EUROPEAN FREE TRADE ASSOCIATION

Working paper: Renewable energy in EFTA 1990-2020

Luxembourg, December 2023

Summary

This publication focuses on the energy production and consumption of the European Free Trade Association (EFTA) countries in the context of UN Sustainable Development Goal (SDG) number 7, "Affordable and clean energy." The research aims to describe how EFTA countries are transitioning towards renewable and low-emission energy sources to achieve sustainable development. The study analyses primary energy sources for electricity and heat production and final energy consumption based on source, sector, and per capita for each member state. While compared with the EU countries, the EFTA countries show a greater reliance on renewable energy, mainly hydropower. Despite advancements, challenges remain in reducing energy consumption to meet SDG targets fully. Nevertheless, the research underscores the ongoing efforts of the EFTA countries in their transition towards a more sustainable energy future.

Introduction

The 2030 Agenda adopted by the UN General Assembly in September 2015 outlines an ambitious and universal plan of action for people, the planet, and prosperity to strengthen universal peace and overcome greenhouse gas emissions[1]. Energy is crucial for achieving all the Sustainable Development Goals, from its role in eradicating poverty through advancements in health, education, water supply, and industrialization, to combating climate change[2]. The EFTA countries have all made progress in incorporating more renewable and low-emission energy sources into their energy policies.

[1] Transforming our world: the 2030 Agenda for Sustainable Development | Department of Economic and Social Affairs (un.org)
[2] Transforming our world: the 2030 Agenda for Sustainable Development | Department of Economic and Social Affairs (un.org)

The purpose of the publication is to describe the EFTA countries' energy production and consumption in the context of UN Sustainable Development Goal number 7, "Affordable and clean energy." Statistics on energy constitute an enormous field of study. The publication is therefore limited to analysing primary energy sources of electricity and heat and final energy consumption based on source, sector, and per capita for each member state. Since UN Sustainable Development Goal number 7 forms the backdrop of the publication, it will be presented at the beginning, together with definitions of key concepts. One of the main presuppositions in reducing greenhouse gas emissions is to produce energy from renewable sources. Statistics on primary energy sources within the production of heat and electricity give an indication of how well the EFTA countries transition into wider use of renewable energy sources. Statistics on final energy consumption by source, sector, and per capita illustrate which type of energy is consumed the most, how different sectors perform compared to each other, as well as the individual consumption.

Renewable Energy

Renewable energy refers to any source of energy that is replenished naturally over time and can be used without depleting its supply. This includes solar, wind, hydropower, ocean, and bioenergy. Energy is fundamental to everything that happens on Earth [3]. Both in the function of people's daily lives and as a driving force in the global economy. Due to the extensive use of non-renewable energy sources, energy is the single most significant contributor to global warming[4]. Non-renewable energy refers to sources of energy that eventually runs out, such as coal, oil, and natural gas (i.e., fossil fuels). One of the most important conditions in sustainable development is the transition from non-renewable to renewable energy sources. Unlike fossil fuels, renewable energy sources produce little or no greenhouse gas emissions, making them an environmentally friendly alternative to traditional energy sources[5].

UN`s Sustainable Development Goals

In September 2015, the United Nations (UN) adopted the "Transforming our World: The 2030 Agenda for sustainable development," a long-term policy framework to instigate a systemic shift in the interdependent relationship between economic growth, social coherence, and environmental protection. The program encompasses poverty reduction and sustainable

[3] What is renewable energy? | United Nations
[4] Net Zero Coalition | United Nations
[5] Renewable energy – powering a safer future | United Nations

development's economic, social, and environmental aspects founded on good governance[6]. The 17 Sustainable Development Goals (SDGs) included in the agenda are designed to address various global challenges, such as poverty, hunger, health, education, gender equality, clean water and sanitation, energy, work, industry and infrastructure, inequality, sustainable cities and communities, responsible consumption, climate action, life below water and on land, peace, justice, strong institutions, and partnerships for the goals[7].

Sustainable Development Goal 7

Energy is important in achieving all the sustainable development goals, but goal number 7 is specifically designed to handle development within the energy area. The targets for SDG 7 are:

7.1. By 2030, ensure universal access to affordable, reliable, and modern energy services.
7.2. By 2030, increase substantially the share of renewable energy in the global energy mix
7.3. By 2030, double the global rate of improvement in energy efficiency.

7.a. By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and clear fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology.

7.b. By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing states, and land-locked developing countries, in accordance with their respective programs of support.

