European Parliament

Promotion of renewable energy sources in the EU

EU policies and Member State approaches

IN-DEPTH ANALYSIS

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Author: Gregor Erbach
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This paper analyses the development of renewable energy sources (RES) in the EU, with a focus on support mechanisms at the EU and Member State level, including current and upcoming reforms. It presents the principal support mechanisms for RES, as well as developments in selected Member States, outlines the main technical and regulatory challenges associated with an increasing share of renewable energy and highlights the involvement and positions of the European Parliament.

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eprs@ep.europa.eu
http://www.eprs.ep.parl.union.eu (intranet)
http://www.europarl.europa.eu/thinktank (internet)
http://epthinktank.eu (blog)

EXECUTIVE SUMMARY

The development of renewable energy sources (RES) is a priority for the EU. One of the goals of the Energy Union strategy is to make the EU the world leader in renewable energies. Renewable energy comprises a wide variety of energy sources. The most important RES in the EU are wood and other biomass, hydropower, biofuels, wind and solar.

Due to their low greenhouse gas emissions compared to fossil fuels, RES are considered as critical for meeting the EU's climate targets. As mostly indigenous energy sources, they also help reduce the EU's dependence on energy imports. Moreover, RES help reduce air pollution. The renewable industries employ over a million people in the EU.

The EU aims to get 20% of its final energy consumption from RES by 2020, and at least 27% by 2030. The Renewable Energy Directive sets national targets for all Member States, which have to develop national action plans and report on progress every two years. The EU emissions trading system favours RES indirectly by raising the cost of fossil fuel combustion. The Fuel Quality Directive promotes the use of biofuels by mandating fuels with lower greenhouse gas intensity. In 2014, the European Commission adopted state aid guidelines to make sure that national support for RES is compatible with EU competition law and internal market rules. The Commission plans to revise the Renewable Energy Directive in 2016. Other legislation related to RES is also under review.

EU Member States are free to decide how they support RES, so long as they comply with the rules of the EU energy market. The most common support mechanisms for renewable electricity have been feed-in tariffs and feed-in premiums, but competitive auctions are becoming increasingly popular.

In 2014, RES had a 16% share in the energy consumption of the EU. Nine Member States have already achieved their targets for 2020, while others will have to make more efforts to reach their goals. Investment in RES in Europe has slowed down in recent years, due to policy changes, a sluggish economy and falling RES technology costs.

The development of RES poses a number of scientific and technical challenges. The integration of increasing amounts of variable renewables, such as wind and solar, in electricity grids requires better balancing supply and demand, more grid interconnections and energy storage. Biomass requires large land areas for forests or energy crops. Challenges like land use change and competition with food production must be addressed.

Investments in RES are facilitated by a predictable regulatory framework that reduces the risk for investors and hence the cost of capital. However, incentives must be reduced in line with falling technology costs, in order to avoid over-compensation and rising energy prices. The Commission is currently preparing a legislative proposal for a new electricity market design that facilitates the integration of RES in the market.

The European Parliament supports the growth of RES in the EU, and has called for a binding 30% RES target for 2030, to be implemented by means of national targets for each Member State. Parliament's Committee on Industry, Research and Energy (ITRE) has worked on own-initiative reports on energy market design and on the renewable energy progress report.

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Main acronyms used

CEF:	Connecting Europe Facility
EFSI:	European Fund for Strategic Investments
ESIF:	European Structural and Investment Funds
ETS:	Emissions Trading System
FiT:	feed-in tariff
FiP:	feed-in premium
GW:	Gigawatt, one billion watts
ILUC:	indirect land use change
IRENA:	International Renewable Energy Agency
LCOE:	levelised cost of energy; cost per unit of energy over the lifetime of a power plant
MWh:	Megawatt-hour
NREAP:	National Renewable Energy Action Plan
PV:	photovoltaic
RED:	Renewable Energy Directive
REFIT:	European Commission's Regulatory Fitness and Performance programme
RES:	renewable energy source

1. Background

Unlike fossil and nuclear fuels, which have only finite reserves expected to last for tens to hundreds of years, RES are going to be available year after year over a very long timeframe. Moreover, RES generally have lower greenhouse gas emissions than fossil fuels, and are therefore expected to play an important role in reaching global climate targets.[1]

RES include:

- biomass from trees and other plants or animal manure;
- hydropower: energy from water flowing from a higher to a lower elevation;
- solar energy, which varies depending on the seasons, time of day and weather;
- wind energy, which varies with the weather;
- geothermal energy;
- wave and tidal energy; and
- waste.

The development of renewable energy sources is a priority for the EU, whose Energy Union strategy includes an objective to make it the world leader in renewable energies.

Table 1: Main RES technologies and their typical applications

RES technology	Energy conversion	Typical applications
solar thermal	sunlight to heat	space heating, water heating
geothermal and heat pumps	temperature differences to heat	
combustion of biomass	biomass to heat	space heating, cooking, water heating
biogas	biomass to gas	space heating, cooking, transportation
biofuels	biomass to liquid fuel	transport, machinery
combustion of biomass in power plant	biomass to electricity (and heat)	multiple uses of electricity
wind turbine	wind to electricity	
solar photovoltaics, concentrated solar power	sunlight to electricity	
waste incineration	waste to electricity (and heat)	
hydropower plant	potential energy to electricity	
wave and tidal energy	waves/tides to electricity	

The promotion of RES in the EU serves two main objectives:

1. climate action: as low-carbon energy sources, RES help avoid the emission of greenhouse gases in the energy sector, and contribute to achieving the EU target of reducing greenhouse gas emission by 40% by 2030, compared to 1990 levels;

[1] The 2015 Paris Agreement sets a global goal of limiting global warming to well below 2 degrees Celsius, making efforts to stay below 1.5 degrees.

2. energy security: as largely indigenous energy sources, RES reduce the EU's dependence on imports of coal, gas, oil and nuclear fuels.

Other benefits derived from the development of RES include industrial innovation, reduced air pollution and the creation of jobs.

The European renewable energy industry has an annual turnover of €129 billion and employs over a million people. EU companies have a share of 40% in all patents for renewable technologies, compared to a 32% share in all patents.

2. EU renewable energy policy

2.1. Legal basis

According to Article 194 of the Treaty on the Functioning of the European Union (TFEU), EU energy policy aims to promote 'the development of new and renewable forms of energy', among other objectives. However, Member States retain the right to choose between different energy sources and determine the general structure of their energy supply. Article 191 TFEU lists climate action as one of the objectives of EU environmental policy.

2.2. EU policies

As part of its climate and energy targets, the EU aims to get 20% of its final energy consumption in 2020 from RES. The target for 2030 set at the October 2014 European Council is a RES share of at least 27%.[2] The Energy Union package of February 2015 includes a political commitment for the EU to become the world leader in renewable energies.

