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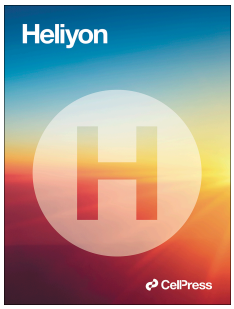

Overview of policy and market dynamics for the deployment of renewable energy sources in Italy: Current status and future prospects

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Overview of policy and market dynamics for the deployment of renewable energy sources in Italy: current status and future prospects

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Abstract

In recent years, the international community has been strongly committed to promoting energy transition due to the various challenges presented by the global energy market. In this context, renewable sources have increasingly assumed a significant role, representing a viable solution to accelerate decarbonization and promote diversification of energy mix. This paper examines Italian energy profile, its status, and future prospects. Policies and incentives on a European and national scale have been analysed to observe the commitment of institutions in promoting energy transition. Policies and incentives on a European and national scale have been analysed to observe the commitment of institutions in promoting energy transition. Projections on future investments (2030) and economic and employment implications have also been provided. The analysis shows that shared investments are essential to achieve climate goals in the short term and that existing plants need to be converted through the use of new, more effective, cost-efficient technologies. Thus, innovation and investments in research and development are key drivers of energy transition, and with proper management, climate change mitigation can be ensured. The analysis provides some useful implications for policymakers who should ensure tax incentives, feed-in tariffs, and clear regulation at the national and regional levels that do not hinder the deployment of renewable energy infrastructure.

Keywords: Energy; Renewable energy resources; Investments; Sustainability; Energy economics.

1. Introduction

The energy sector is a key driver of national socio-economic development. Since the 1990s, global energy consumption has steadily increased by an average of approximately 1-2% annually, resulting in an overall increase of over 70% **[1]**. Over the past few years, the volatility of oil prices, the scarcity of fossil gas and the climate emergency have increasingly impacted the global economy **[2]**. Although these dynamics have highlighted the necessary transition to renewables, the share of different sources in the global energy mix has remained substantially unchanged since 1990. In 2021, fossil fuels still accounted for approximately 82% of overall consumption, while renewables registered only 28.7% **[3,4]**, despite their rapid acceleration accounting for an average annual increase of 16% since 2009 **[3]**. The energy and environmental policies adopted by the most developed countries have emphasised the need to define strategies to reduce and contain carbon emissions. The process finds its roots in the United Nations Framework Convention on Climate Change of 1992, which was followed by the Kyoto Protocol signed in 1997 and culminated with the Paris Climate Agreement of 2015, representing the first universal, legally binding global agreement **[2]**. By the end of 2019, the agreement had been

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signed by 195 countries. The main goal of the Agreement is to contain the average temperature increase well below 2°C compared to pre-industrial levels and to intensify efforts to limit this increase to 1.5°C, to significantly reduce environmental risks and impacts **[5]**. Achieving these goals requires a radical transformation of the global energy system and an exponential increase in electricity production from renewable sources, in the development of renewable gases, and investments in the energy mix. Indeed, it is estimated that an 85% share of renewables and a 40% share of electricity in final energy consumption would lead to a substantial decrease in emissions to around 70% by 2050 **[6]**. To implement the commitments undertaken in the Paris Agreement, the European Union introduced the "Clean Energy Package", a system of rules aimed at pursuing three new objectives to be achieved by 2030: a reduction of at least 40% of greenhouse gas emissions compared to 1990 levels; a share of renewable sources in final energy consumption of at least 32%; and a reduction of primary energy consumption of at least 32.5% **[7]**. In this context, each Member State has developed a proposal for a National Integrated Energy and Climate Plan for the period 2021-2030 that sets out the policies needed to achieve the targets set. Italy adopted its National Energy Efficiency Action Plans (NEEAPs) in 2014, with a target of reducing main energy consumption by 17% by 2020.

The introduction of the Integrated Energy and Climate Plan to drive forward the energy transition process has become even more significant considering the need to reduce dependence on natural gas, oil and solid fuels. However, measures introduced at European level and particularly at Italian level are even further behind the Clean Energy Package **[8]**. This paper reflects on the current dynamics and future prospects of the deployment of renewable energy sources in the Italian electricity market, with a focus on investments in clean energy to observe social, environmental, and economic impacts. The article is structured as follows: Section I introduces the main measures adopted at the European and Italian levels; Section II describes the country's energy profile; Section III illustrates the current situation of clean energy investments and analyses their impact and future prospects.

2. The role of scale: from European to national level

The European Union has implemented various solutions to achieve energy efficiency and energy saving, by developing a comprehensive regulatory framework **[9]**. Among the initial measures, it is important to mention Regulation (EC) No 1099/2008 of the European Parliament and of the Council and Directives 2001/77/EC and 2003/30/EC (RED I) of the European Parliament and the Council. These directives identified various technologies to promote the use of renewables in the transport sector **[10, 11, 12]**. The aforementioned Directives 2001/77/EC and 2003/30/EC were amended and later repealed by Directive 2009/28/EC of the European Parliament on the promotion of of energy from renewable sources, which established a new target to achieve at least 20% of gross final energy consumption from renewable sources by 2020, aiming to improve energy efficiency. **[13]**.

Data recorded at the end of 2020 indicate that the Member States have achieved the targets set by Directive 2009/28/EC. The distribution of targets among member countries was based on the per capita GDP criterion. In Italy, the percentage of energy from renewable sources to be achieved was at least 17% divided among the electricity sector (26% of the target); heating sector (17%), and transport (7%) **[14]**. Between 2012 and 2020, the European Union recorded an increase of 22% (14% in 2012 and 37% in 2020) in energy production from renewable sources **[15,16].** In 2020, wind (36%) and hydro (33%) together accounted for more than two-thirds of the total electricity produced from renewable sources. This was followed by photovoltaics with a 14% share, solid biofuels (8%) and other green sources (8%) **[15,16]**. However, the challenging and delayed implementation of the Directive 2009/28/EC at the Italian level did not facilitate the process. The implementation of the Directive was completed on March 3, 2011 with Legislative Decree n. 28, which defined the tools, mechanisms, incentives, and institutional, financial, and legal framework necessary to achieve the targets up to 2020 concerning the overall share of energy from renewable sources in gross final energy consumption and the share of energy from renewable sources in

transport. Moreover, the allocation of targets between the Italian regions had to wait the Ministerial Decree[2] of March 15, 2012, the so-called Burden Sharing, which entered into force on April 3, 2012.
The Ministerial Decree marked a turning point, assigning each Region and Autonomous Province a minimum share of the increase in energy (electric, thermal and transport) produced from renewable sources, necessary to reach the national target - by 2020 - of 17% of gross final consumption. Data recorded at the end of 2020 show that the Regions fully achieved the set targets **[15,16]**.
Regarding the EU, a significant step was taken with the adoption of Renewable Energy Directive[3] (RED II) 2018/2001, which recast the previous Directive 2009/28/EC and introduced a general policy for the production and promotion of energy from renewable sources in the EU **[13]**. Furthermore, RED II raised the 2020 target of 20% share of energy from renewable sources set by the RED I to 32%, which Member States have committed to achieving by 2030. Specifically, Member States have set targets of at least 32% share of energy from renewable sources in the EU's gross final energy consumption and at least a 14% share in transport by 2023. The quota assigned to Italy is 30%, as outlined in the Integrated National Plan for Energy and Climate 2030 published in January 2020 **[13]**. At the national level, the implementation of Directive (EU) 2018/2001, or RED II, in Italy had to wait for Legislative Decree 199 of November 2021. This Decree contains provisions on energy from renewable sources and defines the necessary tools, mechanisms, incentives and institutional, financial, and legal frameworks required to achieve the target of increasing the share of energy from renewable sources by 2030 **[17].**
The centrality of renewable energy sources in environmental protection is further emphasised in the European Green Deal, a pact presented by the European Commission in December 2019. The document includes a series of proposals to make the EU's climate, energy, transport, and taxation policies suitable for reducing net greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels, representing a further step forward in the energy transition process **[18]**.

3. European energy scenario

Europe-wide developments in the energy transition process are reflected in the most recent data. Although most of the energy available in member states still comes from imported fossil fuels, local generation has been boosted dramatically as early as 2020. Indeed, about 41 percent of the energy produced in the EU came from renewable sources, while a third was generated by nuclear power plants. Even in 2021, EU primary energy production was dominated by renewables, which accounted for 41 percent of total production. For instance, Malta relied exclusively on renewable energy production, while Latvia, Portugal and Cyprus had renewable energy as their main source, with a share of more than 95 percent each. France, Belgium and Slovakia, on the other hand, relied heavily on nuclear power, accounting for 76 percent, 70 percent and 60 percent of national production, respectively [19].
With regard to renewable energy sources, the European Union has set ambitious targets, including increasing the amount of energy produced from renewable sources to around 32%. Figure 1 shows the mix of energy from renewable sources by resource, with an increasing trend for most of the renewable energy sources. The presence of recent patented technologies has enabled the rapid spread of wind, hydro, photovoltaic, and biomass energy throughout Europe. While geothermal energy and energy from the sea (Ocean Energy), have a slow spread, due to very high initial investment costs and the lack of incentives and adequate regulation. The potential of ocean energy, however, could greatly improve energy production, but its initial investment holds back investors and excessive maintenance requires very high costs.