Source: Goal 7 | Department of Economic and Social Affairs (un.org)

The sustainable development goals are universal. Since all the member state has different preconditions for reaching each goal, the order of priority differs. When it comes to SDG 7, the EFTA countries focus on improving energy efficiency and increasing the use of renewable energy sources.

Iceland currently meets 85% of its energy needs with renewable energy sources. The use of non-renewable energy sources is highest within the transport sector. Consequently, by 2023 Iceland aims to use at least 40% of the energy in the transport sector from renewable sources.

[6] THE 17 GOALS | Sustainable Development (un.org)
[7] THE 17 GOALS | Sustainable Development (un.org)

Iceland`s long-term energy policy is to become carbon neutral in 2040 and independent from fossil fuels in 2050[8].

Liechtenstein relies heavily on energy imports, with only 12% of total energy consumption being met by domestic energy sources. The government has implemented various measures and incentives to increase energy efficiency and the use of renewable energy sources with the goal of reaching 20% domestic renewable energy in 2020. Liechtenstein has achieved success in solar energy and sustainable energy policy[9].

Norway produces almost all its electricity from renewable sources, and the share of renewable energy in Norway's total energy consumption is around 73%. Norway aims to improve energy efficiency by 30% in 2030. Although Norway has surplus electricity production in a typical year, electricity consumption is expected to increase in several sectors in the coming years. Norway has phased out fossil fuels in the building sector and is currently phasing out fossil fuels in the transport sector as well, with more than 50% of new cars being electric and only electric cars to be sold from 2025. Norway plans to stop new licenses for oil and gas drilling and phase out the use of fossil energy by 2040[10].

Switzerland's energy strategy 2050 aims to phase out nuclear energy, increase energy efficiency and the proportion of renewable energies, reduce energy consumption, and cut energy-related carbon emissions. Switzerland achieved its targets for electricity production from renewable energies and energy efficiency as laid down in the Energy Act for 2020. However, considerable challenges remain, such as expanding renewable energy to achieve net-zero emissions by 2050 and improving energy efficiency[11].

Energy production

Energy production refers to how much energy a country produces from natural sources. Solid fuels, natural gas, crude oil, nuclear, and renewable energy are primary energy products. It is

[8] https://www.un.org/sites/un2.un.org/files/2021/09/energy_compact_template_version_21_september_final.pdf
[9] https://sustainabledevelopment.un.org/content/documents/23369Full_VNR_Liechtenstein_June_2019.pdf, a new report is supposed to come as Liechtenstein is participating in a Voluntary National Review 2023 for the high level meeting on sustainable development in July 2023
[10] https://sustainabledevelopment.un.org/content/documents/28233Voluntary_National_Review_2021_Norway.pdf
[11] From the report: Implementing 2030 Agenda for Sustainable Development: Voluntary National Review of Switzerland 2022 from Confédération Suisse.

defined as secondary energy products when transforming primary energy into transportable forms[12]. According to SDG number 7, using renewable energy sources to make sustainable cities and societies and limit climate change is important[13].