In January 2014, the Commission published a Blue Energy Action Plan[3] to facilitate the development of ocean energy (offshore wind, wave, tidal and others) in the EU. In February 2016, the Commission presented a strategy for heating and cooling,[4] which aims to reduce the consumption of fossil fuels in the heating and cooling sector by promoting energy efficiency and greater use of RES in buildings and industry.

2.3. Existing EU legislation

The Renewable Energy Directive (RED)[5] requires that 20% of EU final energy consumption must come from RES by 2020. This target is broken down into nationally binding targets for each Member State (ranging from 10% for Malta to 49% for Sweden), taking into account their different starting points.

The RED allows Member States to use various support schemes for RES, including (but not restricted to) 'investment aid, tax exemptions or reductions, tax refunds, renewable energy obligation support schemes including those using green certificates, and direct

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[2] The target is binding at EU level only; without binding targets for individual Member States. How to deliver the target in a cost-effective and sustainable way is part of the ongoing review of the EU renewable energy policies (see Section 2.6).

[3] Communication from the Commission – Blue Energy Action needed to deliver on the potential of ocean energy in European seas and oceans by 2020 and beyond (COM(2014) 0008).

[4] Communication from the Commission – An EU Strategy on Heating and Cooling (COM/2016/051 final).

[5] Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources.

price support schemes including feed-in tariffs and premium payments'. Other mechanisms, such as guarantees of origin, joint projects and cooperation between Member States and with third countries, are also possible. The RED obliges Member States to open their power grids to energy from renewable sources, and even give them priority.

Moreover, the RED requires all Member States to obtain at least 10% of their transport energy from renewable sources by 2020. A 2009 amendment to the Fuel Quality Directive[6] introduced a mandatory target of a 6% reduction, by 2020, in the greenhouse gas intensity of fuels used in road transport and non-road mobile machinery. This target is generally achieved through the use of biofuels, which may be blended with petroleum products. As required by the RED, Member States adopted National Renewable Energy Action Plans (NREAP) in 2010. NREAPs contain national RES targets for the electricity, heating and cooling, and transport sectors, the planned mix of RES technologies and information about policy measures. Member States have to report on their progress every two years. In September 2015, the RED and the Fuel Quality Directive were amended[7], to take indirect land use change[8] into account. The amendment limits the share of biofuels from crops grown on agricultural land to 7%, and sets an indicative target of 0.5% for the use of advanced biofuels (generally based on waste and residues, and therefore not competing with food production).

The RED sets sustainability criteria for biofuels, but not for biomass. In 2010, the Commission published non-binding sustainability criteria regarding biomass for electricity, heating and cooling,[9] and recommended their adoption by Member States. In November 2013, the Commission published a guidance document for the design of renewable energy support schemes.[10]

In the electricity and industrial sectors, the EU emissions trading system (ETS) improves the competitiveness of RES vis-a-vis fossil fuels, for which emissions allowances must be acquired.[11] However, the current price of emission allowances is in many cases not sufficient to incentivise investments in RES.

An evaluation carried out by the Commission in 2014, in the context of the European Commission's Regulatory Fitness and Performance programme (REFIT), indicates that the RED is effective and achieves its objectives, but its implementation could be improved at Member State level.

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6 Directive 2009/30/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 98/70/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emission.

7 Directive (EU) 2015/1513 of the European Parliament and of the Council of 9 September 2015 amending Directive 98/70/EC relating to the quality of petrol and diesel fuels and amending Directive 2009/28/EC on the promotion of the use of energy from renewable sources.

8 Indirect land use change (ILUC) occurs when the cultivation of biofuel crops on a piece of land leads to the use of previously uncultivated land for agriculture or forestry. ILUC is associated with the emission of greenhouse gases.

9 Report from the Commission to the Council and the European Parliament on sustainability requirements for the use of solid and gaseous biomass sources in electricity, heating and cooling (COM/2010/0011 final).

10 European Commission guidance for the design of renewables support schemes (SWD(2013) 439 final).

11 The use of biomass for heat or electricity generation is considered as carbon-neutral and does not fall under the EU ETS.

2.4. State aid guidelines

The Commission adopted new guidelines on state aid for environmental protection and energy[12] in June 2014. The guidelines aim to avoid market distortions resulting from support for RES and to promote a gradual transition towards market-based support for renewable energies. The guidelines gradually introduce competitive bidding processes for public support for RES and promote a transition from feed-in-tariffs to feed-in-premiums (see Section 3.2.1). In addition, certain energy-intensive industries can be partially exempted from surcharges financing RES support, in order to safeguard their competitiveness. The guidelines apply for the 2014–2020 period.

2.5. EU-level support for RES

Support for RES takes place mostly at the level of the Member States (see Section 3.2). Support at EU level includes funding for research and innovation as well as enhancements to the electricity grid to support the integration of RES. The research and innovation framework programme Horizon 2020 supports research and development in photovoltaics, concentrated solar power, wind energy, ocean energy, hydropower, geothermal energy, renewable heating and cooling, energy storage, biofuels and alternative fuels.

The NER 300 programme, funded from the sale of emission allowances from the New Entrants Reserve of the EU ETS, provides funding worth €2.1 billion to 38 innovative renewable energy projects and one carbon capture and storage project. In the context of the post-2020 ETS reform, a new Innovation Fund will be created to fund renewable energy and other low-carbon projects as well as industrial innovation in this sector.

The European Investment Bank (EIB) and the European Fund for Strategic Investments (EFSI) provide loans for the expansion of renewable energy and related energy infrastructures. RES are also supported through regional development funds.

The interconnection of energy grids, which facilitates the integration of RES, is meanwhile supported by Projects of Common Interest (key energy infrastructure projects that are essential for completing the internal energy market and for reaching the EU's energy policy objectives).

On 15 September 2015, the Commission outlined a new Strategic Energy Technology (SET) Plan,[13] which includes renewable energy as one of the priority areas for research and innovation. Three out of eight European Industrial Initiatives under the SET Plan concern renewable energy sources.[14]

2.6. Ongoing and forthcoming developments

The Commission's work programme for 2016 includes the preparation of a new renewable energy package by the end the year, including sustainability criteria for biomass. It will address how to:

- deliver the 27% market share target in a cost-effective and sustainable way;

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[12] Communication from the Commission — Guidelines on State aid for environmental protection and energy 2014-2020 (2014/C 200/01).

[13] Communication from the Commission — Towards an Integrated Strategic Energy Technology (SET) Plan: Accelerating the European Energy System Transformation (C(2015) 6317 final).

[14] European Wind Initiative, Solar Europe Initiative, European Industrial Bioenergy Initiative.

- create an investment climate encouraging investment in renewable energy technologies;
- take the market into account in Member State support schemes;
- address external costs which are not yet fully internalised by competing technologies;
- deal with the fact that markets are to a large extent designed for conventional energy sources;
- address the high and still growing dependence of the EU on imports of energy;
- account for greenhouse gas emissions savings of different bioenergy sources; and
- facilitate regional cooperation.

