to invest should be chosen very carefully, and the places with the least negative impact on the ecological balance should be selected and investments should be made. For example, the construction of hydroelectric power plants can cause serious damage to the ecological balance in the region where they are built. The fact that investments in renewable energy resources used to reduce carbon dioxide emissions and protect the environment may harm the environment from a different viewpoint, should not conflict with the goals to be achieved.

LITERATURE REVIEW

Sadorsky (2009) investigated the relationship between per capita income and per capita renewable energy consumption in 18 emerging countries using panel data analysis. According to the research results, rises in real per capita income have a positive and statistically significant effect on per capita renewable energy consumption. In the long term, a 1% increase in real GDP per capita increases per capita renewable energy consumption in emerging economies by a value between 3.39% and 3.45%.

Apergis et al. (2010) studied the causal relationship between renewable energy consumption, CO_2 emissions, nuclear energy consumption, and economic growth for the period 1984-2007 for a group of 19 developing and developed countries. Panel error correction model was used as a method in the study. According to the long-run estimates, there is a statistically significant negative relationship between nuclear energy consumption and emissions. However, a statistically significant positive relationship between emissions and renewable energy consumption was also found. The findings from the panel Granger causality tests indicate that in the short term nuclear energy consumption plays a significant role in reducing CO_2 emissions but renewable energy consumption does not contribute to reducing emissions.

Aslani et al. (2013) examined the policies and achievements of the Nordic region in the development of renewable energy. In the research, about 3000 pages of documents and articles, include annual reports, project reports, detailed government, and published investigations were reviewed by the authors. It was seen that three factors, namely sustainability, balancing trade-off and self-sufficiency were effective in strategic decision-making to diffusion of renewable energy in Nordic countries. In addition, creating a renewable energy policy aims to ensure energy security, energy diversity, energy efficiency, economic efficiency and reducing carbon dioxide emissions. The authors state that other developed and developing countries can take the Nordic countries as an example in renewable energy implementations.

Irandoust (2016) investigated the relationship between renewable energy consumption, economic growth, technological innovation, and CO_2 emissions in Denmark, Finland, Sweden and Norway using the VAR model, considering the period between 1975-2012. As a result of the analysis, a two-way causality was found between renewable energy and CO_2 emissions for Sweden and Norway, and a one-way causality from renewable energy to CO_2 emissions was found for Denmark and Finland. Additionally, a unidirectional causality from

technological innovation to renewable energy and from growth to renewable energy for the four Nordic countries was also revealed. However, no causality was found from renewable energy to growth.

Özşahin et al. (2016) studied the relationship between renewable energy consumption and economic development in the context of BRICS countries and Turkey between 2000 and 2013. In their study where they analyzed the relationship between the variables in question with the Pedroni, Westerlund panel CUSUM cointegration test and panel ARDL estimator, they found that there is a long-term positive relationship between renewable energy consumption and economic development.

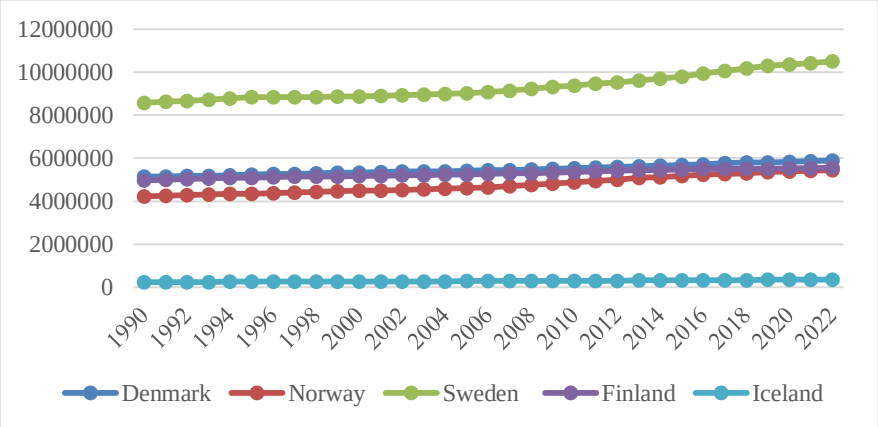
Irandoust (2018) analyzed the relationship between technological innovation and renewables in the Nordic countries (Denmark, Finland, Sweden and Norway) with the bootstrap panel Granger causality approach. The research covering the period of 1975-2012 shows that there is a one-way causality running from technological innovations to renewable energy in Denmark and Norway. Besides, a one-way causality from renewables to innovations in Finland and Sweden was found.