Primary energy sources of electricity and heat production

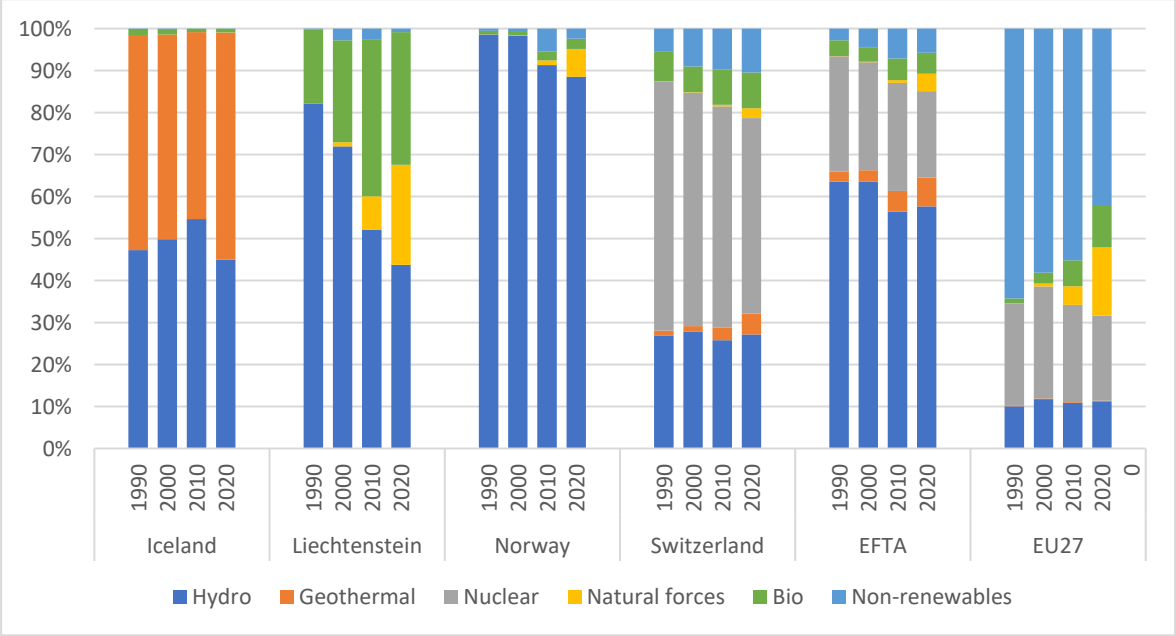

Figure 1. *Sources of electricity and heat production.*
Data*: IS, NO, EU27: Eurostat (nrg_bal_phe), LI: Amt für Statistik (551.201d), CH: Bundesamt für Energie (tables 5 and 24), Bundesamt für Statistik (T8.2.2.5)*
Notes: *Natural forces:* sun, wind, and ocean. *Bio:* renewable waste, solid and gas biofuels. *Non-renewables:* fossil fuels and non-renewable waste.

Figure 1 illustrates which primary energy sources the EFTA countries use to produce electricity and heat. In general, the EFTA countries are largely producing energy from renewable energy sources. With a closer look at each of the EFTA countries, hydropower and geothermal are Iceland's primary energy sources for electricity and heat production. Iceland`s distribution between hydropower and geothermal energy has been relatively stable over the past thirty years. In correspondence with Iceland, 44% of Liechtenstein`s energy production came from hydropower in 2020. In the last thirty years, Liechtenstein has increased the use of natural sources from zero to 24 percentage points. In 2020 almost 90 % of Norway`s electricity and heat production came from hydropower. Over the past thirty years, the use of hydropower as a primary energy source has been stable, with a small increase in the use of natural forces, from 0% in 1990 to 6.6 percentage points in 2020. Switzerland differs somewhat from the other EFTA countries because they still depend on nuclear energy.

[12] Glossary:Primary production of energy - Statistics Explained (europa.eu)
[13] Goal 7 | Department of Economic and Social Affairs (un.org)

Nuclear energy is not a renewable energy source but is considered a low-carbon energy source[14]. The EU countries still depend on non-renewable energy to produce electricity and heat. Over the past thirty years, the share of non-renewable energy use in production of electricity and heat however decreased by approximately 22 percentage points. Natural sources and bioenergy have gradually replaced some of the non-renewable energy sources. Thus, EFTA and EU countries are moving in the same direction of replacing non-renewable energy sources with renewable energy sources in producing electricity and heat, corresponding with SDG number 7.