[2] Legislative Decree 15 March 2012 defines the regional targets for renewable energy sources and the method to manage the failure of regions and autonomous provinces to reach the targets (OJ General Series n.78 of 02-04-2012).

[3] Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources is a recast of Directive 2009/28/EC and was amended by Commission Delegated Regulation (EU) 2022/759 of 14 December 2021

Although renewables play a key role in the European Union, some states are still heavily dependent on fossil fuel imports. Indeed, the second largest primary energy source was nuclear power, with a 31 percent share, while solid fuels, natural gas and crude oil accounted for 18 percent, 6 percent, and 3 percent, respectively. Despite this general trend, energy production varied significantly among member states. Solid fuels were the primary source of energy in Poland (72%), Estonia (56%) and the Czech Republic (45%). Natural gas had the largest share in the Netherlands (58 percent), Italy and Ireland (42 percent), while crude oil had the highest share in Denmark (35%) and Italy (32%).

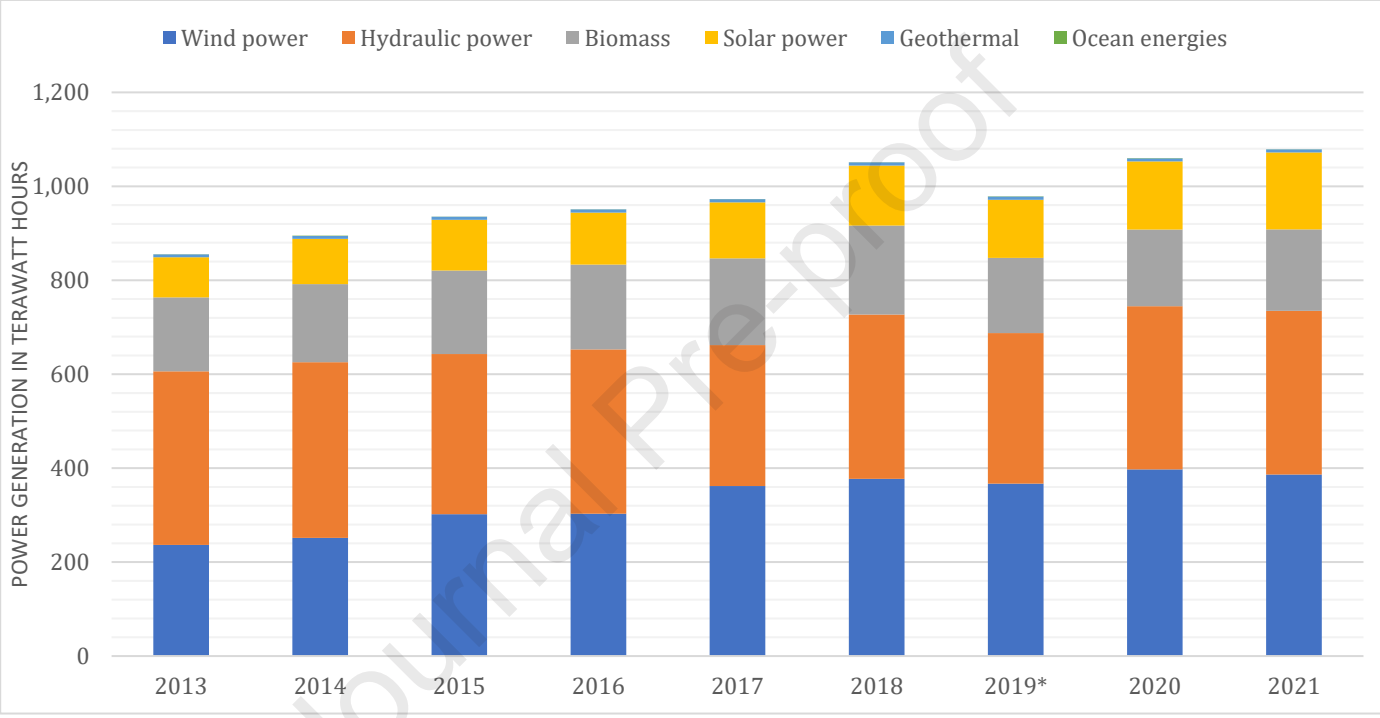


Figure 1. Renewable electricity mix in the European Union from 2013 to 2021, by energy source (in terawatt hours) [20]

These latest figures show that some states are still heavily dependent on fossil fuel imports from third countries. However, the recent geopolitical dynamics that have emerged and the growing concerns about the security of energy supply have led member states to drastically reassess their energy mix and accelerate the transition process not only on the path of decarbonization but also towards a reduction of energy dependence on third countries.

In this context, the war between Russia and Ukraine has had and will continue to have strong repercussions on the energy transition and the energy mix of member states. This is also shown by recent studies conducted by the Fondazione Eni Enrico Mattei for 2023. According to the findings, there are several long-term impacts that the war between Russia and Ukraine will have on the global energy system in the next few years, including a reduction in demand for oil and natural gas, a shift towards a more local and low-carbon energy mix and a reduction in the role of oil and natural gas imports, resulting in a more decarbonized energy mix where fossil fuels will be increasingly replaced by nuclear and renewables [19].

4. Italian energy scenario

The energy framework of the European Union in recent years shows that fossil fuels continue to be the primary source of energy supply. Although the gross energy available in 2020 decreased by about 8% compared to the previous year, the composition of the energy mix remained almost unchanged: oil continued to be the main energy source for the European economy, followed by natural gas, which remained in second place. However, in 2020 both oil and natural gas decreased by about 12% and 2%, respectively. Regarding renewable energy sources, their contribution experienced a gradual growth, exceeding from 2018 onward the share of solid fossil fuels, which dropped by 18% in 2020 compared to 2019 **[21]**.

4.1. Energy data

According to recent data, in 2021, gross primary energy consumption in Italy reached around 151,9 million tons of oil equivalent. As can be seen from Figure2, 2020 was characterised by a sharp decrease in energy consumption, mainly due to high and volatile fossil fuel prices **[22]**, and the restrictions on mobility and economic activities resulting from the pandemic, which altered the normal scenario of energy consumption and energy needs **[23]**. In Italy, the largest share of the energy market in recent years has been accounted for by natural gas, with over 62 million tonnes of oil equivalent consumed in 2021. Oil has been the second largest energy source in Italy, with over 50 million tonnes consumed in the same year. Concerning renewable sources, in 2021 energy consumption amounted to approximately 29.8 Mtoe compared to 28.7 Mtoe in the previous year, thus remaining almost constant and equal to around 30 million less than consumption from fossil sources **[24]**.
With respect to the figures recorded up to 2018, amounting to around 32 Mtoe, from 2019 onwards the growth in consumption from RES began to undergo a gradual, albeit slight, reduction. However, this decrease was accentuated by the significant rise in electricity demand recorded from 2021 onwards, meaning that the fluctuations in the share of renewables in consumption were dependent on the fluctuating trend in final energy consumption rather than on the increase in energy consumption from RES **[25]**.

Considering the supply side, Figure 3 highlights that Italy's energy market still depends mainly on fossil fuels **[26].** In 2021, natural gas (43%), imported oil (32%) and coal (4%) registered the largest share at around 80% of the total energy needs, while renewable energy accounted for 18% of the energy supply. Although energy consumption between 2019 and 2020 registered a decreasing trend, Italy’s electricity demand has been forecast to gradually grow until 2024. Indeed, forecasts show that by 2024, energy consumption will reach over 307 terawatt-hours **[22]**. Thus, reducing dependence on fossil fuels and investing in reliable and clean energy alternatives is essential for the country to meet its energy needs and promote socio-economic development and a transition to a cleaner energy mix.