Miremadi et al. (2019) examined the effects of public R&D expenditures and knowledge spillovers on the development of renewable energy sources in Nordic countries, except Iceland. The results show that with a focus on biofuels, solar and wind energy, the cumulative knowledge stock will rise to 2.4 billion US dollars until 2030. Moreover, it was also found that knowledge spillovers reduce the domestic R&D investment and may strengthen the knowledge stock.

Sharif et al. (2023) analyzed the role of environmental taxes, green technology, and green energy toward a sustainable environment in the context of Nordic countries. Income and population were also considered in the analysis. In the study, CS-ARDL technique was used for the years of 1995-2020. As a result, the authors revealed that green energy, environmental taxes, and green technology have a negative association with CO_2 emissions in the short and long run, while income and population have a positive association between CO_2 emissions in the short and long run.

DEVELOPMENT AND RENEWABLE ENERGY IN THE NORDIC COUNTRIES

In this section, the development and renewable energy situation of five Nordic countries (Denmark, Sweden, Norway, Finland and Iceland), which are located in northern Europe, have been tried to be investigated with graphs. Greenland, Faroe Islands and Åland, located in the Nordic region were not included in the analysis due to data availability.

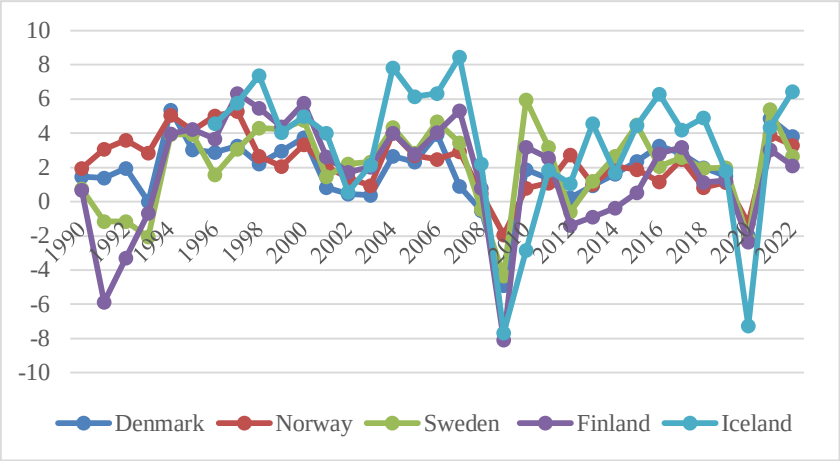


Graph 1: Total Population of the Nordic Countries, 1990-2022

Source: World Bank, 2023 (Accessed: 21.10.2023).

When the population figures of the Nordic countries for the period of 1990-2022 in graph 1 are examined, it is noticeable that it generally shows a horizontally increasing trend. Among the Nordic countries, the largest

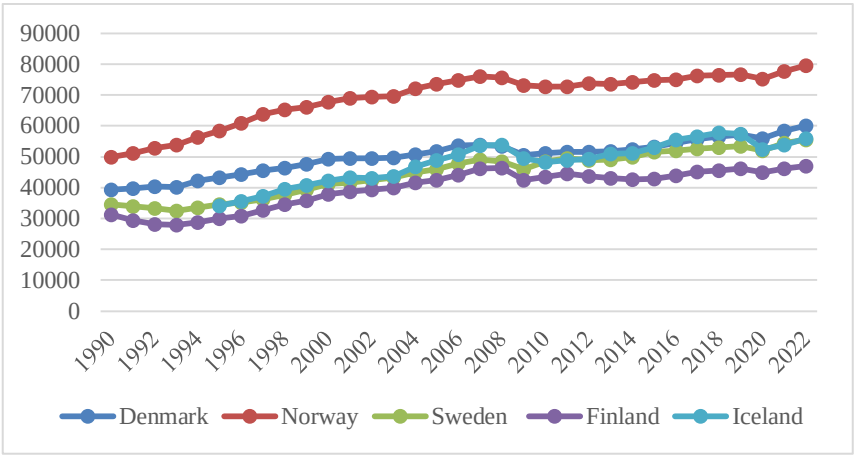
population is in Sweden. Denmark follows Sweden. On the other hand, Iceland appears to be the country with the least population among the Nordic countries.