Primary energy sources of electricity production

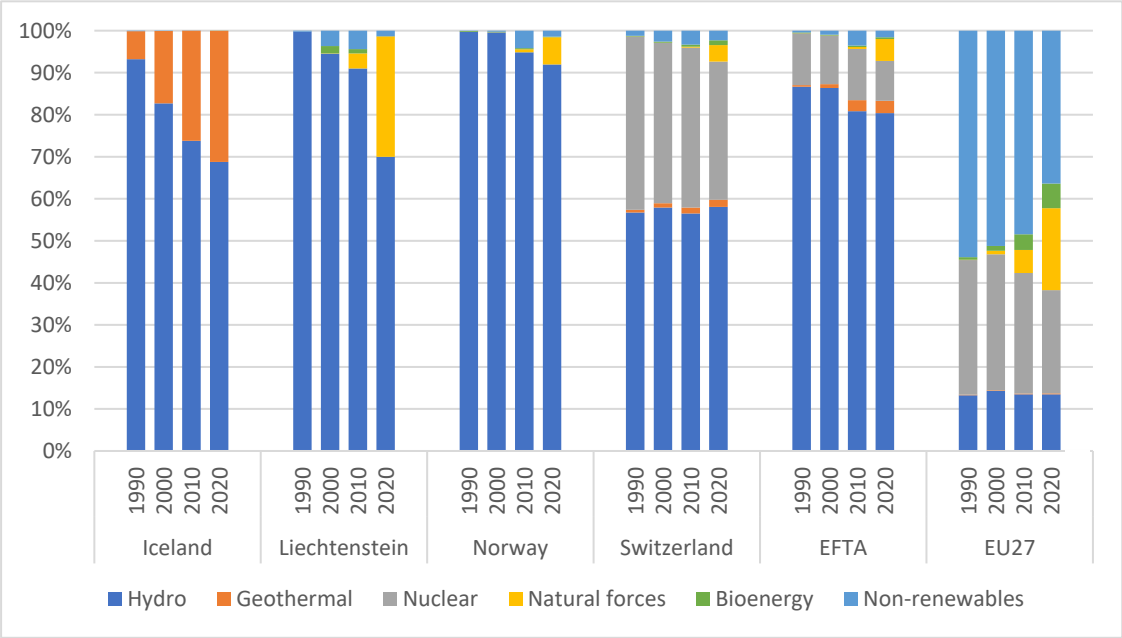

Figure 2. *Sources of electricity production.*
Data: *IS, NO, EU27: Eurostat (nrg_bal_phe), LI: Amt für Statistik (551.201d), CH: Bundesamt für Energie (table 24)*
Notes: *Natural forces:* sun, wind, and ocean. *Bio:* renewable waste, solid and gas biofuels. *Non -renewables*: fossil fuels and non-renewable waste.

Looking more closely at electricity production, figure 2 illustrates that all the EFTA countries depend largely on hydropower. In Iceland, the share of hydropower in electricity production has decreased by approximately 8 percentage points on average in every ten-year interval, replaced by geothermal energy. Liechtenstein has also decreased the use of hydropower. From 2010 to 2020, the share of hydropower in electricity production went down by about 20 percentage points, whereas natural forces increased by corresponding percentages. In Norway, there has been no development beyond a marginal decline in the use of hydropower in favor of natural forces. Together with the rest of the EFTA countries, hydropower is also

[14] Steep decline in nuclear power would threaten energy security and climate goals - News - IEA

Switzerland's largest primary energy source in the electricity production. Compared to the EU, the EFTA countries have a larger share of hydropower. In EU countries, non-renewable energy, together with nuclear energy, is still the largest source in the production of electricity.

Primary energy sources of heat production

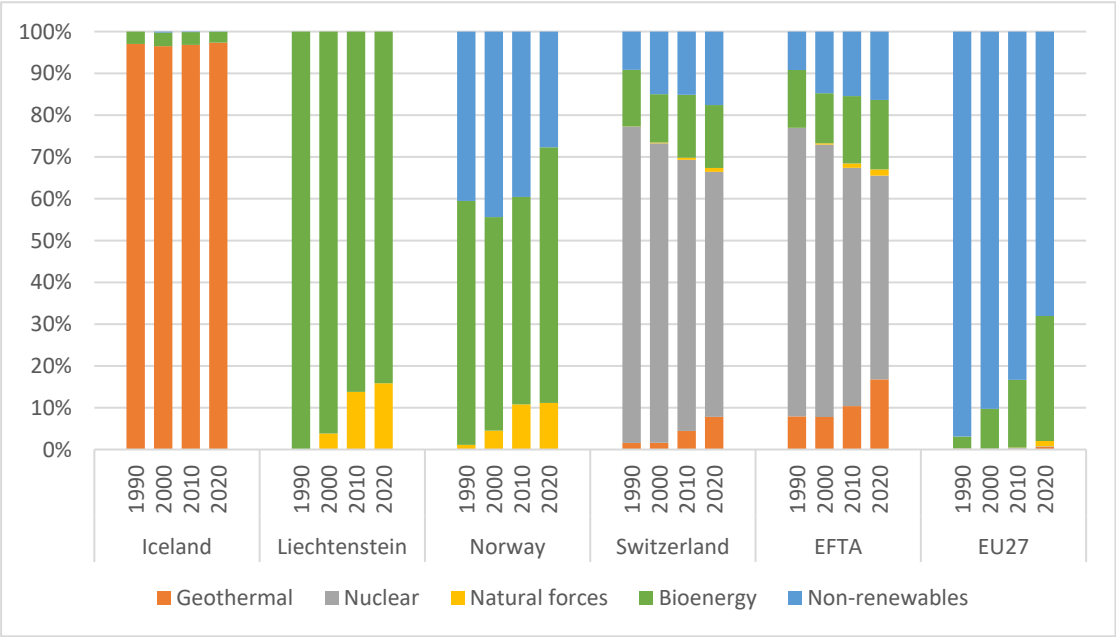

Figure 3. *Sources of heat production.*
Data: *IS, NO, EU27: Eurostat (nrg_bal_phe), LI: Amt für Statistik (551.201d), CH: Bundesamt für Energie (tables 5 and 24)*
Notes: *Natural forces:* sun, wind, and ocean. *Bio:* renewable waste, solid and gas biofuels. *Non -renewables*: fossil fuels and non-renewable waste.