A public consultation on the new RED, which closed in February 2016, received 614 responses.[15] There is consensus among the respondents about the need for a stable and predictable EU legal framework for RES which excludes retroactive changes, the potential of simplified administrative permitting procedures for cost reduction, and the relevance of developing a market fit for RES. Stakeholders disagree about other issues, such as the geographical scope of support schemes and the exposure of RES to market conditions.

A public consultation on a sustainable bioenergy policy for the period after 2020 was launched on 10 February 2016 and closed on 10 May 2016. Related developments are the preparation of legislation on the electricity market design (expected in the 4th quarter of 2016) and an energy efficiency package (REFIT), as well as the development of a governance framework for the Energy Union. A Commission communication on waste-to-energy is foreseen for 2016. The Commission does not intend to propose a renewal of the Fuel Quality Directive, which expires in 2020.

3. RES development in EU Member States

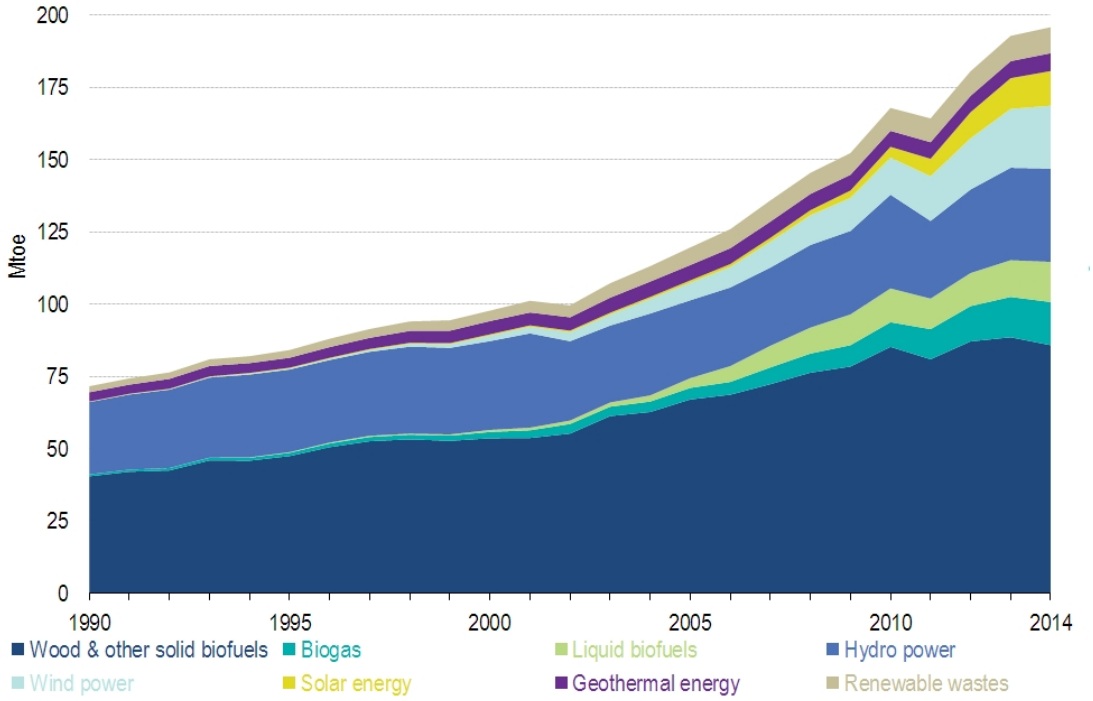
3.1. Progress towards RES targets

Renewable sources accounted for 16% of the EU's energy consumption in 2014. Biomass has by far the largest share of RES in Europe, followed by hydropower, whereas photovoltaics, solar thermal and wind energy had the highest growth rates between 2005 and 2013. If Member States continue to develop RES at their current rate, the target of a 20% share by 2020 is likely to be reached. However, investment in European RES has fallen in recent years: from US$123 billion (€88 billion) in 2011 to US$62 billion (€47 billion) in 2014 and US$49 billion (€44 billion) in 2015, despite record levels of investment in offshore wind projects. According to the United Nations Environmental Programme (UNEP), the reasons for the drop in investments are regulatory uncertainty caused by retroactive cuts in support levels, an economic downturn in southern Europe, reduction of support levels for solar photovoltaics in Germany and Italy, and big drops in the cost of solar panels.[16]

[15] Public consultation on the Renewable Energy Directive for the period after 2020: Analysis of stakeholder views, European Commission, 2016.

[16] Global trends in renewable energy investment 2016, Frankfurt School-UNEP Centre, 2016.

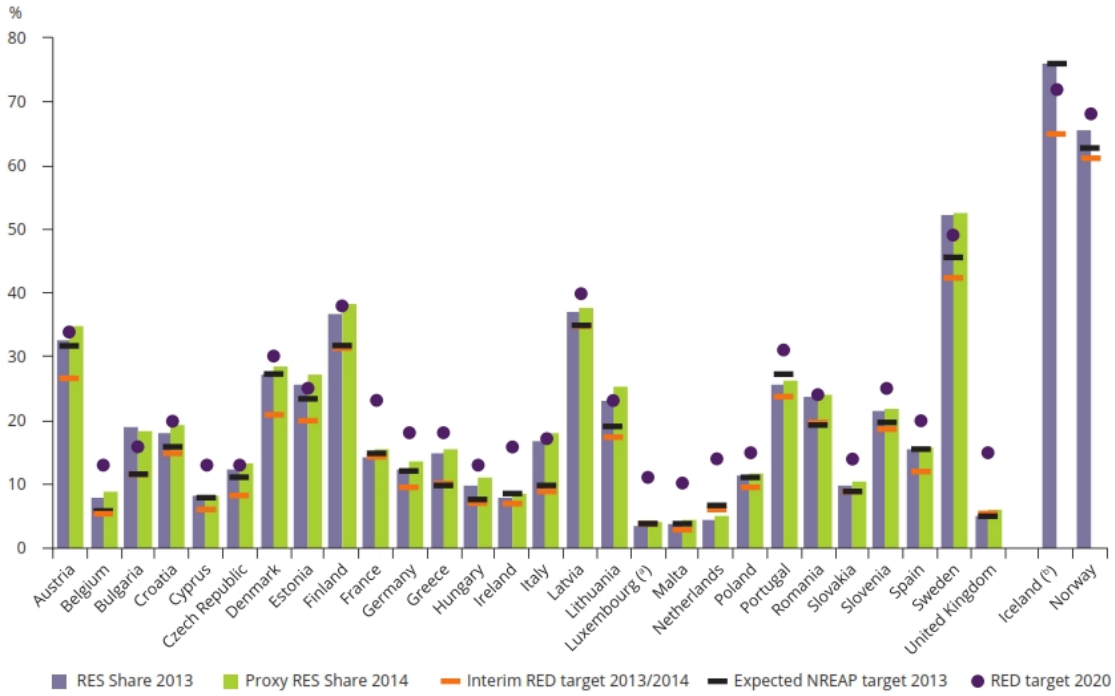
Figure 1 – Primary production of energy from renewable sources, EU-28, 1990-2014



Source: Eurostat (nrg_110a).