Graph 2: Economic Growth Rates (GDP) of the Nordic Countries, 1990-2022

Source: World Bank, 2023 (Accessed: 21.10.2023).

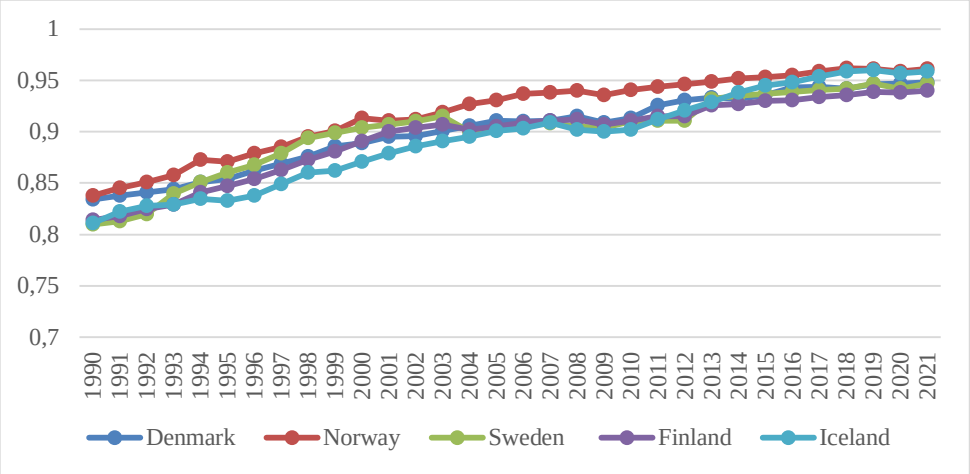
In graph 2, where the economic growth rates of the Nordic countries are given for the years 1990-2022, it is seen that the growth rates follow a fluctuating course. Due to the data availability, Iceland's economic growth figures starts from 1996. As seen in the graph, growth rates decreased in 2008 and took negative values especially in 2009 and 2020. This situation can be interpreted as resulting from the global economic crisis of 2008 and the COVID-19 pandemic that emerged in 2019, respectively. It is seen that the country with the highest growth rate in 2022 is Iceland with 6.44%. Iceland is followed by Denmark and then Norway. The countries with the lowest growth rates in 2022 are Finland with 2.08% and Sweden with 2.64%.



Graph 3: GDP Per Capita of the Nordic Countries, US $, 1990-2022

Source: World Bank, 2023 (Accessed: 21.10.2023).

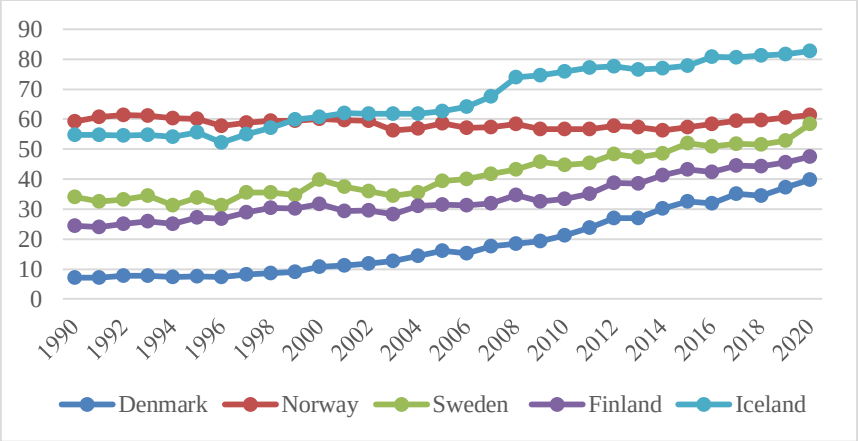
Graph 3 shows the GDP per capita figures of the Nordic countries between 1990 and 2022. Due to the availability of data, GDP per capita figures of Iceland start from 1995. When the data are evaluated in general, there is an increasing trend in the GDP per capita of the Nordic countries. However, it seems that Norway's GDP per capita is quite high compared to other Nordic countries. After Norway, the highest GDP per capita belongs to Denmark and then Iceland. On the contrary, the lowest GDP per capita belongs to Finland and Sweden.