Looking more closely at heat production, figure 3 illustrates that the EFTA countries depend on different energy sources. Iceland is almost solely dependent on geothermal power, with a stable distribution over the last thirty years. Liechtenstein uses mainly bioenergy when producing heat, with a minimal increase in the use of natural forces. In Norway, bioenergy is also the most widespread energy source, but non-renewable energy constitute 28 percentage points of heat produced in 2020. Switzerland depends on nuclear energy in heat production, but the share of nuclear energy has decreased slowly over time, whereas use of bioenergy, geothermal energy, and non-renewable energy in heat production have increased in the last thirty years. The EFTA countries seen as a whole depend on nuclear energy, whereas EU countries use non-renewable energy sources to produce heat. Over the past thirty years, it has been a decline in the use of non-renewable sources with a corresponding increase in the use of bioenergy for both the EFTA and EU countries.

Final energy consumption

Energy production is only one side of the coin, it does not illustrate how much and what type of energy is used. Final energy consumption is the total energy consumed by end-users, such as households, industry, and agriculture. The energy reaches the final consumer's door[15].

Share of energy from renewable sources

(% of final energy consumption)

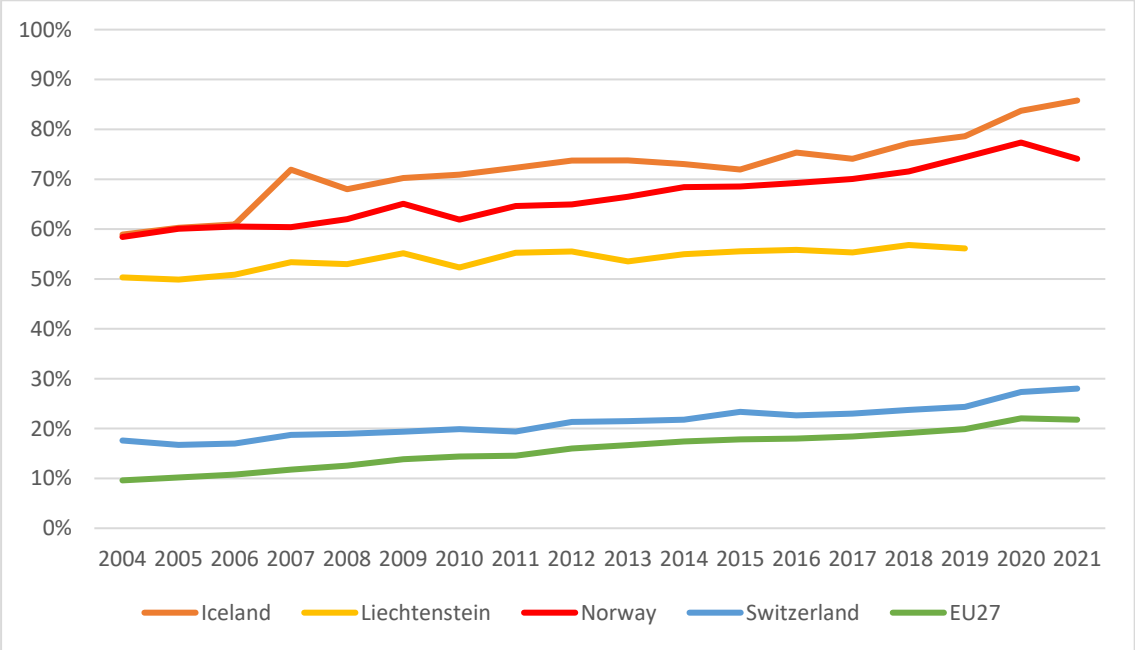

Figure 4. *Share of renewable energy of final energy consumption.*
Data: *IS, NO, EU27: Eurostat (nrg_ind_ren), LI: Tracking (SDG 7), CH: Bundesamt für Statistik (Endverbrauch erneuerbare Energien)*

Iceland reached an 86% share of final energy consumption from renewable sources in 2021, the highest share among the EFTA countries. Over the past decade, Iceland has steadily increased its share of renewable energy. Liechtenstein reached a 56% share of final energy consumption from renewable sources in 2019. The development is similar to Iceland, where the share of final energy consumption from renewable energy sources increased. Norway differs somewhat from Iceland and Liechtenstein because the share of final energy consumption from renewable sources is 74% in 2021, which is 0.3 percentage points lower than in 2020. The lifting of the restrictions linked to the COVID-19 pandemic may have played a role in this decrease[16]. Switzerland has the lowest proportion of renewables among the EFTA countries, where a 28% share of final energy consumption comes from renewable

[15] Final energy consumption in industry - detailed statistics - Statistics Explained (europa.eu)
[16] Renewable energy statistics - Statistics Explained (europa.eu)

sources in 2021. From 2004 to 2021, the share increased by ten percentage points. Switzerland is similar to the general development in EU countries, slowly moving towards a larger use of renewable energy consumption.