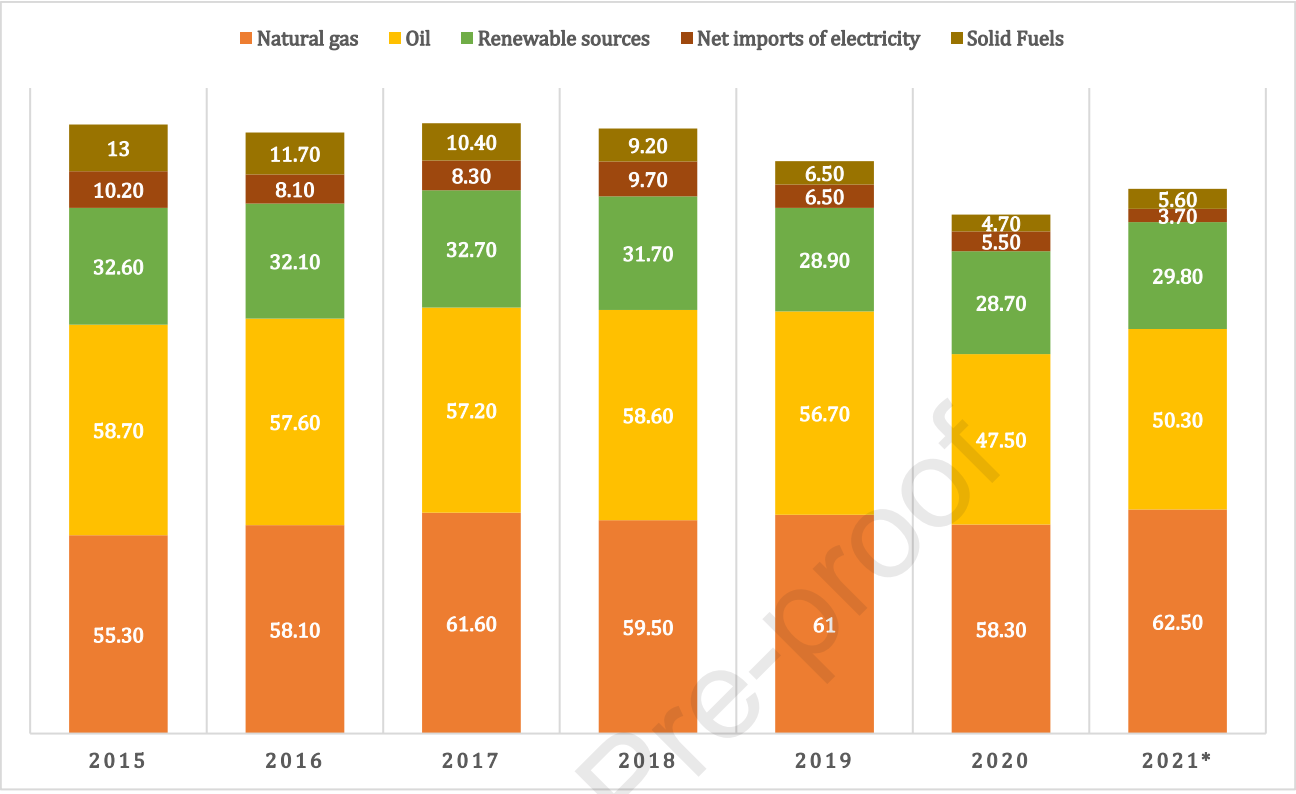


Figure 2. Energy consumption in Italy from 2015 to 2021(*)[4], by source (in million tons of oil equivalent) [22].

Table 1. Energy consumption in Italy from 2015 to 2021(*)[5], by source (in million tons of oil equivalent) [24].

Year	Natural gas	Oil	Renewable sources	Net imports of electricity	Solid Fuels
2015	55,30	58,70	32,60	10,20	13
2016	58,10	57,60	32,10	8,10	11,70
2017	61,60	57,20	32,70	8,30	10,40
2018	59,50	58,60	31,70	9,70	9,20
2019	61	56,70	28,90	6,50	6,50
2020	58,30	47,50	28,70	5,50	4,70
2021*	62,50	50,30	29,80	3,70	5,60

[4] (*) Provisional data
[5] (*) Provisional data

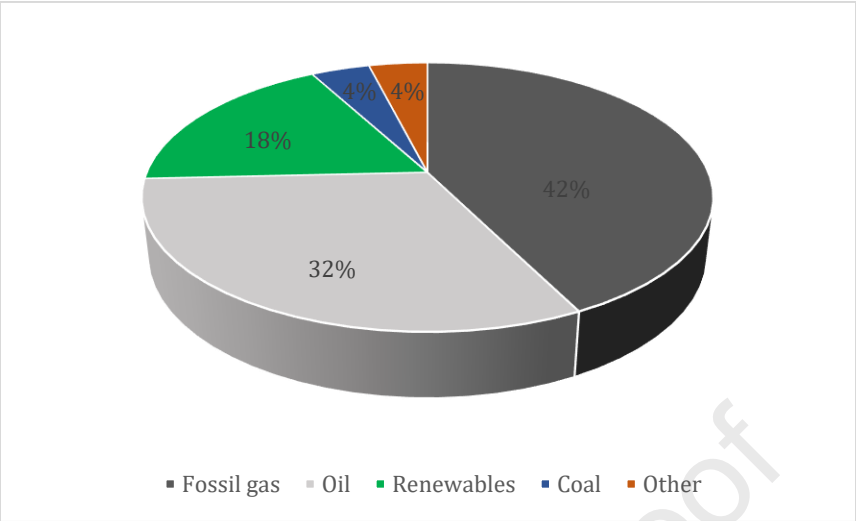


Figure 3 Distribution of the total primary energy supply in Italy in 2021, by energy source [26].

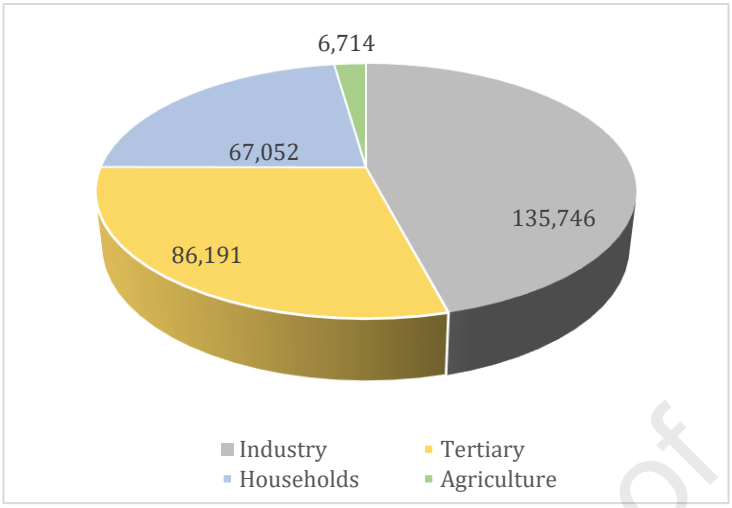
4.2. Energy consumption

Positive forecasts for energy consumption emerged by 2021, when final energy consumption increased by 6% from the previous year and affected all the sectors.

This upward trend began to be recorded mainly due to the recovery of economic indices, i.e., GDP and industrial production, rebounded by around 7% and 12% respectively compared to the previous year, which was heavily affected by the pandemic crisis. The recovery in energy consumption was also favoured by the climate factor, which recorded colder temperatures in the winter season and thus led to an increase in energy consumption at home. The recovery in energy consumption was also aided by the climatic factor, which experienced colder temperatures in the winter season and led to an increase in energy consumption at the household level. However, what negatively affected consumption was the increase in electricity prices driven by reduced investment in fossil fuels and post-pandemic energy demand recovery in the transportation sector and industry. Indeed, in 2021, there was a tripling of oil prices leading to a net increase in gas prices of about 15% with the resulting increase in electricity prices of approximately 10% higher than in 2020 **[25]**.

Regarding sectoral contributions, the main shares of energy consumption are shown in Figure 4. Industry, which had been responsible for about 15% of the 2020 decline, registered the largest quota with a consumption of approximately 135,8 terawatt-hours of the total energy demand. Industrial sector was followed by the tertiary sector which contributed to the total share with a quota of 86,2 terawatt-hours and the household sector that recorded a quota of 67,1 terawatt-hours, including lighting, cooling, and heating and, finally, agriculture 6,7 terawatt-hours **[27]**. The increase in tertiary and civil sector was mainly driven by the recovery of services and domestic energy consumption, both of which had instead affected the 2020 decline due to the restrictions during the pandemic and the harsher climate of 2021 compared to 2020 **[25]**.

