EUROPEAN
COURT
OF AUDITORS

Background paper

Electricity production from wind and solar photovoltaic power in the EU

February 2018

The 2009 Lisbon Treaty gave the European Union (EU) the authority to develop an energy policy containing four essential elements, including the promotion of energy efficiency and savings and the development of new, renewable energy sources. In the 2009 Renewable Energy Directive the target for energy consumption from renewable sources across the EU was set at 20 %, to be reached by the end of 2020.

Our audit examines the design, implementation and monitoring of EU and national strategies for electricity generation from renewables, in particular from wind and solar photovoltaic (PV) sources. We will assess actions taken at Commission level and in four Member States (Germany, Greece, Spain and Poland). Our audit will review the EU and national legal frameworks, and assess the use of EU funding for renewables. Moreover, we will examine a sample of 24 ERDF/CF-funded wind and solar PV projects from the 2007-2013 and 2014-2020 programme periods.

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RENEWABLE ENERGY SOURCES

Renewable energy sources may be defined as those that can be replenished in a human lifetime, unlike finite fossil fuels such as coal, crude oil or natural gas. Renewable energy can be produced from a wide variety of sources including hydro, solar, wind, biomass, waste, wave, tidal and ocean, and geothermal. Renewables are used to produce energy which is converted to electricity, heating and fuel for transport and machinery.

By using more renewables, the EU can lower its dependence on imported fossil fuels and make its energy production more sustainable. Renewables are estimated to have saved 16 billion euro in fossil fuel imports in 2015 and this sum is expected to rise to 58 billion euro by 2030[1].

The expansion of renewables is lowering wholesale electricity prices. According to the European Commission, between 2008 and 2016 wholesale electricity prices dropped by almost 70 %. It is estimated that every percentage point increase in the proportion of renewables used reduces the wholesale electricity price by €0.4/MWh in the EU[2].

Moreover, the use of renewables to produce energy does not cause any greenhouse gas emissions (GHG), except in the case of biomass, and thus it improves air quality and protects the climate. Of all the GHG emitted by the EU[3], almost 80 % is produced by energy based on fossil fuels. In 2015, renewables helped to reduce GHG by an amount equivalent to the total GHG emissions of Italy[4].

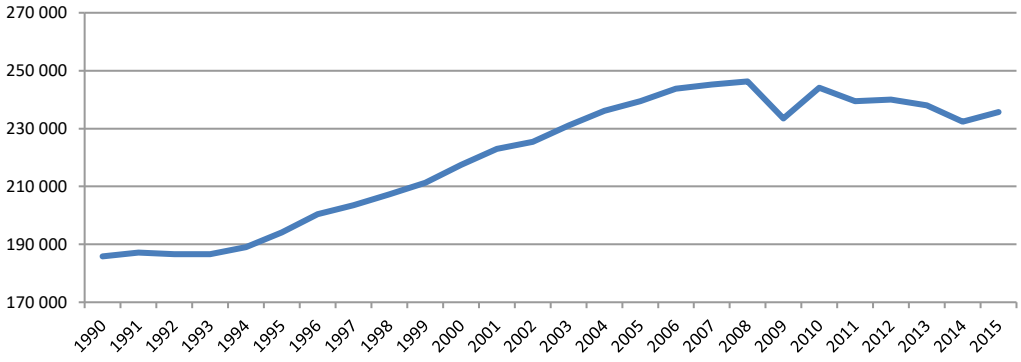
The renewable energy industry contributes significantly to technological innovation and employment across Europe. In 2014, the turnover of the renewable industry in the EU was 144 billion euro and more than 1.2 million people were employed in the sector[5].

Electricity demand

From 1990 until 2008, the consumption of electrical energy in the EU grew continuously. More recently it has remained stable or even decreased slightly as shown in ***Figure 1***. However, future electricity demand will be influenced by changes in the way we consume energy such as the use of smart meters, electric cars and electric heat pumps.