Sources of total energy consumption

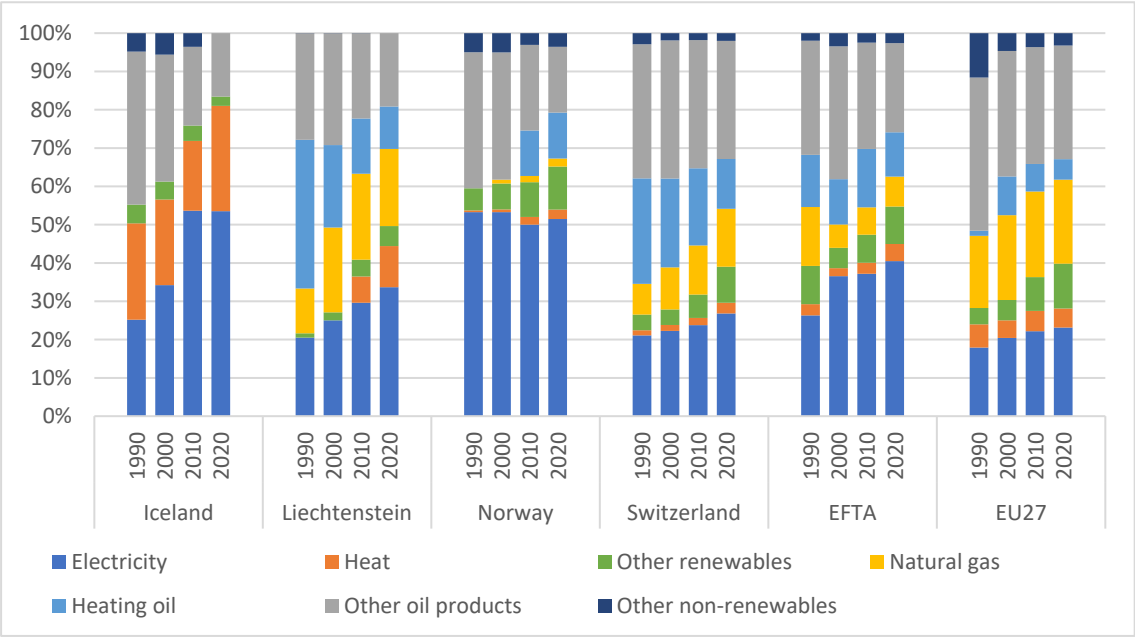

Figure 5. *Sources of total energy consumption.*
Data: *IS, NO, EU27: Eurostat (nrg_bal_c, nrg_cb_oil), LI: Amt für Statistik (551.101d), CH Bundesamt für Energie (tables 17a, 17b, 17c, 17d, 17e)*
Notes: *IS, NO, EU27:* Data transmission on heating oil is voluntary. *Other renewables:* Bioenergy and renewable waste. *Other non-renewables:* Fossil fuels and non-renewable waste.

Sources of energy consumption measure how consumers use different products made of different energy forms. In Iceland, 80% of energy consumption goes to electricity and heat. Earlier in this publication, it was shown that the production of electricity and heat primarily comes from renewable energy sources. The remaining 20% of Iceland's energy consumption comes from other oil products. Over the past thirty years, the share of electricity as a source in consumption has increased by almost 30 percentage points. At the same time, there has been a decline in the use of other oil products. In Liechtenstein, several different sources are consumed. Electricity and natural gas, and other oil products are most widespread. Similar to Iceland, there has also been an increase in the use of electricity in Liechtenstein and a corresponding decrease in the use of other oil products. Electricity corresponds to around half of the energy consumed in Norway. The development has been stable over the past thirty years. Switzerland mainly uses electricity and other oil products as sources of energy consumption. In a comparison between EFTA and the EU, the most significant difference is

that the EFTA countries use electricity more significantly. In contrast, the EU countries have more extensive use of natural gas. The use of other oil products is still quite widespread in both EFTA and the EU.