Figure 4. Final electricity consumption in Italy in 2021, by sector (in gigawatt-hours) [27]

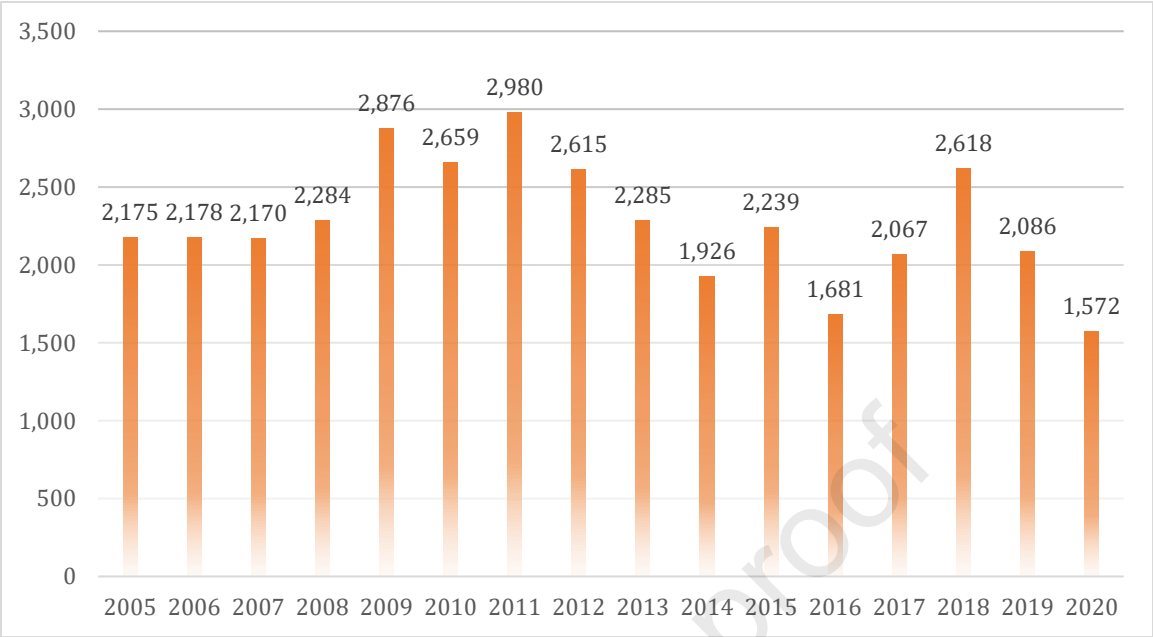


4.3. Energy imports

Italy lacks a sufficient amount of energy resources to meet its national energy needs and must import energy from other European countries. Coal, oil, and natural gas are imported and used to generate electricity. In recent years, , efforts have been focused on promoting the energy mix in order to reduce energy dependence and greenhouse gas emissions, due to energy inflation and the current geopolitical scenario. As shown in Figure 5, the value (in millions of euros) of imported electricity in Italy has decreased over the past two years, but the percentage of imported energy is still extremely high, leaving Italy vulnerable to price fluctuations **[28]**.

Figure 5Value of electricity imported to Italy from 2005 to 2020(*)[6] (in million euros) [28]

[6] (*) Provisional data



5. Renewable Energy Sources

Renewable Energy Sources (RES) have become a crucial focus of Italy's energy policy in recent years due to the country's dependence on fossil fuels and foreign energy supply, as well as the need to reduce greenhouse gas emissions. The government has introduced ambitious targets for increasing the use of renewable energy, with a goal of producing 30% of its electricity from renewable sources by 2030 **[29]**.

Over the past decade, Italy has made significant progress in the use of clean energy sources, to the extent that the 17% renewable energy target to be achieved by 2020 was already reached in 2014, with a value of 17.1%, representing 49.526 MW of the total energy capacity. By the end of 2021, RES accounted for 56,987 MW, representing 18% of the country's total energy consumption **[30]**. This represents an increase of approximately 40% compared to 2008, when renewables accounted for only 11.5% (23.155 MW) of the total energy produced in the country **[15, 16]**.

This development has been driven by the significant increase in energy produced by photovoltaic plants, wind, and hydro, concentrated in the period between 2008-2021. Moreover, the structural conditions of the Italian electricity market have also influenced the impact of RES on electricity prices. Since renewables are free natural resources that reduce Italy's dependence on oil and gas supplies from abroad, they represent a mitigating factor for electricity prices.

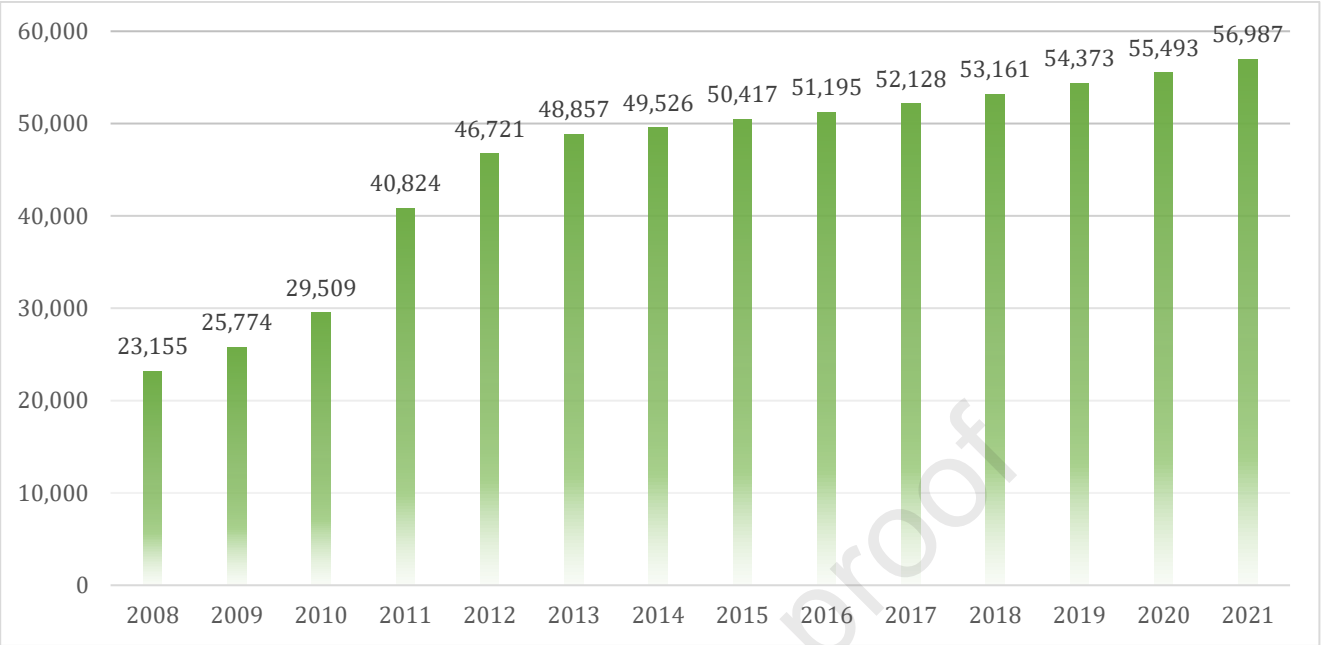


Figure6. Renewable energy capacity in Italy from 2008 to 2021 (in megawatts) [31]

5.1. Hydroelectric Power

Hydroelectric power is one of the main sources of electricity production in Italy's energy mix **[32]**. According to recent data presented in Table 2, despite a reduction in gross hydropower production from 2018, when it amounted to 48,786 GWh, it remains the largest source of renewable energy in the country, with a total gross production of 44.740 GWh (41%) in 2021 **[33]**.

Italy has a significant potential for hydropower generation, with numerous rivers and mountainous regions providing several opportunities for the construction of hydroelectric power plants. Most of the total installed capacity is provided by large-scale hydropower plants, which are concentrated in the northern regions of the country **[34]**. Small-scale hydroelectric facilities also contribute to the overall capacity, especially in mountainous areas **[35]**.

In recent years, there has been a shift towards the modernization of existing hydropower plants to improve their efficiency and environmental sustainability. This has included the installation of new turbines and other equipment, as well as the implementation of measures to reduce the impact of dams on local ecosystems and water resources **[32]**. Thus, hydroelectric power remains a key component of Italy's energy mix, playing a significant role in the country's transition to a more sustainable and low-carbon energy system.

5.2. Photovoltaic

Solar photovoltaic (PV) energy in Italy has experienced a significant growth in recent years. Gross energy production from solar PV increased from 18,862 GWh in 2012 to 25,466 GWh in 2021, as shown in Table 2.

The development of photovoltaic has been driven by favourable policies promoted by the Italian government in the 2019 National Integrated Plan for Climate and Energy. The measures included feed-in tariffs, tax incentives, and regulatory reforms to promote the deployment of solar PV and other renewables **[36]**. Furthermore, the reduction in technology costs have made solar PV increasingly competitive with other sources of energy

generation, accelerating its growth. Indeed, the Levelized Cost of Electricity (LCOE)[7] for Solar PV in Italy has decreased significantly over the past decade, from around €250/MWh in 2010 to around €50/MWh in 2020 **[37]**.
Despite these positive trends, the solar PV industry in Italy also faces challenges. One of the main issues is grid integration, as the rapid growth of solar PV has put strain on the country's electricity infrastructure. Grid constraints and the lack of available land for large-scale installations have limited the diffusion of solar PV, particularly in southern Italy, where the highest capacity has been installed **[38]**.
In response to these challenges, the Italian government has implemented measures, including auctions for new renewable energy projects and incentives for energy storage to help balance the grid **[36]**. Nevertheless, due to the favourable political environment and the falling technology costs, solar PV will play an increasingly significant role in Italy's efforts to reduce the dependence on fossil fuels **[39]**.