Figure 1 **– Growth in demand for electricity in the EU-28, 1990 - 2015**

kilo tonnes of oil equivalent (k toe)



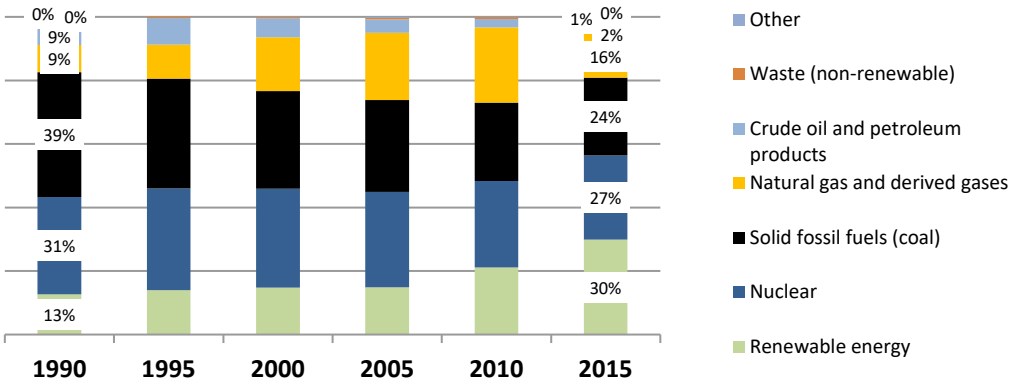
Source: Eurostat, 2017.

Development of the EU energy mix for electricity production

Electricity can be produced from many sources, such as: coal, nuclear and renewable energy, natural gas, crude oil, non-renewable waste and others. The proportion of energy generated from these sources in the EU is presented in ***Figure 2***. The use of renewables has increased significantly in recent years. It represents 30 % of all electricity consumed, a higher proportion than any of the other sources (in particular fossil fuels and nuclear energy).

Figure 2 **– Development of the EU-28 mix of energy in electricity production, 1990-2015 (in five year interval)**

% of total, based on tonnes of oil equivalent (toe)



Source: Eurostat, 2017.

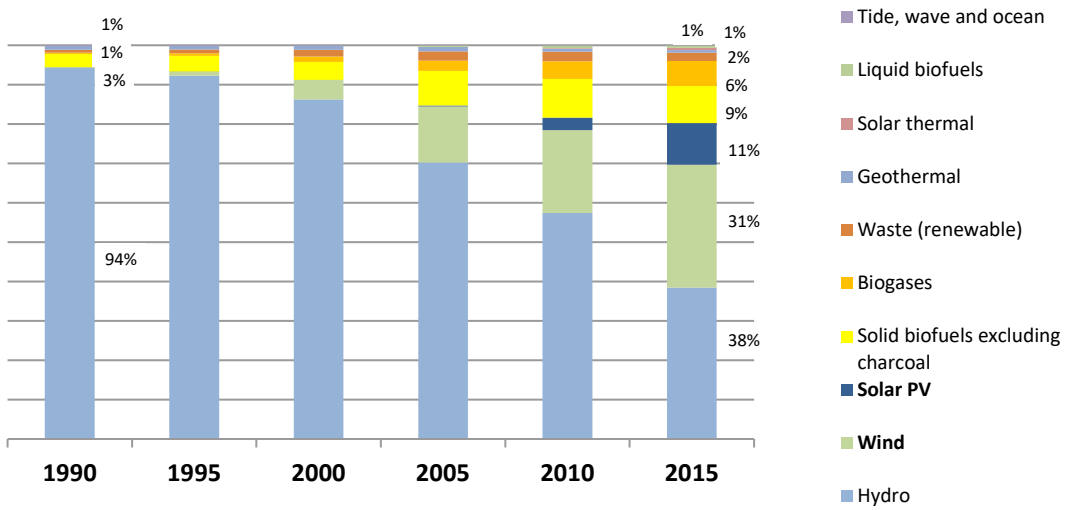
The proportion of renewables used to produce electricity in the Member States varies considerably from one State to another, going from 8 % in Malta to 78 % in Austria. Although renewables dominate electricity production in only 12 Member States, they are part of the national electricity mix in all the Member States. For the EU as a whole, renewables represent the highest, continuously growing, proportion of all the energy sources involved in electricity production (as shown in ***Figure 2***).