According to the Commission, the use of RES in the EU has resulted in around 388 million tonnes of avoided CO_2 emissions and a reduction in the EU demand of fossil fuels by 116 million tonnes of oil equivalent.

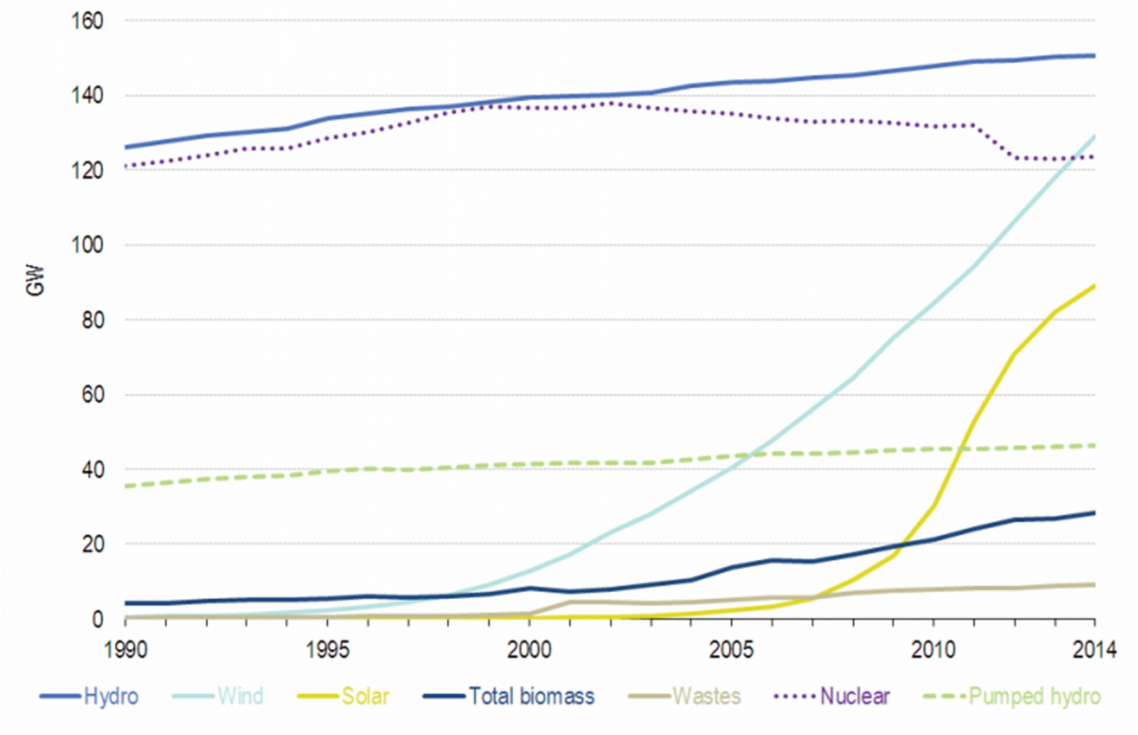
Figure 2 – Member States' RES shares (2013–2014), in relation to the indicative RED target (2013–2014) and 2013 NREAP target



Source: Trends and projections in Europe 2015, European Environment Agency.

While some Member States are on track to achieving the targets set out in the RED and NREAPs, others would have to intensify their efforts (see figure 2).

Figure 3 – Electricity generation capacity, EU-28, 1990-2014



Source: Eurostat (nrg_113a).

In the electricity sector, RES accounted for 28% of total gross electricity generation in 2014. The total electricity generation capacity from RES was around 400 GW, compared to 450 GW for fossil fuel plants.[17] In 2014, RES accounted for 17% of energy consumption in the EU heating and cooling sector and had a 6% share in transport.

The development of RES in Europe is in line with global trends. The year 2015 saw the highest-ever global investment in RES (US$286 billion, excluding large hydro) and increase in RES generation capacity (118 GW for wind and solar). The International Energy Agency reports that global carbon emissions from the energy sector did not grow in 2014 and 2015, although global GDP increased by 6.6%. The data indicate that RES, which accounted for 90% of additional electricity generation in 2015, played a crucial role in containing carbon emissions.

3.2. RES support in EU Member States

Member States are free to choose the policy instruments to reach their national renewable energy targets. Figure 4 gives an overview of the support schemes used in the Member States and the other European Environment Agency (EEA) countries.[18] In 2010, the Member States submitted their National Renewable Energy Action Plans (NREAPs), detailing the strategies they would employ for reaching the targets for electricity, heating and cooling, as well as transport.

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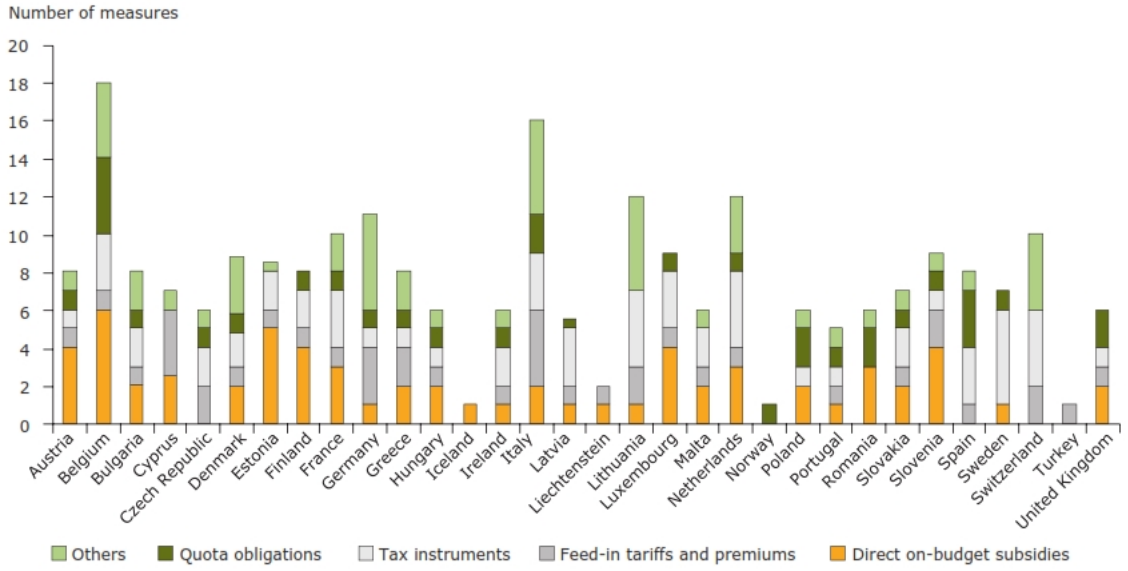
[17] However, the generation capacity of RES is less fully utilised than that of fossil fuel plants because their actual production depends on weather, time of day and season.