Graph 4: Human Development Index of the Nordic Countries, 1990-2021

Source: UNDP, 2023 (Acceseed: 25.10.2023).

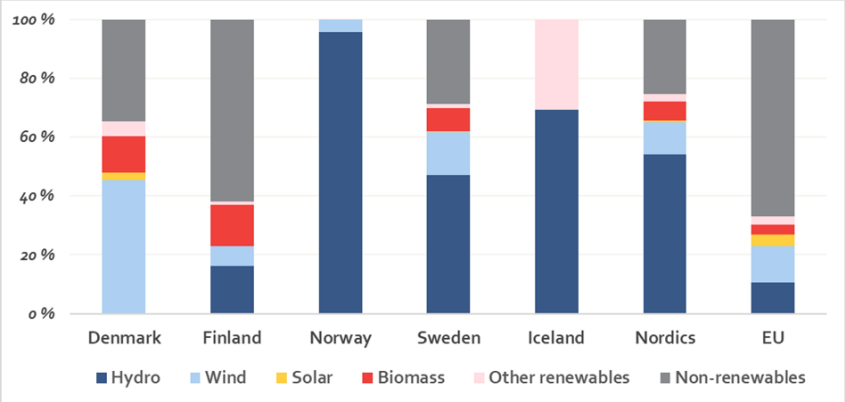
When the human development index in graph 4 is examined, it can be seen that the scores of human development index increased in the Nordic countries between 1990-2021. Accordingly, the country with the highest human development index among this group of countries in 2021 is Norway with 0.961, while Iceland ranks second with 0.959. It is seen that the country with the lowest human development index among the Nordic countries in 2021 is Finland with 0.940. Finland is also the country with both the lowest growth rate and the lowest GDP per capita in the same year.



Graph 5: Renewable Energy Consumption of the Nordic Countries, %, 1990-2020

Source: World Bank, 2023 (Accessed: 21.10.2023).

Graph 5 shows the renewable energy consumption of the Nordic countries between 1990-2020. According to the graph, there is an increasing trend in renewable energy consumption from 1990 to 2020 in all Nordic countries. However, among the Nordic countries, Iceland is the country that used the most renewable energy with 82.79% in 2020. Iceland is followed by Norway and then Sweden. The countries that consume the least renewable energy are Denmark with 39.7% and Finland with 47.49% in 2020. Another striking point in the graph is that Denmark showed a significant increase in renewable energy consumption, especially after 2000, and considerably closed the gap among the other countries.

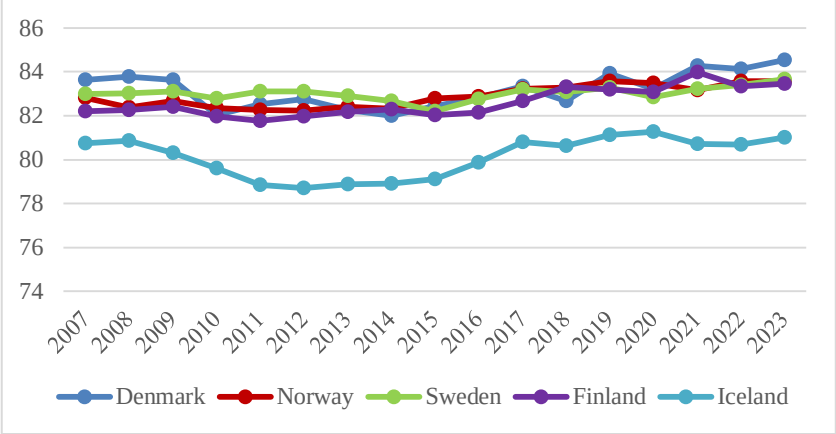


Graph 6: Renewables in the Nordic and EU electricity mix, 2019 (% of consumption)

Source: https://www.nordicenergy.org (Accessed: 02.11.2023).