In the early 90s, hydropower dominated the EU renewables market, producing 94 % of the renewable energy for electricity. At that time, the proportion of electricity produced from wind and solar photovoltaic (PV) power was marginal, as presented in ***Figure 3***.

By 2015, the EU renewables mix had changed significantly. Currently, wind and solar PV power combined are leading the renewables industry in the production of electricity, while hydropower is shrinking in relative terms. Hydropower represents 38 % of gross electricity production, wind 31 %, and solar PV 11 %. The remaining 20 % of electricity is produced from other renewables. These only make up 20 % partly because the technology is not yet developed to a level where electricity can be reliably mass produced.

Figure 3 **– Development of the EU-28 renewables mix for electricity production, 1990 – 2015 (in five year interval)**

% of total, based on toe



Source: Eurostat, 2017.

Electricity production from wind and solar PV power

Our audit concentrates on two of the renewable means of producing electricity, wind and solar PV power, given that their development has been by far the most dynamic of all renewables. Over ten years (2005-2015), gross electricity produced from wind went from 6 057 ktoe in 2005 to 25 956 ktoe (329 %) in 2015 and solar PV power production went from 125 ktoe to 8 799 ktoe (6 939 %) in the same period[6]. It is expected that due to technological developments, wind and solar PV power will soon be the two cheapest electricity sources.

Wind power

The main characteristic of this sector is the significant financial investment required. Moreover the construction of a wind project, especially an offshore wind farm, takes several years and requires permits and authorisations from a series of local authorities. The EU led the wind energy market in terms of capacity until 2014, especially Germany and Spain. Since then, the rate of investment in Asia, mainly in China and India, has pushed the EU into second place.

Solar power

Solar PV energy is easily scalable; it can be generated by large and small-scale parks as well as by households. Its capacity has expanded enormously during the last decade. This has resulted in a significant decrease both in the production cost of the panels and in the subsidies that national authorities offer investors per MW/h produced. Similarly to wind power, EU solar PV energy led the market in terms of capacity until 2015, especially Germany and Italy. Since then, the rate of investment in Asia, mainly in China and Japan, has pushed the EU into second place.

STRATEGIES AND LEGAL FRAMEWORK FOR RENEWABLES

EU Strategies and legal framework

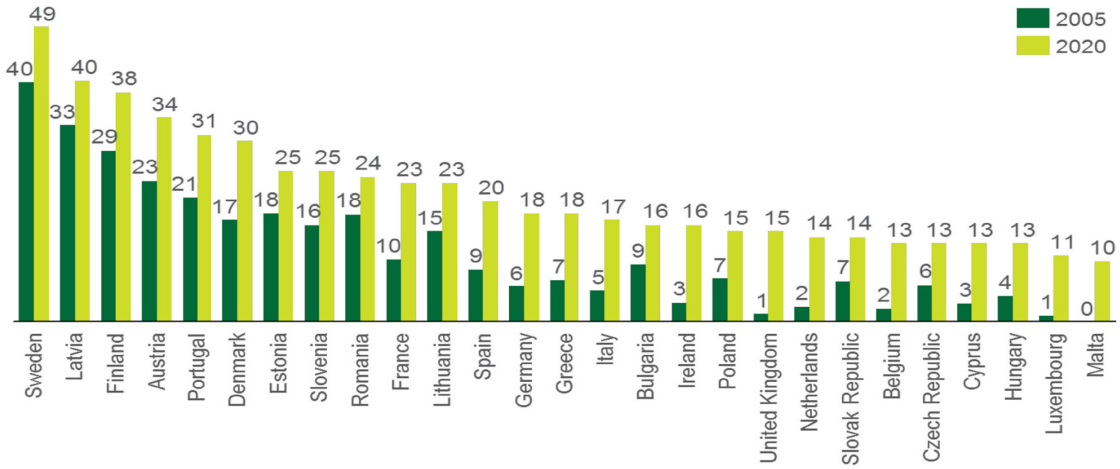
The energy chapter was added to the Treaty on the Functioning of the European Union (TFEU) by the Lisbon Treaty (2009). Article 194 of the TFEU lists the four essential parts of EU energy policy. One of them is the promotion of energy efficiency and energy saving and the development of new and renewable forms of energy. The energy chapter allowed the EU to develop a more strategic and harmonised energy policy, to be implemented by the EU as a whole.