[18] The following information sources provide detailed information about the development of RES, support schemes and grid integration in the EU Member States: RES LEGAL Europe (renewable energy policy and support database); RES-Integration (Member States' measures for integrating RES into the electricity grid and market); Climate and energy profiles (country profiles for EU Member States, provided by the European Environment Agency), Energy from renewable sources: statistics explained (Eurostat).

Figure 4 – Types of instruments to support renewable energy, EEA-32, 2012



Source: EEA Technical report No 21/2014, page 18.

3.2.1. Support for electricity generation

Among the support schemes for electricity generation, **feed-in tariffs** (FiT) are the most widely used. FiTs provide a fixed price per unit of electricity produced (MWh) for a fixed period. They minimise risk for investors by covering costs (generally based on the levelised cost of energy[19]) and profit, and shielding them from developments in the electricity market. Some experts highlight[20] that FiTs have incentivised large RES development, but often at a high cost. While the government determines the price, investors decide about the quantity, so that control of costs becomes an issue.

Feed-in-premiums (FiP), which provide investors with a payment on top of the electricity market prices, are becoming increasingly popular. With FiP, the payment to RES producers depends in part on the electricity market. This leads to a reduction in payments in periods of low electricity prices, compared to fixed FiTs.

With **quota obligations**, the government requires electricity distributors to obtain a fixed proportion of their electricity from renewable sources. If they do not produce enough renewable electricity themselves, they must obtain tradable certificates from RES producers. The government sets the quantity, and the market determines the price. Quota obligations are used in six Member States. They are generally cheaper than feed-in tariffs.

Biomass (mostly wood) for electricity generation is considered carbon-neutral (zero emissions) under the EU ETS, unlike coal and gas. In addition, financial incentives at national level (for instance in the UK) have played a key role in the conversion of coal power plants into wood-fired plants. A 2012 study by the International Institute for Sustainable Development[21] estimates that electricity generation from biomass in the UK and Germany received deployment subsidies of between €50 to €90 per MWh between 2000 and 2009.

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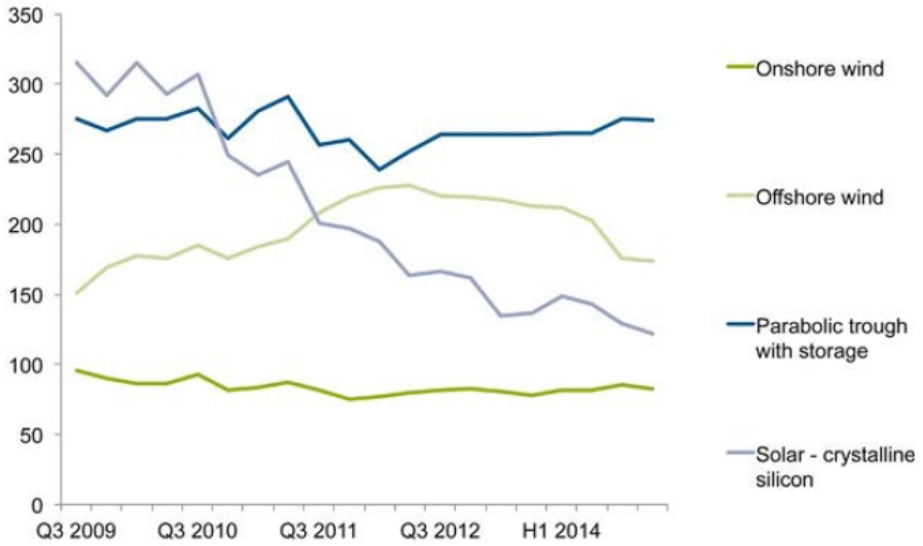
19 Levelised cost of energy (LCOE) is the cost per unit of energy over the lifetime of a power plant.

20 See for example David Buchan's presentation at a European Parliament workshop in November 2012.

21 Assessing the cost-effectiveness of renewable energy deployment subsidies: biomass power in the United Kingdom and Germany, International Institute for Sustainable Development, 2012.

Figure 5 – Global average levelised cost of electricity for wind and solar (US$ per MWh)



Source: Global trends in renewable energy investment 2016, Bloomberg New Energy Finance.

Support schemes for RES are frequently adjusted by Member States, in order to take account of changing market conditions, such as falling costs for technologies (most significantly in the case of solar photovoltaics,[22] see Figure 5).The levelised cost of photovoltaic electricity in Germany fell from over €400/MWh to €90/MWh in 2014 and is expected to fall further.[23] Different levels of support may be given for different technologies, in order to incentivise technological innovation while reducing support for mature technologies. For example, offshore wind now often receives higher levels of support than more mature onshore wind.

In 2012, RES support was given for 12.6% of the electricity produced, according to a report by the Council of European Energy Regulators based on a survey in 23 European countries[24]. The proportion was highest in Denmark (55.9%) and lowest in Norway (0.1%). The average amount of support was €110.65/MWh. It was highest in the Czech Republic (€194.51/MWh), and lowest in Estonia (€10.56/MWh).

Although the EU has an internal energy market, Member States are not obliged to open their support schemes to renewable energy producers in other Member States. This was confirmed by the Court of Justice of the EU in 2014.[25]

3.2.2. Support for biofuels

EU biofuel production has been supported through national biofuels targets that provide a guaranteed market for producers and push prices upwards, and through excise duty exemptions for transport fuels. Estimates of biofuel support in the EU range from €5.5 to 8.4 billion annually.[26]

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[22] A recent study indicates that high demand for photovoltaic modules in European markets has helped reduce the cost of solar photovoltaics worldwide.

[23] Current and future cost of photovoltaics, Fraunhofer ISE, February 2015.

[24] Status Review of Renewable and Energy Efficiency Support Schemes in Europe in 2012 and 2013, Council of European Energy Regulators, January 2015.

[25] Judgment in case C-573/12 (*Ålands Vindkraft AB* v *Energimyndigheten*) and judgment in joined cases C-204/12 to C-208/12 (*Essent Belgium NV* v *Vlaamse Regulieringsinstantie*).

[26] Biofuels—At What Cost? A review of costs and benefits of EU biofuel policies. International Institute for Sustainable Development, 2013; World Energy Outlook 2012, International Energy Agency, 2012.

3.3. Developments in selected Member States

Germany has supported renewable energies for a long time, starting with the electricity feed-in law of 1991. Germany aims for an energy transition away from fossil fuels and nuclear towards RES. According to the 2014 Renewable Energy Law, RES should make up 40–45% of electricity generation by 2025 and 50–60% by 2035. The principal support mechanism for renewable electricity generation has been a feed-in tariff, introduced in the Renewable Energy Law in 2000. The most recent revision of the law, which entered into force in 2014, replaces the feed-in-tariff with a feed-in premium. In 2015, support for electricity from renewable sources amounted to €24 billion.