5.3. Wind Power

Wind power has experienced significant growth in Italy, with a total installed capacity of 18,762 GWh in 2020 and 20,789 GW in 2021, accounting for approximately 19% of electricity generation in 2020 **[33]**.
In recent years, Italy has experienced a significant increase in the installed capacity of wind power. According to data from the Italian Wind Energy Association (ANEV), the country's installed wind power capacity in 2021 reached an increase of 2% compared to the previous year **[40]**. This growth has been driven by both the development of large-scale wind farms, especially in the southern regions of the country, and the favourable government policies introduced with the National Energy Strategy which aims to increase the share of renewable energy sources in the country's energy mix to 28% by 2030 **[41]** through feed-in-tariffs, priority dispatch, and technological advancements **[40]**.
The development of wind energy in Italy has also been supported by the European Union's funding programs, such as Horizon 2020, which has provided funding for several wind energy research projects in the country. These projects include the optimization of wind farm performance, the development of innovative wind turbine technologies, and the assessment of the environmental and socio-economic impacts of wind energy production **[42]**.
However, there are still several challenges that need to be addressed to ensure the sustainable development of wind energy in Italy, such as the need to ensure social and environmental sustainability of wind farm development address potential conflicts with other land uses and intermittency in wind energy production **[40]**. Despite these issues, the capacity of wind power is expected to increase in the next years, particularly in southern Italy **[43]**.

5.4. Bioenergy

Bioenergy has emerged as a promising renewable energy source in Italy in the effort to reduce its dependence on fossil fuels and mitigate the effects of climate change and plays an important role in terms of energy security **[44]**. Bioenergy's important contribution lies in the fact that it is the only renewable source capable of covering energy demands in the form of electricity, heating, and transport fuels.
The main sources of bioenergy in Italy are biomass, i.e., solid fuels of organic origin and waste. Half of the electricity production from solid biomass comes from the combustion of municipal solid waste and represents two thirds (70%) of total bioenergy production with a total installed capacity of 19,634 GWh in 2020 and 18,272 GWh in 2021 **[38]**. The main biomass power plants are in Southern Italy **[45]**.
The Italian government aims at safeguarding the current production of solid biomass by 2030. Concerning the heating sector, Italy has promoted technologies and projects to significantly reduce pollutants and greenhouse gas

[7] LCOE is a method to measure energy costs through operational expenditure.

emissions. In addition, in the transport sector, the potential of biomethane will also be better exploited. Indeed, the National Recovery and Resilience Plan has provided a fund of about 2 billion euro to promote the production of biomethane through projects for the conversion and efficiency improvement of existing biogas plants and for the installation of new plants in the agricultural sector. Furthermore, using biomethane in the transport and electricity sector could generate economic benefits and several positive environmental externalities.

Despite the growing interest in bioenergy in Italy, there are still several challenges that need to be addressed to ensure its sustainable development. These include the need to ensure the sustainability of biomass production and supply chains, the need to address the potential negative impacts of bioenergy production on biodiversity and ecosystem services, and the need to address social and economic issues related to the development of bioenergy in rural areas, including its potential impact on food security and the environment **[46]**.

In conclusion, Italy has made considerable progress in the development of renewable energy sources in recent years. The growth of solar PV and wind power has been particularly notable, driven by favourable policies and technological advancements. The capacity of bioenergy and geothermal energy has also increased, although their growth has been limited by environmental concerns and technical challenges. Italy's commitment to the National Energy Strategy and the EU's renewable energy targets will continue to drive the diffusion of renewable energy sources in the country.

Table 2. Gross energy production by source in (in gigawatt hours) [47]

Year	Hydroeletric	Wind	Photovoltaic	Biomass and Waste
2012	41.875	13.407	18.862	12.487
2013	52.773	14.897	21.589	17.090
2014	58.545	15.178	22.306	18.732
2015	45.537	14.844	22.942	19.396
2016	42.438	17.689	22.104	19.509
2017	36.199	17.742	24.377	19.378
2018	48.786	17.716	22.654	19.153
2019	46.319	20.202	23.688	19.563
2020	47.552	18.762	24.942	19.634
2021	44.740	20.789	25.466	18.272

6. Investment in Clean Energy

In Italy, investments in renewable energies are growing slower than in neighbouring Germany and Spain **[48]**. The Italian political system is committed to promoting and ensuring a dynamic development of renewables, through the green certificate system and Remuneration of Renewable Energy Resources (REM) mechanisms. Indeed, a large-scale deployment of renewable energies could reduce atmospheric emissions and eliminate energy dependency in the short term, as well as impact on social and employment profile. However, to ensure a rapid and steady growth, adequate investments, and government initiatives to improve the infrastructure and distribution of plants are essential to reach the ambitious European targets and become carbon neutral by 2050. The purpose of this section is to illustrate the investments in the renewable energy sector in Italy. Concerning the European and national scenario, the main challenges and opportunities for a sustainable future will be discussed to formulate the strategies that should be implemented to ensure an equitable and sustainable spread.

6.1. Current Situation and Future Prospects

Investments play a significant role in the energy sector to reduce dependence on fossil fuels and stimulate the economy. However, Italy has experienced a rapid decrease in investments for renewables since 2011 and in 2021, 2 billion euros were invested, approximately 12,276 million euros less than in 2011 **[49]**.

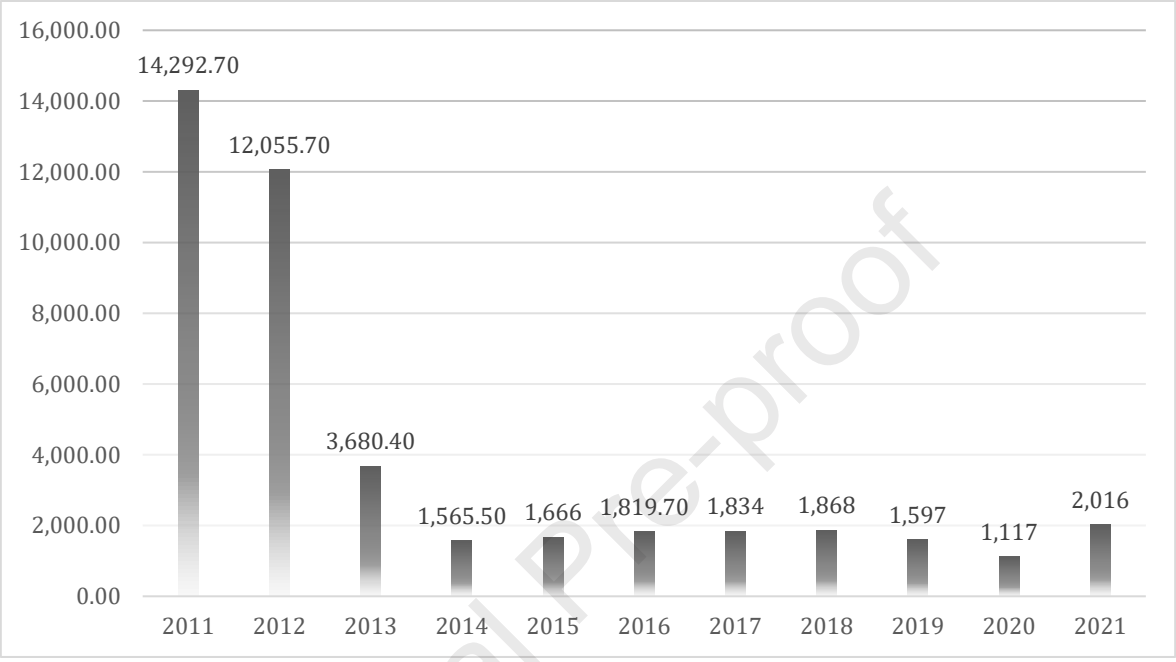


Figure7. Investments in the sector of electricity generated by renewables in Italy from 2011 to 2021(in mln euros) [49]

In Italy, different drivers and factors have contributed to the reduction of investments in renewable energy sector, and it is possible to divide them into four macro-categories:

1. *Political Problems:* political uncertainty and instability can discourage investors who are forced to plan for the long term.
2. *Initial investment:* high upfront financing for the construction of an energy infrastructure as well as the possibility of amortisation over the medium to long term are required.
3. *Authorizations and concessions:* the whole bureaucratic process holds back investment by making it difficult to access new forms of financing.