Nordic countries have an important place in renewable energy and have some of the cleanest energy mixes in the world. But there are large country-specific differences in the way in which these countries are handling the energy transition (https://www.rystadenergy.com). Graph 6 shows the renewables in the Nordic and EU electricity mix for 2019. It is seen that Iceland, which uses the most renewable energy among the Nordic countries, and also Norway and Sweden use most hydropower. While Finland uses hydropower and biomass, Denmark uses most wind energy.

Renewable energy capacity in Denmark, Norway, and Sweden has been increasing steadily, and the sources from where most of the renewable energy comes vary from country to country. Denmark uses a high share of wind power. As a matter of fact, the share of wind energy is high in Denmark. Wind power has covered more than 40% of the country's total electricity consumption during the last six years, and it is the largest renewable electricity source in the country. However, wind power production in Norway is significantly lower than in Denmark and Sweden. Norway's largest renewable energy source is hydropower. On the other hand, Sweden focuses on biofuels but also produces hydropower and wind power (https://www.statista.com).

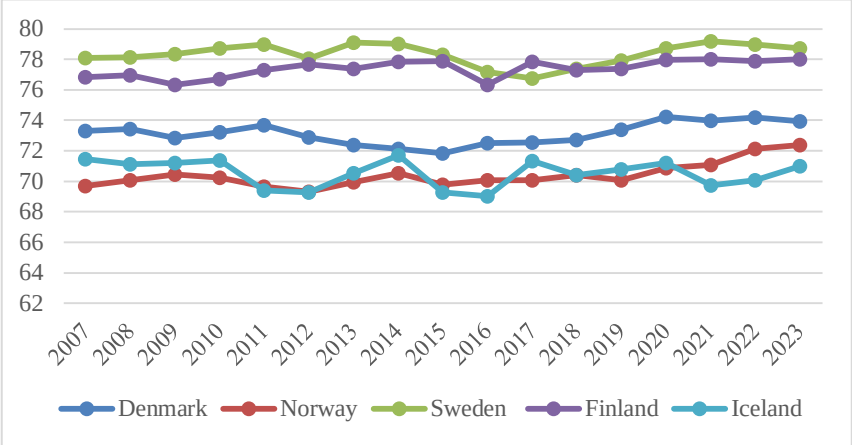


Graph 7: Legatum Prosperity Index – General Score, 2007-2023

Source: Legatum Institute, 2023 (Accessed: 05.12.2023).

A wide variety of indices are used to evaluate the welfare of countries and to compare and rank countries. One of these is the Legatum Prosperity Index covering 167 countries, prepared by the Legatum Institute, headquartered in London. As seen in graph 7, Nordic countries generally receive high scores in the index and are ranked at the top. As of the period under consideration, all countries increased their scores compared to 2007. Only Iceland experienced a significant decrease during the period, but the country also managed to increase its score significantly since 2015. When we look at the places of the Nordic countries in the index since 2007, when the index was first prepared, Denmark, Norway, Sweden and Finland have always been in the top 5; although

Iceland generally ranks between the top 10 and 15, it entered the top 10 in 2022 and ranked 8th in 2023. In 2023, except Iceland, the other Nordic countries; Denmark, Sweden, Norway and Finland made up the top 4 around the world. This situation shows us that the Nordic countries are quite successful in the development indicators used in the preparation of the Legatum Prosperity Index.



Graph 8: Legatum Prosperity Index – Natural Environment, 2007-2023

Source: Legatum Institute, 2023 (Accessed: 05.12.2023).

There are twelve pillars used in the Legatum Prosperity Index. One of these pillars is the natural environment. This title is also used in the study to evaluate the environmental quality of countries. Graph 8 shows the natural environment scores, an important pillar of the Legatum Prosperity Index for the Nordic countries between 2007 and 2023. Although there is a rise in the natural environment scores of other countries included in the analysis except Iceland, it is seen that Sweden ranks first in terms of natural environment. Sweden ranks first in natural environment not only among the Nordic countries, but also among the countries calculated for 167 countries in 2023. While Sweden is followed by Finland and Denmark, Iceland and Norway are in the last place.