In addition, KfW, a promotional bank, offers low-interest loans for specific RES investments. The Renewable Energies Heat Act aims to increase the share of renewable energies in heat provision to 14% by 2020. Germany has also provided subsidies for residential electricity storage systems since 2013.

With the growing penetration of renewables, electricity network operators in Germany face increasing costs for ensuring network stability, which are being passed on to consumers. In 2015, German network operators spent €1 billion to ensure network stability, according to press reports.[27]

According to analysis by the International Renewable Energy Agency, Germany is expected to reach a 27% share of RES in the total energy mix by 2030, with the potential of increasing it to over 30% if renewable energies are more fully utilised in heating and transport.[28]

Despite the growing proportion of renewable sources in electricity generation, Germany faces difficulties in reducing its CO_2 emissions. CO_2 emissions from coal and lignite-based power plants remain high, due to the accelerated shutdown of Germany's nuclear power plants and the low prices for emission allowances in the EU ETS, which do not incentivise a switch from coal to natural gas (which has lower emissions).

Spain has a sizeable domestic RES sector as a result of policies and relatively costly support measures. In 2013, RES had an overall share of 14.9% in the country's energy mix. RES had the highest share in the electricity sector (35.6%) and the heating and cooling sector (14%), but accounted for a mere 0.5% in the transport sector. Annual feed-in premium (FiP)/feed-in tariff (FiT) payments in 2011 were around €5 billion in 2011. To lower support costs, the Spanish government introduced a number of reforms in 2013 and 2014, which abolished the FiT support and introduced a system that offers developers a pre-determined return over the lifetime of their investment. The revised level of support was expected to lead to a €1.7 billion reduction in support payments in 2014, according to the Spanish government. The retroactive nature of the reforms has been criticised as creating regulatory instability. As a result of the reforms, investment in RES has fallen to just US$573 million (€761 million) in 2014, slightly more than the previous year, but far below the peak of US$23.6 billion (€38.7 billion) in 2008.

The **United Kingdom** has achieved an overall RES share of 4.9% in 2013. The electricity sector had the highest RES share (12.8%), followed by transport (4.2%) and heating and cooling (2.4%). RES in the electricity sector are supported through a quota system (the

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[27] Stromnetz-Stabilisierung: Blackout-Abwehr kostete 2015 eine Milliarde Euro, Spiegel Online, 17 January 2016.

[28] Renewable Energy Prospects: Germany, REmap 2030 analysis, IRENA, 2015.

Renewables Obligation) and a feed-in tariff designed to support small-scale RES installations. Since 2015, large-scale RES are supported through a contract-for-difference scheme, under which RES generators are paid the difference between the electricity market price and a 'strike price' (a price for electricity reflecting the cost of investing in a particular low-carbon technology) determined through an auction.

RES subsidies are paid by consumers through their electricity bills. The UK government has fixed the amount of support that RES would receive by 2020. In 2015, the UK Office for Budget Responsibility projected that the limit would be exceeded. To reduce costs, the UK government will introduce some changes to RES support mechanisms. The FiT for small installations will be reduced to £43.9/MWh (€56.1), with a £100 million (€128 million) limit on new spending up to the end of 2018/19. From April 2016, the Renewables Obligation will be closed to new solar PV capacity below 5 MW and onshore wind projects. The UK government expects the changes to reduce RES support payments by £500–600 million (€693-767 million).

Since 2015, final decisions about new onshore wind developments have been taken by local councils, which should only grant permission if the planned site is in an area identified as suitable for wind energy in a Local or Neighbourhood Plan and the concerns of communities identified in consultations have been fully addressed.

4. Technical and scientific challenges

4.1. Variability and electricity grid integration

While some RES are dispatchable[29] (for instance, biofuels, geothermal and waste), others, such as solar and wind, vary according to weather, season and time of the day. The integration of these variable[30] renewables in the electricity grid poses technical challenges with regard to grid stability, transmission capacities and generation capacity in case of demand peaks.

Unlike traditional power plants, which are generally constructed close to the centres of electricity demand, RES are more geographically dispersed. They are located where energy resources (wind, sun and water) as well as land are available. In the case of rooftop solar, many small installations are scattered over a wide area.

The more variable RES are connected to the grid, the greater the challenges become. The challenge of grid integration is addressed by:

- better interconnections that allow surplus electricity to be transported from producing regions to consuming regions (within and between Member States);
- energy storage;
- smart grids[31] and demand-response (consumers adapt electricity demand to supply via price signals); and
- flexible generation capacity to meet electricity demand during periods of low generation from variable renewable sources.

[29] 'Dispatchable' means available on demand at all times.

[30] Also referred to as 'intermittent'.

[31] Smart electricity grids and meters in the EU Member States, European Parliament, EPRS, September 2015.

Regarding electricity interconnections between Member States, the October 2014 European Council urged measures to reach the target of achieving interconnection of at least 10% of installed electricity production capacity for each Member State. As part of the Energy Union package, the Commission published a communication on achieving the 10% interconnection target,[32] which should be reached mainly by implementing projects of common interest (PCI) with financial support from the Connecting Europe Facility (CEF), the European Structural and Investment Funds (ESIF), the European Fund for Strategic Investment (EFSI) and private investors.

4.1.1. Electricity storage

Storage of electricity could help better integrate variable RES into the electricity grid, by storing electricity in times of high supply and delivering it at times of high demand. The most widely used technology is pumped storage (pumping water from a lower to a higher reservoir), but other technologies are rapidly evolving. Battery storage has seen progress in recent years.[33] Other technologies are compressed air storage, power to gas, and energy storage in molten salts for concentrated solar power plants.

Currently, there is no uniform regulatory framework for electricity storage. In some Member States, pumped storage operators have to pay network charges twice (that is, when energy is stored and then when it is delivered). The required unbundling of electricity production from the electricity grid restricts the possibility for network operators to own and operate storage facilities.

A recent study for Parliament's Committee on Industry, Research and Energy (ITRE)[34] investigated market designs and regulatory incentives for energy storage in the EU and made a number of policy recommendations, including incentives for associating storage with renewable energy producers in order to enhance the stability of the electricity system.

4.2. Sustainability of bioenergy

The climate benefits of some renewables, especially bioenergy, are controversial. In the case of wood, burning it releases the CO_2 that trees had captured while growing; this CO_2 is gradually removed from the atmosphere if new trees are grown.[35] In the case of energy crops, greenhouse gas emissions also result from fertiliser production, agriculture and processing, with negative impacts on the overall emissions reduction. When energy crops are planted on previously uncultivated land, there can be substantial emissions from land use change.[36] Indirect land use change can occur when energy crops are grown on agricultural land and consequently food crops are displaced to previously uncultivated land.