An analysis of the data shows that most of the investments have been in the photovoltaic sector (over 1 billion euros) and in wind power (633 million euros). This result is in line with the existing scientific literature **[50]** which confirms that the risk for wind and photovoltaic investments has decreased in recent years and therefore investors prefer these more dependable and widely tested technologies. Indeed, photovoltaics is confirmed as one of the leading green technologies **[51]**. However, using the breakdown by source, it can be observed that over the last six years (2016-2021), the value of investments, especially for hydro and biomass, has decreased significantly, while biogas in the last year has been growing at a national and European level **[52].**

Table 3. Value of investments by technologies in Italy from 2016 to 2021 (in million euros) [53]

Year	Biomass	Hydroeletric	Biogas	Photovoltaic	Wind Power

2016	358	251	105	616	489
2017	72	299	113	580	768
2018	293	84	50	582	859
2019	12	104	74	835	598
2020	8	176	1	807	123
2021	50	185	93	1.055	633

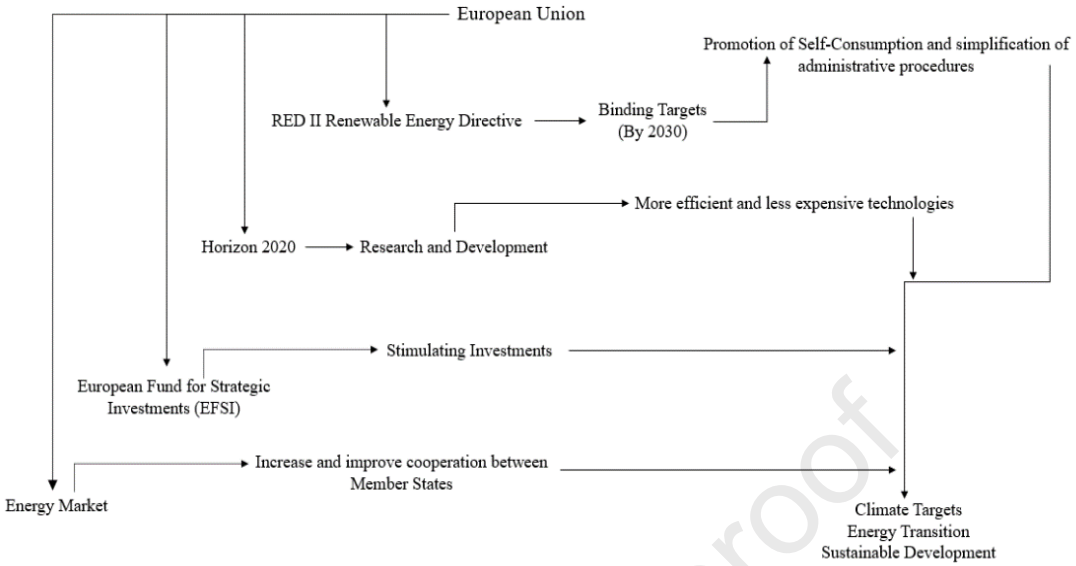
6. Incentive Tools

Based on European Union directives and recommendations, the Italian government has adopted various strategies and initiatives to promote the spread of renewable energy and ensure the energy transition.

6.1. The situation at European and National Levels

The European Union has promoted different initiatives to reach the 2030 climate targets and provide guidance to the Member States, introducing supportive policies **[54]**, namely, RED II directive, Horizon 2020 programs and the European funds for strategic investments. Furthermore, with the promotion of the common energy market, the aim is to increase competitiveness and cooperation between states. In this respect, there are studies **[55]** that explain how the Smart Energy System approach at European level, would be possible without consuming an unlimited and unsustainable amount of bioenergy and that for the achievement of the ambitious European targets (reduction of 80% CO2) by 2050, the energy cost, will be +3% higher than for common fossil fuels.

Figure 8 EU policy framework on the promotion of energy transition



All these European initiatives have a common denominator of ensuring a fair and resilient energy transition that contributes to climate change mitigation and sustainable development. According to the European Union's recommendations, Italy has integrated a series of specific measures into its legal framework. For instance, the National Integrated Energy and Climate (ENCP) Plan aims to ensure a reduction in energy consumption in primary terms. Nevertheless, energy efficiency, electrification of mobility, and changing industrial paradigms are present in all national political agendas and through the so-called "Conto Termico"[8] solutions are offered to ensure the installation and modernization of new systems. such as the Renewable Energy Bonus, introduced into the national legal system through the "Legge di Bilancio" 2022, this facilitation consists in the provision of a tax credit for expenses incurred in the installation of energy storage systems connected to electricity production plants from renewable sources. Moreover, through the National Energy Efficiency Fund, new incentives have been introduced to ensure retraining and modernization in the energy sector.

6.2. Economic and employment spin-offs

In accordance with preliminary estimates provided by the Ministry of Ecological Transition, it can observe that in 2021 approximately 2,016 million euro will be invested in the renewable energy sector with important positive externalities in terms of employment and the economy. In fact, Table 2 shows that the added value for the entire economy is approximately 2,917 million euro. In terms of employment, the annual work units were as follows: 14,011 temporary workers and 33,876 permanent workers, with important and significant job positions in the photovoltaic, wind, hydroelectric and biogas sectors.

Table 4. Economic and occupational repercussions of the development of renewables [56]

Technology	Investment (mln €)	Expenditure O&M (mln €)	Added Value Generated for the Entire Economy (mln €)	Direct and Indirect Temporary Workers	Direct and Indirect Permanent Employees
Photovoltaic	1.055	411	764	6.337	6.169
Eolic	633	340	406	4.864	3.880
Hydroelectric	185	1.063	811	1.625	11.652

[8] Conto Termico is a tool providing incentives for interventions to increase energy efficiency.

Biogas	93	634	518	777	6.308
Solid Biomass	50	612	256	409	3.615
Bioliquids	-	646	118	-	1.621
Geothermal	-	59	43	-	632
Total	2.016	3.765	2.917	14.011	33.876

6.3. Future Challenges

Italy imports substantial shares of electricity with important impacts on public spending and final product prices. Furthermore, the diffusion of renewable energy infrastructures could generate economic, environmental, and social benefits. Finally, the proper relocation of plants and the deployment of energy communities **[57]**, where citizens become "prosumers", namely, producers and consumers **[58]** guarantee the development of a sustainable economy in the medium term, as well as empower communities. Projections for 2030 (Figure9) show that from the estimated values of investments in renewable energies, photovoltaics are expected to receive around 31.5 billion investments (2020-2030), followed by wind, hydro and geothermal. However, scientific literature documents that not only public, but also private investments can foster the spread of the green economy, such as green venture capitalists. [60]

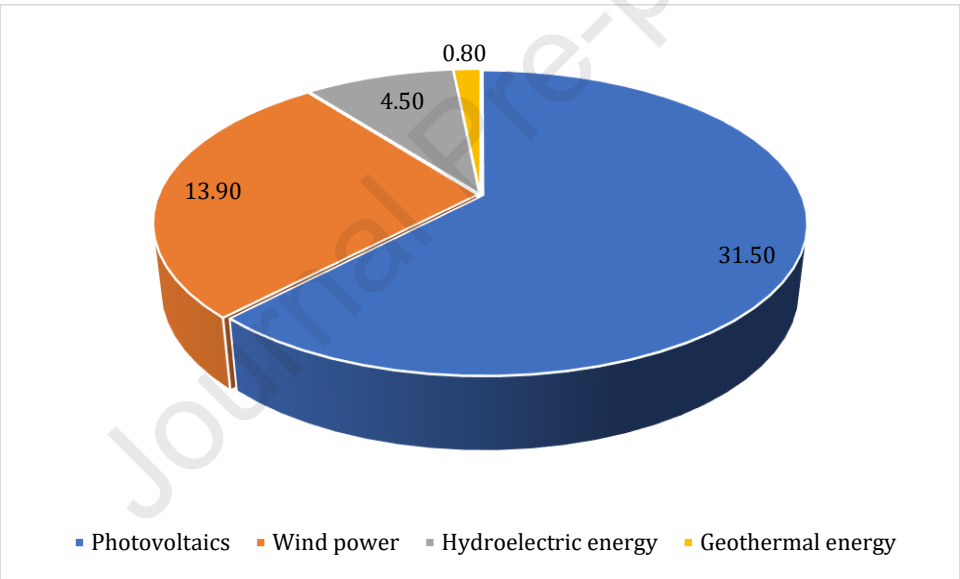


Figure9. Estimated value of investments in renewable energy in Italy from 2020 to 2030, by type of technology (in bln euros) [59]

In conclusion, about investment value projections, it can be affirmed that the future of renewables in Italy is promising. However, there is a need to increase investments in research and development to ensure the deployment of new, more efficient, and effective technologies, as well as the relocation of plants to promote low emission electrification also in rural areas.