Total energy consumption by sector

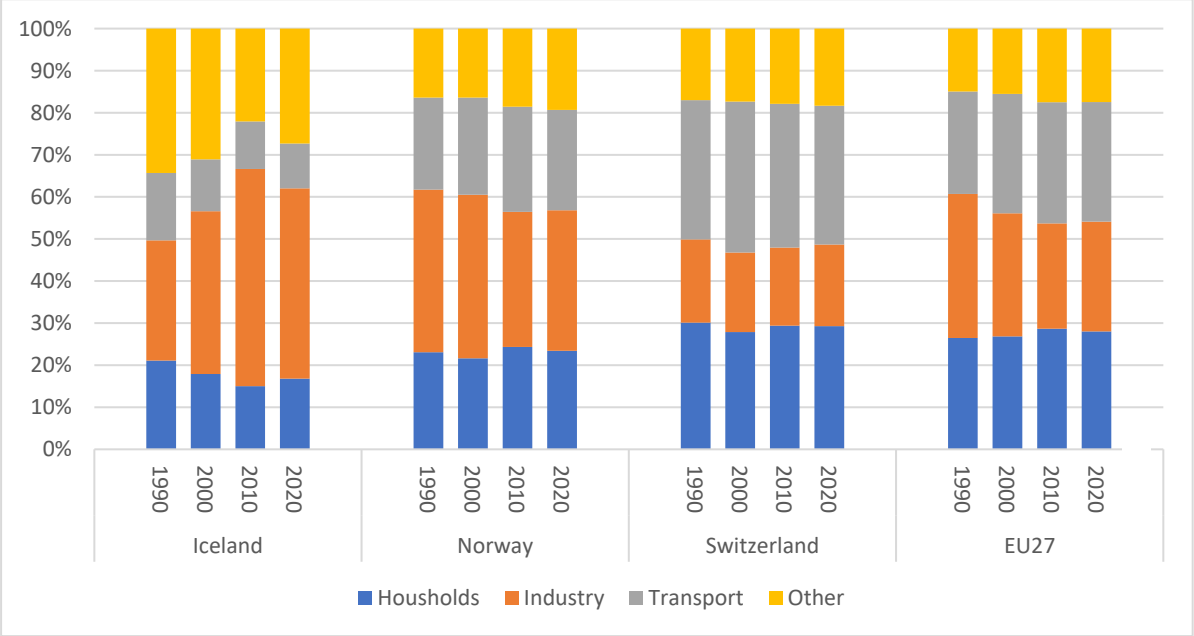

Figure 6. *Energy consumption by sector.*
Data: *IS, NO, EU27: Eurostat (nrg_bal_c and demo_pjan), CH: Bundesamt für Energie (tables 17a-17e), LI: Data not available.*
Notes: *Other: Services, agriculture and fishing.*

Figure 6 illustrates the energy consumption in each sector to provide an overview of which sector has the greatest potential for energy savings. In 2020, the industry sector accounted for 45% of the final energy consumption in Iceland. The industry sector is by far the largest end-user, whereas the sector "Other" accounts for 27%. The industry sector is also the largest end-user in Norway, accounting for 33% of the final energy consumption in 2020. However, there is a more equal distribution between the different sectors in their energy use. In Switzerland, both private households and the transport sector each account for roughly 30% of the final energy consumption. Transport is the largest energy end-user in the EU, where the sector accounts for 30% of final energy consumption. Both private households and the industry sector are large end-users of energy, with private households consuming approximately 30% of the total energy and the industry sector consuming 26% in 2020. It is worth noting that there have been no major changes in the distribution between sectors over the past thirty years.