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[32] Communication from the Commission – Achieving the 10% electricity interconnection target (COM(2015)082 final).

[33] Tesla's Powerwall home battery system, announced in April 2015, is a well-known example.

[34] Energy storage: which market designs and regulatory incentives are needed?, European Parliament Directorate-General for Internal Policies of the Union (IPOL), August 2015.

[35] Although solid biomass is carbon-neutral in the long term, burning of biomass releases CO_2 in the short term, thereby creating a 'carbon debt'. According to the European Environment Agency, it may take between five and over 100 years for the growth of new trees to compensate this carbon debt.

[36] The land use change impact of biofuels consumed in the EU, Ecofys, October 2015.

5. Regulatory and societal challenges

Regulatory challenges concern the rules for promoting continued investment in RES while ensuring security of supply at all times and keeping energy costs under control.

5.1. RES support and EU climate policies

The EU has various policy instruments for addressing climate change: the EU Emissions Trading System (ETS), support for RES and for energy efficiency. The interactions between these instruments can diminish their effectiveness. Some experts point out that support for RES results in reduced demand and lower prices for emission allowances, reducing the effectiveness of the ETS. They argue that emissions could be reduced at a lower cost by relying on the ETS alone.[37] Others consider that RES support is justified because the carbon market (ETS) alone would not drive the desired changes.

5.2. Investment risk

Investments in renewable energies (with the exception of bioenergy) are characterised by high upfront costs and low operational costs. Once an investment decision has been taken, investors have little room for adapting it to changing regulatory and market conditions. Political or regulatory uncertainty increases the risk for investors, and consequently raises the cost of capital,[38] making the overall investment more costly.[39] Some Member States have made retroactive changes to their RES support schemes, which has undermined investors' confidence.[40]

Support for RES also affects investments in conventional power plants. As Member States give electricity from renewable sources priority access to the power grid, some conventional plants are needed only in periods of peak demand or low RES production. As a result, investments in conventional plants become less attractive. Some Member States have therefore introduced or consider introducing payments for reserve generation capacity, in order to ensure that enough power plants are available to handle demand peaks.

As biofuels compete with fossil petroleum products, developments in the oil price contribute to the risk profile of investments in biofuel production. The recent drop in oil prices creates uncertainty about the economic viability of biofuel production.

5.3. Cost of RES support and energy prices

In most Member States, support for RES in electricity is financed by surcharges on consumers' electricity bills, so that they do not affect the state budget. This often results in higher electricity prices for industrial consumers and private households. According to a Commission analysis, the cost of renewable energies constitutes around 6% of the average EU household electricity price and around 8% of the price for industrial consumers, without taking exemptions into account.[41] In order to safeguard industrial competitiveness, some Member States have exempted energy-intensive

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37 Overlapping Policies with the EU ETS, International Emissions Trading Association, July 2015.

38 Capital costs for onshore wind projects range from 3.5-4.5% in Germany to 12% in Greece, according to a survey carried out by the DiaCore project.

39 Options for a sustainable EU renewable energy policy, DIA-CORE Policy Brief, November 2015.

40 Retroactive and retrospective changes and moratoria to RES support, Dörte Fouquet and Jana Viktoria Nysten, Becker Büttner Held, March 2015.

41 Energy prices and costs in Europe (COM(2014) 21/2).

companies from surcharges for RES support. As a result, more of the cost must be borne by households and other consumers.

In some Member States, financial support for RES has remained at a high level, even though investment costs for some technologies (notably photovoltaics) have fallen dramatically. This has led to high profits for investors and to increased energy prices for consumers. For example, Spain's 2011 annual FiT/FiP payments amounted to around €5 billion.

Incentivising the deployment of RES in a cost-effective manner remains a challenge in an environment where the costs of technologies are changing rapidly. The recent trend moves away from schemes where the government sets the level of support towards auctions in which market participants make competitive bids.

5.4. Electricity market design

Support for RES has been one of the subjects of a public stakeholder consultation on the electricity market design. The Commission points out that reaching the EU's 2030 energy and climate objectives means that up to 50% of electricity will be produced with RES, but currently markets are not sufficiently flexible to accommodate the increased share of renewable energy, both on the supply and on the demand side.[42] A new market design should ensure that energy markets can support this transition at minimum cost, by clearing the remaining obstacles for RES and ensuring that the market provides the right signals for sufficient investment in the flexible generation capacity needed to accommodate an increasing share of variable renewables. The consultation closed in October 2015. Regarding RES, the summary report on responses to the consultation[43] states:

- Most stakeholders support the full integration of RES into the market (for example, through full balancing obligations for renewables, phasing-out of priority dispatch and removing subsidies during negative price periods).[44]
- Many stakeholders note that the regulatory framework should enable RES to participate in the market.
- Some respondents underline the need to support the development of aggregators by removing obstacles for their activity to allow full market participation of renewables.

Stakeholders expressed different views regarding the phasing out of public support schemes for RES. While some are in favour of phasing out support schemes as soon as possible, others argue that they will remain an important instrument until technologies have fully matured. They highlight the need to continue subsidising RES and maintaining other market corrections as long as subsidies for fossil fuels and nuclear are still in place.

Some stakeholders suggest that support could increasingly take the form of investment aid (as opposed to operating aid). A large majority of stakeholders support some form

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[42] Communication from the Commission – Launching the public consultation process on a new energy market design (COM(2015) 340 final).

[43] Preliminary results from the public consultation on Electricity Market Design.

[44] Balancing obligations help ensure that electricity generation and demand are in balance at all times; priority dispatch means that RES are given priority on the electricity grid; RES generators who can cover their costs and profit through subsidies may offer electricity at negative prices in the wholesale market.

of coordination of regional support schemes. The need for a reform of the ETS to allow full market integration of RES is often mentioned. Most stakeholders believe that diversified charges and levies contribute to market distortion.

6. Role of the European Parliament

In the context of the European Parliament's long-standing engagement for an ambitious EU climate policy, it supports strong policies to promote RES as well as energy efficiency. Parliament played an important role in shaping the Renewable Energy Directive, notably by insisting on access for RES to electricity grid infrastructure and on establishing sustainability criteria for biofuels. With respect to the biofuels policy reforms adopted in 2015,[45] Parliament favoured a stronger limitation of land-based biofuels and more ambitious targets for advanced biofuels.

6.1. Plenary resolutions

In its resolution of 21 May 2013 on current challenges and opportunities for renewable energy in the European internal energy market, Parliament advocated a target of a 30% share for RES in the EU energy mix by 2030, and targets and milestones for the period up to 2050. It stressed the need for an integrated long-term strategy to promote RES in the EU.

Parliament's resolution of 12 September 2013 on micro-generation considers small-scale electricity and heat generation as a vital element for reaching the EU RES targets in the long term, and for enabling zero-energy and positive-energy buildings. It calls for awareness raising, streamlining of administrative procedures, adaptation of regulatory frameworks and funding for research, development and innovation.