The policy objectives related to the development of renewable energy are defined in the Renewable Energy Directive (RED I)[7], which is the legally binding framework for the promotion of renewables. Among other targets, it obliges Member States to ensure that, for the EU as a whole, a minimum of 20 % of the energy consumed must come from renewables. In addition, the target of the Member States is for 10 to 49 % of their energy to come from renewables by the end of 2020[8].

Figure 4 presents the binding individual national targets of RED I. They do not focus specifically on wind and solar PV, but concern all renewable sources. These targets were set after negotiations with each Member State, taking into account its GDP, its capacity in 2005 and its potential.

Figure 4 **- National overall targets for energy from renewables in gross final consumption of energy (*) in 2020**

in %



Source: Renewable Energy Directive 2009/28/EC of 23 April.

(*)'Gross final consumption of energy' means the energy commodities delivered for energy purposes to industry, transport, households, services including public services, agriculture, forestry and fisheries, including the consumption of electricity and heat by the energy branch for electricity and heat production and including losses of electricity and heat in distribution and transmission.

In 2015, the Commission adopted the 'Energy Union Framework strategy'[9] which gave new momentum to the transition to a low-carbon economy. The strategy also delivered one of the Juncker Commission's five priorities: 'Europe's Energy Union to become the world number one in renewable energies'[10]. By the end of July 2017, of the 163 signed projects to be co-financed by the European Fund for Strategic Investments (the "Juncker Plan"), 54 were related to energy in general.

On 30 November 2016, the European Commission published the 'Clean Energy for all Europeans' package[11], referred to as the 'Winter Package'. It includes a proposal for a revised Renewable Energy Directive (RED II).

The revised Directive is expected to help ease the integration of renewables into the electricity sector and it sets a target of 27 % renewable energy for the EU as a whole by 2030, as a proportion of gross final consumption. The recast Directive should enter into force on 1 January 2021 and will then have to be transposed into national law by 30 June 2021.

The Commission expects that in 2030 half of the EU's electricity generation will come from renewables and that by 2050 the EU's electricity production should be completely carbon-free.

National strategies

Under Article 4 of the RED I Directive, each Member State must adopt a National Renewable Energy Action Plan, which should set out Member States' national targets for the share of energy from renewable sources consumed in transport, electricity and heating and cooling in 2020.

The Member States are free to define the type and level of renewables they want to deploy to meet the legal targets of the Directive. Member States can develop their own support systems for renewables through national schemes, taking into account the state aid rules.

State aid issues

At the beginning of 2016, new state aid guidelines for 2014-2020 were issued by the European Commission. For all new aid schemes and measures, aid to renewable electricity generation must be 'granted as premium in addition to the market price'[12] (feed-in premium). In addition to this requirement, from 2017 the aid should be granted in a competitive bidding process which should be open to all renewable source generators on a non-discriminatory basis. The latter condition is subject to certain exceptions.

ROLES AND RESPONSIBILITIES

European Commission

In the European Commission, the Directorate-General for Energy (DG ENER) is responsible for developing and implementing European energy policy within the scope of Article 194 of the Treaty. The funding to projects receiving ERDF/CF support is provided by the Directorate-General for Regional and Urban Policy (DG REGIO).