Energy Consumption per Capita

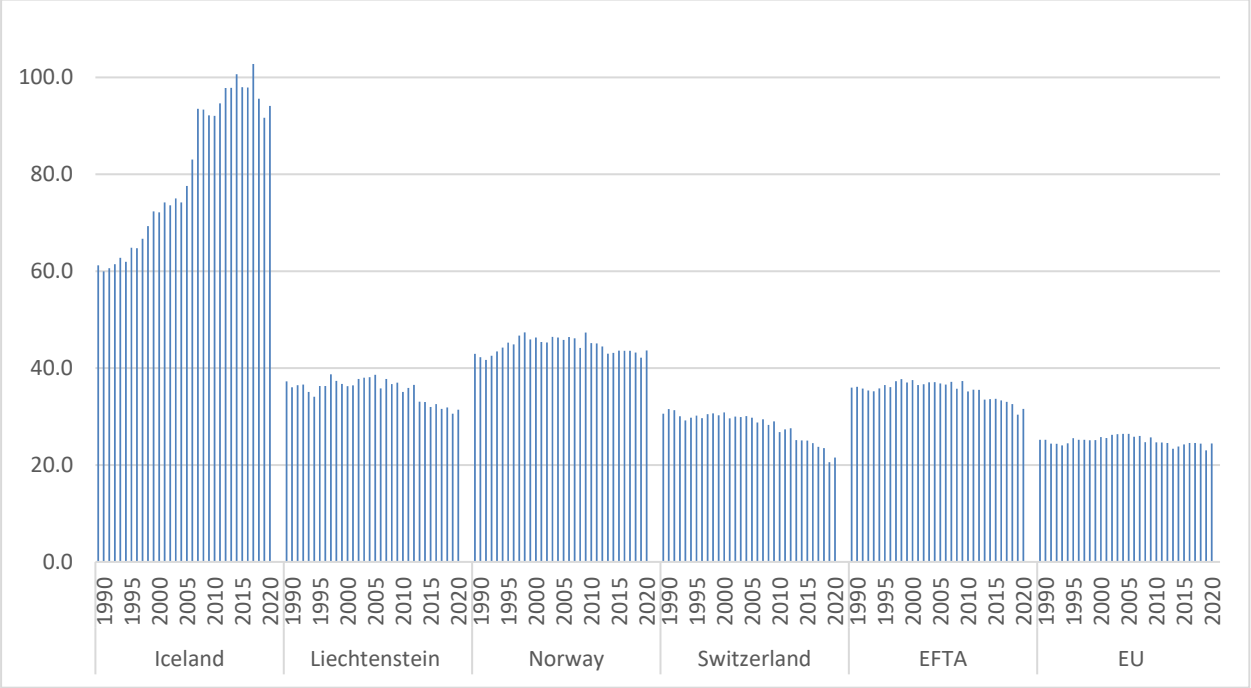

Figure 7. *Consumption per capita in MwH from 1990-2021.*
Data: *IS, NO, EU27: Eurostat (nrg_bal_c and demo_pjan),), LI: Amt für Statistik (551.101d), CH: Bundesamt für Energie (table 16).*

After reviewing how much energy each sector uses, inspecting the energy consumption per capita, measured in megawatts per hour, is also an interesting comparison. Iceland has by far the largest use of energy per capita. The striking increase in energy used also distinguishes Iceland from the other EFTA and EU countries, especially the gap between 2007 and 2008, where the consumption per capita increased from 83 MwH to 93,5 MwH. Liechtenstein has a more stable energy consumption per capita. The consumption per capita has been right under 40 MwH throughout the last thirty years, with a slight decrease from 2010 until today, almost reaching 30 MwH. Norway`s energy consumption per capita has also been stable throughout the last thirty years, with a bit more than 40 MwH for each inhabitant. Out of the EFTA countries, Switzerland is the country that uses the least amount of energy per capita, slowly declining from around 30 to just above 20 Mwh in thirty years. This is less than the other EFTA countries, especially compared to Iceland and Norway. The development in Switzerland is relatively similar to both Liechtenstein and Norway. Consumption per capita has been stable, with a slight decline in the last decade. The EU countries have had a stable energy consumption per capita from 1990 until today, with 25 MwH on average over thirty years span.

Energy production and consumption in comparison with SDG number 7

In the context of EFTA countries, the most important aspect of SDG number 7 is to use more renewable sources more efficiently. The EFTA countries are largely using renewable sources, especially in producing electricity. Hydropower is the most widespread energy source in Iceland, Liechtenstein, and Norway. Switzerland differs to some extent from the other EFTA countries because they still depend on energy from nuclear sources to some extent. In EU countries, non-renewable energy, together with nuclear energy, is the largest source in the production of electricity. In heat production, Iceland, Liechtenstein, and Norway use renewable energy from different sources, such as geothermal and bioenergy. The main energy source in Switzerland`s heat production is nuclear power. The EU countries are still largely dependent on energy from non-renewable sources in heat production. EFTA and EU countries are moving in the same direction, where renewable energy sources are replacing non-renewable energy sources. This development is in correspondence with SDG number 7.

Each EFTA country has a challenge in reducing energy consumption to use energy more efficiently. Other oil products are still an important source of energy consumption in all the EFTA countries and the EU countries. The energy consumed by different sectors has been stable over the past thirty years. The development of energy consumed per capita differs between Iceland and the other EFTA countries. While Liechtenstein, Norway, and Switzerland have decreased in energy consumed per capita, Iceland has had a remarkable increase. The EFTA and the EU countries have a long way to go to reach SDG number 7.

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The **European Free Trade Association (EFTA)** is the intergovernmental organisation of Iceland, Liechtenstein, Norway and Switzerland. The EFTA Secretariat has three duty stations:

- Geneva	in charge of EFTA convention and Free Trade Agreements
- Brussels	in charge of the European Economic Area Agreement
- Luxembourg	in charge of Statistical Coorporation

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