In its resolution of 5 February 2014 on the 2030 climate and energy framework, Parliament also calls for a binding 30% RES target, to be broken down into individual national targets. It notes the importance of regional policy measures in promoting RES and deplores retroactive changes in RES support schemes in some Member States, which have damaged investor confidence. Parliament stressed the importance of biofuels and regretted the Commission's lack of willingness to ensure the continuation of the Fuel Quality Directive after 2020.

In its resolution of 15 December 2015 on the Energy Union strategy, Parliament considers the development of RES as essential to the Energy Union and sees a crucial role for RES in attaining energy security and reducing energy imports. It welcomes the commitment to make the EU the world leader in RES and urges the Commission to develop a corresponding strategy. It calls on Member States and the Commission to ensure transparency, consistency, stability and continuity of regulatory frameworks for renewable energy and to avoid retroactive changes. It advocates better coordination of support schemes.

The resolution of 15 December 2015 on the 10% electricity interconnection target acknowledges the importance of an enhanced electricity grid and reinforced interconnections for the internal energy market and for accommodating a growing share of RES.

[45] Amendments to the RED and the Fuel Quality Directive.

6.2. Committee reports

On 24 May 2016 the ITRE Committee adopted a report[46] on the Commission's renewable energy progress report (rapporteur: Paloma López Bermejo, GUE/NGL, Spain). It expresses concern that a large number of Member States may have to revise policies and instruments to achieve their 2020 targets and proposes enhanced oversight capacities for the Commission; points to the importance of access to capital and the need for an EU financial mechanism aimed at reducing capital costs; calls for simple, affordable and efficient administrative procedures; stresses the importance of stable and cost-effective support schemes and calls for EU legislation to prevent retroactive changes; proposes maintaining priority access to the grid and priority dispatch for RES; supports the modernisation of energy grids; stresses the need to identify and promote best practices; highlights the importance of transparency, public consultation and participation; calls for a differentiated treatment of micro, small and large producers and proposes a basic right to self-generation and self-consumption. It notes the importance of electrification and next generation biofuels for the decarbonisation of the transport sector, and highlights the importance of sustainable forest management and urges caution with regard to the increasing use of forest biomass. The plenary vote is expected for 22 June 2016.

The ITRE draft report on energy market design[47] (rapporteur: Werner Langen, EPP, Germany) supports the goal of increasing the share of renewables but considers permanent subsidies for renewables as outdated and calls for subsidies to be adapted to market conditions in order to rein in costs for consumers; favours the promotion of investment over feed-in priorities and fixed prices; sees a stronger role for carbon and fuel prices in supporting the expansion of renewables; favours balancing responsibilities for renewable power plants; calls for regional coordination in the promotion of renewables; and is of the view that other sources besides renewables have a role to play in the decarbonisation of electricity generation. The draft report is critical of national capacity markets which risk undermining the EU internal energy market. The vote in Committee is expected for 14 June 2016, and the plenary vote in the September 2016 part-session.

7. Outlook

In the coming months, the EU institutions have the challenging task to shape the future of the European energy market and energy system for the period after 2020, through the upcoming proposal for a new energy market design and the review of the Renewable Energy Directive. These reforms are part of a comprehensive update of EU climate and energy policies covering the ETS, effort-sharing for the non-ETS sectors, energy efficiency legislation and governance of the Energy Union.

The revised policies and legislation should facilitate the cost-effective decarbonisation of the European energy system, while at the same time ensuring the security of supply and the affordability of energy for households and industry, as well as fostering industrial innovation and leadership.

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[46] Procedure file 2016/2041(INI) Renewable energy progress report.

[47] Procedure file 2015/2322(INI) Towards a new energy market design.

8. Main references

Biomass for electricity and heating: Opportunities and challenges, EPRS, September 2015.

Costs and benefits of renewable energy sources in Europe up to 2030, DIA-CORE Policy Brief, June 2014.

Electric networks and energy transition in Europe, Michel Cruciani, Ifri, September 2015.

Energy support measures and their impact on innovation in the renewable energy sector in Europe, European Environment Agency, 2014.

EU biofuels policy: Dealing with indirect land use change, ERPS, January 2015.

EU governance of renewable energy post-2020 – risks and options, Tomas Wyns et al., Institute for European Studies - Vrije Universiteit Brussel, December 2014.

European renewable energy network, European Parliament DG IPOL, January 2012.

Fact sheets on the European Union: renewable energy, European Parliament, June 2015.

Global trends in renewable energy investment 2016, Frankfurt School-UNEP Centre, 2016.

How to reconcile national support for renewable energy with internal market obligations? The task for the EU legislature after Ålands Vindkraft and Essent, Marek Szydło, Common Market Law Review, Issue 2, pp. 489–510, 2015.

Implementation appraisal: renewable energy, EPRS, September 2015.

Mid-term evaluation of the Renewable Energy Directive, Study for the European Commission Directorate-General Energy (ENER), April 2015.

Renewable energy in the internal energy market (workshop proceedings), European Parliament DG IPOL, November 2015.

Renewable energy in Europe – approximated recent growth and knock-on effects, EEA Technical report No 1/2015, European Environment Agency, 2015.

Renewable energy progress report (COM(2015) 293 final), European Commission, June 2015.

Renewables 2015 global status report, Renewable Energy Policy Network for the 21st Century, 2015.

Re-powering markets: market design and regulation during the transition to low-carbon power systems, International Energy Agency, February 2016.

Snapshot of renewable energy development in the EU-28, Volume 2: Current status and expected progress in comparison with national renewable energy action plans, Joint Research Centre, 2015.

Status review of renewable and energy efficiency support schemes in Europe in 2012 and 2013, Council of European Energy Regulators, January 2015.

Technical and economic analysis of the European electricity system with 60% RES, Alain Burtin and Vera Silva, EDF R&D, June 2015.

REmap: Roadmap for a renewable energy future, 2016 edition, International Renewable Energy Agency, 2016.

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The development of renewable energy sources (RES) is a priority for the European Union. One of the goals of the EU Energy Union strategy is making the EU the world leader in renewable energies.

The Renewable Energy Directive sets national targets for all Member States, which remain free to decide how they support RES within the EU energy market rules. The Commission plans to revise the Renewable Energy Directive and other RES-related legislation in 2016. Renewables have a growing share in energy consumption in the EU. However, RES investments in Europe have fallen in recent years due to regulatory changes, economic slowdown and falling technology costs. The development of RES poses a number of technical and regulatory challenges, notably their integration into electricity grids and the sustainability of biofuels, and requires a market design that encourages investment while keeping costs under control. The European Parliament supports the growth of RES in the EU and has called for more ambitious targets. Parliament's Committee on Industry, Research and Energy is currently working on own-initiative reports on energy market design and on the renewable energy progress report.

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