Operating aid granted through national financing support schemes must be submitted to the Directorate-General for Competition (DG COMP) for approval if it exceeds 150 million euro annually. DG COMP assesses whether the aid constitutes state aid, and if so, it evaluates whether such state aid is compatible with the internal market.

Member States

The Member State authorities have the right to determine which energy resources to exploit and how, the general structure of their energy supply and the type of national financing support scheme they want to deploy. EU funds can be used for this purpose.

Transmission and distribution system operators

Transmission System Operators are responsible for transporting energy, for instance in the form of electricity distributed at a national or regional level, using fixed infrastructure.

Distribution System Operators are natural or legal persons responsible for operating, maintaining and, if necessary, developing the distribution system in a given area and, where applicable, its interconnections with other systems.

Project providers

Renewable energy projects can be developed by companies or individuals, who may act as producers of energy. In cases where producers consume the energy they produce, they are called ‘prosumers’.

EU FUNDING FOR RENEWABLES

EU support for renewables is provided through several programmes and funds: the ERDF/CF, Intelligent Energy Europe (IEE), the LIFE+ Programme, the EAFRD and the EIB's financing instruments. ***Table 1*** below presents the EU funding for renewables for the 2007-2013 programme period.

Table 1 **– EU funding for renewables 2007-2013 programme period**

Source of funding	Amount earmarked (billion euro)
European Structural and Investment Funds (ESI)	4.5
European Investment Bank (loans)	6.2
EU 7th Framework Programme for Research	0.8
European Economic Programme for Recovery	0.3
EAFRD	0.3

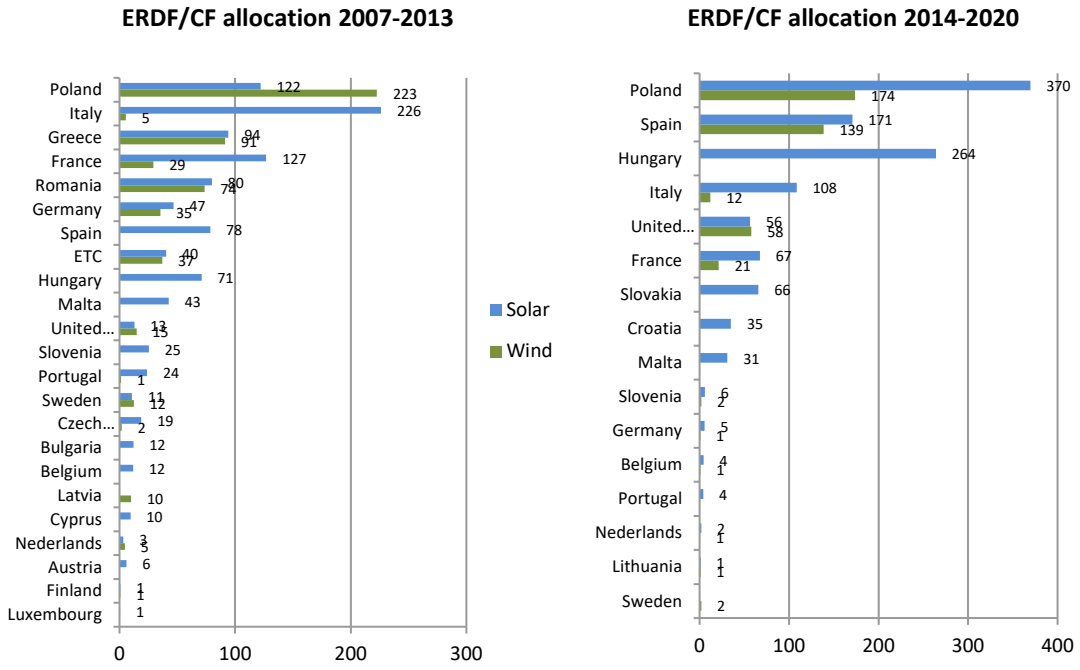
Source: Information provided by Mr Oettinger on behalf of the Commission during a plenary session of the European Parliament on 25 November 2013.