CONCLUSION

Economic development comes first among the ultimate goals of countries. The policies produced by governments are generally aimed at ensuring economic development. As the development levels of countries increase, energy consumption also increases. Today, in particular with the increase in environmental problems, energy supply continuity and increasing energy needs are tried to be met from renewable energy sources. In this study, the use of renewable energy resources and economic development indicators of the Nordic countries, one of the most developed countries in the world, have been tried to be presented and evaluated comparatively.

Economic growth figures follow a fluctuating course in all Nordic countries as of the period covered. Considering GDP per capita, it is seen that a very good amount of income is obtained in all Nordic countries. Norway diverges positively at this point, achieving GDP per capita of almost $80,000 in 2022. Norway, which not only generates the most income but also ranks at the top in the human development index, follows a flat course in renewable energy consumption while other countries show a significant increase. It is seen that Norway, which has significantly increased its GDP per capita and human development in the period in question, has not been able to increase its renewable energy consumption to the same extent. Despite this, it can be said that environmental quality has increased slightly in recent years. Although the increase in income and development levels is not reflected in renewable energy consumption, the increase in environmental quality shows that Norway has achieved success in other matters affecting the environment.

Denmark has the second highest GDP per capita among the Nordic countries. Although the country has shown a significant increase in renewable energy consumption over the years considered, it ranks last. In Denmark, which has shown important progress in human development, while development and GDP per capita have increased, renewable energy consumption has increased more than fivefold over the years. In this case, it

can be said that economic development increases renewable energy consumption for Denmark. Although there has been a slight decrease in environmental quality over time, it can be said that it increased again and reached the level of 2017.

It can be said that Iceland is the best performing country among the Nordic countries in terms of GDP per capita, human development and renewable energy consumption over the years considered. Iceland has achieved a significant success by increasing its GDP per capita from $34,000 to $55,000, its human development index score from 0.81 to 0.96, and its renewable energy consumption from 54% to 83%. The negative situation for Iceland emerges in the Legatum Prosperity Index. Iceland which experienced a decline from 2007, when the index was first calculated to 2015, has shown a rise since 2015, but it is seen that it reached the 2007 level in 2023. A similar situation is also seen in the natural environment title of the Legatum Prosperity Index. This shows that renewable energy consumption does not improve environmental quality for Iceland. Iceland has increased clean energy consumption but failed on other issues affecting the environment. It is thought that this result should be analyzed in more detail for Iceland, which is an island country, and has a much smaller population than other Nordic countries.

When we evaluate Sweden, the country has managed to increase its GDP per capita and human development index score, just like other Nordic countries. At the same time, it is seen that there has been a significant progress in the use of renewable energy consumption. Considering that Sweden is the country with the highest population and the highest increase in population among the countries discussed, the increases in economic development and renewable energy consumption over the years are considered success. Sweden, which ranks second in the Legatum Prosperity Index, is not only among the Nordic countries in the natural environment category of the same index; the country ranks first among all countries included in the index. This situation is quite good for a country with a significant population and a growing population.

In Finland, which is the last country considered, although GDP per capita and human development have increased significantly, the country ranks last among the Nordic countries. Although the country has only surpassed Denmark in renewable energy consumption, it is seen that it has almost doubled compared to 1990. It can be said that the developments are positive for Finland, which has also made progress in the Legatum Prosperity Index and the environment category in the index.

Nordic countries, which are among the most developed countries in the world in terms of social and human rights as well as economic development, have also made significant progress in terms of the use of renewable energy. It is seen that all Nordic countries have increased their GDP per capita and human development levels over the years. A parallel situation also occurs in renewable energy consumption. It is seen that only Norway's renewable energy consumption remains almost the same, while other countries, especially Iceland and Denmark increase their consumption.

A similar successful situation for the Nordic countries also applies to the Legatum Prosperity Index. Among the countries at the top of this index, only Iceland has climbed upwards in recent years, although it has followed a fluctuating course. When we generally evaluate the Nordic countries in terms of the data we have discussed, it is seen that there is a parallel situation between the development levels and the use of renewable energy of the countries.

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