7. Conclusions

Over the past decade, Italy has experienced a rapid spread of renewable energy due to national and European government policies and public and private investments. However, its spread is still very slow and uneven. This problem is linked to some important elements, which can be divided into two profiles, political and economic. On the political side, the presence of short-sighted, often fragmented and complex measures can generate problems in the decision-making process, discouraging investors and new shareholders. On the economic side, the presence of

economic crises and the Covid-19 pandemic have slowed down the number of incentives and investments. However, on the political agendas and on a smaller scale at company level, everyone is aware of the importance of renewables and the need to simplify existing legislation and regulations and promote the adoption and diffusion of new, more modern technologies that are efficient and economical. The analysis confirms that Italy, due to its geographical location, could achieve energy self-sufficiency by developing and improving its energy infrastructure and adopting plant conversion processes. The analysis shows that investing in renewables also generates gains in social and employment terms, fostering the spread of green jobs with important development opportunities for rural areas, which often suffer from depopulation and a lack of employment However, one of the main issues is related to the source of financing and its difficult availability. In fact, the construction of a new energy infrastructure requires extremely high initial costs, with amortisation occurring over the long term. In this direction, policy makers should also facilitate the spread of renewable communities to promote empowerment and awareness, through tax incentives, feed-in tariffs, and regulations. Furthermore, another interesting aspect is related to investments in R&D and the need to implement and ensure the diffusion of cheaper, more effective, efficient, easier to implement, with reduced maintenance costs and significantly improved electrical capacities modern technologies. These strategies are the main focus on which policy makers should invest to promote energy transition to a low-carbon future and pursue the ambitious European targets.
In conclusion, the analysis provides some useful implications for policymakers. First, it provides evidence of the economic and social benefits of investing in renewable energy, which can be used to justify further investment in this area. Second, it highlights the challenges related to financing and the need for policy interventions to facilitate the spread of renewable communities through effective targeted measures. Third, it emphasises the importance of investing in research and development to promote the development and diffusion of cheaper, more effective, and efficient technologies. In fact, the deployment of renewables is often slow also due to the technological complexity of new patents, which require years before they can do their work efficiently. Moreover, their continuous evolution requires continuous updating, which may slow down the process and generate obstacles and restrictions on patent registration. In a nutshell, this study aims to contribute to the existing scientific literature by documenting the Italian energy situation and how it should focus on diversifying renewable energy sources, promoting the energy mix and contributing to the promotion of a resilient and sustainable energy system. However, the results of this study must be seen in the light of some important limitations.

The literature does not provide many studies dealing with the Italian energy situation. Indeed, most of them focus on the European level, which did not allow authors to conduct a comprehensive comparison with the existing scientific literature. Finally, the scarcity of data resulting in some instances from fluctuating technical figures can merely provide approximate estimates and projections.

8. Declaration of concurrent interest

The authors claim that they have no competing monetary interests or known personal relationships that might seem to influence the work reported in this article.

References

[1] H. Ritchie, M. Roser, P. Rosado. "Energy". Published online at OurWorldInData [accessed March 2023], https://ourworldindata.org/energy, 2022

[2] G. Abu-Rumman, A. I. Khdair, S.I. Khdair, Current status and future investment potential in renewable energy in Jordan: An overview. Heliyon, Volume 6, Issue 2, (2020), e03346, ISSN 2405-8440.

[3] IEA, *Renewable Electricity*, Paris, Licence: CC BY 4.0 [accessed March 2023], https://www.iea.org/reports/renewable-electricity, 2022

[4] BP, BP Statistical Review of World Energy. [accessed March 2023], https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html

[5] Paris Agreement to the United Nations Framework Convention on Climate Change, T.I.A.S. No. 16-1104, https://unfccc.int/sites/default/files/english_paris_agreement.pdf, Dec. 12, 2015

[6] D. Gielen, F. Boshell, D. Saygin, M. D. Bazilian, N. Wagner, R. Gorini, The role of renewable energy in the global energy transformation. Energy Strategy Reviews, ISSN 2211-467X, Volume 24, (2019) 38-50, https://doi.org/10.1016/j.esr.2019.01.006

[7] A. Nouicer, L. Meeus, European University Institute, Robert Schuman Centre for Advanced Studies, *The EU Clean Energy Package*, European University Institute (2020), https://data.europa.eu/doi/10.2870/33236

[8] K. Daszkiewicz, Policy and Regulation of Energy Transition. In: Hafner, M., Tagliapietra, S. (eds) The Geopolitics of the Global Energy Transition. Lecture Notes in Energy, vol 73, Springer, Cham, (2020), https://doi.org/10.1007/978-3-030-39066-2_9

[9] A. Hedberg, S. Šipka, The role of European Union policies in accelerating the green transition, Field Actions Science Reports, Special Issue 24 (2022), http://journals.openedition.org/factsreports/6989

[10] Regulation (EC) No 1099/2008 of the European Parliament and of the Council of 22 October 2008 on energy statistics [accessed March 2023], https://www.eea.europa.eu/policy-documents/1099-2008-ec, 2008

[11] Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market [accessed March 2023], https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32001L0077&from=en, 2001

[12] Directive 2003/30/EC of the European Parliament and of the Council of 8 May 2003 on the promotion of the use of biofuels and other renewable fuels for transport [accessed March 2023], https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32003L0030&from=en, 2003

[13] K. Kulovesi, S. Oberthür, Assessing the EU's 2030 Climate and Energy Policy Framework: Incremental change toward radical transformation? RECIEL (2020) 29: 151, 166. https://doi.org/10.1111/reel.12358

[14] GSE, Monitoraggio statistico degli obiettivi nazionali e regionali sulle FER - Anni 2012-2019 [accessed March 2023], https://www.gse.it/documenti_site/Documenti%20GSE/Rapporti%20statistici/Rapporto%20statistico%20di%20monitoraggio%20di%20cui%20al%20DM%2011-5-15%20art%207_anni%202012-2019.pdf, 2021

[15] EUROSTAT, Energy, transport and environment statistics 2020 edition, Statistical Books [accessed March 2023] https://ec.europa.eu/eurostat/documents/3217494/11478276/KS-DK-20-001-EN-N.pdf/06ddaf8d-1745-76b5-838e-013524781340?t=1605526083000, 2020

[16] EUROSTAT, Energy data 2020 edition, Statistical Books [accessed March 2023] https://ec.europa.eu/eurostat/documents/3217494/11099022/KS-HB-20-001-EN-N.pdf/bf891880-1e3e-b4ba-0061-19810ebf2c64?t=1594715608000, 2020

[17] European Commission, Sustainability criteria for biofuels specified [accessed March 2023], https://joint-research-centre.ec.europa.eu/welcome-jec-website/reference-regulatory-framework/renewable-energy-recast-2030-red-ii_en, 2019

[18] A. Sikora, European Green Deal – legal and financial challenges of the climate change. ERA Forum 21, (2021), 681–697.

[19] Fondazione Enrico Mattei, BP Energy Outlook 2023 - Exploring the Impact of Russia-Ukraine War in the Energy Transition [accessed April 2023], https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/energy-outlook/bp-energy-outlook-2023.pdf, 2023

[20] EurObserv'ER. Renewable electricity mix in the European Union from 2013 to 2021, by energy source (in terawatt hours) [Graph]. In Statista. [accessed April 2023] https://www.statista.com/statistics/610362/renewable-electricity-mix-in-eu-28/, February 28, 2023

[21] IEA, *World Energy Outlook 2022*, IEA, Paris, Licence: CC BY 4.0 (report); CC BY NC SA 4.0 (Annex A) [accessed March 2023], https://www.iea.org/reports/world-energy-outlook-2022, 2022

[22] Unione Energie per la Mobilità, Energy consumption in Italy from 2015 to 2021, by source (in million tons of oil equivalent) [Graph]. In Statista. [accessed March 2023] https://www.statista.com/statistics/787237/energy-consumption-by-source-in-italy /, July 26, 2022

[23] ENEA, Rapporto Annuale Efficienza Energetica [accessed March 2023] https://www.efficienzaenergetica.enea.it/component/jdownloads/?task=download.send&id=453&catid=40%20&Itemid=101, 2020

[24] Unione Energie per la Mobilità, Energy consumption in Italy from 2015 to 2021, by source (in million tons of oil equivalent) [Graph]. In Statista [accessed March 2023], https://www.statista.com/statistics/787237/energy-consumption-by-source-in-italy/, July 26, 2022

[25] ENEA, Analisi trimestrale del sistema energetico italiano anno 2021 [accessed April 2023], https://www.pubblicazioni.enea.it/component/jdownloads/?task=download.send&id=469&catid=4&m=0&Itemid=101, January, 2022

[26] Climate Transparency, Distribution of the total primary energy supply in Italy in 2021, by energy source [Graph]. In Statista [accessed March 2023], https://www.statista.com/statistics/873552/energy-mix-in-italy/, October 16, 2022

[27] Terna. Final electricity consumption in Italy in 2021, by sector (in gigawatt-hours) [Graph]. In Statista [accessed March 2023] https://www.statista.com/statistics/792128/final-electricity-consumption-by-sector-in-italy/, January 6, 2023

[28] Unione Energie per la Mobilità, Value of electricity imported to Italy from 2005 to 2020* (in million euros) [Graph]. In Statista [accessed March 2023] https://www.statista.com/statistics/795442/import-value-of-electricity-in-italy/, November 19, 2021