In the 2014-2020 programme period, it is intended to devote 45 billion euro from the ESI Funds to support the shift to a low-carbon economy, including investment in renewable energy, energy efficiency and sustainable urban mobility. Another 58.5 billion euro is to be provided to support smart energy transmission and storage and transport systems.

Figure 5 below presents the allocations to wind and solar PV projects as set out in the latest Operational Programmes approved by the Member States for the 2007-2013 and 2014-2020 programme periods. The data on the actual allocations for the 2007-2013 programme period will become available as soon as the accounts have been closed.

Figure 5 **– ERDF/CF allocated to wind and solar PV per programme period**

in million euro



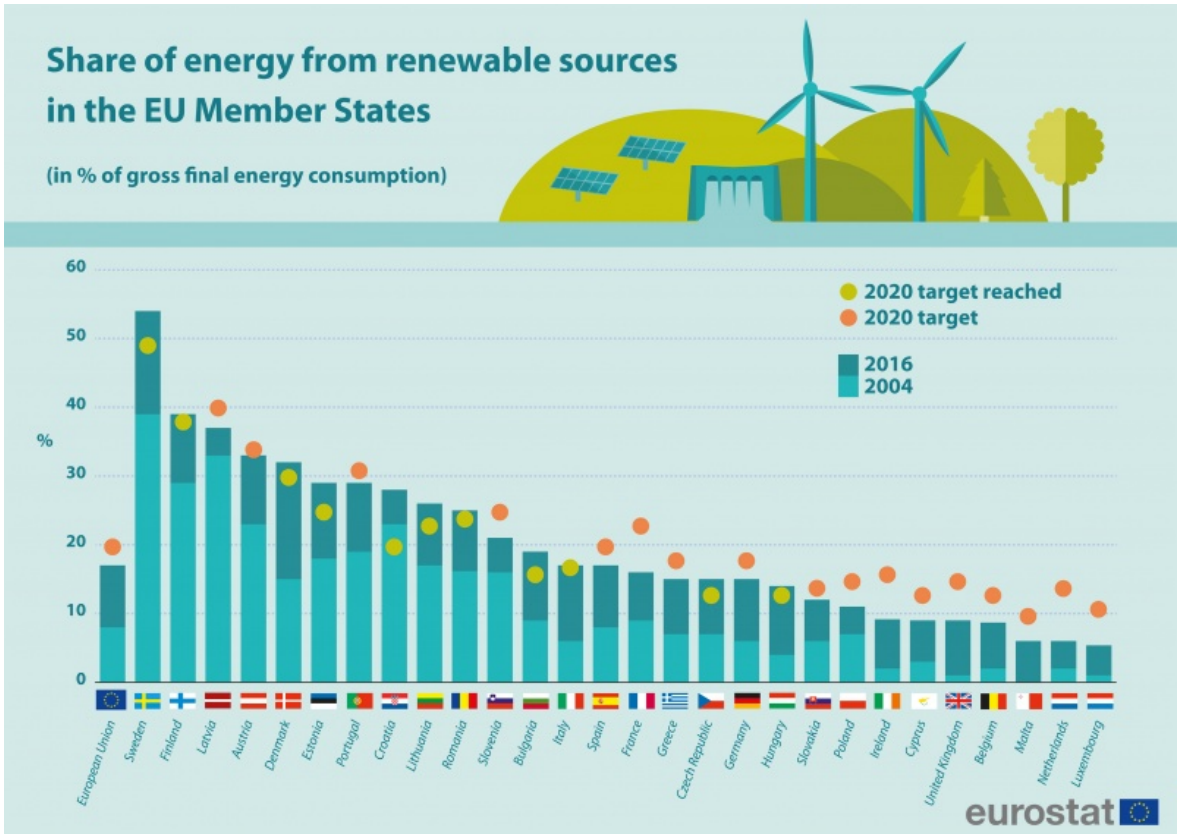
Source: DG REGIO, Budget codes for wind and solar PV, ERDF/CF allocations in the last approved Operational Programmes in the Member States.

Not all Member States allocated ERDF/CF funds for wind and solar PV projects. The six that did not do this for the 2007-2013 period were: Croatia, Denmark, Estonia, Ireland, Lithuania and Slovakia; and the 12 which did not for the 2014-2020 period were: Austria, Bulgaria, Czech Republic, Denmark, Estonia, Greece, Ireland, Cyprus, Latvia, Luxembourg, Romania and Finland.

STATE OF PLAY WITHIN THE EU

According to the 'Renewable Energy Progress Report'[13], all but one Member State (the Netherlands) showed average 2013/2014 renewable shares were on course to meet or exceed their 2020 target. According to 2015 estimates by the Commission, 25 Member States have already exceeded their 2015/2016 aims. In the remaining three (the Netherlands, France and Luxembourg) the proportion of renewable energy they used was below that needed to achieve their 2020 target. ***Figure 6*** presents the progress towards the EU 2020 target for renewables in 2016.

Figure 6 **– Member States' current progress towards the RED I targets in 2016**



Source: Eurostat, 2018.

ISSUES IDENTIFIED WHEN PREPARING THE AUDIT

When preparing our audits, we carry out an issue analysis of the policy area or programmes that we intend to examine. Since these issues are identified before the audit work commences, they should not be regarded as audit observations, conclusions or recommendations.

In the course of our audit on Electricity production from wind and solar PV power in the EU, we will look at those areas in relation to the issues that have been identified. In particular, we will check:

- whether the design of EU and/or national strategies promotes electricity generation from renewables such as wind and solar PV power;
- whether legal uncertainty persists, due to frequent regulatory and/or retrospective changes, affecting the investing environment; and
- whether financing and support schemes for renewables adapt to changing market conditions in order to prevent over-subsidisation or transfer of increased risk to investors.

ABOUT ECA SPECIAL REPORTS AND BACKGROUND PAPERS

The ECA's special reports set out the results of its audits of EU policies and programmes or management topics related to specific budgetary areas.

Background papers provide information in relation to an on-going audit task. They are based on preparatory work undertaken before the start of the audit and are intended as a source of information for those interested in the policy and/or programme being audited.

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[1] European Commission, 'Renewable energy progress report', COM(2017) 57 final, 1.2.2017, page 2; Öko-Institut, Study on technical assistance in realisation of the 2016 report on renewable energy.

[2] European Commission, 'Energy prices and costs in Europe', COM(2016) 769 final, 30.11.2016.

[3] European Commission, 'Energy 2020 A strategy for competitive, sustainable and secure energy', COM(2010) 639 final, 10.11.2010.

[4] European Commission, 'Renewable energy progress report', COM(2017) 57 final, 1.2.2017, page 2.

[5] International Renewable Energy Agency, 'Renewable energy and jobs, Annual review 2015'.

[6] Eurostat, 'Primary production of renewable energy by type, 2005-2015'.

[7] 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 and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (OJ L 140/16, 5.6.2009, p. 16).

[8] Directive 2009/28/EC, whereas 19 and Article 4.

[9] European Commission, 'A framework strategy for a resilient energy union with a forward-looking climate change policy', COM(2015) 080 final, 25.2.2015.

[10] Jean-Claude Juncker, "My Priorities" European People's Party (EPP), 2014.

[11] European Commission, 'Clean Energy For All Europeans', COM(2016) 860 final, 30.11.2016.

[12] European Commission, Commission staff working document: 'Guidelines on State aid for environmental protection and energy 2014-2020', 2014/C 200/01, paragraph 3.3.2.1a.

[13] European Commission, 'Renewable Energy Progress Report', COM(2017) 57 final, 1.2.2017.