[29] Ministero dello Sviluppo Economico. Energia Clima 2030, Piano Nazionale Integrato per l'Energia e il Clima [accessed March 2023], https://www.mise.gov.it/images/stories/documenti/WEB_ENERGIACLIMA2030.pdf

[30] IEA, *World Energy Outlook 2022*, IEA, Paris, Licence: CC BY 4.0 (report); CC BY NC SA 4.0 (Annex A) [accessed March 2023], https://www.iea.org/reports/world-energy-outlook-2022, 2022

[31] IRENA. Renewable energy capacity in Italy from 2008 to 2021 (in megawatts) [Graph]. In Statista. [accessed March 2023], https://www.statista.com/statistics/825951/total-capacity-of-installations-fueled-by-res-in-italy-2008-2017/, (April 8, 2022)

[32] S. Quadroni, P. Espa, S. Zaccara, G. Crosa, R. Bettinetti, M. Mastore, M. F. Brivio, Monitoring and Management of Inland Waters: Insights from the Most Inhabited Italian Region. *Environments* (2022) 9(2):27, https://doi.org/10.3390/environments9020027

[33] ARERA, Annual Report on the State of Services and Regulatory Activities [accessed March 2023], https://www.arera.it/it/inglese/annual_report/relaz_annuale.htm, 2022

[34] T. Duratorre, G. M. Bombelli, G. Menduni, D. Bocchiola, Hydropower Potential in the Alps under Climate Change Scenarios. The Chavonne Plant, Val D'Aosta. *Water* (2020) 12(7):2011, https://doi.org/10.3390/w12072011

[35] T. S. Kishore, E. R. Patro, V. S. K. V. Harish, A. T. A. Haghighi, A Comprehensive Study on the Recent Progress and Trends in Development of Small Hydropower Projects. Energies (2021) 14, 2882, https://doi.org/10.3390/en14102882

[36] A. Colasante, I. D'Adamo, P. Morone, What drives the solar energy transition? The effect of policies, incentives and behavior in a cross-country comparison, Energy Research & Social Science, Volume 85 (2022) 102405, ISSN 2214-6296, https://doi.org/10.1016/j.erss.2021.102405

[37] IRENA, Renewable Power Generation Costs in 2020, International Renewable Energy Agency, Abu Dhabi, ISBN: 978-92-9260-348-9, 2021. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2021/Jan/IRENA_Renewable-Power-Generation-Costs-in-2020.pdf

[38] International Energy Agency (IEA), Italy - Countries & Regions [accessed March 2023], https://www.iea.org/countries/italy

[39] O. O. Apeh, E. L. Meyer, O. K. Overen, Contributions of Solar Photovoltaic Systems to Environmental and Socioeconomic Aspects of National Development. A Review. Energies (2022) 15, 5963. https://doi.org/10.3390/en15165963

[40] IEA (2021). IEA Wind TCP 2021 Annual Report [accessed March 2023], https://usercontent.one/wp/iea-wind.org/wp-content/uploads/2022/12/IEA_Wind_TCP_AR2021_Italy.pdf, 2021

[41] IRENA, Renewable Energy Market Analysis: Southeast Europe. IRENA, Abu Dhabi, ISBN 978-92-9260-166-9, 2019. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Dec/IRENA_Market_Analysis_SEE_2019.pdf

[42] M. Gasser, S. Pezzutto, W. Sparber, E. Wilczynski, Public Research and Development Funding for Renewable Energy Technologies in Europe: A Cross-Country Analysis. *Sustainability* (2022) *14*, 5557, https://doi.org/10.3390/su14095557

[43] l. Serri, L. Colle, B. Vitali, T. Bonomi, Floating Offshore Wind Farms in Italy beyond 2030 and beyond 2060: Preliminary Results of a Techno-Economic Assessment. *Appl. Sci.* (2020) *10*, 8899, https://doi.org/10.3390/app10248899

[44] P. J. Thimet, G. Mavromatidis, Review of model-based electricity system transition scenarios: An analysis for Switzerland, Germany, France, and Italy, Renewable and Sustainable Energy Reviews, Volume 159 (2022) 112102, ISSN 1364-0321, https://doi.org/10.1016/j.rser.2022.112102.

[45] C. Moliner, E. Arato, F. Marchelli, Current Status of Energy Production from Solid Biomass in Southern Italy. *Energies* (2021) 14(9):2576, https://doi.org/10.3390/en14092576

[46] A. Jain, S. Sarsaiya, M. K. Awasthi, R. Singh, R. Rajput, U. C. Mishra, J. Chen, J. Shi, Bioenergy and bio-products from bio-waste and its associated modern circular economy: Current research trends, challenges, and future outlooks. Fuel, Volume 307 (2022) 121859, ISSN 0016-2361, https://doi.org/10.1016/j.fuel.2021.121859.

[47] Autorità di regolazione per Energia Reti e Ambiente - ARERA, Gross energy production from hydroelectric sources in Italy from 2011 to 2021 (in gigawatt hours) [Graph]. In Statista [accessed March 2023], https://www.statista.com/statistics/753558/gross-energy-production-from-hydroelectric-sources-in-italy, July 14, 2022

[48] P. D'Orazio, P. Löwenstein, Mobilising investments in renewable energy in Germany: which role for public investment banks?, Journal of Sustainable Finance & Investment, (2022) 12:2, 451-474, 10.1080/20430795.2020.1777062

[49] Ministero Dello Sviluppo Economico. Investments in the sector of electricity generated by renewables in Italy from 2011 to 2021 (in million euros) [Graph]. In Statista, [accessed March 2023], https://www.statista.com/statistics/799338/investments-in-the-renewable-electricity-sector-in-italy/, July 24, 2022

[50] F. Egli, Renewable energy investment risk: An investigation of changes over time and the underlying drivers, Energy Policy, Volume 140 (2020) 111428, ISSN 0301-4215, https://doi.org/10.1016/j.enpol.2020.111428

[51] X. Li, M. Ramshani, I. A. Khoj, O. Omitaomu, J. M. Hathaway, An agent based model for joint placement of PV panels and green roofs. In Proceedings of the Simulation Conference (WSC), Las Vegas, NV, USA, 3–6 (2017) pp. 1133–1144.

[52] A. G. Capodaglio, A. Callegari, M. V. Lopez, European Framework for the Diffusion of Biogas Uses: Emerging Technologies, Acceptance, Incentive Strategies, and Institutional-Regulatory Support. Sustainability (2016) *8*, 298, https://doi.org/10.3390/su8040298

[53] Ministero della Transizione Ecologica, La Situazione Energetica Nazionale nel 2021. Dipartimento Energia, Direzione Generale Infrastrutture e Sicurezza, https://dgsaie.mise.gov.it/pub/sen/relazioni/relazione_annuale_situazione_energetica_nazionale_dati_2021.pdf, 2021

[54] G. Bölük, R. Kaplan, Effectiveness of renewable energy incentives on sustainability: evidence from dynamic panel data analysis for the EU countries and Turkey. Environ Sci Pollut Res 29, 26613–26630 (2022), https://doi.org/10.1007/s11356-021-17801-y

[55] D. Connolly, H. Lund, B. V. Mathiesen, Modelling and Simulation of Smart Energy Systems. In the Handbook of Clean Energy Systems, J. Yan (Ed.) (2015), https://doi.org/10.1002/9781118991978.hces162

[56] Ministero Della Transizione Ecologica, Dipartimento Energia Direzione Generale Infrastrutture E Sicurezza La Situazione Energetica Nazionale. https://dgsaie.mise.gov.it/pub/sen/relazioni/relazione_annuale_situazione_energetica_nazionale_dati_2021.pdf, 2022

[57] J. J. Cohen, Azarov, A. Kollmann, J. Reichl, Preferences for community renewable energy investments in Europe, Energy Economics, Volume 100, 105386, (2021) ISSN 0140-9883, https://doi.org/10.1016/j.eneco.2021.105386

[58] S. Soeiro, M. Ferreira Dias, Renewable energy community and the European energy market: main motivations, Heliyon, Volume 6, Issue 7 (2020) e04511, ISSN 2405-8440, https://doi.org/10.1016/j.heliyon.2020.e04511

[59] QualEnergia, Estimated value of investments in renewable energy in Italy from 2020 to 2030, by type of technology (in billion euros) [Graph]. In Statista. [accessed March 2023], https://www.statista.com/statistics/887823/value-of-investments-in-renewable-energy-by-type-in-italy/, July 30, 2018

[60] Dhayal, K., S; Giri, A, K., Esposito, L., Agrawal, S., (2023) Mapping the significance of green venture capital for sustainable development: A systematic review and future research agenda, Journal of Cleaner Production, Volume 396, 2023, 136489, ISSN 0959-6526, https://doi.org/10.1016/j.jclepro.2023.136489.

Declaration of interests

☒ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☐The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: