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Renewable energy deployment in the European Union

Renewable energy in the European Union further to Renewable Energy Directive reporting, Vol. 3

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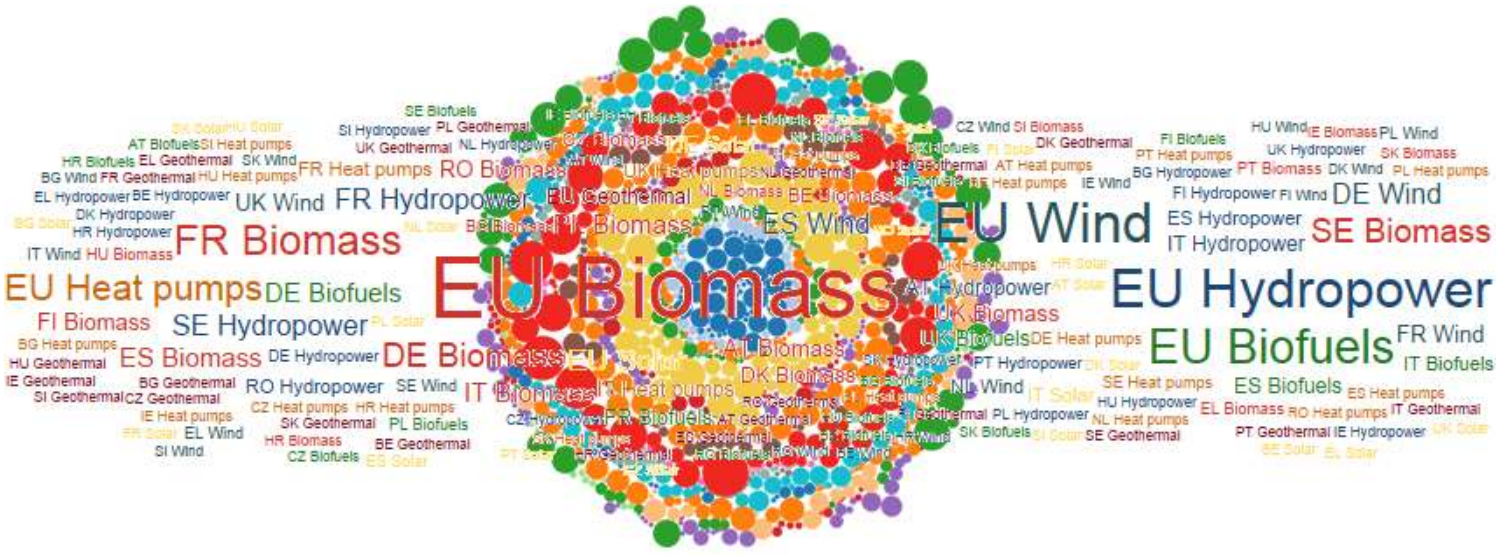

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Title Renewable energy deployment in the European Union

Abstract
The report presents an overview of renewable energy development and progress expected by 2020, as forecasted in the EU Member States' reporting under the Renewable Energy Directive and projected in the EU Reference 2016 and EUCO27 scenarios. The report compares the progress achieved between 2005 and 2015, as reported by EU Member States in their progress reports and the Eurostat SHARES Tool, with the expected results as set out in their national renewable energy action plans. The report goes on to describe in detail each Member State's overall contribution to the development of renewable energy since 2005. The findings draw on the Member States' reporting under the Renewable Energy Directive, the progress each country has made in the use of each renewable energy source and the contribution of renewable energy in each Member State to the heating/cooling, electricity and transport sectors. Findings are summarised in standardised tables and graphs, enabling quick comparison between different countries and for the EU as a whole.

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The report uses established database data, available for download and sourced from EU Member States' reporting under the Renewable Energy Directive, complemented with Eurostat SHARES Tool data.

Manjola Banja coordinated and co-authored this report together with Fabio Monforti-Ferrario of Air and Climate Unit (C.5) and with Katalin Bódis of the Energy Efficiency and Renewables Unit. Fabio Monforti-Ferrario reviewed and improved the report. Katalin Bódis performed the GIS mapping of energy indicators in the EU and the data extraction for the EUCO27 energy scenarios, and organised them in an appropriate output form for subsequent use.

The report also benefited from the contribution of the following co-authors from the Energy Efficiency and Renewables Unit, who mainly helped by improving the first version of the report: Nigel Taylor provided useful comments and suggestions and edited specific sections of the report, Arnulf Jäger -Waldau prepared the summary on solar PV deployment in 2016, while Nicolae Scarlat and Jean-François Dallemand provided additional input.

Manjola Banja and Fabio Monforti-Ferrario led the work to maintain the renewable energy database used in this report and keep it updated.

Nicolae Scarlat and Manjola Banja designed the basic structure of the snapshot report, which was then reworked into its current format by the main author of this report.

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Executive summary

Policy context: The transition to a low carbon economy through a wide range of interacting policies and instruments is consolidating in the European Union. In October 2014 the European Council agreed on the 2030 climate and energy policy framework [1] for the EU, setting an ambitious economy-wide domestic target of reducing greenhouse gas emissions for 2030 by at least 40% compared with 1990; a binding target at EU level of at least 27% for the share of renewables in gross final energy consumption in 2030; an indicative target at EU level to improve energy efficiency by at least 27% in 2030 compared to projections of future energy consumption. Implementing the 2030 energy and climate framework is a priority in the follow-up to the Paris Agreement, which entered into force on 4 November 2016. The overarching goal of the Paris Agreement is to keep the maximum global average temperature rise as close as possible to 1.5 °C. On 30 November 2016, the European Commission presented a package of proposed measures [2] to keep the EU competitive as the clean energy transition changes global energy markets. The package contains the key remaining pieces needed to fully implement the EU's 2030 climate and energy framework on renewables and energy efficiency through three main goals: putting energy efficiency first; achieving global leadership in renewable energies; and providing a fair deal for consumers.

Key Conclusions: Progress towards the 2020 renewable energy targets was on track for the EU and most Member States. Ten Member States (BG, CZ, DK, EE, IT, LT, HR, RO, FI and SE) already exceeded their 2020 target for overall renewable energy share in 2015. More than half of Member States have exceeded their 2020 planned target in the heating/cooling sector. In the electricity sector five Member States reported higher shares of renewable energy than what they planned for 2020 whereas in the transport sector only two Member States were in this position.

In the heating/cooling sector 26 Member States have already met or exceeded their 2015 plans for renewable energy share. The only exceptions were France and Ireland. Some 17 Member States have met or exceeded their 2015 plan for renewable electricity share in the electricity sector. Only the deployment of renewable energy in transport sector lags behind expectations, with just 11 Member States having met or exceeded their plans for 2015.

Overall renewable energy provided 16.7% of gross final energy consumption in 2015, composed of: an 18.6% share in the heating/cooling sector; a 28.8% share in the electricity sector; a 6.7% share in the transport sector. Biomass was the mainstream source of renewable energy in the EU, accounting for 52.4 % of the final renewable energy.

The EU has successfully turned modern technologies such as solar and wind power into central players in the power sector. In 2016 installed capacity in the EU for solar photovoltaics passed the 100 GW milestone, reaching 101.7 GW, which is more than 44 times its 2005 capacity. These two technologies accounted for approximately 18% of the EU's overall renewable energy share in 2015. Meanwhile, non-traditional heat sources (solar thermal and heat pumps) accounted for almost 6% of this share.

The penetration of wind power and solar photovoltaics achieved high levels in final renewable electricity in several Member States. In five Member States, wind power produced half or more than half of final renewable electricity. The installed capacity for solar photovoltaics accounted more than half of renewable energy installed capacity in four Member States. Germany remained the main EU market, having installed above 84 GW of both wind and solar photovoltaics, which represents more than one fifth of final renewable electricity installed capacity. Spain has become the second Member State after Ireland to generate more renewable energy from wind power than any other renewable source, while Luxembourg was the only Member State to use more renewable energy in the form of biofuels. Italy has seen the fastest deployment of solar photovoltaic technology since 2005.

Biomass will be still the main renewable energy source for renewable energy in the EU in 2020. In the same year, modern technologies will dominate the electricity sector, providing more than half of final renewable electricity.

The EU is on track to reach the 2020 target for overall RES

16.7%

Share in gross energy consumption

Ten Member States exceeded their 2020 targets for overall RES share

15 Member States

Exceeded their 2020 plans in Heating/Cooling

Solar PV and wind the main players in electricity sector

~18%

Wind and solar PV share in final renewable energy

Main findings

The European Union (EU)[1] continues to decrease its energy consumption and the energy intensity of its economy meanwhile its economy grow. Only Estonia and Poland consumed in 2015 more energy in primary terms comparing with 2005 meanwhile decreasing the energy intensity of their economy and increasing their GDP (PPS).

The EU economy continues to be more energy effective as the primary energy consumption (PEC) continues dropping moderately. Over the last 10 years, since 2005, the EU economy grew by 27% while primary energy consumption and intensity of its economy fell by 10.7% and 19.3% respectively. Over this ten-year period 25 Member States decreased both the energy intensity of their economy and their primary energy consumption meanwhile increasing their GDP (PPS). Only in Greece primary energy consumption, energy intensity of the economy and GDP (PPS) saw in 2015 lower levels comparing with the respective levels in 2005.

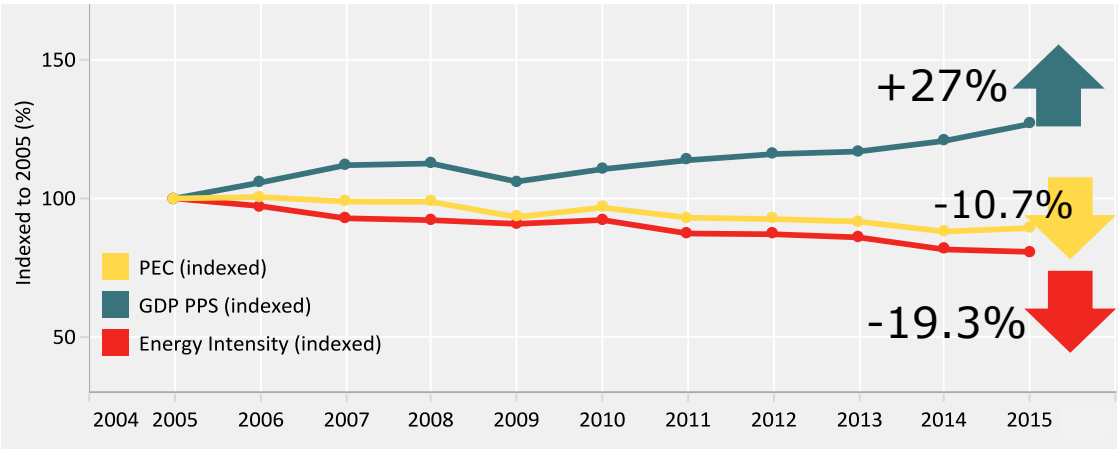

Figure ES- 1. Trend of Primary Energy Consumption, GDP (PPS) and Energy Intensity[2] in EU, 2005-2015

The EU is on track to achieve the 2020 target for overall renewable energy share. Between 2005 and 2015 the overall renewable energy share in the EU grew almost twofold. The EU 2030 binding target is to have at least 27% of the overall renewable energy share in gross final energy consumption.

According to the EU Member States reporting in March 2017 the share of renewables in gross final energy consumption in the EU in 2015 reached **16.7%**. Renewable energy's contribution in heating/cooling, electricity and transport sectors reached 18.6%, 28.8% and 6.7 respectively %. In 2015 Sweden was the main contributor in overall renewable energy's share with 9.7% contribution in relative terms followed by Finland (7.1%), Latvia (6.8%), Austria (5.9%) and Denmark (5.6%).

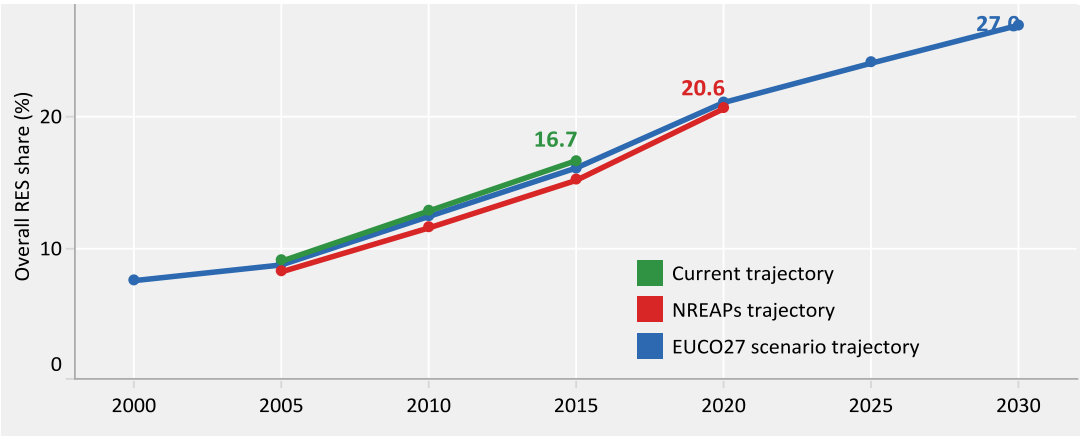

Figure ES- 2. Overall renewable energy share in EU– Current, NREAP and EUCO27 scenario trajectories until 2030

[1] The report analyse the progress between 2005 and 2015, before the United Kingdom withdrawal from the European Union.
[2] Gross inland consumption of energy divided by GDP (kg of oil equivalent per 1 000 EUR)

Most of EU Member States are on track to achieve their 2020 target for overall renewable energy share. The heating/cooling sector saw the largest number of Member States that met or exceeded their 2020 planned renewable energy share in this sector.

Some 10 Member States (BG, CZ, DK, EE, IT, LT, HR, RO, SE and FI) exceeded their 2020 target for overall renewable energy share in 2015. Half of Member States exceeded their 2020 plan in the heating/cooling sector in 2015; in the electricity sector five Member States reported higher shares of renewable energy than what they had planned for 2020. In the transport sector, only two Member States (FI and SE) exceeded their 2020 plans for renewable energy share in 2015.

One-third of MS missed their overall renewable energy share planned for year 2015. On the other hand, almost all Member States met or exceeded their indicative trajectory for renewable energy in 2015.

Some 25 Member States met or exceeded their 2015/2016 renewable energy indicative trajectory in 2015. The exceptions were Luxembourg, France and the Netherlands. In 2015 eight Member States (IE, ES, FR, LU, MT, NL, PL and PT) did not reach their overall renewable energy share planned for 2015. In the heating/cooling sector 26 Member States already met or exceeded their 2015 plans for renewable energy share. The only exceptions were Ireland and France. In the electricity sector 17 Member States met or exceeded their 2015 plans for renewable electricity share whereas IE, EL, FR, LT, LU, HU, MT, NL, AT, SI and SK did not. In the transport sector 11 Member States met or exceeded their 2015 planned shares. BE, CZ, DE, EE, EL, ES, IT, CY, LV, LT, HR, NL, PL, PT, RO, SI and UK did not.

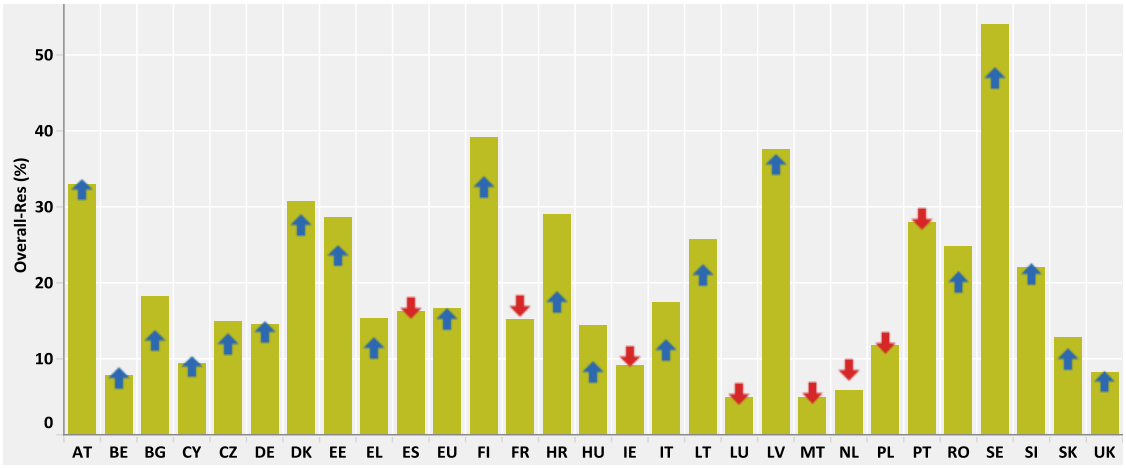

Figure ES- 3. Overall RES share in EU Member States – comparison with NREAP plans, 2015

Germany, France, Sweden, Italy and Spain remained throughout this decade the top five leading countries in the final renewable energy consumption in the EU. Germany and France switched over this decade the leading position in the contribution to the final renewable energy consumption. Germany and Malta had the largest increase throughout decade 2005-2015 respectively in absolute and relative terms.

France had in 2005 the highest relative contribution, at 14.3%, to the final renewable energy consumption followed by Germany (13.7%), Sweden (13.1%), Italy (9.7%) and Spain (7.7%). Over the decade 2005-2015 these MS are still leading the deployment of renewable energy in the EU, in which Germany (17.1%) and France (12.2%) have switched their roles. Germany and Italy had the largest deployment of final renewable energy consumption throughout period 2005-2015 whereas Malta the fastest one. Over the same time span Germany, France, United Kingdom, Italy and Poland were the five Member States that consumed more energy in terms of gross final consumption.

The progress of renewables in heating/cooling sector, that comprises almost half of final renewable energy consumption in the EU, has been slower than the progress in electricity sector. To date, renewable energy in heating/cooling sector is the main source of final renewable energy consumption in most of EU Member States.

Renewable energy in the heating/cooling sector represented more than half of final consumption of renewable energy in 16 Member States (BG, CZ, DK, EE, EL, FR, CY, LV, LT, HR, HU, PL, RO,

SI, FI and SE). The electricity sector represented over half of final renewable energy consumption in only four countries (IE, ES, PT and UK). The transport sector had the highest share among sectors, recording more than 40%, but this was only in Luxembourg. In Estonia and Spain there was no contribution from biofuels in the transport sector in year 2015.

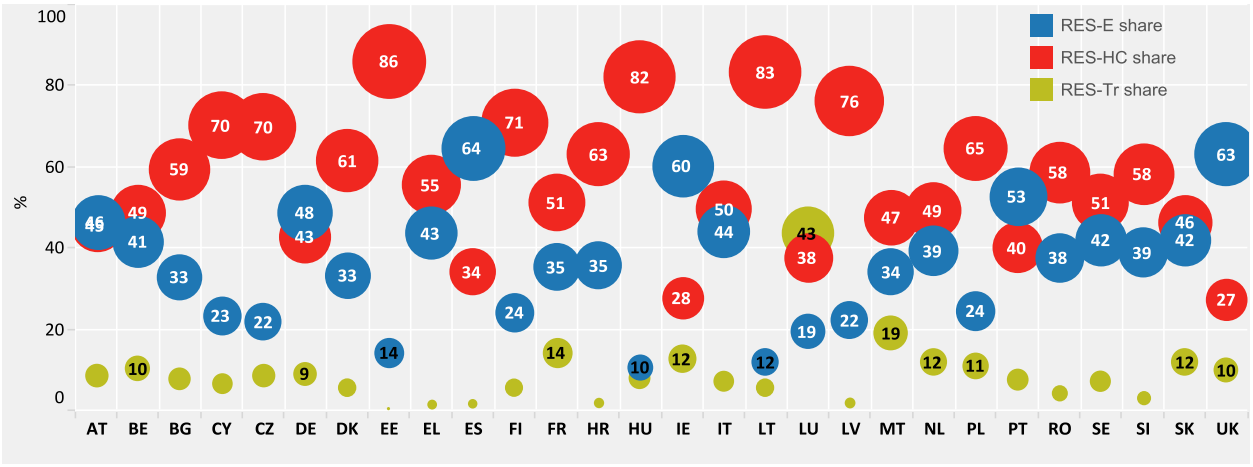

Figure ES- 4. Contributions of Electricity, Heating/Cooling and Transport sectors in EU MS final RES, 2015

Renewables accounted for most of the EU's new generating capacity. Wind power and solar photovoltaics are the largest sources in the EU's new renewable electricity capacity and consumption, having been deployed faster during the 2005-2015 period.

Between 2005 and 2015, the share of renewables in the EU's total electricity capacity increased from 20% to 38%. The contribution of wind power and solar photovoltaics accounted for up to 89% of additional capacity over this ten-year period. In 2015 wind power and solar photovoltaics accounted for one quarter of EU electricity capacity. Wind power was the leading source of new renewable electricity capacity in the EU in 2015, contributing more than half of capacity. The use of solar photovoltaics in the EU blossomed around 2011, providing more than 61% of newly renewable electricity capacity in that year. However, by 2015 the EU solar photovoltaic market's contribution had dropped to one third of new installed renewable electricity capacity. After three consecutive years of downward trend, 2015 saw a higher level of new photovoltaic capacity than the proceeding year, at 7.8 GW.

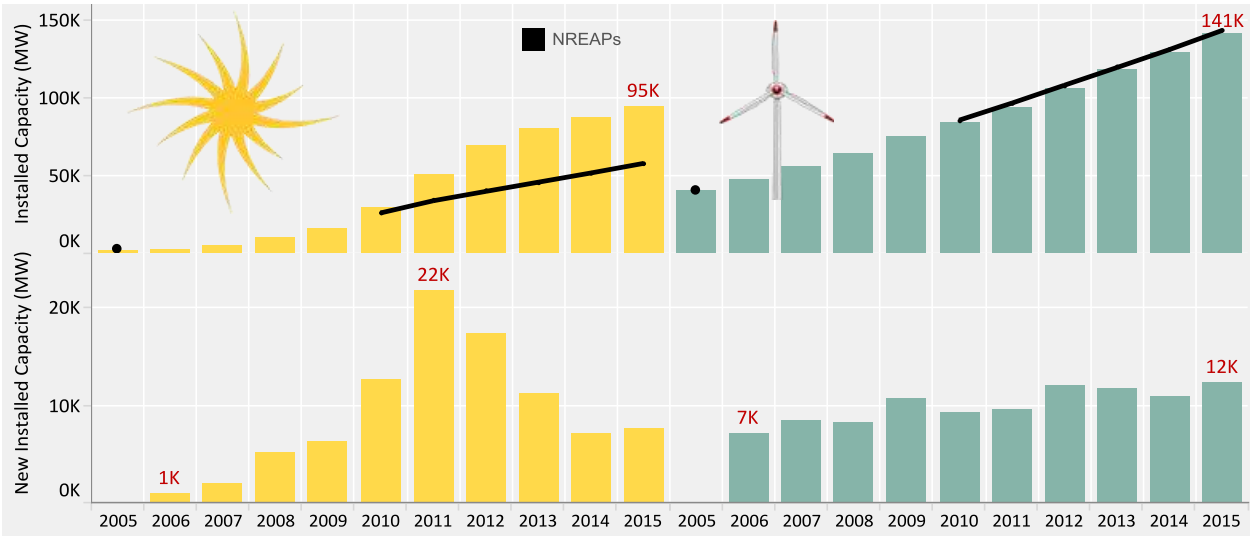

Figure ES- 5. Solar PV and wind installed capacity and annual changes – comparison with NREAPs trend, 2005-2015

Germany remained the largest mature European market in both solar photovoltaic and wind power whereas Italy experienced the fastest deployment of solar photovoltaics between 2005 and 2015. In 2015 United Kingdom was home to half of newly photovoltaic capacity in the EU

The penetration of wind power in final renewable electricity was over 50% in five EU Member States (BE, DK, IE, CY and NL). In four Member States (BE, CZ, LU and MT), solar photovoltaics

accounted for more than half of final renewable electricity's installed capacity. Germany was the leader in the deployment of solar photovoltaics and wind power. In 2015 the cumulative installed capacity of these two technologies in Germany exceeded 84 GW, equivalent to 22.6% of final renewable electricity installed capacity in the EU. Italy experienced the fastest deployment of solar photovoltaic technology between 2005 and 2015. The peak of this deployment took place in 2011, when solar photovoltaic capacity in Italy represented more than 84% of new installed renewable electricity in that year. In 2015 the annual solar photovoltaic market dropped in Germany and in Italy, to 1.6 GW and only 0.3 GW respectively. The United Kingdom saw the highest annual growth in solar photovoltaics in 2015, with that technology contributing more than two thirds of the new installed capacity in that year and almost half of newly photovoltaic capacity in the EU.

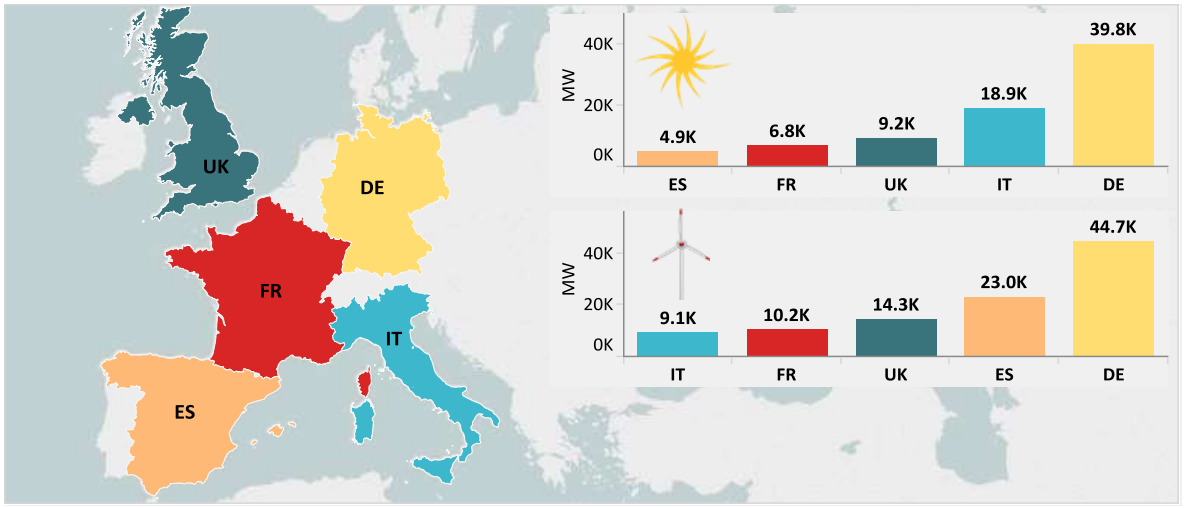

Figure ES- 6. Top five EU MS in solar electricity and wind power installed capacity, 2015

The deployment of renewable energy in electricity sector will continue to expand significantly towards 2030 with wind power and solar technologies dominating the scene.

Towards 2030 the share of renewable energy in electricity sector is projected to top at almost 50% of gross final electricity consumption. Wind power and solar are projected to cover almost two-thirds of final renewable electricity in the EU. Germany will maintain its place as a leader in the deployment of these two technologies. Spain is projected to be the second largest contributor in solar photovoltaic followed by Italy, France and United Kingdom. The deployment of wind power is projected to see the United Kingdom as the second market followed by France, Spain and Italy.

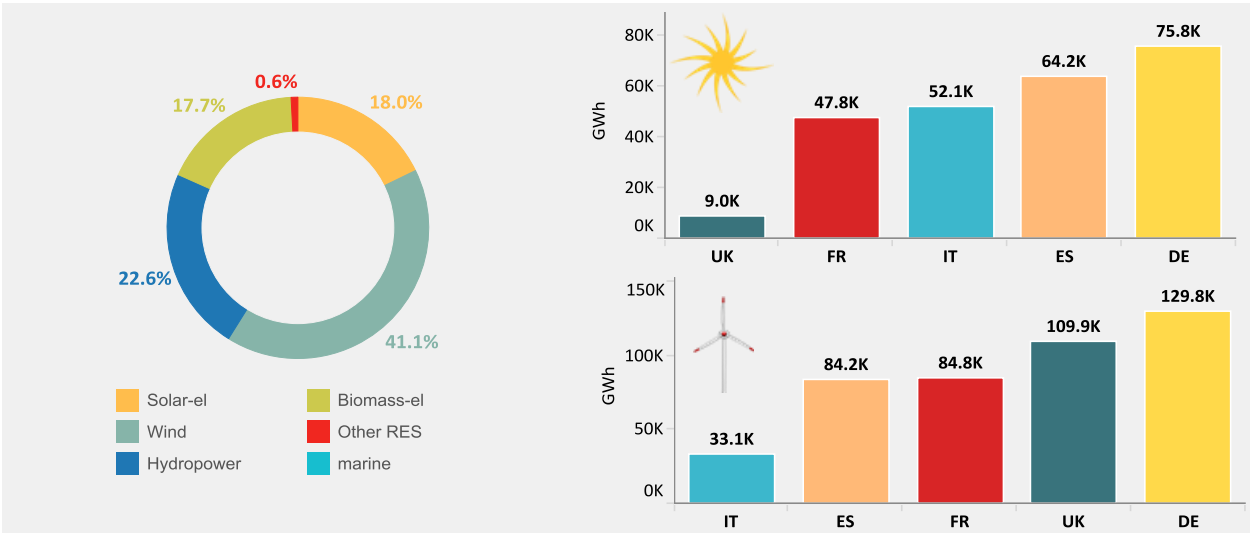

Figure ES- 7. Top five EU Countries in renewable electricity from solar and wind power, 2030 (EUCO27 scenario)

More on recent trends and developments in the EU

Box 1. Wind power and solar photovoltaic in the EU, 2016

In 2016 renewable electricity capacity in the EU accounted for 86% of all new power installations: a total of 21.1 GW from 24.5 GW of new power capacity. In the same year, wind power was installed more than any other form of power generation in Europe accounting for 51% of total power capacity installations.

- There are now 153.7 GW of installed wind power capacity in the EU: 141.1 GW onshore and 12.6 GW offshore;

- 12.5 GW of new wind power capacity was installed and grid-connected in the EU during 2016, a decrease of 3% compared to 2015 annual installations;

- With a total installed capacity of 153.7 GW in 2016 (sharing 17% of EU's total installed capacity) wind energy has now overtaken coal as the second largest form of power generation capacity in Europe;

- 10.9 GW of new onshore wind , and 1.6 GW of new offshore wind was installed in 2016;

- With almost 300 TWh generated in 2016, wind power covered 10.4 % of the EU's electricity demand;

- €27.5 billion were invested in 2016 to finance wind energy development. This was 5% more than the total investment in 2015;

- Germany was the largest market in new wind power capacity installations, with 44% of the total EU installations followed by Spain, the UK and France. 16 EU Member States have more than 1 GW wind power installed and nine of these have more than 5 GW installed. Five EU Member States had a record year in new wind energy installations in 2016: France (1.6 GW), the Netherlands (887 MW), Finland (570 MW), Ireland (384 MW) and Lithuania (178 MW).

Summarized from "Wind in Power, 2016 European Statistics" [19]

In 2016 the capacity of new connected solar photovoltaic systems in the EU decreased by 21% to about 5.8 GW. There are now solar photovoltaic systems with a capacity of 101.7 GW in the EU. 5.8 GW of new solar photovoltaic power capacity was connected to the grid in the EU during 2016, a decrease of 21% compared to 2015 annual connections.

- With a total capacity of 102 GW in 2016 solar photovoltaic power accounts for about 11% of Europe's total installed capacity in the EU;

- The estimated electricity generation of 110 TWh in 2016 covered 3.8 % of the EU's electricity demand;

- The UK was the country which connected most of the new solar power capacity, with 36% of the total EU connections followed by Germany, France, the Netherlands and Italy;

- 12 EU Member States have more than 1 GW solar photovoltaic power installed, out of which five have more than 5 GW installed.

Summarized from "Snapshot on PV in March 2017" [20]

Box 2. Finland National Energy and Climate Strategy

FINLAND 

On 24th November 2016 the Finnish Government published its new Energy and Climate Strategy.

The National Energy and Climate Strategy outlines the actions that will enable Finland to attain the targets specified in the government programme and adopted in the EU for 2030, and systematically set course to achieve an 80-95% reduction in greenhouse gas emissions by 2050. With minor exceptions, Finland will phase out the use of coal for energy. The share of renewable transport fuels will be raised to 40% by 2030, and an obligation will be introduced to blend light fuel oil used in machinery and heating with 10% of bioliquids. The minimum aim is to have 250 000 electric and 50 000 gas-powered vehicles on the roads. The electricity market will be developed at the regional and the European level. The flexibility of electricity demand and supply and, in general, system-level energy efficiency, will be improved. Technology-neutral tendering processes will be organised in 2018-2020, on the basis of which aid will be granted to cost-effective new electricity production from renewable energy. The use of renewable energy will be increased in a sustainable way so that its share will rise to more than 50% during the 2020s and self-sufficiency in renewable energy will rise to more than 55%. The domestic use of imported oil will be halved as planned. The greatest non-ETS sector reductions in emissions will be achieved in the transport sector: this will be the foundation for the medium-term climate policy plan of 2017.

Summarized from "Finland National Energy and Climate Strategy, November 2016" [21]

Box 3. Germany Renewable Energy Act (EEG)

GERMANY 

In 2016, the German Government amended the Renewable Energy Act, the EEG 2017, and other important energy regulations. The core change to the Renewables Energy Act is that support for renewable energy projects will now be mostly determined by market mechanisms by means of an auction system, rather than being fixed by the government through the feed-in tariff system. According to the German Government, this new auction system will ensure that the expansion of renewables proceeds at a steady and controlled pace and at low cost. The EEG 2017 entered into force in January 2017. The most important elements of the newest Renewable Energy Act (EEG 2017) are:

- EEG 2017 reaffirms the objectives of renewable energy development in Germany. Like the former Act (EEG 2014), it calls for a rise in the share of renewables in gross electricity consumption from 32.3% in 2016 to 40-45% by 2025, to 55-60% by 2035, and to at least 80% by 2050;
- Starting in 2017, a competitive auction system will be the main instrument for financing large wind energy, photovoltaic and biomass projects. Funding for renewables will be determined by competitive bidding for a market premium that will be guaranteed for a period of 20 years from the start of energy production.
- The auction system covers onshore and offshore wind farms and solar power installations with an installed capacity of over 750 kilowatts, as well as biomass plants with an installed capacity of over 150 kilowatts
- The feed-in tariff system has been preserved for small installations. Consequently, the private operators of small rooftop photovoltaic installations are practically unaffected by the new auction system. However, the German government assumes that more than 80% of future added capacity will be put to tender.

Renewable energy goals of German government for period 2020-50 define an overall renewable energy share to 30% in year 2030, to 45% in 2040 and to 60% in 2050.

Summarized from "German Renewable Energy Act (EEG 2017)" [22] and "Renewable Energy Sources in Figures, 2015" [23]

Box 4. France Multiannual Energy Plan

FRANCE 

The multiannual energy plan (MEP), established by the French Energy Transition For Green Growth Act, sets out the government's strategic priorities in terms of energy policy. This MEP is consistent with the national low-carbon strategy adopted in October 2015, and is a vital tool for the implementation of the Paris Climate Agreement. The MEP sets out two fundamental priorities: reducing energy consumption, particularly fossil fuel consumption, and developing renewable energy sources.

The MEP is initially divided into two periods (2016-2018 and 2019-2023), and will be reviewed in 2018. MEP results by 2023: (i) Increase installed electricity generation capacity from renewable sources by over 70 % and (ii) increase renewable heat generation by 35 % compared to their 2014 levels, to reach France target of 32% of final energy consumption from renewable sources by 2030; (iii) reduce energy consumption in the transport sector by 11.5 %.

The MEP targets imply total renewable energy capacity of 69980 MW in the low scenario, and 76743 MW in the high scenario by 2023; delivering 150 and 167 TWh renewably sourced electricity per year respectively. For all technologies, MEP gives a clear and ambitious vision of RES development. For solar and onshore wind energy, the MEP targets are going to double the current rhythm [annual rate of installation]: for solar from 1000 to 2000 MW, and for onshore wind from 1000 to 1800 MW. By 2018 a capacity of 10200 MW in expected to have been installed in France and by 2023 this capacity will range from 18200 MW to 20200 MW. The onshore wind targets are set to 15000 MW in 2018 and between 21800 MW and 26000 MW by 2023. The offshore wind targets pitched for just 500 MW by 2018 and between 3000 MW and 6000 MW by 2023.

With renewable capacity expanding in recent years, the MEP scenarios are roundly expected to add to investor and developer confidence that France will remain an attractive country for new capacity going into the next decade. Alongside goals for enhanced electrification, continued demand for renewable energy in France is expected to be secured by national policy to reduce the share of nuclear power in electricity production from about 75 percent to 50 percent by 2025.

Summarized from "Décret no 2016-1442 du 27 Octobre 2016" [24] and Programmation Pluriannuelle de l'Energie, 2016 [25]

Box 5. Solar photovoltaic in Italy

ITALY 

Italy registered a new solar photovoltaic capacity of 84.1 MW in the first quarter of 2017, according to preliminary data released by Italian renewable energy association Anie Rinnovabili. This compares to 90 MW and 83 MW in the first and fourth quarter of 2016 respectively. In March 2017, new additions totalled 32.6 MW, while in February and January new solar photovoltaics capacity was 25.8 MW and 25.7 MW, respectively. The segment for solar photovoltaic systems ranging in size from 4.5 kW to 6 kW account for most of the photovoltaic power installed so far this year with 15.2 MW, followed by installations with a capacity between 20 kW and 100 kW (14.4 MW), systems with a size between 10 kW and 20 kW (12.3 MW), and projects between 200 kW and 500 kW (11.5 MW). Only 3.6 MW of new capacity was installed in the category for photovoltaic systems ranging in size from 500 kW to 1 MW. The regions with the largest share of solar photovoltaic in the first three months of 2017 were Lombardia (13.1 MW), Veneto (11.7 MW) and Emilia-Romagna (9.8 MW), all located in the North of the country. Sicily, which is Italy's southernmost region, occupies the fourth position with 8.6 MW of new photovoltaic installations. Meanwhile, the Italian grid-operator Terna reports that solar was able to cover around 8.8% of the country's electricity demand in March with 2 319 GWh. This was up 27.9% compared to the same month of 2016. Moreover, Terna reports that all photovoltaic installations spread across Italy were able to generate 4 592 GWh in the first quarter of 2017 (up 15% Year-on-Year), thus meeting 5.8% of total demand. Taking into account last year's newly installed solar photovoltaic capacity, which was around 369 MW, and new additions for the first three months of 2017, the country should have reached approximately 19.3 GW of installed solar capacity at the end of March 2017.

Source: PV Magazine [26]

Reporting under Renewable Energy Directive

As laid down in Article 4 of the Renewable Energy Directive (RED) [3], the EU Member States had to prepare **national renewable energy action plans** (**NREAPs**) [4] showing how they were going to reach the renewable energy targets in the electricity, heating/cooling and transport sectors. In their NREAPs, they also had to state the measures they had in place or were planning to achieve their national overall renewable energy targets. The Member States submitted their NREAPs in the course of 2010. Their content was summarised and presented in two previous JRC reports [9], [10].

A Commission decision of 30 June 2010 established a harmonised template [5] for reporting under Article 4 of the RED, making it possible to compare data from different Member States. Moreover, under Article 22 of the RED, each Member State has to submit to the European Commission every 2 years a progress report [6] on the developments in renewable energy sources in that country compared with the interim targets in its NREAP. These progress reports cover the years 2010-2020. The European Commission drew up a template [7] to ensure that the Member State progress reports were complete, covered all Article 22 requirements and were comparable with each other and with the NREAPs. The progress reports have to include the following:

- the contribution expected from energy efficiency and energy saving measures;
- the total contribution expected from each renewable energy technology towards meeting the binding 2020 targets; and
- an indicative interim trajectory for achieving the respective shares of energy from renewable resources in electricity, heating/cooling and transport.

In addition, the Member States have to report on their policies and the measures taken to promote the use of energy from renewable resources in the three sectors mentioned above. They also have to include a section on the sustainability scheme for biofuels and bioliquids consumed in the EU and the economic, social, and environmental consequences of that consumption.

To assist the EU Member States in preparing their biennial progress reports, Eurostat designed the SHARES Tool [8], which offers harmonised calculation of the share of energy from renewable sources. However, this tool does not replace the legal obligations laid down in Articles 22 and 23 of the RED[3].

Article 5 of the RED sets out the methodology for calculating the share of energy from renewable sources. According to that article, the gross final consumption of energy from renewable sources should be the sum[4] of:

- gross final consumption of electricity from renewable energy sources;
- gross final consumption of energy from renewable sources for heating/cooling; and
- final consumption of energy from renewable sources in transport.

Other issues on Member State reporting under the Renewable Energy Directive

- The progress report template includes reporting on the gross electricity production in mixed hydro plants [5] without electricity production due to pumped storage. This hydropower sub-category is not part of Table 10a and Table 10b of the NREAP template[6], putting some limitations on the comparison of gross electricity consumption from

[3] More on definitions and methodology used to report at Eurostat SHARES Tool read SHARES Tool Manual at http://ec.europa.eu/eurostat/web/energy/data/shares

[4] When calculating the share of gross final consumption of energy from renewable sources, gas, electricity and hydrogen from renewable energy sources should be considered only once in gross final consumption of renewable electricity, gross final consumption of renewable heat/cold or final consumption of renewable energy in transport.

[5] Mixed hydro plants are those plants which can be used for two purposes: for pumped storage and to generate genuine additional electricity from hydro power.

[6] Mixed hydro plants were not included as a separate hydropower sub-category in the NREAP template. In the template it is not specified under which hydropower sub-category such plants have to be included. Nine Member States report for this sub-category: BG, DE, EL, ES, FR, IT, AT, PL and PT.

renewable energy sources. In capacity terms, the contribution of mixed hydro plants is not included.

- In the case of some Member States, the values they reported for biomass[7] use in the electricity and heating/cooling sectors in their biennial progress reports to the Commission differed from those reported in the SHARES Tool. In their reporting for the electricity and heating/cooling sectors, 10 Member States reported different values for solid biomass electricity and solid biomass-thermal:
  - Electricity sector: CZ, DE, ES, LT, LU, CY, HU, PT, RO and FI. Luxembourg's reporting on solid biomass electricity for 2014 (i.e. in the 2015 progress report) differs from the reporting in the SHARES Tool for 2014. For biomass electricity, Cyprus reported higher values for solid biomass electricity in the SHARES Tool compared with its 2015 progress report, in which higher values of biogas were found. Romania reported a higher value for solid biomass in its 2015 progress report compared with the SHARES Tool, in which no data on waste[8] (renewable) were found. The other Member States did not include waste (renewable) in their reporting on biomass electricity in their progress reports.
  - Heating/cooling sector: BG, DE, LT, LU, HU, PL, RO, FI, SE and UK. Luxembourg, Hungary, Romania and Sweden reported higher values for solid biomass-thermal in their 2015 progress report compared with the SHARES Tool. The other Member States did not include waste (renewable) in their 2015 progress reports.
- Cyprus reported on the contribution of geothermal and heat pumps to final renewable heat/cold in different ways in its biennial progress report and in the SHARES Tool. In its progress report, Cyprus reported the contribution of geothermal as 'geothermal heat pump' whereas in the SHARES Tool this contribution is reported as 'geothermal thermal'.

[7] Article 2 of the RED defines biomass as 'the biodegradable fraction of products, waste and residues from biological origin from agriculture (including vegetal and animal substances), forestry and related industries including fisheries and aquaculture, as well as the biodegradable fraction of industrial and municipal waste'.

[8] According to Article 2(1)(p) of Directive 2015/1513 'waste' is defined as in Article 3(1) of Directive 2008/98/EC of the European Parliament and of the Council; substances that have been intentionally modified or contaminated to meet that definition are not covered by this definition;

About this report

The first wave of EU Member State biennial progress reports, which provided data for 2009-2010 and 2011-2012, was analysed by JRC in a previous set of publications [9], [10], [11], [12], [13], [14], [15] and [16]. This report, which is based on the data reported by EU Member States under Renewable Energy Directive, updates the information in the previous report [14] with data from the third wave of progress reports, for 2013 and 2014. Member States' reporting to the Eurostat SHARES Tool complements the analysis for 2015.

The first part of the report presents a *snapshot of the energy mix in the EU and a deeper analysis of the current situation for (i) the deployment of renewable energy; (ii) deviations from the aggregated NREAPs plans in each sector, for each source/technology; (iii) progress towards 2020 targets/plans; (iv) projected deployment of renewable energy until 2030.*
The *second part* summarises the Member States' overall contribution to renewable energy since in 2005*: (i) the situation up to 2015; (ii) deviations from their plans in the NREAPs; (iii) progress towards their 2020 targets/plans; (iv) projected deployment of renewable energy until 2030.*

Indicators assessed

- overall renewable energy share in the EU and the shares of renewables in electricity, in heating/cooling and in transport;
- final renewable energy consumption[9] in the EU and in each Member State, as well as in each sector i.e. heating/cooling, electricity and transport;
- the deployment of (i) renewable energy sources [10] in both electricity and heating/cooling (i.e. biomass, geothermal energy and solar energy): and (ii) of biofuels used in transport in each Member State;
- renewable energy sources (both installed capacity and electricity production) in the electricity sector (hydropower, geothermal, solar, marine, wind and biomass);
- renewable energy sources in heating/cooling (geothermal, solar, biomass and heat pumps);
- renewable energy use in transport[11] (bioethanol/bio-ethyl tert-butyl ether (ETBE), biodiesel, other biofuels, biofuels as defined in Annex IX[12] of RED and renewable electricity[13]);
- projections for EU and each Member State from EUCO27 scenario: (i) final renewable energy consumption[14]; (ii) overall renewable energy share; (ii) shares of renewables in electricity, heating/cooling and transport; (iii) final renewable electricity (both installed capacity and generation); (iv) renewable electricity sources in the electricity sector.

Data sources

Since 2011, JRC has kept a database of EU Member State reporting under the Renewable Energy Directive, sourced by national renewable energy action plans (NREAPs) and biennial progress reports. The database is updated each time the next wave of reports is released by Member States or when an NREAP is updated.

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[9] For the commodity of the reader the sum of final renewable electricity, final renewable heat/cold and final renewable enery in transport sector is called "final rebewable energy consumption". This "consumption" is the sum of: hydropower, wind, geothermal-el, solar-el, biomass-el, geothermal-th, solar-th, biomass-th, heat pumps, bioethanol-bio/ETBE, biodiesel, other biofuels and renewable electricity in transport.
[10] For the EU and each Member State, the share of renewable energy sources/technologies is calculated towards the final renewable energy, which differs from the share of renewable energy sources/technologies in final consumption of renewable energy (see the definition in Footnote 9). Final renewable energy is calculated as the sum of all renewable energy sources taken into account only once.
[11] Biofuels are divided into sub-categories (bioethanol-bio/ETBE, biodiesel and other biofuels) based on the ratio between biogasoline, biodiesel and other liquid biofuels, as reported by Member States in Eurostat oil and renewables questionnaires. For the EU the aggregated values for each sub-category are used to calculate the final consumption of energy in this sector.
[12] The amendment of Directive 2009/28/EC by Directive 2015/1513 includes the addition of Annex IX, which sets out a new detailed list of feedstocks and fuels which are to be counted double towards the transport target.
[13] Member States reported as required under Article 3(4)(c) of Directive 2009/28/EC
[14] Available in the EUCO27 scenario is the gross inland consumption of renewable energy. A factor of 1.078 is applied to calculate the final consumption of renewable energy for EU as a whole and for each Member State.

JRC updated this database in 2016 following the release of the 2013-2014 progress reports, due for end-2015 but actually completed in mid-2016. JRC is now preparing the synthesis reports, looking ahead to the release of the next set of progress reports covering the period 2015-2016, which are expected for end-2017. Only three Member States (BG, DE and IT) updated the reporting for the period 2009-2012 in their 2015 progress reports. Austria and Croatia reported an updated deployment of renewable energy for the period 2011-2012 in their 2015 progress reports. No updates were available in 2015 progress reports from the rest of the Member States. Hungary did not report in its 2015 progress report on renewable energy deployment in 2014.

This database also includes the updates and the latest figures that Member States prepare in their reporting to Eurostat through the SHARES Tool[15]. As the NREAPs are now outdated for some Member States, this report makes use of renewable energy deployment projections sourced from the EU reference scenario 2016[16] and EUCO27 scenario[17] to complement the picture for 2020 and provide projections until 2030.

Data publishing and visualization

The JRC renewable energy database is easily accessible to the public through the Data Portal[18] for NREAPs and progress reports, which is an interactive tool for comparing the renewable energy data provided by each EU Member State as required under the RED. Users can access and download more than 30 000 raw data and 60 indicators for each country, covering three sectors: electricity, heating/cooling and transport. The tool also features dashboards on current status and expected developments in each Member State, as well as the impact on greenhouse gas emissions reduction.

How to read this report

This report presents the analysis of a large amount of data on renewable energy in the EU, following two main approaches:

- (i) an absolute increase/decrease, over the whole period under review, in a certain indicator or source during a multiannual or annual period, (ii) comparison with expected figures for a certain year and (iii) progress towards 2020;
- (i) a relative increase/decrease in a certain indicator or source during a multiannual or annual period, (ii) comparison with expected figures for a certain year and (iii) progress towards 2020. The type of relative growth rate (annual or average) used is always highlighted in the text.

Overall RES share current trajectory forecast

The achieved overall renewable energy share during period 2005-2015 is extrapolated using an exponential smoothing algorithm that tends to find a regular pattern in the data, showing how the achieved trend of this indicator can progress under the same conditions.

Tableau software [27] is used to forecast of current trend of overall renewable energy share in each EU Member State as well as for the whole EU. The software automatically selects the best of up to eight models; the best being the one that generates the highest quality forecast.

Each model smoothing parameters are optimized before Tableau assesses forecast quality. The optimization method is global. Therefore, choosing locally optimal smoothing parameters that are not also globally optimal is not impossible. However, initial value parameters are selected according to best practices but are not further optimized. So it is possible for initial value parameters to be less than optimal. Exponential smoothing models iteratively forecast

[15] The EU Member States reporting to Eurostat SHARES Tool includes the figures for renewable energy deployment, updated every year since 2004. This report is sourced from the updated data reported by EU Member States to the Eurostat SHARES Tool in March 2017.
[16] EU Reference Scenario 2016 https://ec.europa.eu/energy/en/data-analysis/energy-modelling
[17] EUCO scenarios: https://ec.europa.eu/energy/en/data-analysis/energy-modelling
[18] NREAPs and progress reports Data Portal - https://ec.europa.eu/jrc/en/scientific-tool/nreap-data-portal

future values of a regular time series of values from weighted averages of past values of the series.

The simplest model: simple exponential smoothing (SES) computes the next level or smoothed value from a weighted average of the last actual value and the last level value. The method is exponential because the value of each level is influenced by every preceding actual value to an exponentially decreasing degree—more recent values are given greater weight.

Three ways of extrapolation are used for to forecast the overall renewable energy share in each EU MS up to 2020: (i) automatic; (ii) additive and (iii) multiplicative. To this forecast it is added also the (iv) linear extrapolation of overall renewable energy share. An additive model is one in which the contributions of the model components are summed, whereas a multiplicative model is one in which at least some component contributions are multiplied. Running the software in automatic mode has determined if a multiplicative or an additive forecast was appropriate for our data.

Country	AUTOMATIC Initial 2016			MULTIPLICATIVE Initial 2016			ADDITIVE Initial 2016			MODELD APPLIEDD
UK	9.7	±	3.7	9.7	±	3.6	8.96	±	1.18	Linear
SK	13.4	±	2.0	13.4	±	2	13.04	±	1.43	Linear
SI	23.5	±	3.4	23.5	±	3.4	22.65	±	2.87	Additive
SE	54.5	±	2.1	55.6	±	3.4	55.27	±	2.91	Linear
RO	25.9	±	2.4	26.6	±	3	25.91	±	2.4	Additive
PT	28.5	±	1.7	28.7	±	2.1	28.51	±	1.73	Additive
PL	12.3	±	1.0	12.9	±	1.5	12.34	±	1.04	Linear
NL	5.9	±	1.0	6.3	±	1.3	6.08	±	0.74	Linear
MT	6.1	±	1.2	8.1	±	8.3	6.1	±	1.21	Additive
LV	37.3	±	4.5	38.4	±	4.6	38.2	±	4.04	Multiplicative
LU	5.1	±	1.1	5	±	2.1	5.11	±	1.05	Linear
LT	26.4	±	2.3	26.4	±	2.3	26.54	±	2.01	Linear
IT	20.1	±	2.1	20	±	4.2	18.83	±	2.13	Additive
IE	9.8	±	0.6	10.6	±	2.3	9.75	±	1.03	Linear
HU	16.5	±	3.6	20.8	±	7.9	16.46	±	3.61	Additive
HR	29.4	±	2.4	29.4	±	2.4	29.19	±	2.1	Additive
FR	16.0	±	2.0	16	±	1.9	15.62	±	1.56	Multiplicative
FI	41.5	±	2.5	41.5	±	2.5	41.17	±	2.08	Linear
ES	17.6	±	1.1	17.9	±	2.6	17.15	±	1.64	Linear
EL	17.7	±	3.2	17.7	±	3.2	16.44	±	2.13	Additive
EE	29.1	±	3.4	30.2	±	4.8	29.06	±	3.36	Automatic
DK	32.8	±	1.4	33.2	±	3.7	32.92	±	2.32	Linear
DE	14.5	±	0.8	15.7	±	2.8	15.14	±	1.64	Linear
CZ	17.0	±	1.0	16.9	±	2.3	15.98	±	1.49	Additive
CY	10.6	±	2.3	10.6	±	2.3	9.86	±	1.14	Linear
BG	19.4	±	2.4	20.7	±	3.5	19.41	±	2.42	Automatic
BE	8.9	±	0.8	10.1	±	3.1	8.76	±	1.1	Linear
AT	34.4	±	2.2	34.6	±	2.8	34.35	±	2.24	Linear
EU	17.6	±	0.6	17.9	±	1.9	17.4	±	1.25	Additive

Introduction

Directive 2009/28/EC established a regulatory framework for promoting the use of energy from renewable sources, setting binding national targets for the share of renewable energy sources in energy consumption and transport to be met by 2020. A Commission Communication of 22 January 2014 established a framework for future EU energy and climate policies and promoted common understanding of how to develop those policies after 2020. In October 2014 the European Council agreed on the 2030 climate and energy policy framework for the EU setting an ambitious economy-wide domestic target of at least 40% greenhouse gas emission reduction for 2030; a biding target at EU level of at least 27% for the share of renewables in Gross final energy consumption in 2030 and an indicative target at EU level of at least 27% for improving energy efficiency in 2030 compared to projections of future energy consumption.

Since the last JRC snapshot report [14], the EU energy policy content has evolved towards a strategy to make Europe's energy landscape more secure, sustainable and competitive. The Paris Agreement that entered into force on 4 December 2016 includes a long-term goal to put the world on track to limit global warming to well below 2°C above pre-industrial levels, and to pursue efforts to limit the temperature increase to 1.5°C. The European Commission has already brought forward key proposals to implement the EU's target to reduce greenhouse gas emissions by 2030. In 2015, it presented a proposal to reform the EU emissions trading system (EU ETS) [17] to ensure that the energy sector and energy-intensive industries deliver the emission reductions needed. In summer 2016, the Commission brought forward proposals for accelerating the low-carbon transition in the other key sectors of the European economy [18].

On 30 November 2016 the European Commission presented the 'Clean Energy for All Europeans' package [2] (the Winter Package). This package consists of numerous legislative proposals together with accompanying documents, aimed at further completing the internal market for electricity and implementing the Energy Union. Part of this package is the recast of Renewable Energy Directive [28] complementing the Energy Union governance by creating the conditions across the three sectors (electricity, heating/cooling and transport) to make it easier to meet the EU 2030 target collectively. According to the new proposal the minimum target of 27% share of renewable energy in gross final consumption set for 2030 is binding at the EU level, but will not be translated into nationally binding targets. Nevertheless the proposal provides flexibility for Member States to implement the envisaged actions and develop the renewable energy sector that corresponds best to their national situation, preferences and potential, provided they at least collectively reach the 2030 target. The contribution of biofuels, bio-liquids and biomass fuels consumed in transport, if produced from food or feed crops, to the calculation of a Member State's gross final consumption of renewable energy is limited to 7% of the final consumption of energy for road and rail in that Member State by 2020.

The European Commission's policy decisions are underpinned by thorough analyses and impact assessments. A wide range of mathematical models and tools are used to explore policy proposals and evaluate their potential energy, transport, economic, social and environmental consequences. Models assess the effectiveness of policies already in place as well as the likely impact of policy proposals.

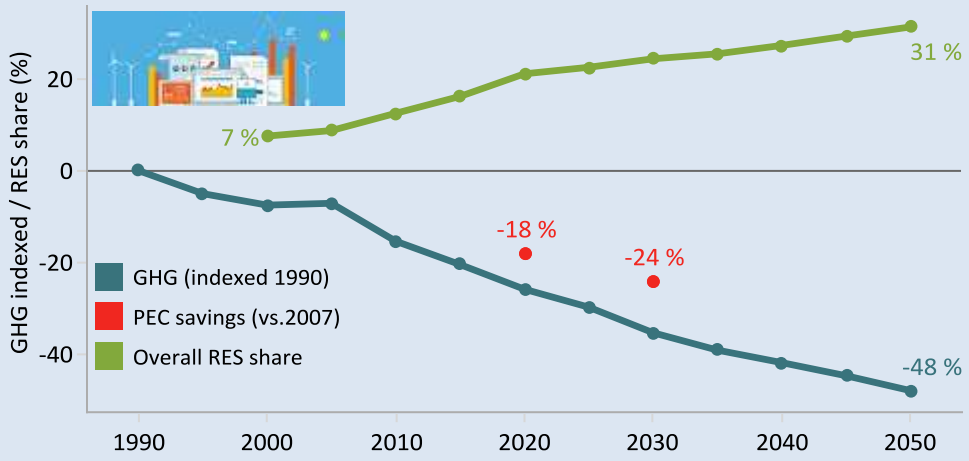
The starting point of the energy modelling is the EU Reference Scenario 2016 [29] projections for indicators such as the share of renewable energy sources or levels of energy efficiency over a five-year period until 2050 for the EU as a whole and for each EU country. Nevertheless the EU Reference Scenario 2016 is not designed as a forecast of what is likely to happen in the future. It rather provides a benchmark against which new policy proposals can be assessed. Using the EU reference Scenario as starting points, EUCO27 and EUCO30 scenarios [30] are created to model the achievement of the 2030 climate and energy targets as agreed by the European Council in 2014 (the first scenario has a 27% energy efficiency target and the second a 30% energy efficiency target).

Box 6. The EU Reference Scenario 2016 and EUCO27, EUCO30 scenarios

The EU Reference Scenario 2016 (REF2016) is set up to meet the binding energy and climate targets for 2020. However, it shows that:

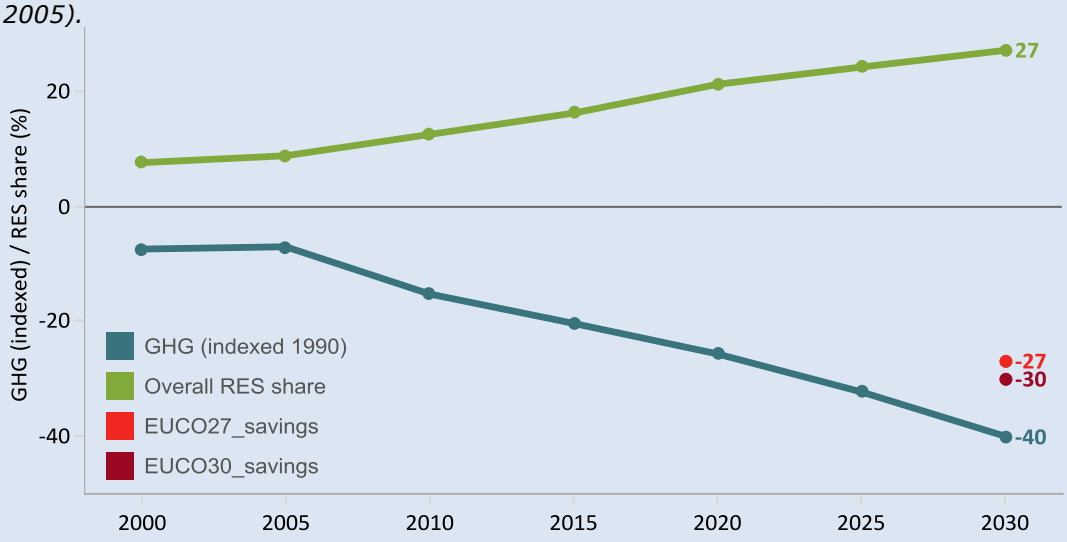
- *Current policies and market conditions will deliver neither our 2030 targets nor our long-term 2050 objective of 80 to 95% GHG emission reductions;*
- *In addition based on current market trends and adopted policies, the energy efficiency 2020 non-binding target is not met in REF2016, the scenario projecting a reduction in primary energy savings (relative to the 2007 baseline) of 18% in 2020 and 24% in 2030 respectively;*

  GHG emissions from sectors covered by the Effort Sharing Decision are projected to decrease by 16% in 2020 and by 24% in 2030 below 2005 levels, less than emissions in sectors covered by the EU emissions trading system.



The EUCO27 scenario is designed to meet all 2030 targets set by the European Council:

- *At least 40% GHG reduction (wrt 1990);*
- *At least 27% share of RES in final energy consumption;*
- *27% primary energy consumption reduction (i.e. achieving 1369 Mtoe in 2030) compared to the PRIMES 2007 baseline (1887 Mtoe in 2030). This equals a reduction of primary energy consumption of 20% compared to historic 2005 primary energy consumption (1713 Mtoe in 2005).*



Source: Energy Modelling EU https://ec.europa.eu/energy/en/data-analysis/energy-modelling

The European Union

After having reached in 2014 the lowest levels since 1990, gross inland consumption of energy (GIC) in the EU increased by 1.2% (+7.9 Mtoe) in 2015. However, at 1 626 Mtoe[19], it remained below the 1990 level. GIC of renewable energy in the EU this year stood at 210 Mtoe[20] or almost 13% of the EU GIC, increasing by 4% (+7.9 Mtoe) from 2014. The share of solid biofuels remained at the 2014 levels whereas gas increased from 21.4% to 22%. Total petroleum products and nuclear decreased their relative contributions compared with 2014, reaching 16.2% and 13.6% respectively (Figure 1). Most EU Member States increased their GIC compared with 2014 especially Italy, Spain and France. Only eight Member States decreased their GIC in this period, among which Sweden had the largest decline.

The energy intensity of the economy continued its downward trend, reaching 120 toe/million EUR in 2015, a decrease of 19.3% since 2005. The import dependency ratio[21] reached 54.1% in 2015, higher than in the last 3 years and near to the 2011 value. In 2014 greenhouse gas emissions[22] reached 4 419 Mt CO_2 eq, 22.9% below the emissions in the baseline year. With greenhouse gas emissions of 2 432 Mt CO_2 eq the energy sector decreased its share to 55%. In 2014 the role of renewable energy resulted resulted in a net savings of greenhouse gas emissions of 691 Mt CO_2 eq, with an additional 233.5 Mt CO_2 eq since 2009.

At 1 529.3 Mtoe the EU's primary energy consumption has decreased by 10.7% since 2005, and is 3.1% (46.6 Mtoe) above the 2020 primary energy consumption target[23]. Final energy consumption (FEC) in the EU was equal to almost two thirds (66.5%) of GIC, at 1 082 Mtoe in 2015, showing that almost 34% of final consumption is in non-energy consumption, transformation losses, consumption in the energy sector, distribution losses and other exchanges, transfers and returns. Among energy sources, solid fuels accounted for almost 40% of FEC in the EU, while the share of renewables stood at 7.9% (Figure 1). In 2015 buildings had the highest share (38.9%) of FEC followed by transport (33.1%) and industry (25.3%)[24]. Only five MS decreased their FEC during period 2014-2015, the highest drop being in Finland. France experienced the largest increase in its FEC in this period together with Germany and Italy.

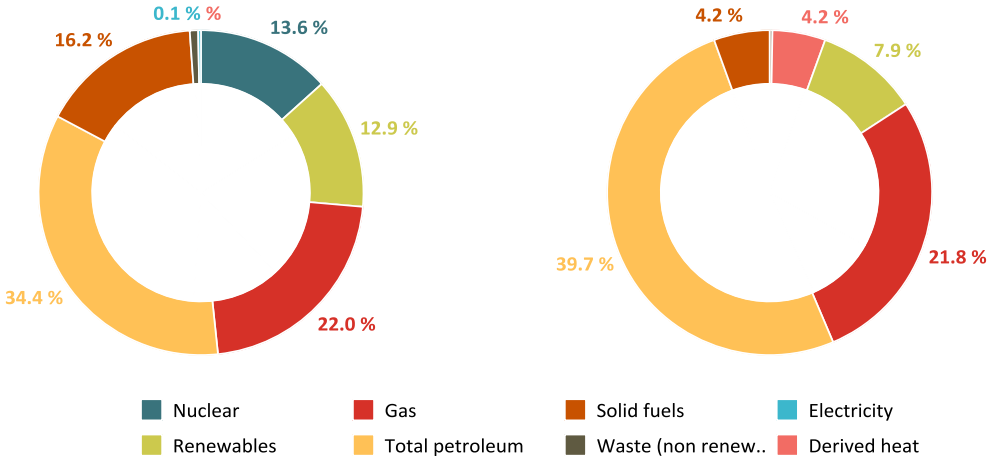


Figure 1. Breakdown of Gross Inland Consumption of Energy (left) - Final Energy Consumption (right) in the EU, 2015

[19] The drop in gross inland consumption of energy in the EU was larger that what was projected in the EU Reference scenario 2016 (1 667 Mtoe in 2015). The projection for this indicator shows that the GIC in the EU is estimated at 1 639 Mtoe in 2020, dropping to 1 554 Mtoe in 2030.

[20] Gross inland consumption of renewable energy in the EU for 2015 was projected at 206.4 Mtoe in the EU Reference scenario 2016. The projections for 2030 are set at 267 Mtoe.

[21] Note: A dependency rate in excess of 100% indicates that energy products have been stocked.

[22] GHG emissions exclude LULUCF (land use, land use change and forestry), including indirect CO_2 and int.aviation. Energy related GHG emissions don't include emissions from transport. GHG emissions from transport include emissions from international aviation. As such these indicators are used for each MS.

[23] The 2020 energy efficiency target for the EU primary energy consumption is 1483 Mtoe and for final energy consumption 1086 Mtoe (European Council Conclusions of 23 and 24 October 2014, EUCO 169/14)

[24] Final energy consumption by sector in the EU in 2015 remained below the projections foreseen in the EU Reference scenario 2016. In 2015 final energy consumption in industry sector was 273.8 Mtoe (284.5 Mtoe projected), in residential sector was 274 Mtoe (299.7 Mtoe projected), in transport sector was 358.6 Mtoe (380.8 Mtoe projected) and in tertiary sector was 170.7 Mtoe (188.3 Mtoe projected)

Final renewable energy consumption

Final renewable energy[25] consumed in the EU increased from 111 Mtoe (4657 PJ) in 2005 to 189 Mtoe (7909 PJ) in 2015. In that year almost half of final renewable energy was consumed in heating/cooling sector and the rest was in electricity sector (42.2%) and transport sector (7.9%). Compared to the aggregated values foreseen in the NREAPs, the final renewable energy consumption was above that planned throughout the period 2010-2015.

Final renewable energy consumption in the EU is expected to further increase to 248.2 Mtoe (10 392 PJ) by 2020. The heating/cooling sector will remain the main source of renewable energy in the EU with a share of 45.1%. The transport sector is expected to consume 13% of final renewable energy whereas the electricity sector's relative contribution will remain unchanged. The EUCO27 scenario for 2020 is in line with aggregated NREAPs projecting final renewable energy consumption at 249 Mtoe (10 432 PJ). For 2030, this projection gives a final consumption of renewable energy at 291 Mtoe (12 202 PJ).

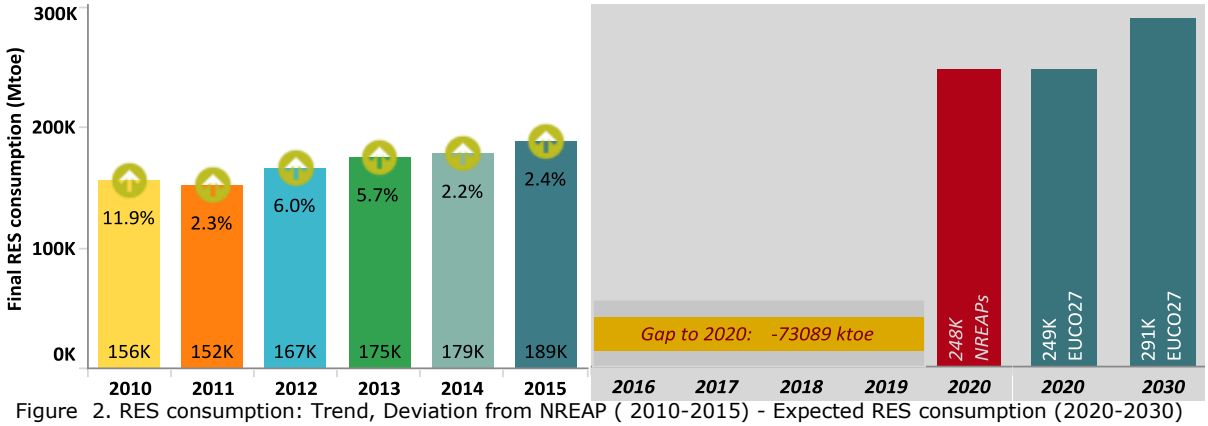


Figure 2. RES consumption: Trend, Deviation from NREAP (2010-2015) - Expected RES consumption (2020-2030)

Renewable energy share

The overall renewable energy contribution in gross final energy consumption in the EU continues its increasing trend reaching 16.7% in 2015 from 8.98% in 2005. The 2020 target of overall renewable energy share in the EU calculated from the aggregated NREAPs is 20.6%, slightly over the legally binding target of 20%. According to the EUCO27 scenario the overall renewable energy share in the EU is projected to reach 21% in 2020 and 27% in 2030.

Figure 3 shows the current trajectory for the overall renewable energy share in the EU compared with the aggregated NREAPs trajectory, the indicative trajectory[26] and the current trend forecast trajectory[27] until 2020.

The upward trend in renewable energy development was expressed in the shares reached in the three sectors: in the electricity sector the share of renewables reached 27.5% in 2014 and 28.8% in 2015, up from 14.8% in 2005. In both years the shares in this sector were higher than in the NREAP plans by a rate of +2.5 percentage points in each year. The 2020 plan of renewable energy share in this sector is set at 33.9%. The EUCO27 projections reveal that the share of renewables in electricity sector has to reach 35.5% in 2020 and 47.3% in 2030.
The renewable energy share in the heating/cooling sector increased to 18.1% in 2014 and 18.6% in 2015, up from 10.9% in 2005. The figures were higher than the expected shares in both years: by +3.0 percentage points in 2014 and by +2.7 percentage points in 2015. The target in the 2020 plan for the share of renewable energy in this sector is set at 21.4 %.

[25] Final renewable energy (the sum of hydropower, solar, wind, marine, geothermal, biomass and heat pumps) in the EU reached 187 Mtoe in 2015, up from 110 Mtoe in 2005.
[26] An indicative trajectory for the EU as a whole can be derived using the formula set out in Annex I to the Renewable Energy Directive, which presents the indicative trajectories for each EU Member State. The indicative trajectory for the EU is presented for illustrative purposes only and has no legal value. This is because the EU as a whole does not have any indicative trajectory under the Renewable Energy Directive.
[27] The current trend forecast trajectory is an exponential smoothing algorithm applied to the overall renewable energy share trend for 2009-2015. The aim is to find a regular pattern in the data, showing how the trend achieved for this indicator can progress under the same conditions. This forecast is presented here for illustrative purposes only, without having any quantitative relevance. A short description of this forecast is provided previously in this report.

According to EUCO27 scenario the share of renewable heat/cold is expected to reach 22.4% in 2020 and 27% in 2030.

The development of renewable energy share in the transport sector was slower than expected in the aggregated NREAPs in both years, reaching 6.54 % in 2014 and 6.7 % in 2015, up from only 1.8 % in 2005. These achievements were 0.2 percentage points and 0.4 percentage points under the expectations for 2014 and 2015 respectively. Under the 2020 plan, the share of renewable energy in this sector is expected to reach 11.1 %.

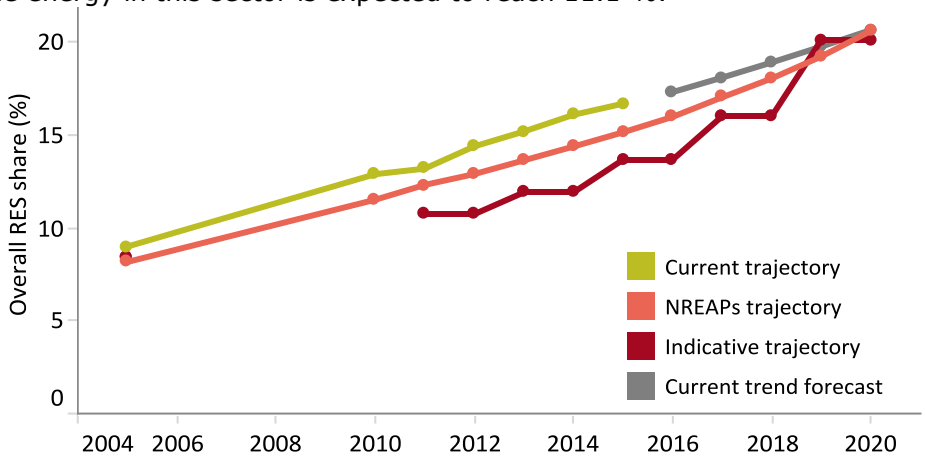


Figure 3. Overall RES share in EU: Current, NREAPs and Indicative trajectories – Current trend forecast, 2005-20

The EU is on track to achieve the 2020 target of 20 % for overall renewable energy share in gross final energy consumption. The development until 2015 was faster for renewable energy share in the electricity sector although it needs to increase more compared to other sectors to reach the 2020 plan. The penetration of renewable energy in the transport sector was slower than planned and remained below expectations.

Renewable energy technologies/sources[28]

Biomass was the main renewable energy source[29] in the EU with a contribution of 52.4% in final renewable energy in 2015, followed by hydropower with 16.7%, wind with 12.5%, biofuels with 7.7%, solar with 6.0%, heat pumps with 4.7% and geothermal with 0.7%.

In this section: (i) Figure 4 presents the current (2009-15) and NREAP projected trend (2016-20) for energy from renewable technologies/sources in the EU. The annual increase/decrease (%) of these sources in these two periods is also available in this figure; (ii) Table 1 presents how the actual figures reported for energy from renewable technologies/sources in the EU compared with what was planned for in the NREAPs. Absolute differences are shown in ktoe.

Table 1. Renewable energy technologies/sources in the EU – deviations from NREAPs, 2010-2015, (ktoe)

	2010	2011	2012	2013	2014	2015
Biomass	16388	9278	12951	13388	8208	10090
Geothermal	-157	-234	-357	-461	-632	-748
Solar	228	1277	2504	2858	3076	3046
Biofuels	-540	-7197	-5072	-5462	-5386	-6411

Solar (electricity and thermal) [30] increased by a compound annual growth rate (CAGR) of 30% (+10 520 ktoe) between 2005 and 2015, reaching 11 337 ktoe (474.6 PJ). This source exceeded what was planned for in the NREAPs throughout the period 2010-2015.

[28] In this section is presented the analysis of sources used in both electricity and heating/cooling sectors as well as the biofuels used in transport sector. The detailed analysis of renewable energy technologies/sources is presented separately in the sections dedicated to each sector, i.e. electricity, heating/cooling and transport.

[29] The share reported in this section refers to the final renewable energy in the EU (and in each MS) which is the sum of all single counted renewable sources. The share of renewable energy sources/technologies in final consumption of renewable energy in 2015 was: *biomass 52.0%, hydropower 15.9%, wind 13.0%, biofuels 7.0%, solar 6.0%, heat pumps 4.6%, geothermal 0.7% and renewable electricity in transport 0.9%.*

[30] The ratio between the average relative increases of solar photovoltaics and solar thermal during period 2005-2015 was 35:1

Deployment of biomass in the electricity and heating/cooling sectors increased by a CAGR of 5.2% (+39 079 ktoe) between 2005 and 2015, reaching 98 149 ktoe (4109 PJ). Biomass development was faster than planned throughout the period 2010-2015. The geothermal electricity and heating/cooling sectors increased by a CAGR of 3.2% (+334) between 2005 and 2015, reaching 1 246 ktoe (52.2 PJ). This development was not fast enough to meet the NREAPs' plans for the period 2010-2015. Biofuels used in transport sector went up by a CAGR of 16% (+10 245 ktoe) between 2005 and 2015, reaching 13 239 ktoe (554 PJ). This development was slower than expected and meant that the NREAP plans throughout the period 2010-2015 were not fulfilled.

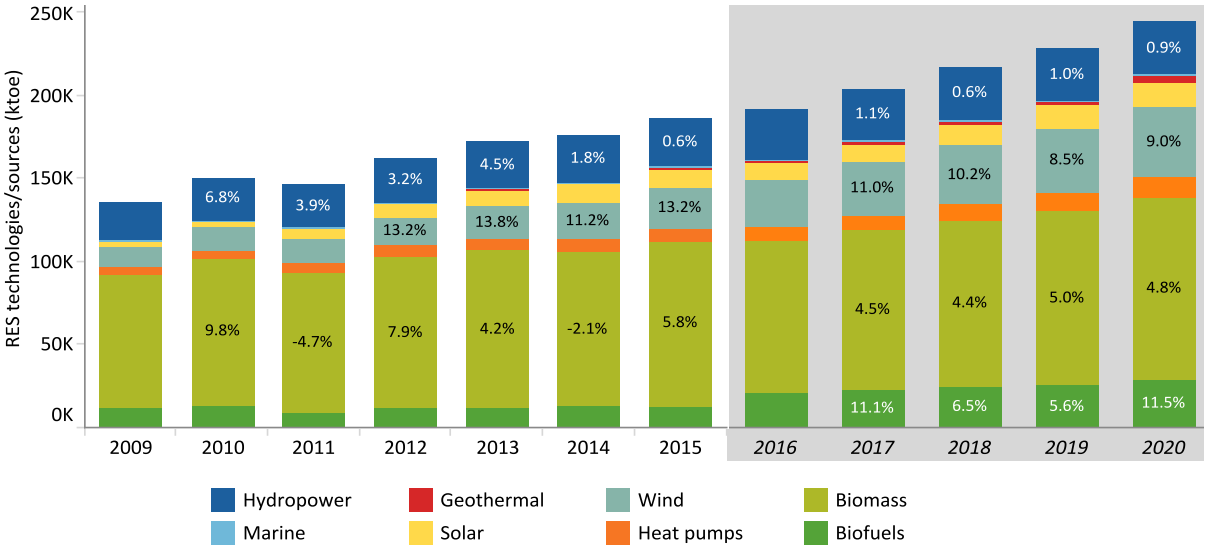


Figure 4. Annual growth of renewable energy technologies in EU: Current (2009-2015) - NREAP planned (2016-2020)

The fast deployment of technologies such as solar and wind might change the relative contributions of renewable energy technologies/sources to the final renewable energy planned to be reached in 2020. Nevertheless, according to the aggregated Member States' NREAPs, the share of biomass in final renewable energy is expected to decrease to 45% in 2020 while the contribution of wind is expected to reach 17.2%, followed by hydropower with 12.9%, biofuels with 11.9%, solar with 6.2%, heat pumps with 5%, geothermal with 1.5% and marine with 0.2%.

Renewable electricity installed capacity

Renewable electricity installed capacity[31] in the EU has increased by a CAGR of 9.1% (+217 GW) since 2005, reaching 374 GW in 2015. Between 2005 and 2015, the share of renewables in the EU's total electricity capacity increased from 20% to 38%. In 2015 the relative share of wind technology reached 37.8 % of final installed capacity, followed by hydropower (28.1 %), solar (26 %), biomass (7.9 %), geothermal (0.2 %) and marine (0.1 %).

Table 2 presents how the actual figures reported for installed capacity from renewable technologies/sources in the EU compared with what was planned for in the NREAPs. Absolute differences are shown in MW.

Table 2. Renewable energy installed capacities in the EU – deviations from NREAP, 2010-2015, (MW)

	2010	2011	2012	2013	2014	2015
Hydropower	-10818	-10790	-12276	-12250	-13527	-14449
Solar-el	4135	18647	30967	36525	37771	39348
Wind	-984	-2308	-1656	-1269	-1815	-1692
Biomass-el	-1432	-59	645	-1945	-2276	-3217
Geothermal-el	-54	-80	-113	-146	-167	-225
Marine	-4	-4	-18	-38	-78	-128

[31] To compare the current renewable electricity installed capacity with the NREAPs plans, the installed capacity is calculated as the sum of: hydropower < 1MW, hydropower 1-10 MW, hydropower > 10 MW, geothermal, solar PV, CSP, wind and biomass. The mixed and pumped storage capacities are not included in this analysis.

Figure 5 presents the current trend for the installed capacity of renewable electricity in the EU, the deviations (in %) from the expected developments during 2010-2015, the 2020 NREAP plan and EUCO27 scenario projection for 2020 and 2030. As shown in this figure, the achieved installed capacity in the EU was above the expected NREAP level throughout period 2011-2015. 2010 was the only year in which the plans were not fulfilled.

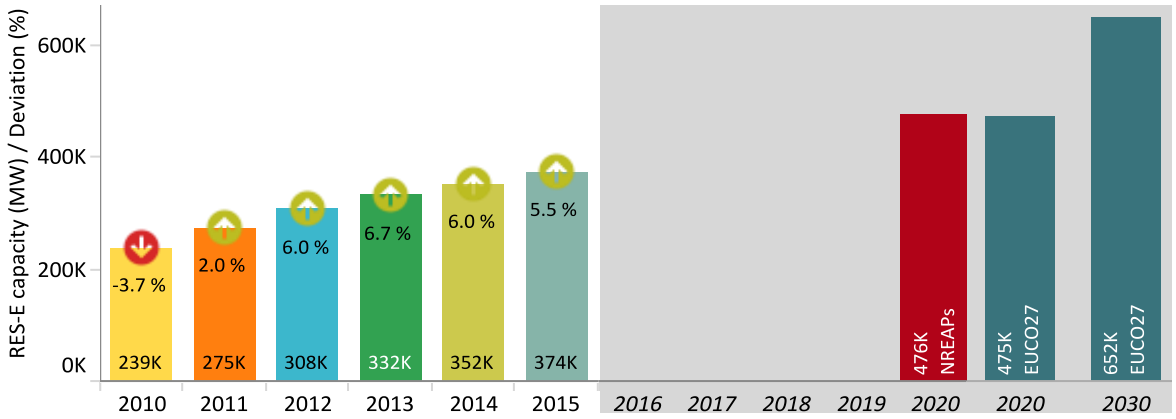


Figure 5. RES-E development and deviation from NREAPs (2010-2015) – NREAPs planned growth (2016-2020)

Solar technology (photovoltaic and concentrated solar power (CSP)) has gone up by a CAGR of 45% (+92.6 GW) since 2005, reaching 94.86 GW. This technology developed faster than planned throughout the period 2010-2015, exceeding by 4% (+3356 MW) in 2014 the plan for the year 2020 (83.7 GW). Wind power increased its installed capacity during the period 2005-2015 by a CAGR of 13.2% (+101 GW), reaching 141.5 GW. However, this source did not reach the aggregated NREAPs' capacities throughout the period 2010-2015. Between 2005 and 2015 the installed capacity biomass for electricity production in the EU increased by a CAGR of 7.9% (+15.6 GW), reaching 29.5 GW. This development was faster than the aggregated NREAPs' capacities for the period 2010-2013 but slower for 2014-2015. Hydropower is the technology that recorded a slower increase in its installed capacity, with a CAGR of only 0.5% (+5288 MW) between 2005 and 2015, reaching 105 GW. This technology remained under the aggregated NREAPs' capacities throughout the period 2010-2015. Marine technology reached only 244 MW in 2015: it has increased very slowly since 2005, by a CAGR of 0.2% (+4 MW). This development remained under the aggregated NREAPs' capacities throughout the period 2010-2015.

The fast increase in solar photovoltaic capacity is likely to change the relative contributions of renewable technologies/sources to the final renewable electricity installed capacity planned for 2020. However, according to the aggregated NREAPs, in 2020 the EU expects to have installed 476.2 GW capacities from renewables. Of this capacity, wind power is expected to account for 44.3%, hydropower 26.7%, solar 19%, biomass 9.2%, marine 0.5% and geothermal 0.3%.

The EUCO27 projections for 2020 are broadly consistent with the aggregated NREAPs in forecasting a net generation capacity of 475 GW, of which wind power will have a share of 43.6%, solar electricity 28.6%, hydropower 27.7% and other renewables only 0.1%. According to these projections, in 2030 the EU is expected to have installed 652 GW of renewable electricity, of which wind will have a share of 43.5%, solar electricity 35.9%, hydropower 20.4% and other renewables 0.2%.

Final renewable electricity consumption

Final renewable electricity consumption in the EU amounted to 927.2 TWh (79.7 Mtoe) in 2015, increasing by a CAGR of 6.6% (+437 TWh) since 2005. Compared with the expected developments, the final consumption of renewable electricity was above the aggregated NREAPs throughout the period 2010-2015. In 2015 hydropower had a share of 39.5% of final renewable electricity consumed in EU, followed by wind with 29.5%, biomass with 18.7%, solar electricity with 11.5%, geothermal with 0.7% and marine with 0.1%.

Table 3 presents how the actual figures reported for renewable electricity from renewable technologies/sources in the EU compared with what was planned for in the NREAPs. Absolute differences are shown in ktoe.

Table 3. Renewable energy technologies/sources in Electricity sector - deviation from NREAPs (ktoe)

	2010	2011	2012	2013	2014	2015
Hydropower	333	197	-104	-145	-429	-454
Wind	-956	-1404	-1652	-1847	-2273	-2004
Solar-el	217	1333	2690	3309	3740	4032
Geothermal-el	-32	-23	-52	-60	-68	-74
Biomass-el	813	629	1016	719	634	709
Marine	-2	-2	-10	-20	-23	-32

The amount of renewable electricity originating from solar photovoltaic increased very fast between 2005 and 2015. It went up by a CAGR of 53% (+101 TWh) reaching, 102.3 TWh (8799 ktoe), which was above the expected NREAP values throughout the period 2010-2015. Already in 2014, the use of this technology had exceeded by 12.4% (+10.2 TWh) the plan for 2020 (82.1 TWh). CSP reached 5 593 GWh (481 ktoe) in 2015; this was below the level provided for under the plans throughout the period 2011-2015. The use of wind technology increased its contribution to renewable electricity between 2005 and 2015 by a CAGR of 15.2% (+215.7 TWh), reaching 284.8 TWh (24.5 Mtoe). Nevertheless this development was somewhat slower than what was projected in the aggregated NREAPs throughout period 2010-2015. Use of biomass for electricity reached 178 TWh (15.3 Mtoe) in 2015, having increased by a CAGR of 9.8% (+108 TWh) since 2005. The use of this source exceeded the aggregated NREAPs plans throughout the period 2010-2015. Use of geothermal electricity increased by a CAGR of 1.9% (+1125 GWh) between 2005 and 2015, reaching 6 523 GWh (561 ktoe). This trend was below that expected for 2010-2015. Hydropower electricity amounted to 349.5 TWh (30 Mtoe) in 2015, increasing by a CAGR of only 0.2% (+5 408 GWh) since 2005. This source did not achieve the targets in the NREAPS for the period 2012-2015.

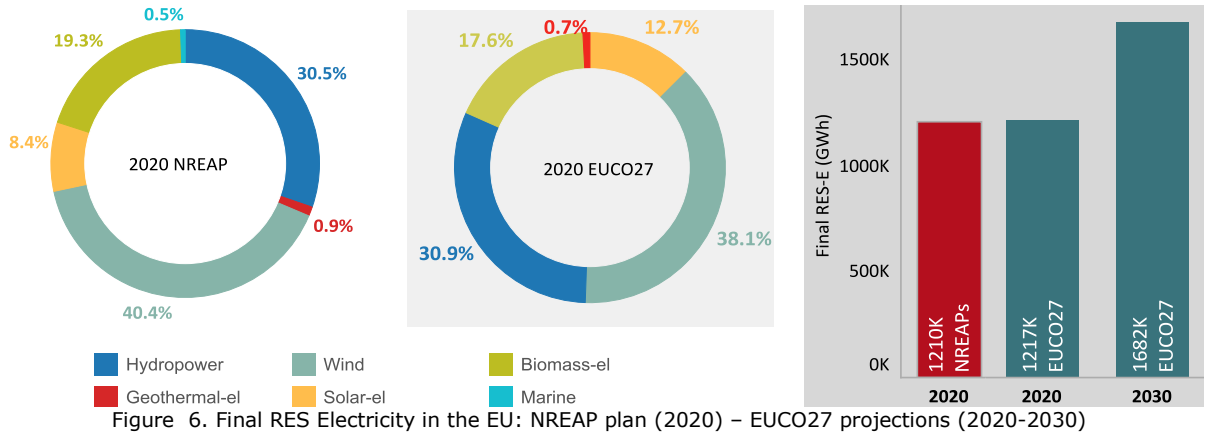


Figure 6. Final RES Electricity in the EU: NREAP plan (2020) – EUCO27 projections (2020-2030)

According to the aggregated NREAPs, the EU expects to have achieved a final renewable electricity consumption of 1 210.4 TWh (104 Mtoe) in 2020. Wind power is expected to be the main contributor with 40.4 %, followed by hydropower with 30.5 %, biomass with 19.3 %, solar with 8.4 %, geothermal with 0.9 % and marine with 0.5 %.

Nevertheless, the respective contributions of the different types of renewable energy technologies are likely to differ from what was planned. This is because of the faster development of solar photovoltaics, which is already now providing an electricity share largely above expectations. In fact, the EUCO27 scenario for 2020 is in line with the aggregated NREAPs, projecting final renewable electricity consumption in the EU at 1 217 TWh (104.7 Mtoe). The shares of renewable energy technologies/sources are more in line with the current achievements of solar technology: wind is at 38.1%, hydropower at 30.9%, biomass at 17.6%, solar photovoltaic at 12.7% and other renewables at 0.7%. Under this scenario, renewable electricity in the EU will reach 1 682 TWh (144.7 Mtoe) in 2030, in which wind will have a share of 41.1%, hydropower 22.6%, solar photovoltaic 18%, biomass 17.7% and other renewables 0.6%.

Final renewable heating/cooling consumption

Final renewable heating/cooling consumption in the EU reached 94.2 Mtoe (3944 PJ) in 2015, having increased by a CAGR of 3.8 % (29.5 Mtoe) since 2005. In 2015 biomass was the main renewable source used in the heating/cooling sector with a relative contribution of 88 %, while the rest came from heat pumps (9.1 %), solar thermal (2.2 %) and geothermal (0.7 %).

Table 4 presents how the actual figures reported for renewable heating/cooling from renewable technologies/sources in the EU compared with what was planned for the NREAPs. Absolute differences are shown in ktoe.

Table 4. Renewable energy technologies/sources in Heating/Cooling sector - deviation from NREAPs (ktoe)

	2010	2011	2012	2013	2014	2015
Solar-th	11	-56	-186	-451	-664	-986
Geothermal-th	-125	-212	-305	-402	-563	-674
Biomass-th	15575	8648	11935	12669	7574	9381
Heat pumps	1484	1625	1484	1406	1578	1314

Figure 7 present the current trend for renewable energy in the heating/cooling sector in the EU, the deviations (in %) from the expected developments between 2010 and 2015 and the 2020 NREAP plan. As shown in this figure, the achieved renewable heat/cold in the EU was above the expected NREAP level throughout the period 2010-2015.

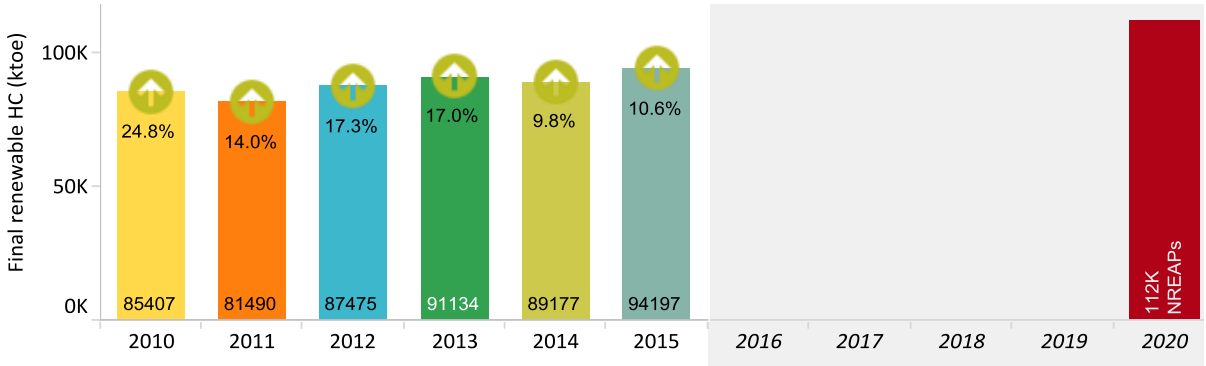


Figure 7. RES-HC development and deviation from NREAPs (2010-2015) – NREAPs planned growth (2016-2020)

The use of biomass as source for heat/cold increased by a CAGR of 3.1% (+21.7 Mtoe) between 2005 and 2015, reaching 70.8 Mtoe (3 469 PJ). This development was fast enough to exceed the planned values in the aggregated NREAPs throughout the period 2010-2015.
The use of heat pumps increased between 2005 and 2015 by a CAGR of 14% (+6 294 ktoe), reaching 8 609 ktoe (360 PJ). This was above the expected values in the NREAPs throughout the period 2010-2015. The use of solar thermal increased between 2005 and 2015 by a CAGR of 11.3% (+1 352 ktoe), reaching 2 055 ktoe (86 PJ). This source did not achieve the expected levels set out in the NREAPs throughout the period 2011-15. Geothermal use in this sector increased by a CAGR of 2.1% (+128 ktoe) between 2005 and 2015, reaching 685 ktoe (28.7 PJ). Nevertheless, this source remained under the expectations of the NREAP throughout the period 2010-2015.

Consumption of renewable energy for the purposes of heating/cooling is expected to reach 111.8 Mtoe (4 680.8 PJ) in 2020. The relative contribution of biomass to this figure will decrease to 81%, while solar thermal is expected to double its share to 5.8%. The contribution of heat pumps is expected to increase to 11% and geothermal will reach 2.4%.

Final renewable energy in transport sector

Renewable energy consumed in the transport sector increased by a CAGR of +13.3 % (+10.6 Mtoe) between 2005 and 2015, reaching 14 944 ktoe (625.7 PJ). In 2015 multiple

counting[32] of renewable energy in the transport sector gives a contribution of 20.3 Mtoe (849 PJ). In 2015 biodiesel accounted for the highest share of total renewable energy used in the transport sector in the EU (70.4 %), while the rest was divided between bioethanol/bio-ETBE (17 %), renewable electricity (10.4 %) and other biofuels (2.2 %).

Table 5 presents how the actual figures reported for the use of renewable energy sources in the transport sector in the EU compared with what was planned for in the NREAPs. Absolute differences are shown in ktoe.

Table 5. Renewable energy sources in Transport sector - deviation from NREAPs (ktoe)

	2010	2011	2012	2013	2014	2015
Biodiesel	-358	-5313	-3406	-3730	-3225	-3819
Bioethanol	-47	-1744	-1542	-1692	-2105	-2465
Other biofuels	-135	-140	-124	-41	-57	-127
Renewable electricity	-166	-152	-271	-257	-319	-278

Figure 8 presents the current trend for renewable energy in the transport sector in the EU, the deviations (in %) from the expected developments between 2010 and 2015 and the 2020 NREAP plan. As shown in this figure, the achieved renewable energy used in the EU transport sector was below the level expected in the NREAPs throughout the period 2010-2015.

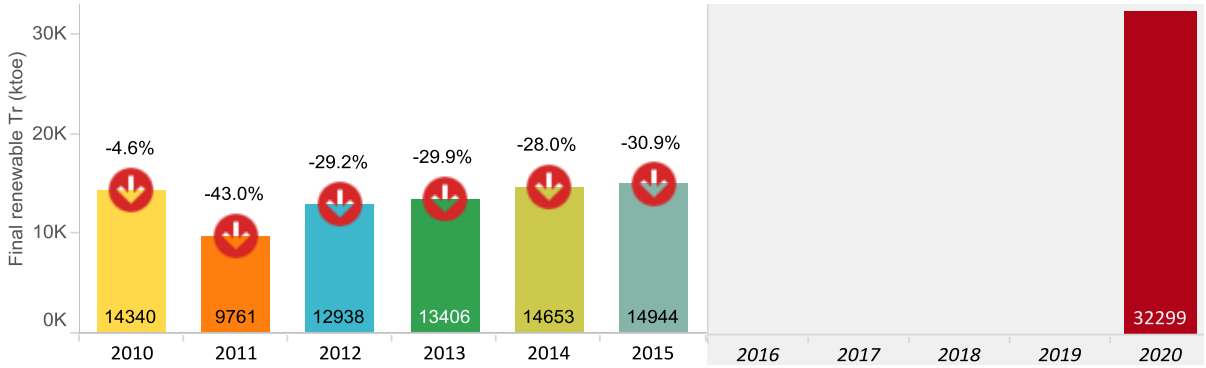


Figure 8. RES-Tr development and deviation from NREAPs (2010-2015) – NREAPs planned growth (2016-2020)

Biodiesel use in transport sector reached 10 579 ktoe (443 PJ) in 2015, increasing by a CAGR of 15.6 % (+8 086 ktoe) since 2005. This development was not at the level expected in the NREAPs throughout the period 2010-2015.

Bioethanol/bio-ETBE increased by a CAGR of 15.3 % (+1 913 ktoe) between 2005 and 2015, reaching 2 520 ktoe (105.5 PJ). However, this biofuel category was below expectations throughout the period 2010-2015. The use of other biofuels reached 141.2 ktoe (5.9 PJ) in 2015, decreasing by a CAGR of -1.2 % (+18 ktoe) since 2005 and missing the targets in the plans throughout the period 2010-2015. Annex IX biofuels had the fastest increase in use between 2005 and 2015: use of such fuels went up by a CAGR of 57 % (+3 102 ktoe), reaching 3 136 ktoe (131 PJ) and exceeding the aggregated NREAP plans throughout the period 2010-2015. Renewable electricity in transport increased by a CAGR of 5 % (+658 ktoe) between 2005 and 2015. In 2015 the amount of renewable electricity used in the EU transport sector presented only 2.1% of the final renewable electrciity In 2015 the EU transport sector consumed only 2.1% of the EU's final renewable electricity.

The use of renewable energy in the transport sector in 2020 is expected to reach 32 301 ktoe (1 352 PJ). Biodiesel is expected to cover 65% of total renewable energy in the transport sector, followed by bioethanol/bio-ETBE with 22.7%, renewable electricity with 10% and other biofuels with 2.3%.

[32] The multiple cunting is used as final RES-Tr numerator to calculate the share of renewable energy in transport sector. The calculations are done based on the provisions in place in Directive 2009/28/EC following its amendment by Directive (EU) 2015/1513.

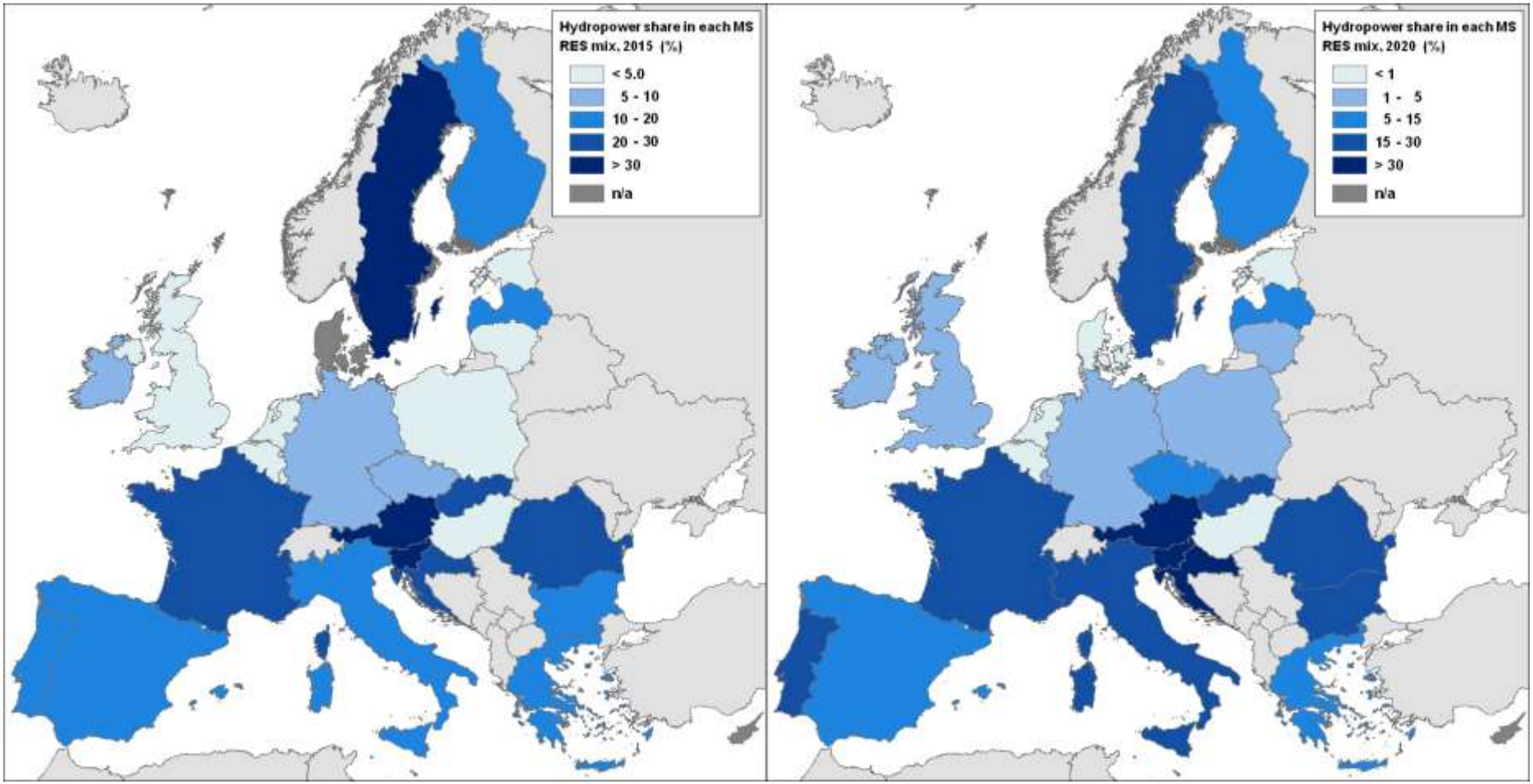


Figure 9. Hydropower's contribution to EU Member States' final renewable energy, 2015 (left) – 2020 (right)

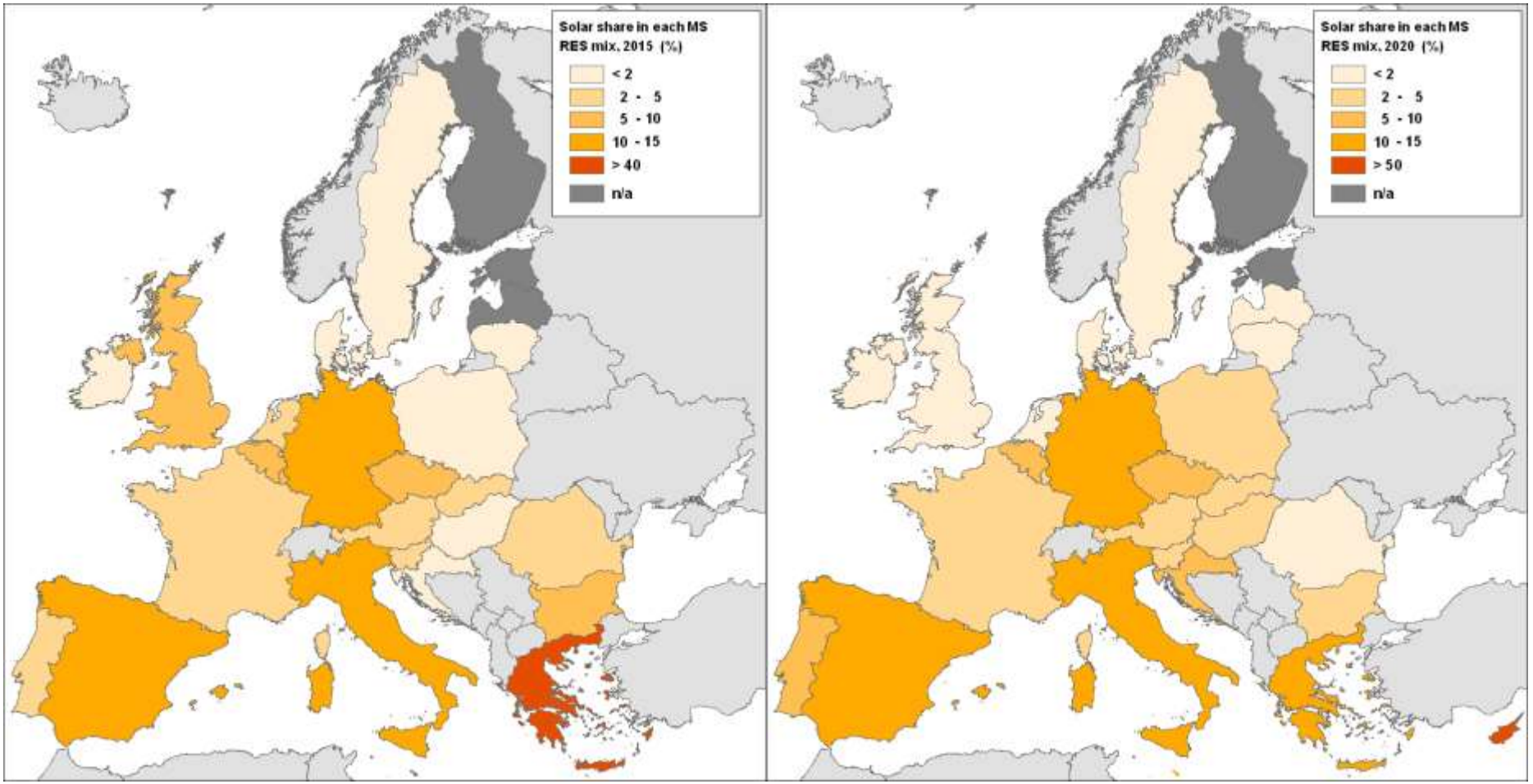


Figure 10. Solar power's contribution to EU Member States' final renewable energy, 2015 (left) – 2020 (right)

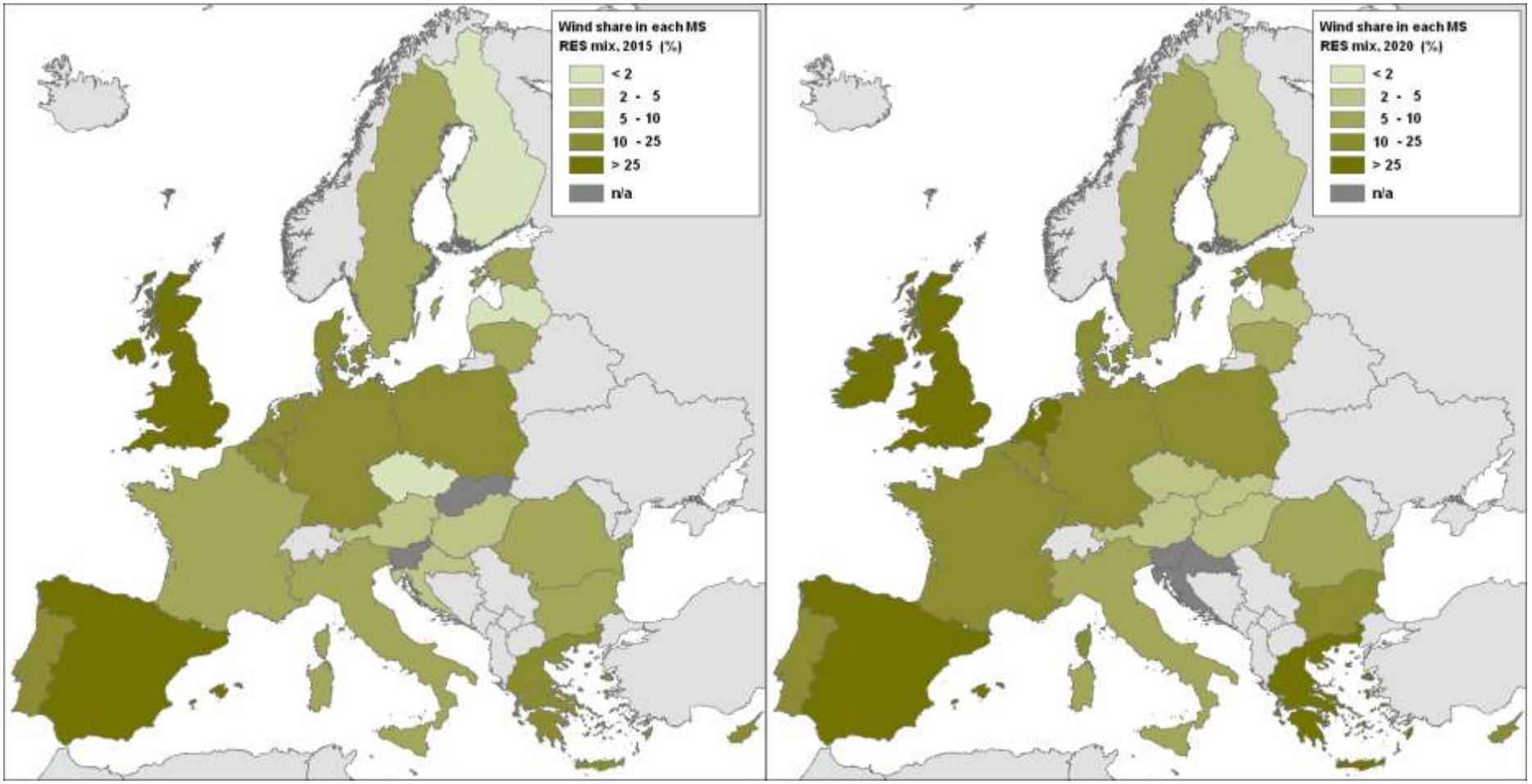


Figure 11. Wind power's contribution to EU Member States' final renewable energy, 2015 (left) – 2020 (right)

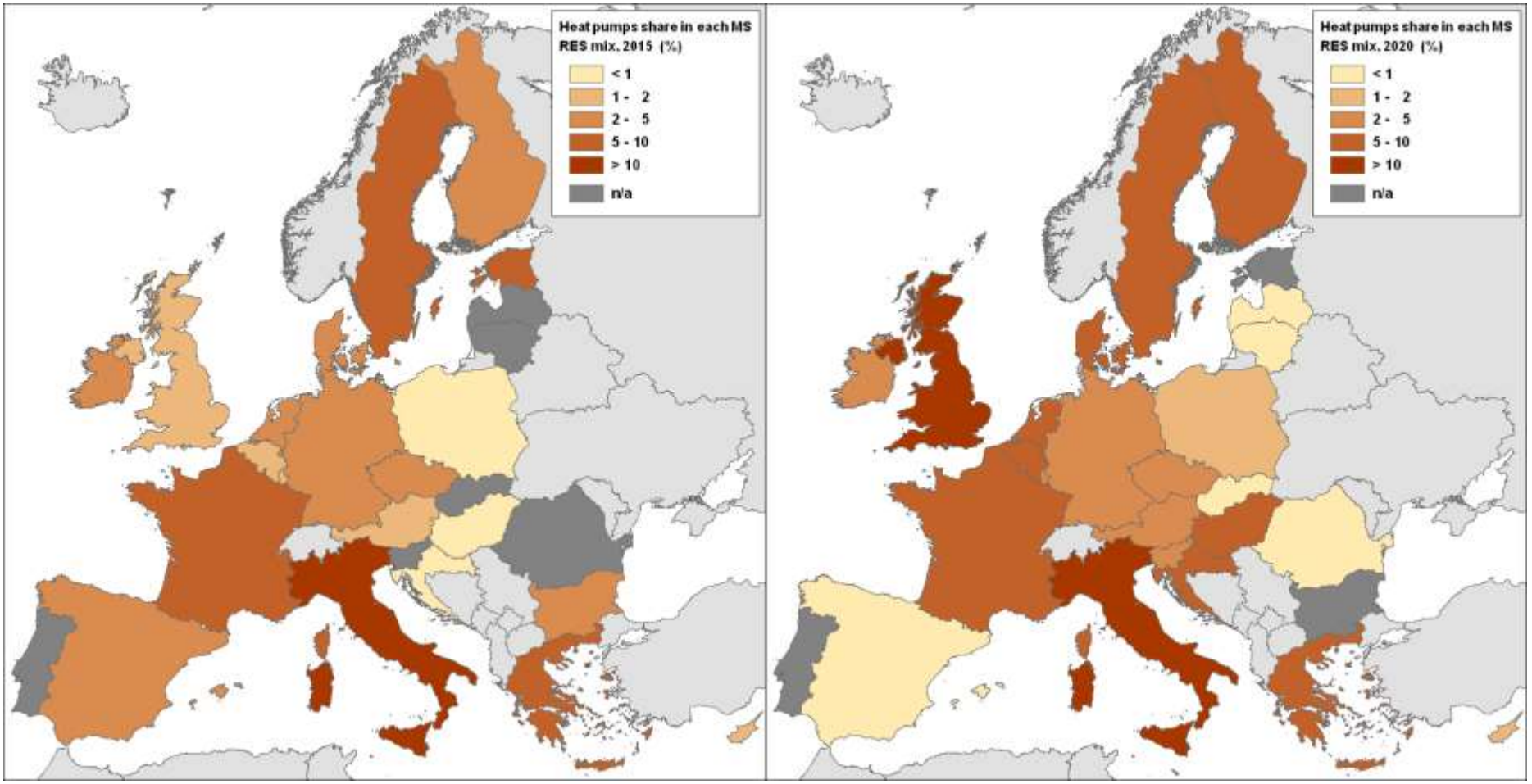


Figure 12. Heat pumps' contribution to EU Member States' renewable energy, 2015 (left) – 2020 (right)

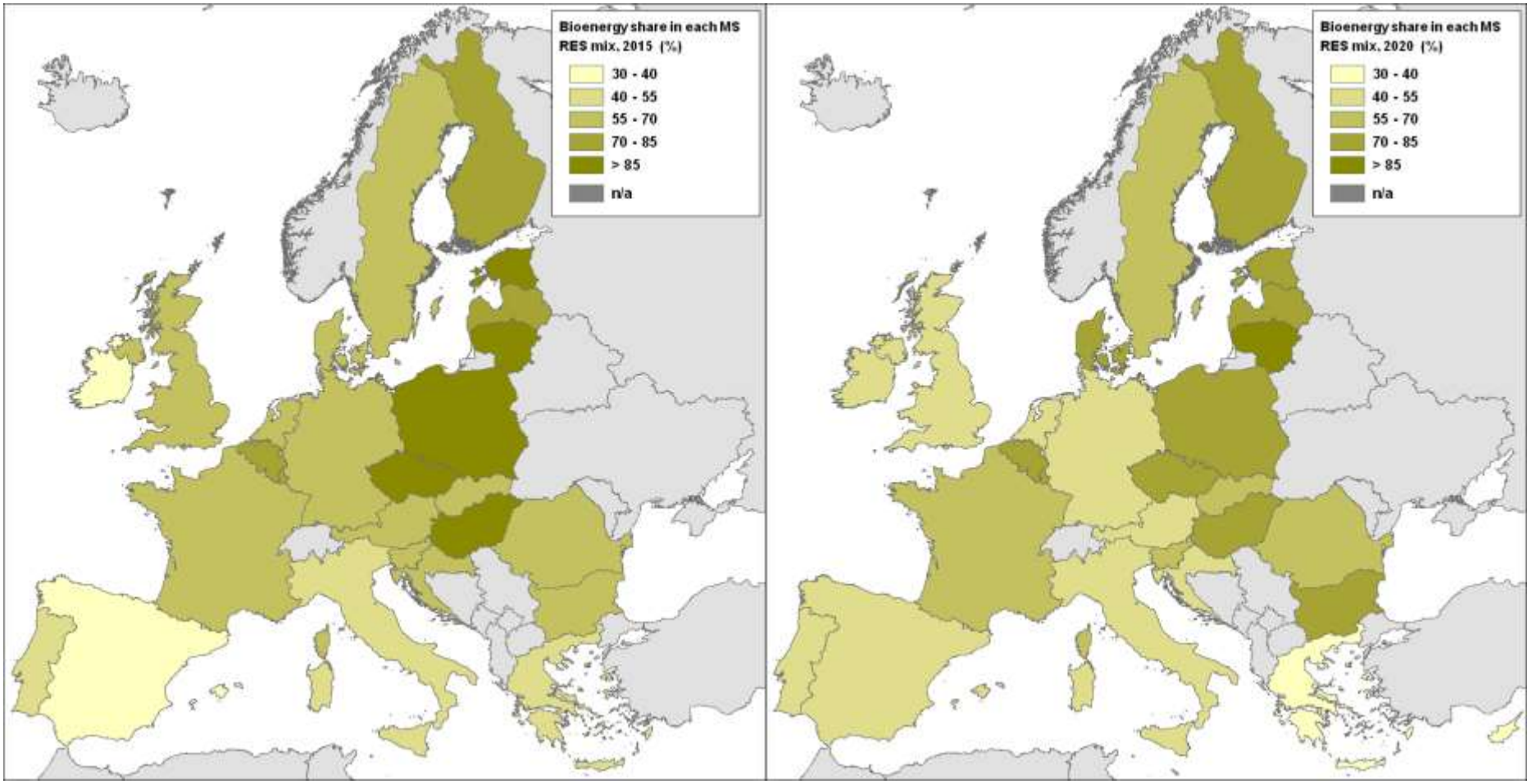


Figure 13. Bioenergy's contribution to EU Member States' final renewable energy, 2015 (left) – 2020 (right)

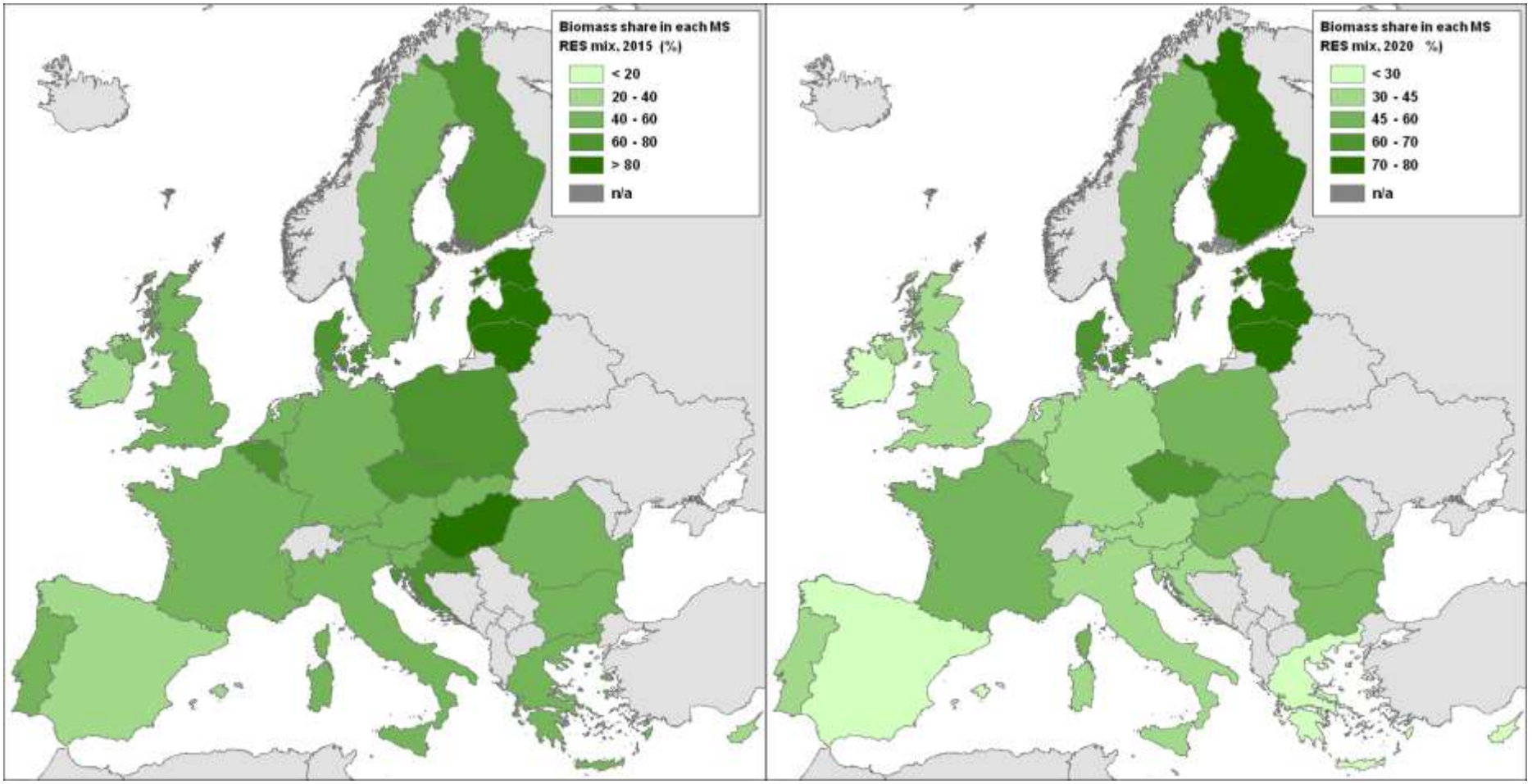


Figure 14. Biomass's contribution to EU Member States' final renewable energy, 2015 (left) – 2020 (right)

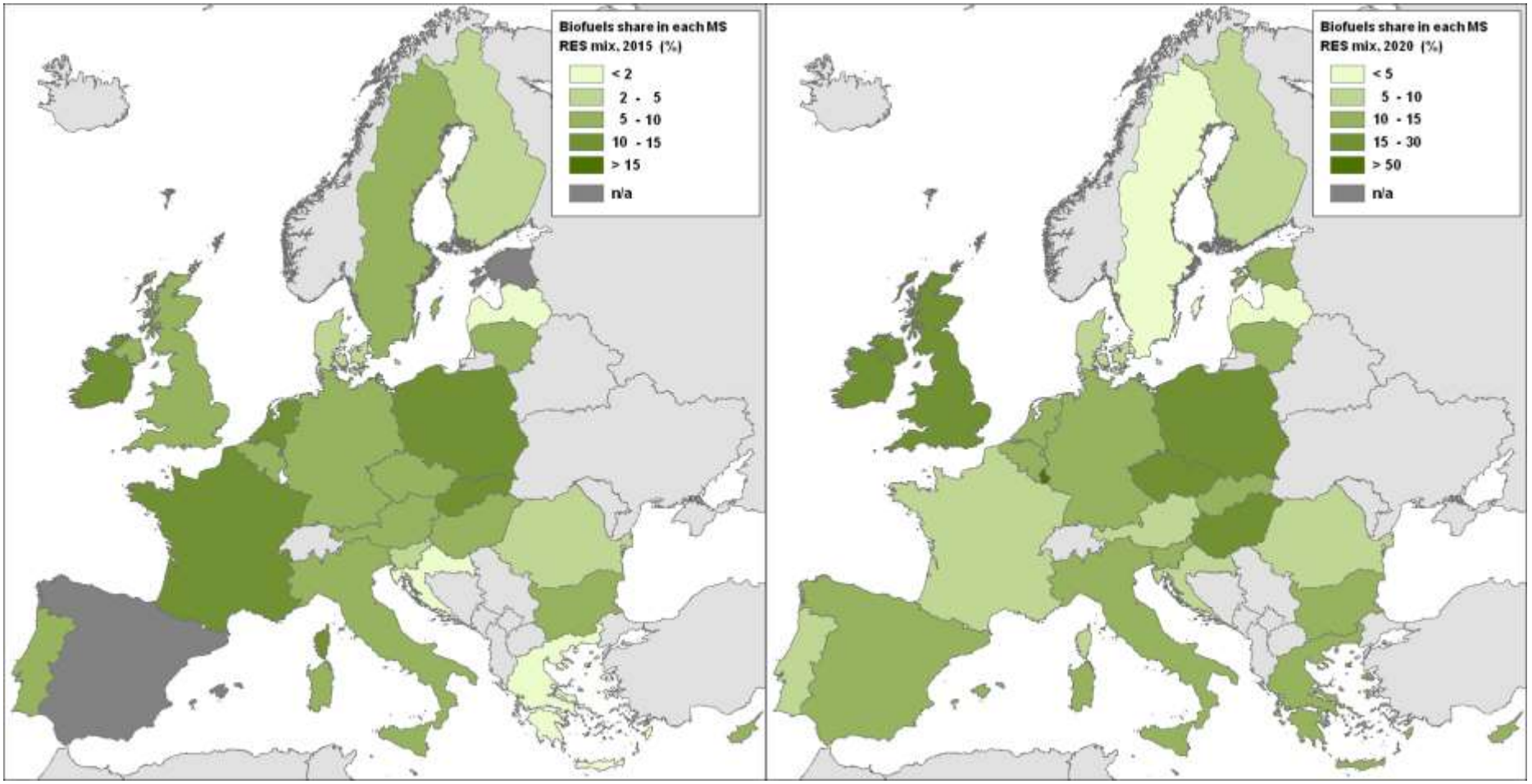


Figure 15. Biofuels' contribution to EU Member States' final renewable energy, 2015 (left) – 2020 (right)

1. Belgium

Energy mix in Belgium is characterized by a higher share of petroleum products and gas and a lower share of solid fuels and renewables (Figure 1). In 2015 gross inland consumption of energy in Belgium totalled to 54.2 Mtoe, 1.2% (+669 ktoe) higher than the consumption in 2014. Consumption of the energy in primary terms amounted to 45.7 Mtoe in 2015, 4.6% above the 2020 energy efficiency target[33]. In the same year, final energy consumption reached 35.8 Mtoe being 10.2% above its 2020 energy efficiency target. Gross final energy consumption increased during period 2014-2015 by 4.5% (+1.6 Mtoe) amounting to 36.2 Mtoe. Energy intensity of the economy stood at the same level as in 2014, at 141 toe/Million Eur. Belgium is an import dependent country reaching in 2015 the highest dependency (at 84.3%) since 1990. Greenhouse gas emissions continued to decline at 118 Mt CO_2 eq in 2014, 21% below the emissions in 1990. Energy remained the main source of emissions with a share of 48.4% (57.1 Mt CO_2 eq). In the same year renewable energies deployment lead to a net savings of GHG emissions of 11.4 Mt CO_2 eq, an additional of 5.4 Mt CO_2 compared to the same indicator in 2009.

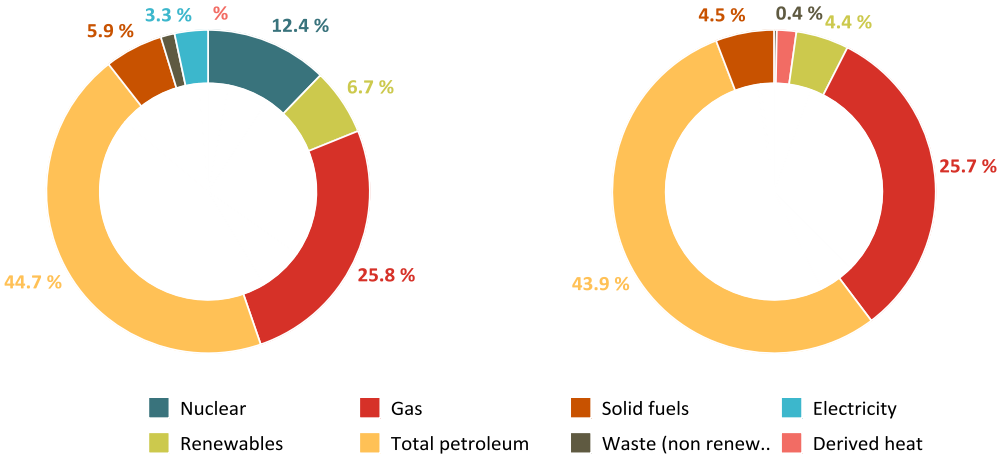


Figure 1. Breakdown of Gross Inland Consumption of Energy (left) - Final Energy Consumption (right) in BE, 2015

1.1 Final renewable energy consumption

Final renewable energy[34] consumed in Belgium between 2005 and 2015 increased by 2146 ktoe with a CAGR of 12.5% reaching 2894 ktoe (121 PJ). Almost half of final renewable energy in year 2015 was consumed in heating/cooling sector and the rest in electricity sector (41.5%) and transport sector (10%).

Figure 1-1 presents the current trend of final renewable energy consumption in Belgium, the deviations (in %) from the expected developments during period 2010-2015 and the 2020 NREAP plan and EUCO27 projections for 2020 and 2030. As shown in this figure the current development of final renewable energy consumption in Belgium was above the plans during period 2010 – 2015.

According to the Belgium NREAP, final renewable energy consumption is expected to further increase until 2020 with a CAGR of 11.9% to reach 5463 ktoe (228.7 PJ). A slight change is expected in the contributions of sectors with an increase from transport sector (16.2%). The contributions of heating/cooling and electricity sectors are expected to be respectively 47.4% and 36.4%. The EUCO27 scenario for 2020 is slightly higher projecting final renewable energy consumption in Belgium at 5758 ktoe (241 PJ). For 2030 this projection reveals the final consumption of renewable energy at 6647 ktoe (278.3 PJ).

[33] Belgium energy efficiency 2020 targets are 43.7 Mtoe in terms of primary energy consumption and 32.5 Mtoe as final energy consumption.
[34] Final renewable energy (the sum of hydropower, solar, wind, marine, geothermal, biomass and heat pumps) in Belgium reached 2859 ktoe in 2015, up from 871.2 ktoe in 2005.

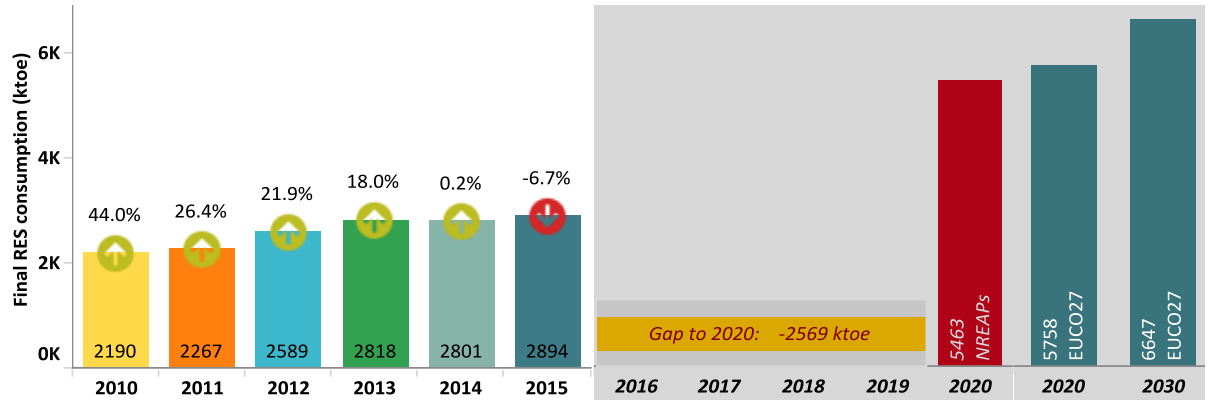


Figure 1 - 1. RES consumption: Trend, Deviation from NREAP (2010-2015) - Expected RES consumption (2020-2030)

1.2 Renewable energy share

The overall renewable energy contribution in gross final energy consumption in Belgium reached 7.98% in 2014 and 7.88% in 2015. The 2020 target that Belgium has to reach for the overall RES share is 13%. According to the EUCO27 scenario the overall renewable energy share in Belgium is projected to reach 14% in 2020 and 17.1% in 2030.

Figure 1-2 shows the current trajectory of the overall renewable energy share in Belgium compared with the NREAP trajectory, the indicative trajectory and the current trend forecast trajectory.

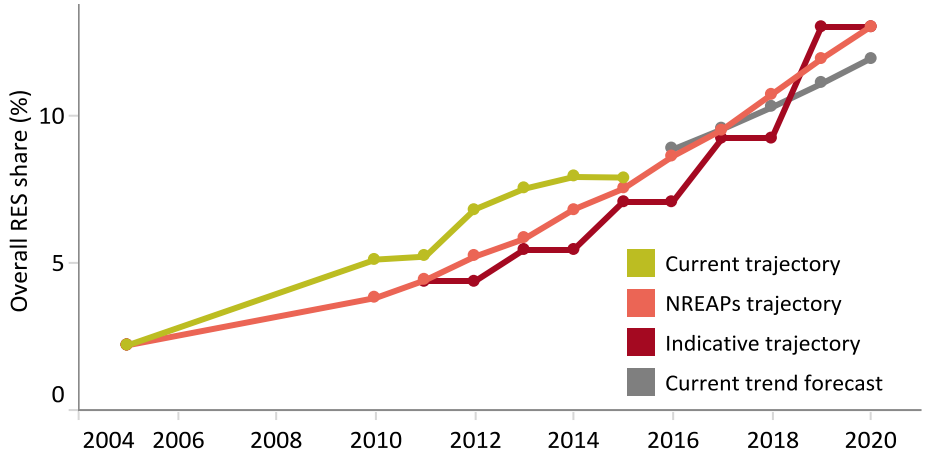


Figure 1 - 2. Overall RES share in BE: Current, NREAPs and Indicative trajectories - Current_trend forecast, 2005-20

Overall renewable energy share in Belgium remained above the NREAP and indicative trajectories throughout 2010-2015. In 2015 overall renewable energy share in Belgium experienced a second drop after the one in 2011, due to the largest increase that Belgium gross final energy consumption experienced during 2014-2015 (+4.5%) compared with the increase of final renewable energy consumption (+3.3%). Given this development, Belgium may need to make additional efforts to stay on course for the 2020 target set in its NREAP.

In electricity sector the share of renewable energy reached 13.39% in 2014 and 15.42% in 2015: both shares were above the NREAP planned values respectively by + 0.3 and +2.7 percentage points. The renewable electricity share foreseen for 2020 in the Belgium NREAP is 20.9%. Renewable energy share in the heating/cooling sector reached 7.64% in 2015 slightly slower than in 2014, 7.68%. The share of renewable energy in this sector was over the planned shares in both years: +1.8 percentage points above in 2014 and +1.0 percentage points above in 2015. The 2020 planned share of renewable heat/cold is set to 11.9%. The share of renewable energy in the transport sector was 5.71% in 2014 decreasing then to 3.82% in 2015. The share of renewable energy in this sector met the planned NREAP value in year 2014 but missed it by -1.98 percentage points in 2015. The share of renewable energy in this sector foreseen for 2020 is 10.14%.

1.3 Final renewable electricity, heating/cooling and use in transport

Final renewable electricity consumption in Belgium has gone up since 2005 with a CAGR of 20.5% (+12 TWh), reaching 13.96 TWh (1200 ktoe) in 2015. This deployment fulfilled the NREAP plans throughout period 2010-2015. In 2015 bioelectricity share was at 39.5% followed by wind (36.2%), solar photovoltaic (22%) and hydropower (2.4%). According to Belgium NREAP the final renewable electricity in 2020 will reach 21121 GWh (1988 ktoe). Of this electricity 93% will be biomass (47.7%) and wind (45.3%). The rest will be shared between solar (4.9%), hydropower (1.9%) and geothermal (0.1%). Nevertheless, the actual picture in 2020 is likely to be different from planned also because of the fastest deployment of solar photovoltaic already now providing an electricity share largely above the expectations.

Actually, the EUCO27 scenario projection shows that in 2020 wind is expected to dominate the renewable electricity consumption (19630 GWh) in Belgium with 61.1%. Solar photovoltaic will cover 20.4%, biomass 16.6% and hydropower 1.9%. Under this scenario Belgium will reach 31638 GWh (2720 ktoe) of renewable electricity in 2030 of which wind will share 60%, solar photovoltaic 21.3%, biomass 16.6% and hydropower 1.8%.

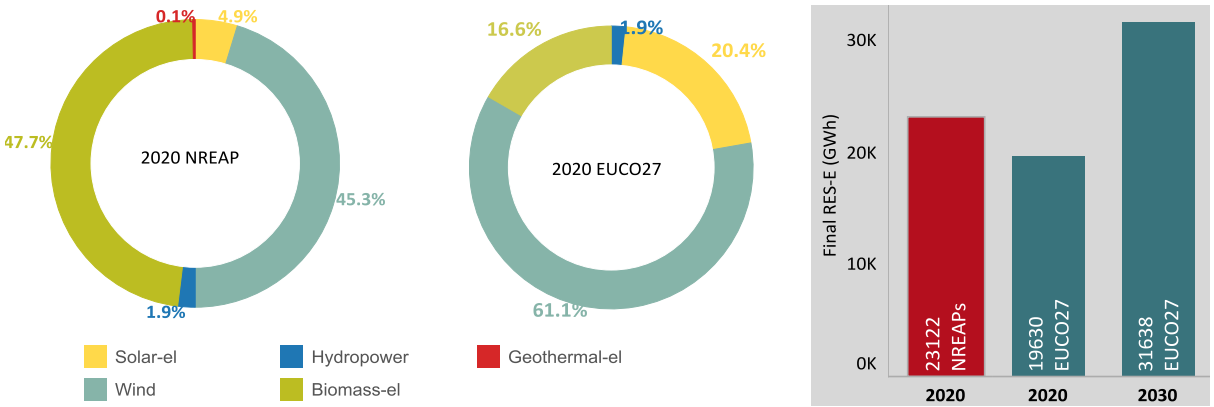


Figure 1 - 3. Final Renewable Electricity in Belgium: NREAP plan (2020) – EUCO27 projections (2020-2030)

The use of renewable energy in heating/cooling in Belgium grew with a CAGR of 7.4% (+718 ktoe) between 2005 and 2015 reaching 1404 ktoe (58.8 PJ). This development was fast enough to fulfil the NREAP plans in period 2010-2014. In 2015 almost 96% of renewable heat/cold production was coming from biomass and the rest was heat pumps (2.9%) solar (1.6%) and geothermal (0.1%). The heat consumption originated from renewable energy sources in Belgium is expected to reach 2588.4 ktoe (108.4 PJ) in 2020 in which biomass will share 78.6%, heat pumps 13.5%, solar thermal 7.7% and geothermal thermal 0.2%.

Final use of renewable energy in transport increased with a CAGR of 30.1% (+269 ktoe) between 2005 and 2015 reaching 290 ktoe (12 PJ). Nevertheless comparing with NREAP the achieved uses were found below the expectations for all years of 2012-15 period. In 2015 biodiesel share was 74.2% followed by bioethanol/bio-ETBE (13.6%) and renewable electricity (12.2%). The use of renewable energy in transport sector in 2020 is expected to amount to 886.3 ktoe (37.1 PJ) in which the share of biodiesel will reach 78.7% while the shares of bioethanol/bio-ETBE and renewable electricity will be 10.3% and 11%.

Table 1 - 1. Final renewable energy in BE: deviations from NREAPin electricity, heating/cooling and transport

	2010	2011	2012	2013	2014	2015
RES-el (ktoe)	179	187	222	162	40	79
RES-hc (ktoe)	462	271	316	341	58	-31
RES-tr (ktoe)	29	16	-72	-74	-93	-254
RES-el (%)	44.5	35.6	33.2	19.6	4.1	7.1
RES-hc (%)	60.2	29.8	31.1	30.5	4.6	-2.2
RES-tr (%)	8.3	4.5	-16.2	-16.5	-17.4	-46.7

1.4 Renewable energy technologies/sources

Biomass was the overall main renewable energy source in Belgium with a 63.4% contribution in renewable energy mix in 2015, followed by wind with 15.2%, solar with 10%, biofuels with 8.9%, hydropower with 1.0%, heat pumps with 1.4% and geothermal with 0.1%. In 2020, the share of biomass in renewable energy mix is expected to decrease to 56% while the contribution of wind is expected to double reaching 17%. Biofuels will follow with 15% together with heat pumps with 6% and solar with 5%.

In this section: (i) Figure 1-4 present the current (2009-2015) and NREAP projected trend (2016-2020) of energy from renewable technologies/sources in Belgium. The annual increase/decrease (%) of these sources in these two periods is also available in this figure; (ii) Table 1-2 presents how the actual figures reported for renewable technologies/sources in Belgium compared with what was planned for the NREAPs. Absolute differences are shown in ktoe.

Solar technology grew fast between 2005 and 2015 with a CAGR of 55.5% (+282 ktoe), reaching 285.6 ktoe (12 PJ). This development was fast enough to exceed the expected NREAP plans throughout period 2010-2015. Biomass use in electricity and heating/cooling sectors showed the highest additional energy production during period 2005-2015 increasing with a CAGR of 11.4% (+1199 ktoe) from 614 ktoe (25.7 PJ) in 2005. This source was found to be over the expected NREAP plans during period 2010-2013 but below expectations in period 2014-2015. Biofuels used in transport sector reached 254.6 ktoe (10.7 PJ) in 2015 being nevertheless below the expected NREAP plans over period 2012-15. Geothermal source use in electricity and heating/cooling sectors reached in 2015 the level of 1.5 ktoe (0.06 PJ) being below the expectations all over period 2010-2015.

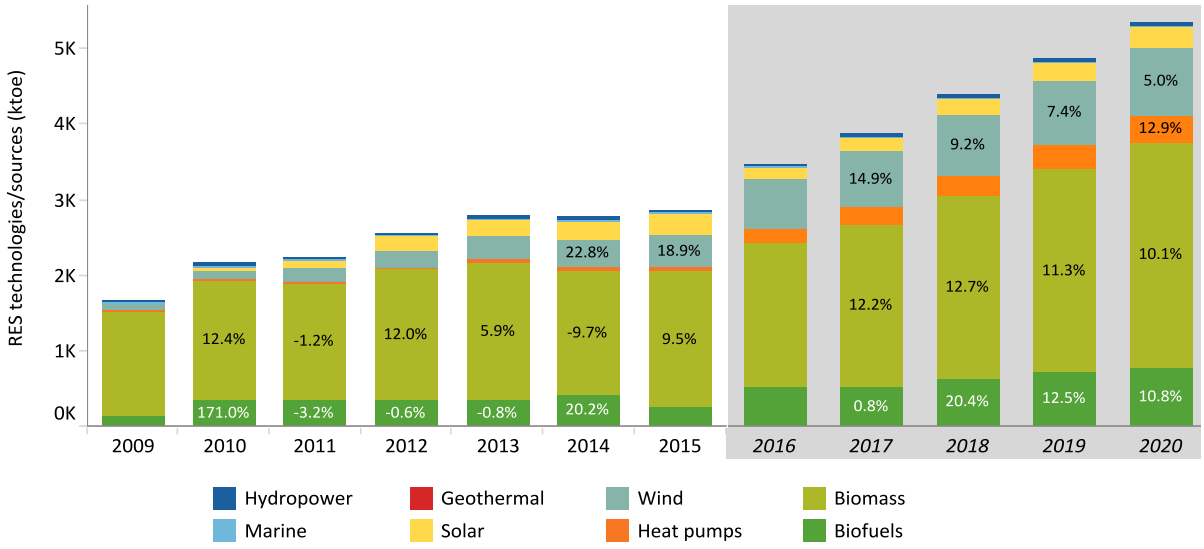


Figure 1 - 4. Annual growth of RE technologies in BE: Current (2009-2015) - NREAP planned 2016-2020

Renewable electricity originated by solar photovoltaic developed very fast between 2005 and 2015 with a CAGR of 117% (+3064 GWh) from the very marginal level of 1.0 GWh in the baseline year. This renewable electricity was found to exceed not only the expected NREAP levels are also exceeded during period 2010-2015, but also the 2020 planned level by 169% (+1926 GWh). Wind power also increased fast its contribution to the renewable electricity that was consumed between 2005 and 2015 with a CAGR of 36% (+4032 GWh) reaching 5054 GWh (18.2 PJ). Nevertheless this development was not fast enough to reach the values planned for 2012-2015. Biomass based electricity increased between 2005 and 2015 with a CAGR of 13.2% (+2809 GWh) reaching 5509 GWh (19.8 PJ) overcoming the expected NREAP levels during period 2010-2013 but remaining under the target in period 2014-2015. Hydropower technology decreased slightly since 2005 with a CAGR of -0.2% reaching 330 GWh (1.2 PJ). This technology didn't reach the NREAP planned levels over period 2013-2015.

Solar thermal source deployed with a CAGR of 23.4% (+19 ktoe) between 20015 and 2015 reaching 22.1 ktoe (0.9 PJ). Nevertheless this development was slower than the projected NREAP one missing the expected levels all over period 2010-2015. Biomass used for heat increased with a CAGR of 7.1% (+664 ktoe) during period 2005-2015 reaching 1340 ktoe (56 PJ) and remaining above the NREAP plans during all period 2010-2015. The development of heat pumps in Belgium was well behind the expected NREAPs levels during the 2011-2015 period, reaching in 2015 only 40.3 ktoe (1.7 PJ) although increasing with a CAGR of 20.5% since 2005.

Bioethanol/bio-ETBE use in Belgium transport sector reached 24 ktoe (1.0 PJ) in 2015 missing the expected NREAP plans in period 2014-2015 Biodiesel use in this sector reached 230 ktoe (9.6 PJ) in 2015 decreasing by 34% (-121 ktoe) from year 2014. In comparison with NREAP planned values the use of biodiesel in Belgium was lower all along the period 2011-15. The use of renewable electricity in transport increased with a CAGR of 5.4% (+14 ktoe) in period 2005-2015 reaching 35 ktoe (1.5 PJ). Comparing with NREAP the use of renewable electricity in transport was under the plans during all period 2011-15. Almost 3% of final renewable electricity in Belgium was used in transport sector in year 2015.

Table 1 - 2. Renewable energy technologies/sources in Belgium – deviations from NREAP, 2010-2015, (ktoe)

	2010	2011	2012	2013	2014	2015
Hydropower	1.8	0.9	0.7	-0.5	-1.2	-5.0
Wind	40.9	26.6	-22.2	-61.0	-88.5	-88.4
Solar-el	22.0	68.8	148.8	187.3	201.7	211.1
Solar-th	-16.9	-28.0	-36.9	-43.3	-56.1	-69.1
Geothermal-th	-1.1	-2.1	-2.1	-2.1	-2.5	-2.6
Biomass-el	113.8	91.1	94.5	36.0	-71.8	-38.2
Biomass-th	510.8	354.0	418.2	461.7	215.1	161.8
Heat pumps	-31.2	-52.9	-63.5	-74.9	-98.2	-121.1
Biodiesel	17.0	4.5	-70.6	-75.3	-67.3	-228.7
Bioethanol	10.6	11.5	1.9	3.6	-19.6	-13.5
Renewable electricity	1.5	-0.1	-3.1	-1.9	-5.7	-12.1

1.5 Renewable electricity installed capacity

The renewable electricity installed capacity in Belgium increased with a CAGR of 24% from 719 MW in 2005 reaching 6242 MW in 2015. In 2015 solar accounted for 50% of renewable electricity installed capacity in Belgium followed by wind with 35%, biomass with 13.2% and hydropower with 1.9%.

Figure 1-5 present the current trend of renewable electricity installed capacity in Belgium, the deviations (in %) from the expected developments during period 2005-2015, the 2020 NREAP plan and EUCO27 scenario projections for 2020 and 2030. As shown in this Figure Belgium fulfilled the plans for renewable electricity installed capacity throughout period 2010-2015.

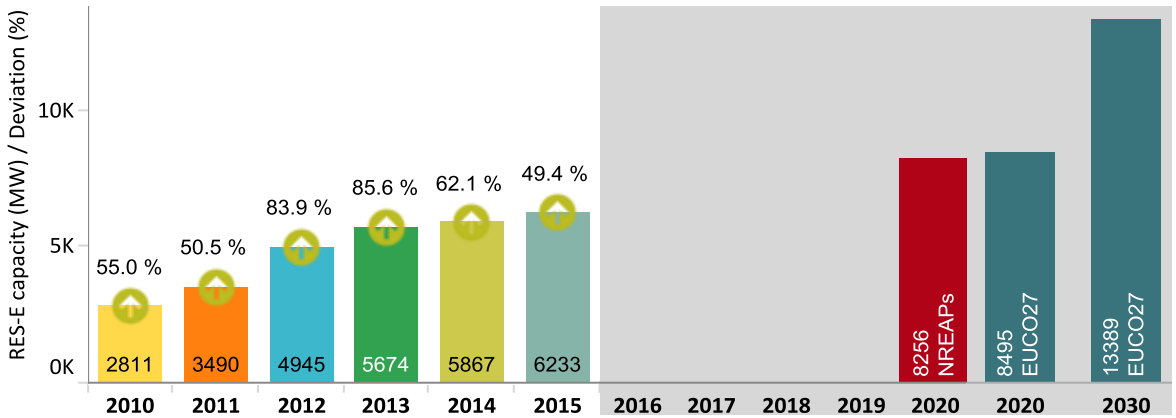


Figure 1 - 5. RES-E capacity development and deviation from NREAPs (2010-2015)– Expected capacity (2020-2030)

The main progress was made in solar photovoltaic which increased with a CAGR of 108.6% (+3120 MW) in 2015 over the very marginal level of 2 MW in the baseline year. This development was so fast that more than two folded the 2020 planned capacity of 1340 MW and exceeded the expected NREAP capacities all over period 2010-2015. Wind power capacity increased with a CAGR of 29.3% (+2009 MW) between 2005 and 2015 from 167 MW in the baseline year. This development was fast enough to surpass the NREAP capacities all over period 2010-2015. Biomass installed capacity increased from baseline year with a CAGR of 6.3% (+378 MW) reaching 823 MW in 2015. This deployment was slower than the NREAP expected trend during period 2013-15. Hydropower capacity increased with a CAGR of 1.4% (+16 MW) between 2005 and 2015 over the 105 MW installed in the baseline year. This increase was enough to allow this source surpassing the expected NREAP capacities throughout period 2010-2015.

According to Belgium NREAP, renewable energy capacity in 2020 is expected to reach 8256 MW in which the contribution of wind will reach 52.3% and the rest will consist in biomass (29.7%), solar photovoltaic (16.2%) and hydropower (2%).

The EUCO27 projections for 2020 are broadly consistent with NREAPs in forecasting a net generation capacity of 8494 MW. Nevertheless forecasted technology shares differ and wind will share 53.7% and solar 45%. According to these projections in 2030 Belgium is expected to have installed 13389 MW of renewable electricity in which wind will share 51.2% and solar 47.4%.

2. Bulgaria

Solid fuels had the highest share in Bulgaria's energy mix in 2015 together with petroleum products and nuclear whereas the share of renewables reached almost 11% (Figure 1). In 2015 gross inland consumption of energy in Bulgaria totalled to 18.5 Mtoe, 4.3% (+767 ktoe) higher than the consumption in 2014. Primary energy consumption was 17.9 Mtoe in 2015, 5.9% above the 2020 energy efficiency target[35]. Final energy consumption reached 9.5 Mtoe being 10.5% above the 2020 energy efficiency target for this indicator. Gross final energy consumption increased during period 2014-2015 by 5.2% (+517 ktoe) amounting to 10.5 Mtoe. Energy intensity of the economy stood at 448.5 toe/Million Eur. Bulgaria's domestic coal and nuclear electricity production influence the relatively low import dependency that reached 35.4% in 2015. Greenhouse gas emissions continued to decline at 57.7 Mt CO_2 eq in 2014, 45% below the emissions in 1990. Energy remained the main source of emissions with a share of 60% (34.6 Mt CO_2 eq). In the same year the role of renewable energy in the reduction of GHG emissions reached a net savings of 7.9 Mt CO_2 eq, an additional of 2.8 Mt CO_2 since 2009.

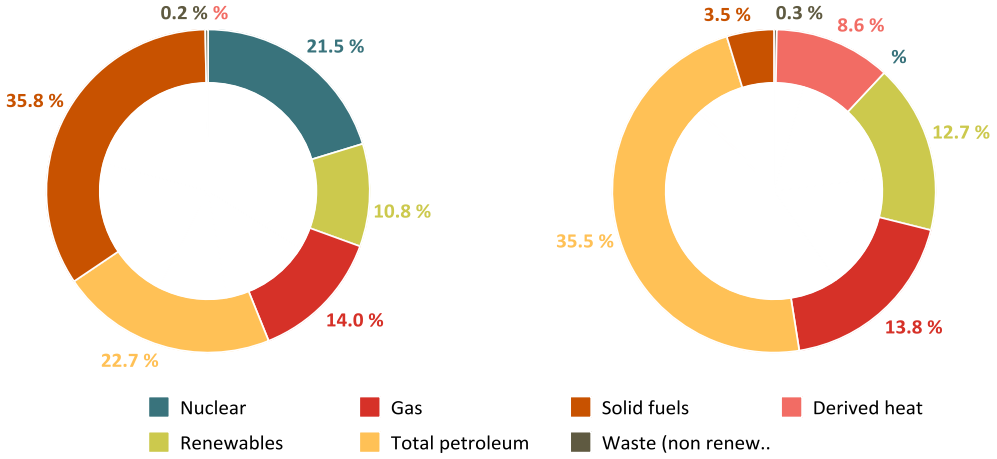


Figure 2. Breakdown of Gross Inland Consumption of Energy (left) - Final Energy Consumption (right) in BG, 2015

2.1 Final renewable energy consumption

Final renewable energy[36] consumed in Bulgaria increased with a CAGR of 6.4% (+889 ktoe) between 2005 and 2015 reaching 1927 ktoe (80.7 PJ). Almost 60% of final renewable energy in Bulgaria is consumed in heating/cooling sector and the rest in electricity sector (32.6 %) and transport sector (7.9%).

Figure 2-1 present the current trend of final renewable energy consumption in Bulgaria and the deviations (in %) from the expected developments during period 2005-2015 as well as the 2020 NREAP plan and EUCO27 projections for 2020 and 2030. As shown in this figure the current development of final renewable energy consumption in Bulgaria was above the plans during period 2010 – 2015.

The renewable energy consumed in Bulgaria is expected to further increase until 2020 with a CAGR of 1.3% to reach 2059 ktoe (86.2 PJ). In this year the transport sector is expected to more than double its relative contribution reaching 14.7% while the contributions of electricity and heating/cooling sectors are expected to be respectively 31.8% and 53.6%. The EUCO27 scenario for 2020 is in line with NREAP projecting final renewable energy consumption in Bulgaria at 2013 ktoe (84.3 PJ). For 2030 this projection reveals the final consumption of renewable energy at 2896 ktoe (121.3 PJ).

[35] Bulgaria energy efficiency 2020 targets are 16.9 Mtoe in terms of primary energy consumption and 8.6 Mtoe as final energy consumption.
[36] Final renewable energy (the sum of hydropower, solar, wind, marine, geothermal, biomass and heat pumps) in Bulgaria reached 1919.6 ktoe in 2015, up from 1031.7 ktoe in 2005.

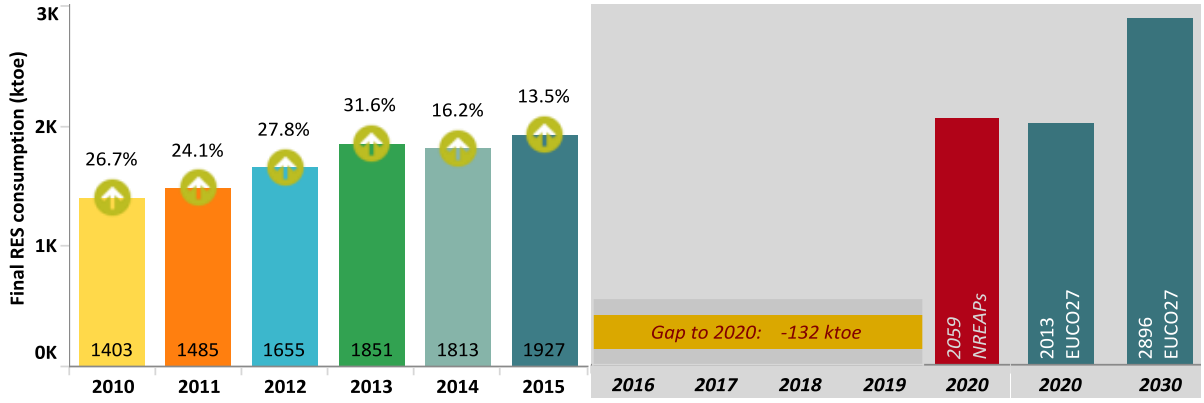


Figure 2 - 1. RES consumption: Trend, Deviation from NREAPs(2010-2015) - Expected RES consumption (2020-2030)

2.2 Renewable energy share

The overall renewable energy contribution in gross final energy consumption in Bulgaria reached 18% in 2014 and 18.2% in 2015. The 2020 planned share in Bulgaria was set to 16%. According to the EUCO27 scenario the overall renewable energy share in Bulgaria is projected to reach 21.1% in 2020 and 30.6% in 2030.

Figure 2-2 shows the current trajectory of overall renewable energy share in Bulgaria, the NREAPs trajectory, the Indicative trajectory as well as the Current trend forecast trajectory.

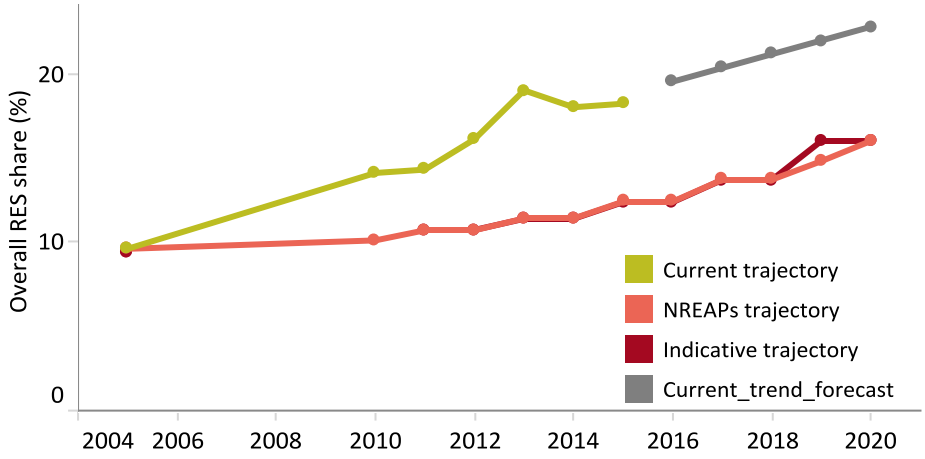


Figure 2 - 2. Overall RES share trajectories in BG: Current, NREAPs and Indicative - Current trend forecast, 2005-20

Overall renewable energy share in Bulgaria remained well above the NREAP and indicative trajectories throughout 2010-2015. Bulgaria exceeded its overall renewable energy target for 2020 (16%) already in 2012. The fastest growth in renewable energy share took place in the heating/cooling sector, which exceeded the plan for 2020 in this sector in 2010.

The share of renewable energy in heating/cooling sector exceeded since in year 2010 the 2020 planned share (23.8%) by + 0.6 percentage points. This fast development has influenced the exceedance of 2020 planned overall RES share in Bulgaria. In year 2015 this share was above the plan by +7.8 percentage points.
In electricity sector the share of renewable energy reached 18.9% in 2014 and 19.1% in 2015. Renewable energy share in this sector was found to be over the NREAP planned share in 2014, by +2.2 percentage points and in 2015 by + 0.5 percentage points. The 2020 planned share in this sector is set to 20.8%.
The share of renewable energy in transport sector reached 5.6% in 2014 and 6.6% in 2015. The share of RES in this sector was found to be above the expected shares: +1.1 percentage points in 2014 and +0.8 percentage points in 2015. The 2020 planned share in this sector is set to 10.8%.

2.3 Final renewable electricity, heating/cooling and use in transport

Final renewable electricity consumption in Bulgaria reached 7303 GWh (628 ktoe) in 2015 increasing with a CAGR of 8% from 3383 GWh (291 ktoe) in 2005. Comparing with the expected NREAPs levels final renewable electricity consumption in Bulgaria was found to be above the plans throughout period 2010-2015. In 2015 hydropower share was at 57% followed by solar photovoltaic (19.5%), wind (19.3%) and biomass (3.8%). In 2020 renewable electricity consumption in Bulgaria is expected to amount to 7604 GWh (654 ktoe) in which wind power will share 34.1% followed by hydropower (48.8%), biomass (11.4%) and solar photovoltaic (5.7%). Nevertheless, the actual picture in 2020 is likely to be different from planned also because of the faster development of solar photovoltaic that is providing an electricity share largely above the plans. The EUCO27 scenario projections show that in 2020 hydropower is expected to dominate the renewable electricity consumption (6833 GWh) in Bulgaria with 63.4%. Solar photovoltaic will cover 16.9%, wind 17.3% and biomass 2.4%. This scenario has projected that renewable electricity in Bulgaria will reach 16153 GWh (1389 ktoe) in 2030 in which wind will share 45.2%, hydropower 26.1%, solar photovoltaic 24.9% and biomass 3.8%.

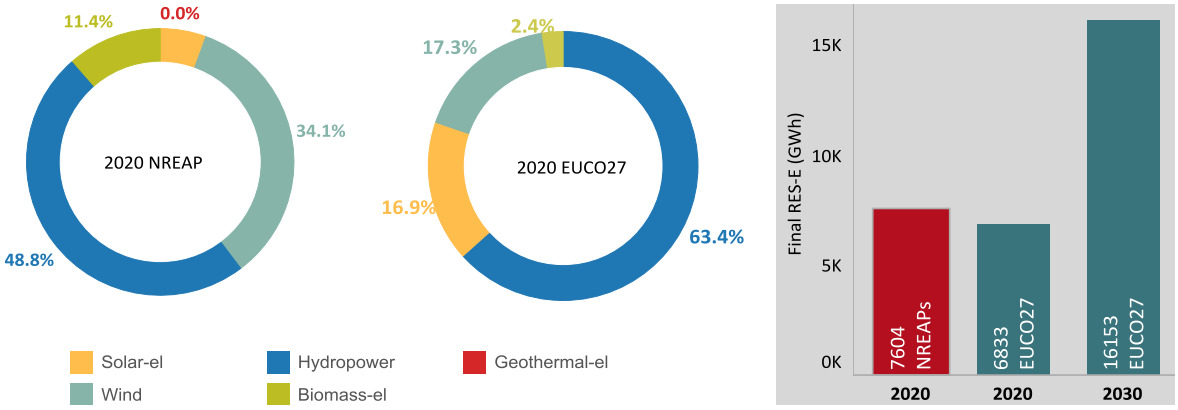


Figure 2 - 3. Final RES Electricity in Bulgaria: NREAP plan (2020) – EUCO27 projections (2020-2030)

The use of renewable energy in heating/cooling sector in Bulgaria increased with a CAGR of 4.6% (+406 ktoe) between 2005 and 2015 reaching 1146.6 ktoe (48 PJ). Comparing with the expected NREAP levels the development of renewable energy in this sector was faster than planned throughout period 2010-2015. In 2015 biomass share in final renewable heat reached almost 89% and the rest was heat pumps (6.5%), geothermal (2.9%) and solar (1.9%). Since 2012 the final use of renewable energy in this sector in Bulgaria exceeded the 2020 plan (1103 ktoe). The fast development of heat pumps in this sector is likely to change the 2020 shares of renewable energy sources in this sector that according to the NREAP are dominated by biomass (97.3%), solar thermal (1.9%) and geothermal (0.8%).

Final renewable energy used in transport sector in Bulgaria reached 152.5 ktoe (6.3 PJ) in 2015 increasing with a CAGR of 37.8% form the level of 6.2 ktoe (0.3 PJ) in the baseline year. Comparing with the expected NREAP levels this development was enough to surpass the plan only in year 2013. Biodiesel share was 80.3% followed by bioethanol-bio/ETBE (12.4%) and renewable electricity (7.4%). The use of renewable energy in transport sector in 2020 is expected to reach 302 ktoe (12.6 PJ) in which biodiesel will share 72.8%, bioethanol-bio/ETBE 19.9%, renewable electricity 5% and other biofuels 2.3%.

Table 2 - 1. Final renewable energy in BG: deviations from NREAPin electricity, heating/cooling and transport

	2010	2011	2012	2013	2014	2015
RES-el (ktoe)	79	55	103	121	78	38
RES-hc (ktoe)	233	279	323	310	188	204
RES-tr (ktoe)	-17	-45	-66	14	-13	-14
RES-el (%)	23.9	14.4	24.2	25.3	14.8	6.5
RES-hc (%)	31.5	36.5	40.4	37.2	20.9	21.6
RES-tr (%)	-46.6	-88.2	-92.8	15.2	-10.0	-8.2

2.4 Renewable energy technologies/sources

Biomass was the main renewable energy source in Bulgaria with a 54.7% contribution in renewable energy in 2015, followed by hydropower with 18.4%, biofuels with 7.6%, solar photovoltaics with 7.4%, wind with 6.2%, heat pumps with 3.9% and geothermal with 1.8%. The Bulgarian NREAP has planned to have this share among renewable energy sources in final reneable energy in 2020: biomass 56.1%, hydropower 15.6%, biofuels 14.9%, wind 10.9%, solar 2.9% and geothermal 0.4%.

In this section: (i) Figure 2-4 present the current (2009-2015) and projected trend (2016-2020) of energy from renewable technologies/sources in Bulgaria. The annual increase/decrease (%) of these sources in these two periods is also available in this figure; (ii) Table 2-2 presents how the actual figures reported for renewable technologies/sources in Bulgaria compared with what was planned for the NREAPs. Absolute differences are shown in ktoe.

Biomass use in electricity and heating/cooling sectors in Bulgaria increased with a CAGR of 4.2% (+348.5 ktoe) between 2005 and 2015 reaching 1040 ktoe (43.5 PJ). This source was above the planned levels throughout period 2010-2015. Solar technology for electricity and heating/cooling reached 140.7 ktoe (5.9 PJ) in 2015, being 2.4 times fold the 2020 plan of 58.4 ktoe (2.4 PJ). Geothermal source deployed with a CAGR of only 0.2% (+0.8 ktoe) between 2005 and 2015 reaching 33.4 ktoe (1.4 PJ), 3.7 times fold the 2020 plan of only 9 ktoe (0.4 PJ). Biofuels use in transport sector reached 144.8 ktoe (6.1 PJ) in 2015 increasing with a CAGR of 66% (+144 ktoe). Comparing with the NREAP plans biofuels use in transport were above only in year 2013.

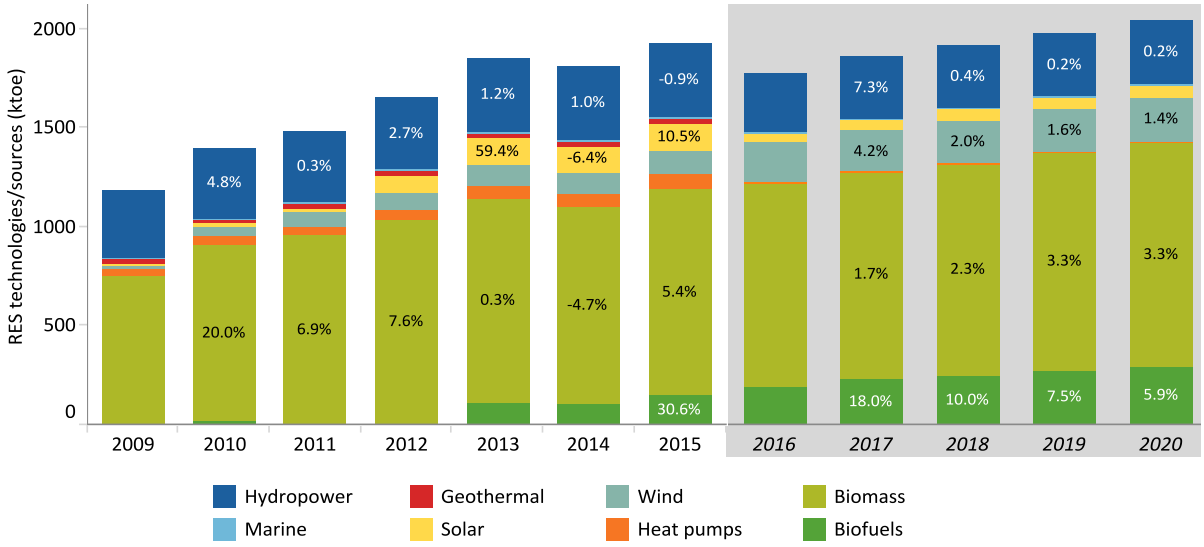


Figure 2 - 4. Annual growth of renewable energy technologies in BG: Current (2009-2015) - NREAP plan 2016-2020

Solar photovoltaic experienced the fastest development increasing with a CAGR of 251% from year 2007 level of only 0.1 GWh, reaching 1383 GWh (119 ktoe). This development was fast enough exceeding not only the expected NREAP levels throughout period 2010-2015 but more than 3 times-fold the 2020 plan. Wind power increased with a CAGR of 74% (+1362 GWh) from the very low level of 5 GWh (0.02 PJ) in 2005. Despite of this development this source didn't reach the expected NREAP throughout period 2010-2015. The development of hydropower renewable electricity between 2005 and 2015 took place with a CAGR of 2.4% (+906 GWh) reaching 4284 GWh (368 ktoe). This source developed faster than the NREAP projections throughout period 2010-2015. Biomass use for electricity reached 270 GWh (23.2 ktoe). Nevertheless these consumptions were found below the expected NREAP level during period 2012-15.

Biomass thermal was developed with a CAGR of 3.9% (+239 ktoe) between 2005 and 2015 reaching 1016.6 ktoe (42.6 PJ). This source was found above the plans throughout period

2010-2015. Solar thermal reached 21.8 ktoe (0.9 PJ) in 2015 increasing with a CAGR of 16.3% (+11.6 ktoe) from the level in 2010. This development was faster than what was planned in the NREAP exceeding the respective levels throughout period 2010-2015. Geothermal thermal absolute contribution remained almost unchanged during period 2005-2015 reaching 33.4 ktoe (1.4 PJ). Comparing with the expected NREAP levels this technology exceeded the plans throughout period 2010-2015. While no expected contribution was planned for the heat pumps, this source reached 75 ktoe (3.1 PJ) in year 2015 increasing with a CAGR of 16.2% (+58 ktoe) since 2005.

The final use of biodiesel in this sector reached 125 ktoe (5.3 PJ) in 2015 increasing with a CAGR of 63.7% (+124 ktoe) since 2005. Nevertheless this increase was found above the plans only in period 2013-14. Bioethanol/bio-ETBE final use reached 19 ktoe (0.8 PJ) in 2015 missing the plans in period 2012-13 and year 2014. Renewable electricity consumed in transport sector increased with a CAGR of only 2.2% (+2 ktoe) reaching 8 ktoe (0.3 PJ). This development was enough to exceed the planned uses throughout period 2010-2015. In 2015 only 1.2% of final renewable electricity in Bulgaria was used in transport sector.

Table 2 - 2. Renewable energy technologies/sources in Bulgaria: Deviations from NREAPs, 2010-2015 (ktoe)

	2010	2011	2012	2013	2014	2015
Hydropower	75.6	68.0	75.5	77.7	79.3	74.5
Wind	-0.1	-17.7	-30.2	-46.8	-60.7	-79.6
Solar-el	0.2	4.4	62.2	102.1	86.6	89.5
Solar-th	4.2	7.4	8.7	11.6	11.2	10.9
Geothermal-th	31.7	31.0	31.0	31.0	30.4	30.4
Biomass-el	3.0	0.1	-4.7	-12.1	-26.8	-45.8
Biomass-th	159.6	198.0	236.2	202.5	81.1	87.6
Heat pumps	37.8	42.5	47.0	64.5	65.0	74.9
Biodiesel	-22.5	-28.8	21.9	10.9	-14.1	-26.0
Bioethanol	3.0	-18.2	-88.9	3.4	0.0	11.8
Renewable electricity	2.8	2.0	1.1	0.2	1.2	0.7

2.5 Renewable electricity installed capacity

Renewable electricity installed capacity in Bulgaria increased with a CAGR of 8.0% between 2005 and 2014 reaching 3989 MW. In 2015 the main contributor in renewable electricity installed capacity was hydropower with 55.3% followed by solar photovoltaic with 25.8%, wind with 17.5% and biomass with 1.4%.

Figure 2-5 present the current trend of renewable electricity installed capacity in Bulgaria, the deviations (in %) from the expected developments during period 2005-2015, the 2020 NREAP plan and EUCO27 scenario projections for 2020 and 2030. As shown in this Figure the achieved installed capacity in Bulgaria was above the expected NREAP level throughout period 2010-2015.

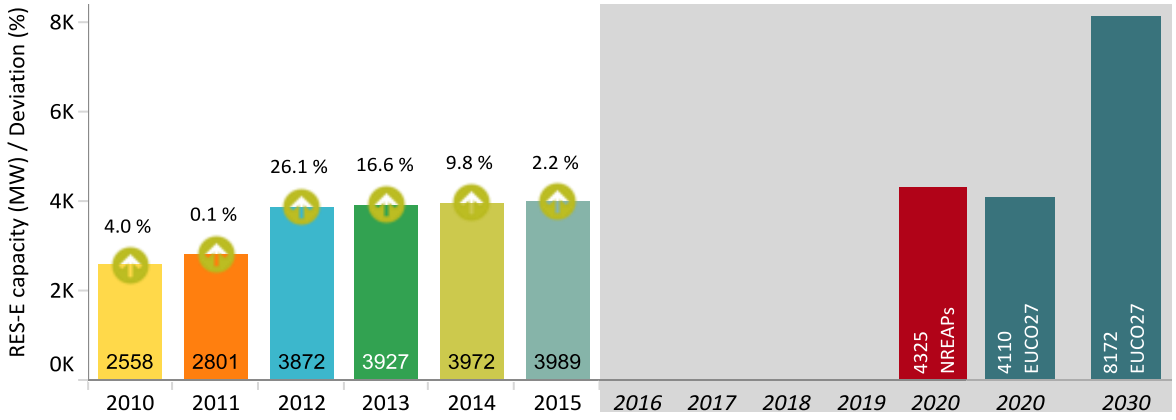


Figure 2 - 5. RES-E capacity development and deviation from NREAPs (2010-2015)– Expected capacity (2020-2030)

Solar photovoltaic reached in 2015 a capacity of 1029 MW which is more than 3 times higher the 2020 planned capacity for this technology. The main development of this technology took place between 2009 and 2012. This technology exceeded the NREAP plans throughout period 2010-2015. Wind capacity developed with a CAGR of 56.4% (+692 MW) between 2005 and 2015 reaching 700 MW. Despite of this increase this source missed the expected NREAP capacities all over period 2011-15. Only in year 2010 this technology developed faster than planned. Hydropower capacity increased slightly with a CAGR of 1.9% (+371 MW) between 2005 and 2015 reaching 2206 MW. This development was slower than the NREAP projected plans throughout period 2010-2015. Biomass capacity in Bulgaria reached 54 MW in year 2015 increasing with a CAGR of 22.7% (+47 MW) between 2005 and 2015. Nevertheless this development was faster than planned only in year 2011. In other years of period 2010-2015 the deployment of this source was found below the expectations.

In 2020 Bulgaria has planned to have installed 4325 MW of renewable energy in which hydropower will still remain the main source of renewable energy mix in Bulgaria (56%). Wind power is expected to almost double its share reaching 33%, while solar capacity share will be decreased by nearly 4 times reaching 7%. The share of biomass is expected to reach 4% in Bulgarian renewable energy mix in 2020.

The EUCO27 projections for 2020 are broadly consistent with NREAPs in forecasting a net generation capacity of 4110 MW projecting almost the same contribution from hydropower (57%). According to these projections in 2030 Bulgaria is expected to have installed 8172 MW of renewable electricity in which solar electricity is excpected to be the main source.

3. Czech Republic

The energy mix in Czech Republic has significantly changed over last 25 years being more diversified. In 2015 the gross inland consumption of energy totalled to 42.4 Mtoe, 0.5% (+202 ktoe) higher than the consumption in 2014. Solid fuels had the highest share together with petroleum products and nuclear whereas the share of renewables reached 10% (Figure 3). Consumption of energy in primary terms was almost 40 Mtoe in 2015, 0.8% above the 2020 energy efficiency target[37]. Final energy consumption reached 24.1 Mtoe being 1.2% below the 2020 energy efficiency target for this indicator. Gross final energy consumption increased during period 2014-2015 by 2.5% (+619 ktoe) amounting to 25.7 Mtoe. Energy intensity of the economy continue decreasing reaching 251 toe/Million Eur. Czech Republic has a relatively low import dependency which nevertheless increased in 2015 to 31.9% compared with 27.8% in 2005. Its import dependence on petroleum products and gas remained still higher, respectively 97.8% and 95%. Greenhouse gas emissions decreased by 36.5% since 1990 reaching 126.8 Mt CO_2 eq in 2014. Energy remained the main source of emissions with a share of 61.4% (78 Mt CO_2 eq). In the same year the role of renewable energy in the reduction of GHG emissions reached a net savings of 8.9 Mt CO_2 eq, only 0.6 Mt CO_2 additional since 2011.

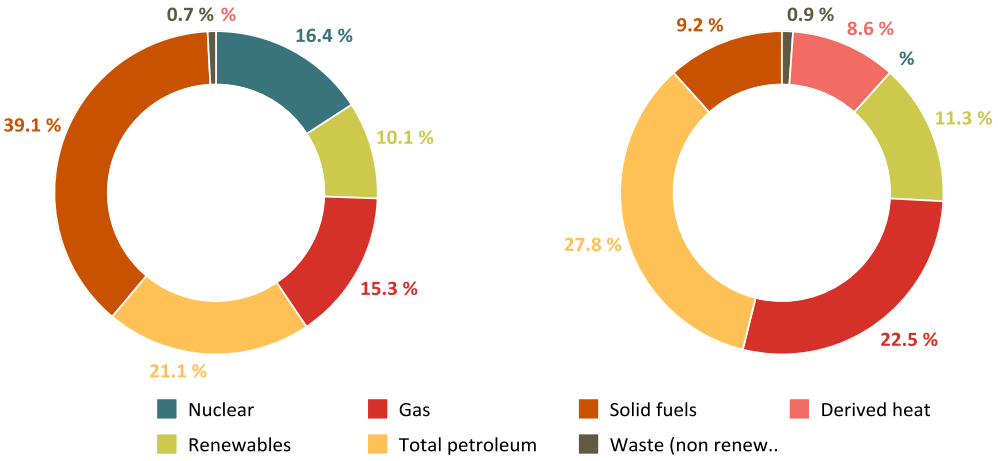


Figure 3. Breakdown of Gross Inland Consumption of Energy (left) - Final Energy Consumption (right) in CZ, 2015

3.1 Final renewable energy consumption

Final renewable energy[38] consumed in Czech Republic increased with a CAGR of 7% (+1917 ktoe) between 2005 and 2015 reaching 3908 ktoe (163.6 PJ). Almost 70% of final renewable energy was consumed in heating/cooling sector and the rest in electricity sector (21.7%) and transport sector (8.5%).

Figure 3-1 present the current trend of final renewable energy consumption in Czech Republic and the deviations (in %) from the expected developments during period 2005-2015 as well as the 2020 NREAP plan. As shown in this figure, the current development of final renewable energy consumption in Czech Republic was over the plans throughout period 2010 – 2015.

Renewable energy consumed in Czech Republic is expected to further increase to 4173 ktoe (174.7 PJ) until 2020. Transport sector is expected to two fold its relative contribution up to 16.6% whereas the contribution of electricity and heating/cooling sectors are expected to reach respectively 21.9% and 61.5%. The EUCO27 scenario for 2020 is lower than the NREAP level projecting final renewable energy consumption in Czech Republic at 3578 ktoe (149.8 PJ). For 2030 this projection reveals the final consumption of renewable energy at 4752 ktoe (199 PJ).

[37] Czech Republic energy efficiency 2020 targets are 39.6 Mtoe in terms of primary energy consumption and 24.4 Mtoe as final energy consumption.
[38] Final renewable energy (the sum of hydropower, solar, wind, marine, geothermal, biomass and heat pumps) in Czech Republic reached 3873.5 ktoe in 2015, up from 1965 ktoe in 2005.

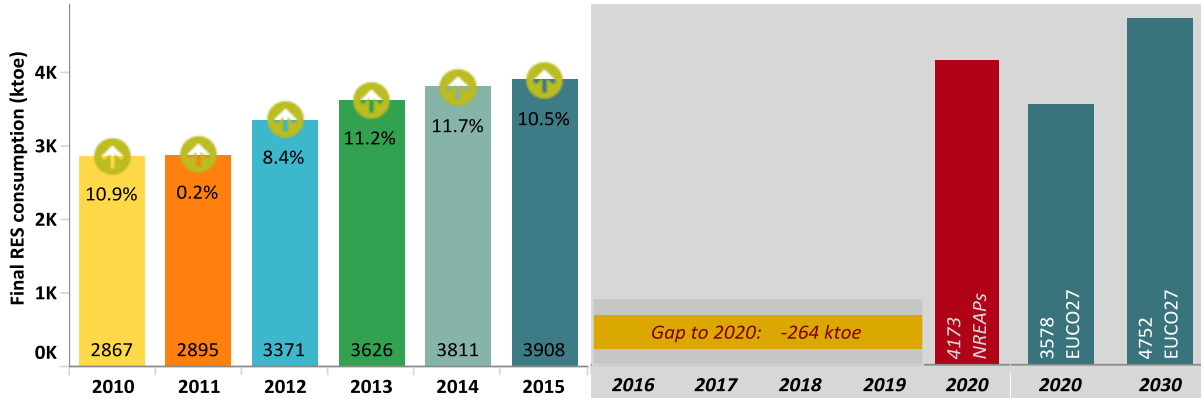


Figure 3 - 1. RES consumption: Trend, Deviation from NREAPs(2010-2015) - Expected RES consumption (2020-2030)

3.2 Renewable energy share

The overall renewable energy contribution in gross final energy consumption in Czech Republic reached 13.4% in 2014 and 15.1% in 2015. The 2020 target of overall RES share for Czech Republic is 14%. According to the EUCO27 scenario the overall renewable energy share in Czech Republic is projected to reach 13.6% in 2020 and 18.4% in 2030.

Figure 3-2 shows the current trajectory of overall renewable energy share in Czech Republic, the NREAPs trajectory, the Indicative trajectory as well as the Current trend forecast trajectory.

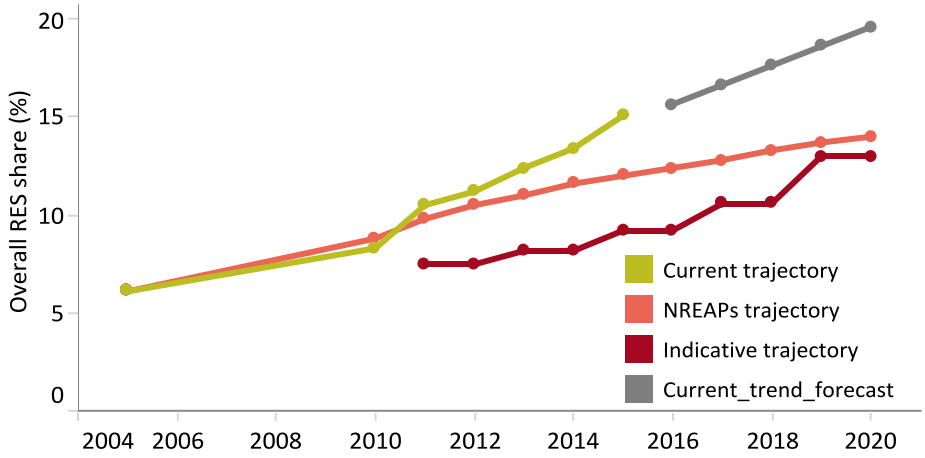


Figure 3 - 2. Overall RES share trajectories in CZ: Current, NREAPs and Indicative - Current trend forecast, 2005-20

Overall renewable energy share in the Czech Republic remained above the not very steep NREAP and indicative trajectories throughout 2011-15. In 2015 overall renewable energy share in the Czech Republic exceeded the 2020 target of 14%. The deployment of renewable energy was faster in both the heating/cooling and electricity sectors, already exceeding in 2015 the planned renewable energy shares for the two sectors for 2020.

Renewable energy share in electricity sector reached 13.9% in 2014 and 14.1% in 2015. The share of renewable energy in this sector exceeded in 2014 by 0.4 percentage points the planned share for 2020 (13.5%).

The renewable energy share in heating/cooling sector reached 16.8% in 2014 and 19.8% in 2015. Czech Republic exceeded since in 2012 by 0.8 percentage points the 2020 plan (15.5%) in this sector.

Renewable energy share in transport sector reached 6.9% in 2014 and 6.45% in 2015. The 2020 plan for renewable energy share in this sector is 10.8%.

3.3 Final renewable electricity, heating/cooling and use in transport

Renewable electricity consumption in Czech Republic amounted to 9952 GWh (848 ktoe) in 2015 increasing with a CAGR of 14.5% since 2005. In 2015 biomass share in final renewable electricity consumption was 48.5% followed by hydropower with 23.2%, solar photovoltaic with 22.9% and wind with 5.3%. Comparing with the expected NREAPs levels final renewable electricity consumption in Czech Republic was found to be above the plans throughout period 2010-2015. In 2020 the renewable electricity consumption in Czech Republic is expected to amount to 10626 GWh (914 ktoe) in which biomass is expected to reach a contribution of 42.2% followed by hydropower with 25.5%, solar photovoltaic with 22.6%, wind with 9.5% and geothermal with 0.2%. The EUCO27 scenario projections show that in 2020 hydropower is expected to dominate the renewable electricity consumption (6366 GWh) in Czech Republic with nearly 40%. Solar photovoltaic will cover 34.3%, biomass 17.3% and wind 8%. This scenario has projected that renewable electricity in Czech Republic will reach 14953 GWh (1286 ktoe) in 2030 in which wind will share 41.6%, biomass 24.2%, hydropower 17.3% and solar photovoltaic 16.8%.

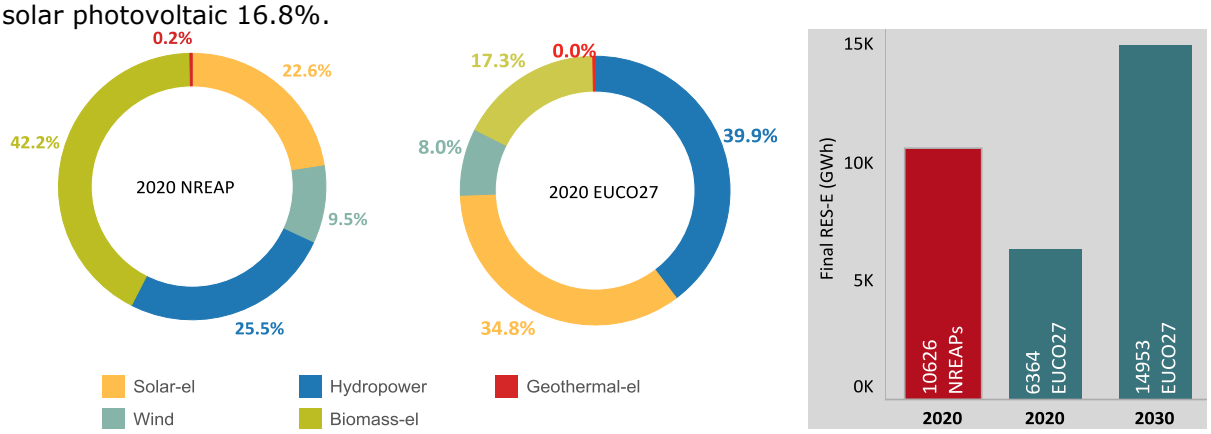


Figure 3 - 3. Final RES Electricity in Czech Republic: NREAP plan (2020) – EUCO27 projections (2020-2030)

The use of renewable energy in heating/cooling in Czech Republic increased with a CAGR of 4.6% between 2005 and 2015 reaching 2728.6 ktoe (114.2 PJ). This development was found above the planned NREAP levels throughout period 2010-2015. In 2014 the final renewable heat/cold in Czech Republic exceeded the 2020 plan (2565 ktoe) by 2.9% (+76 ktoe). In 2015 the contribution of biomass reached almost 96% and the rest was 3.3% heat pumps and 0.6% solar thermal. In 2020 the share of biomass in total renewable heat expected to reach 92% whereas the other technologies/sources will share: heat pumps 6.1%, solar thermal 1.2% and geothermal thermal 0.6%.

The use of renewable energy in transport sector reached 331.6 ktoe (13.9 PJ) in 2015 increasing with a CAGR of 26.8% (+300 ktoe) between 2005 and 2015. This development was slower than planned in the Czech Republic NREAP throughout period 2011-15. Only in year 2010 the final use of renewable energy in this sector was found above the planned use. In 2015 biodiesel share in total renewable energy consumed in this sector was 70.4% while the rest was 19.1% bioethanol/bio-ETBE and 10.6% renewable electricity. In 2020 Czech Republic has planned to use 694 ktoe (29 PJ) of its final renewable energy in transport sector. The expected share of renewable energy sources in this final use will be dominated still by biodiesel that is planned to reach 71.3% and the rest will be: 18.4% bioethanol/bio-ETBE, 7.1% other biofuels and 3.2% renewable electricity.

Table 3 - 1. Final renewable energy in CZ: deviations from NREAP in electricity, heating/cooling and transport

	2010	2011	2012	2013	2014	2015
RES-el (ktoe)	3	7	11	33	52	46
RES-hc (ktoe)	265	256	274	395	414	449
RES-tr (ktoe)	15	-259	-24	-64	-67	-123
RES-el (%)	0.7	1.2	1.6	4.5	6.8	5.7
RES-hc (%)	14.0	13.0	13.1	18.3	18.6	19.7
RES-tr (%)	6.3	-90.8	-7.5	-17.3	-16.1	-27.1

3.4 Renewable energy technologies/sources

Biomass is the main renewable energy source in Czech Republic with a contribution in renewable energy mix in 2015 equal to 78.3%, followed by biofuels with 7.7%, solar with 5.5%, hydropower with 5.1%, heat pumps with 2.3% and wind 1.2%. In 2020, the share of biomass in final renewable energy is expected to reach 66% while biofuels contributions will be 16%. Solar and hydropower wil contribute respectively with 6% and 7%, while heat pumps and wind will share 4% and 2% respectively.

In this section: (i) Figure 3-4 present the current (2009-2015) and NREAP projected trend (2016-2020) of energy from renewable technologies/sources in Czech Republic. The annual increase/decrease (%) of these sources in these two periods is also available in this figure; (ii) Table 3-2 presents how the actual figures reported for renewable technologies/sources in Czech Republic compared with what was planned for the NREAPs. Absolute differences are shown in ktoe.

Solar technology used for electricity and heat purposes increased with a CAGR of 56% (+210 ktoe) during period 2005-2015 reaching 212.4 ktoe (8.9 PJ). Despite of this increase this technology was found below the expected NREAP plans throughout period 2010-2015. Biofuels consumed in transport sector increase during period 2005-2015 with a CAGR of 54.2% (+292.6 ktoe) reaching a use of 296.5 ktoe (12.4 PJ). This development was enough to meet the respective NREAP plans throughout period 2010-2014 but not in year 2015. The use of biomass in electricity and heating/cooling sectors developed with a CAGR of 5.4% (+1244 ktoe) during period 2005-2015 reaching 3032 ktoe (127 PJ). The development of this source was faster than planned exceeding since in 2013 by 2.8% (+77 ktoe) the 2020 plan (2747 ktoe). Even that planned no contribution from geothermal technology was reported for all period 2010-2015.

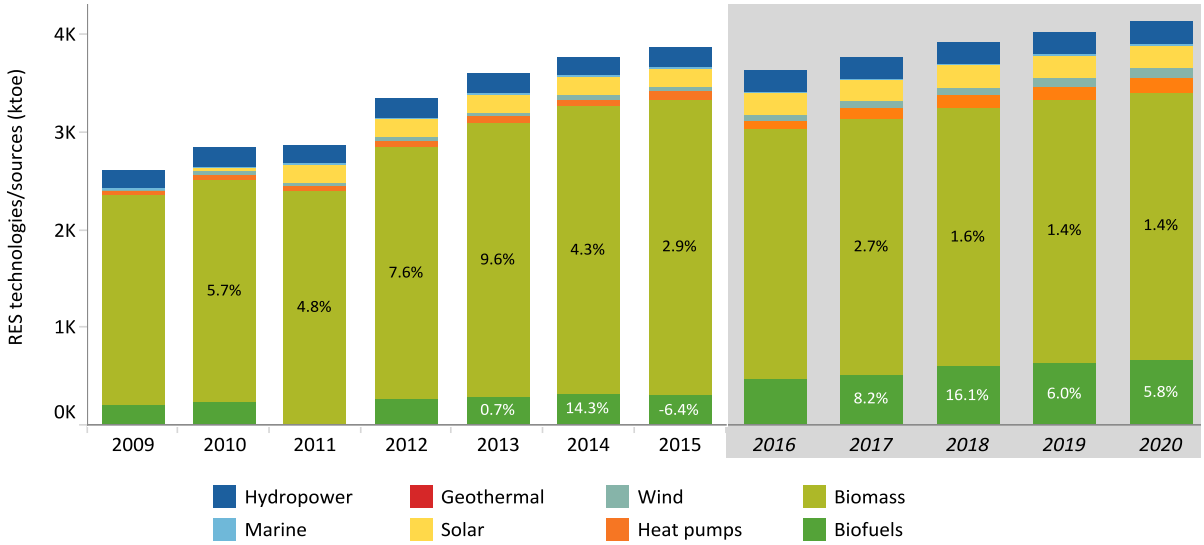


Figure 3 - 4. Annual growth of renewable energy technologies in CZ: Current (2009-2015) - NREAP plan 2016-2020

Renewable electricity originated from solar photovoltaic reached 2264 GWh (194.7 ktoe) in 2015 increasing with a CAGR of 136.5% (+2263 GWh) since 2005. Despite of this increase this technology met the NREAP plans only in year 2011 missing those in all other years of period 2010-2015. Wind power developed with a CAGR of 41.7% (+505 GWh) during period 2005-2015 reaching 521 GWh (44.8 ktoe). This progress met the plans only in year 2012 missing those in other years of period 2010-2015. Biomass used in this sector increased with a CAGR of 20.7% (+4057 GWh) during period 2005-2015 reaching 4789 GWh (412 ktoe). This source exceeded since in 2012 by 4% (179.5 GWh) the expected plan for 2020 (4484 GWh). Hydropower source had an increase with a CAGR of 2.8% (+671 GWh) between 2005 and 2014 over 1618 GWh (5.8 PJ) in the baseline year. Nevertheless this development was not fast enough to exceed the expected NREAP plan in both 2013 and 2014: 0.6% (-14 GWh) under in 2013 and 4.3% (-104 GWh) under in 2014.

Solar thermal increased since 2005 with a CAGR of 21.8% (+15 ktoe) reaching 17.7 ktoe (0.7 PJ) in 2015. This development was enough to exceed the plans only in period 2012-13. Biomass thermal increased with a CAGR of 4.3% (+895 ktoe) between 2005 and 2015 reaching 2620 ktoe (110 PJ). This development was faster than planned throughout period 2010-2015 exceeding since in 2013 by 4.8% (+114 ktoe) the 2020 plan (2361 ktoe). Heat pumps increased with a CAGR of 19.4% (+76 ktoe) over the 2005 level reaching 91 ktoe (3.8 PJ). This technology was found to be over the NREAP plans throughout period 2010-2015.

Biodiesel use in transport sector increased with a CAGR of 51% (+232 ktoe) during period 2005-2015 reaching 236 ktoe (9.9 PJ). This development was not as fast as planned during period 2012-15. Bioethanol/bio-ETBE use in transport sector reached 61 ktoe (2.6 PJ) in 2015 missing nevertheless almost all plans for period 2010-2015. The use of renewable electricity in transport increased with a CAGR of 2.7% (+8 ktoe) between 2005 and 2015 surpassing the expected NREAP pland throughout period 2010-2015. In 2015 Czech Republic used 4.1% of its final renewable electricity in transport sector.

Table 3 - 2. Renewable energy technologies/sources in Czech Republic – deviations from NREAP, 2010-2015, (ktoe)

	2010	2011	2012	2013	2014	2015
Hydropower	0.2	0.0	-2.9	-1.0	-9.0	-14.1
Wind	-0.1	0.0	0.0	-2.2	-7.3	-11.0
Solar-el	0.0	0.0	-3.6	-15.9	-10.4	-1.0
Solar-th	-0.3	-0.1	0.4	0.0	-0.5	-1.3
Geothermal-el	0.0	0.0	0.0	-0.7	-1.5	-1.5
Geothermal-th	0.0	0.0	0.0	-9.0	-15.0	-15.0
Biomass-el	3.1	7.4	17.7	52.7	80.3	73.8
Biomass-th	257.2	249.1	261.9	403.6	427.9	461.9
Heat pumps	7.9	7.2	11.7	0.5	1.7	3.0
Biodiesel	0.2	18.5	-31.8	-59.4	-66.0	-113.7
Bioethanol	-2.0	-293.5	-8.9	-20.5	-16.2	-27.8
Renewable electricity	16.8	16.2	16.3	15.7	15.5	18.1

3.5 Renewable electricity installed capacity

Renewable electricity installed capacity in Czech Republic increased with a CAGR of 13.5% (+3011 MW) between 2005 and 2015 reaching 4192 MW. In 2015 solar technology presented 49% of renewable electricity installed capacity in Czech Republic followed by hydropower with 26%, biomass with 18% and wind with 7%.

Figure 3-5 present the current trend of renewable electricity installed capacity in Czech Republic, the deviations (in %) from the expected developments during period 2005-2015, the 2020 NREAP plan and EUCO27 scenario projections for 2020 and 2030. As shown in this Figure, the achieved installed capacity in Czech Republic was above the expected NREAP plans throughout period 2010-2015.

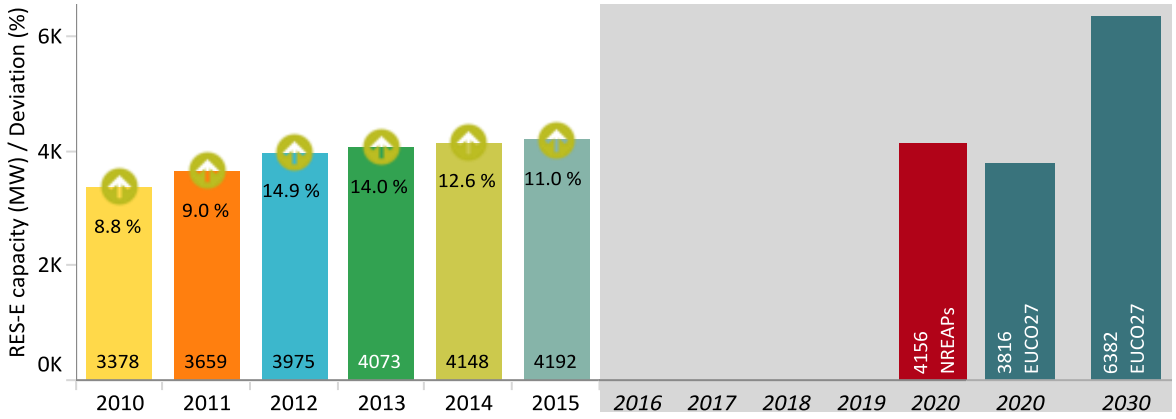


Figure 3 - 5. RES-E capacity development and deviation from NREAPs (2010-2015)– Expected capacity (2020-2030)

Solar photovoltaic had the fastest development between 2005 and 2015 with a CAGR of 114.6% (+2074 MW) over the very low level of 1 MW in the baseline year. This technology was found above the expected NREAP capacities only during period 2012-15. Wind power capacity developed with a CAGR of 29% (+259 MW) between 2005 and 2015 reaching 281 MW. Nevertheless the deployment of this technology was faster than expected only in year 2012 missing the plans in other years of period 2010-2015. Biomass capacity developed with a CAGR of 18.4% (+610 MW) between 2005 and 2015 reaching 748 MW. This development was fast enough to exceed the expected NREAP capacities throughout period 2010-2015. Hydropower capacity developed with a CAGR of 0.6% (+68 MW) between 2005 and 2015 reaching 1088 MW. This technology missed the NREAP plan only in year 2011.

The expected 2020 renewable capacity in Czech Republic is 4156 MW in which solar will remain the main contributor in renewable installed capacities with 51% followed by hydropower with 26%, wind with 14% and biomass with 9%.

The EUCO27 scenario has projected a lower installed capacity in Czech Republic compared with its NREAP, at 3816 MW, with a higher contribution from solar photovoltaic (61%). According to these projections in 2030 Czech Republic is expected to have installed 6382 MW of renewable electricity, in which wind and solar photovoltaic will be the main sources.

4. Denmark

The share of renewables in Denmark's 2015 energy mix five folded comparing with 6% in 1995 being the second source in GIC after petroleum products (Figure 4). In 2015 gross inland consumption of energy in Denmark totalled to 16.7 Mtoe, 0.2% (-36.7 ktoe) less than the consumption in 2014. Primary energy consumption was 16.5 Mtoe in 2015, 7.3% below the 2020 energy efficiency target[39]. Final energy consumption reached 13.9 Mtoe being 6.1% below the 2020 energy efficiency target for this indicator. Gross final energy consumption in Denmark reached almost 15 Mtoe in 2015 increased by 3.2% (+464.6 ktoe) comparing with 2014. Energy intensity of the economy continues its downward trend to 65 toe/Million Eur in 2015. Denmark has a very low import dependency for all products, at 13% in 2015. Nevertheless the import dependence for solid fuels is high, at 85%. Greenhouse gas emissions reached 53.9 Mt CO_2 eq in 2014, 25.6% below the emissions in 1990. Energy remained the main source of emissions with a share of 45.8% (24.7 Mt CO_2 eq). In the same year the role of renewable energy in the reduction of GHG emissions reached a net savings of 17.7 Mt CO_2 eq, an additional of 5.7 Mt CO_2 since 2009.

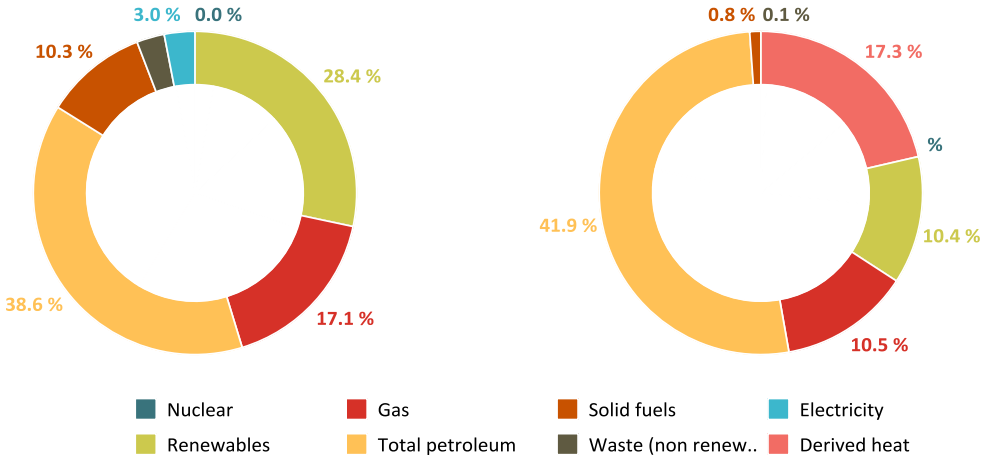


Figure 4. Breakdown of Gross Inland Consumption of Energy (left) - Final Energy Consumption (right) in DK, 2015

4.1 Final renewable energy consumption

Final renewable energy[40] consumed in Denmark increased with a CAGR of 5% (+1994 ktoe) during period 2005-2015 reaching 4636 ktoe (194 PJ) in 2015. More than 61% of renewable energy in Denmark is consumed in heating/cooling sector and the rest in electricity sector (33.2%) and transport sector (5.3%).

Figure 4-1 present the current trend of final renewable energy consumption in Denmark and the deviations (in %) from the expected developments during period 2005-2015 as well as the 2020 NREAP plan and EUCO27 projections for 2020 and 2030. As shown in this figure the current development of final renewable energy consumption in Denmark didn't fulfil the respective plans during period 2011 – 2014.

The renewable energy consumed in Denmark is expected to further increase to 5090 ktoe (213 PJ) until 2020. The share of the contributions between sectors will remain almost unchanged with heating/cooling sector dominating with 59.5% followed by electricity sector with 34.8% and transport sector with 5.7%. The EUCO27 scenario for 2020 is slightly higher than the NREAP level projecting final renewable energy consumption in Denmark at 5227 ktoe (219 PJ). For 2030 this projection reveals the final consumption of renewable energy at 6524 ktoe (273 PJ).

[39] Denmark energy efficiency 2020 targets are 17.8 Mtoe in terms of primary energy consumption and 14.8 Mtoe as final energy consumption.
[40] Final renewable energy (the sum of hydropower, solar, wind, marine, geothermal, biomass and heat pumps) in Denmark reached 4621.6 ktoe in 2015, up from 2634.6 ktoe in 2005.

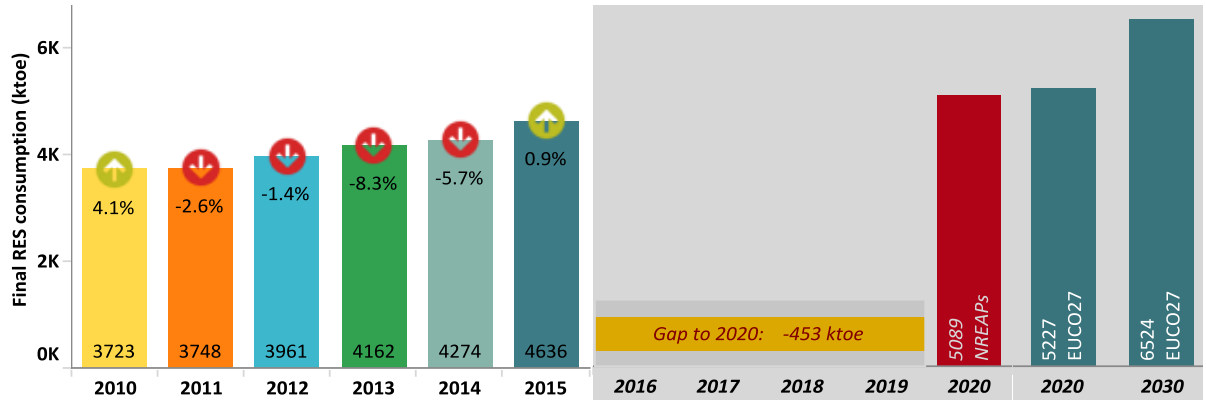


Figure 4 - 1. RES consumption: Trend, Deviation from NREAPs(2010-2015) - Expected RES consumption (2020-2030)

4.2 Renewable energy share

The overall renewable energy contribution in gross final energy consumption in Denmark reached 28.5% in 2014 and 30.8% in 2015. The 2020 target that Denmark has to reach for the overall renewable energy share is 30.4%. According to the EUCO27 scenario the overall renewable energy share in Denmark is projected to reach 33.9% in 2020 and 44.5% in 2030.

Figure 4-2 shows the current trajectory of overall renewable energy share in Denmark, the NREAPs trajectory, the Indicative trajectory as well as the Current trend forecast trajectory.

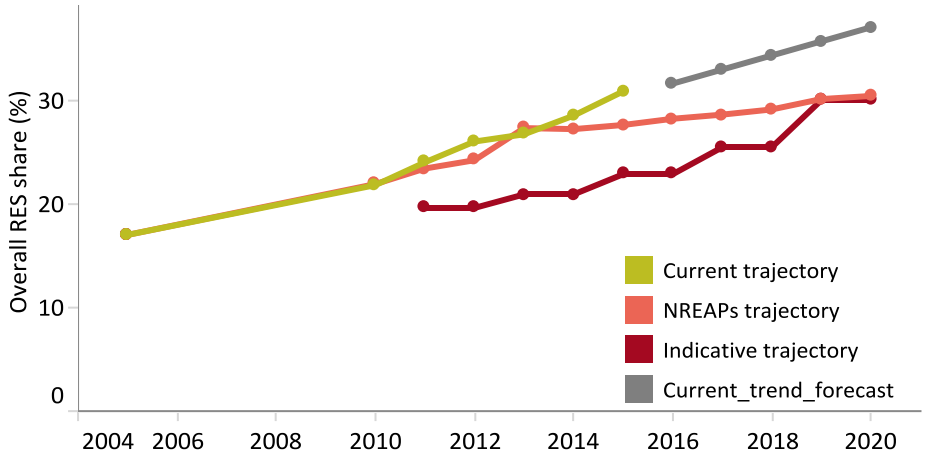


Figure 4 - 2. Overall RES share trajectories in DK: Current, NREAPs and Indicative - Current trend forecast, 2005-20

After a decrease in 2013, overall renewable energy share in Denmark remained above the NREAP and indicative trajectories, even in 2015. In that year the overall renewable energy share in Denmark exceeded the 2020 target of 30.4%.

Renewable energy share in electricity sector in Denmark reached 48.5% in 2014 and 51.3% in 2015 exceeding the NREAP respective plans in both years: +3.0 and +5.6 percentage points respectively. The 2020 plan for renewable electricity share is foreseen to reach 51.9%.

The share of renewable energy in heating/cooling sector reached 37.9% in 2014 and 39.6% in 2015. The development was enough to exceed the expected NREAP shares in both years: +2.6 and +3.6 percentage points respectively. The plan for renewable heat/cold share in 2020 is 39.8%

The renewable energy share in transport sector reached almost 6.7% in each year of period 2014-2015; exceeding by +0.6 percentage points each planned share during this period. The 2020 renewable energy share planned to be reached in this sector in Denmark is 10.1%.

4.3 Final renewable electricity, heating/cooling and use in transport

The development of renewable energy in electricity sector between 2005 and 2015 in relative terms took place with a CAGR of 6.8% (+8620 GWh) reaching the amount of 17891 GWh (1538.6 ktoe). In 2015 wind provided 73% of final renewable electricity and the rest was 23.5% biomass, 3.4% solar photovoltaic and 0.1% hydropower. Compared with expected developments renewable electricity in Denmark was below the plans throughout period 2010 – 14. In 2020 renewable electricity consumption in Denmark is expected to amount to 20594 GWh (74.1 PJ). According to actual NREAP in 2020 the two main contributors are in final renewable electricity in Denmark will be wind with 56.9% and biomass with 43%. The share of hydropower is set to 0.2%. Nevertheless, the actual picture in 2020 is likely to be different from planned also because of the faster development of solar photovoltaic that is providing an electricity share largely above the plans. The EUCO27 scenario projections show that in 2020 wind is expected to dominate the renewable electricity consumption (25538 GWh) in Denmark with nearly 60%. Solar photovoltaic will cover 3%, biomass 33.1% and other RES (mainly geothermal) 3.8%. This scenario has projected that renewable electricity in Denmark will reach 34050 GWh (2928 ktoe) in 2030 in which wind will share 68.8%, biomass 26%, solar photovoltaic 2.3% and other RES 2.8%.

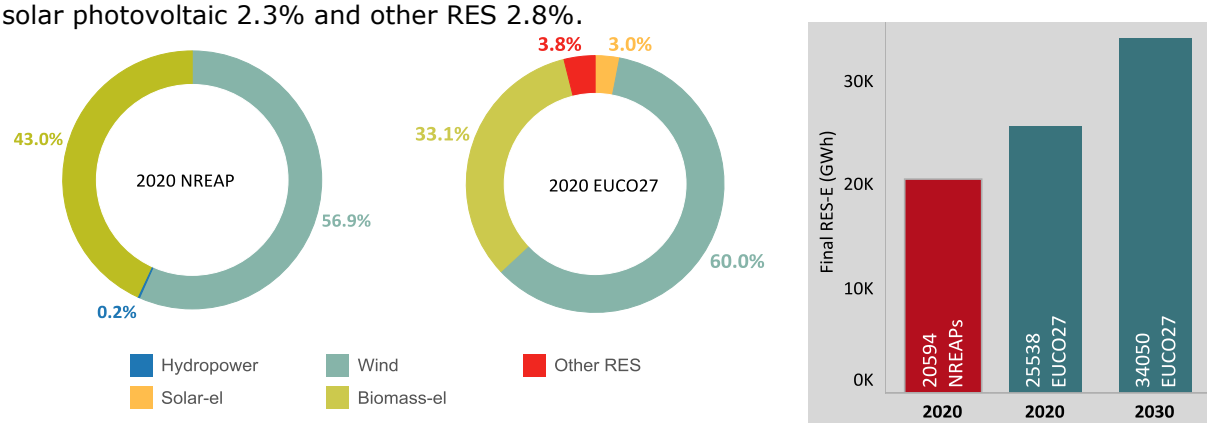


Figure 4 - 3. Final RES Electricity in Denmark: NREAP plan (2020) – EUCO27 projections (2020-2030)

The development of renewable energy in heating/cooling sector between 2005 and 2015 took place with a CAGR of 4.5% (+1014 ktoe) reaching 2851 ktoe (119.4 PJ). In 2015 biomass provided 92.5% of final renewable heat production and the rest was covered by heat pumps with 6.3%, solar with 1.2% and geothermal with 0.1%. Comparing with the NREAP levels renewable heat/cold in Denmark surpassed the plans only in year 2010 and 2015. The heat coming from renewable energy sources in Denmark is expected to reach 3028 ktoe (126.8 PJ) in 2020. According to Denmark NREAP biomass is expected to produce 87.3% of final renewable heat and the rest will be 12.2% heat pumps and 0.5% solar thermal.

In relative terms renewable energy consumed in transport sector developed with a CAGR of 41.5% over the period 2005-2015 reaching 246.7 ktoe (10.3 PJ). Nevertheless the development was not fast enough to meet the NREAP planned values throughout period 2010-2015. Biodiesel has the main use among renewable energy sources in this sector with a share of 94% and the rest was renewable electricity with 6%. The consumption of renewable energy in transport sector in 2020 is expected to be 290 ktoe (12.1 PJ). In this year biodiesel share in total renewable energy consumed in this sector is expected to be 57.6% followed by bioethanol/bio-ETBE with 32.4% and renewable electricity with 10%.

Table 4 - 1. Final renewable energy in DK: deviations from NREAP in electricity, heating/cooling and transport

	2010	2011	2012	2013	2014	2015
RES-el (ktoe)	-5	-33	-3	-145	-7	50
RES-hc (ktoe)	160	-55	-33	-211	-234	10
RES-tr (ktoe)	-6	-12	-21	-21	-16	-19
RES-el (%)	-0.5	-2.9	-0.2	-9.9	-0.5	3.3
RES-hc (%)	6.5	-2.2	-1.3	-7.5	-8.4	0.4
RES-tr (%)	-14.8	-7.8	-8.0	-8.3	-6.2	-7.3

4.4 Renewable energy technologies/sources

Biomass is the main renewable energy source in Denmark with a 66% contribution in final renewable energy in 2015, followed by wind with 25%, biofuels with 5%, heat pumps with 4% and solar with 2%. In 2020, the share of renewable energy sources in renewable energy mix in Denmark is expected to slightly change from the structure in year 2014: biomass with 67%, wind with 20%, heat pumps with 7%, biofuels with 5% and solar with 1%.

In this section: (i) Figure 4-4 present the current (2009-2015) and NREAP projected trend (2016-2020) of energy from renewable technologies/sources in Denmark. The annual increase/decrease (%) of these sources in these two periods is also available in this figure; (ii) Table 4-2 presents how the actual figures reported for renewable technologies/sources in Denmark compared with what was planned for the NREAPs. Absolute differences are shown in ktoe.

Solar (electricity and thermal) deployed with a CAGR of 23.8% (+76 ktoe) between 2005 and 2015 reaching 86 ktoe (3.6 PJ). This source was found above the NREAP plans throughout period 2010-2015 exceeding since in 2011 the plan for year 2020 (16.3 ktoe). Biomass used in electricity and heating/cooling sector developed with a CAGR of 4% (+975 ktoe) during this period reaching 2998 ktoe (125.5 PJ). This development was slower than the NREAP projected one only during period 2013-15. Biofuels use in transport sector reached 232 ktoe (9.7 PJ) in 2015, an increase not fast enough to meet the NREAP plans throughout period 2010-2015.

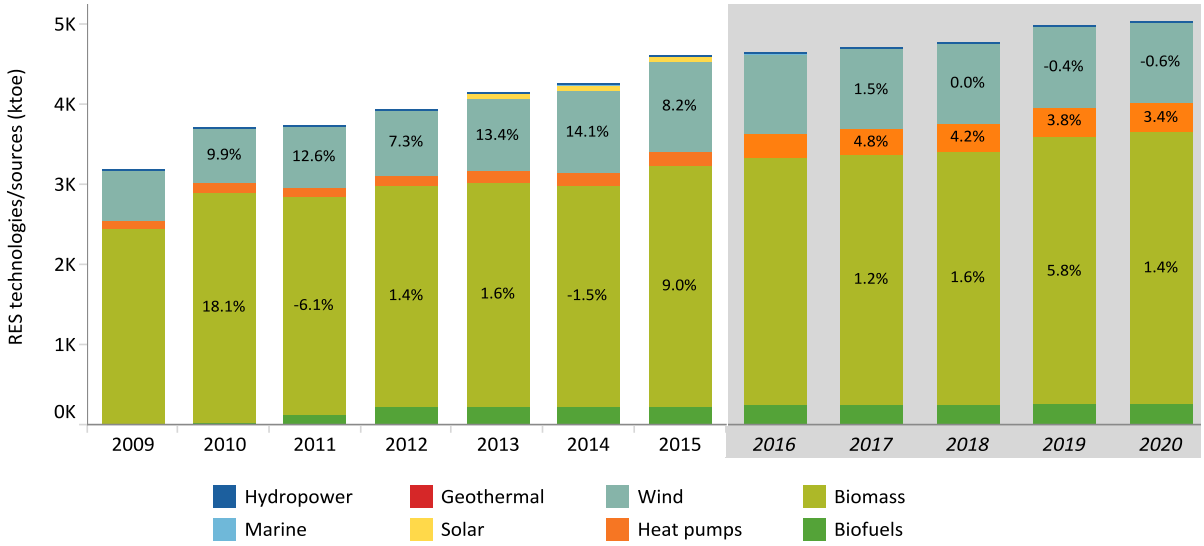


Figure 4 - 4. Annual growth of renewable energy technologies in DK: Current (2009-2015) - NREAP plan 2016-2020

Renewable electricity from solar photovoltaic increased with a CAGR of 75.7% (+602 GWh) between 2005 and 2015 reaching 604 GWh (52 ktoe). This technology deployed faster than planned throughout period 2010-2015 exceeding since in 2012 the plan for year 2020 (4 GWh). Wind power developed with a CAGR of 8% (+6995 GWh) between 2005 and 2015 reaching 13063 GWh (1123 ktoe). This technology was found above the NREAP plans only during period 2014-2015 exceeding in 2014 by 3.1% (+360 GWh) the plan for 2020 (11713 GWh). Biomass electricity increased with a CAGR of 2.9% (+1033 GWh) between 2005 and 2015, reaching 4206 GWh (361.8 ktoe). This development was not enough to surpass the expected NREAP consumptions during period 2013-15. Even that an increase was planned in renewable electricity from hydropower during period 2005-2015 in fact a decrease with a CAGR of -5.5% (-13 GWh) reaching 16 GWh (1.4 ktoe).

Heat production from solar thermal increased with a CAGR of 13% (+24 ktoe) during period 2005-2015 reaching nearly 34 ktoe (1.4 PJ). Comparing with expected NREAP levels this technology was found above throughout period 2010-2015 exceeding since in 2011 (17.6

ktoe) the plan for year 2020 (16 ktoe). Heat pumps contribution increased with a CAGR of 9% (+104 ktoe) since 2005 reaching 179 ktoe (7.5 PJ) in 2015. Despite this increase the heat pumps missed the NREAP planned heat throughout period 2010-2015. Biomass heat developed with a CAGR of 4.2% (+887 ktoe) between 2005 and 2015 reaching 2636 ktoe (110.4 ktoe). Heat coming from this source missed the NREAP plans only durinh period 2013-14. While no planned the contribution of geothermal source reached 1.7 ktoe (0.07 PJ) in 2015.

Biodiesel use in transport sector totalled to 232 ktoe (9.7 PJ) in 2015. This use exceeded the NREAP plans throughout period 2011-15 and in 2012 the plan for year 2020 (167 ktoe). Renewable electricity in transport sector increased with a CAGR of 6.7% (+7 ktoe) in period 2005-2015 reaching 15 ktoe (0.6 PJ). Comparing with NREAP the use of renewable electricity in sector was below the plans throughout period 2010-2015. Only 1.0% of final renewable electricity in Denmark is used in transport sector in year 2015.

Table 4 - 2. Renewable energy technologies/sources in Denmark – deviations from NREAP, 2010-2015, (ktoe)

	2010	2011	2012	2013	2014	2015
Hydropower	-0.8	-0.8	-0.8	-0.8	-0.9	-1.3
Wind	-75.5	-54.7	-31.0	-63.4	64.0	156.6
Solar-el	0.3	1.1	8.8	44.3	51.0	51.7
Solar-th	4.7	5.6	9.0	11.5	17.2	20.1
Geothermal-th	2.5	2.0	3.4	2.7	2.0	1.7
Biomass-el	70.7	20.9	20.2	-125.5	-121.6	-157.2
Biomass-th	243.8	34.3	60.8	-106.1	-123.5	110.2
Heat pumps	-91.5	-96.6	-107.5	-120.4	-130.0	-121.9
Biodiesel	-18.0	0.3	79.6	78.6	82.1	80.0
Bioethanol	13.8	-9.8	-98.0	-96.0	-95.0	-95.0
Renewable electricity	-2.0	-2.4	-2.2	-4.1	-3.2	-4.3

4.5 Renewable electricity installed capacity

The renewable electricity installed capacity in Denmark increased with a CAGR of 6.2% (+3149 W) between 2005 and 2015 reaching 6940 MW exceeding the 2020 plan by 2.7% (+185 MW). In 2015 wind presented 73% of renewable energy installed capacity in Denmark followed by biomass with 16% and solar with 11%.

Figure 4-5 present the current trend of renewable electricity installed capacity in Denmark, the deviations (in %) from the expected developments during period 2005-2015, the 2020 NREAP plan and EUCO27 scenario projections for 2020 and 2030. As shown in this Figure, the achieved installed capacity in Denmark was above the expected NREAP plans throughout period 2010-2015.

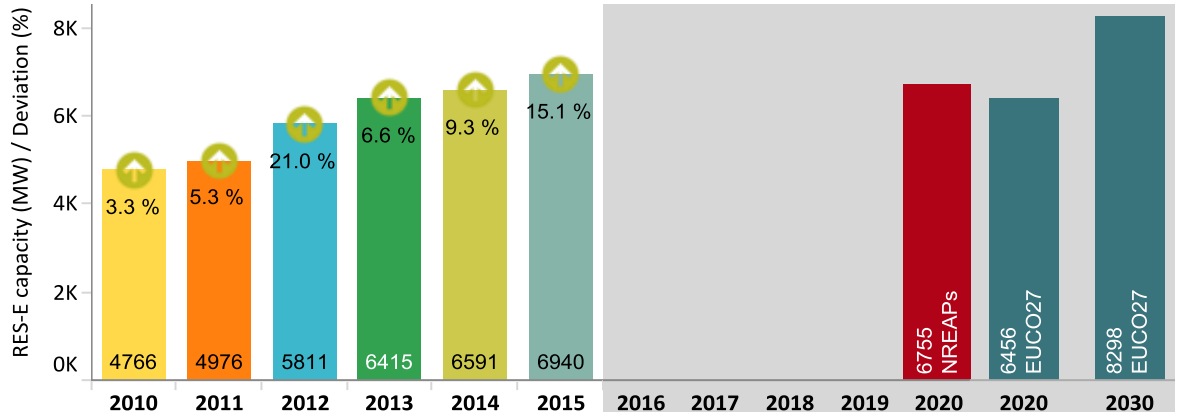


Figure 4 - 5. RES-E capacity development and deviation from NREAPs (2010-2015)–Expected capacity (2020-2030)

Solar photovoltaic had fastest development between 2005 and 2015 with a CAGR of 74.4% (+779 MW) over the very low level of 3 MW in 2005. The deployment of this technology was

faster than planned in the Denmark NREAP throughout period 2010-2015. This technology has exceeded since in 2010 the 2020 plan of 6 MW. The progress from year 2005 in wind capacity had a CAGR of 5% (+1947 MW) reaching 5975 MW in 2015. Comparing with NREAP planned capacities this technology was over throughout period 2010-2015 exceeding since in 2012 the 2020 plan. Biomass installed capacity increase from baseline year with a CAGR of 5.2% (+427 MW) reaching 1076 MW in 2015. This source surpassed the NREAP plans only during period 2011-12. Hydropower capacity decreased with a CAGR of 4.4% (-4 MW) during period 2005-2015 reaching only 7 MW. This technology experienced a slower deployment than what was planned in the NREAP.

In 2020 the picture of renewable energy sources shares might change due to the fast development of solar photovoltaic. According to actual NREAP in 2020 renewable installed capacity will reach 6755 MW and will be composed by 59% wind and 41% biomass.

The EUCO27 projections for 2020 are consistent with NREAPs in forecasting a net generation capacity of 6456 MW. Nevertheless forecasted technology shares differ with wind and solar expected to share the largest part of renewable electricity capacity. According to these projections in 2030 Denmark is expected to have installed 8298 MW of renewable electricity. Solar photovoltaic is expected to share 13% of renewable electricity capacity in Denmark throughout period 2020-2030.

5. Germany

Petroleum products and solid fuels had the highest share in Germany's energy mix in 2015 whereas the share of renewables was just above 12% (Figure 5). In 2015 gross inland consumption of energy in Germany totalled to 314.2 Mtoe, 0.3% (+964 ktoe) higher than the consumption in 2014. Primary energy consumption was 292.9 Mtoe in 2015, 5.9% above the 2020 energy efficiency target[41]. Final energy consumption reached 212 Mtoe being 9.2% above the 2020 energy efficiency target for this indicator. Gross final energy consumption increased during period 2014-2015 by 2.2% (+4715 ktoe) amounting to 219.8 Mtoe. Energy intensity of the economy stood at 112.6 toe/Million Eur continuing to decline. Germany import dependency remained at the level of 62% even in 2015. Import dependency for petroleum products and gas remained high respectively at 96.4% and 90%. Greenhouse gas emissions continued to drop at 924.8 Mt CO_2 eq in 2014, 26.5% below the emissions in 1990. Energy remained the main source of emissions with a share of 65% (601 Mt CO_2 eq). In the same year the role of renewable energy in the reduction of GHG emissions reached a net savings of 154 Mt CO_2 eq, an additional of 47 Mt CO_2 since 2009.

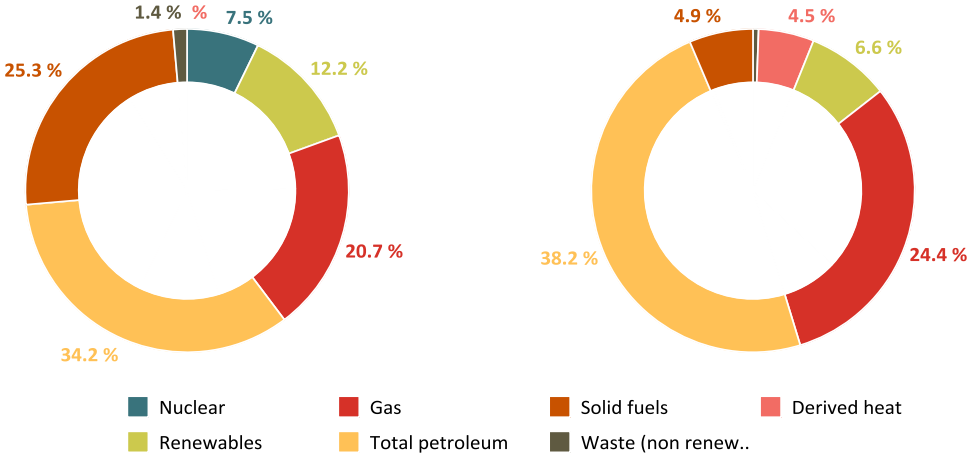


Figure 5. Breakdown of Gross Inland Consumption of Energy (left) - Final Energy Consumption (right) in DE, 2015

5.1 Final renewable energy consumption

Final renewable energy[42] consumed in Germany increased with a CAGR of 7.8% (+17061 ktoe) between 2005 and 2015 reaching 32305 ktoe (1352.5 PJ). More than 48% of final energy consumed in year 2015 was in the form of renewable electricity and the rest was renewable heat/cold (42.8%) and renewable energy in transport (8.8%).

Figure 5-1 present the current trend of final renewable energy consumption in Germany and the deviations (in %) from the expected developments during period 2005-2015 as well as the 2020 NREAP plan and EUCO27 projections for 2020 and 2030. As shown in this figure the current development of final renewable energy consumption in Germany was above the plans throughout period 2010 – 2015.

The renewable energy consumption in Germany is expected to further increase to 39.2 Mtoe (1642.4 PJ) until 2020. Transport sector is expected to increase its share to 15.7% whereas the electricity and heating/cooling sectors will contribute respectively with 47.6% and 36.8%.

The EUCO27 scenario for 2020 has projected higher final renewable energy consumption in Germany than its NREAP level at 47047 ktoe (1970 PJ). For 2030 this projection reveals the final consumption of renewable energy at 49610 ktoe (2077 PJ).

[41] Germany energy efficiency 2020 targets are 276.6 Mtoe in terms of primary energy consumption and 194.3 Mtoe as final energy consumption.
[42] Final renewable energy (the sum of hydropower, solar, wind, marine, geothermal, biomass and heat pumps) in Germany reached 32061.7 ktoe in 2015, up from 15138.5 ktoe in 2005.

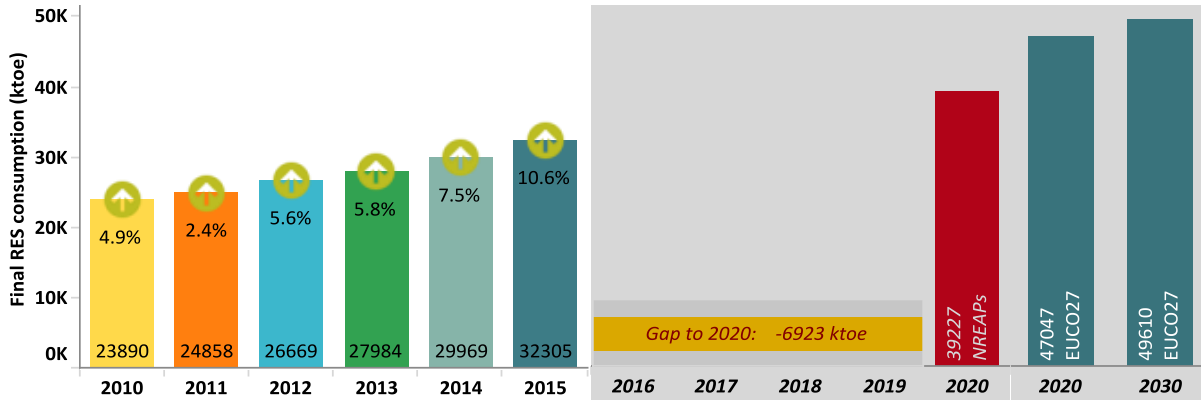


Figure 5 - 1. RES consumption: Trend, Deviation from NREAPs(2010-2015) - Expected RES consumption (2020-2030)

5.3 Renewable energy share

The overall renewable energy contribution in gross final energy consumption in Germany reached 13.8% in 2014 and 14.6% in 2015. A surplus for cooperation mechanism is was available in 2014 at 4.3%. The 2020 target that Germany has to reach for the overall renewable energy share is 19.6%. According to the EUCO27 scenario the overall renewable energy share in Germany is projected to reach 18.6% in 2020 and 23.4% in 2030.

Figure 5-2 shows the current trajectory of overall renewable energy share in Germany, the NREAPs trajectory, the Indicative trajectory as well as the Current trend forecast trajectory.

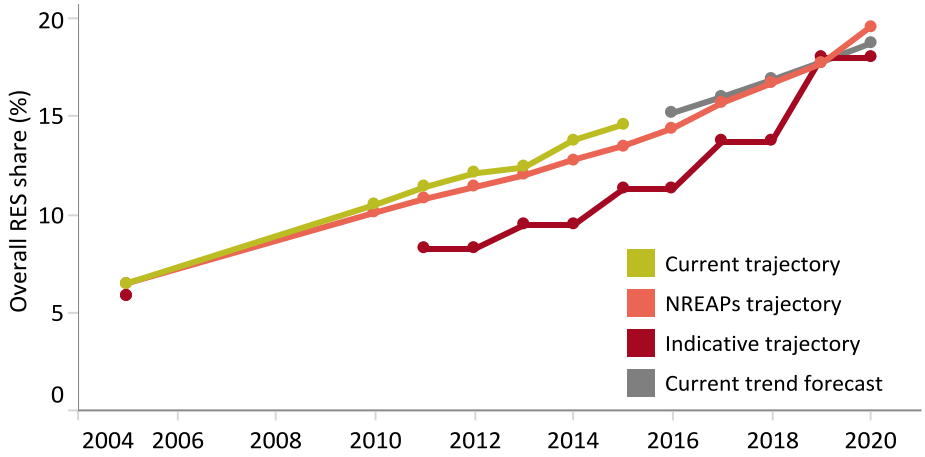


Figure 5 - 2. Overall RES share trajectories in DE: Current, NREAPs and Indicative - Current trend forecast, 2005-20

Overall renewable share in Germany is following the planned NREAP trajectory and staying well above the indicative trajectory. Germany needs to keep to its trajectory of the last 3 years to stay on track for its 2020 target since its planned trajectory for 2016-2020 is steeper.

Germany almost tripled in 2015 the renewable energy share in electricity sector (30.72%) comparing with 2005 level of 10.2%. Comparing with expected NREAP shares this sector was over in both 2014 and 2015 respectively with +3.5 and +3.9 percentage points. 2020 planned share is foreseen to reach 38.6%.

Heating/cooling sector reported a share of 12.2% in 2014 and 12.9% in 2015. These shares were found to be above the expected NREAP plans in both years respectively with +1.2 and 1.1 percentage points. 2020 planned share of renewable energy in this sector is 15.5%.

Renewable energy share in transport sector reached 7.3% in 2014 and 6.8% in. Germany missed the NREAP renewable energy share in this sector in 2015: 0.2 percentage points below the plan. The 2020 expected share in this sector is foreseen to reach 13.2%.

5.3 Final renewable electricity, heating/cooling and use in transport

Renewable electricity consumption in Germany increased with a CAGR of 11% (+118 TWh) between 2005 and 2015 reaching 182 TWh (15.7 Mtoe). In 2015 the main contribution in renewable electricity in Germany was coming from wind, 39% followed by biomass (27.6%), solar photovoltaic (21.3%), hydropower (12.1%) and geothermal (0.1%). Comparing with the expected developments according German NREAP the renewable energy in this sector was above the plans throughout period 2010-2015. In 2020 the renewable electricity consumption in Germany is expected to amount to 217 TWh (18.7 Mtoe) in which wind will share 48.1% followed by solar photovoltaic (19.1%), biomass (22.8%), hydropower (9.2%) and geothermal (0.8%). Nevertheless, the respective contributions of renewable energy sources in 2020 will slightly differ from what was planned because of the faster development of solar photovoltaic and wind that are now providing electricity shares above the plans. The EUCO27 scenario for 2020 is in line with German NREAP projecting final renewable electricity at 215.5 TWh (18.5 Mtoe). Of this electricity wind will share more than 50% followed by solar photovoltaic (22.5%), biomass (16.3%) and hydropower (10.4%). Under this scenario renewable electricity in Germany will reach 287.4 TWh (24.7 Mtoe) in 2030 of which wind will share 45.2%, solar photovoltaic 26.4%, biomass 20.1% and hydropower 8.4%.

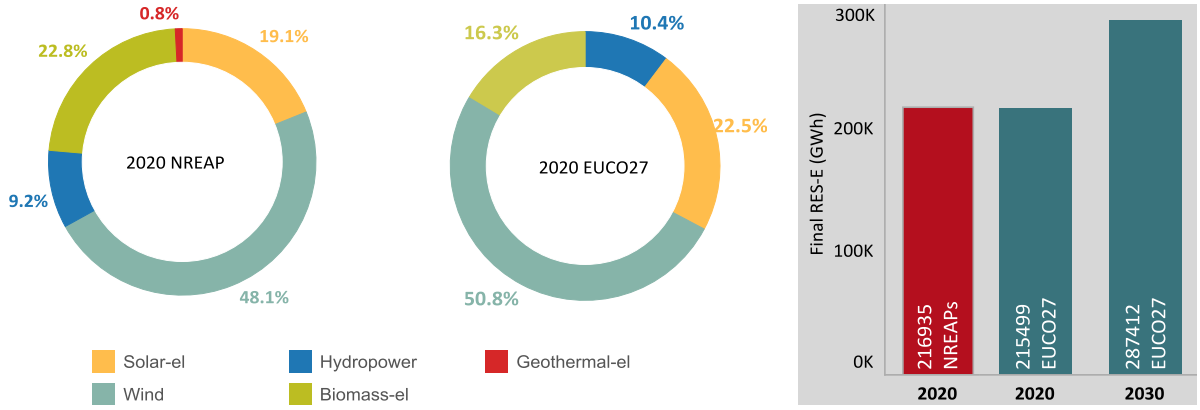


Figure 5 - 3. Final RES Electricity in Germany: NREAP plan (2020) – EUCO27 projections (2020-2030)

Renewable energy in heating/cooling sector in Germany increased with a CAGR of 5.9% (+4396 ktoe) over period 2005-2015 reaching 13818 ktoe (579 PJ). The development of renewable energy in this sector was found above the NREAP projections throughout period 2010-2015. Biomass share reached at 88.1% followed by heat pumps at 6.4%, solar thermal at 4.9% and geothermal at 0.6%. In 2020 Germany is expected to reach 14131 ktoe (604.2 PJ) of renewable heat/cold in which biomass will contribute with 78.7%, solar thermal with 8.6%, heat pumps with 7.9% and geothermal with 4.8%.

The use of renewable energy in transport sector reached 2830 ktoe (118.5 PJ) in 2015 increasing with a CAGR of 3.6% (+851 ktoe) over period 2005-2015. Biodiesel shared 63.7% followed by bioethanol-bio/ETBE 26.5%, other biofuels 1.1% and renewable electricity 8.7%. Comparing with the expected uses this development was found above the NREAP expectations only in year 2014 of period 2010-2015. The use of renewable energy in transport sector in 2020 is expected to be 6140 ktoe (257.1 PJ). In 2020 the contribution of biodiesel is expected to reach 72.4%, bioethanol/bio-ETBE contribution 14%, renewable electricity 10.8% and the other biofuels 2.8%.

Table 5 - 1. Final renewable energy in DE: deviations from NREAP in electricity, heating/cooling and transport

	2010	2011	2012	2013	2014	2015
RES-el (ktoe)	494	843	1,452	1,457	1,680	2,104
RES-hc (ktoe)	1,266	563	401	649	916	1,653
RES-tr (ktoe)	-647	-826	-449	-582	-491	-649
RES-el (%)	5.5	8.4	13.5	12.5	13.3	15.5
RES-hc (%)	12.6	5.4	3.7	5.7	7.8	13.6
RES-tr (%)	-17.4	-21.5	-12.4	-16.6	-13.9	-18.7

5.4 Renewable energy technologies/sources

In 2015 biomass share in final renewable energy in Germany was 51.5% followed by wind technology with 19%, solar with 12.5%, biofuels with 8.1%, hydropower with 5.9%, heat pumps with 2.8% and geothermal with 0.3%. In 2020, the share of biomass in final renewable energy is expected to 40.5% followed by wind (23.3%), biofuels (14.2%), solar (12.5%), hydropower (4.5%), heat pumps (3.0%) and geothermal (2.1%).

In this section: (i) Figure 5-4 present the current (2009-2015) and NREAP projected trend (2016-2020) of energy from renewable technologies/sources in Germany. The annual increase/decrease (%) of these sources in these two periods is also available in this figure; (ii) Table 5-2 presents how the actual figures reported for renewable technologies/sources in Germany compared with what was planned for the NREAPs. Absolute differences are shown in ktoe.

Solar technology (electricity and thermal) developed with a CAGR of 26.9% (+3630 ktoe) during period 2005-2015 reaching 4001 ktoe (167.5 PJ). Comparing with the expected values this source was found over the NREAP throughout period 2010-2015. In relative terms geothermal technology (electricity and thermal) deployed with a CAGR of 8.3% (+52 ktoe). Nevertheless this technology in Germany missed the NREAP planned values throughout period 2011-15. Biomass for electricity and heating/cooling developed with a CAGR of 6.9% (+7995 ktoe) between 2005 and 2015 reaching 16.5 Mtoe (691 PJ). Comparing with the expected developments this source was found above the plans throughout period 2010-2015. Biofuels use in transport sector in Germany increased with a CAGR of 3.3% (+712 ktoe) during period 2005-2015, reaching 2584 ktoe (108.2 PJ). Nevertheless their use in transport sector was lower than what was expected from the NREAP throughout period 2010-2015.

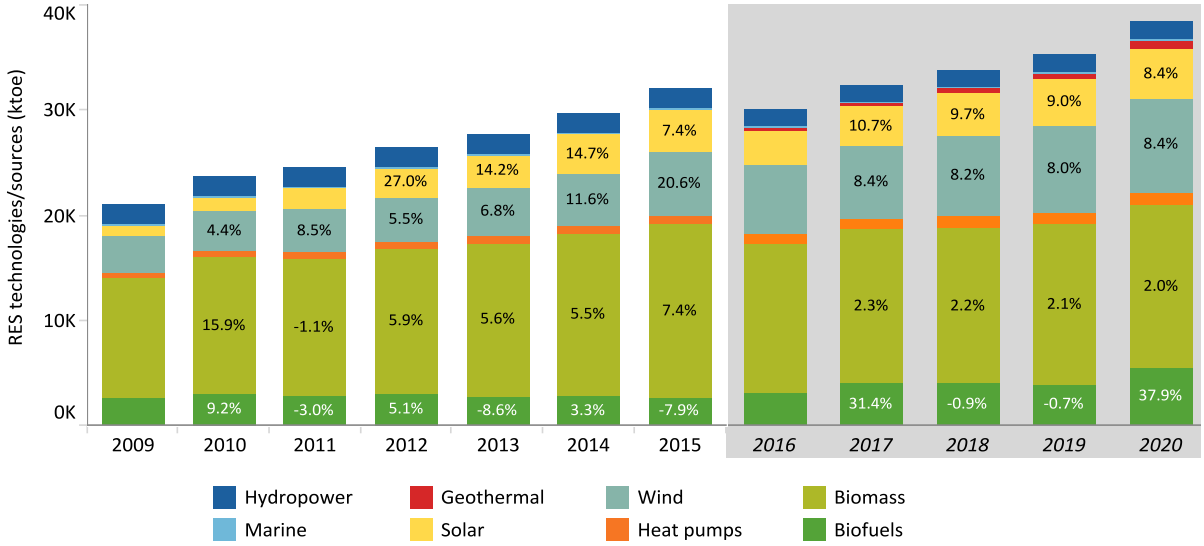


Figure 5 - 4. Annual growth of renewable energy technologies in DE: Current (2009-2015) - NREAP planned 2016-2020

Germany has planned to decrease the contribution of hydropower in its final renewable electricity. On contrary renewable electricity from hydropower increased slightly during period 2005-2015 with a CAGR of only 0.15% (+334 GWh) reaching 21988 GWh (1891 ktoe). The fastest development among renewable electricity sources in Germany between 2005 and 2015 happened in geothermal electricity that increased with a CAGR of 93.7% (+133.9 GWh) reaching 134.1 GWh (11.5 ktoe). Despite of this the development was found slower than the expected NREAP trend throughout period 2011-15. Photovoltaic technology increased in 2015 by a factor of more than 30 over the 2005 level reaching 38.7 TWh (3331 ktoe). This development has been faster than planned in the NREAP throughout period 2010-2015. Electricity coming from wind technology increased with a CAGR of 10.3% (+44.3 TWh) during period 2005-2015 reaching 71 TWh (6100 ktoe). Nevertheless wind development in Germany was not fast enough to exceed the expected levels throughout period 2010-2015. The development of biomass for electricity between 2005 and 2015 took place with a CAGR of

13.4% (+36 TWh) reaching 50.3 TWh (4327 ktoe). This development was not fast enough during period 2010-2014 to meet the NREAP trend.

Geothermal thermal technology developed with a CAGR of 6.9% (+40 ktoe) during period 2005-2015 reaching 83.3 ktoe (3.5 PJ). Nevertheless this development was not enough to meet the NREAP plans during period 2011-15. Heat coming from solar thermal more than doubled between 2005 and 2015 amounting to 671 ktoe (28.1 PJ). This development was well over the expected NREAP levels during period 2010-12 but below in period 2013-15. Biomass source increased between 2005 and 2015 with a CAGR of 5.3% (+4903 ktoe) reaching 12.2 Mtoe (510 PJ). The heat coming from this source remained above the expected NREAP heat consumptions thrpoughout period 2010-2015 exceeding in the last year of this period the plan for year 2020 (11.4 Mtoe). During period 2005-2015 the deployment of heat pumps in Germany took place with a CAGR of 16.4% (+696 ktoe) reaching 890 ktoe (37.3 PJ). This deployment was found faster the the planned one throughout period 2005-2015.

Bioethanol/bio-ETBE use in transport sector reached 749 ktoe (31.4 PJ) in 2015, increasing with a CAGR of 17% (+595 ktoe) since 2005. This increase was nevertheless slower than planned throughout period 2011-15. Biodiesel use increased with a CAGR of 1.4% (+241 ktoe) during this period reaching 1804 ktoe (75.5 PJ). Nevertheless this remained above the plan only in year 2012 throughout period 2010-2015. Other biofuels (biogas and vegetable oils) reached 31.3 ktoe (1.3 PJ) in 2015. Comparing with the plans this development was found above the plans only during period 2013-14. The use of Annex IX biofuels in Germany reached 529.8 ktoe (22.2 PJ) in 2015. This use was found above the NREAP plans during period 2011-14 but below in year 2015. No imported biofuels is reported for period 2010-2015. The use of renewable electricity in transport increased with a CAGR of 8.7% (+139 ktoe) between 2005 and 2015 reaching 246 ktoe (10.3 PJ). This development was slower than the one planned in the NREAP remaining behind all over period 2010-2015. In 2015 only 1.6% of final renewable electricity in Germany was used in transport sector.

Table 5 - 2. Renewable energy technologies/sources in Germany – deviations from NREAP, 2010-2015, (ktoe)

	2010	2011	2012	2013	2014	2015
Hydropower	307.5	341.4	333.7	251.3	227.0	257.0
Wind	-137.1	-229.9	-319.9	-395.8	-414.4	80.9
Solar-el	191.8	484.3	772.5	921.6	1,104.1	1,080.6
Solar-th	44.1	53.7	16.1	-38.0	-54.5	-69.8
Geothermal-el	0.1	-2.9	-6.2	-7.2	-13.7	-20.9
Geothermal-th	23.1	-13.6	-47.9	-80.9	-103.5	-150.7
Biomass-el	131.6	250.5	672.6	687.9	777.5	707.0
Biomass-th	1,132.9	441.4	351.7	687.0	981.0	1,784.0
Heat pumps	66.3	81.5	81.2	80.9	92.7	90.0
Biodiesel	-642.7	-283.7	46.0	-184.1	-139.1	-270.3
Bioethanol	114.6	-398.5	-346.4	-334.2	-276.2	-246.9
Other biofuels	-57.0	-80.3	-64.9	28.6	27.7	-3.7
Renewable electricity	-62.0	-63.4	-83.9	-92.0	-103.1	-128.2

5.5 Renewable electricity installed capacity

Renewable electricity installed capacity in Germany increased with a CAGR of 13.6% (+69.3 GW) reaching 96.2 GW in 2014, surpassing the NREAP plan for year 2017. In 2015 wind power capacity overcome photovoltaic capacity reaching a share of 46.1% in final renewable electricity capacity in Germany. Solar photovoltaics reached a capacity that shared 41.4% followed by biomass with 7.4%, hydropower with 4.8% and geothermal with 0.03%.

Figure 5-5 present the current trend of renewable electricity installed capacity in Germany, the deviations (in %) from the expected developments during period 2005-2015, the 2020 NREAP plan and EUCO27 scenario projections for 2020 and 2030. As shown in this figure, the

achieved installed capacity in Germany was above the expected NREAP plans throughout period 2010-2015.

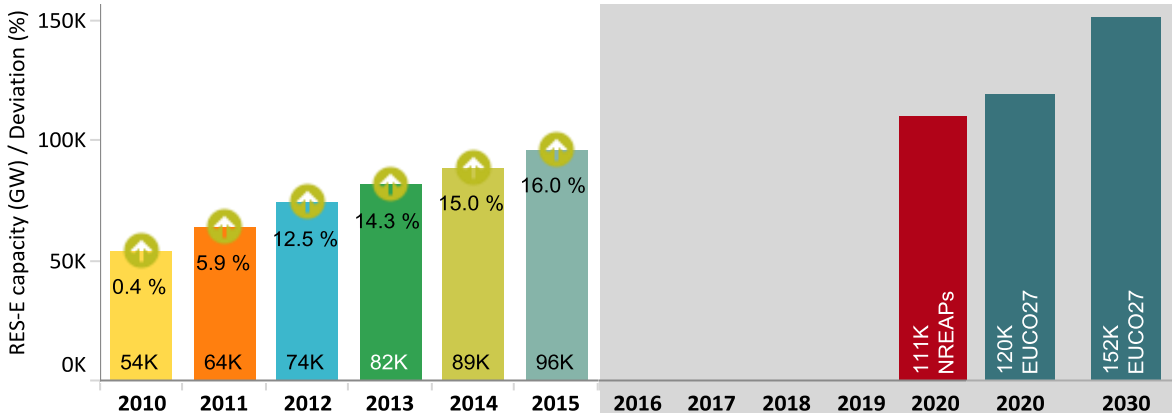


Figure 5 - 5. RES-E capacity development and deviation from NREAPs (2010-2015)– Expected capacity (2020-2030)

Solar photovoltaic technology increased in capacity with a CAGR of 34.5% (+37.7 GW) between 2005 and 2015 reaching 39.8 GW. The deployment of this technology was faster than what Germany planned in the NREAP throughout period 2010-2015. Germany has planned to decrease the hydropower capacity during period 2005-2020. Despite of this hydropower installed capacity is getting slightly higher year by year increasing with a CAGR of 1.0% (+443 MW) between 2005 and 2015. Hydropower capacity was found to be over the NREAP planned capacities throughout period 2010-2015. Furthermore it was in 2015 above the 2020 planned capacity by 6.2% (+268 MW). Wind installed capacity increased from the baseline year with a CAGR of 9.3% (+26.3 GW) reaching 44.7 GW in 2015. Nevertheless this development was enough to exceed the expected NREAP capacities only during period 2013-15. Biomass capacity developed with a CAGR of 11.7% (+4759 MW) during period 2005-2015 reaching a capacity of 7111 MW. Nevertheless the development of biomass capacity in Germany was slower than what was planned in the NREAP throughout period 2010-2015.

In 2020 Germany has planned to reach a capacity of 111 GW in renewable electricity. In 2020 photovoltaic and wind power are expected to have the main contribution in renewable electricity installed capacities in Germany with 47% and 41% followed by biomass with 8% and hydropower with 4%.

The EUCO27 projections for 2020 are slightly higher than NREAPs in forecasting a net generation capacity of 120 GW. The projections are consistent with NREAP in the forecast of solar photovoltaic capacity in 2020 whereas the wind power projections are higher (almost 50% of renewable electricity capacity). According to these projections in 2030 Germany is expected to have installed 152 GW of renewable electricity with solar photovoltaic (78.2 GW) surpassing the wind contribution.

6. Estonia

Solid fuels dominated the Estonia's 2015 energy mix with almost 62%. The share of renewables reached almost 15% (Figure 6) from 7% in 1995. In 2015 gross inland consumption of energy in Estonia reached 6.2 Mtoe, 6.3% (-423 ktoe) less than the consumption in 2014. Primary energy consumption was 6.2 Mtoe in 2015, 4.6% under the 2020 energy efficiency target[43]. Final energy consumption reached 2.8 Mtoe equal to the 2020 energy efficiency target for this indicator. Gross final energy consumption decreased during period 2014-2015 by 2.3% (-71.8 ktoe) amounting to 3.1 Mtoe. Energy intensity of the economy reached 358 toe/Million Eur in 2015. Estonia import dependence for all products is very low, at 7.4% in 2015. Nevertheless Estonia is totally dependent on gas import even that gas share in GIC is at the level of 6.2%. The import dependence rate for solid fuels was negative, at 0.3% in 2015. Estonia has decreased by 47% its greenhouse gas emissions since 1990. Energy remained the main source of emissions with a share of 77.6% (16.4 Mt CO_2 eq).

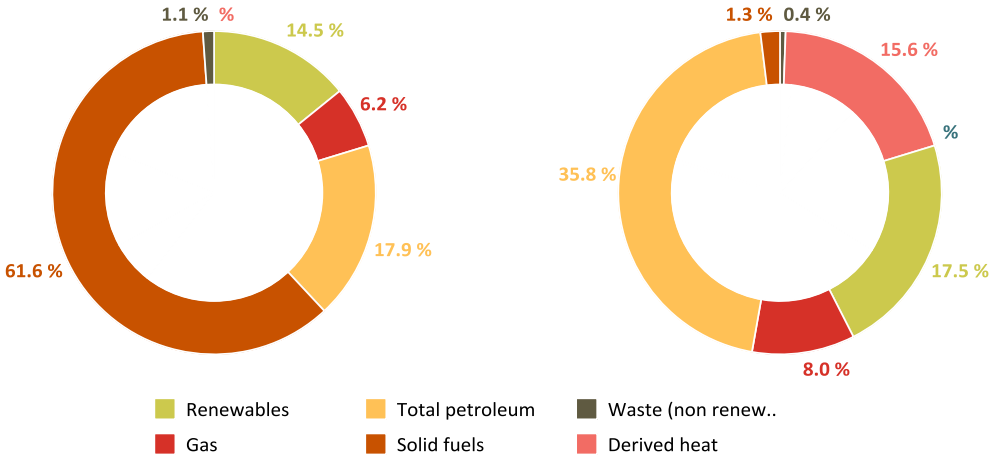


Figure 6. Breakdown of Gross Inland Consumption of Energy (left) - Final Energy Consumption (right) in EE, 2015

6.1 Final renewable energy consumption

Final renewable energy[44] consumed in Estonia increased with a CAGR of 4.8% (+329.5 ktoe) during period 2005-2015 reaching 878.6 ktoe (36.8 PJ), exceeding by 1.9% (+17 ktoe) the plan for year 2020. Heating/cooling sector had the main contribution with a share of 85.8% whereas the contributions of electricity and transport sectors were respectively 14% and 0.1%.

Figure 6-1 present the current trend of final renewable energy consumption in Estonia and the deviations (in %) from the expected developments during period 2005-2015 as well as the 2020 NREAP plan and EUCO27 projections for 2020 and 2030. As shown in this figure the current development of final renewable energy consumption in Estonia was above the plans throughout period 2010 – 2015.

The expected growth of final renewable energy consumption in Estonia until 2020 is expected with only 23.7 ktoe (1 PJ) to reach 862 ktoe. Heating/cooling will remain the main sector with a share of 70.5% in final renewable consumption whereas the shares of other sectors will be 19.1% (electricity sector) and 10.4% (transport sector). The EUCO27 scenario for 2020 has projected higher final renewable energy consumption in Estonia than its NREAP level at 964 ktoe (40.4 PJ). For 2030 this projection reveals the final consumption of renewable energy at 1068 ktoe (44.7 PJ).

[43] Estonia's energy efficiency 2020 targets are 6.5 Mtoe in terms of primary energy consumption and 2.8 Mtoe as final energy consumption.
[44] Final renewable energy (the sum of hydropower, solar, wind, marine, geothermal, biomass and heat pumps) in Estonia reached 877.6 ktoe in 2015, up from 547.8 ktoe in 2005.

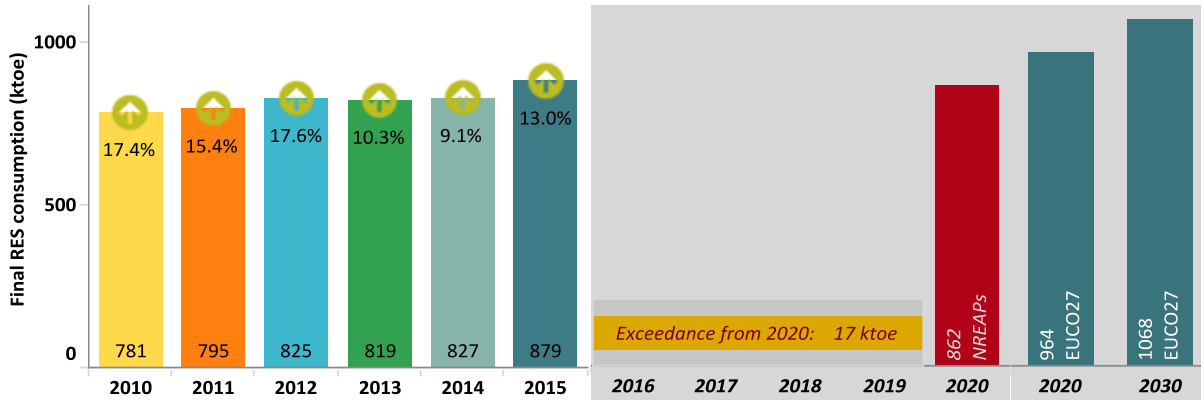


Figure 6 - 1. RES consumption: Trend, Deviation from NREAPs(2010-2015) - Expected RES consumption (2020-2030)

6.2 Renewable energy share

The overall renewable energy contribution in gross final energy consumption in Estonia reached 26.3% in 2014 and 28.6% in 2015. A surplus of 3.07% for cooperation mechanism was available in 2014. According to the EUCO27 scenario the overall renewable energy share in Estonia is projected to reach 25.9% in 2020 and 30.5% in 2030.

Figure 6-2 shows the current trajectory of overall renewable energy share in Estonia, the NREAPs trajectory, the Indicative trajectory as well as the Current trend forecast trajectory.

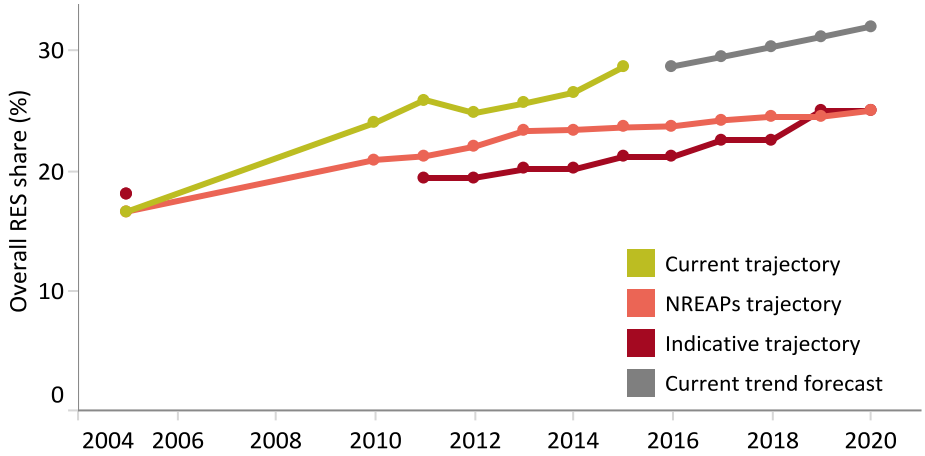


Figure 6 - 2. Overall RES share trajectories in EE: Current, NREAPs and Indicative - Current trend forecast, 2005-20

Overall renewable energy share in Estonia remained above the flattened NREAP and indicative trajectories throughout 2010-2015. Estonia already exceeded the target of overall renewable energy share for 2020 (25%) in 2011. Renewable energy share in the heating/cooling sector developed faster, exceeding by 10 percentage points the 2020 plan in 2011. Deployment of renewable energy in the transport sector was very slow between 2005 and 2015.

The development of heating/cooling sector was determinant in the fast penetration of overall renewable energy in Estonia. Estonia has planned a flat trajectory for the development of renewable energy in this sector, not exceeding 40%, but since in 2011 the renewable energy share in this sector exceeded with 10 percentage points the 2020 NREAP plan reaching 48.4%. In 2015 the renewable energy share in this sector reached 49.6%, 11.2 percentage points above the 2020 plan. Renewable energy share in electricity sector reached 14.1% in 2014 and 15.1% in 2015 surpassing the plans in both years respectively by +2.1 and +1.9 percentage points. The 2020 planned share in this sector is foreseen to reach 17.6%. The renewable energy share in transport sector increased very slow, reaching only 0.4% in 2015, missing the plan with -4.4 percentage points. The 2020 planned share in this sector is expected to reach 10%.

6.3 Final renewable electricity, heating/cooling and use in transport

Renewable electricity consumption in Estonia developed with a CAGR of 30.7% (+1337 GWh) between 2005 and 2015 reaching 1435.4 GWh (123.4 ktoe). In 2015 biomass was the main source of renewable electricity in Estonia with a share of 52.9% followed by wind with 45.3% and hydropower with 1.8%. Comparison with NREAP showed that the renewable electricity in Estonia was over the expected development throughpout period 2010-2015. According to Estonia NREAP in 2020 the renewable electricity consumption is expected to amount to 1913 GWh (164.5 ktoe). Wind is expected to have the main contribution in renewable electricity portfolio with 80.3% and the rest is expected to be covered by biomass (18.1%) and hydropower (1.6%).
The EUCO27 scenario projection for 2020 is lower than what planned in Estonia's NREAP, at 1575 GWh (135.5 ktoe). Biomass is expected to be the first source with more than 55%. Wind will follow with 42.2% together with hydropower (2.1%) and solar photovoltaic (0.1%). Under this scenario renewable electricity consumption in Estonia will reach 2346 GWh (201.7 ktoe) in 2030 in which wind will dominate with a share at nearly 60%.

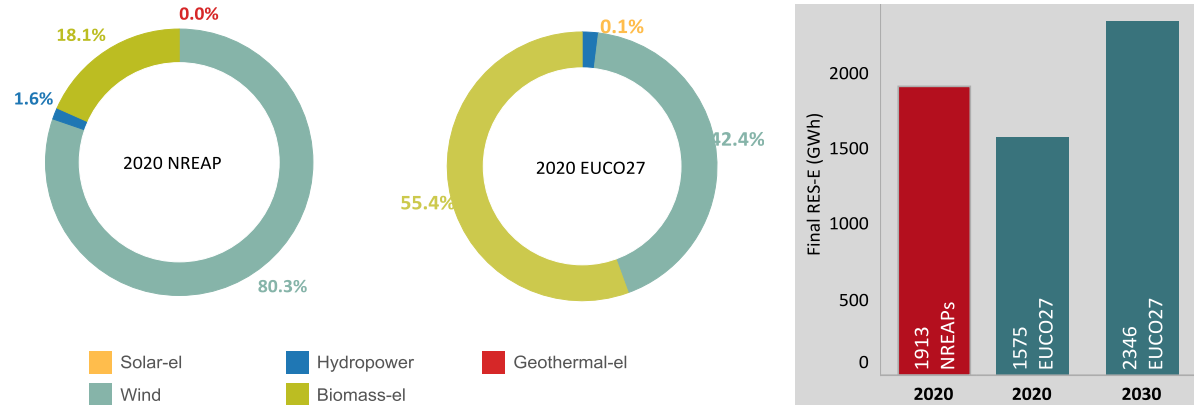


Figure 6 - 3. Final RES Electricity in Estonia: NREAP plan (2020) – EUCO27 projections (2020-2030)

Renewable energy in heating/cooling sector in Estonia developed with a CAGR of 3.4% (+215 ktoe) between 2005 and 2015 reaching 754.2 ktoe (31.6 PJ). In 2015 biomass contribution in this sector was 92.6% and the rest was covered by heat pumps (7.3%). Comparing with expected heat production it was found that Estonia produced more heat that what it planned all over period 2010-2015. Since year 2008 Estonia exceeded the 2020 plan (607 ktoe) on renewable heat/cold consumption by 0.8% (+4.7 ktoe). In 2015 this exceedance was with 24.2% (+147.2 ktoe). The actual picture is likely to be different in 2020 from what Estonia has planned in its NREAP, to use only biomass for its renewable heat/cold needs, also because the unplanned contribution of heat pumps in this sector.

Renewable energy use in transport sector in Estonia reached only 1 ktoe (0.05 PJ) being 19.4% (-0.3 ktoe) below the use in the baseline year. This use remained below the NREAP expectations throughout period 2011-15. During period 2010-2015 no use of compliant biofuels in transport sector is reported from Estonia. According to its NREAP in 2020 Estonia has planned to use 90 ktoe of renewable energy in which biodiesel is expected to have a share of 56.8% followed by bioethanol-bio/ETBE with 42.2%, renewable electricity with 0.7% and other biofuels with 0.3%.

Table 6 - 1. Final renewable energy in EE: deviations from NREAP in electricity, heating/cooling and transport

	2010	2011	2012	2013	2014	2015
RES-el (ktoe)	35	39	71	12	12	7
RES-hc (ktoe)	81	73	65	83	83	128
RES-tr (ktoe)	0	-6	-13	-19	-26	-34
RES-el (%)	67.1	65.6	116.7	12.4	11.6	5.8
RES-hc (%)	13.2	11.7	10.4	13.3	13.2	20.5
RES-tr (%)	30.0	-81.3	-90.5	-94.1	-96.3	-97.1

6.4 Renewable energy technologies/sources

Final renewable energy in Estonia in 2015 was composed by biomass (87%), wind (6.4%), heat pumps (6.3%) and hydropower (0.3%). According to Estonia NREAP, in 2020 the share of biomass in final renewable energy is expected to decrease up to 74%, while the contributions of wind and biofuels will be increased respectively to 15.3% and 10.4%. The contribution of hydropower is expected to remain at a low level, 0.3%.

In this section: (i) Figure 6-4 present the current (2009-2015) and NREAP projected trend (2016-2020) of energy from renewable technologies/sources in Estonia. The annual increase/decrease (%) of these sources in these two periods is also available in this figure; (ii) Table 6-2 presents how the actual figures reported for renewable technologies/sources in Estonia compared with what was planned for the NREAPs. Absolute differences are shown in ktoe.

During period 2005-2015 biomass used for electricity and heating/cooling increased with a CAGR of 3.5% (+222 ktoe) reaching 764 ktoe (32 PJ). Estonia exceeded since 2009 by 5.4% (34.6 ktoe) the 2020 planned level (636.8 ktoe) of biomass for energy purposes. No contributions from compliant biofuels, geothermal and solar in total renewable energy mix were registered in Estonia during period 2010-2015.

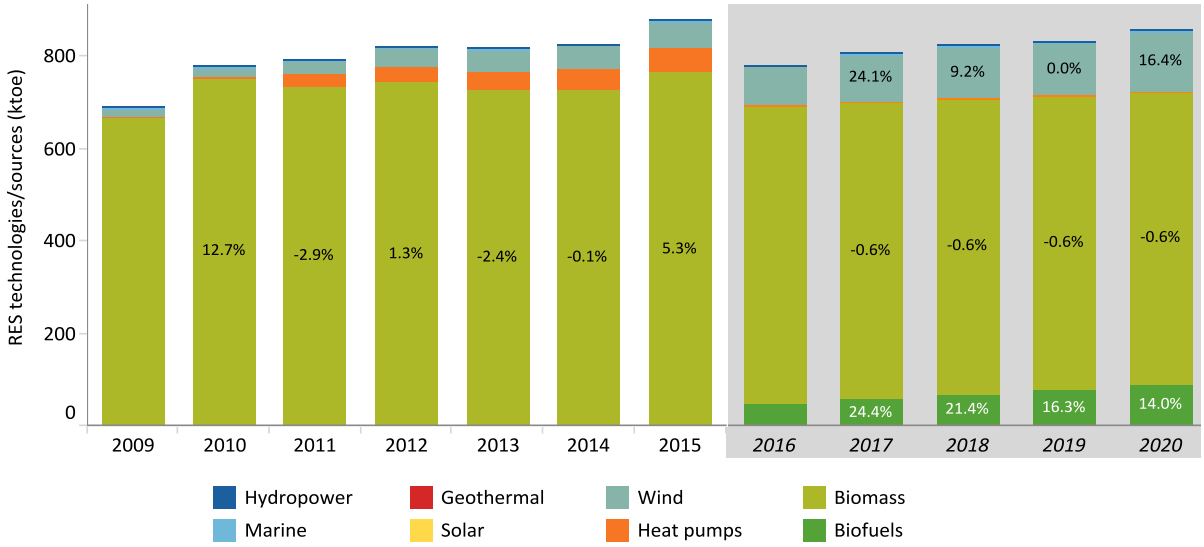


Figure 6 - 4. Annual growth of renewable energy technologies in EE: Current (2009-2015) - NREAP planned 2016-2020

Renewable electricity from biomass increased with a CAGR of 36% (+725 GWh) during period 2005-reaching 760 GWh (65.4 ktoe). This source was found above the NREAP projections all over period 2010-2015. Wind power development the same time span took place with a CAGR of 29.4% (+600 GWh) reaching 650 GWh (56 ktoe). This source exceeded the NREAP planned electricity consumption only in year 2012 missing the plans in all other years of period 2010-2015. Renewable electricity coming from hydropower reached in 2015 26 GWh (2.2 ktoe) increasing with a CAGR of 6.5% (+12 GWh). This technology was found above the NREAP plan only in period 2012-13.

Biomass thermal consumed for heating/cooling purposes was developed with a CAGR of 2.6% (+159 ktoe) during period 2005-2015 reaching 698.6 ktoe (29.2 PJ). This source developed well above the NREAP expectations exceeding since in 2008 by 0.8% (+4.7 ktoe) the 2020 plan (607 ktoe). While no plans were found in Estonian NREAP for the development of heat pumps, this technology reached 55.6 ktoe (2.3 PJ) in 2015.

Even than planned no use of compliant biofuels is used in Estonia during period 2010-2015. Renewable electricity in transport decreased with a CAGR of -2.1% (-0.3 ktoe) over period 2010-2015 exceeding nevertheless the NREAP levels throughout this period. In 2015 only 0.8% of final renewable electricity in Estonia was used in transport sector.

Table 6 - 2. Renewable energy technologies/sources in Estonia – deviations from NREAP, 2010-2015, (ktoe)

	2010	2011	2012	2013	2014	2015
Hydropower	-0.3	-0.9	0.3	0.2	-0.8	-0.4
Wind	-7.8	-0.9	13.6	-16.5	-23.4	-28.5
Biomass-el	42.9	40.8	57.2	28.3	36.3	35.6
Biomass-th	80.7	44.9	31.7	43.0	34.4	72.6
Heat pumps	0.0	27.9	33.5	40.2	48.4	55.6
Biodiesel	-0.9	-6.9	-8.2	-11.3	-16.7	-20.5
Bioethanol	0.0	0.0	-5.6	-8.4	-10.0	-14.0
Other biofuels	0.0	0.0	-0.1	-0.1	-0.1	-0.2
Renewable electricity	1.2	1.2	1.2	1.0	0.8	0.7

6.5 Renewable electricity installed capacity

Renewable electricity installed capacity in Estonia increased with a CAGR of 26% (+434 MW) between 2005 and 2015 reaching 482 MW. In 2015 wind covered 62.2% of total renewable electricity capacity in Estonia and the rest was biomass (36.5%) and hydropower (1.3%).

Figure 6-5 present the current trend of renewable electricity installed capacity in Estonia, the deviations (in %) from the expected developments during period 2005-2015, the 2020 NREAP plan and EUCO27 scenario projections for 2020 and 2030. As shown in the figure the installed capacity in Estonia surpassed the expected NREAP plans throughout period 2010-2015.

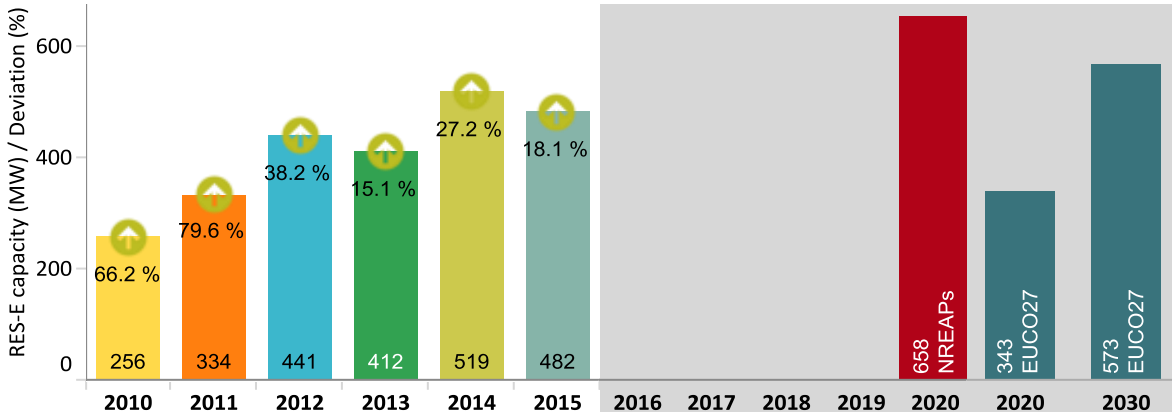


Figure 6 - 5. RES-E capacity development and deviation from NREAPs (2010-2015)– Expected capacity (2020-2030)

Wind power technology developed with a CAGR of 25.5% (+269 MW) during period 2005-2015 reaching 300 MW. Nevertheless comparing with the expected NREAP developments this technology was found to have surpassed the plan only in year 2011. Even that not planned biomass capacity in Estonia reached 176 MW in 2015. Hydropower capacity increased slightly during 2005-2015 with a CAGR of only 1.8% (+1 MW) reaching 6 MW. Nevertheless this technology remained under the NREAP plans throughout period 2010-2015.

In 2020 renewable electricity capacity is expected to reach 658 MW in which the main contribution will come from wind power (99%) and only 1% from hydropower. The EUCO27 projections differ from NREAP in forecasting a generation capacity of 343 MW in 2020 and 573 in 2030 keeping nevertheless the domination of wind power technology in electricity installed capacity.

7. Ireland

Petroleum products had the highest share in Ireland's energy mix in 2015 together with solid fuels whereas the share of renewables reached at 7.6% (Figure 7). In 2015 gross inland consumption of energy in Ireland was 14.2 Mtoe, 4.5% (+417 ktoe) higher than the consumption in 2014. Primary energy consumption was 14 Mtoe in 2015, 3.7% above the 2020 energy efficiency target[45]. Final energy consumption reached 11.2 Mtoe equal to the 2020 energy efficiency target for this indicator. Energy intensity of the economy continued dropping until 62 toe/Million Eur in 2015. Ireland has a high import dependency for all products, at 88.7% in 2015. The dependence on imported gas stood at 96.5% whereas the dependence rate of petroleum products reached 104%. Greenhouse gas emissions resulted at 60.5 Mt CO_2 eq in 2014, 5.7% over the emissions in 1990. Energy remained the main source of emissions even with a lower share compared with 1990, at 39% (23.7 Mt CO_2 eq). In the same year the role of renewable energy in the reduction of GHG emissions reached a net savings of 3.3 Mt CO_2 eq, an additional of only 0.3 Mt CO_2 since 2009.

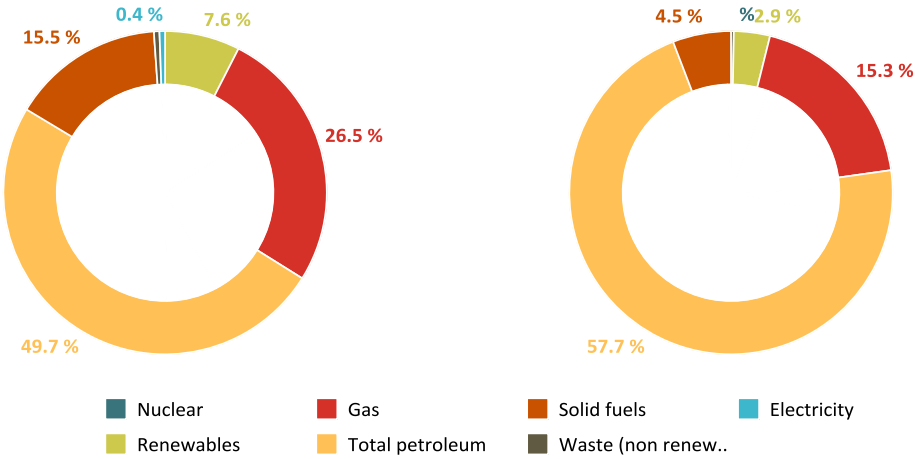


Figure 7. Breakdown of Gross Inland Consumption of Energy (left) - Final Energy Consumption (right) in IE, 2015

7.1 Final renewable energy consumption

Final renewable energy[46] consumed in Ireland increased with a CAGR of 11% (+676.4 ktoe) during period 2005-2015 reaching 1040.4 ktoe (43.6 PJ). Almost one-third of final renewable energy in Ireland was consumed in the form of renewable heat/cold. Renewable electricity dominated the portfolio with a share of 60% whereas the renewable energy used in transport shared only 12.4%.

Figure 7-1 present the current trend of final renewable energy consumption in Ireland and the deviations (in %) from the expected developments during period 2005-2015 as well as the 2020 NREAP plan and EUCO27 projections for 2020 and 2030. As shown in this Figure the current development of final renewable energy consumption in Ireland was below the plans during period 2010 – 15.

The renewable energy consumption in Ireland is expected to further increase to 2306 ktoe (96.5 PJ) until 2020. Electricity sector will still dominate but the share in the final renewable energy planned will decrease to 51.9%. The rest will be divided between renewable energy heat/cold (25.6%) and renewable energy in transport (22.5%). The EUCO27 scenario for 2020 has projected lower final renewable energy consumption in Ireland than its NREAP level at 1840 ktoe (77 PJ). For 2030 this projection reveals the final consumption of renewable energy at 2433 ktoe (102 PJ).

[45] Ireland energy efficiency 2020 targets are 13.5 Mtoe in terms of primary energy consumption and 11.2 Mtoe as final energy consumption.
[46] Final renewable energy (the sum of hydropower, solar, wind, marine, geothermal, biomass and heat pumps) in Ireland reached 1039.7 ktoe in 2015, up from 363.4 ktoe in 2005.

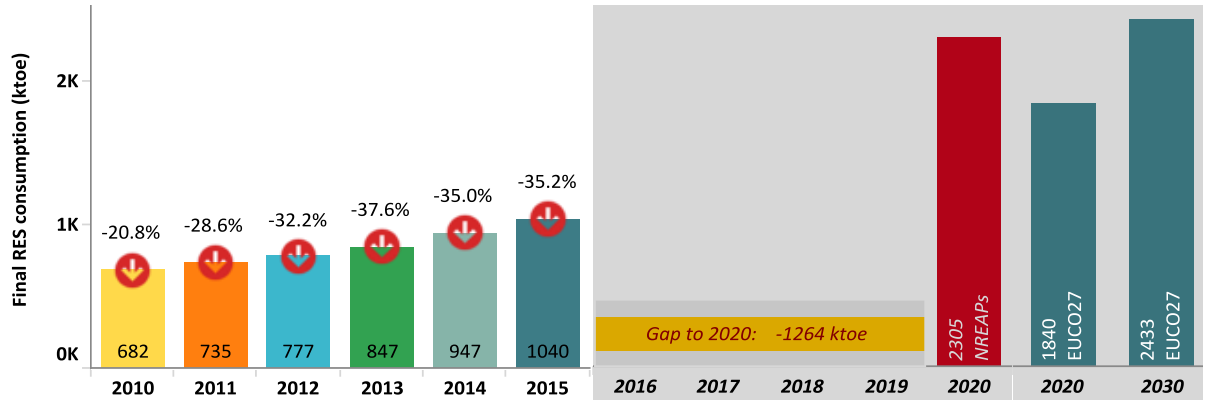


Figure 7 - 1. RES consumption: Trend, Deviation from NREAPs(2010-2015) - Expected RES consumption (2020-2030)

7.2 Renewable energy share

Renewable energy share in gross final energy consumption in Ireland reached 8.7% in 2014 and 9.2% in 2015. In 2020 the target that Ireland has to reach for the overall renewable energy share is 16%. According to the EUCO27 scenario the overall renewable energy share in Ireland is projected to reach 15.4% in 2020 and 21.9% in 2030.

Figure 7-2 shows the current trajectory of overall renewable energy share in Ireland, the NREAPs trajectory, the Indicative trajectory as well as the Current trend forecast trajectory.

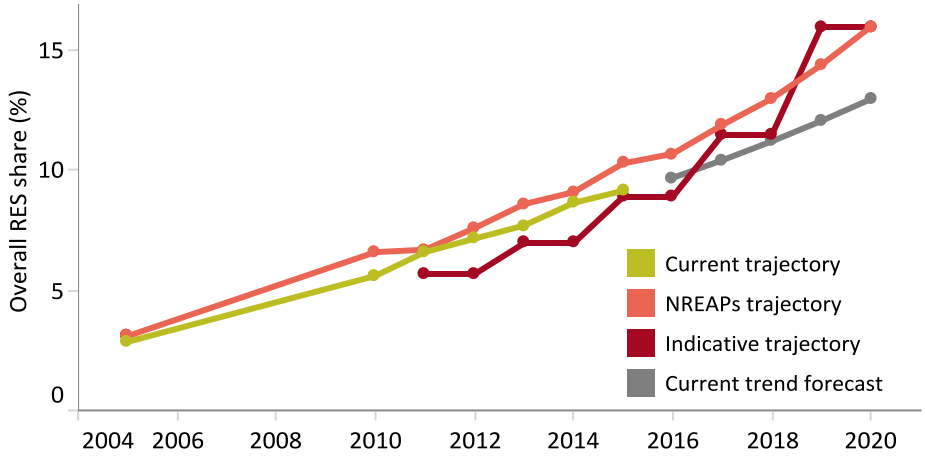


Figure 7 - 2. Overall RES share trajectories in IE: Current, NREAPs and Indicative - Current trend forecast, 2005-20

Overall renewable energy share in Ireland remained below the NREAP trajectory throughout 2010-2015 but was above the indicative trajectory. However, growth is insufficient for the 2020 target to be met. The electricity and heating/cooling sectors lag well behind expectations. By contrast, deployment of renewable energy in the transport sector is in line with what was planned in the NREAP.

Renewable electricity share in Ireland reached 22.9% in 2014 and 25.2% in 2015. Nevertheless the achieved shares are well behind the expected plans since Ireland has set an ambiguous 2020 target for the renewable energy share in this sector, at 42.5%.
Even the development of renewables in heating/cooling sector with achieved shares of 6.6% in 2014 and 6.4% in 2015 was not enough to meet the NREAP planned shares throughout period 2010-2015. The 2020 planned share of renewable energy in this sector is foreseen to reach 12%.
The share of renewable energy in transport sector reached 5.8% in 2014 and 6.8%[47] in 2015 exceeding the planned shares throughout period 2011-15. The 2020 planned share of renewable energy in this sector is set to 10%.

[47] Remarks sourced from SHARES Tool detailed results- IRELAND: There are concerns that the share in transport sector for 2015 is closer to 5.7% due to the fact that until March 2017 the oil questionnaire for year 2015 is not yet finalized.

7.3 Final renewable electricity, heating/cooling and use in transport

Ireland more than triples its renewable electricity consumption during period 2005-2015, reaching 7264 GWh (624.7 ktoe). Despite of this, development renewable electricity consumption in Ireland missed the NREAP plans throughout period 2010-2015. In 2015 more than 83% of final renewable electricity was originated from wind and the rest was hydropower (10%) and biomass (6.5%). In 2020 the renewable electricity consumption in Ireland is expected to amount to 13907 GWh (1196 ktoe) in which wind is planned to have a share of 86.1% followed by biomass with 7.2%, hydropower with 5% and marine with 1.7%.

The EUCO27 scenario projection for 2020 is consistent with Ireland NREAP regarding the contributions of renewable energy sources. The projection for this year is at 12338 GWh (1061 ktoe) of which wind will share 88%. Hydropower, biomass and solar photovoltaic are projected to share respectively 6.2%, 5.5% and 0.1%. Under this scenario renewable electricity in Ireland will reach 15244 GWh (1311 ktoe) in 2030 of which wind will share nearly 95%.

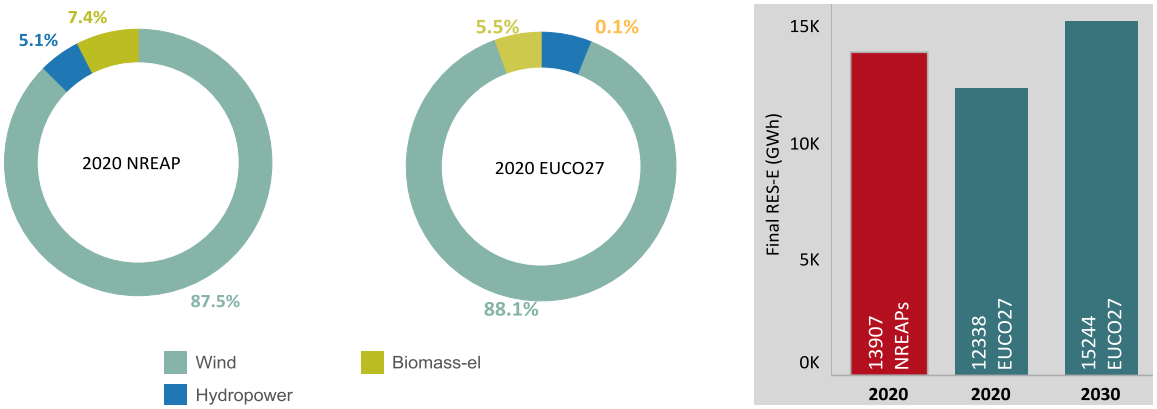


Figure 7 - 3. Final RES Electricity in Ireland: NREAP plan (2020) – EUCO27 projections (2020-2030)

The use of renewable energy in heating/cooling sector developed with a CAGR of 4.2% (+87.3 ktoe) reaching 286.8 ktoe (12 PJ). This development was slower than what is planned in the Ireland NREAP all over period 2011-15. Only in 2010 renewable heat/cold exceeded the planned consumption in this sector. Almost 80% was the share of biomass in renewable energy heat/cold in year 2015 whereas other sources, heat pumps and solar thermal, shared respectively 15.7% 4.5%. The renewable heat consumption in Ireland is expected to reach 590 ktoe (24.7 PJ) in 2020 in which the share of biomass is expected to reach 82.4%, heat pumps 14.2% and solar thermal 3.4%.

The use of renewable energy in transport increased with a CAGR of 53% (+127 ktoe) during 2005-2015 reaching 129 ktoe (5.4 PJ). Renewable energy used in this sector missed the NREAP planned levels all over period 2010-2015. Biodiesel was in 2015 the main renewable energy source in transport sector with a share of 72.2% followed by bioethanol-bio/ETBE (27.1%), and renewable electricity (0.7%). In 2020 renewable energy consumed in transport sector is expected to reach 519 ktoe (21.7 PJ). Biodiesel is expected to cover almost 66% of renewable energy in this sector followed by bioethanol-bio/ETBE (26.8%), renewable electricity (7.1%) and other biofuels (0.2%).

Table 7 - 1. Final renewable energy in IE: deviations from NREAP in electricity, heating/cooling and transport

	2010	2011	2012	2013	2014	2015
RES-el (ktoe)	-144	-192	-168	-274	-253	-230
RES-hc (ktoe)	8	-32	-85	-104	-106	-164
RES-tr (ktoe)	-43	-70	-116	-132	-151	-172
RES-el (%)	-28.5	-31.7	-26.6	-35.4	-31.5	-26.9
RES-hc (%)	3.7	-12.5	-27.2	-29.9	-27.5	-36.4
RES-tr (%)	-31.4	-41.7	-57.6	-56.1	-56.3	-57.1

7.4 Renewable energy technologies/sources

Wind was the main renewable energy source in Ireland in 2015 with a 5/.1% contribution, followed by biomass with 25.9%, biofuels with 12.3%, hydropower with 6./%, heat pumps with 4.3% and solar with 1.3%. In 2020 wind share will decrease slightly to 45.4%. Biofuels use are expected to double their share while the biomass contribution will decrease up to 25.2%. The contributions of hydropower and solar are expected also to decrease in 2020 respectively to 2.7% and 0.9%.

In this section: (i) Figure 7-4 present the current (2009-2015) and NREAP projected trend (2016-2020) of energy from renewable technologies/sources in Ireland. The annual increase/decrease (%) of these sources in these two periods is also available in this figure; (ii) Table 7-2 presents how the actual figures reported for renewable technologies/sources in Ireland compared with what was planned for the NREAPs. Absolute differences are shown in ktoe.

Biofuels used in transport sector in Ireland had the fastest development between 2005 and 2015 with a CAGR of 61% (+127 ktoe) reaching 128 ktoe (4.9 PJ). Despite of this increase biofuels use didn't reach the expected NREAP levels throughout period 2010-2015. Biomass in electricity and heating/cooling sectors reached 269.6 ktoe (11.3 PJ) in 2015 developing with a CAGR of 3.4% (+76 ktoe) over 2005 level. Nevertheless this source missed NREAP plans throughout period 2010-2015. Solar source in both electricity and heating/cooling reached 13.1 ktoe (0.5 PJ) in 2015 increasing with a CAGR of 40% (+12.7 ktoe) during period 2005-2015. Comparing with expected NREAP plans this source surpassed the NREAP plans throughout period 2010-2015.

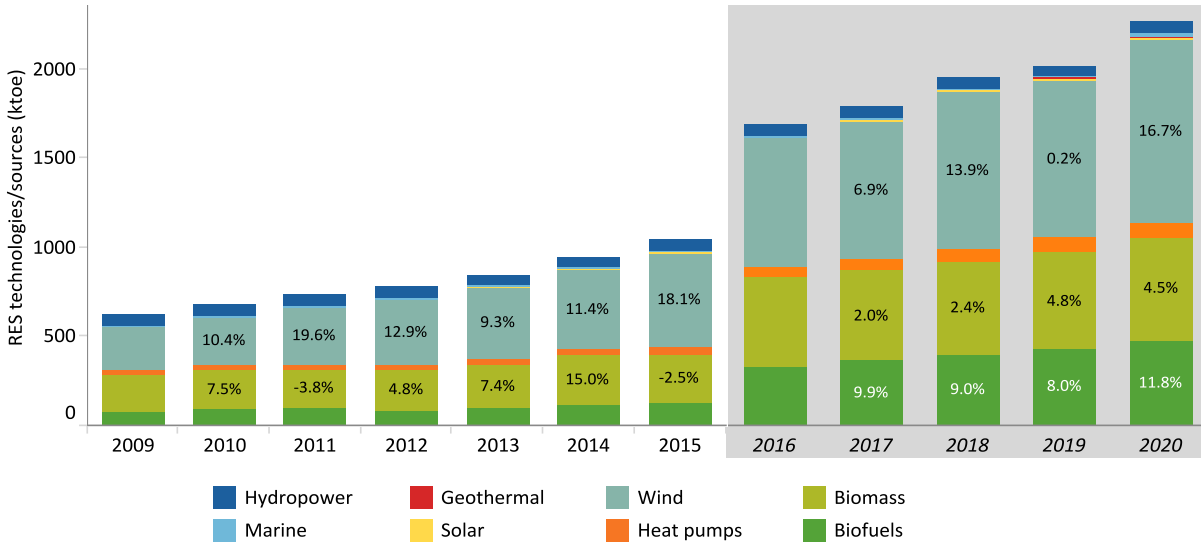


Figure 7 - 4. Annual growth of renewable energy technologies in IE: Current (2009-2015) - NREAP planned 2016-2020

Bioelectricity in Ireland developed with a CAGR of 13.8% (+345 GWh) between 2005 and 2015 reaching 475 GWh (41 ktoe). Despite this development biomass produced less than planned throughout period 2010-2015. Renewable electricity from wind developed with a CAGR of 18.5% (+4951 GWh) during period 2005-2015 reaching 6062 GWh (521 ktoe). Nevertheless wind power was found to be lower comparing with expected NREAP plans throughout period 2010-2015. While a downward trend with a CAGR of -0.5% (-36 GWh) in renewable electricity from hydropower took place between 2005 and 2015 this technology produced more than planned throughout period 2010-2015. Even that no renewable electricity consumption was planned to come from solar photovoltaics it grew to 2 GWh (0.1 ktoe) in 2015.

Solar thermal increased with a CAGR of 40% (+12.5 ktoe) between 2005 and 2015 reaching 13 ktoe (0.5 PJ). This technology was found above the expected plans throughout period 2010-2015. Biomass used for heat/cold developed with a CAGR of 2.3% (+46 ktoe) during

period 2005-2015 reaching 229 ktoe (9.6 PJ). This development was slower than the NREAP projected one all over period 2010-2015. Heat pumps increased between 2005 and 2015 with a CAGR of 20% (+38 ktoe) reaching 45.2 ktoe (1.9 PJ). Nevertheless heat consumptions were found under the expected NREAP consumptions over period 2012-15.

Bioethanol-bio/ETBE use in transport sector reached 35 ktoe (1.5 PJ) in 2015 remaining below the NREAP planned levels throughout period 2010-2015. Between 2005 and 2015 biodiesel use in transport sector developed with a CAGR of 56% (+92 ktoe) between 2005 and 2015 reaching 93 ktoe (3.9 PJ). In comparison with NREAP planned values the uses of biodiesel in Ireland were under throughout period 2010-2015. The role of Annex IX biofuels was expected to be very marginal in Ireland. In contrary their use reached 121.4 ktoe in 2015 being above the expected NREAP uses throughout period 2010-2015. Almost no change happened in the use of renewable electricity in transport during period 2005-2015 missing slightly the NREAP plans of 1 ktoe throughout period 2010-2015. In 2015 only 0.1% of final renewable electricity in Ireland was used in transport sector.

Table 7 - 2. Renewable energy technologies/sources in Ireland – deviations from NREAP, 2010-2015, (ktoe)

	2010	2011	2012	2013	2014	2015
Hydropower	4.5	4.2	5.0	3.3	0.7	0.9
Wind	-145.7	-191.7	-169.8	-246.9	-225.6	-195.8
Solar-el	0.0	0.0	0.1	0.1	0.1	0.1
Solar-th	3.5	4.1	3.2	3.3	2.2	1.0
Biomass-el	-2.9	-4.9	-3.1	-30.4	-27.8	-35.4
Biomass-th	-3.0	-38.3	-87.2	-102.4	-102.1	-159.3
Heat pumps	7.5	2.7	-0.6	-4.8	-6.3	-5.8
Biodiesel	-31.6	-59.1	-95.6	-100.1	-101.8	-115.8
Bioethanol	-9.8	-10.1	-19.5	-30.7	-48.0	-55.0
Other biofuels	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9
Renewable electricity	-0.3	-0.3	-0.2	-0.2	-0.2	-0.1

7.5 Renewable electricity installed capacity

Renewable energy installed capacity in Ireland increased with a CAGR of 13.5% (+1966 MW) between 2005 and 2015 reaching 2737 MW. Wind technology contribution was 89.1% while hydropower, biomass and solar followed respectively with 8.7%, 2.1% and 0.1%.

Figure 7-5 present the current trend of renewable electricity installed capacity in Ireland, the deviations (in %) from the expected developments during period 2005-2015, the 2020 NREAP plan and EUCO27 scenario projections for 2020 and 2030. As shown in the figure, the installed capacity in Ireland missed the expected NREAP plans throughout period 2010-2015.

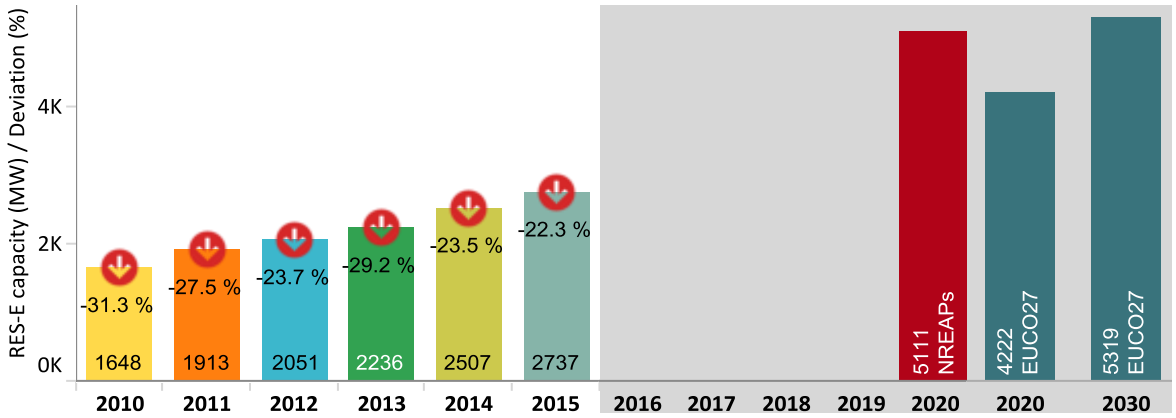


Figure 7 - 5. RES-E capacity development and deviation from NREAPs (2010-2015)– Expected capacity (2020-2030)

The main progress from year 2005 was made in wind technology developing until 2015 with a CAGR of 16.8% (+1923 MW) reaching 2440 MW. Nevertheless this development was not

enough to exceed the NREAP capacities planned for period 2010-2015. Biomass installed capacity developed with a CAGR of 11.2% (+38 MW) during period 2005-2015 being nevertheless under the expected capacities throughout period 2010-2015. Ireland has planned no changed in hydropower capacity up to 2020. Nevertheless a slightly increase with a CAGR of 0.1% (+3 MW) happened since in 2005 reaching 237 MW in 2015, over the expected plans throughout period 2020-15. While no contributions were planned in solar photovoltaic technology Ireland reported since in 2009 a capacity of 0.61 MW. A slightly increase happened since then reaching in 2015 the capacity of 2 MW.

In 2020 renewable electricity capacity in Ireland is expected to reach 5111 MW in which wind power is expected to remain the main contribution in renewable installed capacities covering more than 90% of it. Contributions of hydropower, biomass and marine technologies are expected to be limited respectively at 5%, 3% and 1%.

With a net generation capacity from renewables of 4222 MW the EUCO27 projections for 2020 are below the NREAP plan, being in line only for the share of wind power. According to this projection in 2030 Ireland is expected to have installed 5319 MW with wind as the dominating source.

8. Greece

Petroleum products together with solid fuels cover almost three-fourth of Greece gross inland consumption of energy in 2015. Gas and renewables divided almost the same relative contribution at 11% (Figure 8). Gross inland consumption of energy in Greece remained almost unchanged during period 2014-2015, at 24.4 Mtoe. Primary energy consumption was 23.7 Mtoe in 2015, 12.5% under the 2020 energy efficiency target [48]. Final energy consumption reached 16.4 Mtoe being 20% under the 2020 energy efficiency target for this indicator. Gross final energy consumption increased during period 2014-2015 by 6.4% (+1048 ktoe) amounting to 17.4 Mtoe. Energy intensity of the economy has fluctuated during period 2005-2015 having the highest value in 2012, at 144.7 toe/Million Eur. In 2015 this indicator stood at 132 toe/Million Eur. Greece has a considerable import dependence rate, at 77.1% in 2015, influenced by the high dependence rate for petroleum products (105.4%) and gas (99.9%). Greenhouse gas emissions in Greece in 2014 were 104.3 Mt CO_2, only 2.8% below the emissions in 1990. Energy remained the main source of emissions with a share of 55.3% (57.6 Mt CO_2 eq). In the same year the role of renewable energy in the reduction of GHG emissions reached a net savings of 17 Mt CO_2 eq, an additional of 5.4 Mt CO_2 since 2009.

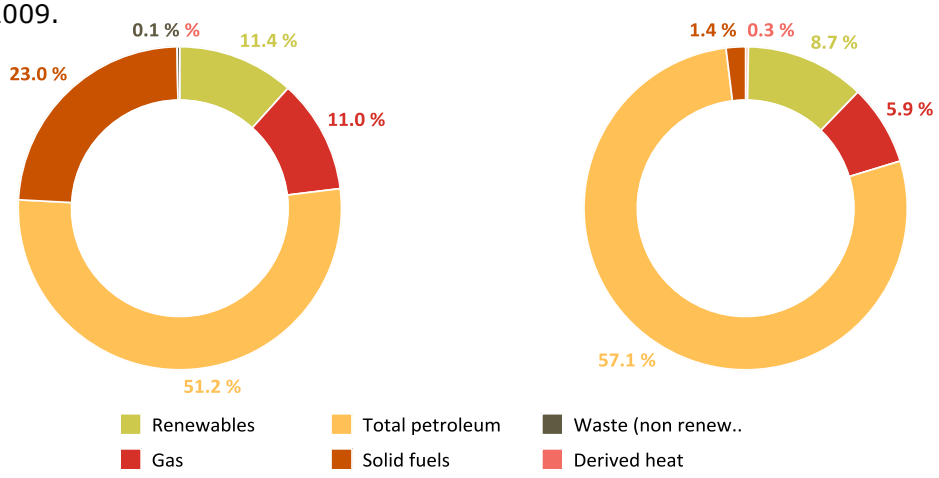


Figure 8. Breakdown of Gross Inland Consumption of Energy (left) - Final Energy Consumption (right) in EL, 2015

8.1 Final renewable energy consumption

Final renewable energy[49] consumed in Greece increased since 2005 with a CAGR of 5.9% (+1167.7 ktoe) reaching 2692 ktoe (133.6 PJ) in 2015. More than 55% of final renewable energy was consumed in heating/cooling sector and the rest in electricity sector (43.3%) and transport sector (1.5%).

Figure 8-1 present the current trend of final renewable energy consumption in Greece and the deviations (in %) from the expected developments during period 2005-2015 as well as the 2020 NREAP plan and EUCO27 projections for 2020 and 2030. As shown in this figure the current development of final renewable energy consumption in Greece was below the plans during period 2010 – 15.

Renewable energy consumed in Greece is expected to further increase to 5034 ktoe (210.8 PJ) until 2020. Due to the expected significant increase of the use of renewable energy in transport sector the structure of final renewable energy is expected to change compared with the current one: heating/cooling 37.9%, electricity 49.5% and transport 12.6%. The EUCO27 scenario for 2020 has projected much low final renewable energy consumption in Greece than its NREAP level, at 2992 ktoe (125 PJ). For 2030 this projection reveals the final consumption of renewable energy at 4763 ktoe (199 PJ).

[48] Greece energy efficiency 2020 targets are 27.1 Mtoe in terms of primary energy consumption and 20.5 Mtoe as final energy consumption.
[49] Final renewable energy (the sum of hydropower, solar, wind, marine, geothermal, biomass and heat pumps) in Greece reached 2683.7 ktoe in 2015, up from 1522 ktoe in 2005.

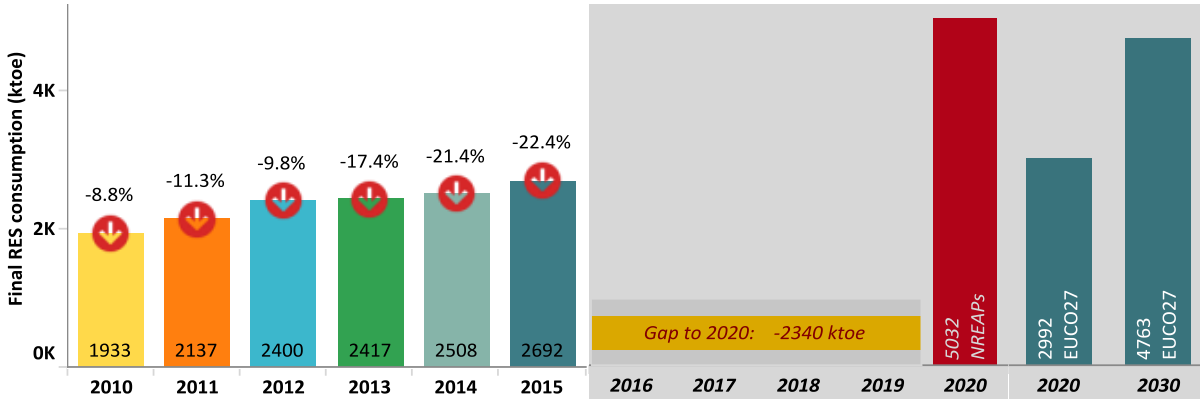


Figure 8 - 1. RES consumption: Trend, Deviation from NREAPs(2010-2015) - Expected RES consumption (2020-2030)

8.2 Renewable energy share

The overall renewable energy contribution in gross final energy consumption in Greece reached 15.3% in 2014 and 15.4% in 2015. The 2020 target that Greece has to reach for the overall RES share is 18%. According to the EUCO27 scenario the overall renewable energy share in Greece is projected to reach 18.5% in 2020 and 33.8% in 2030.

Figure 8-2 shows the current trajectory of overall renewable energy share in Greece, the NREAPs trajectory, the Indicative trajectory as well as the Current trend forecast trajectory.

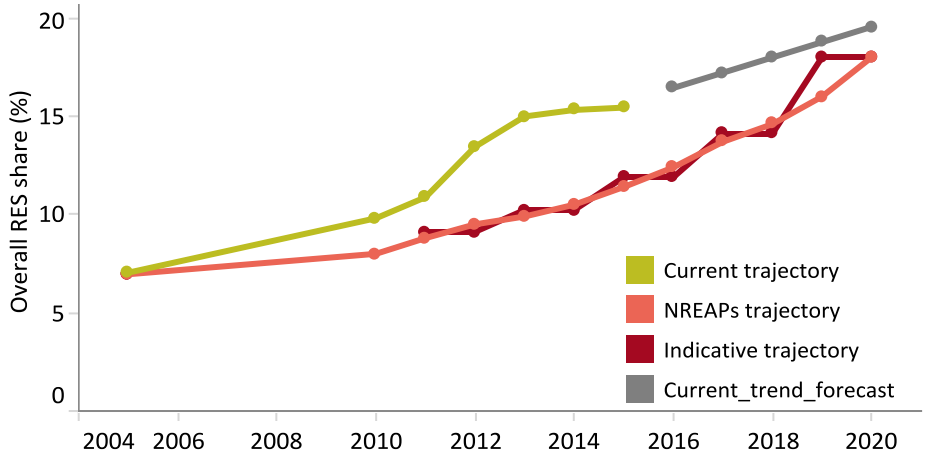


Figure 8 - 2. Overall RES share trajectories in EL: Current, NREAPs and Indicative - Current trend forecast, 2005-20

Overall renewable energy share in Greece remained well above the NREAP and indicative trajectories throughout 2010-2015. If Greece sticks to the trend achieved during 2011-2014 it will be on track to achieve the 2020 target. The fastest development took place in the heating/cooling sector, whereas the other two sectors lagged behind their respective plans.

Renewable energy share in heating/cooling sector reached 26.9% in 2014 and 25.9% in 2015 having the fastest development during period 2005-2015. It exceeded since in year 2012 the 2020 planned share (19.7%) of renewable energy in this sector by 3.7 percentage points.

Between 2005 and 2015 the share of renewable energy in electricity sector almost triple-fold reaching 21.9% in 2014 and 22.1% in 2015. Nevertheless this sector missed the NREAP planned shares throughout period 2010-2015. The planned share for 2020 is planned to reach 39.8%.

The share of renewable energy in transport sector increased slowly, reaching only 1.4% in 2015. Comparing with NREAP planned shares Greece didn't meet them in this sector throughout period 2010-2015. The 2020 planned share in this sector is foreseen to reach 10.1%.

8.3 Final renewable electricity, heating/cooling and use in transport

Renewable electricity consumption in Greece amounted to 13569 GWh (1167 ktoe) in 2015 increasing with a CAGR of 10.1% (+8378 GWh) since 2005. Nevertheless renewable electricity consumption in Greece didn't reach the NREAP planned consumption missing the respective values all over period 2011-15. In 2015 hydropower covered 36.4% of renewable electricity consumption followed by wind with 33.1%, solar with 28.7% and biomass with 1.7%. In 2020 renewable electricity in Greece is expected to reach 28973 GWh (2492 ktoe) in which wind power is expected to be the main source with a contribution of 58%. Hydropower is expected reach a contribution of 22.7% being followed by solar with 12.4%, biomass with 4.3% and geothermal with 2.5%. The EUCO27 scenario projection for 2020 is lower that what planned in the NREAP but the contributions of renewable energy technologies/sources are more in line with the current development. So for 2020 this projection gives 16205 GWh (1394 ktoe) of renewable electricity of which hydropower will share 36.4%, wind 32.1% and solar photovoltaic 29.1%. Under this scenario the projected final renewable electricity in Greece will reach 37271 GWh (1389 ktoe) in 2030 of which wind will share 50%, solar photovoltaic 32.6%, hydropower 15% and biomass 2.4%.

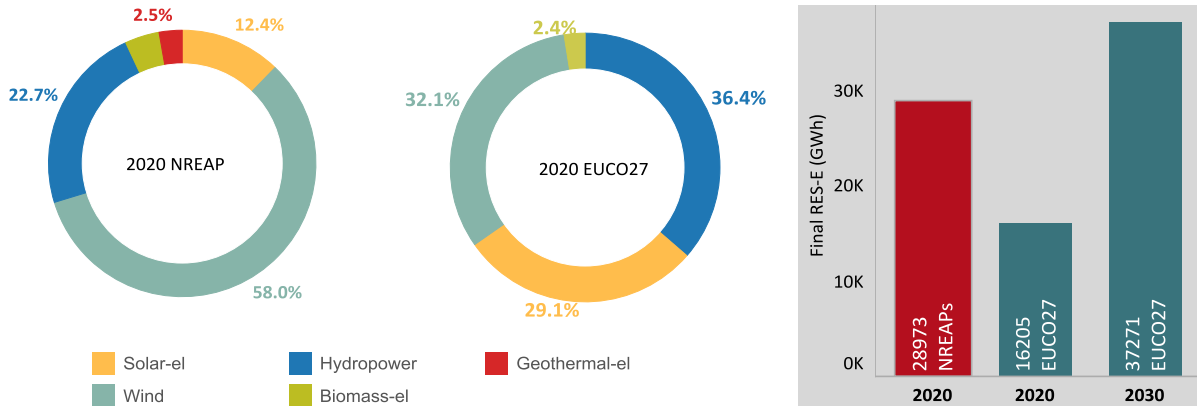


Figure 8 - 3. Final RES Electricity in Greece: NREAP plan (2020) – EUCO27 projections (2020-2030)

The use of renewable energy in heating/cooling in Greece increased with a CAGR of only 3.3% (+409 ktoe) during period 2005-2015 reaching 1485 ktoe (62.2 PJ). The development of renewable energy in this sector was faster than planned only during period 2011-12 missing the plans in other years of period 2010-2015. In 2015 biomass covered 72.2% of final renewable heat/cold followed by heat pumps (13.9%), solar thermal (13.2%) and geothermal (0.7%). In 2020 final renewable energy in heating/cooling is expected to reach 1907 ktoe (79.8 PJ) in which biomass will still remain the main source of renewable heat consumption with a share of 64.1%. Solar thermal contribution is expected to reach 18.6% followed by heat pumps with 14.6% and geothermal with 2.7%.

Renewable energy used in transport sector increased with a CAGR of 32.3% (+37.8 ktoe) between 2005 and 2015 reaching 40.3 ktoe (1.7 PJ). Nevertheless this type of renewable energy missed the NREAP plans all over period 2011-15. Only in year 2010 the use of renewable energy in transport sector was found above the plan. In 2015 biodiesel contributed with 79% and the rest was covered by renewable electricity (21%). In 2020 Greece has planned to use in transport sector 633.5 ktoe (26.5 PJ) of renewable energy in which the contribution of sources is expected to be leaded by bioethanol/bio-ETBE (65.4%), followed by biodiesel (32%), renewable electricity (2.6%).

Table 8 - 1. Final renewable energy in EL: deviations from NREAP in electricity, heating/cooling and transport

	2010	2011	2012	2013	2014	2015
RES-el (ktoe)	-380	-470	-580	-703	-825	-359
RES-hc (ktoe)	-1,041	-1,090	-1,131	-1,180	-1,191	-64
RES-tr (ktoe)	-16	-116	-172	-197	-228	-353
RES-el (%)	-51.3	-53.1	-55.5	-58.4	-60.0	-23.5
RES-hc (%)	-82.0	-83.1	-83.3	-82.9	-81.0	-4.1
RES-tr (%)	-14.7	-54.0	-66.8	-65.7	-66.1	-89.8

8.4 Renewable energy technologies/sources

Biomass was the main renewable energy source in Greece with a 40.7% contribution in final renewable energy in 2015, followed by solar with 19.8%, hydropower with 15.8%, wind with 14.4%, heat pumps with 7.7%, biofuels with 1.2% and geothermal with 0.4%. In 2020, the final renewable energy in Greece is expected to be dominated by wind technology with a share of 28.8% followed by biomass with 26.5%, solar with 13.3%, biofuels with 12.3%, hydropower with 11.3%, heat pumps with 5.6% and geothermal with 2.3%.

In this section: (i) Figure 8-4 present the current (2009-2015) and NREAP projected trend (2016-2020) of energy from renewable technologies/sources in Greece. The annual increase/decrease (%) of these sources in these two periods is also available in this figure; (ii) Table 8-2 presents how the actual figures reported for renewable technologies/sources in Greece compared with what was planned for the NREAPs. Absolute differences are shown in ktoe.

Solar technology used for electricity and heat developed between 2005 and 2015 with a CAGR of 18.1% (+431 ktoe) reaching 532 ktoe (22.3 PJ). Comparing with expected developments solar technology exceeded the planned levels throughout period 2012-15. Biofuels use in transport sector reached 31.8 ktoe (1.3 PJ) in 2015. Nevertheless this development was slower than planned missing the respective plans throughout period 2011-15. The increase of biomass consumption in both electricity and heating/cooling sectors took place with a CAGR of only 1.2% (+119 ktoe) during period 2005-2015 reaching 1092 ktoe (45.7 ktoe). This development was slower than planned surpassing the NREAP plans only during period 2011-12. Geothermal technology in electricity and heating/cooling sectors experienced during period 2005-2015 decrease with a CAGR of -2.2% (-2.5 ktoe) reaching 9.8 ktoe (0.4 PJ). This development remained slower than planned throughout period 2010-2015.

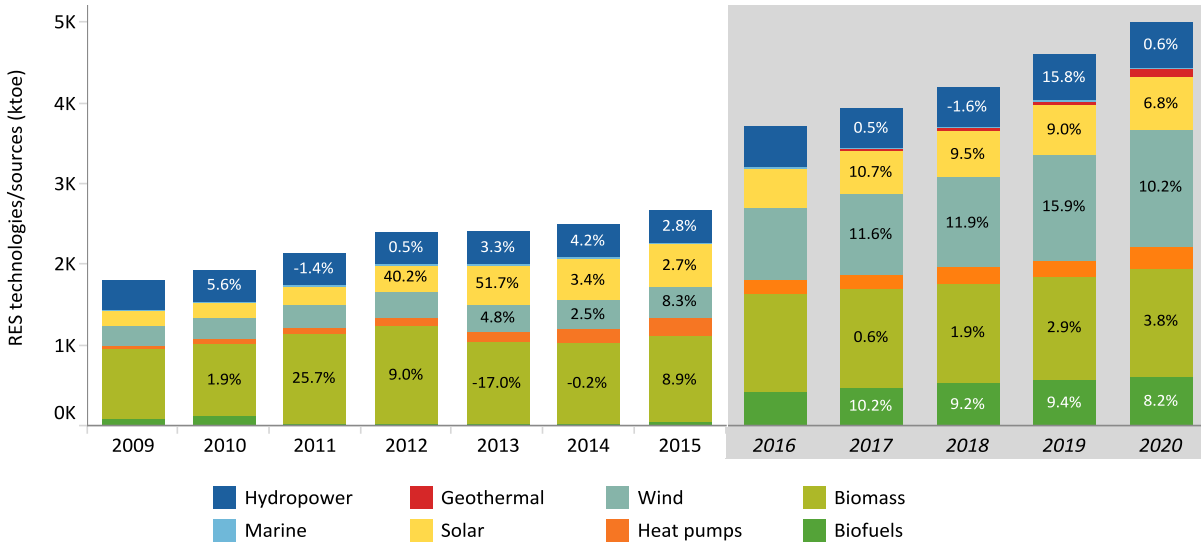


Figure 8 - 4. Annual growth of renewable energy technologies in EL: Current (2009-2015) - NREAP planned 2016-2020

In electricity sector solar technology (totally photovoltaic) had the fastest development between 2005 and 2015 with a CAGR of 129.7% (+3899 GWh) reaching 3900 GWh (335 ktoe). This technology was found above the NREAP plans throughout period 2011-15 exceeding since in 2013 the planned level for 2020 (3648 GWh). Wind power developed during period 2005-2015 with a CAGR of 13.1% (+3179 GWh) reaching 4497 GWh (386.7 ktoe). Nevertheless this development was slower than planned in the NREAP all over period 2010-2015. The development of biomass in this sector took place with a CAGR of 6.6% (+110 GWh) during period 2005-2015 reaching 231 GWh (20 ktoe). This development was slower than planned missing the NREAP plans all over period 2010-2015. Hydropower contribution reached 4942 GWh (425 ktoe) in 2015 following an increase trend with a CAGR of 2.8% (+1190 GWh) since 2005. Despite of this increase this technology experienced

negative exceedances from the NREAP plans throughout period 2010-2015. Greece has planned to introduce the contribution from geothermal technology in electricity sector in year 2014. Despite this no contribution from this technology was reported for this year.

Solar thermal technology developed with a CAGR of 6.9% (+95 ktoe) since 2005 reaching 196.4 ktoe (8.2 PJ) in 2015. Nevertheless the development of this technology in Greece remained below the NREAP plans throughout period 2010-2015. Heat pumps developed faster then planned between 2010 and 2015 reaching 207 ktoe (8.7 PJ). Consumption of heat originated from biomass developed slowly with a CAGR of only 1.1% (+33 ktoe) over period 2005-2015 reaching 1072 ktoe (45 PJ). This development was enough to exceed the expected heat production for period 2011-12 but not enough for other years of period 2010-2014. Geothermal had a slowly development between 2005 and 2014 with a CAGR of 1.8% (+2 ktoe) reaching 11.7 ktoe (0.5 PJ). This development was found above the expected NREAP one only in period 2011-12.

Use of bioethanol in transport sector in Greece was expected to happen since in year 2010. Despite of this expectation no use of bioethanol in transport sector was reported in Greece up to 2015. Biodiesel use in this sector didn't developed with the expected growth rate during period 2010-2015, reaching only 31.8 ktoe (1.3 PJ). While no contribution was expected from biofuels from wastes, residues, ligno-cellulosic material, their use grew to 23 ktoe in 2015 two times-fold in 2010-2015 time span. The use of renewable electricity in transport reached 8.5 ktoe (0.4 PJ) in 2015, almost double-folding the level achieved in year 2010. Comparing with expected use of renewable electricity in this sector it missed the plan in period 2011-13 exceeding it in 2010 and 2015. In 2015 only 0.7% of final renewable electricity in Greece was used in transport sector.

Table 8 - 2. Renewable energy technologies/sources in Greece – deviations from NREAP, 2010-2015, (ktoe)

	2010	2011	2012	2013	2014	2015
Hydropower	-41.1	-53.0	-76.6	-85.4	-73.0	-63.8
Wind	-19.3	-98.6	-169.4	-263.4	-367.6	-445.3
Solar-el	-7.2	12.1	85.7	225.8	210.4	184.5
Solar-th	-32.7	-43.1	-45.6	-73.0	-71.2	-74.6
Geothermal-el	0.0	0.0	0.0	0.0	-10.6	-10.6
Geothermal-th	-8.0	-5.1	-7.9	-10.5	-10.3	-13.2
Biomass-el	-5.5	-4.1	-4.4	-3.5	-18.7	-23.4
Biomass-th	-144.8	57.6	135.3	-94.9	-120.8	-55.9
Heat pumps	55.5	53.5	53.5	66.8	87.0	79.7
Biodiesel	59.9	-49.6	-58.3	-74.0	-83.0	-98.2
Bioethanol	-43.0	-142.0	-171.0	-198.0	-226.0	-256.0
Renewable electricity	0.3	-0.3	-0.8	-0.1	0.7	1.3

8.5 Renewable electricity installed capacity

The renewable electricity installed capacity in Greece increased since 2005 with a CAGR of 9.8% (+2923 MW) reaching 7439 MW in 2015. In 2015 hydropower and solar photovoltaic had almost the same relative share in installed renewable electricity capacity respectively 36% and 35%. The contributions of wind and biomass were respectively 28% and 1%.

Figure 8-5 present the current trend of renewable electricity installed capacity in Greece, the deviations (in %) from the expected developments during period 2005-2015, the 2020 NREAP plan and EUCO27 scenario projections for 2020 and 2030. As shown in this figure the installed capacity in Greece missed the expected NREAP plans throughout period 2010-2015.

Solar technology (photovoltaic) made the main progress from 2005 increasing the installed capacity with a CAGR of 119.6% (+2603 MW) reaching 2604 MW in 2015. The development was fast enough to exceed not only the NREAP plans throughout period 2010-2015 but also to be 5.3% (+129 MW) above the plan for 2020 since in 2013. In 2015 this exceedance reached 6.3% (+154 MW). Wind capacity development between 2005 and 2015 took place

with a CAGR of 15.6% (+ 1600 MW) reaching 2091 MW. Nevertheless these capacities remained under the excepted NREAP plans throughout period 2010-2015. The increase in biomass capacity resulted with a CAGR of only 7.8% (+27 MW) between 2005 and 2015 reaching 51 MW. The increase didn't follow the planned growth rate established in the NREAP missing the respective capacities throughout period 2010-2015. Hydropower installed capacity registered a slightly increase during period 2005-14 with a CAGR of 1.1% (+286 MW) remaining under the expectations for period 2010-2015.

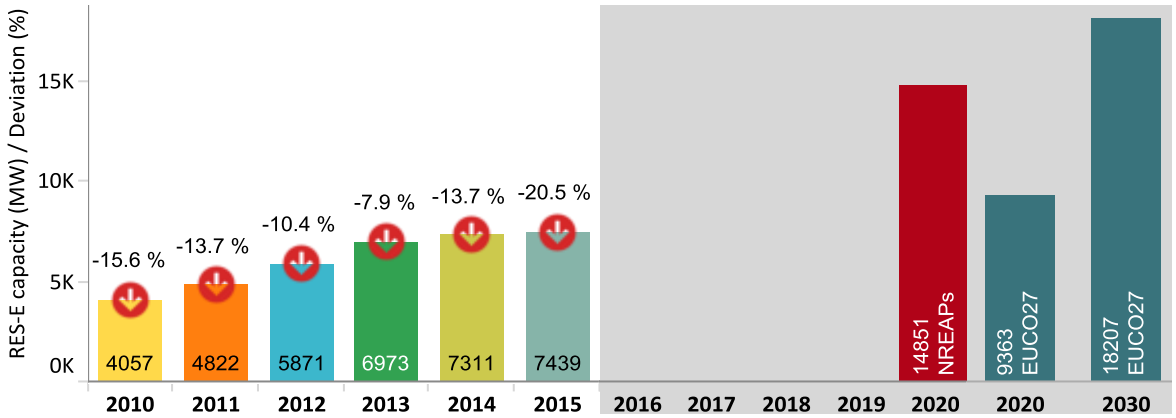


Figure 8 - 5. RES-E capacity development and deviation from NREAPs (2010-2015)– Expected capacity (2020-2030)

According to Greece NREAP in 2020 renewable electricity installed capacity is planned to reach 14851 MW in which wind power is expected to cover almost half of this capacity followed by hydropower with 31%. The fast development of solar photovoltaic will change the contributions of these technologies within the renewable electricity capacity in Greece in 2020.

The projections from EUCO27 scenario reveal for 2020 a lower net generation capacity in Greece, at 9363 MW, being nevertheless more in line with the current development of solar photovoltaic capacity. According to these projections Greece is expected to reach a net generation capacity of 18207 MW in 2030.

9. Spain

Renewables were the third source of 2015 energy mix in Spain, at 13.7%, following the petroleum products and gas (Figure 9). During period 2014-2015 gross inland consumption of energy in Spain increased by 4.1% (+4738 ktoe), reaching 121.4 Mtoe. Primary energy consumption was 117 Mtoe in 2015, 2.3% under the 2020 energy efficiency target[50]. With 80.5 Mtoe the final energy consumption was found 0.5% higher than the 2020 energy efficiency target for this indicator. Gross final energy consumption increased during period 2014-2015 by 1.3% (+1001 ktoe) amounting to 83.5 Mtoe. Spain energy intensity of the economy stood at 113.7 toe/Million Eur, or 0.9% higher than in the previous year. Spain import dependency rate decreased during period 2005-2015, reaching 73.3% in 2015 that remained high for both gas and petroleum products. Greenhouse gas emissions in Spain have increased to 342.7 Mt CO_2 eq in 2014, 17.5% over the emissions in 1990. More than 72% (238 Mt CO2 eq) of the emissions was sourced from energy sector. In the same year the role of renewable energy in the reduction of GHG emissions reached a net savings of 55 Mt CO_2 eq, an additional of 9 Mt CO_2 since 2009.

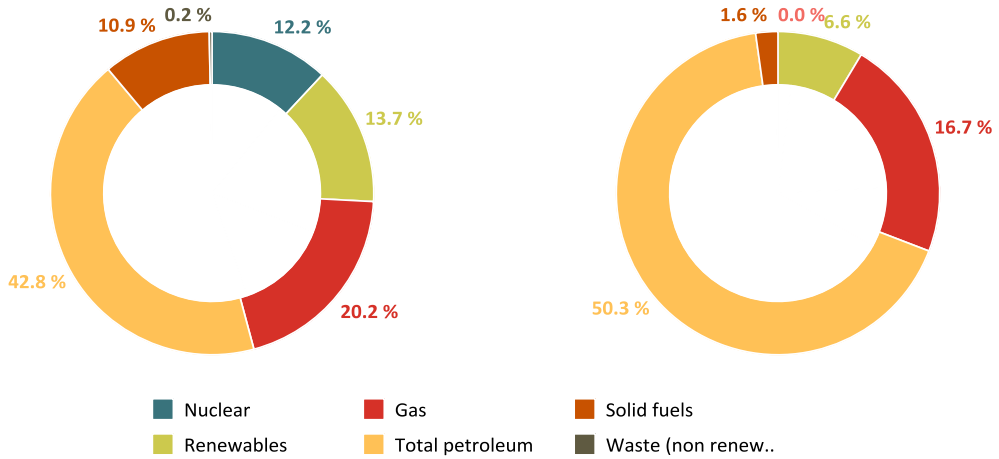


Figure 9. Breakdown of Gross Inland Consumption of Energy (left) - Final Energy Consumption (right) in ES, 2015

9.1 Final renewable energy consumption

Final renewable energy[51] consumed in Spain increased between 2005 and 2015 with a CAGR of 4.7% (+5060 ktoe) reaching 13673 ktoe (572.5 PJ). Almost two-thirds of final renewable energy in Spain is consumed in the form of renewable electricity (64.5%) and the rest as renewable heat/cold (34.1%) and renewable energy in transport (1.4%).

Figure 9-1 present the current trend of final renewable energy consumption in Spain and the deviations (in %) from the expected developments during period 2005-2015 as well as the 2020 NREAP plan and EUCO27 projections for 2020 and 2030. As shown in this figure, the current development of final renewable energy consumption in Spain was below the plans during period 2011 – 15.

Renewable energy consumption in Spain is expected to further increase to 21028 ktoe (880.4 PJ) until 2020. Since a significant increase is planned to take place in renewable energy use in transport sector the share of three sectors is expected to change from the picture in 2014: renewable electricity is expected to cover 59.1% of final renewable energy expected whereas renewable heat/cold and renewable energy in transport will share respectively 25.7% and 15.2%. The EUCO27 scenario for 2020 has projected lower final renewable energy consumption in Spain than its NREAP level, at 17948 ktoe (751 PJ). For 2030 this projection reveals the final consumption of renewable energy at 24273 ktoe (1016 PJ).

[50] Spain energy efficiency 2020 targets are 119.8 Mtoe in terms of primary energy consumption and 80.1 Mtoe as final energy consumption.
[51] Final renewable energy (the sum of hydropower, solar, wind, marine, geothermal, biomass and heat pumps) in Spain reached 13482.8 ktoe in 2015, up from 8526 ktoe in 2005.

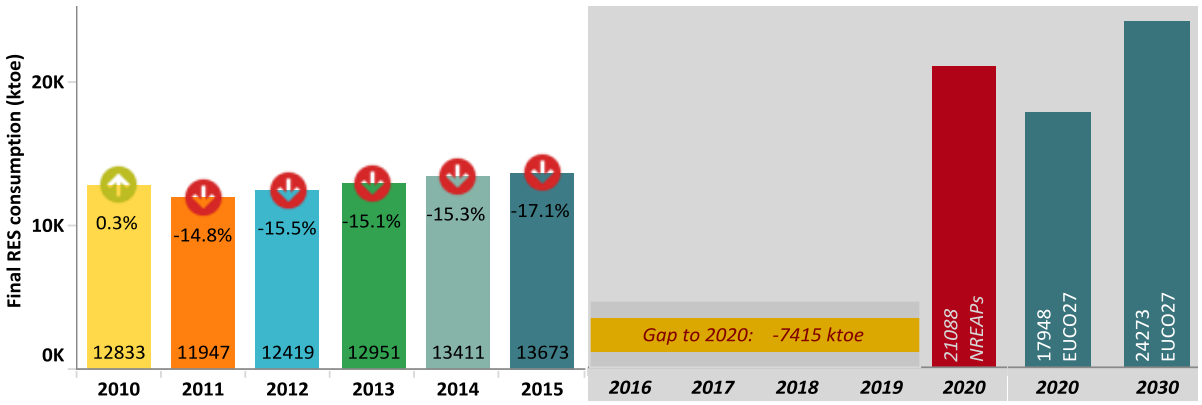


Figure 9 - 1. RES consumption: Trend, Deviation from NREAPs(2010-2015) - Expected RES consumption (2020-2030)

9.2 Renewable energy share

The overall renewable energy contribution in gross final energy consumption in Spain reached 16.1% in 2014 and 16.2% in 2015. The 2020 target that Spain has to reach for the overall renewable energy share is 20.8%. According to the EUCO27 scenario the overall renewable energy share in Spain is projected to reach 21% in 2020 and 31.1% in 2030.

Figure 9-2 shows the current trajectory of overall renewable energy share in Spain, the NREAPs trajectory, the Indicative trajectory as well as the Current trend forecast trajectory.

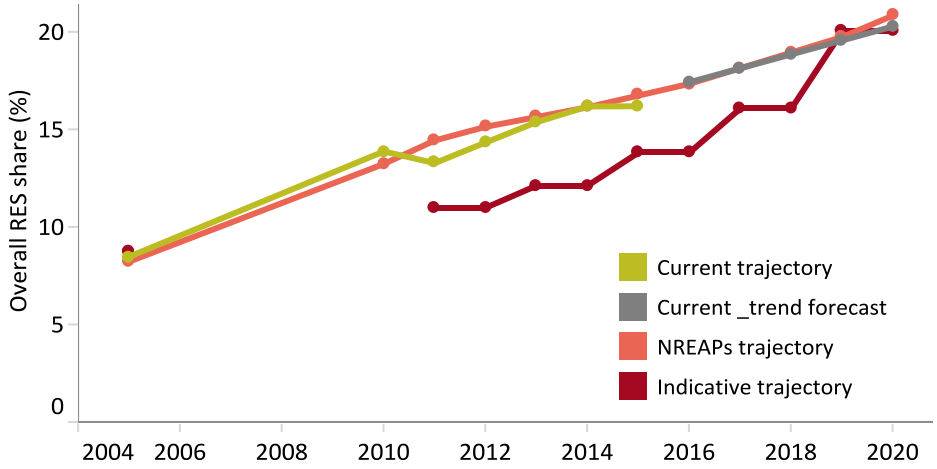


Figure 9 - 2. Overall RES share trajectories in ES: Current, NREAPs and Indicative - Current trend forecast, 2005-20

Overall renewable energy share in Spain remained above the indicative trajectory throughout 2010-2015. This development was slightly slower than the NREAP planned trajectory, meeting it only in 2014. The transport sector lags well behind the plans, and this is influencing the current trajectory of Spain's overall renewable energy share.

Renewable energy share in electricity sector reached 37.8% in 2014 and 36.9% in 2015 surpassing the respective plans throughout period 2010-2015. The 2020 planned share in this sector is set to 39%

In heating/cooling sector the share of renewable energy reached 15.7% in 2014 and 16.8% in 2015. This development enables Spain to exceed respective NREAP planned shares throughout period 2010-2015. The planned 2020 share for this sector is set to 17.3%.

The share of renewable energy in transport sector in Spain during period 2005-2015 was not at the expected levels reaching only 1.7% in 2015 missing the expected NREAP planned shares throughout period 2011-15. The planned share for 2020 in this sector is foreseen to reach 11.3%.

9.3 Final renewable electricity, heating/cooling and use in transport

Renewable electricity consumption in Spain amounted to 102.5 TWh (8819 ktoe) in 2015 increasing since 2005 with a CAGR of 6.4% (+47.4 TWh). Nevertheless the renewable electricity consumption in Spain remained below the NREAP plans all over period 2011-15. In 2015 wind power provided 49.8% of renewable electricity in Spain followed by hydropower with 31.1%, solar with 13.5% and biomass with 5.6%. In 2020 the renewable electricity consumption in Spain is expected to amount to 144.8 TWh (12.5 Mtoe) in which the contribution of wind power will cover half of renewable electricity consumption expected and the other half will be shared among hydropower (22.7%), solar (18.5%), biomass (5.4%) and geothermal (0.2%). The EUCO27 scenario projection for 2020 is lower than the Spain NREAP plan for this year, at 111.6 TWh (9.6 Mtoe). Of this electricity wind will share 50.5%, hydropower 29.8%, solar 14.3% and biomass 5.4%. Under this scenario final renewable electricity in Spain will reach 191.4 TWh (16.5 Mtoe) in 2030 of which wind will share 44%, solar photovoltaic 33.5%, hydropower 17.5% and biomass 5.0%.

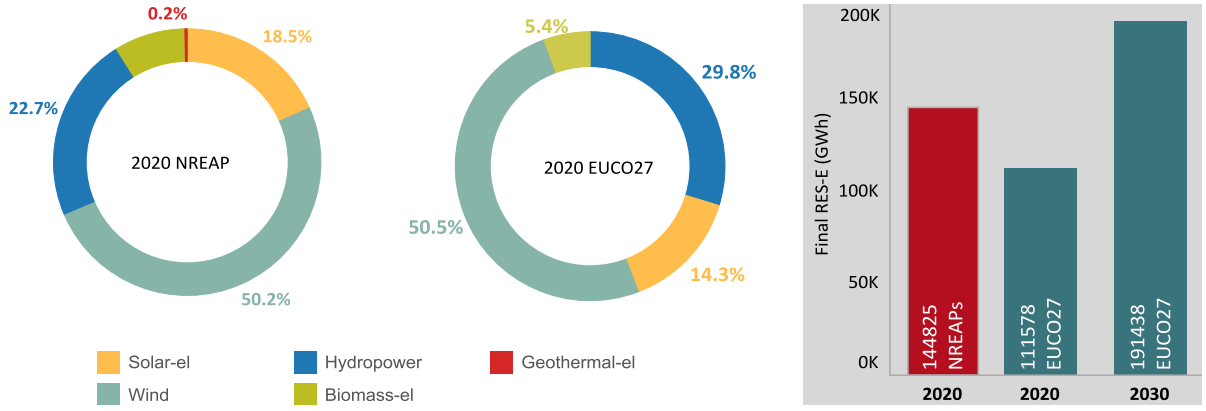


Figure 9 - 3. Final RES Electricity in Spain: NREAP plan (2020) – EUCO27 projections (2020-2030)

The use of renewable energy in heating/cooling sector in Spain increased with a CAGR of 2.8% (+1131 ktoe) between 2005 and 2015 reaching 4663 ktoe (195.2 PJ). The achieved development in this sector was faster than the development projected in the NREAP surpassing the respective levels throughout period 2011-15. In 2015 biomass provided almost 86.1% of total renewable heat consumed in Spain and the rest was covered by heat pumps (7.6%), solar thermal (5.9%) and geothermal (0.4%). In 2020 the use of renewable energy in this sector is expected to reach 5357.3 ktoe (224.3 PJ) in which the share of biomass will reach almost 86%. Contributions of solar thermal, heat pumps and geothermal will be respectively with 11.9%, 2% and 0.2%.

According to its NREAP Spain had planned a significant increase of renewable energy use in transport sector during period 2005-2015 with a CAGR of 26.2% (+2255 ktoe). In contrary the use of renewable energy in this sector was very slow missing the respective NREAP levels all over period 2010-2015. In 2015 Spain reported only the use of renewable electricity in this sector. In 2020 the use of renewable energy in transport sector is expected to reach 3215.6 ktoe (134.6 PJ) in which biodiesel share will reach 71.9% and the rest will be bioethanol-bio/ETBE (12.4%) and renewable electricity (15.6%).

Table 9 - 1. Final renewable energy in ES: deviations from NREAP in electricity, heating/cooling and transport

	2010	2011	2012	2013	2014	2015
RES-el (ktoe)	-380	-470	-580	-703	-825	-359
RES-hc (ktoe)	-1,041	-1,090	-1,131	-1,180	-1,191	-64
RES-tr (ktoe)	-16	-116	-172	-197	-228	-353
RES-el (%)	-51.3	-53.1	-55.5	-58.4	-60.0	-23.5
RES-hc (%)	-82.0	-83.1	-83.3	-82.9	-81.0	-4.1
RES-tr (%)	-14.7	-54.0	-66.8	-65.7	-66.1	-89.8

9.4 Renewable energy technologies/sources

In 2015 biomass was the main renewable energy source in Spain with a 33.5% contribution, followed by wind with 32.6%, hydropower with 20.3% and solar with 10.9%, heat pumps with 2.6% and geothermal with 0.1%. In 2020 wind power is expected to have the highest contribution with 30.3% followed by biomass with 27.7%, solar with 14.3%, hydropower with 13.7%, biofuels with 13.2%, heat pumps with 0.5%, geothermal with 0.2% and marine with 0.1%.

In this section: (i) Figure 9-4 present the current (2009-2015) and NREAP projected trend (2016-2020) of energy from renewable technologies/sources in Spain. The annual increase/decrease (%) of these sources in these two periods is also available in this Figure; (ii) Table 9-2 presents how the actual figures reported for renewable technologies/sources in Spain compared with what was planned for the NREAPs. Absolute differences are shown in ktoe.

Solar technology for electricity and heating/cooling increased with a CAGR of 36.6% (+1404 ktoe) between 2005 and 2015 reaching 1469 ktoe (61.5 PJ). Nevertheless this development was not fast enough to meet the projected NREAP development throughout period 2012-15. Biomass for energy in Spain increased with a CAGR of only 2% (+818.3 ktoe) during period 2005-2015 reaching 4509.6 ktoe (188.8 PJ). The biomass use for energy purposes in Spain developed slower than what was planned in the NREAP exceeding the respective levels only in period 2011-13. Even than planned no use of biofuels in transport sector was reported for period 2011-15.

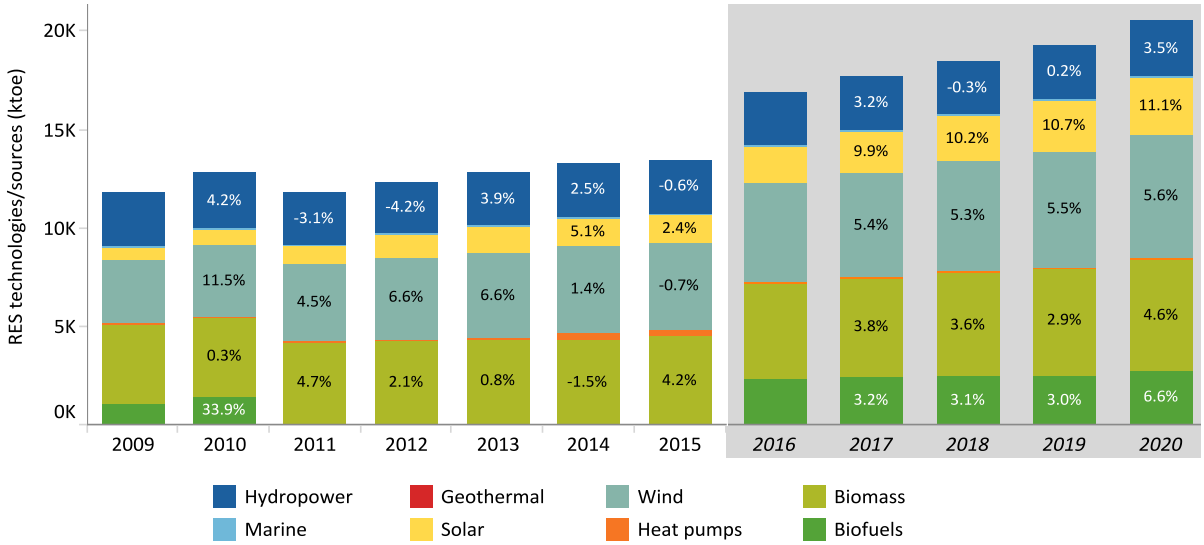


Figure 9 - 4. Annual growth of renewable energy technologies in ES: Current (2009-2015)-NREAP planned 2016-2020

Solar photovoltaic developed during period 2005-2015 increasing with a CAGR of 70% (+8226 GWh) reaching 8267 GWh (711 ktoe). This increase was faster than planned throughout period 2010-2013 but slower in 2014-2015. Renewable electricity from CSP in Spain developed with a CAGR of 49% (+4832 GWh) during period 2010-2015 reaching 5593 GWh (481 ktoe). Despite these increases the achieved consumption was found to be under the NREAP levels throughout period 2011-15. Wind power developed with a CAGR of 9.4% (+30326 GWh) between 2005 and 2015 reaching 51055 GWh (4391 ktoe). Despite of this development this technology missed the respective NREAP levels throughout period 2011-15. Biomass use in electricity sector developed with a CAGR of 8.1% (+3111 GWh) between 2005 and 2015 reaching 5764 GWh (496 ktoe). Nevertheless this source remained under the expected NREAP consumptions throughout period 2010-2015. Hydropower developed very slowly between 2005 and 2015, with a CAGR of only 0.06% (+204 GWh), reaching 31878 GWh (2741 ktoe). Comparing with expected development this source missed the NREAP plan only in year 2012.

Solar thermal technology increased with a CAGR of 16.3% (+216 ktoe) reaching 277.3 ktoe (11.6 PJ) in 2015. The development of this technology was found below the expected NREAP levels only in period 2014-2015. Spain introduces the heat pump technology only in year 2014 with a contribution of 331.8 ktoe (13.9 PJ), almost three times higher than the plan for year 2020. In 2015 the contribution from this technology reached 353 ktoe (14.8 PJ). Geothermal source increased from year 2005 to 2015 with a CAGR of 10% (+11.6 ktoe) reaching 18.8 ktoe (0.8 PJ) almost two times-fold the 2020 planned level (9.5 ktoe) for heat consumption from this source. This source was found above the NREAP projections all over period 2010-2015. Biomass thermal developed between 2005 and 2015 with a CAGR of only 1.5% (+551 ktoe) reaching 4014 ktoe (168 PJ). Comparing with expected NREAP development this source was found above the plans all over period 2010-2015. In 2015 the use of renewable electricity in transport sector reached 192 ktoe (8 PJ) developing with a CAGR of 8.2% (+104 ktoe) between 2005 and 2015. In 2015 only 2.2% of final renewable electricity in Spain was used in transport sector. Comparing with expected NREAP uses renewable electricity in transport developed slower than planned throughout period 2010-2015. In 2015 Spain used 2.2% of its final renewable electricity in transport sector.

Table 9 - 2. Renewable energy technologies/sources in Spain – deviations from NREAP, 2010-2015, (ktoe)

	2010	2011	2012	2013	2014	2015
Hydropower	71	0	-80	54	76	44
Wind	32	-21	-1	-2	-162	-391
Solar-el	19	-14	-35	-127	-218	-300
Solar-th	0	15	22	10	-7	-31
Geothermal-th	12	13	14	14	15	14
Biomass-el	-18	-79	-86	-40	-103	-119
Biomass-th	2	93	121	45	-22	-46
Heat pumps	-17	-20	-22	-25	304	322
Biodiesel	-36	-1,816	-1,878	-1,900	-1,930	-1,970
Bioethanol	4	-232	-281	-281	-290	-301
Renewable electricity	-30	-18	-58	-58	-78	-37

9.5 Renewable electricity installed capacity

Renewable electricity installed capacity in Spain increased with a CAGR of 6.8% (+21.8 GW) between 2005 and 2015 reaching 45.1 GW. In 2015 almost 51% renewable installed capacity in Spain was wind power and the rest was hydropower (31.2%), solar photovoltaic (15.9%) and biomass (2.0%)

Figure 9-5 present the current trend of renewable electricity installed capacity in Spain, the deviations (in %) from the expected developments during period 2005-2015, the 2020 NREAP plan and EUCO27 scenario projections for 2020 and 2030. As shown in this figure the installed capacity in Spain missed the expected NREAP plans throughout period 2011-15. 2010 was the only year in which Spain fulfilled the NREAP plan.

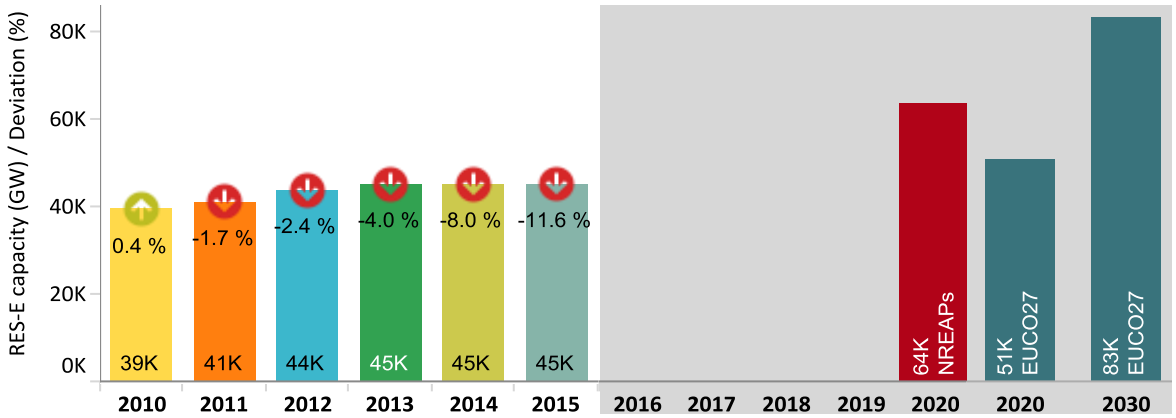


Figure 9 - 5. RES-E capacity development and deviation from NREAPs (2010-2015)– Expected capacity (2020-2030)

Solar photovoltaic had the fastest development with a CAGR of 55.2% (+4796 MW) during period 2005-2015 reaching 4856 MW. These capacities missed the plans throughout period 2012-15. Concentrated solar power (CSP) technology in Spain reached 2300 MW in 2015. Despite of this increase the capacity of CSP technology was found to be under the expected NREAP throughout period 2011-15. Biomass capacity for electricity consumption increased with a CAGR of 5.9% (+395 MW) between 2005 and 2015 reaching 901 MW. Nevertheless these capacities were found to be under the expected NREAP levels throughout period 2010-2015. The capacity of wind power developed during period 2005-2015 with a CAGR of 8.7% (+13025 MW) reaching 22943 MW. Nevertheless this technology didn't meet the expected NREAP levels being under throughout period 2010-2015. Hydropower capacity developed with a CAGR of only 1.0% (+1277 MW) during period 2005-2015 reaching 14086 MW. This source missed the plans only during period 2011-12

In 2020 the installed capacity of renewable energy sources is expected to reach 64 GW in which wind power will share a contribution of 56.1% followed by hydropower with 21.7%, solar with 18.9%, biomass with 3.1%, marine 0.2% and geothermal 0.1%.

The EUCO27 projections for 2020 are not consistent with NREAPs in forecasting a net generation capacity of 51 GW, being nevertheless in line for solar photovoltaic contribution. According to these projections in 2030 Spain is expected to have installed 83 GW of renewable electricity in which solar photovoltaic will share more than 35%.

10. France

Nuclear had the highest share in France's energy mix in 2015 together with petroleum products whereas the share of renewables reached only 8.6% (Figure 10). In 2015 gross inland consumption of energy in France totalled to 252.8 Mtoe, 1.7% (+4180 ktoe) higher than the consumption in 2014. Primary energy consumption was 239.4 Mtoe in 2015, 8.9% above the 2020 energy efficiency target[52]. Final energy consumption reached 144.3 Mtoe being 9.8% above the 2020 energy efficiency target for this indicator. Gross final energy consumption increased during period 2014-2015 by 2.2% (+3294 ktoe) amounting to 150 Mtoe. Energy intensity of the economy continues to drop remaining at 120 toe/Million Eur in 2015. Import dependency rate in France decreased slowly reaching 46% in 2015. Greenhouse gas emissions continued to decline at 475.4 Mt CO_2 eq in 2014, 14.6% below the emissions in 1990. Energy remained the main source of emissions with a share of 39.7% (189 Mt CO_2 eq). In the same year the role of renewable energy in the reduction of GHG emissions reached a net savings of 82.4 Mt CO_2 eq, an additional of 40.6 Mt CO_2 since 2009.

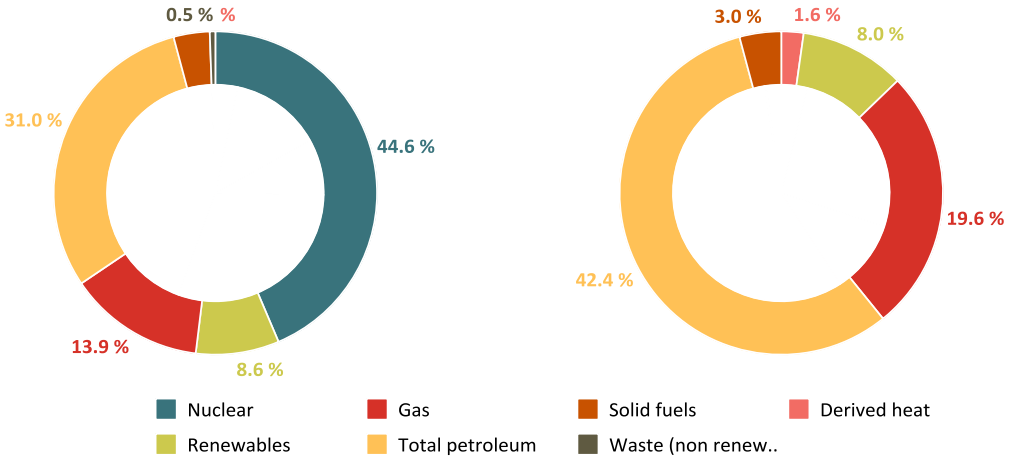


Figure 10. Breakdown of Gross Inland Consumption of Energy (left) - Final Energy Consumption (right) in FR, 2015

10.1 Final renewable energy consumption

Final renewable energy[53] consumed in France has gone up with a CAGR of 3.8% (+7105 ktoe) between 2005 and 2015 reaching 23004 ktoe (963 PJ), already one third of 2020 plan. In that year more than half of the final renewable energy was consumed in heating/cooling and the rest was in electricity sector (35%) and transport sector (14%).

Figure 10-1 present the current trend of final renewable energy consumption in France, the deviations (in %) from the expected developments during period 2005-2015 and the 2020 NREAP plan and EUCO27 projections for 2020 and 2030. As shown in this figure the NREAP plans for final renewable energy consumption in France were not fulfilled throughout period 2010 – 15

Final renewable energy consumption in France is planned to reach 37148 ktoe (1555 PJ) in 2020. Of this consumption renewable heating/cooling will share 53.1% followed by renewable electricity with 35.9% and renewable energy in transport with 10.9%. The EUCO27 scenario for 2020 has projected lower final renewable energy consumption in France than its NREAP level, at 37148 ktoe (1474 PJ). For 2030 this projection reveals even lower final consumption of renewable energy in France, at 34935 ktoe (1463 PJ).

[52] France energy efficiency 2020 targets are 219.9 Mtoe in terms of primary energy consumption and 131.4 Mtoe as final energy consumption.
[53] Final renewable energy (the sum of hydropower, solar, wind, marine, geothermal, biomass and heat pumps) in France reached 22783.3 ktoe in 2015, up from 15777.7 ktoe in 2005.

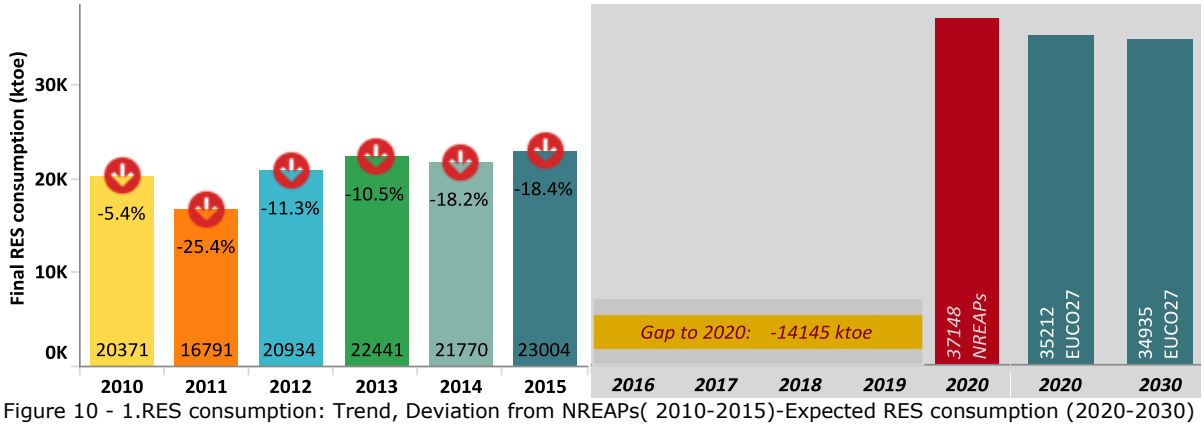


Figure 10 - 1.RES consumption: Trend, Deviation from NREAPs(2010-2015)-Expected RES consumption (2020-2030)

10.2 Renewable energy share

The overall renewable energy contribution in gross final energy consumption in France reached 14% in 2013 and 14.3% in 2014. The 2020 target that France has to reach for the overall RES share is 23%. According to the EUCO27 scenario the overall renewable energy share in France is projected to reach 23.6% in 2020 and 26.5% in 2030.

Figure 10-2 shows the current trajectory of overall renewable energy share in France, the NREAPs trajectory, the Indicative trajectory as well as the Current trend forecast trajectory.

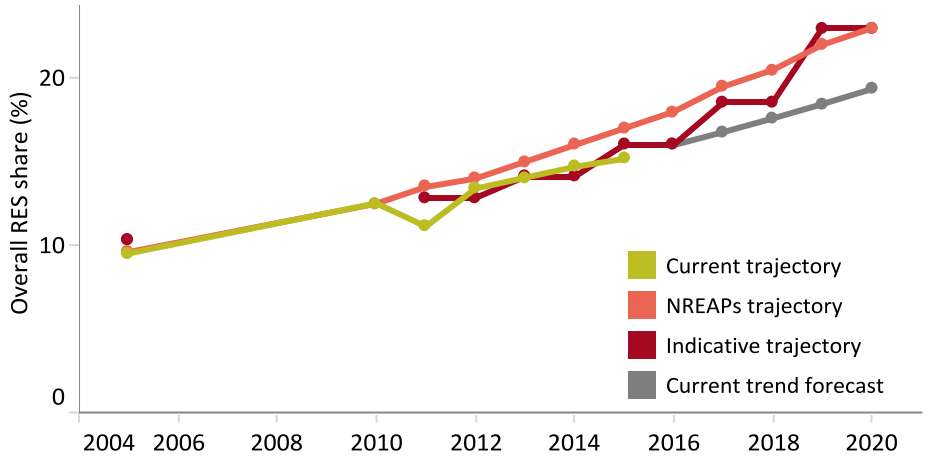


Figure 10 - 2. Overall RES share trajectories in FR: Current, NREAPs and Indicative - Current trend forecast, 2005-20

Overall renewable energy share in France remained under the NREAP trajectory throughout 2010-2015, but was more or less in line with the indicative trajectory. France missed both its NREAP and indicative trajectories in 2011 and 2015. This development means that France is not on course to reach the 2020 target on overall renewable energy share. The renewable energy share was deployed faster than planned only in the transport sector.

In electricity sector the share of renewable energy reached 18.3% in 2014 and 18.8% in 2015 a development not fast enough to meet the plans during period 2012-15. The 2020 plan for renewable energy share in this sector is foreseen to reach 27%.

The renewable energy share in heating/cooling sector reached 18.8% in 2014 and 19.8% in 2015 being nevertheless under the planned trajectory throughout period 2010-2015. The plan for renewable energy share in this sector in year 2020 is set to 33%.

The share of renewable energy in transport sector reached 8.5% in 2015 remaining over the planned shares throughout period 2012-15. A significant drop of this indicator took place in year 2011, at 0.95%. The 2020 plan in this sector is expected at 10.5%.

10.3 Final renewable electricity, heating/cooling and use in transport

Renewable electricity consumption in France amounted to 93.7 TWh (8057 ktoe) in 2015 going up with a CAGR of 2.9% (+23.5 TWh) between 2005 and 2015. Nevertheless the renewable electricity consumption in France missed the NREAP planned values throughout period 2010-2015. In 2015 hydropower technology shared 64.2% followed by wind (21.2%), solar photovoltaic (7.7%), biomass (6.3%) and marine (0.5%). In 2020 the renewable electricity consumption in France is expected to amount to 155.3 TWh (13.4 Mtoe) in which hydropower is expected to remain still the main contributor with a share of 46.2% followed by wind power with 37.3%, biomass (11.1%), solar photovoltaic (4.4%), marine (0.7%) and geothermal (0.3%).

The EUCO27 scenario projection for 2020 is slightly higher compared with France NREAP plan, at 168.5 TWh (14.5 Mtoe). Of this electricity hydropower will share 39.7%, wind 32.7%, solar 18.7%, biomass 8.4% and geothermal 0.5%. Unde this scenario final renewable electricity in France will reach 217.8 TWh (18.7 Mtoe) in 2030 of which wind will share 38.9%, hydropower 29.4%, solar photovoltaic 22%, biomass 8.7% and geothermal 0.9%.

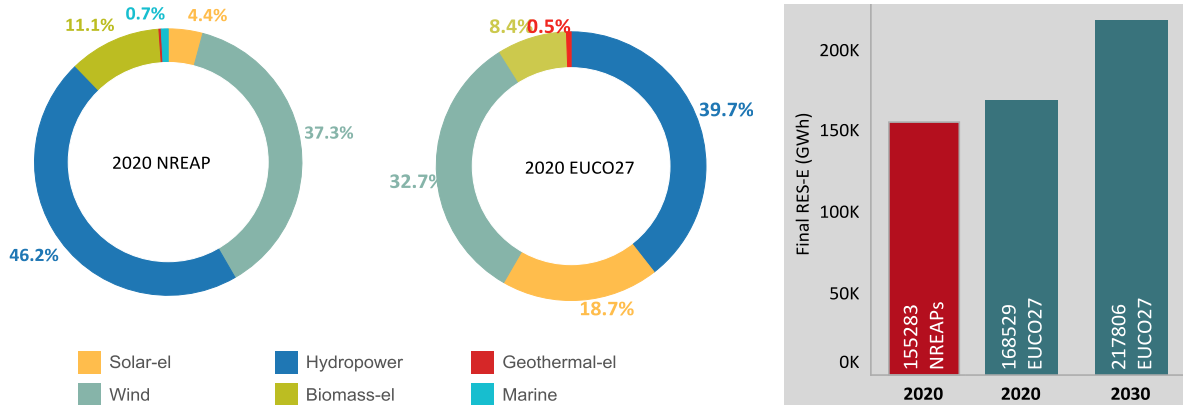


Figure 10 - 3. Final RES Electricity in France: NREAP plan (2020) – EUCO27 projections (2020-2030)

The use of renewable energy in heating/cooling sector in France increased with a CAGR of 2.5% between 2005 and 2015 reaching 11728 ktoe (491 PJ). The development of renewable energy consumed in this sector was under the NREAP plans all over period 2010-2015. In 2015 biomass shared 81.2% of final renewable heat/cold folloed by heat pumps (17%), geothermal (1%) and solar thermal (0.8%). The renewable heat consumption in France is expected to reach 19732 ktoe (826 PJ) in 2020. Biomass will still be the main source with 84.8% followed by heat pumps (10%), solar thermal (3.1%) and geothermal (2.1%).

The use of renewable energy in transport reached 3218 ktoe (134.7 PJ) in 2015 increasing with a CAGR of 16.3% (+2505 ktoe) since 2005. This development was enough to exceed the NREAP level expected only in period 2014-2015. Biodiesel reached a share of 79.8%, followed by bioethanol-bio/ETBE (13.3%) and renewable electricity (6.9%). The use of renewable energy in transport sector in 2020 is expected to be 4062 ktoe (170 PJ) in which biodiesel will reach 70%, bioethanol-bio/ETBE (16%), renewable electricity (6.9%), other biofuels (3.9%).

Table 10 - 1. Final renewable energy in FR: deviations from NREAP in electricity, heating/cooling and transport

	2010	2011	2012	2013	2014	2015
RES-el (ktoe)	-713	-848	-991	-1,290	-1,613	-1,880
RES-hc (ktoe)	-121	-2,038	-1,414	-1,104	-3,223	-3,312
RES-tr (ktoe)	-329	-2,829	-262	-243	7	3
RES-el (%)	-9.5	-10.8	-12.0	-14.7	-17.3	-18.9
RES-hc (%)	-1.1	-17.5	-11.6	-8.4	-22.9	-22.0
RES-tr (%)	-11.4	-94.6	-8.4	-7.8	0.2	0.1

10.4 Renewable energy technologies/sources

Biomass was the main renewable energy source in France with a 44% contribution in final renewable energy in 2015, followed by hydropower with 22.7%, biofuels with 13.2%, heat pumps with 8.7%, wind with 7.3%, solar with 3.2%, geothermal with 0.5% and marine energy with 0.2%. In 2020, the share of biomass in renewable energy mix in France is expected to remain at 49%, followed by hydro with 17%, wind with 14%, biofuels with 10%, heat pumps with 5%, solar with 4%, geothermal with 1%, and marine energy with 0.3%.

In this section: (i) Figure 10-4 present the current (2009-2015) and NREAP projected trend (2016-2020) of energy from renewable technologies/sources in France. The annual increase/decrease (%) of these sources in these two periods is also available in this Figure; (ii) Table 10-2 presents how the actual figures reported for renewable technologies/sources in France compared with what was planned for the NREAPs. Absolute differences are shown in ktoe.

Renewable energy from solar technology in electricity and heating/cooling sectors increased with a CAGR of 39.7% (+698 ktoe) between 2005 and 2015 reaching 723.2 ktoe (30.3 PJ). Comparing with the NREAP levels this development was found faster than what was planned throughout period 2011-15. Biofuels use in transport during 2005-2015 took place with a CAGR of 17.6% (+2405 ktoe) reaching 2996.3 ktoe (125.4 PJ). Comparing with the NREAP levels the use of biofuels was found above only in period 2014-2015. Biomass use in electricity and heating/cooling sectors in France reached 10 Mtoe (420 PJ) in 2015 increasing with a CAGR of 1% (+915 ktoe) since 2005. Due to this slow development the biomass in France missed the expected NREAP uses throughout period 2010-2015.

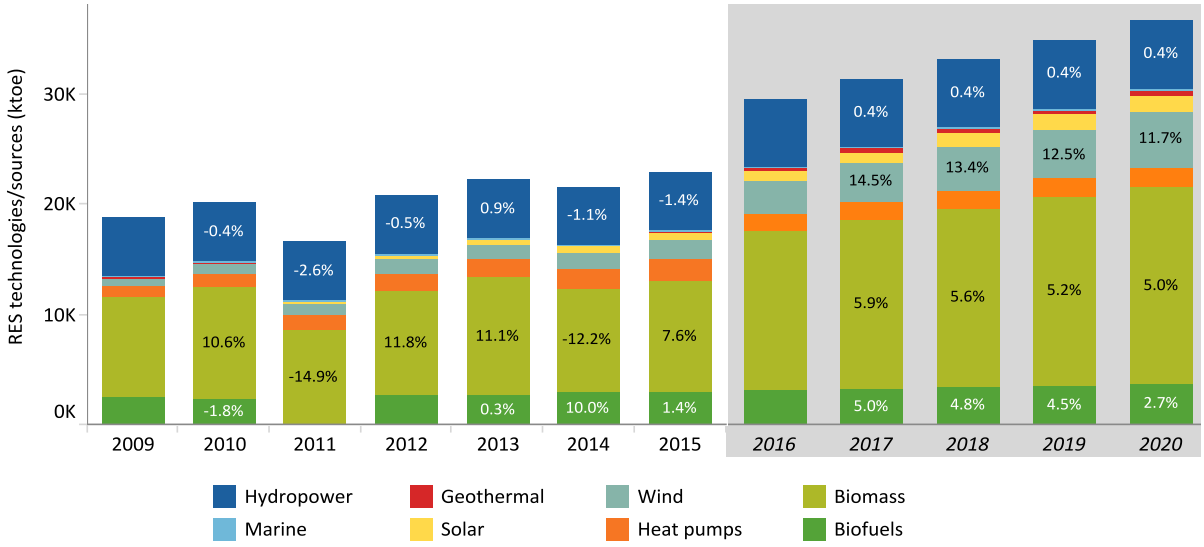


Figure 10 - 4.Annual growth of renewable energy technologies in FR: Current (2009-2015)-NREAP planned 2016-2020

Hydropower contribution reached 60.2 TWh (5174 ktoe) in 2015 decreasing slightly with a CAGR of -0.8% (-5060 GWh) since 2005. This technology was found under the NREAP expectations throughout period 2010-2015. Solar photovoltaic technology increased with a CAGR of 92.3% (+7249 GWh) between 2005 and 2015 reaching 7260 GWh (624 ktoe). This development was faster than what was projected in the France NREAP throughout period 2010-2015 meeting since in 2014 the planned level for 2020 (5913 GWh). Even that planned no contribution from CSP technology was reported foer period 2010-2015. Wind technology developed with a CAGR of 34% (+18.8 TWh) during period 2005-2015 reaching 19.9 TWh (1710 ktoe). Nevertheless this development was found to be slower that what is planned in the NREAP throughout period 2010-2015. Biomass use for electricity reached 5925 GWh (510 ktoe) in 2015 increasing with a CAGR of 5.7% (+2535 GWh) since 2005. Nevertheless in comparison with expected renewable electricity the current development was found to be under the NREAP levels throughout the period 2010-2015. The development trend of marine technology took place with a CAGR of only 0.1% (+7 GWh) over the period 2005-2015

reaching 487 GWh (42 ktoe). This technology was found below the expected NREAP levels throughout period 2010-2015. Even that planned no contribution from geothermal technology was reported for period 2010-2015.

Heat pumps technology deployed between 2005 and 2015 with a CAGR of 25.8% (+1789 ktoe) reaching 1990 ktoe (83.3 PJ). The development was found above the NREAP levels throughout period 2010-2015. Solar thermal increased between 2005 and 2015 with a CAGR of 15% (+74 ktoe) reaching 99 ktoe (4.1 PJ). Despite of this the development of this source was slower than what was projected in the NREAP throughout period 2010-2015. Biomass use for heat consumption developed with a CAGR of only 0.8% (+697 ktoe) during period 2005-2015 reaching 9518 ktoe (398.5 PJ). The use of biomass in France missed the NREAP plans throughout period 2010-2015. Geothermal use for heat consumption increased between 2005 and 2015 with a CAGR of 1.4% (+16 ktoe) reaching 121.4 ktoe (5.1 PJ). This development was found below the NREAP projected one throughout period 2010-2015.

Biodiesel made the main progress in transport sector during 2005-2015 increasing with CAGR of 18% (+2079 ktoe) reaching 2568 ktoe (107.5 PJ). Despite of this increase these uses surpassed the plans only in period 2014-2015. Bioethanol/bio-ETBE increased also fast during period 2005-2015 with a CAGR of 15.5% (+326 ktoe) reaching 428 ktoe (18 PJ). Nevertheless this development resulted slower than the one projected in the NERAP throughout period 2010-2015. Even that planned no other biofuels (biogas and vegetable oils) were used in France during period 2010-2015. While no contribution was expected for the use of Annex IX biofuels their use reached 139 ktoe (5.8 PJ) in 2015. Renewable electricity used in transport increased with a CAGR of 6.2% (+100 ktoe) between 2005 and 2015 reaching 222 ktoe (9.3 PJ). This contribution was found to have missed the NREAP levels throughout period 2010-2015. In 2015 france used only 2.8% of its final renewable electricity in the transport sector.

Table 10 - 2. Renewable energy technologies/sources in France – deviations from NREAP, 2010-2015, (ktoe)

	2010	2011	2012	2013	2014	2015
Hydropower	-513	-676	-726	-704	-783	-878
Wind	-100	-168	-332	-532	-761	-925
Solar-el	1	97	229	250	304	368
Solar-th	-66	-84	-103	-190	-275	-366
Geothermal-el	-13	-16	-19	-22	-24	-27
Geothermal-th	-57	-72	-87	-110	-150	-189
Biomass-el	-86	-83	-134	-262	-329	-393
Biomass-th	-288	-2,131	-1,411	-1,073	-3,158	-3,242
Heat pumps	290	249	188	269	359	485
Biodiesel	-142	-2,250	-75	-54	192	193
Bioethanol	-151	-550	-147	-159	-137	-122
Other biofuels	0	0	0	0	-10	-30
Renewable electricity	-36	-29	-40	-30	-39	-38
Marine	-2	-2	-10	-20	-20	-26

10.5 Renewable electricity installed capacity

The renewable electricity installed capacity in France increased with a CAGR of 6.6% (+17.1 GW) between 2005 and 2015 reaching 36.2 GW. In 2015 the hydropower presented 50% of renewable electricity installed capacity in France followed by wind with 28%, solar with 19%, biomass 2% and marine 1%.

Figure 10-5 present the current trend of renewable electricity installed capacity in France, the deviations (in %) from the expected developments during period 2005-2015, the 2020 NREAP plan and EUCO27 scenario projections for 2020 and 2030. As shown in this figure the installed capacity in France missed the expected NREAP plans throughout period 2010-2015.

Solar photovoltaic had the fastest development increasing with a CAGR of 87% (+6742 MW) between 2005 and 2015 reaching 6755 MW. This development was well above the expected

NREAP levels throughout period 2010-2015 exceeding also the 2020 plan by 25% (+1355 MW). Wind technology developed with a CAGR of 31% (+9527 MW) over period 2005-2015 reaching 10217 MW. Nevertheless this development was not fast enough to meet the expected NREAP capacities throughout period 2011-15. Biomass installed capacity increase with a CAGR of 10.5% (+508 MW) during period 2005-2015 reaching 803 MW. Despite of these increase the achieved biomass capacities were found to be under the respective NREAP ones throughout period 2010-2015. Hydropower capacity increased slightly between 2005 and 2014 with a CAGR of 0.2% (+355 MW). Due to this slow deployment this technology was found to be under the respective NREAP capacities throughout period 2010-2015. No changes happened in marine technology installed capacity during period 2005-2015 remaining at the level of 240 MW missing the expectations throughout period 2012-15.

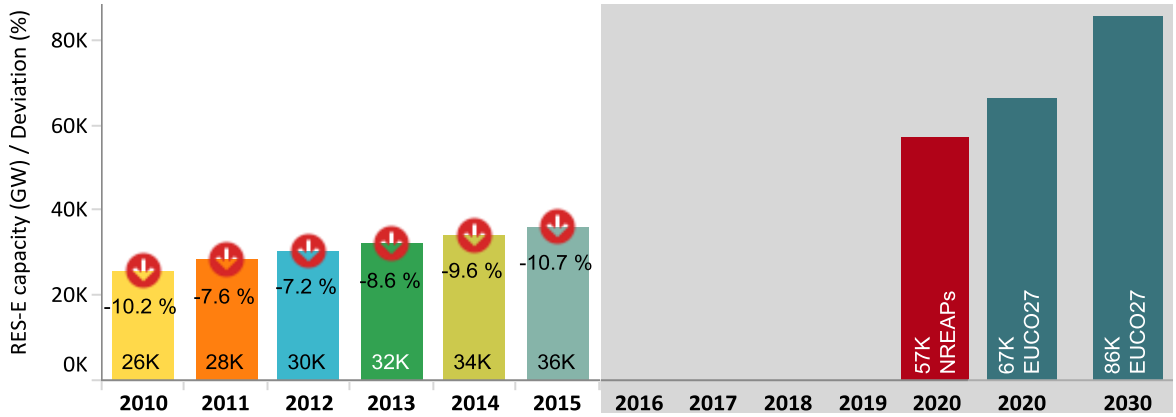


Figure 10 - 5. RES-E capacity development and deviation from NREAPs (2010-2015)– Expected capacity (2020-2030)

In 2020 France has planned in its NREAP an installed capacity of 57 GW in which wind power is expected to have the main contribution. The fastest deployment of solar photovoltaic will change the shares of renewable technologies/sources within the portfolio of planned renewable electricity installed capacity.

The EUCO27 projections for 2020 show a net generation capacity of 67 MW in which three main technologies, hydropower, wind and solar photovoltaic, will share more or less one third of this capacity. According to these projections in 2030 France is expected to have installed 86 GW of renewable electricity.

11. Italy

Petroleum products and gas shared together 72% of gross inland consumption in Italy in 2015. With almost 17% renewables overcome the relative contribution of solid fuels (Figure 11) from 9% in 1995. Gross inland consumption of energy in Italy totalled to 156.2 Mtoe, 3.4% (+5142 ktoe) higher than the consumption in 2014. Primary energy consumption was 149.6 Mtoe in 2015, 5.3% under the 2020 energy efficiency target [54]. Final energy consumption reached 116.4 Mtoe being 6.1% below the 2020 energy efficiency target for this indicator. Gross final energy consumption increased during period 2014-2015 by 2.6% (+3110 ktoe) amounting to 121.7 Mtoe. Energy intensity of the economy, at 100.5 toe/Million in 2015, continue dropping even that a slightly increase took place during period 2014-2015. Italy's import dependency rate was 77% in 2015 remaining relatively high for solid fuels (100.4%), gas (90.4%) and petroleum products (89.4%). Greenhouse gas emissions continued dropping, at 428 Mt CO_2 eq in 2014, 18.6% below the emissions in 1990. Energy remained the main source of emissions with a share of 55% (235 Mt CO_2 eq). In the same year the role of renewable energy in the reduction of GHG emissions reached a net savings of 84.8 Mt CO_2 eq, an additional of 30 Mt CO_2 since 2009.

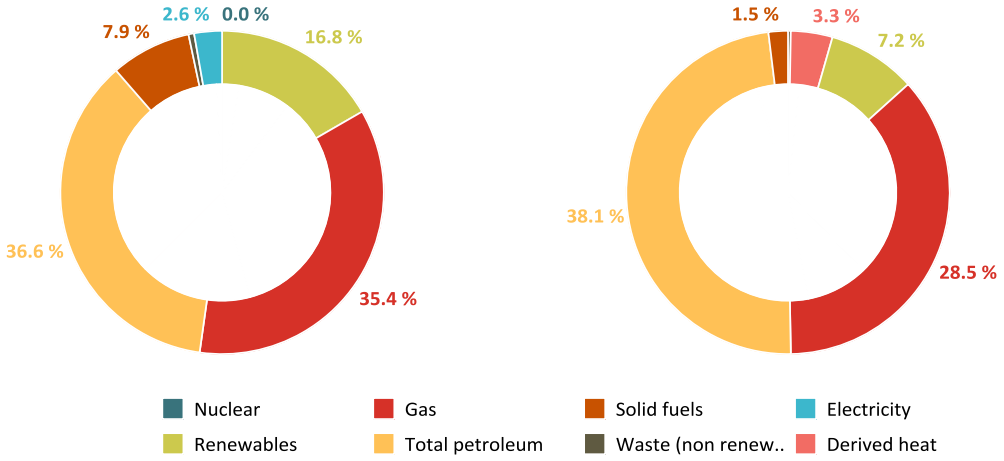


Figure 11. Breakdown of Gross Inland Consumption of Energy (left) - Final Energy Consumption (right) in IT, 2015

11.1 Final renewable energy consumption

Final renewable energy[55] in Italy reached 21578 ktoe (903 PJ) in 2015, almost 99% of 2020 plan, increasing with a CAGR of 7.2% (+10790) since 2005. Final renewable energy in heating/cooling sector contributed with 49.5% whereas electricity sector with 43.7%. Only 6.7% was the share of renewable energy used in transport sector.

Figure 11-1 present the current trend of final renewable energy consumption in Italy and the deviations (in %) from the expected developments during period 2005-2015 as well as the 2020 NREAP plan and EUCO27 projections for 2020 and 2030. As shown in this figure the current development of final renewable energy consumption in Italy was above the plans throughout period 2010 – 15

In 2020 it is expected that the final renewable energy in Italy will reach 21859 ktoe (915.2 PJ) 2020 (including 1.1 Mtoe or 47.2 PJ from transfer from other MS and third countries through cooperation mechanism). In 2020 Italy renewable energy used in transport will almost double its share in the final renewable energy consumption whereas heating/cooling and electricity sector will share respectively 47.8% and 38.9%. The EUCO27 scenario for 2020 is in line with Italy NREAP, projecting a final consumption of renewable energy at 21849 ktoe (914.8 PJ). For 2030 this projection reveals the final consumption of renewable energy at 27676 ktoe (1159 PJ).

[54] Italy energy efficiency 2020 targets are 158 Mtoe in terms of primary energy consumption and 124 Mtoe as final energy consumption.
[55] Final renewable energy (the sum of hydropower, solar, wind, marine, geothermal, biomass and heat pumps) in Italy reached 21287.5 ktoe in 2015, up from 10651.8 ktoe in 2005.

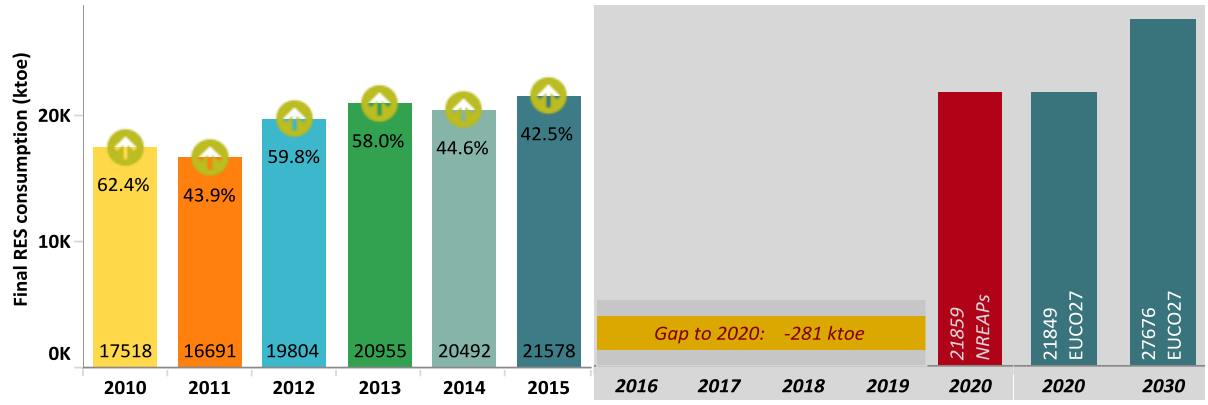


Figure 11 - 1. RES consumption: Trend, Deviation from NREAPs(2010-2015)-Expected RES consumption (2020-2030)

11.2 Renewable energy share

The overall share of renewable energy in Italy increased from 7.55% in 2005 to 17.07% in 2014 and 17.49% in 2015. The 2020 overall RES share target expected to be achieved in Italy is 17%. According to the EUCO27 scenario the overall renewable energy share in Italy is projected to reach 19.9% in 2020 and 28.4% in 2030.

Figure 11-2 shows the current trajectory of overall renewable energy share in Italy, the NREAPs trajectory, the Indicative trajectory as well as the Current trend forecast trajectory.

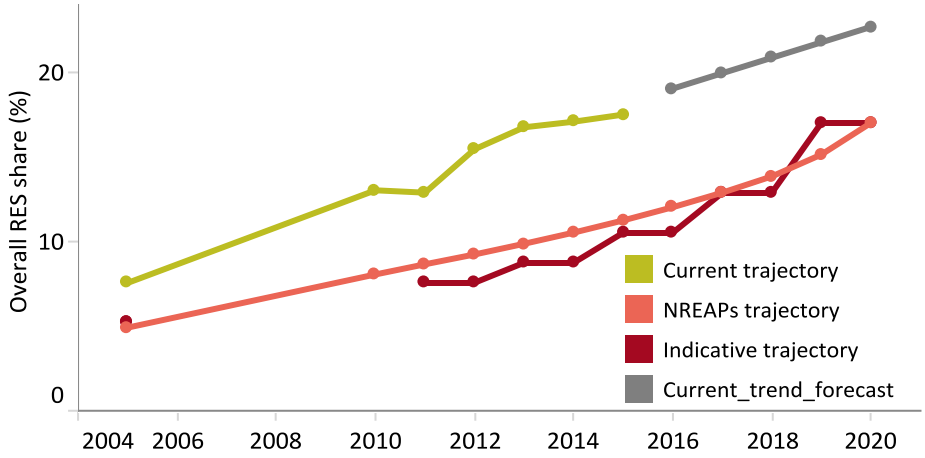


Figure 11 - 2. Overall RES share trajectories in IT: Current, NREAPs and Indicative - Current trend forecast, 2005-20

Overall renewable energy share in Italy remained well above the NREAP and indicative trajectories throughout 2010-2015. In 2014 the achieved overall renewable energy share exceeded the 2020 target by 0.07 percentage points.

The fastest development took place in renewable electricity share reaching 33.5% in 2015. The share of renewable energy in electricity sector was well above the NREAP planned shares throughout period 2010-2015. This development has exceeded the 2020 plan (26.4%) since year 2012.

Renewable energy share in heating/cooling sector reached 18.9% in 2014 and 19.2% in 2015 exceeding since 2013 the plan for year 2020 (17.1%).

The share of renewable energy in transport sector reached 5.0% in 2014 and 6.4% in 2015 missing the NREAP planned shares in both years: -1.0 percentage points below in 2014 and -0.2 percentage points below in 2015. A share of 10.14% is foreseen for the development of renewable energy in this sector in 2020.

11.3 Final renewable electricity, heating/cooling and use in transport

Renewable electricity in Italy had gone up with a CAGR of 6.9% (+53.3 TWh) between 2005 and 2015 reaching 109.7 TWh (9435 ktoe). This development has been over the NREAP projections throughoutl over period 2010-2015. Renewable electricity development in Italy exceeded by 2.2% (+2.2 TWh) in 2013 the plan of year 2020 (98.9 TWh). In 2015 hydropower reached a share of 41.9% followed by solar photovoltaic (20.9%), biomass (17.7%), wind (13.9%) and geothermal (5.6%). The actual development of renewable electricity due to the fast increase of solar photovoltaic is likely to influence the contributions of renewable electricity technologies/sources in 2020. According to Italia's NREAP hydropower's share will reach 42.5% followed by wind (20.2%), biomass (19%), solar photovoltaic (11.5%) and geothermal (6.8%). The EUCO27 scenario projection for 2020 is more in line with the current shares of renewable energy technologies/sources in this sector. According to this projection the final renewable electricity in Itali in 2020 will reach 115.4 TWh (9923 ktoe) of which hydropower will share 41.2% followed by solar 22.1%, biomass 18.6%, wind 12.7% and geothermal 5.4%. Under this scenario has projected that renewable electricity in Italy will reach 173.1 TWh (14.9 Mtoe) in 2030 of which solar photovoltaic will share 30.1%, hydropower 28.6%, wind 19.1%, biomass 18.7% and geothermal 3.6%.

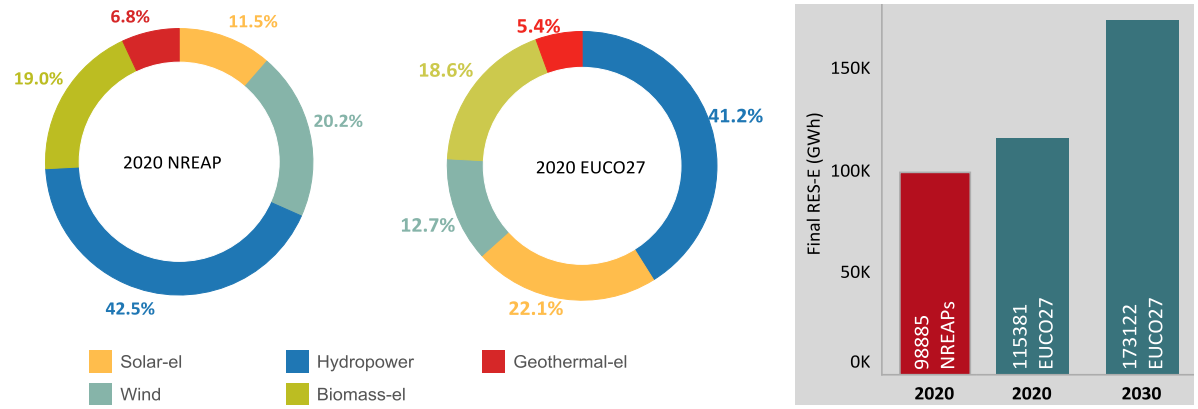


Figure 11 - 3. Final RES Electricity in Italy: NREAP plan (2020) – EUCO27 projections (2020-2030)

Final renewable energy in heating/cooling sector increased between 2005 and 2015 with a CAGR of 6.6%, reaching 10687 ktoe (447.5 PJ). Comparing with NREAP developments the final consumption of renewable heat/cold was found over the plans all over period 2010-2015. In 2020 final renewable heat/cold in Italy is expected to reach 10456 ktoe (437.8 PJ). Final renewable energy in this sector exceeded the plan for year 2020 (10456 ktoe) in 2013. In 2015 biomass reached a share of 72.8% followed by heat pumps (24.2%), solar thermal (1.8%) and geothermal (1.2%). The current deployment in this sector will influence the 2020 contributions of renewable energy technologies/sources. Nevertheless for year 2020 the share of renewable energy technologies/sources in this sector is planned to be lead by biomass with 54.2% followed by heat pumps with 27.7%, solar thermal with 15.2% and geothermal with 2.9%.

Renewable energy in transport sector increased with a CAGR of 16.6% (+1142 ktoe) during period 2005-2015 reaching 1456.2 ktoe (61 PJ). Nevertheless this development stood behind the plans during period 2013-15. In 2015 biodiesel reached a share of 78.2% followed by renewable electricity (20.1%) and bioethanol-bio/ETBE (1.7%). For 2020 Italy has planned to reach a final use of 2899 ktoe (121.4 PJ) from renewable energy sources. Biodiesel will still dominate with 64.8% followed by bioethanol-bio/ETBE with 20.7%, renewable electricity with 12.7% and other biofuels with 1.7%.

Table 11 - 1. Final renewable energy in IT: deviations from NREAP in electricity, heating/cooling and transport

	2010	2011	2012	2013	2014	2015
RES-el (ktoe)	181	976	1,748	2,343	2,459	2,391
RES-hc (ktoe)	6,168	3,904	5,644	5,587	4,428	4,626
RES-tr (ktoe)	384	211	21	-234	-561	-583
RES-el (%)	3.2	16.2	27.8	35.8	36.2	33.9
RES-hc (%)	160.2	93.0	123.2	111.4	80.4	76.3
RES-tr (%)	32.3	15.4	1.3	-13.7	-30.0	-28.6

11.4 Renewable energy technologies/sources

The use of biomass was the major contributor to final renewable energy in 2015 with a 44.4% share, followed by hydropower with 18.6%, heat pumps with 12.1%, solar with 10.2%, wind with 6.2%, biofuels with 5.5%, and geothermal with 3.1%. According to Italian NREAP biomass is expected to have a share of 33.9% followed by hydropower with 16.8%, heat pumps with 13.5%, biofuels with 11.8%, solar with 11.9%, wind with 8% and geothermal with 4.1%.

In this section: (i) Figure 11-4 present the current (2009-2015) and NREAP projected trend (2016-2020) of energy from renewable technologies/sources in Italy. The annual increase/decrease (%) of these sources in these two periods is also available in this Figure; (ii) Table 11-2 presents how the actual figures reported for renewable technologies/sources in Italy compared with what was planned for the NREAPs. Absolute differences are shown in ktoe.

Solar source developed with a CAGR of 53.4% (+2133 ktoe) between 2005 and 2015 reaching 2163 ktoe (90.5 PJ). The development was fast enough to surpass the NREAP plans throughout period 2010-2015. Biomass used in electricity and heating/cooling sectors developed with a CAGR of 7.2% (+4726 ktoe) between 2005 and 2015 reaching 9445 ktoe (395.4 PJ). This development was faster than planned throughout period 2010-2015 surpassing in 2015 by 30% (+2161 ktoe) the plan for year 2020. Geothermal use for electricity and heat consumption decreased with a CAGR of 0.1% (-6.2 ktoe) during period 2005-2015 reaching 665 ktoe (27.8 PJ). This downward trend putted this source under the NREAP plans throughout period 2010-2015. The use of biofuels in transport sector developed with a CAGR of 20.7% (+987 ktoe) between 2005 and 2015 reaching 1164 ktoe (48.7 PJ). This development was slower than what was planned only during period 2013-15.

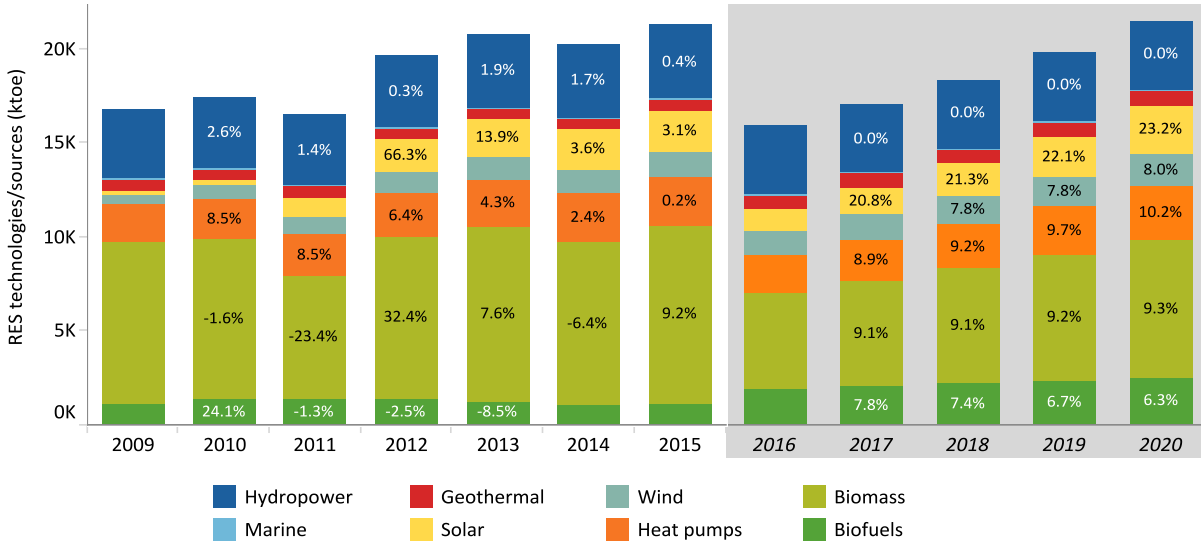


Figure 11 - 4. Annual growth of renewable energy technologies in IT: Current (2009-2015)-NREAP planned 2016-2020

Solar photovoltaic experienced an increase with a CAGR of 93.6% (+22.9 TWh) between 2005 and 2015 reaching 23 TWh (1973 ktoe), more than two-fold of 2020 plan. This development was over NREAP projections throughout period 2011-15. Renewable electricity from wind developed with a CAGR of 19.6% (+12.7 TWh) over period 2010-2015 reaching 15.3 TWh (1316 ktoe). This development was found over NREAP projections throughout period 2010-2015. Hydropower renewable electricity in Italy reached 45.3 TWh (3950 ktoe) increasing with a CAGR of 0.48% (+2149 GWh). This development was found to be above the expectation from NREAP throughout period 2010-2015. The increase of renewable electricity from biomass during period 2005-2015 took place with a CAGR of 15.3% (+14.7 TWh) reaching 19.4 TWh (1665.5 ktoe). This source was found above the NREAP expectations throughout period 2010-2015 exceeding by 3.1% (+586 GWh) in the last year of this period the plan for 2020. Electricity from geothermal rose with a CAGR of only 1.5% (+861 GWh)

between 2005 and 2015 reaching 6.2 TWh (532 ktoe). The current development of this source was found slower than the NREAP projected all over period 2010-2015.

Solar thermal almost 7 times folded (+163 ktoe) its contribution in 2015 compared with the baseline level of 27 ktoe (1.1 PJ). Nevertheless the NREAP plans for this source were missed for all period 2011-15. Heat pumps increased with a CAGR of 9.2% (+1514 ktoe) during period 2005-2015 reaching 2585 ktoe (108 PJ). This development was found well above the NREAP expectations throughout period 2010-2015. Biomass heat consumption developed with a CAGR of 6.1% (+3463 ktoe) during period 2005-2015 reaching 7780 ktoe (326 PJ). This source exceeded throughout period 2010-2015 the respective plans as well as the plan for year 2020 (5670 ktoe). Geothermal was the only source that decrease its heat consumption between 2005 and 2015 with a CAGR of -4.6% (-80 ktoe) reaching 132.8 ktoe (5.6 PJ). Due to this negative trend this source was found under the NREAP levels throughout period 2010-2015.

Biodiesel increased with a CAGR of 20.5% (+962 ktoe) between 2005 and 2015 reaching 1139 ktoe (47.7 PJ). Comparing with NREAP plans this source was found over the plans during period 2010-2013 but below in period 2014-2015. The use of bioethanol/bio-ETBE reached 25 ktoe (1.0 PJ) in 2015 missing the NREAP projections throughout period 2010-2015. Even that planned no contribution from other biofuels (biogas and vegetable oils) was seen in transport sector during period 2010-2015. The use of Annex IX biofuels grew to 451 ktoe (18.9 PJ) during period 2005-2015. Nevertheless this development surpassed the expected levels only in years 2012 and 2015.. The use of renewable electricity developed with a CAGR of 7.9% (+155 ktoe) between 2005 and 2015 reaching 292 ktoe (12.2 PJ). This development was found lower than the NREAP projections during period 2010-2013 surpassing then in two following years the planned levels. 3.1% of final renewable electricity in Italy in year 2015 was used in the transport sector.

Table 11 - 2. Renewable energy technologies/sources in Italy – deviations from NREAP, 2010-2015, (ktoe)

	2010	2011	2012	2013	2014	2015
Hydropower	107	162	174	248	316	332
Wind	33	78	179	223	199	142
Solar-el	-6	642	1,274	1,446	1,443	1,432
Solar-th	21	-8	-37	-82	-146	-234
Geothermal-el	-22	-8	-23	-26	-14	-1
Geothermal-th	-87	-93	-105	-111	-123	-127
Biomass-el	68	101	144	454	514	486
Biomass-th	5,413	3,102	4,843	4,849	3,833	4,260
Heat pumps	820	902	943	931	865	727
Biodiesel	429	317	191	4	-220	-235
Bioethanol	-26	-79	-133	-210	-319	-349
Other biofuels	-5	-9	-14	-18	-23	-27
Renewable electricity	-14	-19	-23	-10	1	28

11.5 Renewable electricity installed capacity

Renewable electricity installed capacity in Italy increased with a CAGR of 10.6% (+29.5 GW) during period 2005-2015 reaching 46.4 GW. In 2015 solar photovoltaic covered 40.7% of renewable electricity installed capacity followed by hydropower with 31.5%, wind with 19.7%, biomass with 6.4% and geothermal with 1.7%.

Figure 11-5 present the current trend of renewable electricity installed capacity in Italy, the deviations (in %) from the expected developments during period 2005-2015, the 2020 NREAP plan and EUCO27 scenario projections for 2020 and 2030. As shown in this figure the installed capacity in Italy exceeded the expected NREAP plans throughout period 2011-15. 2010 was the only year in which the plans were not fulfilled.

Solar photovoltaic installed capacity in Italy between 2005 and 2015 increased with a CAGR of 88% (+18858 W) reaching 18892 MW. This development was faster than planned

throughout period 2010-2015 exceeding since in 2011 by 48.5% (+4173 MW) the plan for year 2020. Wind power developed with a CAGR of 18.8% (+7502 MW) during period 2005-2015 reaching 9137 MW. Comparing with NREAP planned capacities the current development was faster throughout period 2011-15. Biomass installed capacity increased with a CAGR of 16.5% (+2310 MW) between 2005 and 2015 reaching 2952 MW. This development was faster than the NREAP plans only during period 2012-15. Hydropower capacity increased slightly between 2005 and 2015 with a CAGR of only 0.5% (+738 MW) reaching 14628 MW. This technology was found to be under the respective NREAP capacities throughout period 2010-2015. The development of geothermal capacity took place with a CAGR of 1.4% (+97 MW) between 2005 and 2015 missing the NREAP planned capacities throughout period 2010-2015.

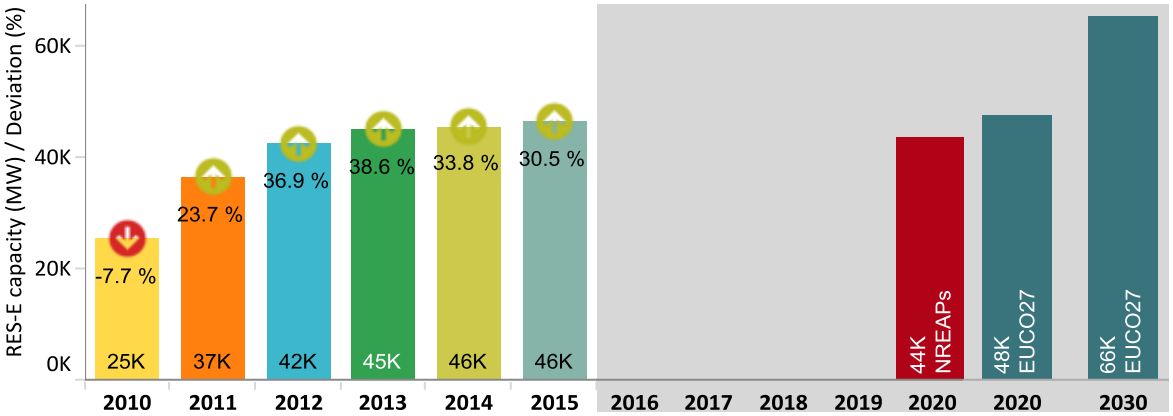


Figure 11 - 5. RES-E capacity development and deviation from NREAPs (2010-2015)– Expected capacity (2020-2030)

In 2020 Italy is expected to have installed 44 GW of renewable electricity capacity with a share of hydropower up to 40.6%. The fastest deployment of solar photovoltaic will change the relative contributions of renewable technologies/sources within the portfolio of renewable electricity capacity in this year.

The EUCO27 projections for 2020 are slightly higher than the NREAP plan, at 48 GW, with a domination of solar photovoltaic technology. According to this projection in 2030 Italy is expected to have installed 66 GW of renewable electricity with a net domination of solar photovoltaic, more than 45%.

12. Cyprus

Cyprus's energy mix is characterized by the large share of petroleum products (92.8%) whereas the share of renewables was at 6.5% (Figure 12). In 2015 gross inland consumption of energy in Cyprus totalled to 2.3 Mtoe, 1.9% (+43.3 ktoe) higher than the consumption in 2014. Primary energy consumption was 2.2 Mtoe in 2015, being in line with the 2020 energy efficiency target[56]. Final energy consumption reached 1.7 Mtoe being 5.6% below the 2020 energy efficiency target for this indicator. Energy intensity of the economy has followed a decreasing trend reaching 128.7 toe/Million Eur in 2015. Cyprus import dependency remained still high, at 97.7% in 2015. Greenhouse gas emissions in Cyprus reached 8.4 Mt CO_2 eq in 2014, 43.9% above the emissions in 1990. Nevertheless these emissions decreased between 2005 and 2014 by 9%, more than the 2014 ESD target (-5.33%). Energy remained the main source of emissions with a share of 45% (4.1 Mt CO_2 eq). In the same year the role of renewable energy in the reduction of GHG emissions reached a net savings of 0.43 Mt CO_2 eq, an additional of 0.15 Mt CO_2 since 2009.

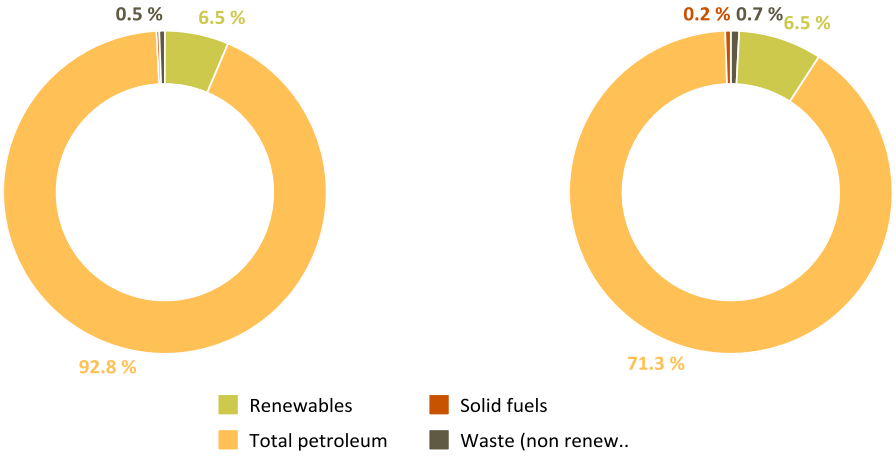


Figure 12. Breakdown of Gross Inland Consumption of Energy (left) - Final Energy Consumption (right) in CY, 2015

12.1 Final renewable energy consumption

Final renewable energy[57] consumed in Cyprus developed with a CAGR of 10.8% (+90.7 ktoe) reaching 141.7 ktoe (5.9 PJ) in 2015. Almost one-fifth of final renewable energy in Cyprus was coming from electricity sector. The role of heating/cooling sector was dominant with a contribution of 70% whereas transport sector contributed with only 6.7%.

Figure 12-1 present the current trend of final renewable energy consumption in Cyprus and the deviations (in %) from the expected developments during period 2005-2015 as well as the 2020 NREAP plan and EUCO27 projections for 2020 and 2030. As shown in this figure the current development of final renewable energy consumption in Cyprus was found below the plans all over period 2011-15. Only in year 2010 this consumption exceeded the plan for that year.

Renewable energy consumption in Cyprus is expected to further increase to 263 ktoe (11 PJ) until 2020. Renewable energy use in transport sector is expected to double its relative contribution in the planned final renewable energy in Cyprus whereas the rest will be shared between renewable heat/cold (47%) and renewable electricity (38.4%). The EUCO27 scenario for 2020 has projected lower final renewable energy consumption in Cyprus than its NREAP level, at 227 ktoe (9.5 PJ). For 2030 this projection reveals the final consumption of renewable energy at 284 ktoe (11.9 PJ).

[56] Cyprus energy efficiency 2020 targets are 2.2 Mtoe in terms of primary energy consumption and 1.8 Mtoe as final energy consumption.
[57] Final renewable energy (the sum of hydropower, solar, wind, marine, geothermal, biomass and heat pumps) in Cyprus reached 141.7 ktoe in 2015, up from 51 ktoe in 2005.

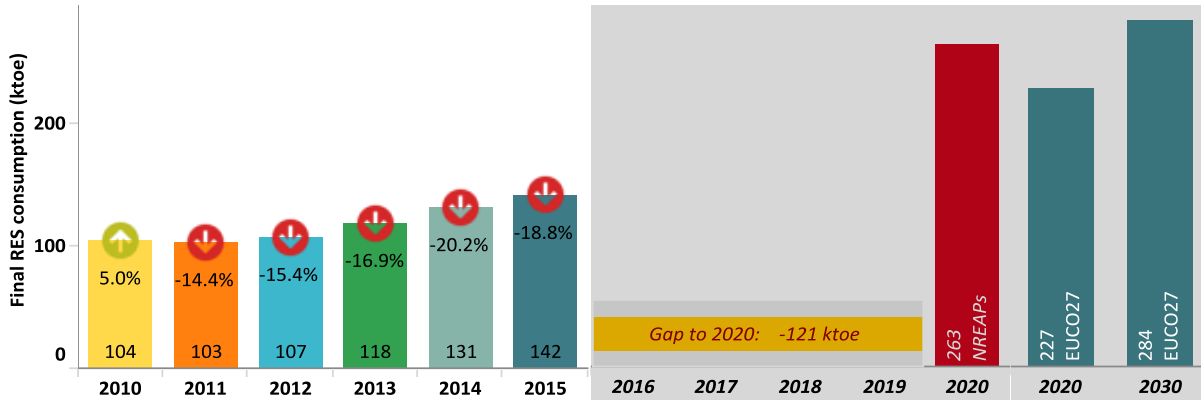


Figure 12 - 1. RES consumption: Trend, Deviation from NREAPs(2010-2015)-Expected RES consumption (2020-2030)

12.2 Renewable energy share

The overall renewable energy contribution in gross final energy consumption in Cyprus reached 8.9% in 2014 and 9.4% in 2015. The 2020 target that Cyprus has to reach for the overall RES share is 13%. According to the EUCO27 scenario the overall renewable energy share in Cyprus is projected to reach 14.9% in 2020 and 20.1% in 2030.

Figure 12-2 shows the current trajectory of overall renewable energy share in Cyprus, the NREAPs trajectory, the Indicative trajectory as well as the Current trend forecast trajectory.

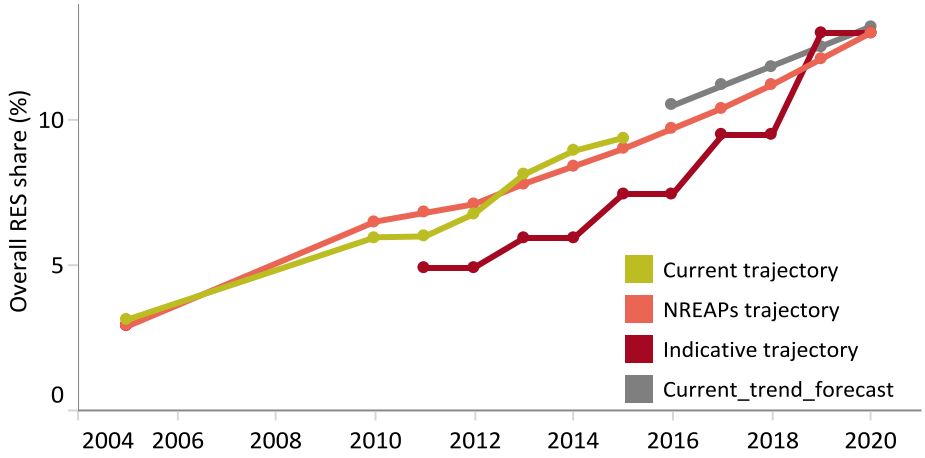


Figure 12 - 2. Overall RES share trajectories in CY: Current, NREAPs and Indicative - Current trend forecast, 2005-20

Overall renewable energy share in Cyprus was above both the NREAP and indicative trajectories from 2013 to 2015 only. Renewable energy shares in the electricity and heating/cooling sectors are currently growing faster than planned, keeping Cyprus on track to achieve the 2020 target.

The renewable energy share in heating/cooling sector in Cyprus reached 21.6% in 2014 and 22.5% in 2015. Comparing with expected NREAP renewable heating/cooling shares Cyprus was over throughout period 2010-2015. The 2020 planned share in this sector is foreseen to reach 23.5%.

Renewable energy share in electricity sector was 7.4% in 2014 and 8.4% in 2015 being above the planned NREAP shares only during period 2012-15. The renewable energy share in this sector for 2020 is foreseen to reach 13%.

Renewable energy share in transport sector reached 2.7% in 2014 decreasing then to 2.5 % in 2015. The share of renewable energy in this sector remained lower than the expected shares throughout period 2010-2015. In 2020 Cyprus has planned to reach a share of 10.0% for renewable energy in this sector.

12.3 Final renewable electricity, heating/cooling and use in transport

Renewable electricity consumption in Cyprus amounted to 382.6 GWh (33 ktoe) in 2015 developed with a CAGR of 92% (+382 GWh) from the very low level in the baseline year. This development was slower than the NREAP planned one throughout period 2011-2014. Only in 2010 a positive deviation from the plan was found. In 2015 wind power contributed with more than 53% while the rest was solar photovoltaic (33.1%) and biomass (13.4%).

In 2020 the renewable electricity consumption in Cyprus is expected to amount to 1175 GWh (101 ktoe) in which solar electricity is expected to be the main source with 45.4% followed by wind with 42.5% and biomass with 12.1%.

The EUCO27 scenario projection for 2020 is slightly lower than the Cyprus NREAP plan at 1057 GWh (91 ktoe) of which solar photovoltaic will share 54.5%, wind 39.9% and biomass 5.6%. Under this scenario the final renewable electricity in Cyprus will reach 1750 GWh (150.5 ktoe) in 2030 of which solar photovoltaic will share almost 60%, wind 31.1% and biomass 9.8%.

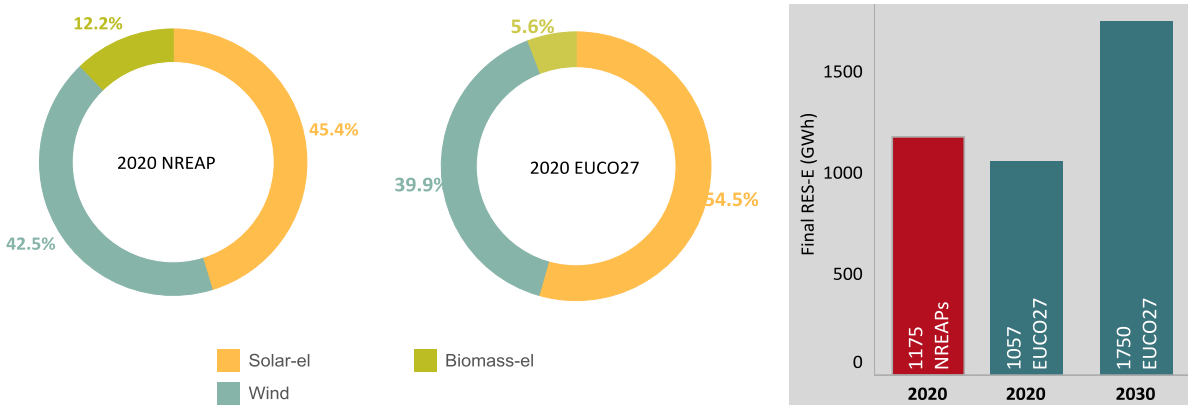


Figure 12 - 3. Final RES Electricity in Cyprus: NREAP plan (2020) – EUCO27 projections (2020-2030)

Renewable energy in heating/cooling sector in Cyprus developed with a CAGR of 6.9% (+48 ktoe) between 2005 and 2015 reaching 99.4 ktoe (4.2 PJ). This development was faster than planned in the NREAP only during period 2010-12. Solar thermal was the main source in this sector with 68.3% followed by biomass (30.2%) and geothermal 1.6%. In 2020 the renewable heat/cold is expected to reach 123.6 ktoe (5.2 PJ) in which solar thermal is expected to share 73.2% of fianl renewable heat/cold followed by biomass and heat pumps with respectively 24.4% and 2.4%.

The use of renewable energy in transport reached only 9.5 ktoe (0.4 PJ) in 2015 developing slower than planned throughout period 2010-2015. In 2015 only biodiesel is reported to have been used in this sector. In 2020 Cyprus has planned to use in the transport sector 38.5 ktoe (1.6 PJ) of renewable energy in which biodiesel is expected to reach a share of 60.3% followed by bioethanol-bio/ETBE with 38.2% and renewable electricity with 1.5%.

Table 12 - 1. Final renewable energy in CY: deviations from NREAP in electricity, heating/cooling and transport

	2010	2011	2012	2013	2014	2015
RES-el (ktoe)	0	-7	-2	-7	-19	-18
RES-hc (ktoe)	5	7	1	-2	-3	-2
RES-tr (ktoe)	-1	-17	-18	-15	-11	-13
RES-el (%)	6.9	-33.1	-10.3	-22.8	-40.9	-35.4
RES-hc (%)	6.8	8.3	1.1	-2.5	-2.7	-1.6
RES-tr (%)	-4.3	-100.0	-100.0	-74.0	-54.0	-58.3

12.4 Renewable energy technologies/sources

In 2015 solar technology was the main renewable energy source in Cyprus with a contribution of 55.6%, followed by biomass with 24.2%, wind with 12.4%, biofuels with 6.7%, and heat pumps with 1.1%. In 2020, the share of solar in final renewable energy in Cyprus is expected to decrease slightly to 52%, followed by wind and biomass with slightly more than 16% each, biofuels 14.4% and heat pumps with only 1%.

In this section: (i) Figure 12-4 present the current (2009-2015) and NREAP projected trend (2016-2020) of energy from renewable technologies/sources in Cyprus. The annual increase/decrease (%) of these sources in these two periods is also available in this figure; (ii) Table 12-2 presents how the actual figures reported for renewable technologies/sources in Cyprus compared with what was planned for the NREAPs. Absolute differences are shown in ktoe.

The development of solar in electricity and heating/cooling sector took place with a CAGR of 6.7% (+37.4 ktoe) between 2005 and 2015 reaching 78.7 ktoe (3.3 PJ). This development was not enough to surpass the expected NREAP plans in period 2013-15. Biomass for electricity and heating/cooling purposes developed with a CAGR of 13.5% (24.7 ktoe) reaching 34.4 ktoe (1.4 PJ). This development was slower than the one planned only in year 2012.

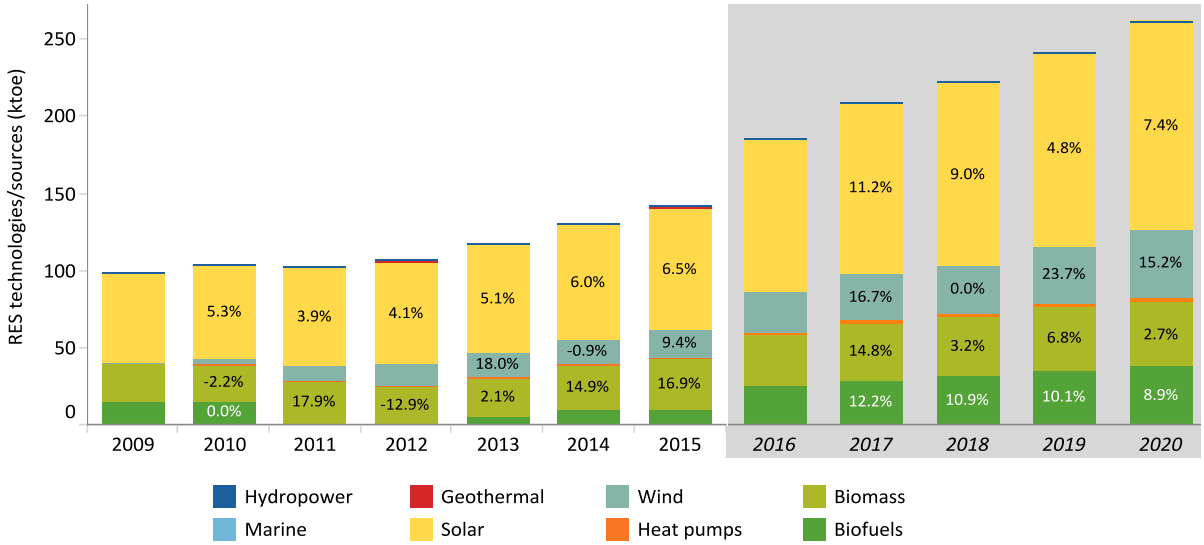


Figure 12 - 4.Annual growth of renewable energy technologies in CY: Current (2009-2015)-NREAP planned 2016-2020

The development of solar photovoltaic technology between 2005 and 2015 resulted with a CAGR of 71.8% (+126 GWh) from the very low level of 0.6 GWh. This development was found above the NREAP plans only in year 2010 and period 2012-13. Wind technology developed with a CAGR of 46% (+174 GWh) between 2010 and 2015 reaching 204.7 GWh (18 ktoe). Comparing with the expected development this technology increased slowly being under the plans throughout period 2011-15. Biomass use for electricity increased with a CAGR of 7.8% (+16 GWh) during period 2010-2015 reaching 51.2 GWh (4.4 ktoe). Comparing with the plans biomass source in Cyprus was found below throughout period 2012-15.

Biomass thermal increased with a CAGR of 12% (+20 ktoe) between 2005 and 2015 reaching 30 ktoe (1.3 PJ) in 2015. Comparing wiotht he plans this source was found below only in year 2013. Heat pump[58] (geothermal) was the only technology in Cyprus that developed faster the planned throughout period 2010-2015 increasing with a CAGR of 15.6% (+0.8 ktoe) reaching 1.6 ktoe (0.07 PJ). Renewable heat from solar thermal increased with a CAGR of 5.1% (+27 ktoe) during period 2005-17 reaching 68 ktoe (2.84 PJ). Nevertheless this development remained below the NREAP trend all over period 2012-15.

[58] To be consistent with the analysis reported in the previous JRC reports the contribution of geothermal technology in Cyprus is analysed as geothermal heat pumps.

Biodiesel was the only type of renewable energy that was used in the transport sector in Cyprus between 2010 and 2015 decreasing with a CAGR of -3.0% (-5.6 ktoe) reaching 9.5 ktoe (0.4 PJ). Comparing with expected biodiesel NREAP plan Cyprus was under throughout period 2010-2015. The use of biofuels from wastes, residues, lingo-cellulosic material, reached 5.97 ktoe (0.2 PJ) in 2015 being above the expected NREAP uses throughout period 2013-15. Even that planned no other biofuels (biogas and vegetable oils) and renewable electricity was used in transport sector in Cyprus during period 2010-2015. Even that planned no use of renewable electricity is reported for period 2010-2015 in Cyprus.

Table 12 - 2. Renewable energy technologies/sources in Cyprus – deviations from NREAP, 2010-2015, (ktoe)

	2010	2011	2012	2013	2014	2015
Wind	0.0	-7.2	-2.5	-7.4	-7.6	-8.2
Solar-el	0.0	-0.1	0.2	1.7	-10.2	-7.0
Solar-th	1.8	1.2	-0.1	-2.4	-4.9	-7.3
Biomass-el	0.4	0.1	0.0	-1.6	-1.4	-2.8
Biomass-th	3.1	5.1	0.4	-0.3	2.1	5.8
Heat pumps	0.4	0.5	0.7	0.4	0.2	-0.1
Biodiesel	-0.7	-16.8	-18.1	-14.4	-9.9	-10.4
Bioethanol	0.0	0.0	0.0	0.0	-1.3	-2.6
Renewable electricity	0.0	-0.1	-0.1	-0.2	-0.2	-0.3

12.5 Renewable electricity installed capacity

Renewable electricity installed capacity in Cyprus reached 244 MW in 2015 increasing with a CAGR of 73% (+243 MW) from the baseline capacity. Wind power is the dominated capacity in Cyprus with a share of 65% in 2015. The rest was solar photovoltaic (31%) and biomass (4%).

Figure 12-5 present the current trend of renewable electricity installed capacity in Cyprus, the deviations (in %) from the expected developments during period 2005-2015, the 2020 NREAP plan and EUCO27 scenario projections for 2020 and 2030. As shown in this figure the installed capacity in Cyprus was higher than the expected NREAP plans throughout period 2010-2013. Only in period 2014-2015 Cyprus didn't fulfil the expected plans.

In 2005 Cyprus report on 1.0 MW installed capacity on renewable energy which was totally solar photovoltaic that increased further with a CAGR of 54.2% (+75 MW) until 2015. This development was fast enough to surpass the NREAP plans throughout period 2010-2013 but not in the last two years. While planned no CSP capacities are reported for period 2020-15. Wind capacity increased with a CAGR of 14% (+76 MW) during period 2010-2015 reaching 158 MW. Nevertheless this development was slower than planned throughout period 2013-15. Biomass installed capacity in Cyprus reached 10 MW in 2015 increasing with a CAGR of 58% (+9 MW) from the capacity in 2007. This deployment was found above the plans throughout period 2010-2015.

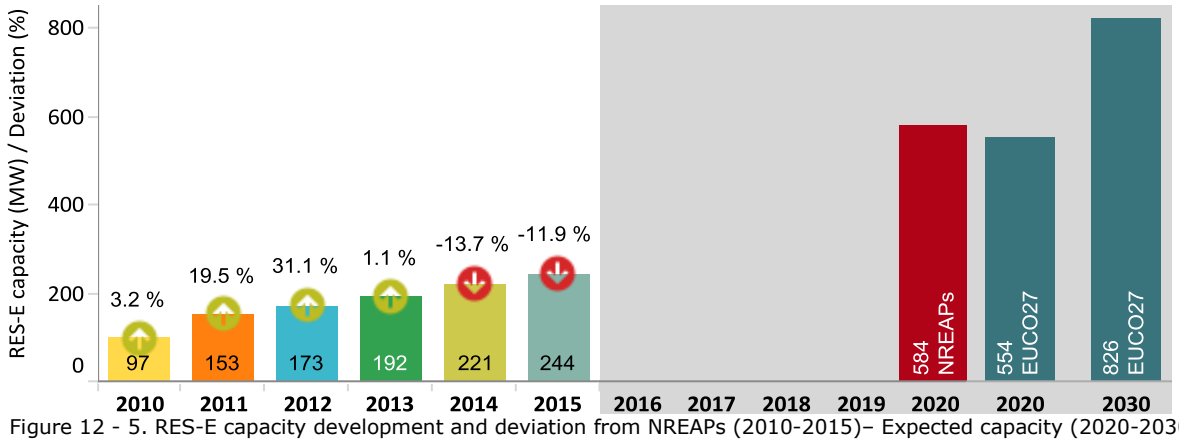


Figure 12 - 5. RES-E capacity development and deviation from NREAPs (2010-2015)– Expected capacity (2020-2030)

In 2020 Cyprus expect to reach a capacity of 584 MW in renewable energy in which wind will contribute to be the main capacity but with a share of 51%. Solar photovoltaic is expected to share 46% of renewable electricity capacity and biomass only 3%.

The EUCO27 projections for 2020 are broadly consistent with Cyprus NREAP on the net generation capacity, at 554 MW, but not in regard to the dominating source that in this projection is solar photovoltaic. According to this projection in 2030 Cyprus is expected to have installed 826 MW of renewable electricity keeping still solar photovoltaic the main source.

13. Latvia

Renewables had the highest share (35.3%) in Latvia's energy mix in 2015 together with petroleum products and gas (Figure 13). In 2015 gross inland consumption of energy in Latvia totalled to 4.4 Mtoe, 1.3% (+60 ktoe) less than the consumption in 2014. Primary energy consumption was 4.3 Mtoe in 2015, 20.4% under the 2020 energy efficiency target[59]. Final energy consumption reached 3.8 Mtoe being 15.6% below the 2020 energy efficiency target for this indicator. Gross final energy consumption decreased during period 2014-2015 by 2.5% (-101 ktoe) amounting to 3.97 Mtoe. Energy intensity of the economy stood at 207 toe/Million Eur, 4% lower than in 2014. Latvia's import dependence ratio in 2015 was 51%. Nevertheless Latvia has high import dependence ratio for petroleum products (103%) and gas (98.6%). Greenhouse gas emissions continued to decline at 11.7 Mt CO_2 eq in 2014, 55.8% below the emissions in 1990. Energy remained the main source of emissions with a share of 34.2% (4 Mt CO_2 eq). In the same year the role of renewable energy in the reduction of GHG emissions reached a net savings of 5.4 Mt CO_2 eq, an additional of 0.4 Mt CO_2 since 2009.

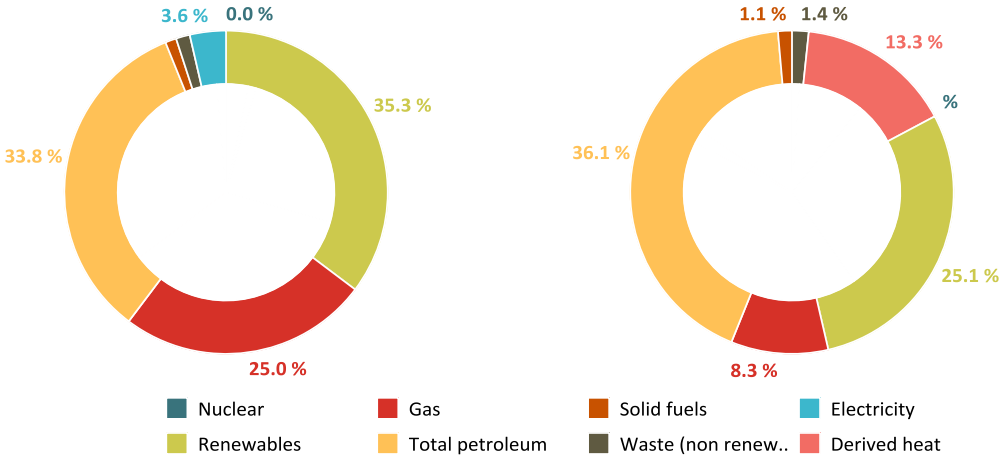


Figure 13. Breakdown of Gross Inland Consumption of Energy (left) - Final Energy Consumption (right) in LV, 2015

13.1 Final renewable energy consumption

Final renewable energy[60] consumed in Latvia developed since year 2005 with a CAGR of only 0.8% (+112 ktoe) reaching 1496 ktoe (62.6 PJ) in 2015. Renewable heat/cold was the main source of final renewable energy consumed in Latvia in 2015 with a contribution of 76.1% whereas electricity and transport sector shared respectively 22.1% and 1.8%.

Figure 13-1 present the current trend of final renewable energy consumption in Latvia and the deviations (in %) from the expected developments during period 2005-2015 as well as the 2020 NREAP plan and EUCO27 projections for 2020 and 2030. As shown in this figure the current development of final renewable energy consumption in Latvia didn't fulfil the plans in years 2011 and 2015.

According to the Latvia NREAP, final renewable energy consumption is expected to further increase until 2020 with a CAGR of 5.2% to reach 1927 ktoe (80.7 PJ). The contribution of three sectors will be still leaded by heating/cooling with 72.5% followed by electricity sector with 23.2% and transport sector with 4.3%. The EUCO27 scenario for 2020 has projected a lower consumption (1816 ktoe) compared with Latvia's NREAP. Under this scenario in 2030 Latvia expect to reach a final consumption of renewable energy at 1904 ktoe (79.7 PJ).

[59] Latvia energy efficiency 2020 targets are 5.4 Mtoe in terms of primary energy consumption and 4.5 Mtoe as final energy consumption.
[60] Final renewable energy (the sum of hydropower, solar, wind, marine, geothermal, biomass and heat pumps) in Latvia reached 1491.5 ktoe in 2015, up from 1378.5 ktoe in 2005.

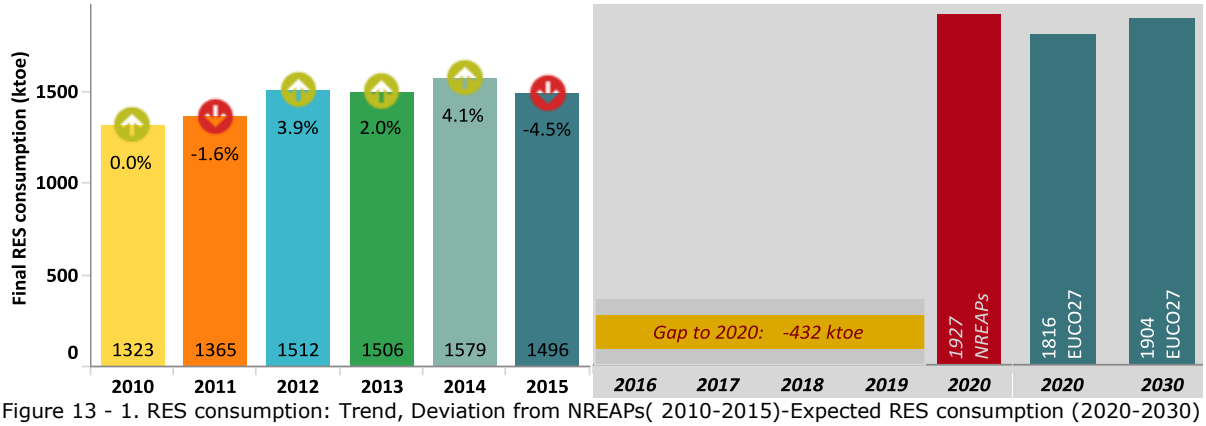


Figure 13 - 1. RES consumption: Trend, Deviation from NREAPs(2010-2015)-Expected RES consumption (2020-2030)

13.2 Renewable energy share

The overall renewable energy contribution in gross final energy consumption in Latvia reached 38.7%% in 2014 and 37.6% in 2015 having the third highest share among EU MSs. The 2020 NREAP target that Latvia has to reach for the overall renewable energy share is 40%. According to the EUCO27 scenario the overall renewable energy share in Latvia is projected to reach 40.3% in 2020 and 45.5% in 2030.

Figure 13-2 shows the current trajectory of overall renewable energy share in Latvia, the NREAPs trajectory, the Indicative trajectory as well as the Current trend forecast trajectory.

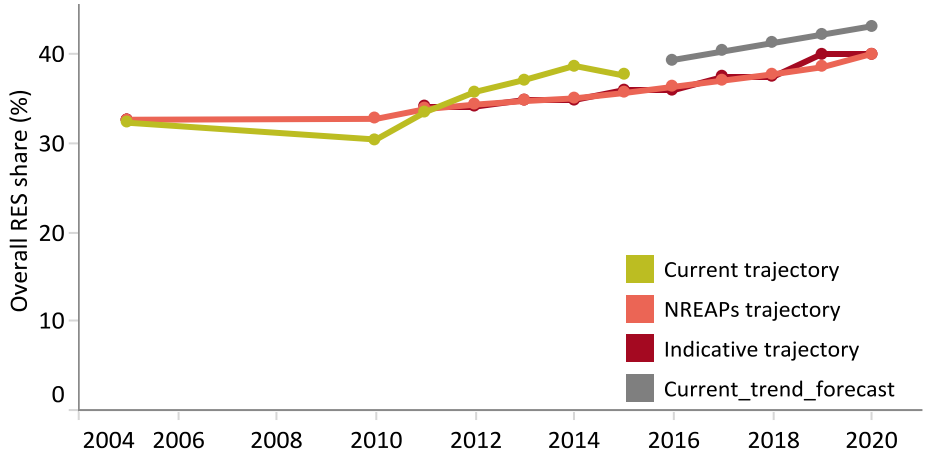


Figure 13 - 2. Overall RES share trajectories in LV: Current, NREAPs and Indicative - Current trend forecast, 2005-20

Overall renewable energy share in Latvia remained above both the flattened NREAP and indicative trajectories between 2012 and 2015 and the country is on track for the 2020 target. However, the slight slowdown in renewable energy deployment in 2014 and 2015 might mean that Latvia will need to make more efforts to stay on course for the 2020 target.

Renewable energy share in heating/cooling sector reached 52.2% in 2014 and 51.8 in 2015. This development was faster than planned only in period 2013-15. The 2020 plan for this sector is foreseen to reach 53.4%.
The share of renewable energy in electricity sector reached 51.1% in 2014 and 52.2% in 2015 being over the expected shares only during period 2013-15. The 2020 plan on renewable energy share in this sector is set to 59.8%.
The share of renewable energy in transport sector reached 4.1% in 2014 and 3.9% in 2015 missing the planned shares in this sector throughout period 2010-2015. The 2020 plan of renewable energy share in this sector is set to 10%.

13.3 Final renewable electricity, heating/cooling and use in transport

Final renewable electricity in Latvia grew to 3842 GWh (330.3 ktoe) in 2015 deploying with a CAGR of 2.4% (+8.7 GWh) since 2005. Throughout period 2010-2014 final renewable electricity in Latvia surpassed the respective NREAP plans. Only in 2015 Latvia didn't fulfil the expected plan. In this year more than 76% of renewable electricity in Latvia was coming from hydropower and the rest was biomass (20%) and wind (3.8%). In 2020 the final renewable electricity in Latvia is expected to reach 5191 GWh (446.4 ktoe) of which hydropower will share 58.8% biomass 23.6%, wind 17.5% and solar 0.1%.

The EUCO27 scenario has projected a lower final renewable electricity in Latvia for year 2020 compared with its NREAP, at 4452 GWh (383 ktoe). Of this electricity hydropower will share 71%, biomass 14.9% and wind 14.1%. Under this scenario the final renewable electricity in Latvia will reach 5327 GWh (458 ktoe) in 2030 of which the share of hydropower will be lower at 59.3% wind 23.4% and biomass 17.7%.

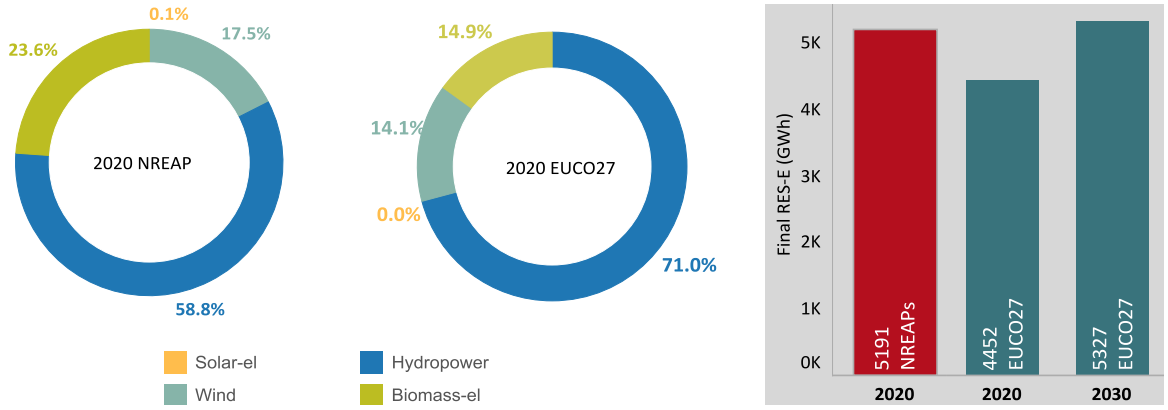


Figure 13 - 3. Final RES Electricity in Latvia: NREAP plan (2020) – EUCO27 projections (2020-2030)

Renewable energy in heating/cooling sector in Latvia developed with a CAGR of only 0.2% (+23.4 ktoe) during period 2005-2015 reaching 1138 ktoe (47.8 PJ). This development was enough to surpass the expected NREAP plans in year 2010 and all over period 2012-14. In 2015 renewable heat/cold in Latvia was totally biomass. In 2020 the renewable heat/cold consumption in Latvia is expected to reach 1398 ktoe (58.5 PJ) in which the contribution of biomass is expected to change slightly to 99.6% and the rest is expected to be heat pumps (0.3%) and solar thermal (0.1%).

The use of renewable energy in transport increased with a CAGR of 12.4% (+19 ktoe) since 2005 reaching 27.2 ktoe (1.14 PJ) in 2015. Nevertheless these increases were found below the NREAP uses all over period 2010-2015. Biodiesel had the main share with 57.5% followed by bioethanol-bio/ETBE (26.2%) and renewable electricity (16.3%). The use of renewable energy in 2020 is expected to be 83 ktoe (3.5 PJ) in which a very different picture is planned: other biofuels will have the main use with 37.3% followed by biodiesel with 33.7%, bioethanol-bio/ETBE with 21.7% and renewable electricity with 7.2%.

Table 13 - 1. Final renewable energy in LV: deviations from NREAP in electricity, heating/cooling and transport

	2010	2011	2012	2013	2014	2015
RES-el (ktoe)	10	6	17	24	12	-1
RES-hc (ktoe)	1	-11	62	30	75	-43
RES-tr (ktoe)	-11	-17	-22	-24	-24	-26
RES-el (%)	3.9	2.2	6.0	8.3	3.7	-0.4
RES-hc (%)	0.1	-1.0	5.5	2.7	6.6	-3.6
RES-tr (%)	-25.2	-39.0	-48.0	-51.0	-48.0	-48.6

13.4 Renewable energy technologies/sources

In 2015 biomass contribution in the final renewable energy in Latvia reached 80.8% and the rest was coming from hydropower (16.9%), biofuels (1.5%) and wind (0.8%). In 2020 the contributions of biomass and hydropower in final renewable energy is expected to decrease slightly respectively to 77.9% and 13.7%. The contribution of wind, biofuels, heat pumps and solar are expected to be 4.1%, 4.0%, 0.2% and 0.1%.

In this section: (i) Figure 13-4 present the current (2009-2015) and NREAP projected trend (2016-2020) of energy from renewable technologies/sources in Latvia. The annual increase/decrease (%) of these sources in these two periods is also available in this figure; (ii) Table 13-2 presents how the actual figures reported for renewable technologies/sources in Latvia compared with what was planned for the NREAPs. Absolute differences are shown in ktoe.

Biofuels use in transport sector in Latvia increased with a CAGR of 24.2% (+19 ktoe) between 2005 and 2015 reaching 22.8 ktoe (0.95 PJ). In comparison with NREAP development biofuels use in this sector were under the respective levels throughout period 2010-2015. Biomass use for electricity and heat/cold in Latvia between 2005 and 2015 developed with a CAGR of only 0.7% (+86 ktoe) reaching 1205 ktoe (50.4 PJ). This development missed the plans only in years 2011 and 2015. Even that planned no introduction of solar technology took place in Latvia during period 2012-15.

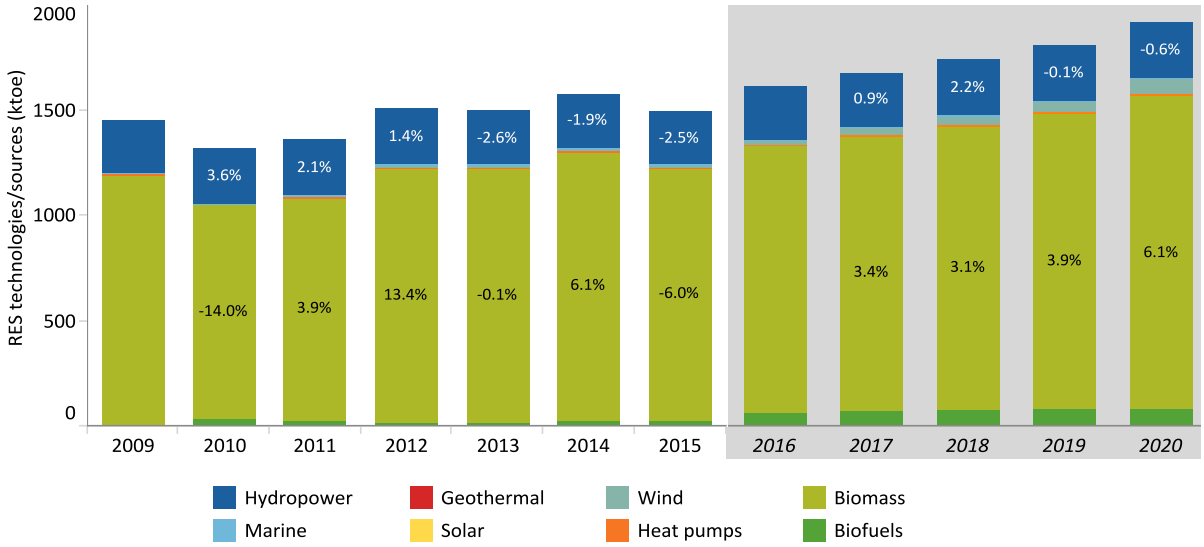


Figure 13 - 4. Annual growth of renewable energy technologies in LV: Current (2009-2015)-NREAP planned 2016-2020

Hydropower technology development trend was negative between 2005 and 2015 with a CAGR of -0.1% (-21.4 GWh) reaching 2926 GWh (252 ktoe). The development of this technology was found above the plans throughout period 2010-2014 but below in 2015. Renewable electricity consumption originated from biomass developed with a CAGR of 33.8% (+728 GWh) between 2005 and 2015 reaching 769 GWh 66.2 ktoe). Comparing with expected developments according to NREAP biomass use for electricity consumption was found to be above the plans only in period 2012-15. Wind power renewable electricity increased with a CAGR of 12.3% (+100.2 GWh) during period 2005-2015 reaching 146 GWh (12.5 ktoe). Despite of this development this technology was found to be under the expected NREAP plans throughout period 2010-2015. Even that planned no contribution from solar photovoltaic was registered in Latvia during period 2010-2015.

Biomass thermal was the only renewable energy source used in heating/cooling sector in Latvia in year 2015 developing with a CAGR of only 0.2% (+23 ktoe) since 2005 reaching 1138.3 ktoe (47.7 PJ). This source developed under the NREAP plans only in years 2011 and 2015. Even that planned no contribution from heat pumps was reported for period 2013-15.

Biodiesel use in transport sector during 2005-2015 increased with a CAGR of 19.7% (+13 ktoe) reaching 15.7 ktoe (0.66 PJ). Comparing with the expected NREAP levels this source

remained throughout period 2010-2015 below the plans. Bioethanol/bio-ETBE use in transport sector reached 7.1 ktoe (0.3 PJ) in 2015 decreasing with a CAGR of -3.2% (-1.3 ktoe) since 2010. Due to this downward trend the use of this source was under the NREAP plans throughout period 2010-2015. The use of renewable electricity in transport over period 2005-2015 decreased with a CAGR of -2.7% (-1.4 ktoe) remaining nevertheless above the NREAP plans throughout period 2010-2015. In 2015 only 1.3% of final renewable electricity is used in Latvia transport sector.

Table 13 - 2. Renewable energy technologies/sources in Latvia – deviations from NREAP, 2010-2015, (ktoe)

	2010	2011	2012	2013	2014	2015
Hydropower	11.0	9.7	12.8	13.3	6.7	-3.4
Wind	-0.2	-0.7	-0.1	-0.7	-3.0	-7.1
Solar-el	0.0	0.0	-0.1	-0.1	-0.1	-0.1
Solar-th	0.0	0.0	0.0	-1.0	-1.0	-1.0
Biomass-el	-0.6	-3.0	4.6	11.7	8.2	9.1
Biomass-th	0.6	-10.6	62.2	32.1	77.4	-39.7
Heat pumps	0.0	0.0	0.0	-1.0	-1.0	-2.0
Biodiesel	-6.2	-9.6	-11.5	-9.8	-5.8	-4.3
Bioethanol	-5.6	-9.0	-11.3	-12.4	-13.2	-11.9
Other biofuels	0.0	0.0	-1.0	-4.0	-6.0	-10.0
Renewable electricity	1.2	1.5	1.7	1.8	0.5	0.4

13.5 Renewable electricity installed capacity

Renewable electricity installed capacity in Latvia amounted to 1784 MW in 2015 increasing with a CAGR of 1.3% (+212 MW) over the capacity in the baseline year. In 2015 almost 90% of installed capacity was hydropower and the rest biomass (7.1%) and wind (3.8%).

Figure 13-5 present the current trend of renewable electricity installed capacity in Latvia, the deviations (in %) from the expected developments during period 2005-2015, the 2020 NREAP plan and EUCO27 scenario projections for 2020 and 2030. As shown in this figure, the installed capacity in Latvia was faster than the expected NREAP plans throughout period 2010-2015.

Biomass installed capacity in Latvia increased with a CAGR of 28.8% (+116 MW) between 2005 and 2015 reaching 126 MW. This development was enough to surpass the planned capacities throughout period 2010-2015. Hydropower capacity increased slightly with a CAGR of only 0.3% (+53 MW) over period 2005-2015 reaching 1589 MW. These capacities were found to be above the plans in each year of period 2010-2015. Wind power capacity between 2005 and 2015 increased with a CAGR of 10.3% (+43 MW) reaching 69 MW. The development of the wind capacity was over the planned one only in year 2010 and in period 2012-13. No solar photovoltaic capacity was registered in Latvia in period 2010-2015 even that an installed capacity equal to 1 MW was planned for this period.

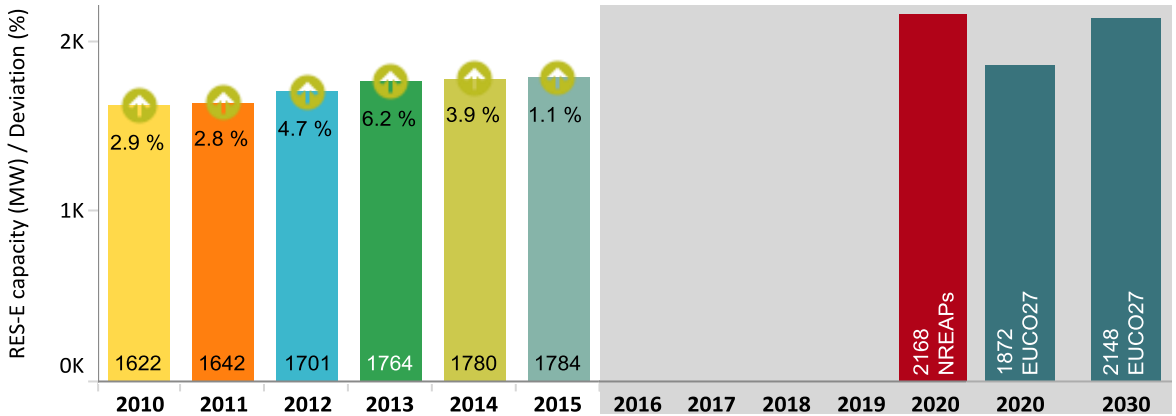


Figure 13 - 5. RES-E capacity development and deviation from NREAPs (2010-2015)– Expected capacity (2020-2030)

In 2020 the expected renewable electricity capacity in Latvia will be 2168 MW in which hydropower contribution is expected to be 71.5% followed by wind and biomass with respectively 19.2% and 9.2%.

The EUCO27 projections for 2020 and 2030 are slightly lower than the NREAP plan for year 2020. Nevertheless in all these projections hydropower remains the main source of renewable electricity in Latvia.

14. Lithuania

Petroleum products and gas had the highest share in Lithuania's energy mix in 2015 whereas the renewables was the third source with 20.5% (Figure 14). In 2015 gross inland consumption of energy in Lithuania totalled to 6.9 Mtoe, 3.3% (+218.6 ktoe) higher than the consumption in 2014. Primary energy consumption was 5.8 Mtoe in 2015, 10.8% below the 2020 energy efficiency target[61]. Final energy consumption reached 4.9 Mtoe being 16.7% above the 2020 energy efficiency target for this indicator. Gross final energy consumption decreased during period 2014-2015 by 0.4% (-19 ktoe) amounting to 5.1 Mtoe. Energy intensity of the economy had in 2014 the lowest level (202.5 toe/Million Eur) since 2005 increasing then slightly in 2015 at 205.4 toe/Million Eur. Lithuania's import dependence rate stood at 78.4%, increasing during period 2005-2015. The import dependence ratio for petroleum products was higher than 100% and for gas reached 99.7%. Greenhouse gas emissions continued to decline at 19.4 Mt CO_2 eq in 2014, 59.3% below the emissions in 1990. Energy remained the main source of emissions with a share of 30% (5.9 Mt CO2 eq). In the same year the role of renewable energy in the reduction of GHG emissions reached a net savings of 1.5 Mt CO_2 eq.

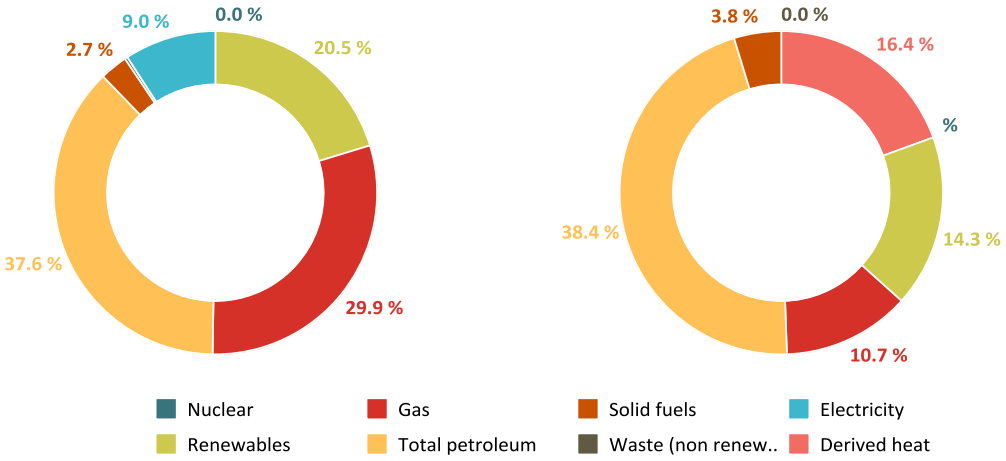


Figure 14. Breakdown of Gross Inland Consumption of Energy (left) - Final Energy Consumption in LT, 2015 (right)

14.1 Final renewable energy consumption

In 2015 final renewable energy[62] consumed in Lithuania reached 1308.5 ktoe (54.8 PJ) growing with a CAGR of 4.4% (+455 ktoe) from 2005 level. Almost 83% of final renewable energy in Lithuania was used for heating/cooling purposes and the rest in electricity (11.7%) and transport (5.3%).

Figure 14-1 present the current trend of final renewable energy consumption in Lithuania and the deviations (in %) from the expected developments during period 2005-2015 as well as the 2020 NREAP plan and EUCO27 projections for 2020 and 2030. As shown in this figure the actual development of final renewable energy consumption in Lithuania fulfilled the plans throughout period 2010-2015

In 2020 final renewable energy in Lithuania is expected to reach 1474.9 ktoe (61.8 PJ). The share of renewable heat/cold will reach 71.3% whereas renewable electricity and renewable energy in transport will share respectively 17.2% and 11.5%. The EUCO27 scenario has projected lower levels than the Lithuanian NREAP for the final renewable energy consumption in 2020 and 2030, 1250 (52.3 PJ) ktoe and 1247 ktoe (52.2 PJ), respectively.

[61] Lithuania energy efficiency 2020 targets are 6.5 Mtoe in terms of primary energy consumption and 4.2 Mtoe as final energy consumption.
[62] Final renewable energy (the sum of hydropower, solar, wind, marine, geothermal, biomass and heat pumps) in Lithuania reached 1307 ktoe in 2015, up from 852 ktoe in 2005.

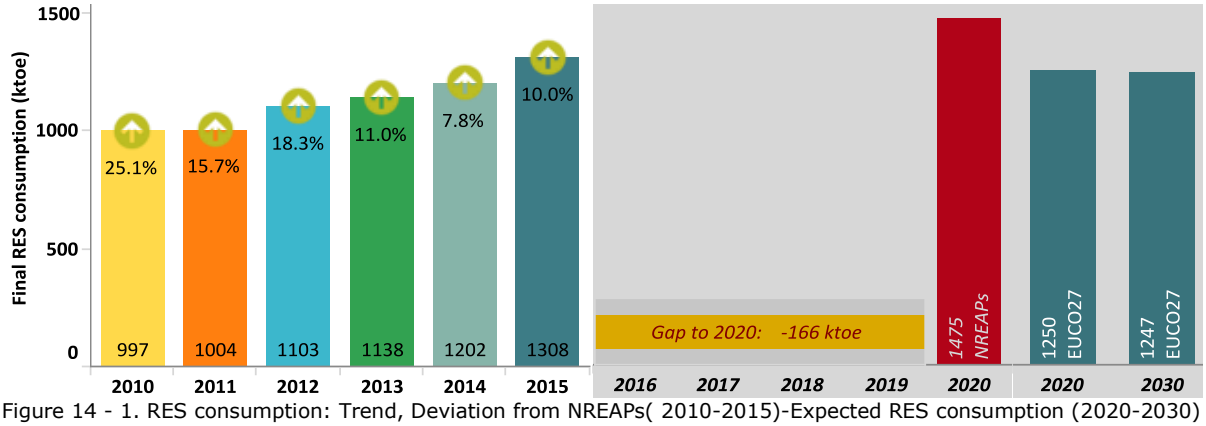


Figure 14 - 1. RES consumption: Trend, Deviation from NREAPs(2010-2015)-Expected RES consumption (2020-2030)

14.2 Renewable energy share

The overall renewable energy share in gross final energy consumption in Lithuania reached 23.6% in 2014 and 25.8% in 2015. The 2020 target that Lithuania has planned for overall renewable energy share is 24%. According to the EUCO27 scenario the overall renewable energy share in Lithuania is projected to reach 24.3% in 2020 and 26.9% in 2030.

Figure 14-2 shows the current trajectory of overall renewable energy share in Lithuania, the NREAPs trajectory, the Indicative trajectory as well as the Current trend forecast trajectory.

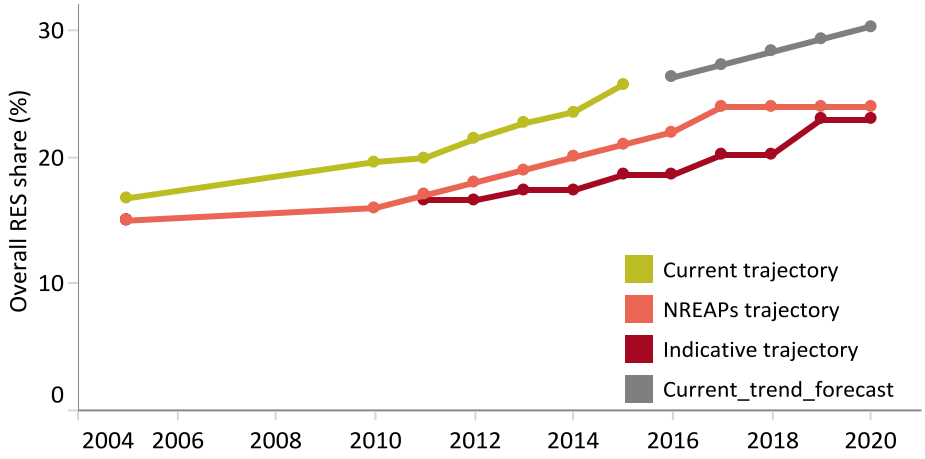


Figure 14 - 2. Overall RES share trajectories in LT: Current, NREAPs and Indicative-Current trend forecast, 2005-2020

Overall renewable energy share in Lithuania remained well above the NREAP and indicative trajectories throughout 2010-2015. In 2015 it exceeded the 2020 planned overall renewable energy share by +1.8 percentage points. Growth was faster only in the heating/cooling sector, whereas the other two sectors experienced slower than planned deployment of renewable energy.

In heating/cooling sector the share of renewable energy reached 40.6% in 2014 and 46.1% in 2015 which is 7.1 percentage points over the 2020 plan (39%) for this share.

Renewable energy share in electricity sector reached 13.7% in 2014 and 15.5% in 2015. This development was slower than planned throughout period 2010-2015. In 2020 the plan for the renewable energy share is expected to reach 21%.

The share of renewable energy in transport sector reached 4.3% in 2014 and 4.6% in 2015. This development was slower than planned missing the NREAP share throughout period 2010-2015. The plan for year 2020 is set to 10%.

14.3 Final renewable electricity, heating/cooling and use in transport

Renewable electricity consumption in Lithuania increased with a CAGR of 15.1% (+1345 GWh) during period 2005-2015 reaching 1783 GWh (153.3 ktoe). Nevertheless the renewable electricity consumption in Lithuania remained below the NREAP plans throughout period 2010-2015. In 2015 wind technology shared 46.9% followed by biomass with 25%, hydropower with 24%, and solar photovoltaic with 4.1%. The fast development of solar photovoltaic will influence the shares of renewable energy technologies in 2020. According to its NREAP Lithuania expect to reach 2958 GWh (254.4 ktoe) in 2020 in which wind is planned to reach a share of 42.3% followed by biomass (41.3%), hydropower (15.9%) and solar photovoltaic (0.5%). The EUCO27 scenario for 2020 has projected a much lower final renewable electricity in Lithuania compared with its NREAP, at 1996 GWh (103 ktoe) of which wind will share 38.4% biomass 36.3%, hydropower 22% and solar photovoltaic 3.2%. Under this scenario the final renewable electricity in Lithuania will reach 3089 GWh (266 ktoe) in 2030 of which hydropower will share 59.3% wind 23.4% and biomass 17.2%.

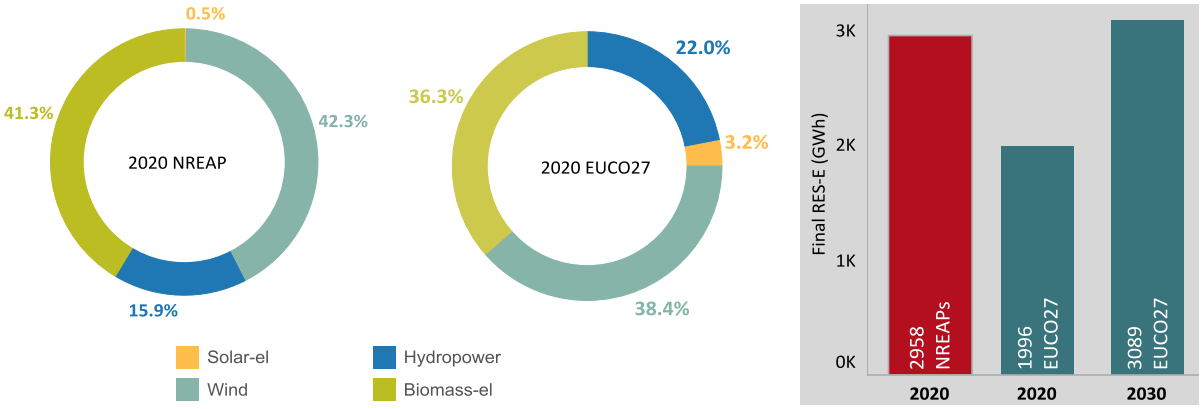


Figure 14 - 3. Final RES Electricity in Lithuania: NREAP plan (2020) – EUCO27 projections (2020-2030)

Renewable heat/cold in Lithuania reached 1086 ktoe (45.5 PJ) in 2015 increasing with a CAGR of 3.0% (+275 ktoe) since year 2005. This development was faster than what projected in the NREAP exceeding the expected uses throughout period 2010-2015. In 2015 almost total renewable energy consumed in heating/cooling sector in Lithuania was biomass (99.9%) with a very marginal contribution of geothermal technology (0.1%). In 2020 final renewable heat/cold is expected to reach 1051 ktoe (44 PJ) in which the contribution of biomass is expected to decrease slightly to 97.3% while the other technologies, heat pumps, solar and geothermal, are expected to increase respectively to 1.3%, 0.9% and 0.5%.

The use of renewable energy in transport developed with a CAGR of 31.2% (+64.4 ktoe) during period 2005-2015 reaching 69 ktoe (2.9 PJ). Despite of this increase, the final use of renewable energy in this sector was found to be under the expected NREAP plans throughout period 2010-2015. In 2015 the contribution of biodiesel in total renewable energy consumed in this sector reached 84% and the rest was bioethanol/bio-ETBE (13.9%) and renewable electricity (2.1%). The 2020 use of renewable energy in Lithuania in transport sector is expected to reach 169.5 ktoe (7.1 PJ) in which the contribution of bioethanol/bio-ETBE is expected to reach 21.2% while the contribution of biodiesel will decrease to 77.3%. The contribution of renewable electricity will be marginal in the total renewable energy that is expected to be used in Lithuania in 2020 with 1.5%.

Table 14 - 1. Final renewable energy in LT: deviations from NREAP in electricity, heating/cooling and transport

	2010	2011	2012	2013	2014	2015
RES-el (ktoe)	-6	-10	-5	-8	-28	-31
RES-hc (ktoe)	215	158	189	152	148	192
RES-tr (ktoe)	-9	-12	-14	-31	-33	-42
RES-el (%)	-7.4	-10.6	-4.4	-6.1	-17.2	-16.8
RES-hc (%)	32.3	22.2	25.3	19.0	17.2	21.5
RES-tr (%)	-17.0	-20.0	-18.4	-33.9	-35.1	-37.6

14.4 Renewable energy technologies/sources

In 2015 almost 86% of final renewable energy in Lithuania was biomass and the rest biofuels (5.2%), wind (5.5%), hydropower (2.8%) and solar (0.5%). In 2020 biomass share is expected to reach 76.6% followed by biofuels with 11.3%, wind 7.3%, hydropower 2.8%, heat pumps 1%, solar 0.7% and geothermal 0.3%.

In this section: (i) Figure 14-4 present the current (2009-2015) and NREAP projected trend (2016-2020) of energy from renewable technologies/sources in Lithuania. The annual increase/decrease (%) of these sources in these two periods is also available in this figure; (ii) Table 14-2 presents how the actual figures reported for renewable technologies/sources in Lithuania compared with what was planned for the NREAPs. Absolute differences are shown in ktoe.

Biofuels use in transport sector in Lithuania reached 67.5 ktoe (2.8 PJ) in 2015 increasing with CAGR of 35.3% (+64.3 ktoe) since 2005. Nevertheless the uses of biofuels in transport sector were under the expected NREAP ones throughout period 2010-2015. Biomass use for electricity and heating/cooling increased with a CAGR of 3.3% (+314 ktoe) between 2005 and 2015 reaching 1124 ktoe (47 PJ). This development was faster than the NREAP planned one exceeding the respective expected levels throughout period 2010-2015. Solar technology was introduced in Lithuania only in 2012 increasing since then with a CAGR of 30.4% (+6.1 ktoe) reaching 6.3 ktoe (0.3 PJ). The development of this technology surpassed the projected NREAP development only during period 2013-15.

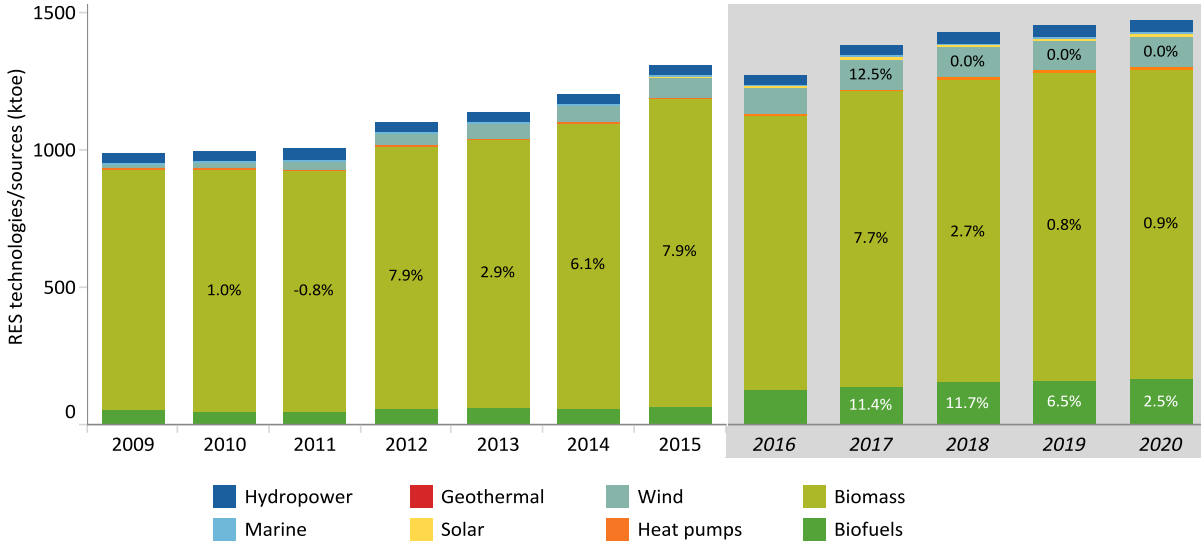


Figure 14 - 4. Annual growth of renewable energy technologies in LT: Current (2009-2015)-NREAP planned 2016-2020

Renewable electricity consumption originated from wind technology increased with a CAGR of 82.8% (+834 GWh) between 2005 and 2015 reaching 836 GWh (72 ktoe). Nevertheless this development was found to be under the projected NREAP consumptions throughout period 2010-2015. Biomass use for electricity consumption increased until 2015 with a CAGR of 52.3% (+440 GWh) since 2005 reaching 447 GWh (38.4 ktoe). Nevertheless this development was not enough to surpass the NREAP expected levels throughout period 2010-2015. Hydropower contribution decreased slightly during period 2005-2015 with a CAGR of -0.05% (-2 GWh) reaching 427 GWh (36.7 ktoe). Comparing with the expected contributions this technology was found below the plans throughout period 2010-2015. Even than planned for an early introduction solar photovoltaic technology was introduced in 2012 developing further with a CAGR of 216% (+71 GWh) reaching 73.3 GWh (6.3 ktoe). Since in 2013 this technology almost three folded the plan for year 2020 (15 GWh).

Biomass use for heat consumption in Lithuania reached 1085.4 ktoe (45.4 PJ) in 2015 increasing with a CAGR of 3.0% (+276 ktoe) since 2005. This development was found above

the NREAP plans throughout period 2010-2015. Even that planned no use of solar thermal and heat pumps took place in Lithuania during period 2011-15.
Biodiesel progress in transport sector during period 2005-2015 took place with a CAGR of 36.2% (+55.3 ktoe) reaching 58 ktoe (2.4 PJ). Nevertheless this development was not fast enough to meet the NREAP plans throughout period 2010-2015. Bioethanol/bio-ETBE use increased with a CAGR of 31% (+9 ktoe) between 2005 and 2015 reaching 10 ktoe (0.4 PJ). This development was also slower than planned throughout period 2010-2015. No other biofuels (biogas and vegetable oils) were used in Lithuania all over period 2010-2015. Renewable electricity in transport sector reached 1.5 ktoe (0.06 PJ) in 2015 increasing with a CAGR of 1.4% (+0.2 ktoe) since 2005. This increase was fast enough to surpass the NREAP plans throughout period 2010-2015. In 2015 only 1.0 of final renewable electricity in Lithuania was used in transport sector.

Table 14 - 2. Renewable energy technologies/sources in Lithuania – deviations from NREAP, 2010-2015, (ktoe)

	2010	2011	2012	2013	2014	2015
Hydropower	-1.1	-0.6	-0.3	-0.5	-1.1	-1.6
Wind	-4.4	-5.5	-0.1	-4.7	-14.0	-7.6
Solar-el	0.0	-0.2	-0.1	3.3	5.5	5.2
Solar-th	0.0	-1.0	-2.0	-3.0	-4.0	-5.0
Geothermal-th	-0.7	-1.4	-1.1	-3.2	-3.1	-3.2
Biomass-el	-0.1	-3.8	-4.4	-6.3	-18.2	-27.0
Biomass-th	215.6	163.6	196.4	163.0	159.9	206.4
Heat pumps	0.0	-3.0	-4.0	-5.0	-5.0	-6.0
Biodiesel	-7.5	-7.7	-0.8	-12.9	-12.8	-21.1
Bioethanol	-2.7	-4.3	-13.6	-18.4	-20.5	-20.4
Renewable electricity	0.8	0.4	0.5	0.5	0.4	-0.1

14.5 Renewable electricity installed capacity

Renewable electricity installed capacity in Lithuania reached 688 MW in 2015 increasing over baseline capacity with a CAGR of 18.8% (+565 MW). In 2015 wind installed capacity in Lithuania covered 63.4% of renewable electricity installed capacity. The rest was hydropower with 17%, solar photovoltaic with 10% and biomass with 9.6%.

Figure 14-5 present the current trend of renewable electricity installed capacity in Lithuania, the deviations (in %) from the expected developments during period 2005-2015, the 2020 NREAP plan and EUCO27 scenario projections for 2020 and 2030. As shown in this figure only in years 2012 and 2015 the deployment of renewable electricity installed capacity in Lithuania was faster than the expected NREAP plans.

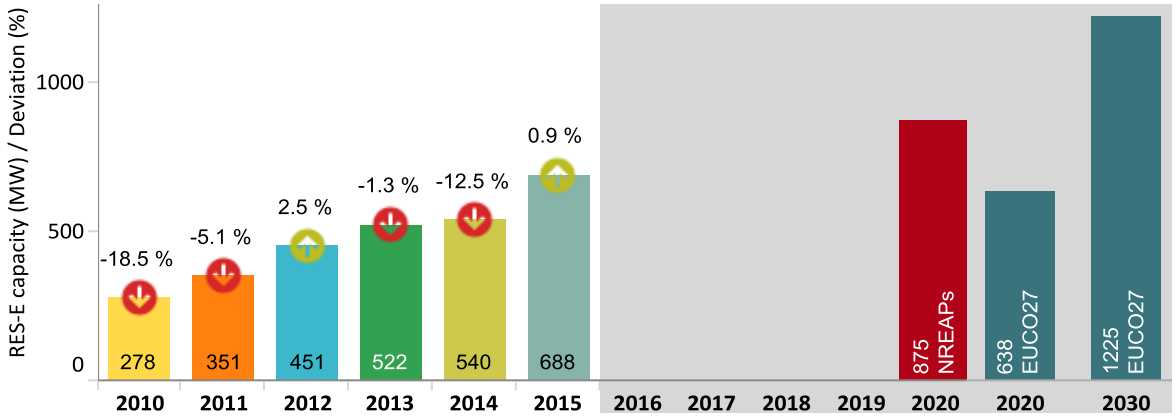


Figure 14 - 5. RES-E capacity development and deviation from NREAPs (2010-2015)– Expected capacity (2020-2030)

Wind capacity in Lithuania deployed with a CAGR of 83.6% (+435 MW) between 2005 and 2015 reaching 436 MW. Despite of this increase wind power capacity was found over the NREAP plans only in period 2011-12. Lithuania introduced solar photovoltaic technology in year 2012 with a capacity of 7 MW even that planned to take place since in 2010. Up to 2015

this technology deployed with a CAGR of 114.4% (+62 MW) exceeding the planned capacities throughout period 2012-15. Biomass installed capacity in Lithuania reached only 66 MW in 2014 developing with a CAGR of 29.4% (+61 MW) during period 2005-2015. Nevertheless this development was not faster than what was projected in the NREAP missing the respective expected capacities throughout period 2010-2015. Even than planned to be increased no change took place in hydropower installed capacity in Lithuania during period 2005-2015 remaining at the level of 117 MW.

In year 2020 Lithuania has planned to reach an installed capacity equal to 875 MW for renewable energy. Wind power will still remain the main contributor with 57.2%. The achieved capacity of solar photovoltaic will change the shares of renewables within the net generation capacity in Lithuania in 2020.

The EUCO27 projection for 2020 on net generation capacity in Lithuania is lower than what planned in the NREAP, at 638 MW. This projection is in line with the current contributions of wind power and solar photovoltaic technology. Under this scenario Lithuania is expected to have installed 1225 MW of renewable electricity capacity in 2030.

15. Luxembourg

Petroleum products shares almost two-thirds of Luxembourg's energy mix in 2015 whereas the share of renewables reached almost 5% (Figure 15). In 2015 gross inland consumption of energy in Luxembourg totalled to 4.2 Mtoe, 1.1% (-45 ktoe) less than the consumption in 2014. Primary energy consumption was 4.1 Mtoe in 2015, 8.9% below the 2020 energy efficiency target[63]. Final energy consumption reached 4.0 Mtoe being 4.8% below the 2020 energy efficiency target for this indicator. Gross final energy consumption decreased during period 2014-2015 by 1.6% (-63.6 ktoe) amounting to 3.82 Mtoe. Energy intensity of the economy continues decreasing reaching 90.7 toe/Million Eur. Luxembourg has a very high import dependency, at 95.7% in 2015, particularly on gas (99.4%) and petroleum products (100%). Greenhouse gas emissions continued to decline at 12 Mt CO_2 eq in 2014, 9.4% below the emissions in 1990. Transport became the main source of emissions with a share of 61% (7.3 Mt CO_2 eq). In 2013 the role of renewable energy in the reduction of GHG emissions reached a net savings of 0.5 Mt CO_2 eq.

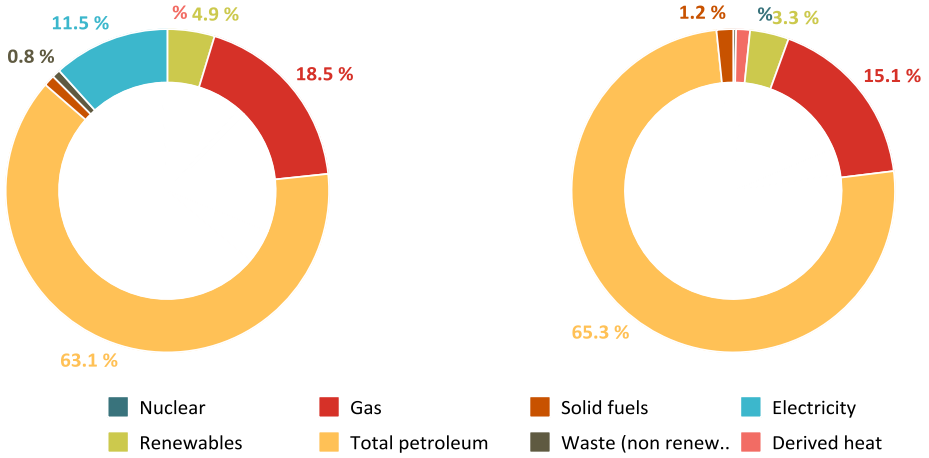


Figure 15. Breakdown of Gross Inland Consumption of Energy (left) - Final Energy Consumption) in LU, 2015 (right

15.1 Final renewable energy consumption

Final renewable energy[64] consumed in Luxembourg reached 193 ktoe (8.1 PJ) in 2015 developing with a CAGR of 12% (+131 ktoe) during period 2005-2015. More than 43% of final renewable energy in Luxembourg is used in transport sector and the rest in heating/cooling (37.6%) and electricity sector (19.1%).

Figure 15-1 present the current trend of final renewable energy consumption in Luxembourg and the deviations (in %) from the expected developments during period 2005-2015 as well as the 2020 NREAP plan and EUCO27 projections for 2020 and 2030. As shown in this figure the current development of final renewable energy consumption in Luxembourg was above the plans throughout period 2010 – 15

The renewable energy consumed in Luxembourg is expected to further increase to 401.3 ktoe (16.8 PJ) until 2020. Transport sector is expected to dominate the final renewable energy expected consumption in this year with a share of 56.4% whereas heating/cooling and electricity sectors contributions will be respectively 26.9% and 16.7%. The EUCO27 scenario for 2020 has projected lower levels for final renewable energy consumption, at 363 ktoe (15.2 PJ). For 2030 this projection reveals the final consumption of renewable energy at 420 ktoe (17.6 PJ).

[63] Luxembourg energy efficiency 2020 targets are 4.5 Mtoe in terms of primary energy consumption and 4.2 Mtoe as final energy xonsumption.

[64] Final renewable energy (the sum of hydropower, solar, wind, marine, geothermal, biomass and heat pumps) in Luxembourg reached 190.6 ktoe in 2015, up from 61.2 ktoe in 2005.

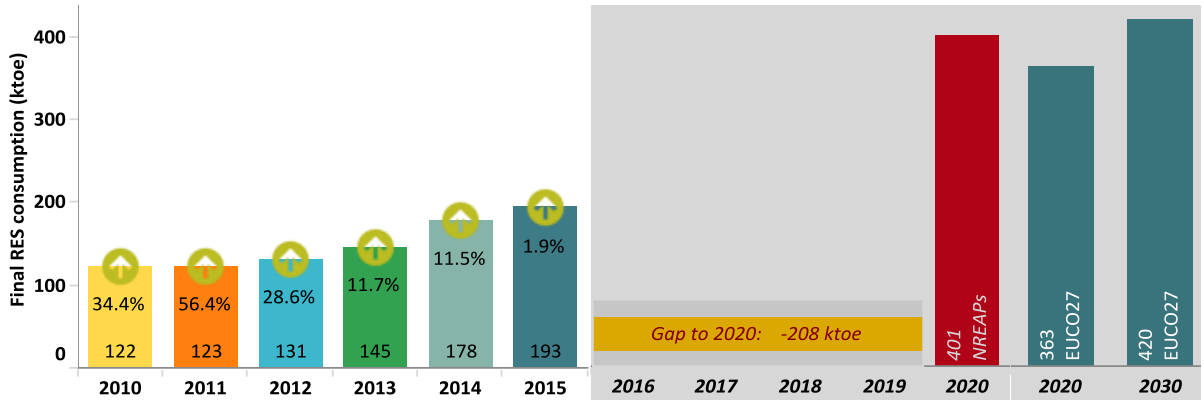


Figure 15 - 1.RES consumption: Trend, Deviation from NREAPs(2010-2015)- Expected RES consumption (2020-2030)

15.2 Renewable energy share

The overall renewable energy contribution in gross final energy consumption in Luxembourg reached 4.5% in 2015 and 5.0% in 2015. The 2020 target that Luxembourg has to reach for the overall renewable energy share is 11.0%. According to the EUCO27 scenario the overall renewable energy share in Luxembourg is projected to reach 8.2% in 2020 and 9.7% in 2030.

Figure 15-2 shows the current trajectory of overall renewable energy share in Luxembourg, the NREAPs trajectory, the Indicative trajectory as well as the Current trend forecast trajectory.

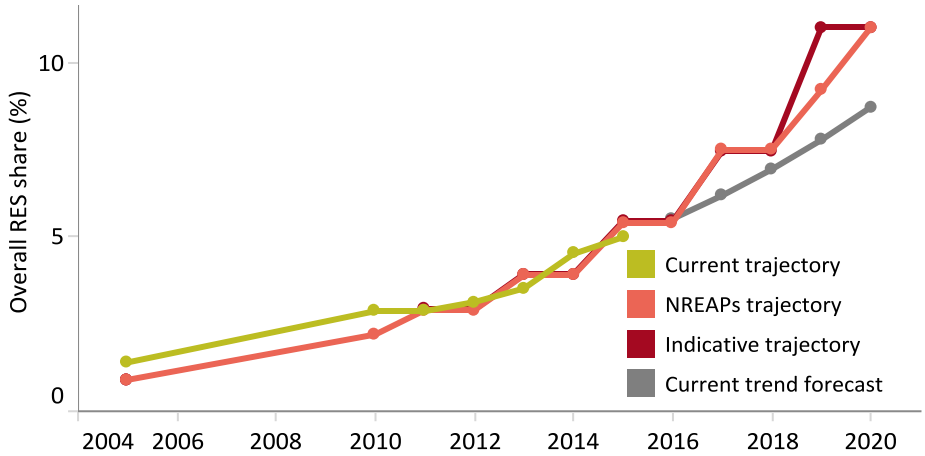


Figure 15 - 2. Overall RES share trajectories in LU: Current, NREAPs and Indicative - Current trend forecast, 2005-20

Overall renewable energy share in Luxembourg remained above the NREAP and indicative trajectories throughout 2010-2015. This development means that Luxembourg is not on track to achieve its 2020 target, particularly as the trajectory will become steeper in the upcoming years.

Renewable energy share in heating/cooling sector reached 7.2% in 2014 decreasing then to 6.9% in 2015. This development remained faster than what was expected according to the NREAP throughout period 2010-2015. The 2020 planned share of the renewable energy in this sector is 8.5%.

In electricity sector the share of renewable energy reached 5.9% in 2014 and 6.2% in 2015. Despite of this increase the share of renewable energy in this sector remained below the plans throughout period 2010-2015. The 2020 plan for the share of renewable electricity is set to 11.8%.

The share of renewable energy in transport sector reached 5.4% in 2014 and 6.5% in 2015 remaining over the planned trajectory throughout period 2010-2015. The planned share for 2020 is expected to reach 10%.

15.3 Final renewable electricity, heating/cooling and use in transport

Renewable electricity consumption in Luxembourg amounted to 428.6 GWh (37 ktoe) in 2015 increasing with a CAGR of 7.4% (+219 GWh) since 2005. This development was not enough to meet the NREAP trend throughout period 2010-2015. In 2015 biomass reached a share of 30.4% being followed by hydropower and solar photovoltaic that reached the same share, 24.2% each. Wind contribution in this year reached 21.2%. In 2020 the renewable electricity consumption is expected to reach 781 GWh (67.2 ktoe) in which biomass will share 42.8% followed by wind (30.6%), hydropower (15.9%) and solar photovoltaic (10.8%).

The EUCO27 scenario projectios for renewable electricity in Luxembourg in period 2020-2030 differs from the NREAP plan projecting a higher Figure for this indicator, at 907 GWh (78 ktoe) in 2020, and different shares for technologies: wind at 55.2%, biomass at 19.3%, solar photovoltaic at 13.3% and hydropower at 12.1%. This scenario has projected that renewable electricity in Luxembourg will reach 1211 GWh (104 ktoe) in 2030 in which the share of wind will reach at 46.2%, solar photovoltaic at 26.4%, biomass 17.9% and hydropower at 9.4%.

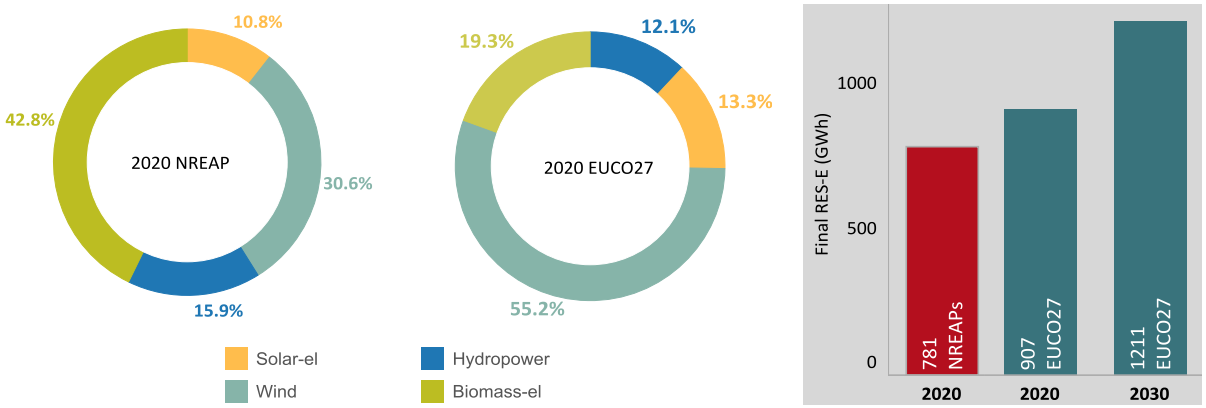


Figure 15 - 3. Final RES Electricity in Luxembourg: NREAP plan (2020) – EUCO27 projections (2020-2030)

The use of renewable energy in heating/cooling in Luxembourg reached 72.7 ktoe (3.0 PJ) in 2014 developing with a CAGR of 5.5% (+30 ktoe) since 2005. This increase was faster than the NREAP plans throughout period 2010-2015. In 2015 biomass contributed with 92.8% and the rest was heat pumps (4.6%) and solar thermal (2.6%). Renewable heat/cold in Luxembourg is expected to reach 107.9 ktoe (4.5 PJ) in 2020 in which heat pumps and solar thermal are expected to reach respectively 15.7% and 7.5%. Biomass will share 76..8%.

Renewable energy consumed in transport sector in Luxembourg increased with a CAGR of 43.7% (+82 ktoe) over period 2005-2015 reaching 83.7 ktoe (3.5 PJ). This development was faster than what was planned in the NREAP only throughout period 2011-14. Biodiesel is the main source in this sector with a share of 88.5%. 8.2% and 3.2% were the respective relative contributions of bioethanol/bio-ETBE and renewable electricity. In 2020 the use of renewable energy in this sector is expected to reach 226.2 ktoe (9.5 PJ) in which biodiesel share is expected to reach 85.2% and the rest: bioethanol/bio-ETBE 10.2% and renewable electricity 4.6%.

Table 15 - 1. Final renewable energy in LU: deviations from NREAP in electricity, heating/cooling and transport

	2010	2011	2012	2013	2014	2015
RES-el (ktoe)	2	1	-2	-4	-7	-12
RES-hc (ktoe)	30	22	20	16	23	16
RES-tr (ktoe)	0	21	11	3	2	-1
RES-el (%)	8.0	2.9	-7.5	-12.5	-17.5	-23.9
RES-hc (%)	117.3	79.8	59.4	38.4	48.0	27.8
RES-tr (%)	-1.0	81.0	29.4	6.6	3.5	-0.8

15.4 Renewable energy technologies/sources

Biofuels was the main renewable energy source in Luxembourg in 2015 with a 42.3% contribution in final renewable energy, followed by biomass with 41.3%, solar with 5.7%, hydropower with 4.7%, wind with 4.1%, and heat pumps with 1.8%. In 2020, the contribution of biofuels is expected to cover 55.2% of final renewable energy planned for this year while the contribution of biomass is expected to decrease to 28.6%. The contribution of other renewable energy sources will be as following: wind 5.3%, heat pumps 4.3%, solar 3.9% and hydropower 2.7%.

In this section: (i) Figure 15-4 present the current (2009-2015) and NREAP projected trend (2016-2020) of energy from renewable technologies/sources in Luxembourg. The annual increase/decrease (%) of these sources in these two periods is also available in this figure; (ii) Table 15-2 presents how the actual figures reported for renewable technologies/sources in Luxembourg compared with what was planned for the NREAPs. Absolute differences are shown in ktoe.

Biofuels use in transport sector in Luxembourg increased between 2005 and 2015 with a CAGR of 65% (+80.4 ktoe) reaching 81 ktoe (3.4 PJ). This development was faster than what was planned in the NREAP exceeding the respective planned uses throughout period 2011-15. Biomass use for electricity and heat/cold consumption in Luxembourg increased until 2015 with a CAGR of 5.5% (+32.4 ktoe) since 2005 reaching 78.7 ktoe (3.3 PJ). This development was enough to surpass the expected NREAP uses throughout period 2010-2015. The development of solar technology took place with a CAGR of 20% (+9 ktoe) since 2005 reaching 10.8 ktoe (0.5 PJ). This technology remained over the NREAP plans throughout period 2010-2015.

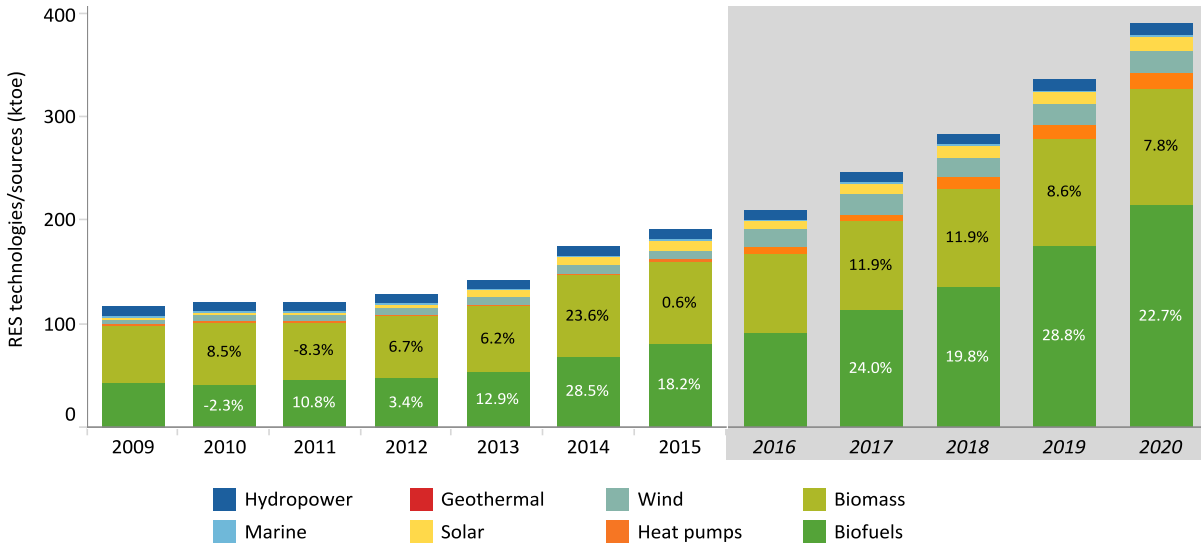


Figure 15 - 4.Annual growth of renewable energy technologies in LU: Current (2009-2015)-NREAP planned 2016-2020

Solar photovoltaic increased with a CAGR of 19.3% during period 2005-2015 reaching 104 GWh (8.9 ktoe). The development of this technology in Luxembourg was found faster than planned throughout period 2010-2015. It exceeded since in 2014 by 12.8% (+10.7 GWh) the plan for 2020 (84 GWh). The development of hydropower experienced an increase with a CAGR of 0.2% (+11.6 GWh) between 2005 and 2015 reaching 104 GWh (8.9 ktoe). This development was slower that what was planned according to the NREAP throughout period 2010-2015. Biomass electricity increased with a CAGR of 11% (+84.3 GWh) between 2005 and 2015 reaching 131 GWh (11.2 ktoe). This development was slower than planned only during period 2012-15. Renewable electricity from wind power increased over 2005 level with a CAGR of 5.5% (+37.5 GWh) reaching 91 GWh (7.8 ktoe) in 2015. Nevertheless this development was not faster than the expected NREAP one missing the plans throughout period 2011-15.

Solar thermal developed between 2005 and 2015 with a CAGR of 23% (+1.6 ktoe) reaching 1.9 ktoe (0.08 PJ). This development was faster than what was planned in the NREAP exceeding the respective heat consumptions throughout period 2010-2014 remaining then below the plan in 2015. Heat pumps technology increased in relative terms with a CAGR of 38.2% (+3.2 ktoe) between 2005 and 2015 reaching 3.4 ktoe (0.14 PJ). Nevertheless this development was not as fast as planned in the NREAP being under the respective expected heat consumptions throughout period 2010-2015. Biomass use for heat consumption in Luxembourg increased with a CAGR of 4.8% (+25.2 ktoe) between 2005 and 2015 reaching 67.5 ktoe (2.8 PJ). Comparing with NREAP development the use of biomass for heat was higher than the respective expected uses throughout period 2010-2015.

Biodiesel use in transport sector reaching 74 ktoe (3.1 PJ) increasing with a CAGR of 13% (+33.8 ktoe) since 2010. This development was fast enough to surpass the expected NREAP biodiesel uses throughout period 2010-2015. Bioethanol/bio-ETBE contribution increased with a CAGR of 61.5% (+6.3 ktoe) during period 2010-2015 reaching 7 ktoe (0.3 PJ). Even that not planned uxembourg used during period 2005-2015 in its transport sector other biofuels that reached 0.1 ktoe in 2015. The use of renewable electricity in transport sector increased with a CAGR of 8.8% (+1.5 ktoe) between 2005 and 2015 reaching 2.7 ktoe (0.11 PJ). This increase was not enough to meet the NREAP plans throughout period 2010-2015. The share in final renewable electricity of renewable electricity used in transport sector in Luxembourg reached 7.3% in year 2015.

Table 15 - 2. Renewable energy technologies/sources in Luxembourg – deviations from NREAP, 2010-2015, (ktoe)

	2010	2011	2012	2013	2014	2015
Hydropower	-0.2	-0.2	-0.2	-0.2	0.0	-0.2
Wind	0.6	-0.4	-2.0	-4.1	-7.0	-8.7
Solar-el	0.1	0.5	0.8	3.4	3.9	3.3
Solar-th	0.2	0.2	0.3	0.4	0.3	-0.5
Biomass-el	1.3	0.8	-0.8	-3.6	-4.3	-6.0
Biomass-th	30.2	22.5	20.3	16.3	23.4	17.2
Heat pumps	-0.5	-0.6	-0.6	-0.5	-0.5	-0.8
Biodiesel	3.4	17.6	14.1	8.6	7.2	2.3
Bioethanol	-4.1	3.7	-2.8	-4.9	-4.1	-1.9
Other biofuels	0.4	0.2	0.2	0.2	0.1	0.1
Renewable electricity	-0.1	-0.1	-0.3	-0.4	-0.8	-1.1

15.5 Renewable electricity installed capacity

Renewable electricity installed capacity in Luxembourg has gone up with a CAGR of 8.9% (+132 MW) between 2005 and 2015 reaching 230 MW. Solar technology covered 50.4% of renewable electricity installed capacity in Luxembourg followed by wind power with 27.8%, hydropower with 14.8% and biomass with 7.0%.

Figure 15-5 present the current trend of renewable electricity installed capacity in Luxembourg, the deviations (in %) from the expected developments during period 2005-2015, the 2020 NREAP plan and EUCO27 scenario projections for 2020 and 2030. As shown in this figure, the installed capacity in Luxembourg surpassed the expected NREAP plans throughout period 2010-2013. Only in period 2014-2015 Luxembourg didn't reach the planned renewable electricity capacities.

Solar photovoltaic increased its capacity between 2005 and 2015 with a CAGR of 17.1% (+92 MW) reaching 116 MW. This development was faster then what was projected in the NREAP exceeding the expected capacities throughout period 2010-2015 as well as the 2020 plan of 113 MW. Biomass capacity reached in 2015 the amount of 16 MW increasing with a CAGR of 12.3% (+11 MW). This source deployed slower than planned in the NREAP throughout period 2010-2015. Wind capacity increased with a CAGR of 6.2% (+29 MW) between 2005 and 2015 reaching the capacity of 64 MW. Comparing with NREAP capacities this technology deployed faster during period 2010-12 but slower throughout period 2013-15. Even than an

increase was planned in hydropower capacity during period 2005-2015 this technology didn't change from the baseline level of 34 MW.

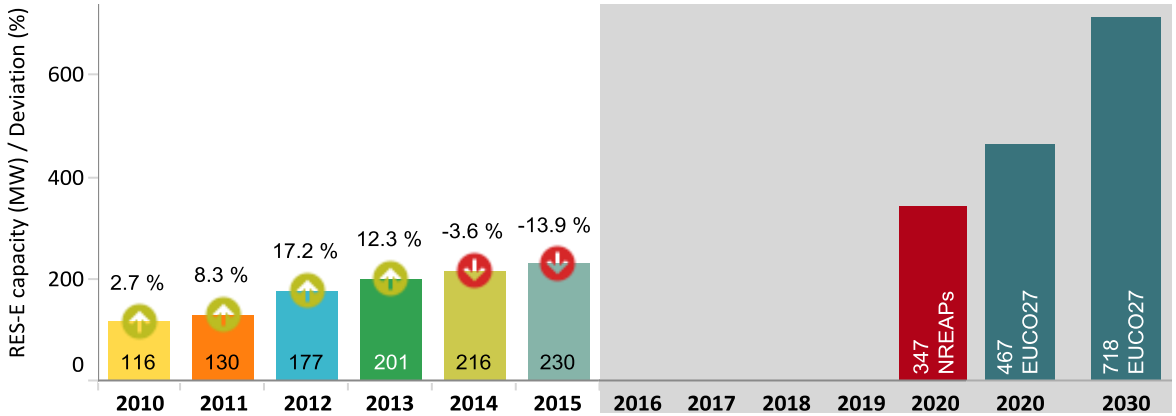


Figure 15 - 5. RES-E capacity development and deviation from NREAPs (2010-2015)– Expected capacity (2020-2030)

In 2020 Luxembourg NREAP has planned to have installed 347 MW of renewable electricity in which wind power is expected to have the main contribution with 38% followed by solar photovoltaic with 32%, biomass with 17% and hydropower with 13%.

The EUCO27 projection on net generation capacity from renewables in 2020 is higher than what planned in the Luxembourg NREAP, at 467 MW. Of this capacity wind will still be the main contributor. The projection is in line with the NREAP regarding the contribution of solar photovoltaic. Under this scenario Luxembourg is expected to have installed 718 MW of renewable electricity in 2030.

16. Croatia

Petroleum products together with gas and renewables had the highest share in Croatia's energy mix in 2015 (Figure 16). In 2015 gross inland consumption of energy in Croatia totalled to 8.5 Mtoe, 4.0% (+330 ktoe) higher than the consumption in 2014. Primary energy consumption was 8 Mtoe in 2015, 30.4% below the 2020 energy efficiency target[65]. Final energy consumption reached 6.6 Mtoe being 5.7% below the 2020 energy efficiency target for this indicator. Gross final energy consumption increased during period 2014-2015 by 5.5% (+358 ktoe) amounting to 6.8 Mtoe. Energy intensity of the economy stood at 194 toe/Million Eur, 2.4% higher than in 2014. Croatia has a relatively low import dependence rate, at 48.3% in 2015. Nevertheless the dependence import ratio remained high for solid fuels (103%) and petroleum products (79.6%). Greenhouse gas emissions reached 23.3 Mt CO_2 eq in 2014, 26.6% below the emissions in 1990. These emissions decreased between 2005 and 2014 by 21%, more than the 2014 ESD target (4.91%). Energy remained the main source of emissions with a share of 45.5% (10.6 Mt CO_2 eq). In the same year the role of renewable energy in the reduction of GHG emissions reached a net savings of 9.8 Mt CO_2 eq, an additional of 0.4 Mt CO_2 since 2011.

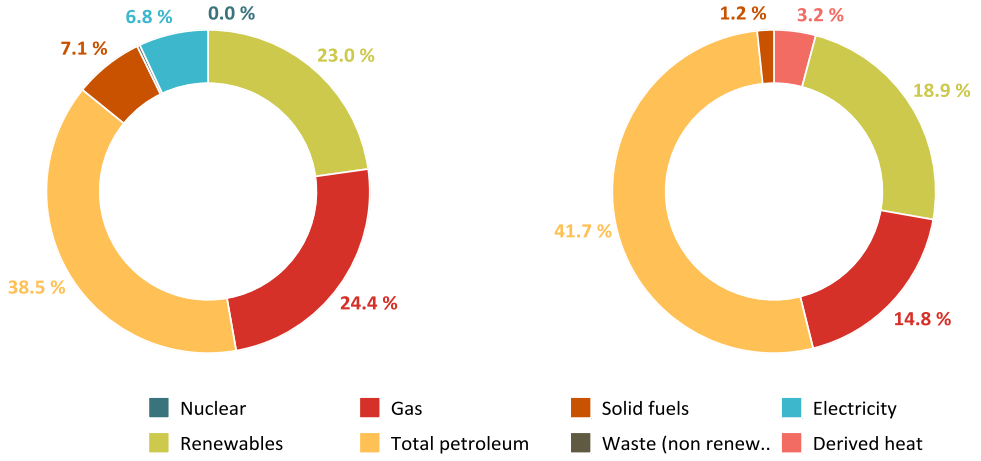


Figure 16. Breakdown of Gross Inland Consumption of Energy (left) - Final Energy Consumption (right) in HR, 2015

16.1 Final renewable energy consumption

Final renewable energy[66] consumed in Croatia grew from 2005 with a CAGR of 1% (+197 ktoe) to 1991 ktoe (83.4 PJ) in 2015 which was 33.8% (+502.5 ktoe) above the 2020 plan (1488 ktoe) set in Croatia's NREAP. 63% of final renewable energy consumption in Croatia was in heating/cooling sector whereas renewable electricity and renewable energy in transport shared 35.4% and 1.7% respectively.

Figure 16-1 present the current trend of final renewable energy consumption in Croatia and the deviations (in %) from the expected developments during period 2005-2015 as well as the 2020 NREAP plan and EUCO27 projections for 2020 and 2030. As shown in this Figure the current development of final renewable energy consumption in Croatia was above the plans throughout period 2010 – 2015

According to Croatia NREAP the contribution of three sectors in the final renewable energy expected to be consumed will be leaded by renewable electricity with 48.5% followed by renewable heat/cold with 40.7% and renewable energy in transport with 10.9%. The EUCO27 scenario has projected lower levels for final renewable energy consumption compared to its NREAP in both 2020 and 2030 respectively, at 1319 ktoe (55.2 PJ) and 1605 ktoe (67.2 PJ).

[65] Croatia energy efficiency 2020 targets are 11.5 Mtoe in terms of primary energy consumption and 7.0 Mtoe as final energy consumption.
[66] Final renewable energy (the sum of hydropower, solar, wind, marine, geothermal, biomass and heat pumps) in Croatia reached 1082 ktoe in 2015, up from 1786 ktoe in 2005.

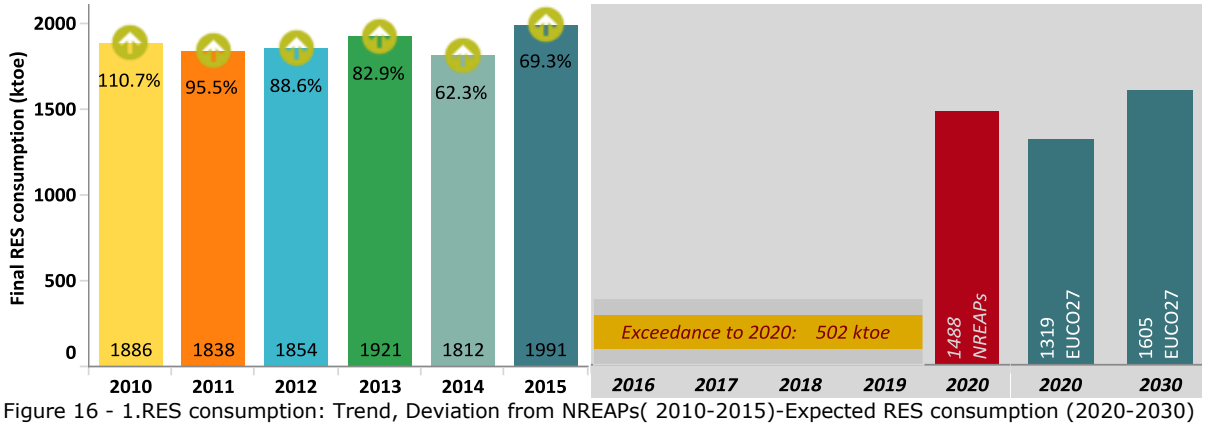


Figure 16 - 1.RES consumption: Trend, Deviation from NREAPs(2010-2015)-Expected RES consumption (2020-2030)

16.2 Renewable energy share

The overall renewable energy contribution in gross final energy consumption in Croatia reached 27.9% in 2014 and 29%. The 2020 target that Croatia has set in its NREAP is 20.1%. According to the EUCO27 scenario the overall renewable energy share in Croatia is projected to reach 21.3% in 2020 and 28.3% in 2030.

Figure 16-2 shows the current trajectory of overall renewable energy share in Croatia, the NREAPs trajectory, the Indicative trajectory as well as the Current trend forecast trajectory.

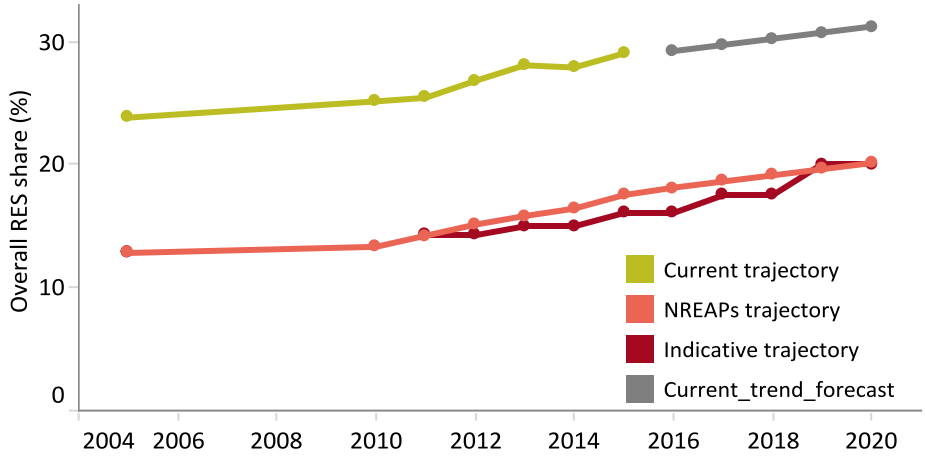


Figure 16 - 2. Overall RES share trajectories in HR: Current, NREAPs and Indicative - Current trend forecast, 2005-20

Croatia's achievements in terms of overall renewable energy share have been faster than planned. Croatia has exceeded the overall renewable energy 2020 target and the 2020 plans for the electricity and heating/cooling sectors. Renewable energy's share in the heating/cooling sector has exceeded the 2020 plan since 2004. Only in the transport sector has the deployment of renewable energy been slower than what was planned for in the Croatian NREAP.

The share of renewable energy in electricity sector reached 45.3% in 2014 and 45.4% in 2015. Croatia surpassed the 2020 planned share for this sector (39%) since in 2013.

Renewable energy share in heating/cooling sector reached 36.2% in 2014 and 38.6% in 2015. This indicator has been over the 2020 NREAP plans (19.6%) throughout period 2005-2015.

The share of renewable energy in transport sector reached 2.2% in 2013 and 2.1% in 2014. The 2020 planned share for this sector is set to 12.54%.

16.3 Final renewable electricity, heating/cooling and use in transport

Renewable electricity consumption in Croatia reached 8193 GWh (704.5 ktoe) in 2015 developing with a CAGR of 2.8% (+1968 GWh) during period 2005-2015. This development was well above the plans for period 2010-2015. In 2015 hydropower contribution reached 89% of final renewable electricity and the rest was wind with 8.5%, biomass with 2.1% and solar photovoltaic with 0.4%. In 2020 the renewable electricity consumption in Croatia is expected to reach 8388.4 GWh (721.4 ktoe) in which the hydropower share is planned to 79.6% followed by wind (10.5%), biomass (8.3%), geothermal (0.9%) and solar (0.7%).

The EUCO27 scenario projection of 2020 final renewable electricity in Croatia shows a similar picture with the NREAP plan. Nevertheless this scenario projected lower final renewable electricity for this year, at 7376 GWh (634 ktoe). Of this electricity hydropower will share 85.7%, wind 9.5%, biomass 3.9% and solar photovoltaic 0.9%. Under this scenario the final renewable electricity in Croatia will reach 10.7 TWh (918 ktoe) in 2030 of which hydropower will share 59.9%, wind 20%, solar photovoltaic 16.9% and biomass 3.3%.

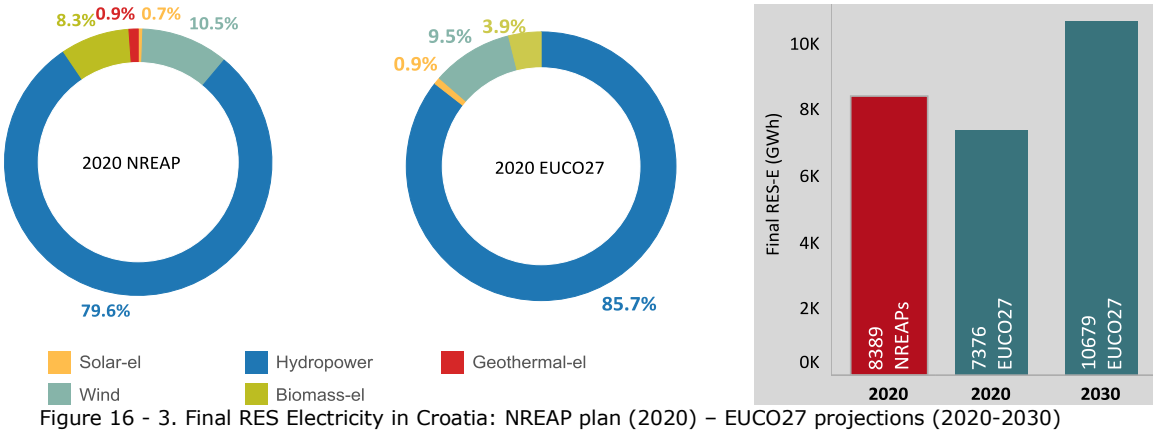


Figure 16 - 3. Final RES Electricity in Croatia: NREAP plan (2020) – EUCO27 projections (2020-2030)

Renewable energy in heating/cooling in Croatia reached 1253.4 ktoe (52.5 PJ) in 2015 at almost the level it had in 2005, 1251 ktoe (52.4 PJ), and more than two –fold of 2020 plan (605 ktoe). This indicator was well over the NREAP plans throughout period 2010-2015. In 2015 biomass contribution was at the share of 97% whereas heat pumps, geothermal and solar thermal stood respectively at 1.2%, 0.9% and 0.8%. In 2020 biomass share is expected to reach 65.5% followed by thermal (16.1%), heat pumps (15.8%) and geothermal (2.6%).

Renewable energy in transport sector in Croatia reached 33 ktoe (1.4 PJ) in 2015 increasing with a CAGR of 15.3% (+25.1 ktoe) during period 2005-2015. This development resulted slower than in the NREAP throughout period 2010-2015. In 2015 the contribution of renewable energy in transport sector in Croatia was shared between biodiesel (73.2%) and renewable electricity (26.8%). The use of renewable energy in transport sector in 2020 is expected to reach 161.6 ktoe (6.8 PJ) in which biodiesel will contribute with 75.2%, renewable electricity with 11.5%, bioethanol/bio-ETBE with 10.1% and other biofuels with 3.2%.

Table 16 - 1. Final renewable energy in HR: deviations from NREAP in electricity, heating/cooling and transport

	2010	2011	2012	2013	2014	2015
RES-el (ktoe)	73	53	53	65	66	68
RES-hc (ktoe)	919	864	852	823	662	797
RES-tr (ktoe)	-1	-19	-34	-17	-33	-50
RES-el (%)	13.7	9.8	9.8	11.2	10.8	10.7
RES-hc (%)	262.3	232.4	216.8	198.7	152.1	174.6
RES-tr (%)	-9.3	-70.0	-80.9	-30.3	-47.0	-60.4

16.4 Renewable energy technologies/sources

In 2015 biomass was the main source of final renewable energy in Croatia with 62.6% followed by hydropower (30.5%), wind (3.7%), biofuels (1.2%), heat pumps and solar (0.8% each) and geothermal (0.5%). In 2020 hydropower is planned to contribute with 39.1% followed by biomass with 31.1%, biofuels with 9.7%, solar with 7%, heat pumps with 6.5%, wind with 5.1% and geothermal with 1.5%.

In this section: (i) Figure 16-4 present the current (2009-2015) and NREAP projected trend (2016-2020) of energy from renewable technologies/sources in Croatia. The annual increase/decrease (%) of these sources in these two periods is also available in this figure; (ii) Table 16-2 presents how the actual figures reported for renewable technologies/sources in Croatia compared with what was planned for the NREAPs. Absolute differences are shown in ktoe.

Solar technology (electricity and heating/cooling) reached 15.3 ktoe (0.6 PJ) in 2015 increasing with a CAGR of 21% (+13 ktoe) since 2005. This development was slower than expected missing the plans throughout period 2011-15. Biomass use in electricity and heating/cooling sectors in Croatia decreased slightly since 2005 with a CAGR of -0.04% (-4.5 ktoe) reaching 1240 ktoe (52 ktoe) in 2015. This source was well above the expected uses throughout period 2010-2015.

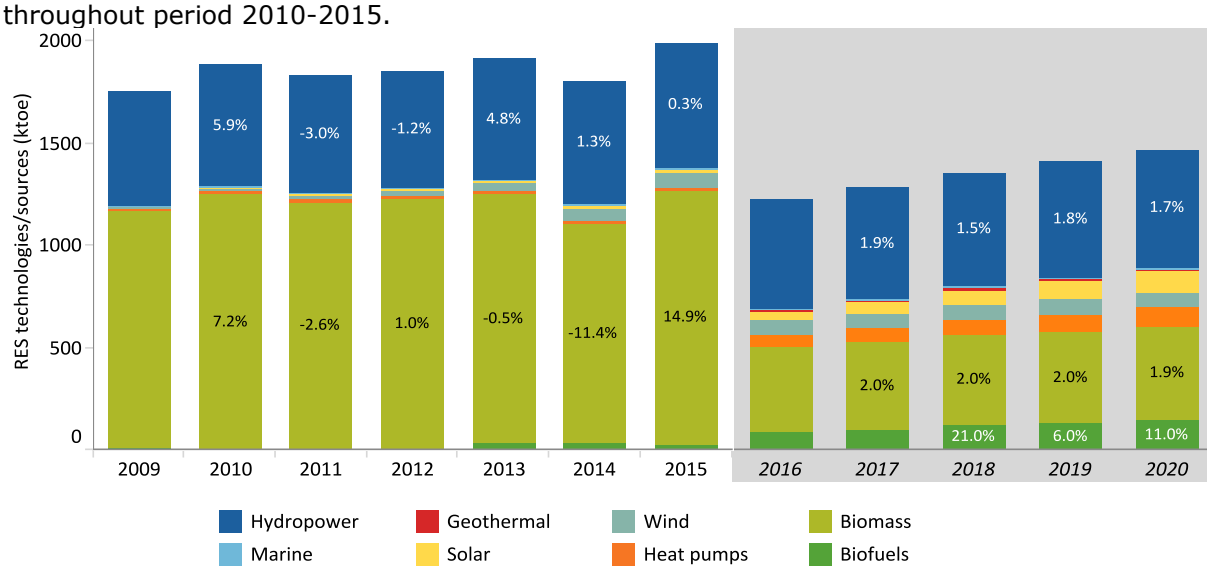


Figure 16 - 4. Annual growth of renewable energy technologies in HR:Current (2009-2015)-NREAP planned 2016-2020

Solar photovoltaic technology contribution reached 57.3 GWh (4.9 ktoe) in 2015, increasing with a CAGR of 243% (+57.1 GWh) since 2010. Nevertheless this development was found above the plans only in years 2010 and 2014. Renewable electricity from wind technology developed with a CAGR of 53% (+834 GWh) between 2005 and 2015 reaching 846 GWh (72.7 ktoe). Only in 2014 the contribution from this technology surpassed the respective NREAP plan. Biomass contribution in electricity sector reached 265 GWh (22.8 ktoe) increasing with a CAGR of 34.2% (+251 GWh). This contribution was well above the planned one all over period 2010-2014 missing the plan in 2015. Hydropower renewable electricity experienced an increase with a CAGR of 1.3% (+825 GWh) during period 2005-2015 reaching 7025 GWh (604 ktoe). This technology was found above the plans all over period 2010-2015 as well as the 2020 plan (397 ktoe). This technology surpassed since in 2013 the plan for year 2020 (6679 GWh).

Biomass use in heating/cooling sector reached 1217 ktoe (51 PJ) in 2015 decreasing slightly with a CAGR of -0.2% (-26 ktoe) over period 2005-2015. This source was found well above the plans during period 2010-2015. The 2015 biomass contribution was more than 3 times-fold the 2020 plan set in the Croatian NREAP. Solar thermal developed with a CAGR of 16.3% (+8.1 ktoe) during period 2010-2015 reaching 10.4 ktoe (0.4 PJ). This source developed faster than planned only in year 2010. Heat pumps contribution in this sector increased with

a CAGR of 11% (+10 ktoe) during period 2005-2015 reaching 15.3 ktoe (0.6 PJ). Despite of this increase this technology developed slower than planned during period 2010-2015.

Biodiesel use in transport sector in Croatia reached 24.2 ktoe (1 PJ) in 2015 increasing with a CAGR of 55.7% (+21.5 ktoe) since 2010. The use of biofuels Croatia remained below the planned trend throughout period 2011-15. Bioethanol/bio-ETBE was planned to be introduced in transport sector in year 2013. Nevertheless a contribution of 1.2 ktoe was registered during period 2011-13 whereas no contribution was reported until 2015. The use of renewable electricity in transport sector reached 8.9 ktoe (0.37 PJ) in 2015 increasing with a CAGR of 1.1% (+0.9 ktoe) during period 2005-2015. This development was found under the expected one throughout period 2010-2015. Only 1.3% was the share in the final renewable electricity of renewable electricity used in transport sector in Croatia in year 2015.

Table 16 - 2. Renewable energy technologies/sources in Croatia – deviations from NREAP, 2010-2015, (ktoe)

	2010	2011	2012	2013	2014	2015
Hydropower	73.5	60.8	54.5	62.9	54.0	80.3
Wind	-0.7	-8.2	-4.1	-3.7	2.3	-2.9
Solar-el	0.0	-1.0	-0.4	-0.7	0.4	-0.2
Solar-th	1.3	-0.6	-2.5	-4.2	-6.0	-7.7
Geothermal-el	0.0	0.0	0.0	0.0	0.0	-3.1
Geothermal-th	1.9	0.7	-0.4	-1.9	0.8	-0.5
Biomass-el	0.0	1.8	3.5	6.3	9.6	-5.8
Biomass-th	917.2	870.5	866.5	845.3	691.0	831.0
Heat pumps	-1.4	-7.0	-11.6	-16.3	-23.6	-25.8
Biodiesel	0.0	-17.4	-32.1	-12.2	-23.1	-31.4
Bioethanol	0.0	0.0	0.0	-2.0	-6.5	-16.2
Renewable electricity	-1.1	-1.4	-2.0	-2.9	-3.4	-2.8

16.5 Renewable electricity installed capacity

Renewable electricity installed capacity in Croatia reached 2434 MW in 2015 increasing with a CAGR of 3% (+622 MW) during period 2005-2015. In 2015 more than 78% of renewable installed capacity in Croatia was hydropower and the rest wind (17.2%), biomass (2.2%) and solar (2.0%).

Figure 16-5 present the current trend of renewable electricity installed capacity in Croatia, the deviations (in %) from the expected developments during period 2005-2015, the 2020 NREAP plan and EUCO27 scenario projections for 2020 and 2030. As shown in this figure, the installed capacity in Croatia deployed slower than the expected NREAP plans throughout period 2010-2015.

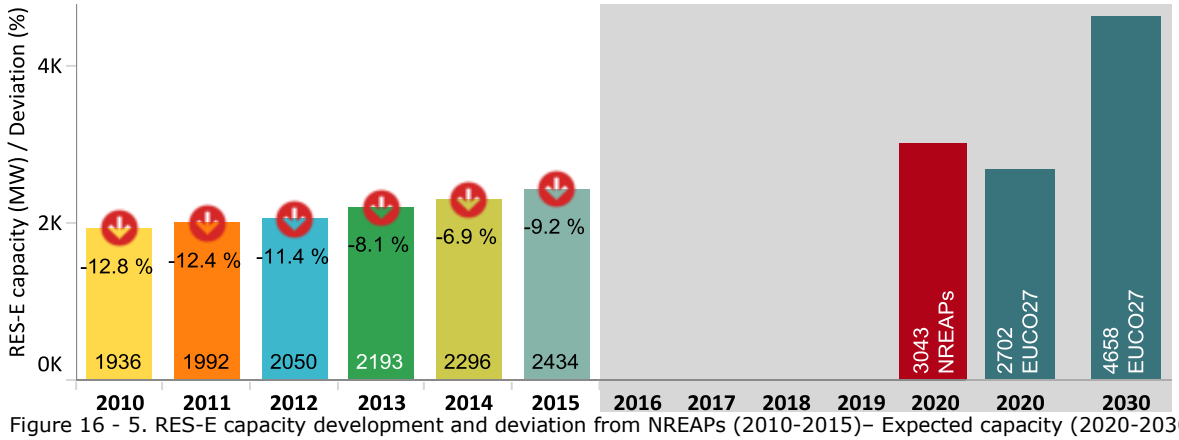


Figure 16 - 5. RES-E capacity development and deviation from NREAPs (2010-2015)– Expected capacity (2020-2030)

Solar photovoltaic installed capacity reached 48 MW in year 2015 increasing with a CAGR of 129% (+44 MW) since 2012. This technology was found over the plans only during period 2013-14. Wind power reached 418 MW in 2015 increasing with a CAGR of 53% (+412 MW)

since 2005. The deployment of this technology in Croatia was faster than planned in the NREAP throughout period 2010-2015. Biomass capacity increased with a CAGR of 38.8% (+51 MW) during 2010-2015 reaching 53 MW. Biomass capacity development was faster than planned throughout period 2010-2014 but slower in year 2015. Hydropower capacity increased with a CAGR of only 0.6% (+111 MW) during 2005-2015 reaching 1915 MW. Comparing with the expected capacities this technology was behind throughout period 2020-15.

In 2020 Croatia has planned to reach 3043 MW of renewable electricity capacity of which hydropower will share 80.7% wind, biomass, solar photovoltaic and geothermal 13.1%, 4.1%, 1.7% and 0.3% respectively.

The EUCO27 projection for 2020 net generation capacity from renewables in Croatia is lower than the planned NREAP capacity being in line nevertheless regarding the relative share of hydropower. Under this projection Croatia is expected to have installed 4653 MW of renewable electricity in 2030.

17. Hungary

In 2015 gas, petroleum products and nuclear had the highest share in Hungary's energy mix whereas the share of renewables reached at 8.2% (Figure 17). In 2015 gross inland consumption of energy in Hungary totalled to 24.2 Mtoe, 5.7% (+1314 ktoe) higher than the consumption in 2014. Primary energy consumption was 22.3 Mtoe in 2015, 16.2% below the 2020 energy efficiency target[67]. Final energy consumption reached 16.3 Mtoe being 10.4% below the 2020 energy efficiency target for this indicator. Gross final energy consumption increased during period 2014-2015 by 6.7% (+1134 ktoe) amounting to 18.1 Mtoe. Energy intensity of the economy stood at 224 toe/Million Eur, 2.5% higher than in 2014. Import dependence ratio in 2015 was at 55.6%. Nevertheless the import dependence remained high for petroleum products, at 93.2%. Greenhouse gas emissions continued to decline at 57.7 Mt CO_2 eq in 2014, 39% below the emissions in 1990. Between 2005 and 2014 the decrease was with -25%, higher than the 2014 ESD target of -27.4%. Energy remained the main source of emissions with a share of 50.4% (29 Mt CO_2 eq).

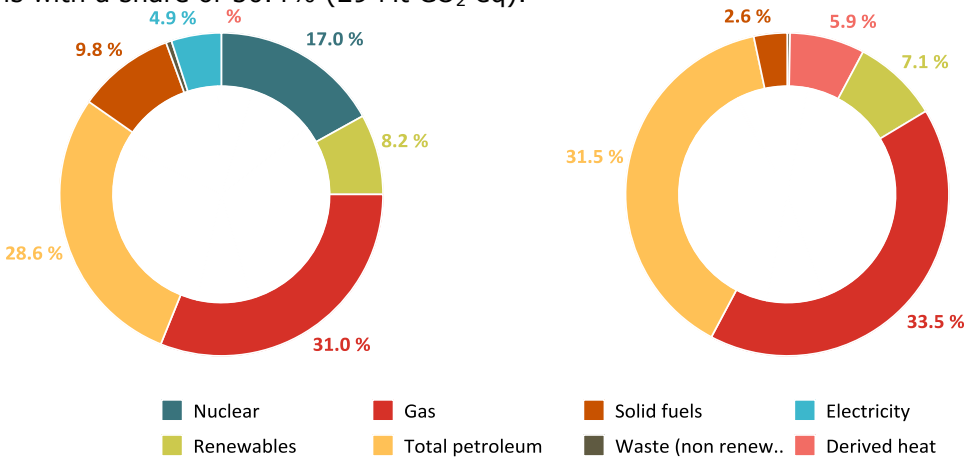


Figure 17. Breakdown of Gross Inland Consumption of Energy (left) - Final Energy Consumption (right) in HU, 2015

17.1 Final renewable energy consumption[68]

Final renewable energy[69] consumed in Hungary increased with a CAGR of 11.9% (+52.8 ktoe) between 2005 and 2015 reaching 1558.6 ktoe (65.3 PJ) in which 82% was renewable heat/cold, 10.5% renewable electricity and 7.5% renewable energy in transport.

Figure 17-1 present the current trend of final renewable energy consumption in Hungary, the deviations (in %) from the expected developments during period 2005-2015 and the 2020 NREAP plan and EUCO27 projections for 2020 and 2030. As shown in this figure the actual development of final renewable energy consumption in Hungary was above the plans throughout period 2010 – 15

Renewable energy consumption in Hungary is expected to further increase to 2879.3 ktoe (120.6 PJ) until 2020 in which heat/cold will share 64.7%, electricity 16.7% and transport 18.6%. The EUCO27 scenario for 2020 has projected a lower final renewable energy consumption, at 2505 ktoe (105 PJ). For 2030 this projection gives 2979 ktoe (124.7 PJ).

[67] Hungary energy efficiency 2020 targets are 26.6 Mtoe in terms of primary energy consumption and 18.2 Mtoe as final energy consumption.

[68] Hungary revised back to 2010 the contribution of renewable energy in Heating/Cooling sector in its reporting to Eurostat SHARES Tool 2015. Here the explanation *"HEA (Hungarian Energy Agency) did not collect directly households survey data on energy consumption until last year (2016). For solid biomass, residential consumption was derived from supply data and historical time-series, taking into account heating degree days, etc. As a consequence of 431/2014/EU Commission Regulation, HEA has contracted the Hungarian Central Statistical Office (HCSO) to extend its regular Household Budget and Living Condition Survey with energy consumption related questions. After the introduction of the household survey as a new source of data, it enabled the estimation of consumption directly from reported consumption data. As a result, the HCSO household survey showed that solid biofuel consumption in the residential sector was highly underestimated. For this reason there is a significant break in the time-series of residential solid biomass consumption*".In the analysis presented in this section the updated data are taken in consideration.

[69] Final renewable energy (the sum of hydropower, solar, wind, marine, geothermal, biomass and heat pumps) in Hungary reached 2617 ktoe in 2015, up from 842.4 ktoe in 2005.

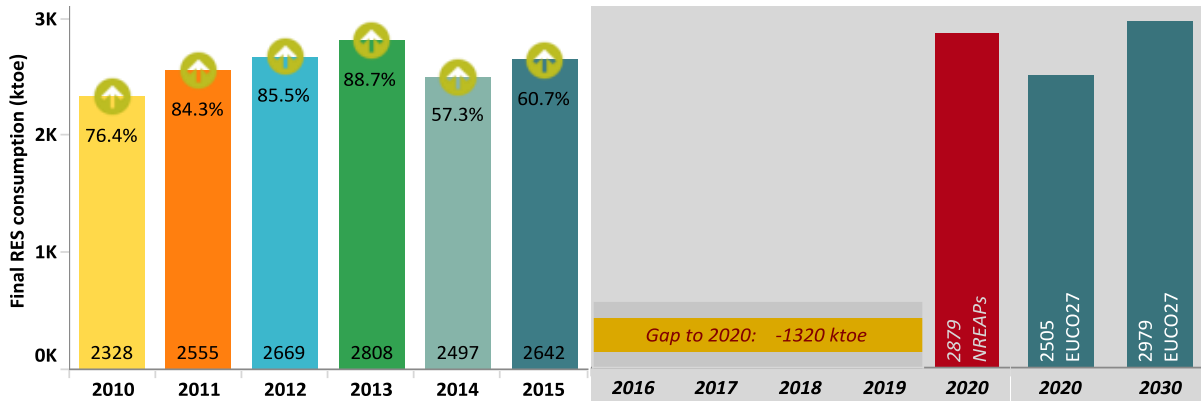


Figure 17 - 1. RES consumption: Trend, Deviation from NREAPs(2010-2015)-Expected RES consumption (2020-2030)

17.2 Renewable energy share

The overall renewable energy contribution in gross final energy consumption in Hungary reached 14.6% in 2014 and 14.5% in 2015. The 2020 target that Hungary has set for the overall renewable energy share is 14.7%. According to the EUCO27 scenario the overall renewable energy share in Hungary is projected to reach 13.2% in 2020 and 15.4% in 2030.

Figure 17-2 shows the current trajectory of overall renewable energy share in Hungary, the NREAPs trajectory, the Indicative trajectory as well as the Current trend forecast trajectory.

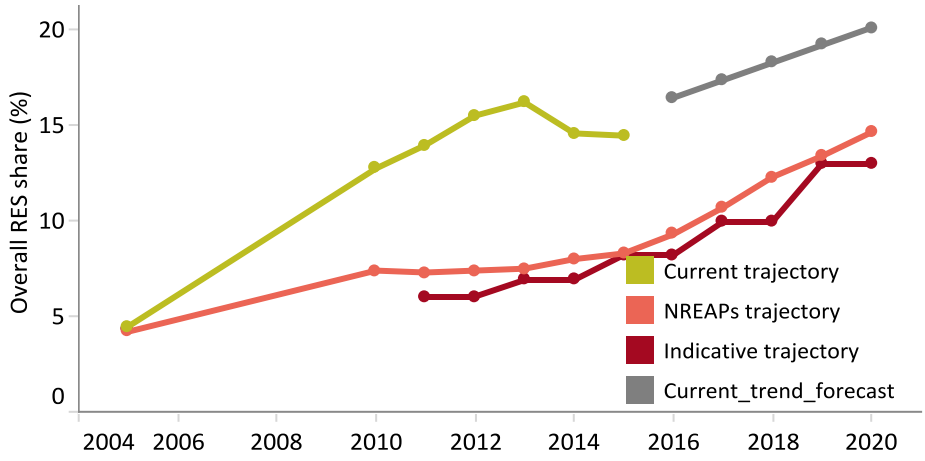


Figure 17 - 2. Overall RES share trajectories in HU: Current, NREAPs and Indicative - Current trend forecast, 2005-20

Overall renewable energy share in Hungary remained well above the NREAP and indicative trajectories throughout 2010-2015. In 2012 and 2013 Hungary exceeded the 2020 target for overall renewable energy share due to the fast deployment of renewables in the heating/cooling sector. Nevertheless a decrease took place in the following 2 years, bringing the overall renewable energy share below the 2020 target. This deployment is enough to enable Hungary to achieve its 2020 target.

Renewable energy share in heating/cooling sector reached 21.2% in 2014 and 21.3% in 2015. Hungary exceeded since in 2011 the 2020 planned share for this sector (18.9%) by +1.2 percentage points.
Renewable electricity share reached 7.3% in 2014 remained unchanged even in 2015. The development of renewable electricity share was slower than what was expected from NREAP during period 2011-15. The 2020 planned share for this sector is set to 10.9%.
In transport sector the share of renewable energy reached 6.9% in 2014 and 6.2% in 2015. Comparing to the expected NREAP renewable energy shares in this sector Hungary was over the plans throughout period 2010-2015. The 2020 planned share for this sector is set to 10%.

17.3 Final renewable electricity, heating/cooling and use in transport

Renewable electricity consumption in Hungary amounted to 3215 GWh (276.4 ktoe) in 2015 increasing with a CAGR of 5.7% (+1360 GWh) since 2005. This development was not fast as it was planned in the NREAP being under the respective plans throughout period 2010-2015. In year 2015 biomass share reached 67.2% followed by wind (21.8%), hydropower (7.1%) and solar photovoltaic (3.8%). In 2020 renewable electricity consumption in Hungary is expected to amount to 5597 GWh (481.3 ktoe) in which the contribution of biomass will reach 59.4% and the rest will be wind (27.6%), geothermal (7.3%), hydropower (4.2%) and solar photovoltaic (1.4%).

Comparing with Hungary NREAP the EUCO27 scenario for 2020 has projected a much lower final renewable electricity, at 3525 GWh (303 ktoe) of which biomass will share 63.6%, wind 25.2%, hydropower 6.3%, solar photovoltaic 2.8% and geothermal 1.8%. Under this scenario the final renewable electricity in Hungary will reach 5067 GWh (436 ktoe) in 2030 of which biomass will share 39.6% solar photovoltaic 37%, wind 17.6%, hydropower 4.6% and geothermal 1.3%.

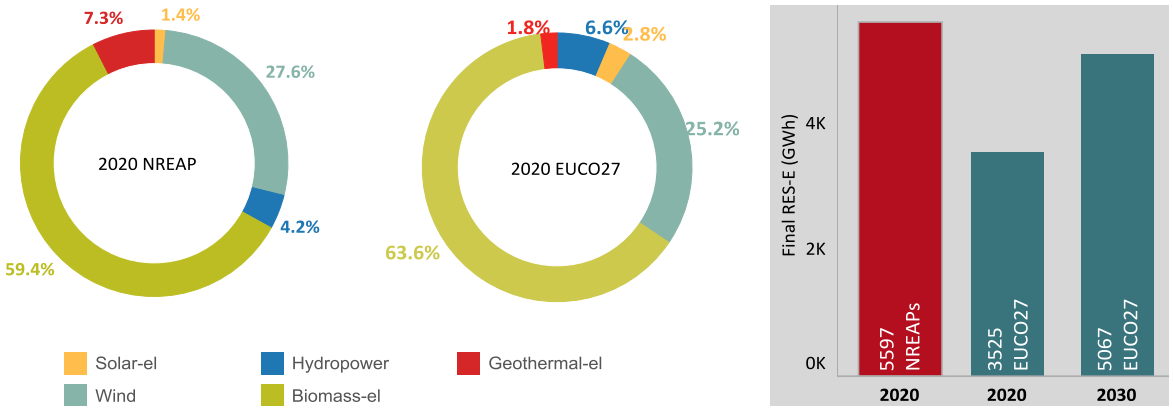


Figure 17 - 3. Final RES Electricity in Hungary: NREAP plan (2020) – EUCO27 projections (2020-2030)

Renewable energy in heating/cooling sector in Hungary reached 2166.4 ktoe (90.7 PJ) in 2015 increasing with a CAGR of 12.3% (+1486 ktoe) since 2005. This use was over the expected NREAP uses all over period 2010-2015 exceeding by 0.8% (+14.6 ktoe) in 2010 the plan for 2020 (1863 ktoe). In 2015 biomass shared almost 95% of final renewable heat/cold followed by geothermal (4.4%), solar thermal (0.5%) and heat pumps (0.2%). In 2020 the use of renewable energy in heating/cooling sector in Hungary is planned to reach 1863 ktoe (78 PJ) in which biomass will contribute with 68.8% followed by geothermal with 19.2%, heat pumps with 7.7% and solar thermal with 4.4%.

Renewable energy in transport sector in Hungary reached 199.3 ktoe (8.3 PJ) in 2015 increasing with a CAGR of 28.6% (+183 ktoe) since 2005. The use of renewable energy in this sector missed the NREAP plans in period 2012-13 and in year 2015. In this year biodiesel share reahced 66.1% followed by bioethanol/bio-ETBE (21.2%) and renewable electricity (12.7%). The use of renewable energy in transport sector in 2020 is expected to be 535 ktoe (22.4 PJ) in which of bioethanol/bio-ETBE share 56.8%, biodiesel 37.8%, renewable electricity 4.5% and other biofuels 0.9%.

Table 17 - 1. Final renewable energy in HU: deviations from NREAP in electricity, heating/cooling and transport

	2010	2011	2012	2013	2014	2015
RES-el (ktoe)	16	-12	-47	-60	-82	-57
RES-hc (ktoe)	130	193	162	171	82	1,121
RES-tr (ktoe)	40	-17	-55	-71	-34	-67
RES-el (%)	6.3	-4.9	-17.5	-20.1	-23.5	-17.1
RES-hc (%)	14.1	20.5	17.1	18.0	8.3	107.3
RES-tr (%)	26.8	-8.5	-24.3	-30.0	-13.4	-25.1

17.4 Renewable energy technologies/sources

In 2015 biomass use for energy had a share of 85.6% in final renewable energy in Hungary. The rest includes the contributions of other renewable energy sources: biofuels with 6.6%, geothermal with 3.6%, wind with 2.3%, solar with 0.81%, hydropower with 0.75% and heat pumps with 0.2%. In 2020 biomass share is expected to reach 54.9% remaining still the main source of renewable energy in Hungary. The rest will be covered by biofuels with 17.9%, geothermal with 13.7%, heat pumps with 5%, wind with 4.7, solar with 3.1% and hydropower with 0.7%.

In this section: (i) Figure 17-4 present the current (2009-2015) and NREAP projected trend (2016-2020) of energy from renewable technologies/sources in Hungary. The annual increase/decrease (%) of these sources in these two periods is also available in this figure; (ii) Table 17-2 presents how the actual figures reported for renewable technologies/sources in Hungary compared with what was planned for the NREAPs. Absolute differences are shown in ktoe.

Solar technology use for electricity and heat/cold production reached 21.2 ktoe (0.9 PJ) in 2015 increasing with a CAGR of 27% (+19.3 ktoe) during period 2010-2015. Nevertheless this source developed slower than planned missing the NREAP trend throughout period 2010-2015. Biofuels use in transport sector in Hungary reached 174 ktoe (7.3 PJ) in 2015 increasing their use between 2010 and 2015 with a CAGR of 52.4% (+171.4 ktoe). Despite of this increase the use of biofuels in this sector was found below the NREAP plans throughout period 2011-15. Biomass used for energy purposes in Hungary increased its contribution during period 2005-2015 with a CAGR of 11.8% (+1506 ktoe) reaching 2241 ktoe (93.8 PJ). This development was found well above the NREAP plans throughout period 2010-2015.

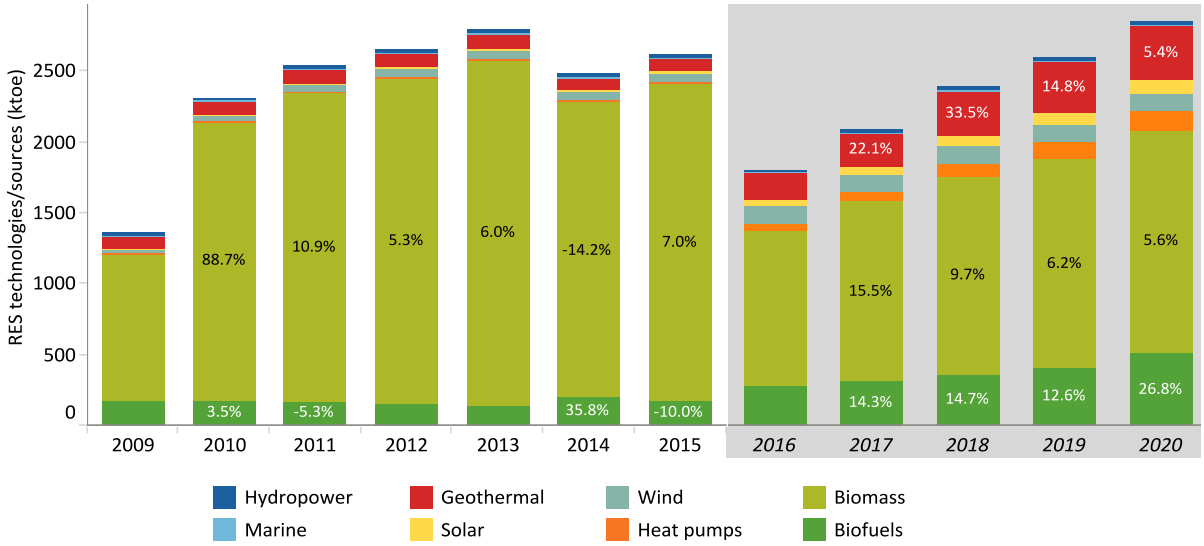


Figure 17 - 4. Annual growth of renewable energy technologies in HU:Current (2009-2015)-NREAP planned 2016-2020

Solar photovoltaic technology in Hungary experienced a development with a CAGR of 170.3% (+122 GWh) during period 2010-2015 reaching 122.6 GWh (10.5 ktoe). This development was enough to surpass the plans only in period 2013-15. Wind power contribution reached 701 GWh (60.3 ktoe) in 2015 incerasing with a CAGR of 48.6% (+688 GWh) between 2005 and 2015. Nevertheless this development was slower than planned throughout period 2010-2015. Biomass for electricity reached a contribution of 2161 GWh (186 ktoe) in 2015 increasing with a CAGR of 2.7% (+504 GWh) since 2005. Despite of this increase this source remained below the plans throughout period 2011-15. No changes were planned in the renewable electricity in Hungary coming from hydropower during period 2005-2015. In fact it increases with a CAGR of 2.2% (+45.4 GWh) reaching 230 GWh (19.8 ktoe). Due to this increase hydropower technology was producing more renewable electricity in Hungary than what was planned in the NREAP throughout period 2010-2015.

Biomass thermal contribution increased during period 2005-2015 with a CAGR of 13.2% (+1463 ktoe) reaching 2055 ktoe (86 PJ). This development was found well above the NREAP plans throughout period 2010-2015. Solar thermal contribution reached 10.7 ktoe (0.4 PJ) increasing with a CAGR of 18.7% (+8.8 ktoe) during period 2005-2015. This development resulted slower than the one planned throughout period 2010-2015.

Bioethanol/bio-ETBE use in transport sector increased its contribution during period 2005-2015 with a CAGR of 32.3% (+40 ktoe) reaching 42 ktoe (1.8 PJ). Despite of this upward trend this biofuel category remained under the NREAP plans throughout period 2011-15. Biodiesel use in Hungary for transport contributed with 132 ktoe (5.5 PJ) in 2015, a development that took place with a CAGR of 2.3% (+14 ktoe) since 2010. Nevertheless this development was slower than planned during period 2011-15. Only in 2010 biodiesel contribution surpassed the respective plan. No other biofuels (biogas and vegetable oils) were used in Hungary period 2010-2015. The biofuels from wastes, residues and ligno-cellulosic material increased with a CAGR of 5.3% (+4.5 ktoe) during period 2011-15 reaching a contribution of 24.1 ktoe (2.2 PJ). This contribution was found above the NREAP plans only during period 2011-12 and year 2015. The use of renewable electricity in this sector reached 25 ktoe (1.1 PJ) in 2015 increasing with a CAGR of 6.5% (+12 ktoe) during period 2010-2015. This development was found faster than NREAP plans throughout period 2010-2015. The share of renewable electricity used in this sector in the final renewable electricity in Hungary reached 9.2% in year 2015.

Table 17 - 2. Renewable energy technologies/sources in Hungary – deviations from NREAP, 2010-2015, (ktoe)

	2010	2011	2012	2013	2014	2015
Hydropower	1	2	2	3	3	3
Wind	-15	-4	-20	-38	-51	-58
Solar-el	0	0	0	1	3	8
Solar-th	-1	-2	-5	-8	-12	-20
Geothermal-el	0	0	0	-2	-2	-2
Geothermal-th	-3	-4	-13	-19	-56	-51
Biomass-el	29	-10	-29	-23	-34	-8
Biomass-th	962	1,210	1,359	1,487	1,110	1,225
Heat pumps	-6	-6	-8	-9	-16	-32
Biodiesel	8	-14	-32	-28	-11	-12
Bioethanol	22	-15	-31	-56	-31	-64
Other biofuels	0	0	0	0	-1	-1
Renewable electricity	10	11	8	13	9	10

17.5 Renewable electricity installed capacity

Renewable electricity installed capacity in Hungary reached 1045 MW in 2015 increasing with a CAGR of 9.8% (+636 MW) since the capacity in 2005. In 2015 biomass installed capacity had a contribution of 47% followed by wind with 31.5%, solar with 16.1% and hydropower with 5.5%.

Figure 17-5 present the current trend of renewable electricity installed capacity in Hungary, the deviations (in %) from the expected developments during period 2005-2015, the 2020 NREAP plan and EUCO27 scenario projections for 2020 and 2030. As shown in this figure, the installed capacity in Hungary was below the expected NREAP plans throughout period 2012-2015. Only in period 2010-2011 the planned capacities in Hungary were fulfilled.

Solar photovoltaic was introduced in Hungary in 2008 with a capacity of 1 MW. Up to 2015 this capacity reached 168 MW increasing with a CAGR of 108%. This development was faster than planned during period 2011-15. In 2014 solar photovoltaic capacity surpassed the planned capacity with 22.2% (+14 MW). Biomass installed capacity reached 491 MW in 2015 increasing with a CAGR of 3.7% (+148 MW) during period 2005-2015. This development missed the planned capacity only during period 2013-13. Wind power capacity reached 329 MW in 2015 increasing with a CAGR of 34.5% (+312 MW) since 2005. Nevertheless this development was slower than planned in the NREAP throughout period 2010-2015.

Hydropower installed capacity reached 57 MW in year 2015 increasing with a CAGR of 1.5% (+8 MW) from the 2005 capacity. This increase was enough to surpass the planned capacities throughout period 2010-2015.

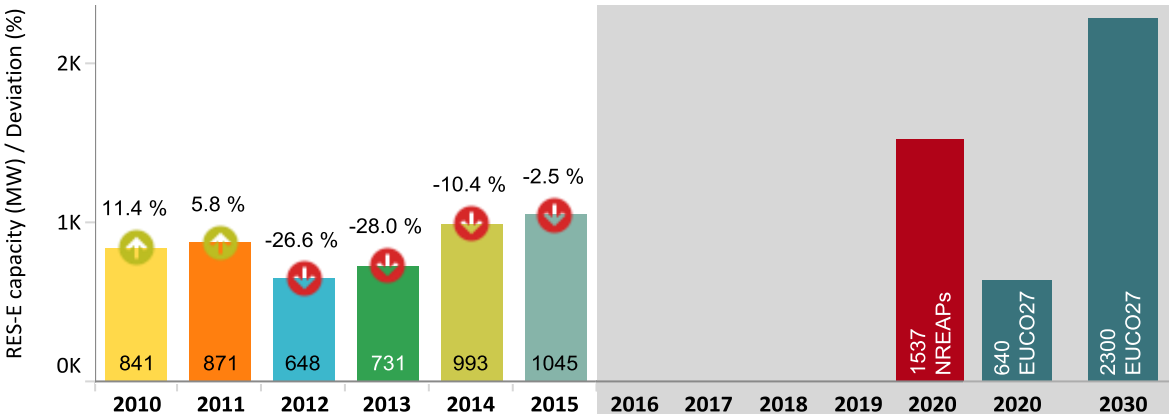
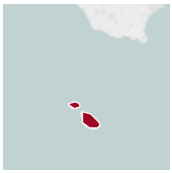


Figure 17 - 5. RES-E capacity development and deviation from NREAPs (2010-2015)– Expected capacity (2020-2030)

In 2020 renewable electricity in Hungary is expected to reach 1537 MW in which wind contribution will reach 49% followed by biomass with 39%. The fast development of solar photovoltaic is expected to change the relative contributions within the renewable electricity capacity in 2020.

The EUCO27 projection for 2020 is well below the Hungarian NREAP plan on net generation capacity, at 640 MW. Only the current share of solar photovoltaic is kept in this projection. Under this scenario Hungary is expected to have installed 2300 MW of renewable electricity in 2030.

18. Malta



Energy mix in Malta has a very low diversity, due to the higher share of petroleum products, whereas the share of renewables reached only 2.6% (Figure 18). In 2015 gross inland consumption of energy in Malta totalled to 0.76 Mtoe, 14.7% (-0.13 Mtoe) lower than the consumption in 2014. Primary energy consumption was 0.8 Mtoe in 2015, 10.2% above the 2020 energy efficiency target[70]. Final energy consumption reached 0.57 Mtoe being 4.6% above the 2020 energy efficiency target for this indicator. Energy intensity of the economy continued to decrease reaching 90.3 toe/Million Eur. Malta has a high import dependence rate for petroleum products, at 97.8% in 2015. Greenhouse gas emissions continued to decline at 3.3 Mt CO_2 eq in 2014, 51% below the emissions in 1990, but 2% above the emissions in year 2005. Energy remained the main source of emissions with a share of 55.8% (1.8 Mt CO2 eq). In the same year the role of renewable energy in the reduction of GHG emissions reached a net savings of 0.14 Mt CO_2 eq, an additional of 0.12 Mt CO_2 since 2009.

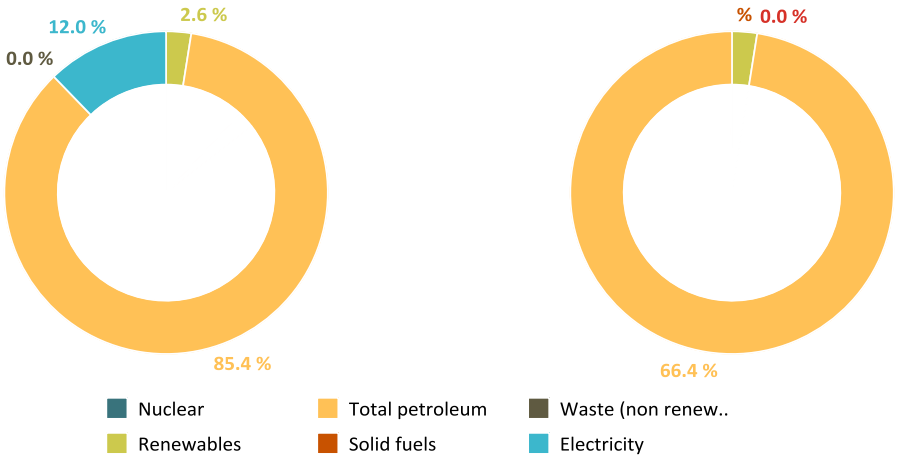


Figure 18. Breakdown of Gross Inland Consumption of Energy (left) - Final Energy Consumption (right) in MT, 2015

18.1 Final renewable energy consumption

Final renewable energy[71] consumption in Malta reached developed with a CAGR of 47.4% (+24.8 ktoe) during period 2010-2015 reaching 25.4 ktoe (1.1 PJ). More than 47% of final renewable energy in Malta was originated from heating/cooling sector. Renewable energy in electricity and transport sector shared the rest respectively 33.9% and 18.7%.

Figure 18-1 present the current trend of final renewable energy consumption in Malta and the deviations (in %) from the expected developments during period 2005-2015 as well as the 2020 NREAP plan and EUCO27 projections for 2020 and 2030. As shown in this figure the current development of final renewable energy consumption in Malta was above the plans only during period 2012-2013 missing in the other years the planned contributions.

The renewable energy use in Malta is expected to further increase to 58.3 ktoe (2.4 PJ) until 2020. The structure of final renewable energy expected to be consumed in this year will change significantly from the current one. Almost 70% of this indicator will be renewable electricity. Transport sector will contribute with 23.2% whereas renewable heat/cold will share only 7.7%.
The EUCO27 scenario has projected lower contribution of final renewable energy in 2020 comparing with Malta's NREAP, at 45 ktoe (1.9 PJ). For 2030 this projection reveals the final consumption of renewable energy at 55 ktoe (2.3 PJ).

[70] Malta energy efficiency 2020 targets are 0.726 Mtoe in terms of primary energy consumption and 0.547 Mtoe as final energy consumption.
[71] Final renewable energy (the sum of hydropower, solar, wind, marine, geothermal, biomass and heat pumps) in Malta reached 25.4 ktoe in 2015, up from 0.5 ktoe in 2005.

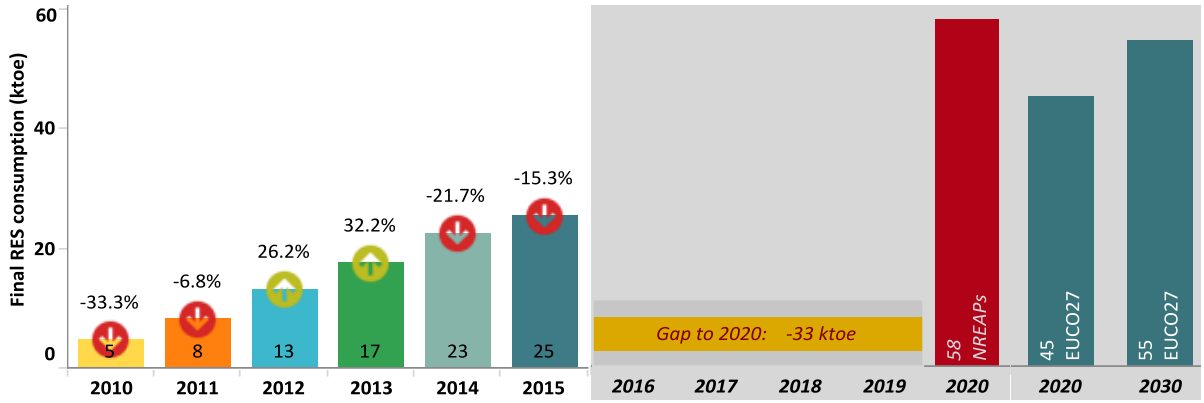


Figure 18 - 1. RES consumption: Trend, Deviation from NREAPs(2010-2015)-Expected RES consumption (2020-2030)

18.2 Renewable energy share

Overall renewable energy contribution in gross final energy consumption in Malta reached 4.7% in 2014 and 5.0% in 2015. The 2020 target that Malta has to reach for the overall renewable energy share is 10.2%. According to the EUCO27 scenario the overall renewable energy share in Malta is projected to reach 11.7% in 2020 and 14.1% in 2030.

Figure 18-2 shows the current trajectory of overall renewable energy share in Malta, the NREAPs trajectory, the Indicative trajectory as well as the Current trend forecast trajectory.

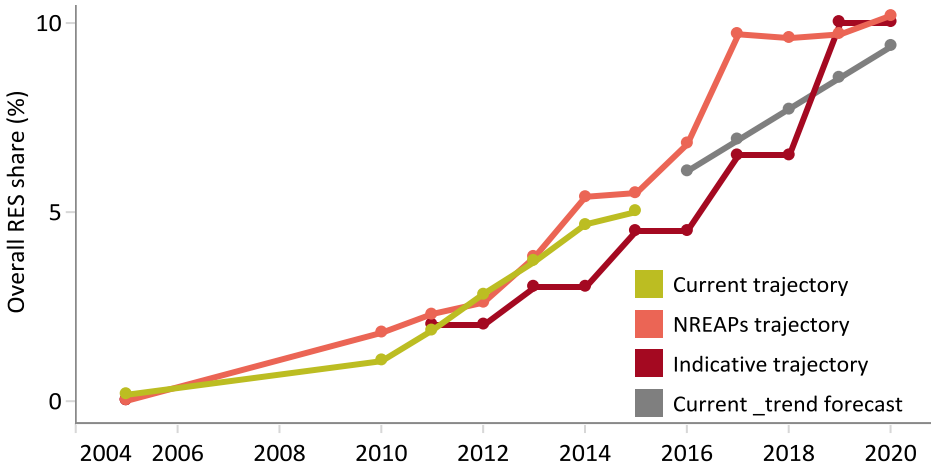


Figure 18 - 2. Overall RES share trajectories in MT: Current, NREAPs and Indicative - Current trend forecast, 2005-20

Throughout 2010-2015 overall renewable energy share in Malta remained broadly in line with the NREAP trajectory but was above the indicative trajectory. This development might put Malta's achievement of the 2020 target for overall renewable energy share at risk.

Renewable energy share in heating/cooling sector reached 14.5% in 2014 decreasing then to 14.1% in 2015. Malta has planned to decrease the renewable energy share in this sector during period 2005-2020. In contrary with the plans Malta increase since 2010 the share of renewables in this sector. The renewable energy share in this sector exceeded since in 2010 (7.8%) the planned share for year 2020 (6.2%).

In electricity sector the share of renewable energy reached 3.3% in 2014 and 4.2% in 2015. This development was very slow compared with expected NREAP development during period 2010-2015. The 2020 planned share in this sector is set to 13.8%.

The share of renewable energy in transport sector was 4.6% in 2014 and 4.7% in 2015. This development was faster than planned only in period 2014-2015 missing the plans throughout period 2010-2013. The 2020 planned share in this sector is set to 10.7%.

18.3 Final renewable electricity, heating/cooling and use in transport

Renewable electricity in Malta amounted to 100 GWh (8.6 ktoe) in 2015 surpassing expected NREAP plans only in period 2011-12. In 2015 solar photovoltaic contribution reached 93.4% followed by biomass with 6.6%.

In 2020 the renewable electricity consumption in Malta is expected to amount to 468.9 GWh (40.3 ktoe) in which wind technology is planned to provide 54.2% of final renewable electricity planned for this year. Biomass and solar photovoltaic contributions are set respectively at 36.7% and 9.2%.

The EUCO27 scenario for year 2020 renewable electricity in Malta differs from its NREAP projecting a much lower level, at 334 GWh (28.7 ktoe). Of this electricity solar photovoltaic will share 97.6% followed by biomass 2.4%. Under this scenario the final renewable electricity in Malta will reach 382 GWh (33 ktoe) in 2030 of which solar photovoltaic will share 96.6% and biomass 3.4%.

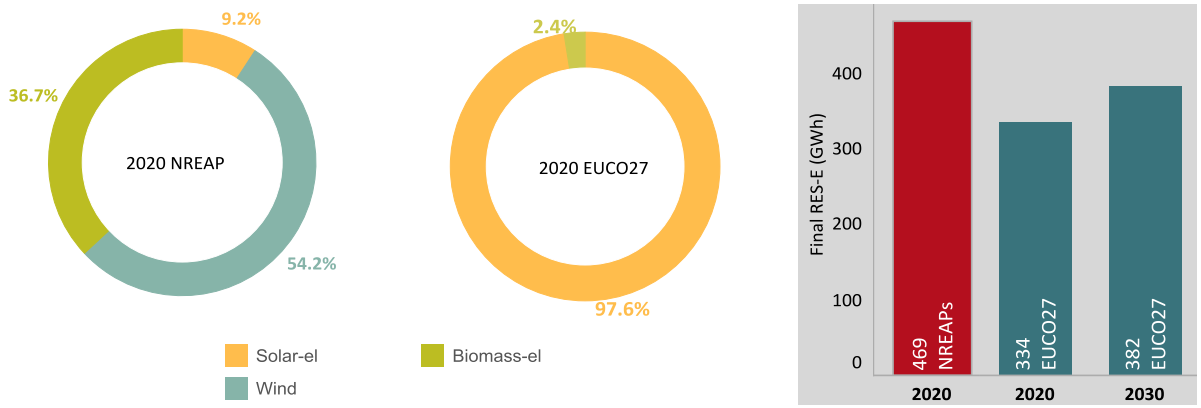


Figure 18 - 3. Final RES Electricity in Malta: NREAP plan (2020) – EUCO27 projections (2020-2030)

Renewable energy in heating/cooling sector in Malta reached 12 ktoe (0.5 PJ) in 2015 increasing with a CAGR of 36.7% (+11.5 ktoe) since 2005. Comparing with expected development renewable electricity in Malta was found over the NREAP plan throughout period 2010-2014. Due to the fact that the 2020 plan for this sector is set lower than any other planned value Malta exceeded in 2010 (4.6 ktoe) the expected 2020 NREAP plan (4.5 ktoe). In 2015 heat pumps was the main source in this sector with 48.7% followed by solar thermal (35.8%) and biomass (15.5%). In 2020 solar thermal and biomass are planned to share respectively 61.6% 38.4% of final renewable heat/cold in Malta.

The use of renewable energy in transport reached 4.7 ktoe (0.2 PJ) in 2015 surpasing the NREAP plans only during period 2011-14. In 2015 renewable energy this sector was totally represented by biodiesel coming from wastes, residues and ligno-cellulosic material. The use of renewable energy in transport sector in 2020 is expected to be 13.5 ktoe (0.57 PJ) in which biodiesel will be the main source with 52% followed by bioethanol/bio-ETBE with 42.8% and renewable electricity with 5.2%.

Table 18 - 1. Final renewable energy in MT: deviations from NREAP in electricity, heating/cooling and transport

	2010	2011	2012	2013	2014	2015
RES-el (ktoe)	0	0	1	-1	-13	-11
RES-hc (ktoe)	1	1	3	6	7	7
RES-tr (ktoe)	-3	-2	-1	-1	0	0
RES-el (%)	-89.0	6.0	37.0	-24.6	-66.4	-56.5
RES-hc (%)	31.3	19.7	61.2	128.0	138.9	142.7
RES-tr (%)	-100.0	-45.7	-23.6	-25.2	-8.3	-8.8

18.4 Renewable energy technologies/sources

Final renewable energy in Malta in 2015 was dominated by solar technology with a share of 48.6% followed by heat pumps with 23.1%, biofuels with 18.6% and biomass with 9.6%. In 2020 wind is expected to have the main contribution in final renewable energy in Malta with 38% followed by biomass with 28.6%, biofuels with 22.3% and solar with 11.2%.

In this section: (i) Figure 18-4 present the current (2009-2015) and NREAP projected trend (2016-2020) of energy from renewable technologies/sources in Malta. The annual increase/decrease (%) of these sources in these two periods is also available in this figure; (ii) Table 18-2 presents how the actual figures reported for renewable technologies/sources in Malta compared with what was planned for the NREAPs. Absolute differences are shown in ktoe.

Solar technology for electricity and heating/cooling reached 12.3 ktoe (0.5 PJ) in 2015 increasing with a CAGR of 37.1 (+11.8 ktoe) during period 2005-2015. This development was faster than planned in the NREAP exceeding the plans throughout period 2010-2015. In 2013 the solar technology used for energy purposes exceeded by 3.7% (+0.24 ktoe) the 2020 plan (6.43 ktoe). In 2015 this exceedance was with 92% (+5.9 ktoe). Biofuels use in Malta increased with a CAGR of 27% (+2.9 ktoe) during period 2010-2015 reaching 4.7 ktoe (0.2 PJ). This development was slower than the one planned missing the plans throughout period 2010-2015. Biomass use in Malta for electricity and heat production reached 2.43 ktoe (0.1 PJ) in year 2015 developing since 2010 with a CAGR of 22% (+1.5 ktoe). Despite of this increase biomass for energy in Malta remained under the respective plans throughout period 2010-2015 except for year 2012.

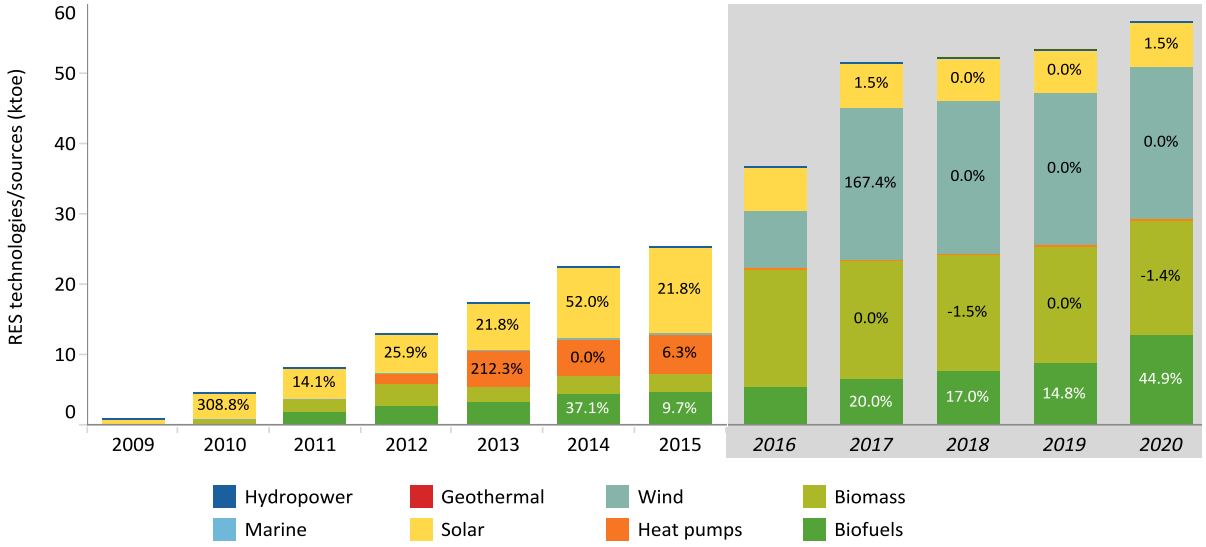


Figure 18 - 4.Annual growth of renewable energy technologies in MT: Current (2009-2015)-NREAP planned 2016-2020

Solar photovoltaic technology reached 93 GWh (5.9 ktoe) in 2015 increasing with a CAGR of 168% (+92.8 GWh) during period 2010-2015. Despite of this development this technology was found over the NREAP plans only in year 2012 and period 2014-2015. Biomass use for renewable electricity purposes in Malta was introduced in year 2011 with a contribution of 4.9 GWh (0.4 ktoe). During period 2011-15 this technology increased with a CAGR of 7.9% (+1.7 GWh) reaching 6.6 GWh (0.58 ktoe). This development was found over the plans only in period 2011-13. Even than planned not contribution from wind power is reported for period 2010-2015.

Solar thermal contribution in heating/cooling sector reached 4.3 ktoe (0.18 PJ) in 2015 increasing with a CAGR of 23.4% (+4 ktoe) since 2005. This development was found faster than the one planned throughout period 2010-2015. This technology exceeded since in 2010 (3.7 ktoe) the 2020 plan (2.76 ktoe). In 2015 this exceedance was with 55.8% (+1.5 ktoe). Biomass contribution in this sector reached the level of 1.9 ktoe (0.08 PJ) in 2015 increasing with a CAGR of 16% (+1.0 ktoe) since 2010. This development was slower than planned throughout period 2010-2015. While no contribution from heat pumps was planned in the

Malta's NREAP this technology registered in 2012 a contribution of 1.8 ktoe (0.07 PJ) that reached 5.9 ktoe (0.24 PJ) in 2015.

Biodiesel use in transport sector reachec 4.7 ktoe (0.2 PJ) in 2015 increasing with a CAGR of 26.9% (+2.9 ktoe) during period 2010-2015. This biofuel category was found over the NREAP plans during period 2011-15. All biodiesel in Malta is coming from wastes, residues and ligno-cellulosic material. Even that planned no use of renewable electricity in this sector was reported for period 2010-2015. No use of bioethanol/bio-ETBE and other biofuels in transport sector was registered in Malta during period 2010-2015. Even than planned no use of renewable electricity in this sector was reported for period 2010-2015.

Table 18 - 2. Renewable energy technologies/sources in Malta – deviations from NREAP, 2010-2015, (ktoe)

	2010	2011	2012	2013	2014	2015
Wind	0.0	-0.3	-0.3	-0.4	-0.9	-1.5
Solar-el	-0.5	-0.2	0.1	-0.9	2.4	4.5
Solar-th	1.2	1.3	1.3	1.4	1.5	1.6
Biomass-el	0.0	0.3	0.6	0.3	-14.2	-14.2
Biomass-th	-0.1	-0.4	-0.1	-0.6	-0.2	-0.3
Heat pumps	0.0	0.0	1.8	5.5	5.5	5.9
Biodiesel	-1.2	0.6	1.6	1.9	3.0	3.4
Bioethanol	-1.8	-2.1	-2.5	-2.9	-3.3	-3.7
Renewable electricity	0.0	0.0	0.0	0.0	-0.1	-0.1

18.5 Renewable electricity installed capacity

The renewable electricity installed capacity in Malta increased to 77 MW in 2015 increasing with a CAGR of 138% (+76 MW) during period 2010-2015. The installed capacity in Malta in year 2015 was 96.1% solar photovoltaic, 3.9% biomass and 0.1% wind power.

Figure 18-5 present the current trend of renewable electricity installed capacity in Malta, the deviations (in %) from the expected developments during period 2005-2015, the 2020 NREAP plan and EUCO27 scenario projections for 2020 and 2030. As shown in this figure the installed capacity in Malta was larger than the expected NREAP plans throughout period 2011-13 and in year 2015.

Solar photovoltaic developed its capacity with a CAGR of 135.5% (+73 MW) between 2010 and 2015. This technology was found over the NREAP plans throughout period 2010-2015. Even that planned to be introduced since in 2011 only in period 2013-15 Malta reported on installed capacities of biomass, at 3 MW in each year. This development was found over the NREAP plan in year 2013 but under in period 2014-2015.

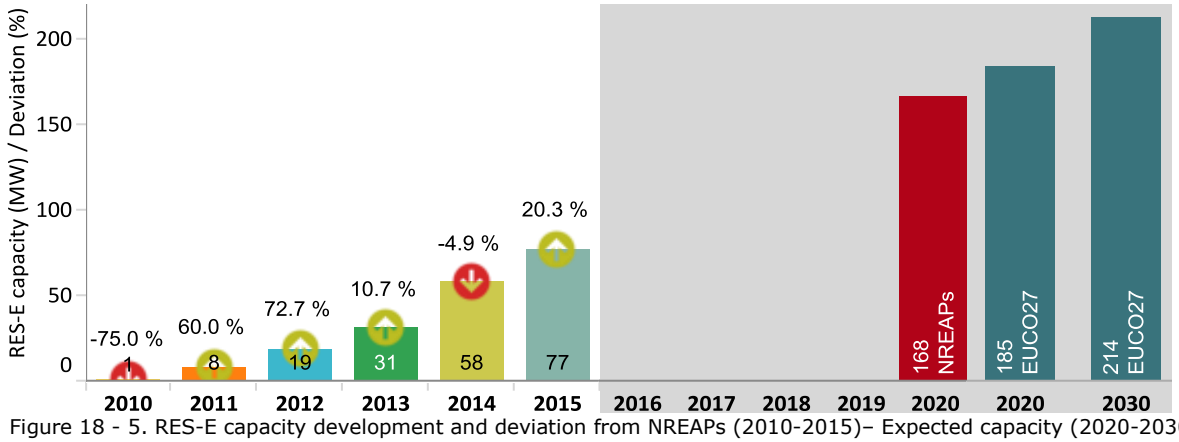


Figure 18 - 5. RES-E capacity development and deviation from NREAPs (2010-2015)– Expected capacity (2020-2030)

In 2020 the renewable electricity capacity in Malta is expected to reach 168 MW of which wind will share 65%, biomass 18% and solar photovoltaic 17%. The EUCO27 projection for 2020 is slightly larger than the NREAP plan on net generation power capacity in Malta, at 185 MW, totally solar photovoltaic. Under this scenario Malta is expected to have installed 214 MW of renewable electricity in 2030.

19. The Netherlands

Petroleum products and gas had the highest share in Netherlands energy mix in 2015 whereas the share of renewables was only 4.7% (Figure 19). In 2015 gross inland consumption of energy in Netherlands totalled to 77.3 Mtoe, 0.7% (+547 ktoe) higher than the consumption in 2014. Primary energy consumption was 64.3 Mtoe in 2015, 5.9% above the 2020 energy efficiency target[72]. Final energy consumption reached 48.5 Mtoe being 7.1% above the 2020 energy efficiency target for this indicator. Gross final energy consumption increased during period 2014-2015 by 2.5% (+1195 ktoe) amounting to 48.8 Mtoe. Energy intensity of the economy stood at 118 toe/Million Eur continuing its downward trend. Netherlands' has a relatively low import dependence ratio, at 52%, but a high dependence rate for solid fuels (112.4%) and petroleum products (101.4%). The import dependence rate for gas is negative. Greenhouse gas emissions reached 198 Mt CO_2 eq in 2014, 12.7% below the emissions in 1990. Comparing with 2014 ESD target greenhouse gas emissions decreased more, at -12% comparing with -5.3%. Energy remained the main source of emissions with a share of 62.3% (123.3 Mt CO_2 eq). In the same year the role of renewable energy in the reduction of GHG emissions reached a net savings of 10.4 Mt CO_2 eq, an additional of 1.9 Mt CO_2 since 2009.

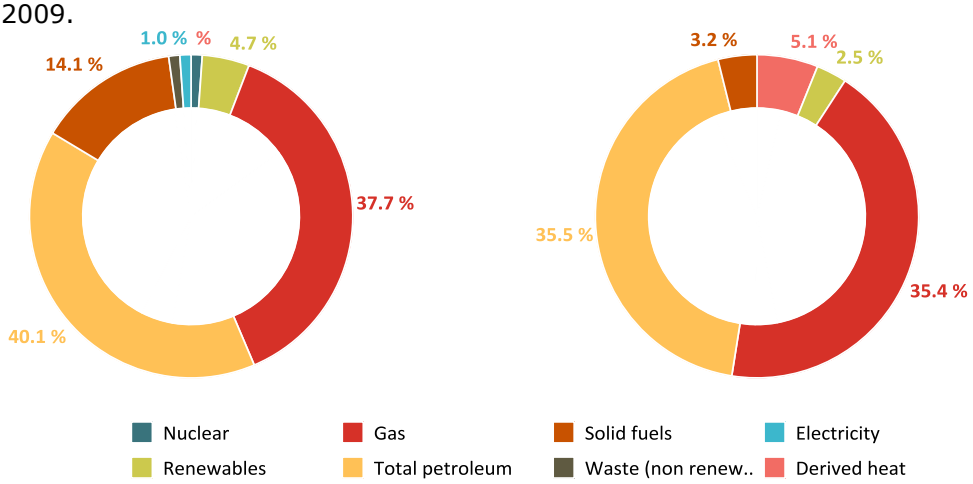


Figure 19. Breakdown of Gross Inland Consumption of Energy (left) - Final Energy Consumption (right) in NL, 2015

19.1 Final renewable energy consumption

Final renewable energy[73] consumed in Netherlands increased with a CAGR of 7.5% (+1490 ktoe) during period 2005-2015 reaching 2885 ktoe (121 PJ). Renewable heat/cold shared 49.2% of final renewable energy consumed, whereas the shares of renewable electricity and renewable energy in transport were respectively 39.2% and 11.6%.

Figure 19-1 present the current trend of final renewable energy consumption in Netherlands, the deviations (in %) from the expected developments during period 2005-2015 and the 2020 NREAP plan and EUCO27 projections for 2020 and 2030. As shown in this figure the current deployment of final renewable energy consumption in Netherlands was below the plans throughout period 2011-2015.

Renewable energy consumed in Netherlands is expected to further increase to 7411 ktoe (310.3 PJ) until 2020. The role of three sectors will change since renewable electricity is expected to share 58.4% of expected final renewable energy consumption. Renewable heat/cold and renewable in transport are expected to contribute respectively with 29.4% and 12.2%. The EUCO27 scenario has projected higher contribution of final renewable energy in 2020 comparing with Netherlands NREAP, at 8564 ktoe (358.6 PJ). For 2030 this projection reveals the final consumption of renewable energy at 8488 ktoe (355.4 PJ).

[72] The Netherlands' energy efficiency 2020 targets are 60.7 Mtoe in terms of primary energy consumption and 52.2 Mtoe as final energy consumption.
[73] Final renewable energy (the sum of hydropower, solar, wind, marine, geothermal, biomass and heat pumps) in Netherlands reached 2847.3 ktoe in 2015, up from 1375.6 ktoe in 2005.

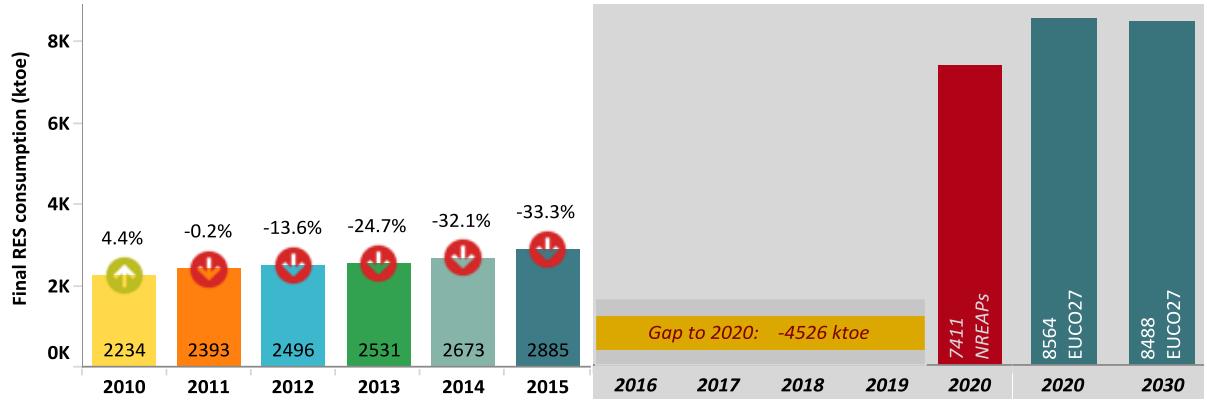


Figure 19 - 1. RES consumption: Trend, Deviation from NREAPs(2010-2015)-Expected RES consumption (2020-2030)

19.2 Renewable energy share

Overall, the Netherlands received 5.5% in 2014 and 5.8% in 2015 of its energy from renewable energy sources. The 2020 target of the overall renewable energy share is 14.5%. According to the EUCO27 scenario the overall renewable energy share in Netherlands is projected to reach 13.1% in 2020 and 15.8% in 2030.

Figure 19-2 shows the current trajectory of overall renewable energy share in Netherlands, the NREAPs trajectory, the Indicative trajectory as well as the Current trend forecast trajectory.

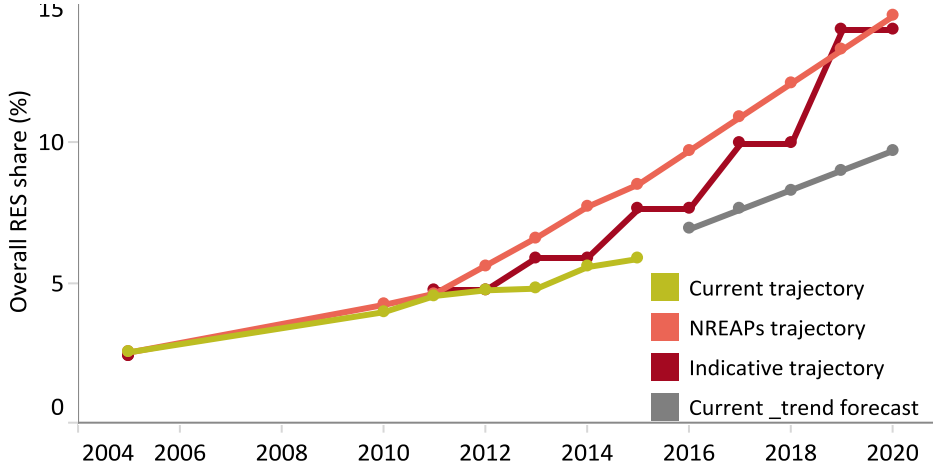


Figure 19 - 2. Overall RES share trajectories in NL: Current, NREAPs and Indicative - Current trend forecast, 2005-20

Overall renewable energy share in the Netherlands remained under the NREAP and indicative trajectories throughout 2010-2015. This development has put at risk the achievement of the 2020 target, making additional measures necessary. Moreover, the planned overall renewable energy share trajectory becomes steeper in the upcoming years.

The renewable energy share in heating/cooling sector reached 5.2% in 2014 and 5.5% in 2015. This development was slower than the planned one approaching to the plans only during period 2014-2015. The 2020 planned share for this sector is foreseen to reach 8.7%.

Renewable energy share in electricity sector reached 10% in 2014 and 11.1% in 2015. This development was much slower than planned missing the respective plans throughout period 2010-2015. The 2020 planned share in this sector is foreseen to reach 37%.

The share of renewable energy in transport sector increased to 6.2% in 2014 and 5.3% in 2015. This development was broadly in line with planned trend missing it nevertheless in year 2015, -0.8 percentage points below. The 2020 planned share of renewable energy in this sector is set to 10.4%.

19.3 Final renewable electricity, heating/cooling and use in transport

Renewable electricity consumption in Netherlands' grew to 13164 GWh (1132 ktoe) in 2015 developing with a CAGR of 5.9% (+5721 GWh) since 2005. Nevertheless this development was slower than planned throughout period 2012-2015. In 2015 wind contributed with 52.5% followed by biomass with 38.2%, solar with 8.5% and hydropower with 0.7%. In 2020 the renewable electricity consumption in Netherlands' is expected to amount to 50315 GWh (4327 ktoe) of which wind is expected to share 64.4%, biomass 33.1%, solar 1.1%, marine 1% and hydropower 0.4%.

Comparing with its NREAP the EUCO27 scenario has projected a lower final renewable electricity in Netherlands' for 2020, at 48841 GWh (4200 ktoe). Of this electricity wind will share 57%, biomass 32.5%, solar photovoltaic 10.2% and hydropower 0.2%. Under this scenario the final renewable electricity in Netherlands' will reach 46946 GWh (4037 ktoe) in 2030 in which the share of wind will be at 59.3%, biomass at 29.2%, solar photovoltaic at 11.3% and hydropower at 0.2%.

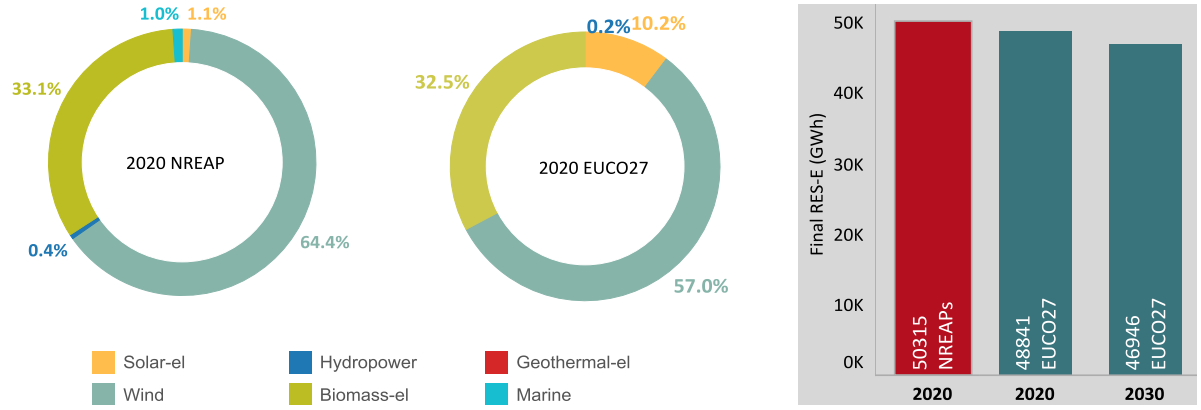


Figure 19 - 3. Final RES Electricity in Netherlands: NREAP plan (2020) – EUCO27 projections (2020-2030)

Between 2005 and 2015 the use of renewable energy in heating/cooling in Netherlands developed with a CAGR of 6.8% (+686 ktoe), reaching 1419 ktoe (59.4 PJ). This development remained over the NREAP plans throughout period 2010-2015. In 2015 biomass contributed with 84.5% followed by heat pumps with 9.5%, geothermal with 4.1% and solar thermal with 1.9%. In 2020 renewable energy in this sector is expected to reach 2179 ktoe (91.2 PJ) in which biomass will contribute with 69.8% followed by heat pumps with 17.3%, geothermal with 11.9% and solar thermal with 1.1%.

The use of renewable energy in transport reached 334 ktoe (14 PJ) in 2015 increasing with a CAGR of 31% (+312 ktoe) since 2005. Comparing with expected NREAP levels this indicator missed the plans throughout period 2010-2015. In 2015 the contribution of biodiesel reached 46.3% followed by bioethanol/bio-ETBE (42.2%) and renewable electricity (11.4%). The use of renewable energy in this sector in 2020 is expected to be 905 ktoe (37.9 PJ in which biodiesel will reach a share of 61% followed by bioethanol/bio-ETBE (31.2%) and renewable electricity (7.8%).

Table 19 - 1. Final renewable energy in NL's: deviations from NREAP in electricity, heating/cooling and transport

	2010	2011	2012	2013	2014	2015
RES-el (ktoe)	92	51	-281	-653	-1,093	-1,227
RES-hc (ktoe)	66	26	17	8	12	40
RES-tr (ktoe)	-65	-81	-129	-185	-184	-256
RES-el (%)	10.1	5.2	-20.7	-38.8	-51.9	-52.0
RES-hc (%)	7.2	2.6	1.6	0.7	0.9	2.9
RES-tr (%)	-20.3	-18.7	-28.2	-36.5	-33.1	-43.4

19.4 Renewable energy technologies/sources

In 2015 biomass covered 57.3% of final renewable energy in Netherlands' followed by wind with 20.9%, biofuels with 10.4%, heat pumps with 4.7%, solar with 4.3%, geothermal with 2.1% and hydropower with 0.3%. In 2020 it is expected that the contribution of biomass in final renewable energy will reach 40.2%. Contributions of biofuels, heat pumps, solar and hydropower are also expected to be respectively at 11.4%, 5.1%, 1.0% and 0.2%. In meanwhile the contributions of wind and marine are expected to be increase respectively to 38.0% and 0.6%.

In this section: (i) Figure 19-4 present the current (2009-2015) and NREAP projected trend (2016-2020) of energy from renewable technologies/sources in Netherlands'. The annual increase/decrease (%) of these sources in these two periods is also available in this figure; (ii) Table 19-2 presents how the actual figures reported for renewable technologies/sources in Netherlands compared with what was planned for the NREAPs. Absolute differences are shown in ktoe.

Solar technology use for electricity and heating/cooling reached 123.6 ktoe (5.2 PJ) in 2015 increasing with a CAGR of 19.8% (+103.4 ktoe) during period 2005-2015. This technology was found above the plans throughout period 2010-2015. In 2014 this technology exceeded by 31% (+22.4 ktoe) the 2020 plan (72 ktoe). Biomass use for electricity and heating/cooling in Netherlands' reached 1631 ktoe (68.3 PJ) in year 2015 increasing with a CAGR of 3.5% (+478.4 ktoe) since 2005. Nevertheless biomass contribution was lower than the expected one during period 2013-15. Biofuels use in transport sector in Netherlands amounted to 296 ktoe (12.4 PJ) in 2015 increasing with a CAGR of 61.8% (+293.5 ktoe) since 2005. In comparison with expected NREAP uses biofuels missed the plans throughout period 2010-2015.

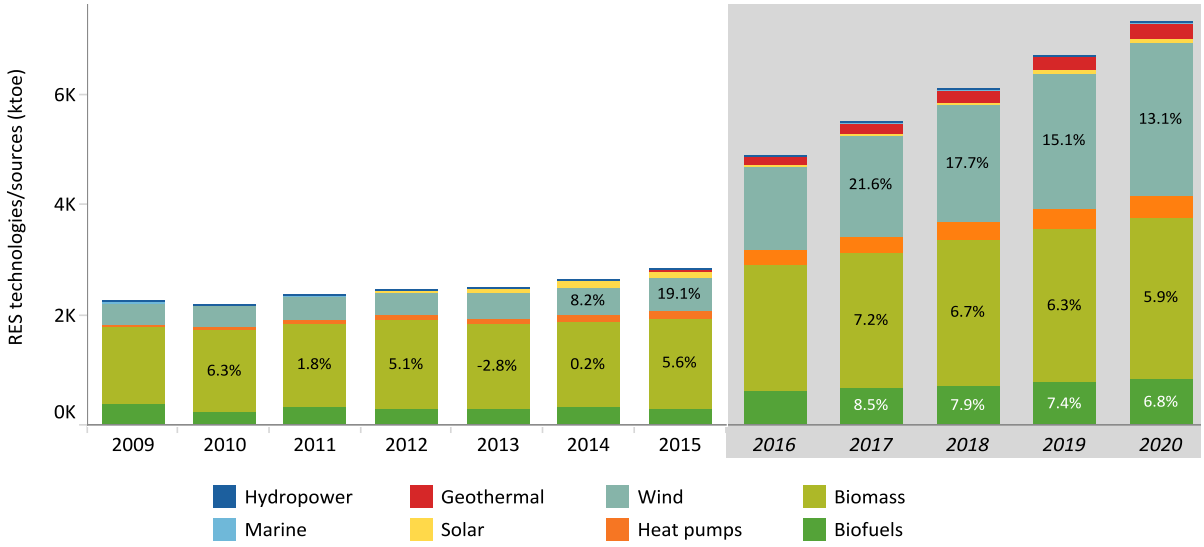


Figure 19 - 4. Annual growth of renewable energy technologies in NL:Current (2009-2015)-NREAP planned 2016-2020

Renewable electricity coming from solar photovoltaic developed with a CAGR of 41.3% (+1086 GWh) during period 2005-2015 reaching 1122 GWh (96.4 ktoe). This technology developed faster than planned in period 2011-15. Since in 2014 solar photovoltaic in Netherlands' exceeded the plan for 2020 (570 GWh). In 2015 the renewable electricity originated from wind technology was 6916 GWh (595 ktoe) increasing with a CAGR of 13% (+4882 GWh) since 2005. Nevertheless the development of this technology was slower than planned during period 2012-15. Biomass use for electricity purposes decreased slowly with a CAGR of only -0.5% (-246 GWh) between 2005 and 2015 reaching 5028 GWh (432 ktoe). This development missing the respective NREAP plans during period 2012-14. Renewable energy coming from hydropower technology in Netherlands remained almost at the level of baseline year reaching 99 GWh (8.5 ktoe) in 2015. This technology was found under the expected plans all over period 2010-2015.

Solar thermal technology in Netherlands' developed with a CAGR of 4.7% (+10 ktoe) during period 2005-2015 reaching 27.2 ktoe (1.1 PJ). This development was found over the expected NREAP plans throughout period 2010-2015. This technology exceeded since in 2010 (23.7 ktoe) the 2020 plan (23 ktoe). Heat pumps technology used in this sector reached 135 ktoe (5.7 PJ) in 2015 increasing with a CAGR of 23% (+118 ktoe) during period 2005-2015. Nevertheless this development was not enough to surpass the NREAP plans throughout period 2010-2015. Biomass use for heat production in Netherlands reached 1199 ktoe (50.2 PJ) in 2015 increasing since 2005 with a CAGR of 5.5% (+500 ktoe). This source developed faster than planned throughout period 2010-2015. Use of geothermal technology in this sector amounted to 58.5 ktoe (2.5 PJ) in 2015 increasing with a CAGR of 50.4% (+51 ktoe) during period 2010-2015. Nevertheless this development was slower than what was planned in the NREAP for this technology throughout period 2010-2015.

Bioethanol/bio-ETBE use in transport sector reached 141 ktoe (5.4 PJ) in 2015 increasing during period 2010-2015 with a CAGR of 0.96% (+6.6 ktoe). This biofuel category was found under the NREAP plans throughout period 2010-2015. Biodiesel use increased with a CAGR of 10.4% (+60.6 ktoe) during period 2010-2015 reaching 154.7 ktoe (6.5 PJ). Despite of this development biodiesel use in Netherlands' remained under its NREAP plans throughout period 2010-2015. The contribution of Annex IX biofuels in Netherlands grew to 144 ktoe (6.0 PJ) in 2015 developing faster than planned during period 2011-15 exceeding in 2011 (166 ktoe) the plan for year 2010 (155 ktoe). Renewable electricity in transport sector reached 38 ktoe (1.6 PJ) increasing with a CAGR of 6.7% (+18 ktoe) during period 2005-2015. This development made possible that in comparison with expected NREAP developments these uses were well over during period 2010-2015. The share of renewable electricity used in this sector in the final renewable electricity in Netherlands' was 3.4% in 2015..

Table 19 - 2. Renewable energy technologies/sources in Netherlands – deviations from NREAP, 2010-2015, (ktoe)

	2010	2011	2012	2013	2014	2015
Hydropower	-2	-4	-7	-7	-7	-7
Wind	3	22	-141	-254	-514	-580
Solar-el	-1	0	8	28	50	75
Solar-th	4	6	7	8	9	10
Geothermal-th	-31	-49	-63	-70	-76	-72
Biomass-el	93	34	-141	-419	-622	-716
Biomass-th	160	147	162	169	188	219
Heat pumps	-67	-78	-89	-99	-109	-117
Biodiesel	-45	-38	-60	-112	-106	-195
Bioethanol	-33	-57	-83	-87	-91	-76
Other biofuels	0	0	0	0	0	0
Renewable electricity	14	14	14	14	14	15

19.5 Renewable electricity installed capacity

The renewable electricity installed capacity in Netherlands amounted to 5481 MW in 2015 increasing with a CAGR of 9.4% (+3258 MW) during period 2005-2015. In 2015 wind technology installed capacity covered almost 62% of renewable electricity installed capacity in Netherlands. Solar contribution reached 27.6% and the rest was covered by biomass with 9.8% and hydropower with 0.7%.

Figure 19-5 present the current trend of renewable electricity installed capacity in Netherlands, the deviations (in %) from the expected developments during period 2005-2015, the 2020 NREAP plan and EUCO27 scenario projections for 2020 and 2030. As shown in this figure, the installed capacity in Netherlands was below the foreseen NREAP plans throughout period 2010-2015.

Solar photovoltaic technology developed its capacity between 2005 and 2015 with a CAGR of 40.4% (+1464 MW) reaching 1515 MW, more than twofold the planned 2020 capacity for this technology. The increase of wind technology during period 2005-2015 took place with a CAGR

of 10.7% (+2167 MW) reaching 3391 MW. Nevertheless wind installed capacity was found to be under the expected capacities throughout period 2012-15. Only in period 2010-11 this technology surpassed the respective plans. Biomass installed capacity reached 538 MW in year 2015 decreasing with a CAGR of 5.1% (-373 MW) during period 2005-2015. Comparing with expected NREAP developments these capacities were found to be under throughout period 2010-2015. Hydropower installed capacity in Netherlands remained at the level of 37 MW between 2005 and 2015 even that an increase during this period was planned.

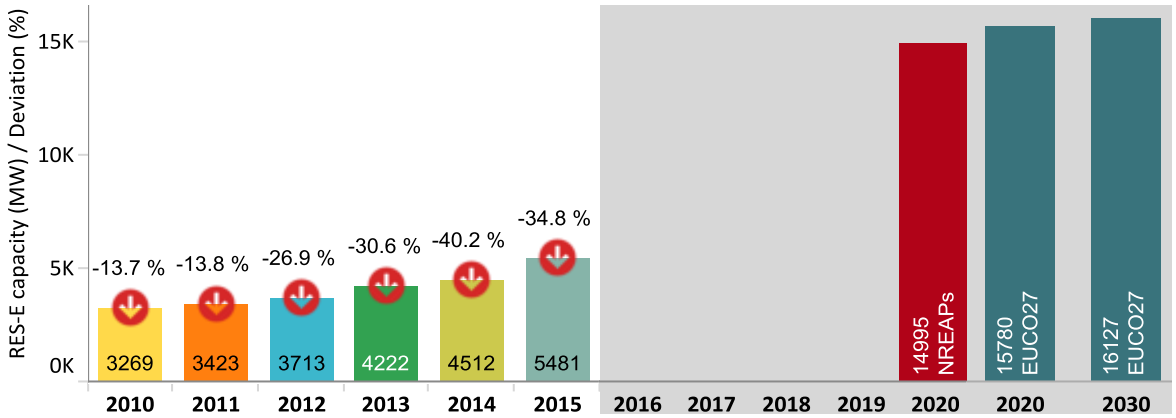


Figure 19 - 5. RES-E capacity development and deviation from NREAPs (2010-2015)– Expected capacity (2020-2030)

In 2020 the Netherlands planned to reach an installed renewable electricity capacity equal to 14995 MW in which wind power will share 74.5% followed by biomass (19.3%), solar photovoltaic (4.8%) and hydropower (0.5%). Marine technology is expected to have a very marginal contribution with 0.9%.

The EUCO27 projection for 2020 is broadly consistent with NREAP on net generation capacity from renewables in Netherlands, at 15780 MW, in which wind remains the main source. Under this projection the Netherlands is expected to have installed 16127 MW of renewable electricity in 2030.

20. Austria

Energy mix in Austria is dominated by petroleum products and renewables (29%) followed by gas (Figure 20). In 2015 gross inland consumption of energy in Austria totalled to 33.2 Mtoe, 2.4% (+782 ktoe) higher than the consumption in 2014. Primary energy consumption was 31.3 Mtoe in 2015, 0.6% below the 2020 energy efficiency target [74]. Final energy consumption reached 27.4 Mtoe being 9.2% above the 2020 energy efficiency target for this indicator. Gross final energy consumption increased during period 2014-2015 by 3% (+816 ktoe) amounting to 28 Mtoe. Energy intensity of the economy stood at 107 toe/Million Eur, 1.4% higher than in 2014. Austria import dependence for all products was 60.7% in 2015. The import dependence ratios are high for petroleum products and gas. Greenhouse gas emissions were only 1.8% (-1.4 Mt CO_2 eq) below the 1990 level, at 78.3 Mt CO_2 eq in 2015. Comparing with year 2005 the emissions dropped by 17%, equal to 2014 ESD target. Energy remained the main source of emissions with a share of 37.3% (29.2 Mt CO_2 eq). In the same year the role of renewable energy in the reduction of GHG emissions reached a net savings of 28.4 Mt CO_2 eq, lower than in 2009 (28.8 Mt CO_2 eq).

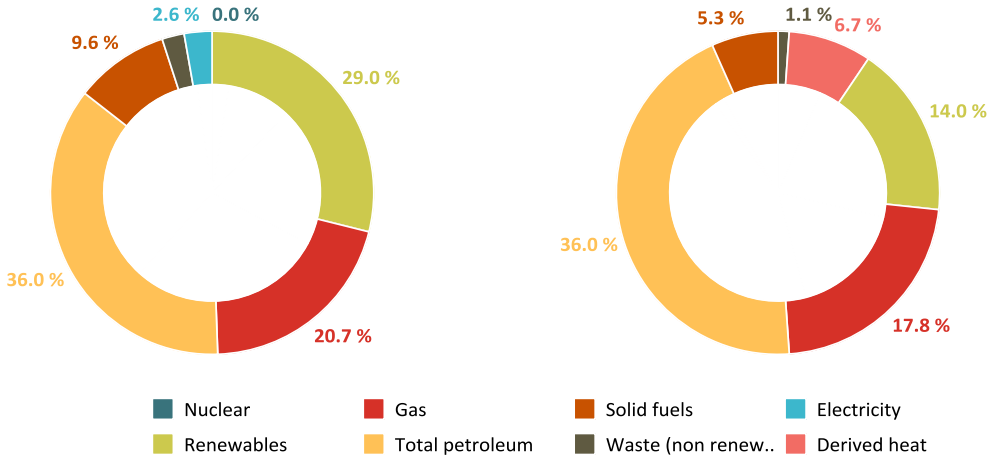


Figure 20. Breakdown of Gross Inland Consumption of Energy (left) - Final Energy Consumption (right) in AT, 2015

20.1 Final renewable energy consumption

The renewable energy [75] consumed in Austria reached 9412.4 ktoe (394 PJ) in 2015 increasing with a CAGR of 3.1% (+2496 ktoe) during period 2005-2015. Renewable energy in electricity had the highest share in final renewable energy consumed in Austria with 46.1%. The share of renewable heat/cold stood at 45.3% whereas in transport sector 8.6% of final renewable energy was used.

Figure 20-1 present the current trend of final renewable energy consumption in Austria and the deviations (in %) from the expected developments during period 2005-2015 as well as the 2020 NREAP plan and EUCO27 projections for 2020 and 2030. As shown in this figure the current development of final renewable energy consumption in Austria was above the plans throughout period 2010 – 2015

Renewable energy consumed in Austria is expected to further increase to 9539 ktoe (399 PJ) until 2020. The contribution of sectors will change in favour of renewable electricity (47.2%). Renewable heat/cold and renewable energy in transport sector will contribute respectively with 43.8% and 9%. The EUCO27 scenario for 2020 is in line with its NREAP projecting a final renewable, at 9472 ktoe (396.6 PJ). For 2030 this projection reveals the final consumption of renewable energy at 10601 ktoe (443.8 PJ).

[74] Austria energy efficiency 2020 targets are 31.5 Mtoe in terms of primary energy consumption and 25.1 Mtoe as final energy consumption.

[75] Final renewable energy (the sum of hydropower, solar, wind, marine, geothermal, biomass and heat pumps) in Austria reached 9231.3 ktoe in 2015, up from 6734.8 ktoe in 2005. Austria reported an updated deployment of renewable energy during period 2010-12 in its 2015 progress report.

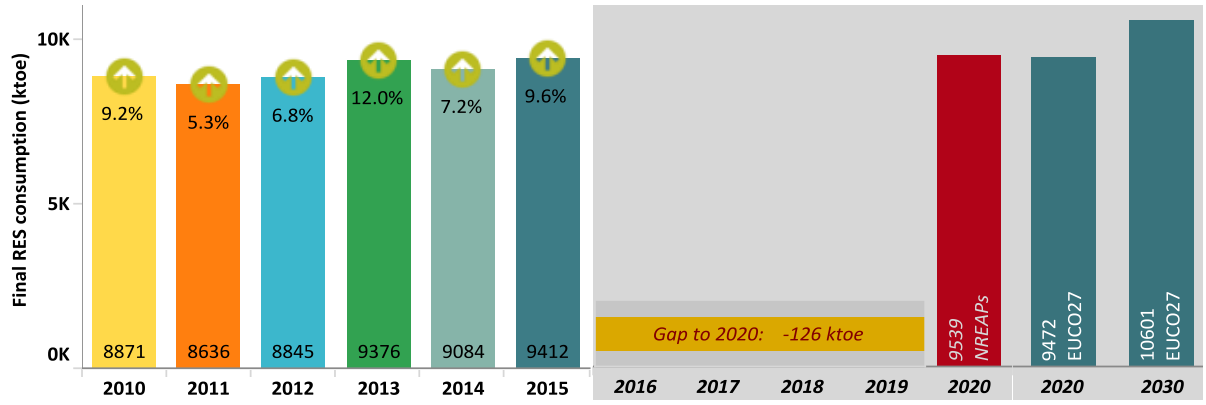


Figure 20 - 1. RES consumption: Trend, Deviation from NREAPs(2010-2015)-Expected RES consumption (2020-2030)

20.2 Renewable energy share

The overall renewable energy contribution in gross final energy consumption in Austria reached 32.8 % in 2014 and 33% in 2015. In 2020 the overall renewable energy share target for Austria is 34.2%. According to the EUCO27 scenario the overall renewable energy share in Austria is projected to reach 35.2% in 2020 and 41% in 2030.

Figure 20-2 shows the current trajectory of overall renewable energy share in Austria the NREAPs trajectory, the Indicative trajectory as well as the Current trend forecast trajectory.

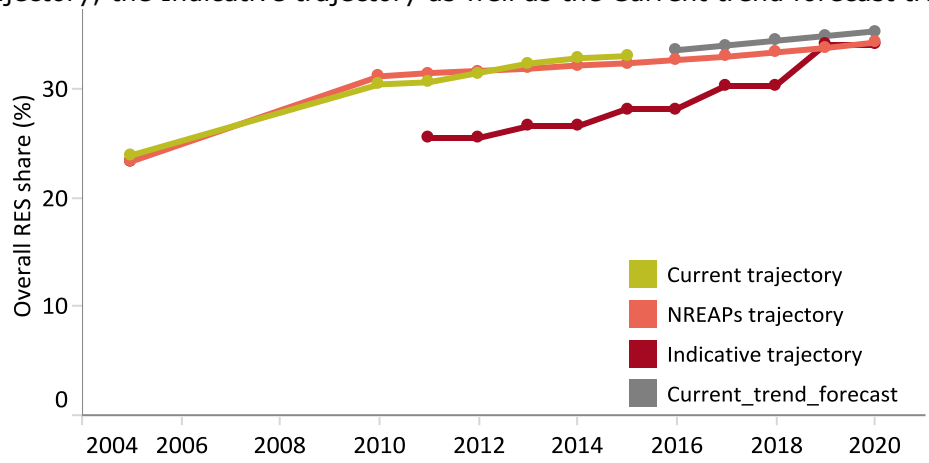


Figure 20 - 2. Overall RES share trajectories in AT: Current, NREAPs and Indicative - Current trend forecast, 2005-20

Overall renewable energy share in Austria followed more or less the NREAP trajectory during 2010-2015. It remained above the indicative trajectory, putting Austria on track to meet the 2020 target.

The development of renewable energy share in heating/cooling sector[76] in Austria reached 32.68% in 2014 remaining almost in this level even in 2015 (32.64%). This development was above the plans only in period 2012-15. The 2020 plan in this sector is foreseen to reach 32.6%.
Renewable energy share in electricity sector reached 70.1% in 2014 and 70.3% in 2015.This development was slower than the NREAP projected throughout period 2010-2015. The 2020 plan is expected to reach 70.6%.

The share of renewable energy in transport sector reached 10.9% in 2014 and 11.4% in 2015 being over the plans throughout period 2010-2015. The 2020 planned share is 11.6%.

[76] In its 2015 Progress report Austria has reported higher shares on the contribution of renewable energy in Heating/Cooling sector. The shares reported for renewable energy contribution in this sector in period 2013-14 were respectively 43.2% and 45.3%.

20.3 Final renewable electricity, heating/cooling and use in transport

Renewable electricity in Austria developed with a CAGR of only 1.9% (+8841 GWh) during period 2005-2015 reaching 50482 GWh (4341 ktoe). This development was found faster than the NREAP one throughout the period 2010-2015. In 2015 hydropower was the main source of renewable electricity with 80% followed by wind with 9.4%, biomass with 8.7%, and solar photovoltaic with 1.9%.

In 2020 renewable electricity in Austria is expected to reach 52378 GWh 8188.6 PJ) in which hydropower will remain the main source of renewable electricity consumption in Austria with 80.4% followed by biomass (9.8%), wind (9.2%) and solar (0.6%).

The EUCO27 scenario for 2020 is in line with Austria NREAP, at 52191 GWh (4488 ktoe) of which hydropower will share 82.4%, wind 8.5%, biomass 6.8% and solar photovoltaic 2.2%. Under this scenario the final renewable electricity in Austria will reach 67470 GWh (5802 ktoe) in 2030. Of this electricity hydropower will share 66.3%, wind 18.2%, solar photovoltaic 9.2% and biomass 6.0%.

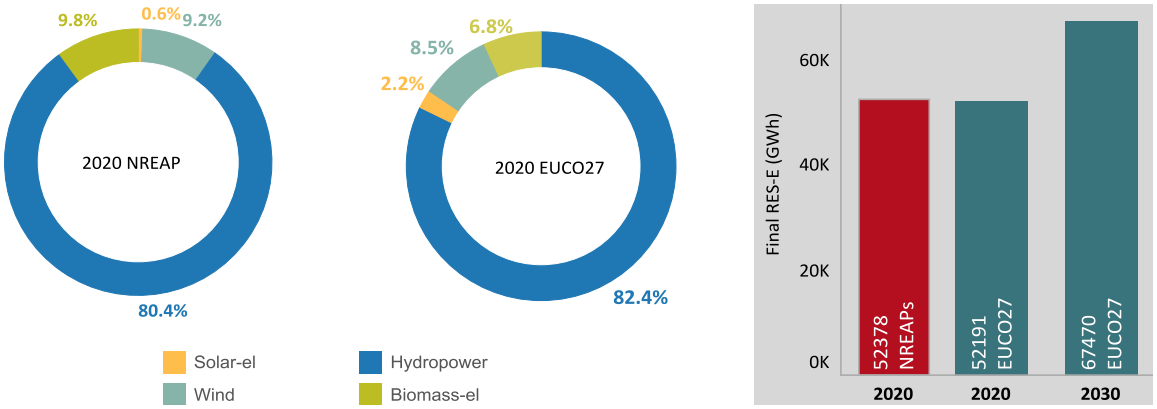


Figure 20 - 3. Final RES Electricity in Austria: NREAP plan (2020) – EUCO27 projections (2020-2030)

Renewable energy in heating/cooling sector increased with a CAGR of 3.2% (+1160 ktoe) between 2005 and 2015 reaching 4263 ktoe (178.5 PJ). This development was over the trend projected in the NREAP throughout period 2010-2015 exceeding since in 2010 the plan for 2020 (4178 ktoe). In 2015 more than 91% of renewable energy was originated from biomass whereas the rest was coming from solar thermal (4.3%), heat pumps (4.1%) and geothermal (0.5%). In 2020 biomass still will remain the main contributor with 86.3% followed by solar thermal with 6.4%, heat pumps with 6.3% and geothermal with 1%.

The use of renewable energy in transport sector increased in 2015 with a CAGR of 13.2% since 2005 reaching the amount of 808.4 ktoe (33.8 PJ). This development was well faster that the plans throughout this period except for year 2013. In 2015 the contribution of renewable energy sources in this sector was as following: biodiesel 70.2%, bioethanol/bio-ETBE 7.2%, renewable electricity 22.5% and other biofuels (0.1%). In 2020 renewable energy consumed in transport sector is expected to reach 856 ktoe (35.8 PJ) in which biodiesel will reach the share of 47.9% followed by renewable electricity (31.8%), other biofuels (11%) and bioethanol/bio-ETBE (9.3%).

Table 20 - 1. Final renewable energy in AT: deviations from NREAP in electricity, heating/cooling and transport

	2010	2011	2012	2013	2014	2015
RES-el (ktoe)	68	48	92	156	181	197
RES-hc (ktoe)	556	371	458	849	343	455
RES-tr (ktoe)	124	15	12	-1	89	176
RES-el (%)	1.7	1.2	2.3	3.9	4.4	4.7
RES-hc (%)	15.2	10.1	12.4	22.7	9.1	11.9
RES-tr (%)	21.9	2.6	2.1	-0.2	14.6	27.9

20.4 Renewable energy technologies/sources

Biomass was the main renewable energy source in Austria with a 46.2% contribution in renewable energy consumed in 2015, followed by hydropower with 37.6%, biofuels with 6.8%, wind with 4.4%, solar with 2.9% and heat pumps with 1.9%. In 2020, the share of biomass in renewable energy mix in Austria is expected to decrease its contribution up to 43.7% while an increase is expected in the contribution of other sources: hydropower (39.1%), biofuels (6.3%), wind (4.5%), solar (3.2%), heat pumps (2.8%) and geothermal (0.4%).

In this section: (i) Figure 20-4 present the current (2009-2015) and NREAP projected trend (2016-2020) of energy from renewable technologies/sources in Austria. The annual increase/decrease (%) of these sources in these two periods is also available in this figure; (ii) Table 20-2 presents how the actual figures reported for renewable technologies/sources in Austria compared with what was planned for the NREAPs. Absolute differences are shown in ktoe.

Biomass in both electricity and heating/cooling sectors progress during period 2005-2015 took place with a CAGR of 3.1% (+1113 ktoe) reaching 4261 ktoe (178.4 PJ). This development was faster than planned exceeding since in 2010 the plan for year 2020 (4049.6 ktoe). Solar technology for electricity and heating/cooling increased with a CAGR of 11.1% (+173 ktoe) between 2005 and 2015 reaching 265.3 ktoe (11.1 PJ). This development was fast enough to surpass the expected NREAP levels throughout period 2010-2015. Geothermal use for energy production in Austria increased with a CAGR of 1.9% (+3.7 ktoe) since 2005 reaching 21 ktoe (0.9 PJ) in 2015. Nevertheless this development was slower than the NREAP projected one throughout period 2011-15. Biofuels use in transport sector increased with a CAGR of 28.6% (+576 ktoe) between 2005 and 2015 reaching 626.5 ktoe (26.2 PJ). The use of biofuels in Austria surpassed the expected NREAP uses throughout period 2010-2015.

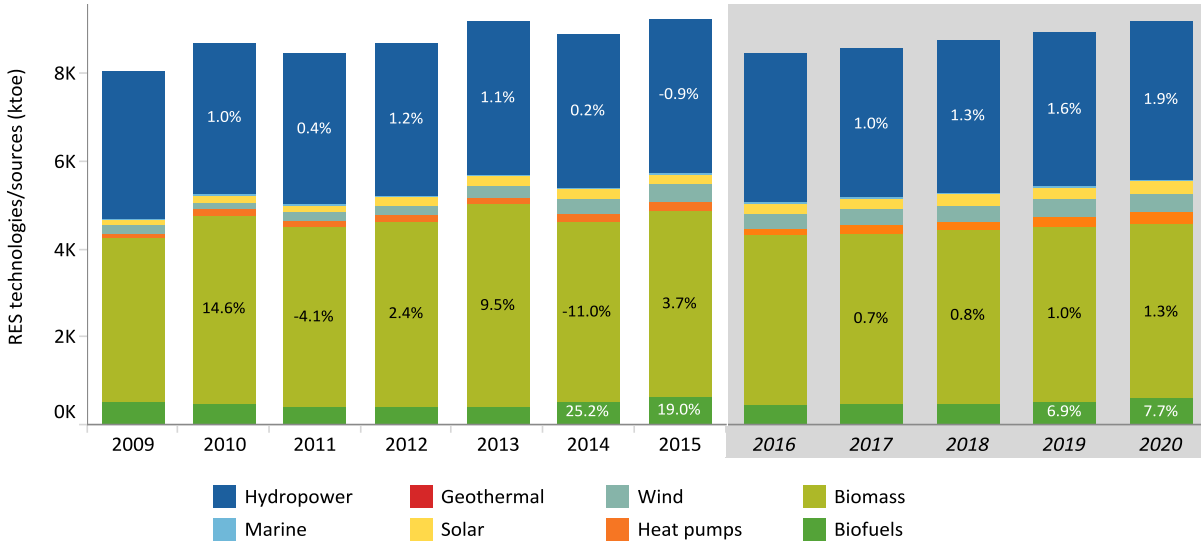


Figure 20 - 4.Annual growth of renewable energy technologies in AT: Current (2009-2015)-NREAP planned 2016-2020

During period 2005-2015 solar photovoltaic deployed with a CAGR of 46.2% (+916 GWh) reaching 937 GWh (81 ktoe). This development was faster than the planned one throughout period 2010-2015 exceeding since in 2012 the plan for year 2020 (306 GWh). Biomass use for electricity in Austria had an increase with a CAGR of 5.5% (+1830 GWh) during period 2005-2015 reaching 4409 GWh (379 ktoe). Nevertheless this development was not fast enough to meet the expected NREAP uses throughout period 2020-15. The development of wind power between 2005 and 2015 resulted with a CAGR of 13.7% (+3423 GWh) reaching 4735 GWh (407). This technology missed the expected NREAP plans only during period 2011-13. Hydropower renewable electricity reached 40408 GWh (3475 ktoe) in 2015 as the result of a slight increase since 2005 with a CAGR of 0.7% (+2682 GWh). This development was found above the expectations throughout period 2010-2015. Geothermal contribution in

electricity sector decreased with a CAGR of -30.5% (-2 GWh) during period 2005-2015 reaching only 0.1 GWh. This technology missed the respective NREAP plans throughout period 2010-2015.

In the heating/cooling sector biomass consumed reached 3881 ktoe (162.5 PJ) in 2015 deploying with a CAGR of 2.9% (+956 ktoe) since 2005. This source had the main role in exceeding the 2020 plan of renewable energy consumed in this sector exceeding since in 2010 the expected plan for 2010 (3607 ktoe. The development of heat pumps in this sector took place with a CAGR of 9.8% (+106 ktoe) during period 2005-2015 reaching 176 ktoe (7.4 PJ). This source was found over the expected NREAP plans throughout period 2010-2015. The heat originated from solar thermal developed since 2005 with a CAGR of 7.4% (+94 ktoe) reaching 184.7 ktoe (7.7 PJ) in 2015. The development of this source was faster than planned throughout period 2010-2015.

Biodiesel progress in transport sector during 2005-2015 took place with a CAGR of 27.3% (+517 ktoe) reaching 567 ktoe (23.8 PJ). This development was found above the NREAP plans throughout period 2010-2015. Bioethanol/bio-ETBE use in this sector reached 58 ktoe (2.4 PJ) in 2015 decreasing with a CAGR of -5.9% (-20.5 ktoe) over the 2010 use. Comparing with the NREAP uses this source missed the plans only during period 2013-15. Renewable electricity in transport sector in Austria reached in 2015 almost the level it had in 2005, 182 ktoe (7.6 PJ) missing the expected uses throughout period 2012-15. The share of renewable electricity used in transport in final renewable electricity in 2015 was 4.2%.

Table 20 - 2. Renewable energy technologies/sources in Austria – deviations from NREAP, 2010-2015, (ktoe)

	2010	2011	2012	2013	2014	2015
Hydropower	90.0	93.4	123.2	148.3	139.1	84.7
Wind	0.1	-32.1	-37.4	-15.3	29.6	82.1
Solar-el	0.3	6.5	19.2	38.8	54.7	66.0
Solar-th	37.8	30.3	29.3	21.7	14.2	3.7
Geothermal-el	-0.1	-0.1	-0.1	-0.1	-0.1	-0.2
Geothermal-th	1.5	-0.8	0.1	-1.0	-6.2	-6.0
Biomass-el	-22.2	-19.8	-12.5	-15.6	-42.3	-35.8
Biomass-th	494.1	309.3	391.1	783.6	288.8	418.4
Heat pumps	22.8	32.7	37.8	44.4	45.9	38.6
Biodiesel	140.4	63.4	70.1	72.4	170.3	258.4
Bioethanol	24.8	8.8	10.9	0.0	-2.5	-2.7
Renewable electricity	21.4	6.5	-4.0	-6.6	-11.1	-9.1

20.5 Renewable electricity installed capacity

Renewable electricity installed capacity in Austria has gone up with a CAGR of 2.6% (+2872 MW) between 2005 and 2015 reaching 12735 MW. In 2015 hydropower contribution reached 63.8% followed by wind with 19.5%, biomass with 9.3%, and solar photovoltaic with 7.4%.

Figure 20-5 present the current trend of renewable electricity installed capacity in Austria, the deviations (in %) from the expected developments during period 2005-2015, the 2020 NREAP plan and EUCO27 scenario projections for 2020 and 2030. As shown in this figure the installed capacity in Austria surpassed the foreseen NREAP plans throughout period 2010-2015.

Solar photovoltaic capacity increased with a CAGR of 41% (+907 MW) during period 2005-14 reaching 937 MW. This technology exceeded since in 2012 the plan for year 2020, being almost threefold of this plan in 2015. Wind capacity increased with a CAGR of 12.3% (+1711 MW) since 2005 reaching 2489 MW in 2015. The development was fast enough to surpass the expected NREAP ones only in period 2013-15. Biomass installed capacity reached 1188 MW in 2015 decreasing with a CAGR of 1.5% (-198 MW) since 2005. This development was fast enough to exceed the plans throughout period 2010-2013 but not for period 2014-2015. Hydropower capacity increased with a CAGR of only 0.6% (+453 MW) between 2005 and

2015 reaching 8120 MW. These capacities were found to be under the expected hydropower capacities throughout period 2010-2015. Geothermal capacity development between 2005 and 2015 follow the NREAP projected one remaining in the level of 1 MW of baseline year.

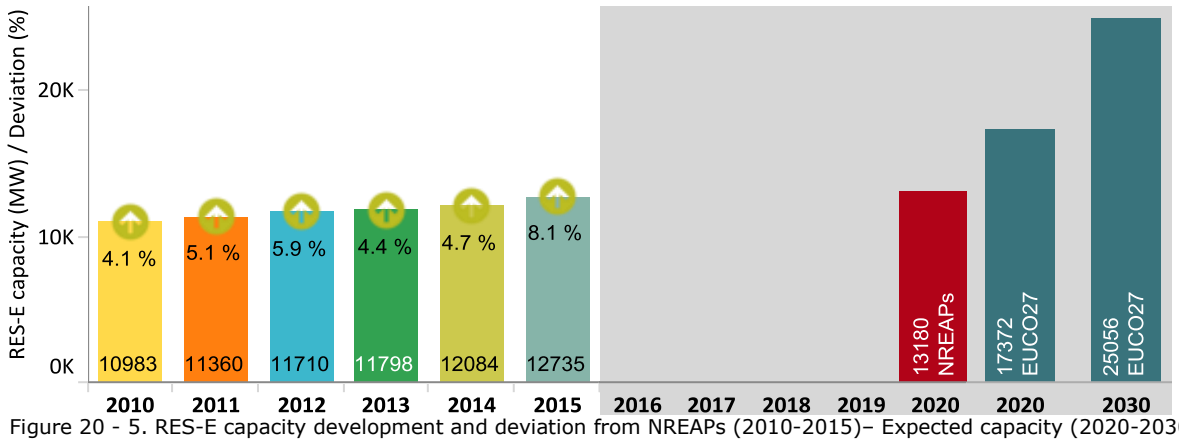


Figure 20 - 5. RES-E capacity development and deviation from NREAPs (2010-2015)– Expected capacity (2020-2030)

In 2020 Austria has planned an installed capacity from renewables at 13180 MW in which hydropower will share 68%; biomass and solar respectively 9.7% and 2.4% while wind 19.6%.

The EUCO27 projection for 2020 is larger than the NREAP plan, at 17372 MW, keeping hydropower as the main source. According to this projection Austria is expected to have installed 25056 MW of renewable electricity in 2030.

21. Poland

In 2015 more than half of energy mix in Poland is solid fuels whereas the share of renewables was 9.4% (Figure 21). In 2015 gross inland consumption of energy in Poland totalled to 95.4 Mtoe, 1.2% (+767 ktoe) higher than the consumption in 2014. Primary energy consumption was 90 Mtoe in 2015, 6.6% below the 2020 energy efficiency target[77]. Final energy consumption reached 62.3 Mtoe being 13% below the 2020 energy efficiency target for this indicator. Gross final energy consumption increased during period 2014-2015 by 1.4% (+924 ktoe) amounting to 65.2 Mtoe. Energy intensity of the economy continued to decrease reaching 227 toe/Million Eur. Although in an increasing trend, Poland has a low import dependence rate at 29.3% due to the domestic solid fuels presence. The import dependence for petroleum and gas is relatively high respectively 96.8% and 76.2%. Greenhouse gas emissions continued to decline at 381.7 Mt CO_2 eq in 2014, 19.4% below the emissions in 1990. These emissions decreased between 2005 and 2014 by -4%, more than the 2014 ESD target (9.8%) Energy remained the main source of emissions with a share of 69.3% (265 Mt CO_2 eq). In the same year the role of renewable energy in the reduction of GHG emissions reached a net savings of 34.4 Mt CO_2 eq, an additional of 10.6 Mt CO_2 since 2009.

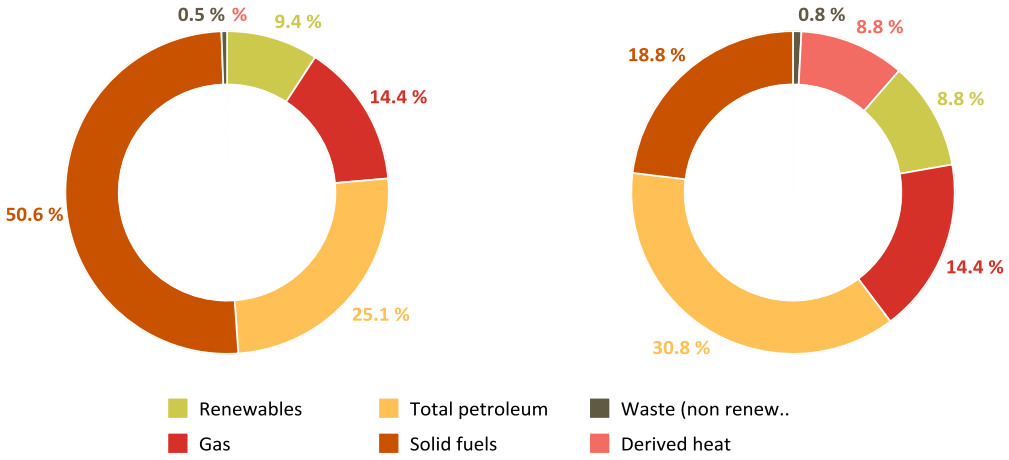


Figure 21. Breakdown of Gross Inland Consumption of Energy (left) - Final Energy Consumption (right) in PL, 2015

21.1 Final renewable energy consumption

Final renewable energy consumption in Poland reached 7749 ktoe (324.4 PJ) in 2015 developing with a CAGR of 6.1% (+3451 ktoe) since 2005. Renewable energy in heating/cooling sector had a contribution of 64.6% whereas electricity and transport followed with 24.4% and 10.9%.

Figure 21-1 present the current trend of final renewable energy consumption in Poland and the deviations (in %) from the expected developments during period 2005-2015 as well as the 2020 NREAP plan and EUCO27 projections for 2020 and 2030. As shown in this figure the current development of final renewable energy consumption in Poland was above the plans throughout period 2010 – 2015.

Renewable energy consumed in Poland is expected to further increase to 10666 ktoe (446.6 PJ) until 2020. The contribution of renewable energy in transport sector is expected to reach 18.8% and the renewable heat/cold and electricity will contribute respectively with 55.5% and 25.7%. The EUCO27 scenario has projected a slightly higher final renewable consumption in Poland for, at 11494 ktoe (481 PJ), compared with its NREAP. For 2030 this scenario projects a final consumption of renewable energy at 15707 ktoe (657.6 PJ).

[77] Poland energy efficiency 2020 targets are 96.4 Mtoe in terms of primary energy consumption and 76.4 Mtoe as final energy consumption.

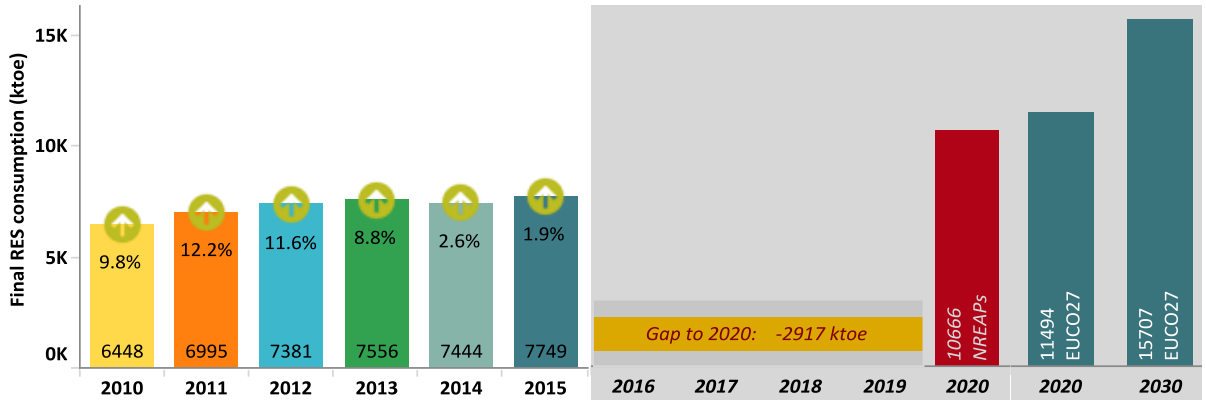


Figure 21 - 1. RES consumption: Trend, Deviation from NREAPs(2010-2015)-Expected RES consumption (2020-2030)

21.2 Renewable energy share

The overall renewable energy contribution in gross final energy consumption in Poland reached 11.5% in 2014 and 11.8% in 2015. The 2020 target that Poland has to reach for the overall renewable energy share is 15.85%. According to the EUCO27 scenario the overall renewable energy share in Poland is projected to reach 15.1% in 2020 and 20.2% in 2030.

Figure 21-2 shows the current trajectory of overall renewable energy share in Poland, the NREAPs trajectory, the Indicative trajectory as well as the Current trend forecast trajectory.

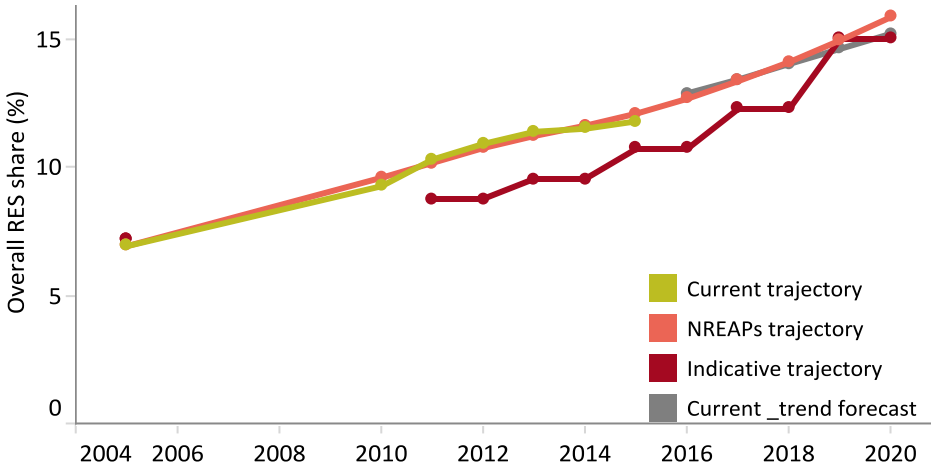


Figure 21 - 2. Overall RES share trajectories in PL: Current, NREAPs and Indicative - Current trend forecast, 2005-20

Overall renewable energy share in Poland remained more or less in line with the NREAP trajectory but above the indicative trajectory throughout 2010-2015. Further efforts might be needed since the growth in the electricity and transport sectors is slower than planned.

The share of renewable energy in heating/cooling sector reached 14% in 2014 and 14.3% in 2015. This indicator remained above the planned trend for this sector throughout period 2011-15. The 2020 plan for this sector is set to 17.1%.

The share of renewable electricity reached 12.4% in 2014 and 13.4% in 2015. This development was faster than planned only in year 2012 and period 2014-2015. The 2020 plan for renewable electricity is set to 19.1%.

In transport sector the share of renewable energy reached 6.2% in 2014 and 6.4% in 2015 being nevertheless under the expected shares during period 2012-15. The 2020 plan of renewable energy in transport sector in Poland is set to 11.4%.

21.3 Final renewable electricity, heating/cooling and use in transport

Renewable electricity consumption in Poland amounted to 22030 GWh (1894 ktoe) in 2015 increasing with a CAGR of 19% (+18173 GWh) during period 2005-2015. The development of renewable electricity in Poland was faster than planned in the NREAP for period 2011-15. In 2015 biomass covered 45.1% of final renewable electricity in Poland followed from wind (44%), hydropower (10.7%) and solar photovoltaic (0.3%). In 2020 the renewable electricity consumption in Poland is expected to amount to 31850 GWh (2739 ktoe) in which wind technology is expected to reach a share of 46% followed by biomass with 44.6% and the rest will be hydropower with 9.3%.

The EUCO27 scenario for 2020 is broadly in line with Poland NREAP, regarding the contributions of renewable energy technologies/sources even that a lower final renewable electricity is projected, at 25380 GWh (2183 ktoe). Of this electricity wind and biomass will share 45.1% each, hydropower 9.6% and solar photovoltaic 0.3%. Under this scenario the final renewable electricity in Poland will reach 51412 GWh (4421 ktoe) in 2030 of which wind will share 59.5%, biomass 34.9%, hydropower 5.4% and solar photovoltaic 0.2%.

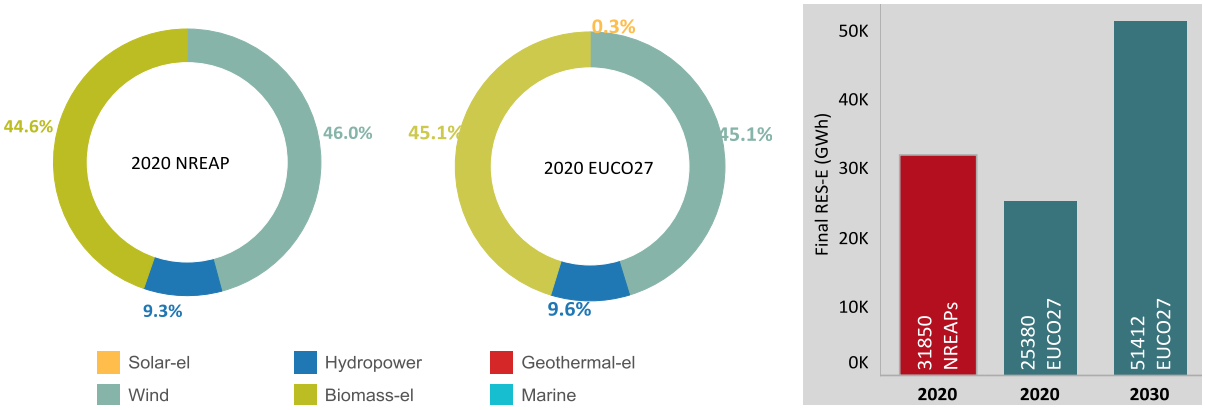


Figure 21 - 3. Final RES Electricity in Poland: NREAP plan (2020) – EUCO27 projections (2020-2030)

Renewable energy in heating/cooling in Poland reached 5007 ktoe (210 PJ) in 2015 increasing with a CAGR of 2.6% (+1139 ktoe). The use of renewable energy in this sector was over the expected NREAP levels during all period 2010-2015. In 2015 almost all heat produced in Poland was coming from biomass, 98.2%. Only 0.9% was coming from solar and the rest was geothermal (0.4%) and heat pumps (0.5%). In 2020 the Poland expected to get 5921 ktoe (247.9 PJ) energy in form of heat from the use of renewable energy in this sector in which the contribution of biomass will be at 85.9%, solar thermal at 8.5%, geothermal at 3% and heat pumps at 2.5%.

Renewable energy in transport amounted to 848 ktoe (35.5 PJ) in 2015, developing with a CAGR of 24% (+749 ktoe) during period 2005-2015. Nevertheless this use was under the NREAP plans throughout period 2010-2015. In 2015 the use of biodiesel in transport sector had a share of 73.9% followed by bioethanol/bio-ETBE with 18.1% and renewable electricity with 8%. The use of renewable energy in transport sector in 2020 is expected to be 2006 ktoe (84 PJ) in which biodiesel will still remain the main source with 72.3% followed by bioethanol/bio-ETBE with 22.5%, other biofuels with 3.3% and renewable electricity with 1.9%.

Table 21 - 1. Final renewable energy in PL: deviations from NREAP in electricity, heating/cooling and transport

	2010	2011	2012	2013	2014	2015
RES-el (ktoe)	-23	18	183	60	146	200
RES-hc (ktoe)	662	844	886	1,001	595	475
RES-tr (ktoe)	-65	-101	-301	-449	-550	-528
RES-el (%)	-2.5	1.6	14.4	4.2	9.3	11.8
RES-hc (%)	16.6	20.7	21.2	23.4	13.6	10.5
RES-tr (%)	-6.6	-9.5	-25.9	-35.7	-41.8	-38.4

21.4 Renewable energy technologies/sources

In 2015 biomass was the main renewable energy source in Poland with a contribution of 75.1%, followed by wind with 10.8%, biofuels with 10.2%, hydropower with 2.6%, solar with 0.6%, geothermal and heat pumps with 0.3% each. In 2020, the contribution of biomass in final renewable energy is expected to decrease up to 59.4% followed by biofuels (18.5%), wind (11.9%), solar (4.8%), hydropower (2.4%), geothermal (1.7%) and heat pumps (1.4%).

In this section: (i) Figure 21-4 present the current (2009-2015) and NREAP projected trend (2016-2020) of energy from renewable technologies/sources in Poland. The annual increase/decrease (%) of these sources in these two periods is also available in this figure; (ii) Table 21-2 presents how the actual figures reported for renewable technologies/sources in Poland compared with what was planned for the NREAPs. Absolute differences are shown in ktoe.

Solar technology developed with a CAGR of 79.5% (+49.7 ktoe) between 2005 and 2015 reaching 49.9 ktoe (2.1 PJ) in 2015. Nevertheless this development was well under the expected NREAP developments throughout period 2010-2015. Biomass use for energy purposes reached 5768 ktoe (241.5 PJ) in 2015 increased with a CAGR of 3.8% (+1782 ktoe since 2005. Comparing with expected NREAP levels this development was over throughout period 2010-2015. The development of biofuels between 2005 and 2015 took place with a CAGR of 31.8% (+731 ktoe) reaching 780.3 ktoe (32.7 PJ). Nevertheless in comparison with expected NREAP use this source in Poland was found to be under throughout period 2010-2015.

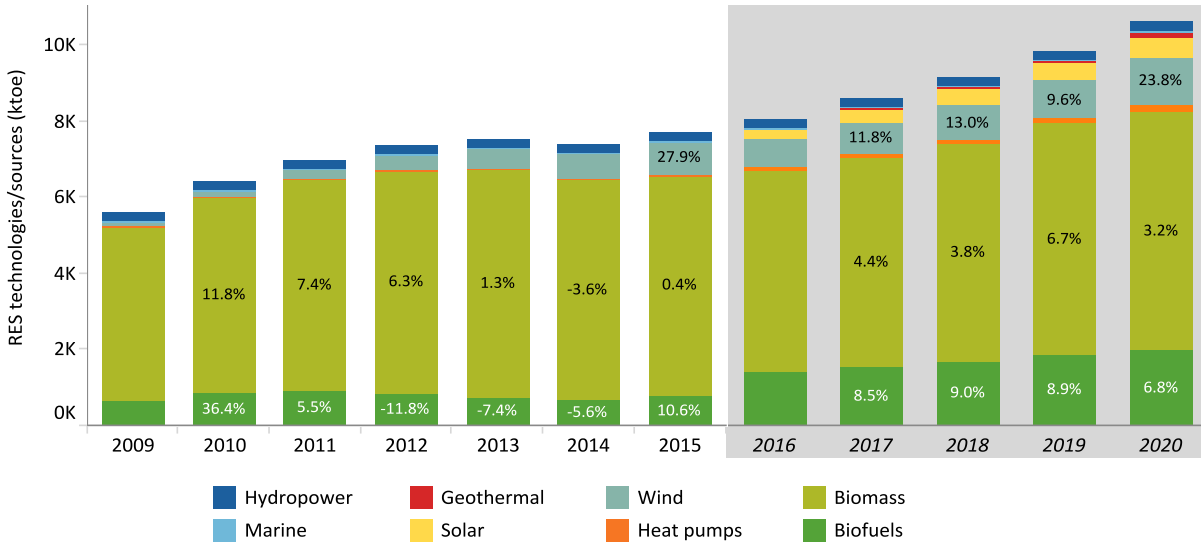


Figure 21 - 4. Annual growth of renewable energy technologies in PL: Current (2009-2015)-NREAP planned 2016-2020

Wind technology contribution reached 9687 GWh (833 ktoe) in 2015 increasing with a CAGR of 47.2% (+9484 GWh) since 2005. This development was faster than planned only in period 2012-15. Between 2005 and 2015 biomass contribution reached 9933 GWh (854 ktoe) increasing with a CAGR of 20.7% (+8422 GWh). The development of this source was faster than planned in the NREAPs throughout period 2010-2015 except for year 2013. Renewable electricity coming from solar photovoltaic reached 57 GWh (4.9 ktoe) in 2015 increasing with a CAGR of 324% (+56.5 GWh) during period 2011-15. Nevertheless this development was slower than planned during period 2011-12. In 2013 it met the NREAP plan and surpassed it in 2014 exceeding also the low 2020 contribution of 3 GWh (0.3 ktoe). Hydropower technology reached 2353 GWh (202 ktoe) in 2015 increasing slightly between 2005 and 2015 with a CAGR of 0.94% (+210 GWh). This technology surpassed the NREAP plans only during period 2010-12.

Biomass use for heating/cooling developed with a CAGR of 2.5% (+1058 ktoe) between 2005 and 2015 reaching 4914 ktoe (206 PJ). This development was faster than the one projected in the NREAP throughout period 2010-2015. Geothermal technology increased with a CAGR of 6.7% (+10 ktoe) during period 2005-2015 reaching 21.7 ktoe (0.9 PJ). Nevertheless this development was not fast enough to surpass the NREAP plans during period 2010-2015. Solar thermal reached only 45 ktoe (0.9 PJ) in 2015 increasing with a CAGR of 77.7% (+44.9 ktoe) since 2005. This technology deployed slower than what was planned in the NREAP throughout period 2010-2015. Between 2010 and 2015 the development of heat coming from heat pumps took place with a CAGR of 21% (+15.8 ktoe) reaching 25.7 ktoe (1.1 PJ). This development was slower than planned throughout period 2010-2015.

Biodiesel use in transport sector increased with a CAGR of 45% (+611 ktoe) during period 2005-2015 reaching 627 ktoe (26.2 PJ) in 2015. Despite of this increase biodiesel use remained under the plans throughout period 2011-15. Bioethanol/bio-ETBE reached 153 ktoe (6.4 PJ) in 2015 increasing its use with a CAGR of 16.3% (+120 ktoe) since 2005. Nevertheless this increase was not enough to surpass the expected development projected in the NREAP missing the respective plans throughout period 2010-2015. Even than planned no other biofuels (biogas and vegetable oils) were used in Poland in period 2010-2015. Even than planned, Poland didn't report on the use of Annex IX biofuels during period 2010-2015. Renewable electricity contribution in this sector reached 68 ktoe (2.8 PJ) in 2015, increasing with a CAGR of 3.2% (+18 ktoe) since 2005. This development was fast enough to surpass the expected uses throughout period 2010-2015. In 2015 only 0.5% of final renewable electricity in Poland is used in transport sector.

Table 21 - 2. Renewable energy technologies/sources in Poland – deviations from NREAP, 2010-2015, (ktoe)

	2010	2011	2012	2013	2014	2015
Hydropower	6	5	2	-1	-3	-7
Wind	-52	-29	18	74	103	199
Solar-el	0	0	0	0	0	5
Solar-th	-11	-33	-68	-82	-79	-131
Geothermal-th	-10	-11	-13	-16	-23	-35
Biomass-el	24	42	164	-13	46	3
Biomass-th	697	911	996	1,135	735	687
Heat pumps	-15	-23	-29	-35	-38	-46
Biodiesel	11	0	-166	-288	-385	-366
Bioethanol	-109	-138	-170	-186	-190	-181
Other biofuels	0	0	0	-13	-13	-26
Renewable electricity	34	37	35	39	39	45

21.5 Renewable electricity installed capacity

The renewable electricity installed capacity in Poland reached 6538 MW in 2015 increasing with a CAGR of 24.7% (+5820 MW) since 2005. In 2015 wind covered 75% of final renewable electricity installed capacity followed by biomass with 14%, hydropower with 9% and solar 2%.

Figure 21-5 present the current trend of renewable electricity installed capacity in Poland, the deviations (in %) from the expected developments during period 2005-2015, the 2020 NREAP plan and EUCO27 scenario projections for 2020 and 2030. As shown in this figure the installed capacity in Poland surpassed the expected NREAP plans only throughout period 2012-2015.

Wind technology capacity reached 4886 MW in 2015 increasing with a CAGR of 44.7% (+4765 MW) since 2005. Comparing with expected installed capacities this technology was found over the plans throughout period 2010-2015. Biomass installed capacity experienced an increase with a CAGR of 33% (+901 MW) between 2005 and 2015 reaching 966 MW. Nevertheless this development was not enough to meet the expected NREAP levels throughout period 2010-2015. Solar photovoltaic met the 2013 plan of 2 MW installed

capacity whereas in 2015 it increased to 108 MW, 36 times-fold the plan of 2020 (3 MW). Hydropower capacities reached 588 MW in 2015 increasing with a CAGR of only 0.8% (+46 MW) from 2005 capacity. This increase was not enough to put the installed capacity of this technology over the expected NREAP capacities throughout period 2010-2015.

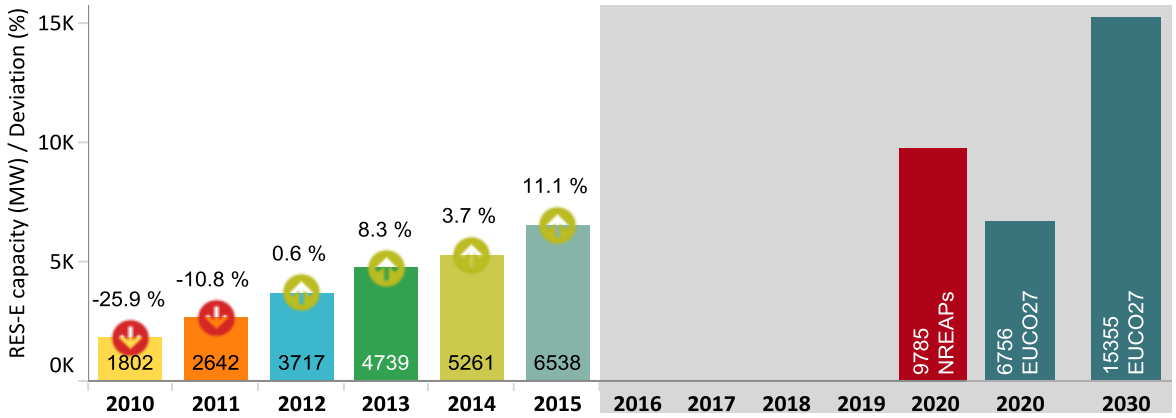
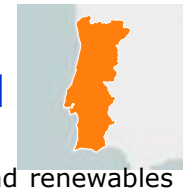


Figure 21 - 5. RES-E capacity development and deviation from NREAPs (2010-2015)– Expected capacity (2020-2030)

In 2020 Poland has planned to reach an installed capacity from renewables at 9785 MW in which wind power will share 62.3% followed by biomass with 25.9% and hydropower with 11.8%. The development of solar photovoltaic beyond the plans will change the relative contributions of renewable technologies/sources within the expected installed capacity for 2020.

The EUCO27 projection for 2020 is much lower than what is planned in the NREAP, at 6756 MW, but reflecting the current share of solar photovoltaic capacity. According to this projection Poland is expected to have installed 15355 MW of renewable electricity in 2030.

22. Portugal



Petroleum products and renewables shared more than two-thirds of Portugal's energy mixes in 2015 (Figure 22). Renewables overcome both relative contributions of gas and solid fuels in Portugal's energy mix. In 2015 gross inland consumption of energy in Portugal totalled to 23 Mtoe, 4.1% (+912 ktoe) higher than the consumption in 2014. Primary energy consumption was 21.7 Mtoe in 2015, 3.6% below the 2020 energy efficiency target[78]. Final energy consumption reached 16 Mtoe being 8% below the 2020 energy efficiency target for this indicator. Gross final energy consumption increased during period 2014-2015 by 1.2% (+188 ktoe) amounting to 16.4 Mtoe. Energy intensity of the economy remained almost unchanged since 2010; at 134 toe/Million Eur. Import dependence ratio for all products was 77.4% in 2015. Portugal had a share of near or equal to 100% for gas, petrol and solid fuels. Greenhouse gas emissions reached 67.5 Mt CO_2 eq in 2014, 8.7% higher than in 1990. Nevertheless Portugal decreased these emissions by 25% between 2005 and 2014, a higher decrease than the 2014 ESD target (-2.26%). Energy remained the main source of emissions with a share of 42% (28.3 Mt CO_2 eq). In the same year the role of renewable energy in the reduction of GHG emissions reached a net savings of 12.7 Mt CO_2 eq, an additional of 4.7 Mt CO_2 since 2009.

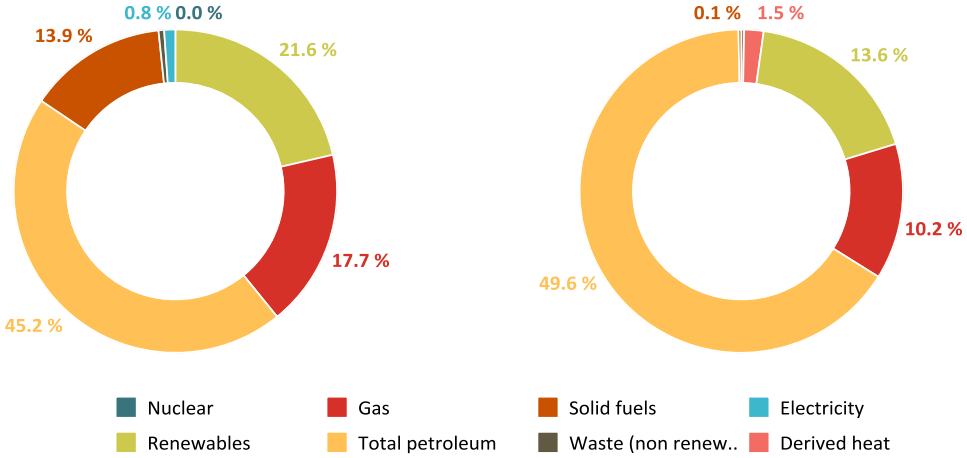


Figure 22. Breakdown of Gross Inland Consumption of Energy (left) - Final Energy Consumption (right) in PT, 2015

22.1 Final renewable energy consumption

Final renewable energy consumed in Portugal developed with a CAGR of only 1.9% (+801 ktoe) over period 2005-2015 reaching 4603 ktoe (192.7 PJ). Almost 53% of renewable energy consumed in Portugal was coming from electricity sector whereas the contributions of two other sectors heating/cooling and transport were respectively 40% and 7.4%.

Figure 22-1 present the current trend of final renewable energy consumption in Portugal and the deviations (in %) from the expected developments during period 2005-2015 as well as the 2020 NREAP plan and EUCO27 projections for 2020 and 2030. As shown in this figure the current development of final renewable energy consumption in Portugal was below the plans throughout period 2011 – 2015.

Renewable energy consumed in Portugal is expected to further increase to 6102.3 ktoe (255.5 PJ) until 2020. Electricity sector will remain the main source of final renewable energy in Portugal with 50.2% in contribution followed by heating/cooling with 41.1% and transport with 8.8%.
The EUCO27 scenario has projected a lower final renewable consumption in Portugal for 2020, at 5833 ktoe (244 PJ), compared with its NREAP. For 2030 this projection reveals the final consumption of renewable energy at 6851 ktoe (286.8 PJ).

[78] Portugal energy efficiency 2020 targets are 22.5 Mtoe in terms of primary energy consumption and 17.4 Mtoe as final energy consumption.

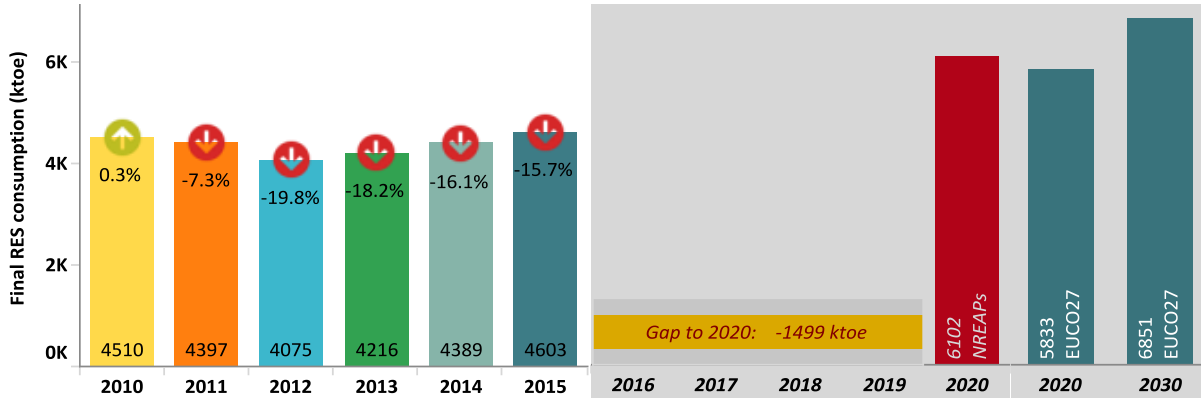


Figure 22 - 1. RES consumption: Trend, Deviation from NREAPs(2010-2015)-Expected RES consumption (2020-2030)

22.2 Renewable energy share

The overall renewable energy contribution in gross final energy consumption in Portugal reached 27% in 2014 and 28% in 2015. The 2020 target that Portugal has to reach for the overall renewable energy share is 31%. According to the EUCO27 scenario the overall renewable energy share in Portugal is projected to reach 33.4% in 2020 and 41.8% in 2030.

Figure 22-2 shows the current trajectory of overall renewable energy share in Portugal, the NREAPs trajectory, the Indicative trajectory as well as the Current trend forecast trajectory.

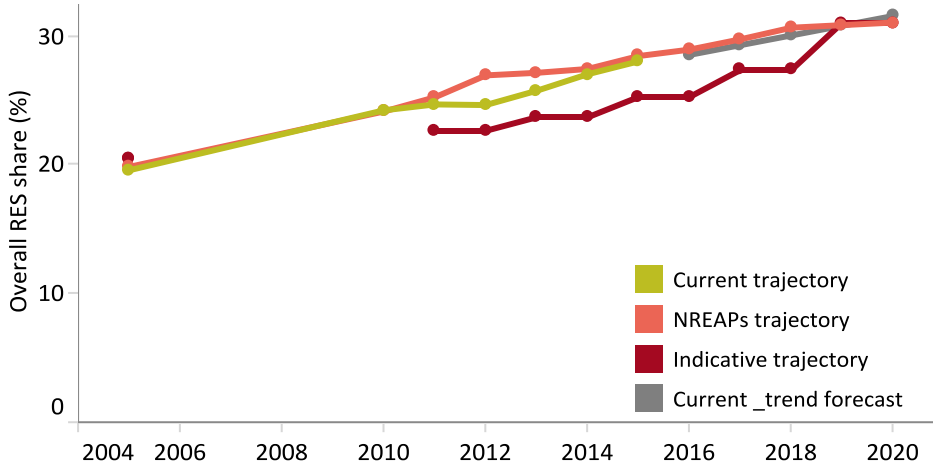


Figure 22 - 2. Overall RES share trajectories in PT: Current, NREAPs and Indicative - Current trend forecast, 2005-20

Overall renewable energy share in Portugal remained under the NREAP trajectory but above the indicative trajectory throughout 2010-2015. Use of renewables in the electricity and transport sectors developed slower than expected. Additional efforts might be required to maintain the trend achieved in 2014 and 2015 to stay on course for the 2020 target.

Portugal has planned to decrease the overall RES share in heating/cooling sector between 2005 and 2020. The share of renewable energy in this sector followed an increasing trend since 2005 reaching 34% in 2014 and 33.4% in 2015 above the 2020 plan of 30.6%.

Renewable energy share in electricity sector reached 52.08% in 2014 and 52.6% in 2015. The development of renewable electricity share in Portugal was faster than planned only in year 2011 and in period 2014-2015. The 2020 planned share in this sector is 55.3%.

The development of renewable energy share in transport sector reached 3.7% in 2014 and 7.4% in 2015 after a period with a very slow development. Despite of this fast increase this indicator remained below the plans throughout period 2010-2015. The 2020 planned share in this sector is 10%.

22.3 Final renewable electricity, heating/cooling and use in transport

Renewable electricity consumption in Portugal has gone up with a CAGR of 6.7% (+13.5 TWh) between 2005 and 2015 reaching 28.2 TWh (2423 ktoe). The deployment of renewable electricity in Portugal was faster than planned only in period 2010-2011. In other years of period 2010-2015 Portugal didn't fulfil the NREAP plans. In 2015 hydropower shared 42.8% followed by wind (42.6%), biomass (11%), solar photovoltaic (2.8%) and geothermal (0.7%). In 2020 renewable electricity consumption in Portugal is expected to amount to 35.6 TWh (3060 ktoe) in which wind will be the main source with 41% followed by hydropower (39.5%), biomass (9.9%), solar (7.0%), geothermal (1.4%) and marine (1.2%).

The EUCO27 scenario for 2020 is in line with Portugal NREAP, at 34.2 TWh (2940 ktoe), but it is projecting different contributions of renewable energy technologies/sources in this sector: hydropower is projected at 54.3%, wind at 34.4%, biomass at 9% and solar photovoltaic at 2.3%. Under this scenario has projected that renewable electricity in Portugal will reach 45.6 TWh (4011 ktoe) in 2030 in which the share of wind will be at 41.8%, hydropower at 40.5%, solar photovoltaic at 10.7% and biomass at 7.1%.

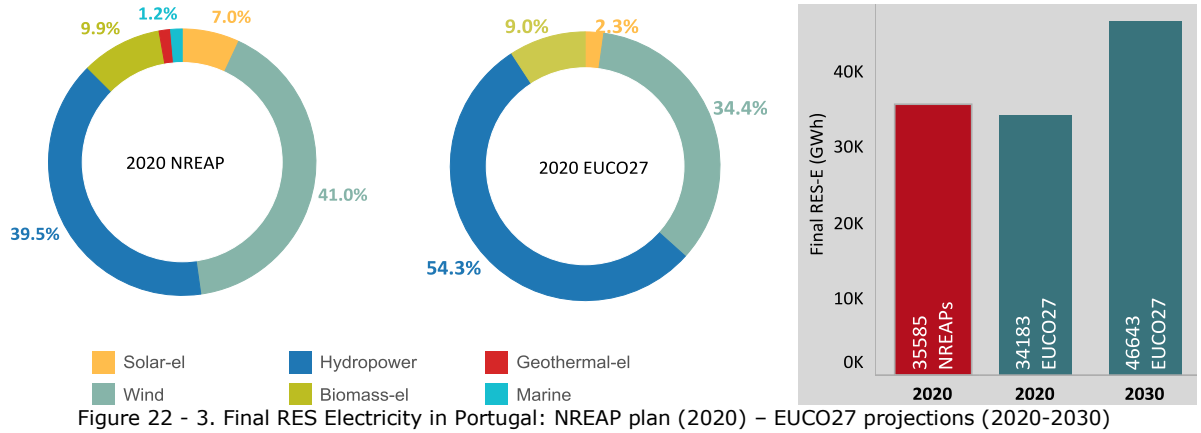


Figure 22 - 3. Final RES Electricity in Portugal: NREAP plan (2020) – EUCO27 projections (2020-2030)

Renewable energy in heating/cooling sector decreased with a CAGR of -3.1% (-690 ktoe) during period 2005-2015 reaching 1839 ktoe (77 PJ). This decrease was higher than planned in the Portugal NREAP throughout period 2011-15. In 2015 biomass was the main source of renewable heat/cold with 95.5% whereas solar thermal and geothermal shared respectively 4.4% and 0.1%. In 2020 the heat production from renewable energy sources in Portugal is expected to reach 2507 ktoe (105.0 PJ) in which biomass will still remain the main source with a share of 92.6%. The share of solar thermal is expected to be increased up to 6.4% and geothermal only to 1%.

Transport sector developed the renewable energy with a CAGR of 40.8% (+330 ktoe) during period 2005-2015 reaching 341 ktoe (14.3 PJ). Nevertheless this development missed the NREAP plans all over period 2011-15. In 2015 biodiesel use shared 88.7% of contribution followed by bioethanol/bio-ETBE (6.5%), renewable electricity (3.8%) and other biofuels (0.9%). The use of renewable energy in transport sector in 2020 is expected to be 538 ktoe (22.4 PJ) in which biodiesel will contribute with 84.1% followed by renewable electricity with 10.8% and bioethanol/bio-ETBE with 5.1%.

Table 22 - 1. Final renewable energy in PT: deviations from NREAP in electricity, heating/cooling and transport

	2010	2011	2012	2013	2014	2015
RES-el (ktoe)	13	59	-146	-118	-72	-108
RES-hc (ktoe)	-21	-115	-568	-504	-595	-623
RES-tr (ktoe)	22	-289	-291	-315	-178	-125
RES-el (%)	0.6	2.8	-6.3	-5.0	-2.9	-4.3
RES-hc (%)	-1.0	-4.9	-23.3	-20.6	-24.3	-25.3
RES-tr (%)	7.3	-94.4	-94.1	-93.7	-52.1	-26.9

22.4 Renewable energy technologies/sources

In 2015 more than 44% of renewable energy in Portugal was coming from biomass followed by hydropower with 22.6%, wind with 22.5%, wind with 10.8%, biofuels with 7.1%, solar with 3.2% and geothermal with 0.4%. In 2020, the share of biomass in final renewable energy is expected to decrease up to 43.4%, followed by wind with 20.8%, hydropower with 20%, biofuels with 7.9%, solar with 6.2%, geothermal with 1.1% and marine energy with 0.6%.

In this section: (i) Figure 22-4 present the current (2009-2015) and NREAP projected trend (2016-2020) of energy from renewable technologies/sources in Portugal. The annual increase/decrease (%) of these sources in these two periods is also available in this Figure; (ii) Table 22-2 presents how the actual figures reported for renewable technologies/sources in Portugal compared with what was planned for the NREAPs. Absolute differences are shown in ktoe.

Solar technology developed with a CAGR of 23.2% (+126 ktoe) during period 2005 and 2015 reaching 148.7 ktoe (6.2 PJ). Nevertheless this technology missed the plans throughout period 2010-2015. Geothermal technology reached 19 ktoe (0.8 PJ) in 2015 increasing with a CAGR of 11.6% (+11.9 ktoe) since year 2005. This technology missed to meet the expected NREAP levels throughout period 2010-2015. Biomass was the renewable energy source that decreased during period 2005-2015 with a CAGR of -2.9% (-625.5 ktoe) reaching 2024 ktoe (84.8 PJ). Because of this decrease this technology missed the expected NREAP levels throughout period 2011-15. Biofuels use in transport sector reached 327 ktoe (6.34 PJ) in 2015 after a significant decrease during period 2011-13. Comparing with the expected NREAP plans, Portugal uses less biofuels throughout period 2011-15.

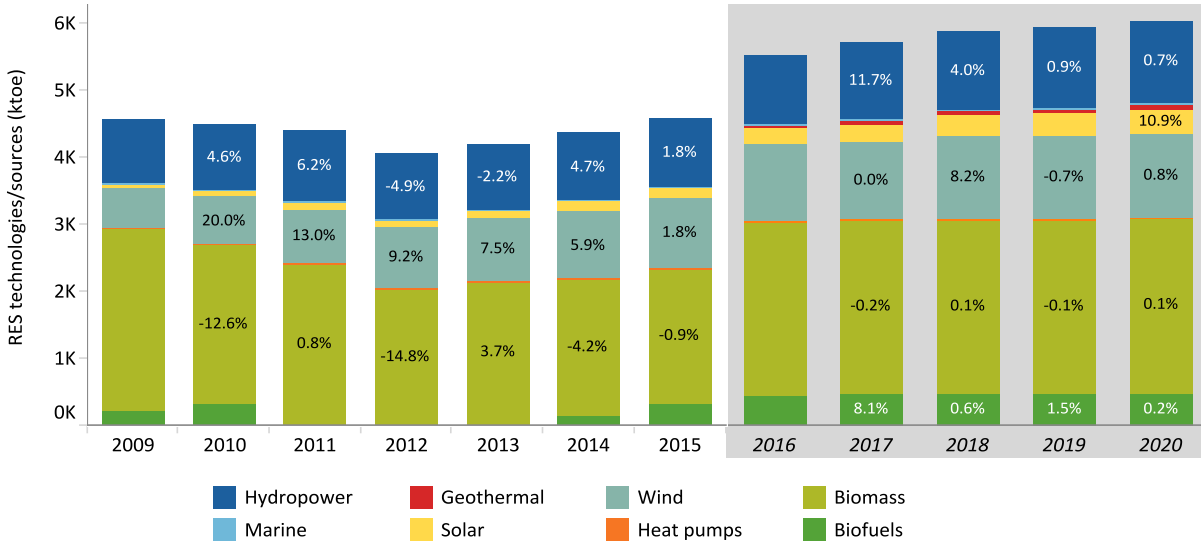


Figure 22 - 4. Annual growth of renewable energy technologies in PT: Current (2009-2015)-NREAP planned 2016-2020

The development of solar electricity in Portugal took place with a CAGR of 74.7% (+793 GWh) during period 2005-2015 reaching 796 GWh (68.5 ktoe). Nevertheless this development was not enough to meet the NREAP plans throughout period 2010-2015. Even that planned no electricity coming from CSP technology was reported for period 2010-2015. Wind technology experienced an increase with a CAGR of 21.2% (+10251 GWh) during period 2005-2015 reaching 12001 GWh (1032 ktoe). Despite of this increase wind power development remained under the NREAP planned trend throughout period 2010-2015. Geothermal electricity increased between 2005 and 2015 with a CAGR of 11% (+133 GWh) reaching 204 GWh (17.5 ktoe). This development missed the NREAP plans in years 2012 and 2015. Biomass for electricity in Portugal developed with a CAGR of 6.3% (+1423 GWh) between 2005 and 2015 reaching 3104 GWh (267 ktoe). This development was faster than planned during period 2010-2011 but slower in period 2012-2015. Hydropower contribution between 2005 and 2015 increased with a CAGR of 0.8% (+902 GWh) reaching 12074 GWh

(1038 ktoe). This technology surpassed the plans throughout period 2010-2015. Even that planned no contribution from marine technology was reported for period 2010-2015.

Portugal has planned a slight decrease with a CAGR of -0.6% for the use of biomass thermal during period 2005-2020. In fact during period 2005-2015 the decrease of biomass thermaltook place but with a CAGR of -3.5% (-748 ktoe) reaching 1757.4 ktoe (74 PJ). Due to this largest drop this source was found below the plans throughout period 2010-2015. Between 2005 and 2015 solar thermal increased with a CAGR of 13.6% (+58 ktoe), reaching 80.3 ktoe (3.4 PJ). Nevertheless this development was not enough to meet the expected NREAP levels throughout period 2010-2015. The development of geothermal technology in this sector was slower than what was planned throughout period 2010-2015 reaching only 1.5 ktoe (0.05 PJ) after the increase with a CAGR of 4.3% (+0.5 ktoe) that took place since 2005.

Biodiesel use in transport sector experienced a significant decreased during period 2011-13 increasing then further to 302 ktoe (12.7 PJ) Due to this downward trend biodiesel missed the NREAP plans during period 2011-15. Even that no plans were in place in the NREAP for the use of bioethanol/bio-ETBE before 2015, Portugal introduced it in 2013 with a very marginal contribution 0.1 ktoe. In 2015 this contribution reached 22 ktoe (0.9 PJ) being nevertheless below the plans for this year. Annex IX biofuels reached 35.7 ktoe (0.7 PJ) in 2015 increasing with a CAGR of 121% (+15.5 ktoe) during period 2010-2014. This biofuel category exceeded in 2013 (9.4 ktoe) the 2020 plan (8 ktoe). No other biofuels (biogas and vegetable oils) is planned to be used in Portugal in transport sector. In contrary this biofuel sub-category reached 3.2 ktoe (0.1 PJ) in 2015. Renewable electricity in this sector developed with a CAGR of 1.6% (+2 ktoe) during period 2005-2015 reaching only 13 ktoe (0.5 PJ). Due to this slow development renewable electricity in transport sector was found below the NREAP plans throughout period 2010-2015. In 2015 only 0.5% of final renewable electricity in Portugal is used in transport sector.

Table 22 - 2. Renewable energy technologies/sources in Portugal – deviations from NREAP, 2010-2015, (ktoe)

	2010	2011	2012	2013	2014	2015
Hydropower	149	202	63	41	54	84
Wind	-156	-158	-193	-126	-70	-127
Solar-el	-2	-10	-11	-21	-27	-31
Solar-th	-2	-2	-5	-10	-17	-25
Geothermal-th	-9	-10	-12	-14	-15	-16
Biomass-el	18	22	-3	-12	-27	-22
Biomass-th	-10	-103	-551	-480	-563	-582
Biodiesel	24	-279	-279	-297	-160	-103
Bioethanol	0	0	0	0	1	-2
Other biofuels	4	0	0	0	3	3
Renewable electricity	-6	-10	-12	-18	-22	-24
Marine	0	0	0	-1	-3	-6

22.5 Renewable electricity installed capacity

The renewable energy installed capacity in Portugal increased with a CAGR of 5.3% (+933.7 MW) over period 2005-14 reaching 10118 MW. In 2014 almost 48% of renewable installed capacity in Portugal was covered by wind while the rest was hydropower (42.5%), biomass (5.2%), solar (4.1%) and geothermal (0.2%).

Figure 22-5 present the current trend of renewable electricity installed capacity in Portugal, the deviations (in %) from the expected developments during period 2005-2015, the 2020 NREAP plan and EUCO27 scenario projections for 2020 and 2030. As shown in this figure, the installed renewable electricity capacity in Portugal was below the NREAP plans throughout period 2010-2015.

Solar photovoltaic capacity increased with a CAGR of 71.8% (+445 MW) during period 2005-2015 reaching 447 MW. Nevertheless this increase was not enough to meet the NREAP plans

throughout period 2010-2015. Wind power reached 4937 MW in 2015 increasing with a CAGR of 16.6% (+3873 MW) since 2005 capacity. Despite of this increase wind power missed the NREAP plans throughout period 2010-2015. Biomass capacity in Portugal increased with a CAGR of 6.7% (+256 MW) over period 2005-2015 reaching 537 MW. This increase was not at the expected level missing all NREAP plans throughout period 2010-2015. Hydropower technology experienced a slightly increase with a CAGR of 1.1% (+456 MW) of its capacity between 2005 and 2015 reaching 4379 MW. This development was well below the expected one throughout period 2010-2015. Geothermal capacity in Portugal remained unchanged at the level of 25 MW in each year of period 2006-15 from 14 MW in 2005. These capacities were found over the plans throughout period 2010-12 but below in period 2013-15. Marine technology registered only 1 MW in year 2015 missing the respective NREAP planned capacities throughout period 2010-2015.

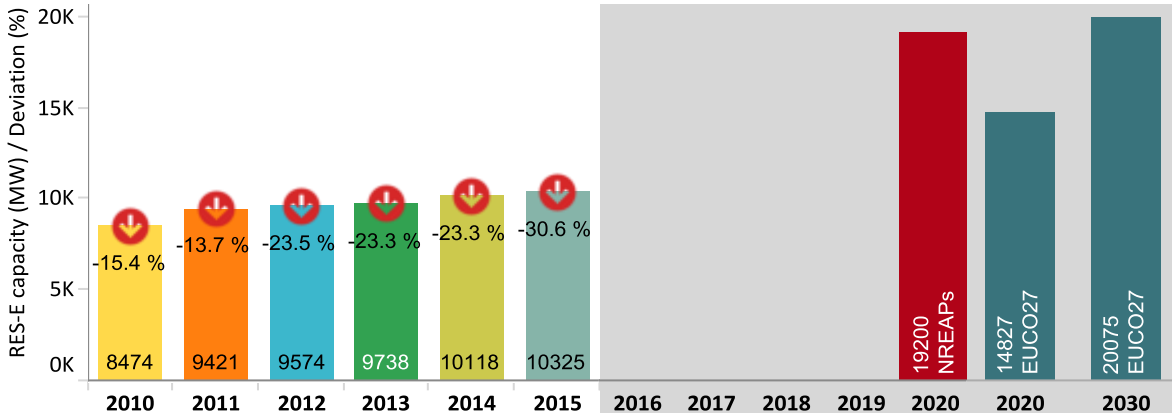


Figure 22 - 5. RES-E capacity development and deviation from NREAPs (2010-2015)– Expected capacity (2020-2030)

In 2020 Portugal has planned to reach an installed capacity of 19200 MW of which hydropower will share 49.7% followed by wind (35.8%), solar photovoltaic (7.8%), biomass (5%), marine (1.3%) and geothermal (0.4%).

The EUCO27 projection for 2020 shows a lower net generation capacity form renewables compared with Portugal NREAP, at 14827 MW. These projections are in line with NREAP in keeping hydropower and wind the two main technologies in Portugal's renewable electricity capacity. According to this projection in 2030 Portugal is expected to have installed a capacity of 20075 MW of renewable electricity.

23. Romania

Petroleum product and gas are the main sources of Romania's energy mix in 2015. With 18.4% renewables overcome the solid fuels relative contribution in energy mix (Figure 23). In 2015 gross inland consumption of energy in Romania totalled to 32.4 Mtoe, 0.8% (+256 ktoe) higher than the consumption in 2014. Primary energy consumption was 31.3 Mtoe in 2015, 27.2% below the 2020 energy efficiency target[79]. Final energy consumption reached 21.9 Mtoe being 27.7% below the 2020 energy efficiency target for this indicator. Gross final energy consumption increased during period 2014-2015 by 0.8% (+176 ktoe) amounting to 23.4 Mtoe. Romania continues decreasing the energy intensity of the economy that reached 226.7 toe/Million Eur. Romania has a very low import dependence ratio, at 17.1% in 2015. Only 1.8% was the import dependence ratio for gas in Romania in this year. Greenhouse gas emissions continued to decline at 112 Mt CO_2 eq in 2014, 56% below the emissions in 1990. Comparing with 2014 ESD target (4.28%) GHG emissions in Romania are well below, 25% less comparing with 2005. Energy remained the main source of emissions with a share of 54.5% (61 Mt CO_2 eq). In the same year the role of renewable energy in the reduction of GHG emissions reached a net savings of 44.7 Mt CO_2 eq, an additional of 18.6 Mt CO_2 since 2009.

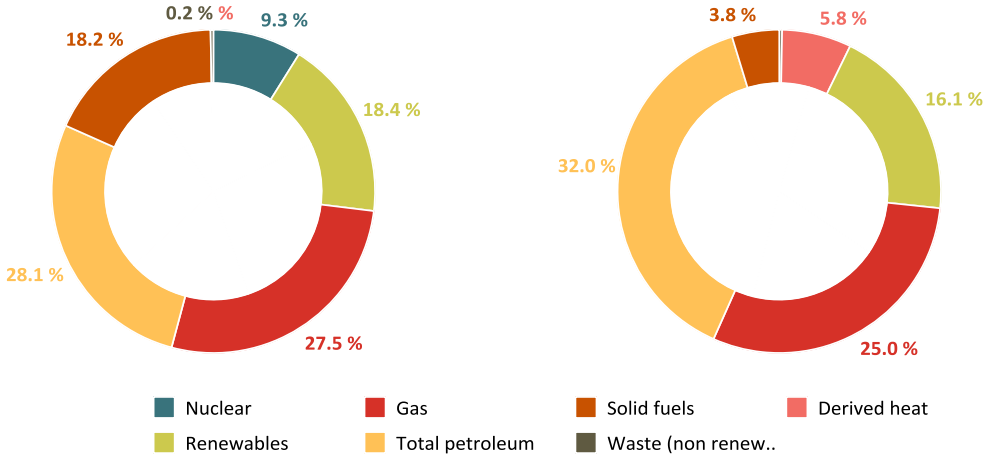


Figure 23. Breakdown of Gross Inland Consumption of Energy (left) - Final Energy Consumption (right) in RO, 2015

23.1 Final renewable energy consumption

Renewable energy consumed in Romania reached 5846 ktoe (245 PJ) in 2015 developing with a CAGR of 2.6% (+1301 ktoe) during period 2005-2015. More than 58% of final renewable energy in Romania is renewable heat/cold. Other forms of renewable energy reached a share of 37.6% (renewable electricity) and 4.1% (renewable transport).

Figure 23-1 present the current trend of final renewable energy consumption in Romania and the deviations (in %) from the expected developments during period 2005-2015 as well as the 2020 NREAP plan and EUCO27 projections for 2020 and 2030. As shown in this figure the current development of final renewable energy consumption in Romania was above the plans throughout period 2010 – 2015

Final renewable energy consumption in Romania is expected to further increase to 7288 ktoe (305 PJ) until 2020. Transport sector will increase its contribution reaching 7.6% whereas renewable heat/cold and renewable electricity will share respectively 55.4% and 37%. The EUCO27 scenario has projected a lower final renewable consumption in Romania for 2020, at 6466 ktoe (271 PJ), compared with its NREAP. For 2030 this scenario projects a final consumption of renewable energy at 7801 ktoe (326.6 PJ).

[79] Romania's energy efficiency 2020 targets are 43 Mtoe in terms of primary energy consumption and 30.3 Mtoe as final energy consumption.

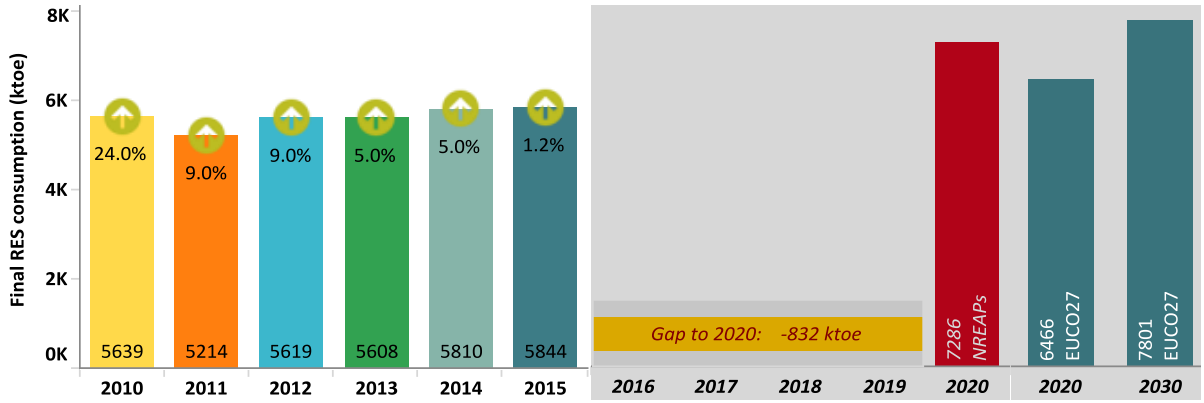


Figure 23 - 1. RES consumption: Trend, Deviation from NREAPs(2010-2015)-Expected RES consumption (2020-2030)

23.2 Renewable energy share

The overall renewable energy contribution in gross final energy consumption in Romania remained at 24.8% during period 2014-2015. According to the EUCO27 scenario the overall renewable energy share in Romania is projected to reach 26.2% in 2020 and 32.8% in 2030.

Figure 23-2 shows the current trajectory of overall renewable energy share in Romania, the NREAPs trajectory, the Indicative trajectory as well as the Current trend forecast trajectory.

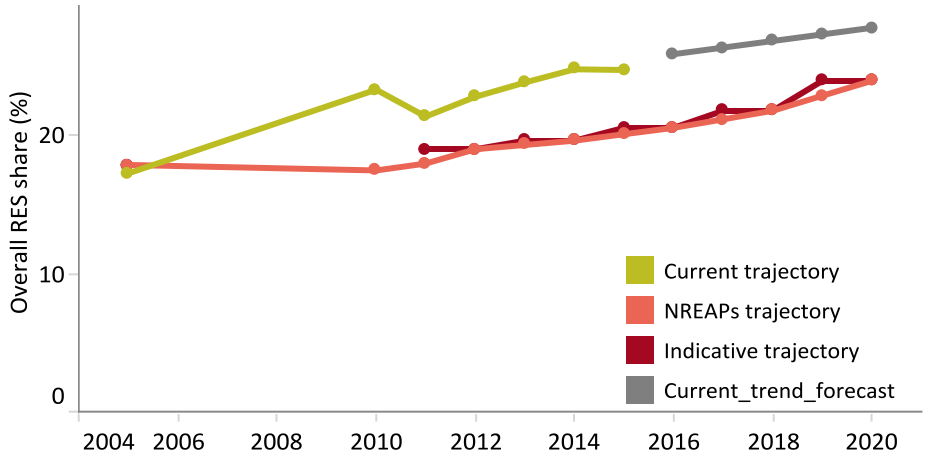


Figure 23 - 2. Overall RES share trajectories in RO: Current, NREAPs and Indicative - Current trend forecast, 2005-20

Overall renewable energy share in Romania remained above the NREAP and indicative trajectories throughout 2010-2015. In 2014 Romania exceeded the 2020 target for overall renewable energy share (24%). Romania needs to review the renewable energy shares for overall contribution of renewable energy as well as for heating/cooling and electricity sectors so that it keeps pace with the current development of renewable energy.

Renewable energy share in heating/cooling sector reached 26.7% in 2014 and 25.9% in 2015. Romania exceeded since in 2008 (23.2%) the 2020 planned share (22.1%) in this sector.

In electricity sector the share of renewable energy increased from 30.08% in the baseline year reaching 41.7% in 2014 and 43.2% in 2015. The share of renewable electricity in Romania exceeded in 2015 the 2020 planned share (42.6%) with 0.5 percentage points.

The share of renewable energy in transport sector developed slower than what was projected in the NREAP throughout period 2010-2015. It reached 4.7% in 2014 and 5.5% in 2015.The expected 2020 planned share in this sector is 10%.

23.3 Final renewable electricity, heating/cooling and use in transport

Renewable electricity consumption in Romania amounted to 25.5 TWh (2197 ktoe) in 2014 developing with a CAGR of 5.3% (+10.4 TWh) since 2005. Comparing with the expected developments this indicator was found below the plans throughout period 2011-15. In 2015 hydropower provided 64.5% of renewable electricity and the rest was wind (25.7%), solar photovoltaic (7.8%) and biomass (2%). In 2020 the renewable electricity consumption in Romania is expected to amount to 31.4 TWh (113 PJ) in which hydropower share will reach at 63%, wind at 26.8%, biomass at 9.2% and solar photovoltaic at 1%.

The EUCO27 scenario projected a lower final renewable electricity for 2020 compared with the Romania NREAP, at 25.9 TWh (2232 ktoe). Nevertheless the contributions of renewable energy technologies/sources are more in line with the actual development: hydropower at 64.4%, wind at 25.1%, solar photovoltaic at 7.5% and biomass at 2.9%. This scenario has projected that renewable electricity in Romania will reach 39.4 TWh (3391 ktoe) in 2030 in which the share of wind will be at 43.3%, hydropower at 42.6%, solar photovoltaic at 10.3% and biomass at 3.9%.

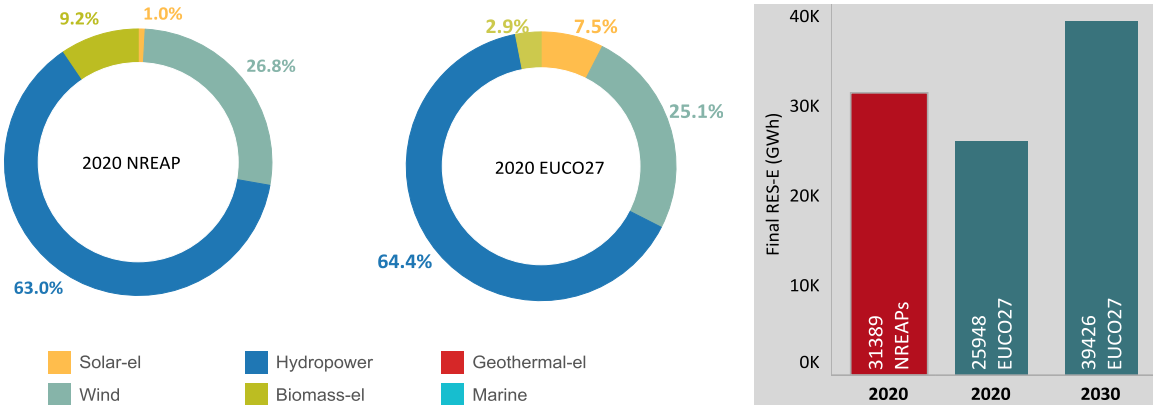


Figure 23 - 3. Final RES Electricity in Romania: NREAP plan (2020) – EUCO27 projections (2020-2030)

The use of renewable energy in heating/cooling in Romania reached 3410 ktoe (161.2 PJ) in 2015 increasing with a CAGR of 0.6% (+208 ktoe) since 2005. This development was fast enough to surpass the expected NREAP uses throughout period 2010-2015. In 2015 almost all renewable energy consumed in heating/cooling sector was biomass (99.2%) and a very marginal part was geothermal (0.8%). In 2020 renewable energy consumed in this sector is expected to reach 4038 ktoe (169 PJ) in which the contribution of biomass is expected to reach 96% and the rest is expected to be covered by geothermal (2%), solar thermal (1.7%) and heat pumps (0.3%).

The use of renewable energy in transport amounted to 237.4 ktoe (9.9 PJ) in 2015 increasing with a CAGR of 21.2% (+203 ktoe) between 2005 and 2015. Despite of this increase renewable energy used in this sector missed the NREAP plans all over period 2010-2015. In 2015 biodiesel share reached at 59.4% followed by bioethanol/bio-ETBE (25.9%) and renewable electricity (14.7%). The use of renewable energy in transport sector in 2020 is expected to reach 550.6 ktoe (23.1 PJ) in which biodiesel share will reach 59.2% while the bioethanol/bio-ETBE is expected to increase its contribution to 29.6%. The rest is expected to be renewable electricity (9.6%), other biofuels (1.2%) and hydrogen (0.4%).

Table 23 - 1. Final renewable energy in RO: deviations from NREAP in electricity, heating/cooling and transport

	2010	2011	2012	2013	2014	2015
RES-el (ktoe)	54	-51	-134	-202	-148	-170
RES-hc (ktoe)	1,148	670	705	582	606	410
RES-tr (ktoe)	-112	-190	-108	-114	-180	-171
RES-el (%)	3.7	-3.1	-7.3	-10.0	-6.6	-7.2
RES-hc (%)	40.7	23.6	23.5	19.6	20.7	13.7
RES-tr (%)	-43.1	-65.3	-34.0	-32.8	-47.8	-41.9

23.4 Renewable energy technologies/sources

Already 59% of final renewable energy in Romania in 2015 was biomass and the rest hydropower (24.4%), wind (9.7%), biofuels (3.3%) solar (2.9%) and geothermal (0.4%). In 2020, the share of biomass in renewable energy mix is expected reach 57% followed by hydropower 23.5%, wind 10%, biofuels 6.9%, solar 1.3%, geothermal 1.1% and heat pumps 0.2%.

In this section: (i) Figure 23-4 present the current (2009-2015) and NREAP projected trend (2016-2020) of energy from renewable technologies/sources in Romania. The annual increase/decrease (%) of these sources in these two periods is also available in this figure; (ii) Table 23-2 presents how the actual figures reported for renewable technologies/sources in Romania compared with what was planned for the NREAPs. Absolute differences are shown in ktoe.

Solar source used for energy purposes in Romania reached 171 ktoe (7.2 PJ) in 2015 increasing very fast with a CAGR of 344% from the low level of 0.1 ktoe in 2010. Solar technology in Romania exceeded the 2020 plan (97.5 ktoe) in year 2014 with 43% (+41.9 ktoe). Biomass use for energy purposes reached 3428 ktoe (143.5 PJ) in 2015 increasing with a CAGR of 0.7% (+244 ktoe) since 2005. This development was faster than the NREAP projected one exceeding the respective plans throughout period 2010-2015. Biofuels use in transport sector developed with a CAGR of 12% (+87 ktoe) between 2010 and 2015 reaching 203 ktoe (8.5 PJ). This development was slower than the projected one remaining under the respective NREAP uses throughout period 2010-2015.

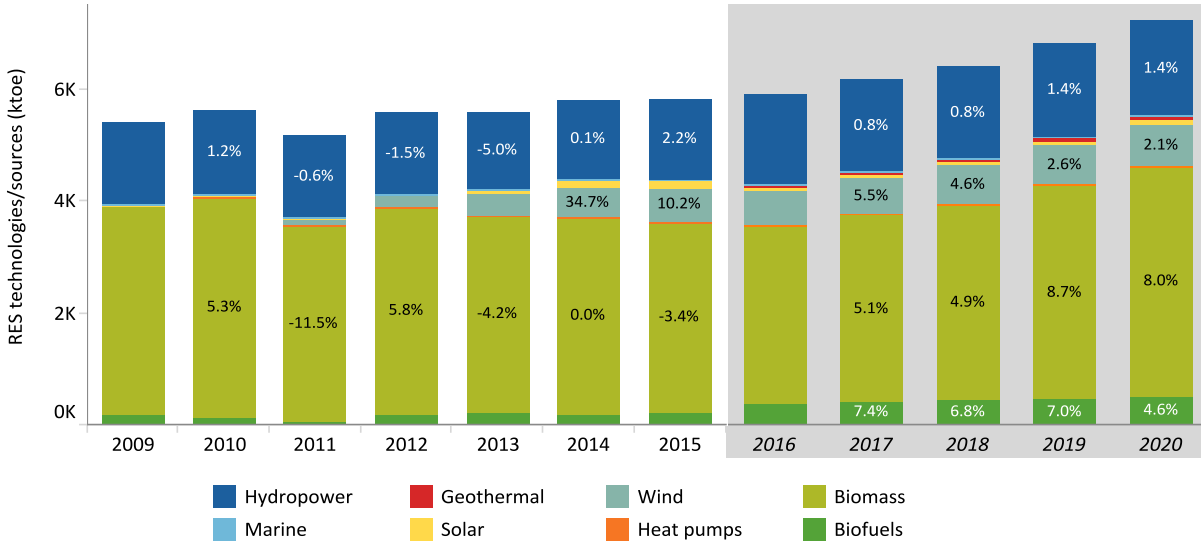


Figure 23 - 4.Annual growth of renewable energy technologies in RO: Current (2009-2015)-NREAP planned 2016-2020

Wind technology progressed with a CAGR of 85.6% (+6268 GWh) reaching 6566 GWh (565 ktoe). Nevertheless this development was not at the planned scale during period 2010-2015 exceeding the plan only in year 2014. Solar photovoltaic technology is introduced in year 2011 and since then increased with a CAGR of 510% (+1981 GWh) reaching 1982 GWh (170 ktoe) in 2015. Solar photovoltaic developed very fast after year 2012 exceeding in 2013 by a factor of 1.3 the 2020 plan (320 GWh). In 2015 solar photovoltaic technology more than 6 times-folded the 2020 plan. Biomass use in electricity sector reached 523 GWh (45 ktoe) in 2015 increasing with a CAGR of 56.3% (+517 GWh) over 2005 level. Nevertheless this development was found slower than expected all over period 2011-15. Hydropower renewable electricity developed with a CAGR of 0.8% (+1298 GWh) between 2005 and 2015 reaching 16477 GWh (1417 ktoe). This technology missed the expected developments throughout period 2012-15.

Biomass use in heating/cooling sector increased with a CAGR of 0.6% (+200 ktoe) reaching 3383 ktoe (142 PJ). The development of this source was faster than planned throughout

period 2010-2015. Geothermal source developed with a CAGR of 3.7% (+7.8 ktoe) between 2005 and 2015 reaching 25.7 ktoe (1.1 PJ). The development of this source was slower than the NREAP projected one missing the respective expected levels throughout period 2010-2015. Solar thermal technology in Romania was found at the low amount of 0.5 ktoe (0.02 PJ) in 2015 developing during period 2010-2015 slower than planned in the NREAP. Even that planned no introduction of heat pump technology took place in Romania during period 2011-15.

Biodiesel developed with a CAGR of 15.5% (+72.4 ktoe) during period 2010-2015 reaching 141 ktoe (5.9 PJ). Nevertheless biodiesel use in transport sector in Romania was found below the plans throughout period 2010-2015. In 2015 the use of bioethanol/bio-ETBE reached 61.5 ktoe (2.6 PJ) increasing with a CAGR of 5.6% (+14.7 ktoe) over 2010 use. Comparing with the expected development tis biofuel category was found under throughout period 2010-2015. After the increase it experienced in 2011 (37.8 ktoe) surpassing the NREAP plan for that year, renewable electricity use in transport reached 35 ktoe (1.5 PJ) in 2015, the same level as in 2005, missing the plans in other years of period 2010-2015. In 2015 only 1.6% of final renewable electricity in Romania is used in transport sector.

Table 23 - 2. Renewable energy technologies/sources in Romania – deviations from NREAP, 2010-2015, (ktoe)

	2010	2011	2012	2013	2014	2015
Hydropower	64.4	30.3	-22.9	-130.3	-177.5	-189.4
Wind	-13.9	-60.0	-57.7	-18.1	0.6	-4.1
Solar-el	0.0	-0.7	-3.6	27.5	126.9	155.0
Solar-th	0.1	-1.0	-2.9	-5.8	-9.5	-13.5
Geothermal-el	0.0	0.0	0.0	0.0	0.0	0.0
Geothermal-th	-2.9	-7.8	-13.4	-15.7	-21.9	-26.3
Biomass-el	3.7	-20.5	-50.2	-81.6	-97.7	-131.3
Biomass-th	1,150.5	679.9	722.0	605.7	640.5	452.4
Heat pumps	0.0	-1.0	-1.0	-2.0	-3.0	-3.0
Biodiesel	-80.4	-121.3	-58.9	-58.2	-99.0	-101.0
Bioethanol	-28.3	-69.7	-45.7	-47.3	-70.4	-59.5
Renewable electricity	-3.4	1.4	-3.5	-8.4	-11.1	-10.5

23.5 Renewable electricity installed capacity

Renewable electricity installed capacity in Romania reached 10933 MW in 2015 growing up with a CAGR of 5.7% (+4643 MW) from 2005. In 2015 hydropower installed capacity contributed with 58.2% followed by wind with 28.6%, solar photovoltaic with 12.1% and biomass with 1.1%.

Figure 23-5 present the current trend of renewable electricity installed capacity in Romania, the deviations (in %) from the expected developments during period 2005-2015, the 2020 NREAP plan and EUCO27 scenario projections for 2020 and 2030. As shown in this figure, the installed renewable electricity capacity in Romania was below the NREAP plans throughout period 2010-2012 and in year 2015.

Solar photovoltaic technology increase its capacity with a CAGR of 503% (+1325 MW) over period 2011-15 from the very low capacity (1 MW) in 2011. This development was speeded up only in period 2013-15 exceeding in this period the expected NREAP capacities. In 2013 the solar photovoltaic installed capacity two folded the 2020 plan. This exceedance was with a factor of 5 in 2015. Wind power technology developed with a CAGR of 123.6% (+3129 MW) from the level of 1 MW in the baseline year. Despite of this increase this technology was found over the plans only in period 2013-14. Biomass capacity in Romania reached 118 MW in 2015 increasing with a CAGR of 29.4% (+103 MW) from year 2011. Nevertheless this source was under the expected NREAP plans throughout period 2011-2015. Hydropower capacity reached 6359 MW in 2015 developed nevertheless slower than what was planned in the NREAP throughout period 2010-2015.

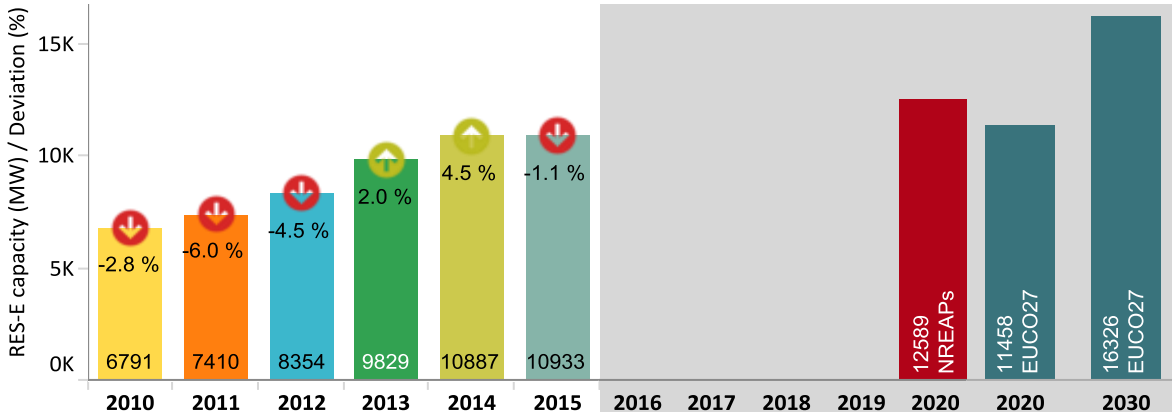


Figure 23 - 5. RES-E capacity development and deviation from NREAPs (2010-2015)– Expected capacity (2020-2030)

In 2020 Romania has planned in its NREAP an installed capacity from renewables at 12589 MW in which hydropower will share 61.4% followed by with 31.8%, biomass with 4.8% and solar photovoltaic with 2.1%.

The 2020 projection from EUCO27 scenario is broadly in line with the Romania NREAP for this year, at 11458 MW. Hydropower and wind are projected to remain the main sources of renewable electricity capacity in Romania in 2020. According to this scenario Romania is expected to have installed a net generation capacity from renewables of 16326 MW in 2030.

24. Slovenia

Petroleum products and nuclear had the highest share in Slovenia's energy mix in 2015, whereas the share of renewables reached 16% (Figure 24). In 2015 gross inland consumption of energy in Slovenia totalled to 6.6 Mtoe, 1.1% (-74 ktoe) under the consumption in 2014. Primary energy consumption was 6.5 Mtoe in 2015, 11% below the 2020 energy efficiency target[80]. Final energy consumption reached 5.1 Mtoe being 7.8% under the 2020 energy efficiency target for this indicator. Energy intensity of the economy stood at 177.6 toe/Million Eur decreasing further compared with 2005 (220 toe/Million Eur). Slovenia has a relatively low import dependence ratio, at 48.7% in 2015. Nevertheless in 2015 Slovenia import dependence ratio for gas and petroleum products was very high, 99.6% for each. Greenhouse gas emissions continued to decline at 16.7 Mt CO_2 eq in 2014, 10.8% below the emissions in 1990. The decrease of GHG emissions from 2005 took place with -19%, more than the 2014 ESD target (2.52%). Energy remained the main source of emissions with a share of 47.3% (7.9 Mt CO_2 eq). In the same year the role of renewable energy in the reduction of GHG emissions reached a net savings of 6.2 Mt CO_2 eq, an additional of 4.9 Mt CO_2 since 2009.

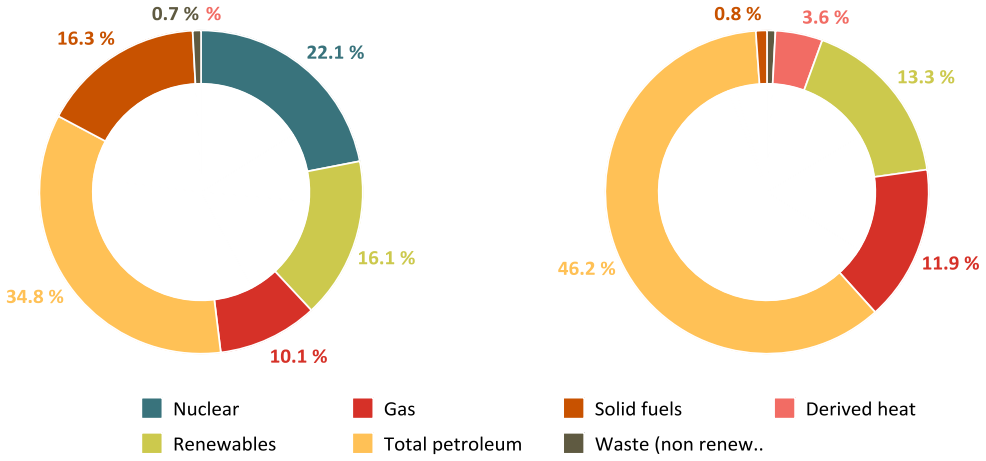


Figure 24. Breakdown of Gross Inland Consumption of Energy (left) - Final Energy Consumption (right) in SI, 2015

24.1 Final renewable energy consumption

Renewable energy consumed in Slovenia reached 1076.2 ktoe (45.1 PJ) in 2015 increasing with a CAGR of 2.8% (+257.8 ktoe) over the final consumption in 2005. Heating/cooling is the dominant sector in Slovenia with a contribution of 58.3% in 2015. Renewable electricity and renewable energy used in transport reached a contribution respectively at 38.6% and 3.1%.

Figure 24-1 present the current trend of final renewable energy consumption in Slovenia and the deviations (in %) from the expected developments during period 2005-2015 as well as the 2020 NREAP plan and EUCO27 projections for 2020 and 2030. As shown in this figure the current development of final renewable energy consumption in Slovenia was above the plans throughout period 2010 – 2014. Only in year 2015 Slovenia didn't reach the NREAP plan.

The renewable energy consumed in Slovenia is expected to further increase to 1353 ktoe (56.6 PJ) until 2020. Since a significant increase is expected from the use of renewable energy in transport sector until 2020 its contribution will reach 15% whereas the other two sectors will contribute with 46.1% (heating/cooling) and 39% (electricity). The EUCO27 scenario has projected a lower final renewable consumption in Slovenia for 2020, at 1293 ktoe (54 PJ), compared with its NREAP. For 2030 this projection reveals the final consumption of renewable energy at 1469 ktoe (61.5 PJ).

[80] Slovenia energy efficiency 2020 targets are 7.3 Mtoe in terms of primary energy consumption and 5.1 Mtoe as final energy consumption.

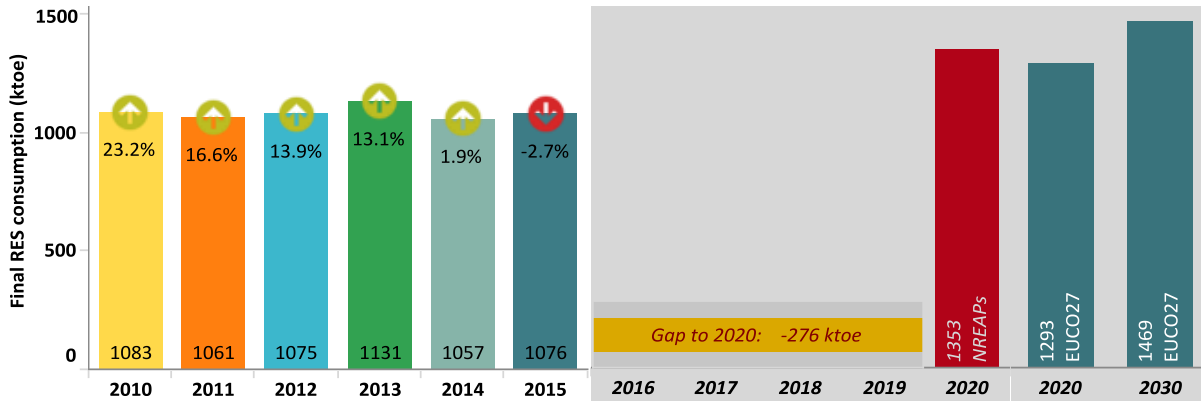


Figure 24 - 1. RES consumption: Trend, Deviation from NREAPs(2010-2015)-Expected RES consumption (2020-2030)

24.2 Renewable energy share

The overall renewable energy contribution in gross final energy consumption in Slovenia increased to 21.5% in 2014 and 22% in 2015. The 2020 target that Slovenia has to reach for the overall renewable energy share is 25.3%. According to the EUCO27 scenario the overall renewable energy share in Slovenia is projected to reach 25.2% in 2020 and 30.3% in 2030.

Figure 24-2 shows the current trajectory of overall renewable energy share in Slovenia, the NREAPs trajectory, the Indicative trajectory as well as the Current trend forecast trajectory.

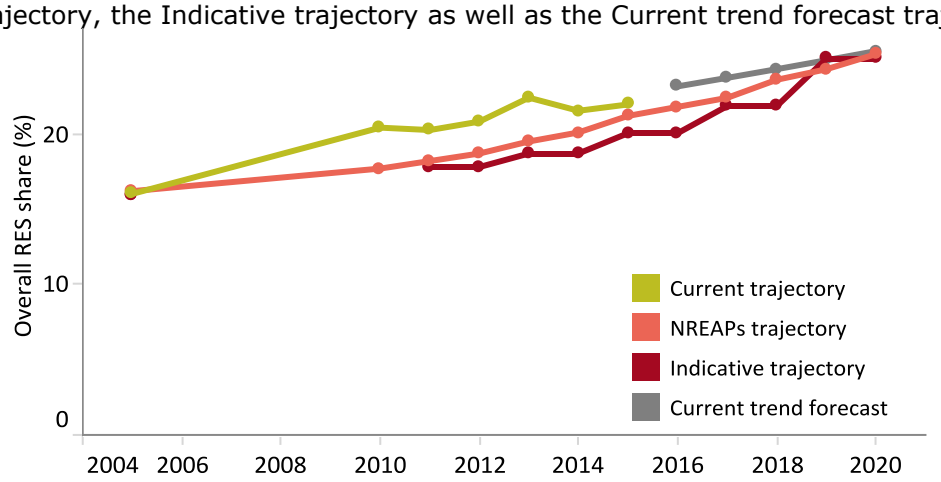


Figure 24 - 2. Overall RES share trajectories in SI: Current, NREAPs and Indicative - Current trend forecast, 2005-20

Overall renewable energy share in Slovenia remained above the NREAP and indicative trajectories throughout 2010-2015. Slovenia seems on track to achieve the 2020 target. However, the development of renewable energy in the transport sector lagged behind expectations in the last 2 years and renewable electricity developed slower than planned from 2010 to 2015.

Renewable energy share in heating/cooling sector reached 32.4% in 2014 and 34.1% in 2015. In 2012 Slovenia exceeded the 2020 planned share (30.8%) for this sector by 0.5 percentage points.
The share of renewable energy in electricity sector increased to 33.9% in 2014 and 32.7% in 2015. The development of renewable energy share in this sector was slower than planned during almost all years of period 2010-2015. The renewable energy share in this sector is expected to reach 39.3% in 2020.
Transport sector reported a share of renewable energy of 2.9% in 2014 and 2.2% in 2015. This development was slower than what was planned in the NREAP during period 2014-2015. The 2020 share of renewable energy in this sector is set to 10.5%.

24.3 Final renewable electricity, heating/cooling and use in transport

Renewable electricity consumption in Slovenia reached 4833 GWh (416 ktoe) in 2015 increasing with a CAGR of 1.3% (+595 GWh) since 2005. This development was slower than what Slovenia has planned in its NREAP throughout period 2011-15. Hydropower was the main source in 2015 with a contribution of 88.7% followed by solar photovoltaic (5.7%), biomass (5.5%) and wind (0.1%). In 2020 the renewable electricity consumption in Slovenia is expected to amount to 6127 GWh (527 ktoe) in which hydropower will dominate with 83.6% followed by biomass with 11%, wind with 3.1% and solar photovoltaic with 2.3%.

For 2020 the EUCO27 scenario projected lower final renewable electricity consumption compared with the Slovenian NREAP, at 5517 GWh (474 ktoe). Hydropower contribution is projected at 82.3% followed by solar photovoltaic at 7.1%, biomass at 5.4% and wind at 5.1%. Under this scenario the final renewable electricity in Slovenia will reach 7724 GWh (664 ktoe) in 2030 of which hydropower will share 65.7%, solar photovoltaic 19.2%, biomass 10.4% and wind 4.7%.

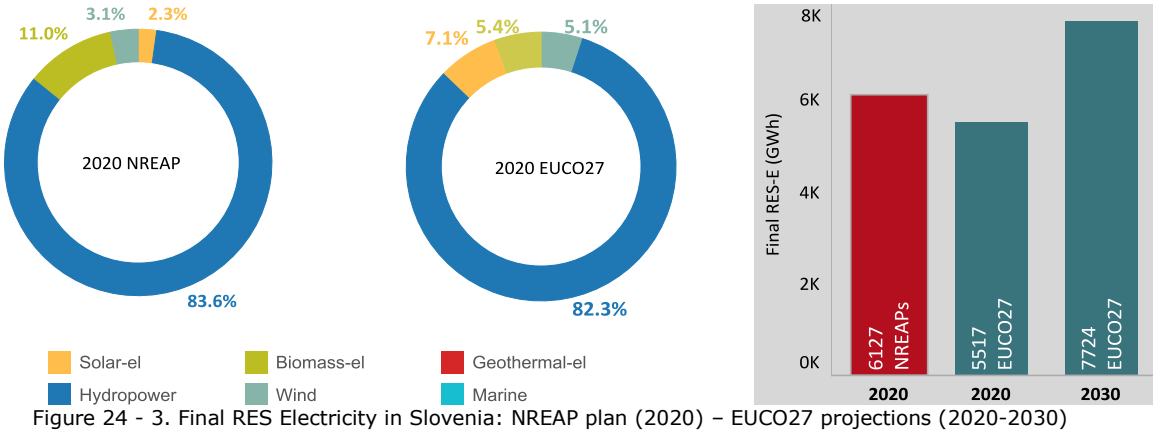


Figure 24 - 3. Final RES Electricity in Slovenia: NREAP plan (2020) – EUCO27 projections (2020-2030)

Renewable energy in heating/cooling sector reached 627.2 ktoe (26.3 PJ) in 2015 increasing with a CAGR of 3.4% (+178 ktoe) since 2005. The development of renewable energy consumed in this sector was faster than what was planned in the NREAP throughout period 2010-2015. In 2015 biomass share reached at 91.5% followed by geothermal at 6.7% and solar thermal at 1.7%. In 2020 heating/cooling sector in Slovenia has planned to use an amount of renewable energy equal to 623 ktoe (26.1 PJ) in which biomass is expected to cover 84.3% of total heat production expected followed by heat pumps with 9.1%, solar thermal with 3.4% and geothermal with 3.1%.

The use of renewable energy in transport sector in Slovenia developed with a CAGR of 21% (+28.4 ktoe) during period 2005-2015 reaching 33.4 ktoe (1.4 PJ). This development was slower in year 2011 and period 2013-15. In 2015 biodiesel used in transport sector reached a share of 67.8% and the rest was renewable electricity (12.9%) and bioethanol/bio-ETBE (19.3%). The use of renewable energy in transport sector in 2020 is expected to reach 202.7 ktoe (8.5 PJ). In 2020 is expected that biodiesel will have a share of 85.7% and the rest will be bioethanol/bio-ETBE (9.1%) and renewable electricity (5.2%).

Table 24 - 1. Final renewable energy in SI: deviations from NREAP in electricity, heating/cooling and transport

	2010	2011	2012	2013	2014	2015
RES-el (ktoe)	4	-4	-4	-9	-5	-43
RES-hc (ktoe)	197	164	134	141	52	65
RES-tr (ktoe)	3	-9	1	0	-27	-53
RES-el (%)	0.9	-1.1	-1.1	-2.2	-1.3	-9.3
RES-hc (%)	44.3	35.1	27.3	27.3	9.6	11.6
RES-tr (%)	6.9	-18.7	2.4	0.0	-36.6	-61.3

24.4 Renewable energy technologies/sources

Biomass contribution in total renewable energy in Slovenia reached 55.7% in 2015. Hydropower was the second renewable energy source with 34.4% followed by geothermal with 3.9%, solar with 3.2% and biofuels with 2.9%. In 2020, the share of biomass in renewable energy mix is expected to decrease to 43.5% while a slightly decrease is expected for hydropower (32.8%) and geothermal (1.5%) contribution. Contribution of biofuels is expected to increase up to 14.3% and the rest will be covered by other technologies: heat pumps 4.2% and solar 2.5%.

In this section: (i) Figure 24-4 present the current (2009-2015) and NREAP projected trend (2016-2020) of energy from renewable technologies/sources in Slovenia. The annual increase/decrease (%) of these sources in these two periods is also available in this figure; (ii) Table 24-2 presents how the actual figures reported for renewable technologies/sources in Slovenia compared with what was planned for the NREAPs. Absolute differences are shown in ktoe.

Solar technology for electricity and heat/cold increased with a CAGR of 16% (+10 ktoe) during period 2010-2015 reaching 34.5 ktoe (1.4 PJ). This development met in 2014 the 2020 plan being above the plans throughout period 2010-2015. During period 2005-2015 biomass (bioelectricity and bioheat) use for energy purposes developed with a CAGR of 2.7% (+134 ktoe) reaching 596.7 ktoe (25 PJ). This development was fast enough to exceed the expected NREAP values throughout period 2010-2015. Biofuels use in Slovenia reached 29 ktoe (1.2 PJ) in 2015 decreasing with a CAGR of -8.2% (-15.5 ktoe) since 2010. The use of biofuels in Slovenia was found above the NREAP plans only in year 2010 and during period 2012-2013.

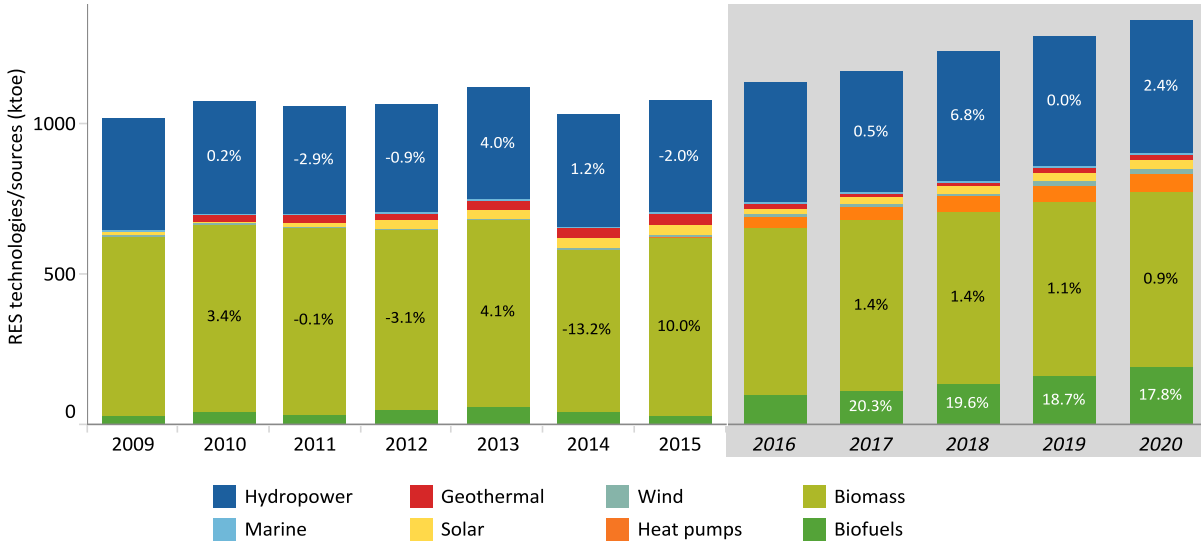


Figure 24 - 4. Annual growth of RES technologies in SI: Current (2009-2015) - NREAP planned 2016-2020

Between 2005 and 2015 solar photovoltaic contribution increased with a CAGR of 145% (+274 GWh) reaching 274.2 GWh (24 ktoe). This technology exceeded since in 2012 (163 GWh) the 2020 plan (139 GWh). Renewable electricity coming from biomass developed with a CAGR of 8.8% (+150 GWh) during period 2005-2015 reaching 264 GWh (23 ktoe). Despite of this increase bioelectricity in Slovenia remained behind the NREAP plans throughout period 2010-2015. Wind power technology was introduced in Slovenia only in 2013 with a contribution of only 4 GWh (0.3 ktoe) increasing to 6 GWh (0.5 ktoe) in 2015. These contributions were lower than planned throughout period 2013-15. Reaching 4290 GWh (369 ktoe) in 2015 hydropower contribution increased with a CAGR of 4% (+165 GWh) since 2005. Despite of this increase this technology was below the expected developments throughout period 2011-15.

Biomass use for heating/cooling purposes in Slovenia developed with a CAGR of 2.5% (+125 ktoe) during period 2005-2015 reaching 574 ktoe (24 PJ). This development was faster than planned throughout period 2010-2015. Bioheat in Slovenia exceeded in 2009 (583 ktoe) the

2020 plan (525 ktoe). Geothermal technology for electricity and heating/cooling developed with a CAGR of 16% (+10 ktoe) during period 2005-2015 reaching 42.3 ktoe (1.8 PJ). This technology exceeded since in 2010 (26.3 ktoe) the plan for year 2020 (20 ktoe). Solar thermal developed with a CAGR of 6% (+2.8 ktoe) during period 2010-2015 reaching 10.9 ktoe (0.5 PJ). This development was fast enough to surpass the NREAP plans all over period 2010-2015.

Bioethanol/bio-ETBE use in transport sector in Slovenia amounted to only 6.4 ktoe (0.3 PJ) in 2015. This increase was enough to surpass the plan throughout period 2010-2014 but not in year 2015. Biodiesel use in transport sector reached 22.6 ktoe (0.9 ktoe) in 2015 decreasing with a CAGR of 11% (-17.8 ktoe) from the use in year 2010. The use of biodiesel was found above the NREAP plans in year 2010 and during period 2012-13. No other biofuels (biogas and vegetable oils) and no biofuels from wastes, residues, and lingo-cellulosic material were used in Slovenia in period 2010-2015. Renewable electricity use in transport sector reached 4.3 ktoe (0.2 PJ) in 2015 decreasing with a CAGR of -1.4% (-0.7 ktoe) since 2005. The use of renewable electricity in Slovenia was found below the NREAP expectation throughout period 2010-2015. In 2015 only 1.0% of final renewable electricity in Slovenia is used in transport sector.

Table 24 - 2. Renewable energy technologies/sources in Slovenia – deviations from NREAP, 2010-2015, (ktoe)

	2010	2011	2012	2013	2014	2015
Hydropower	10.7	-0.1	-3.3	-7.7	-4.6	-23.2
Wind	-0.2	-0.3	-0.3	-0.9	-0.7	-8.9
Solar-el	0.1	4.2	12.1	16.2	19.3	20.4
Solar-th	3.1	2.9	2.8	2.4	1.8	0.9
Geothermal-th	8.3	10.4	12.1	15.2	16.9	23.3
Biomass-el	-7.0	-7.9	-12.7	-17.0	-19.5	-30.9
Biomass-th	186.2	166.6	130.1	139.6	41.6	79.0
Heat pumps	-7.0	-14.0	-19.0	-25.0	-31.0	-38.0
Biodiesel	3.8	-8.6	1.8	0.5	-24.6	-49.0
Bioethanol	0.3	0.7	1.3	2.0	1.0	-1.2
Renewable electricity	-0.9	-1.2	-1.8	-2.4	-3.0	-2.6

24.5 Renewable electricity installed capacity

Renewable electricity installed capacity in Slovenia reached 1421 MW in 2015 increasing with a CAGR of 3.6% (+424 MW) between 2005 and 2015. In 2015 hydropower installed capacity covered 79% of renewable electricity capacity in Slovenia. Solar photovoltaic contribution was 17% followed by biomass with 4%.

Figure 24-5 present the current trend of renewable electricity installed capacity in Slovenia, the deviations (in %) from the expected developments during period 2005-2015, the 2020 NREAP plan and EUCO27 scenario projections for 2020 and 2030. As shown in this figure, the installed renewable electricity capacity in Slovenia was above the NREAP plans throughout period 2011-2015.

Solar photovoltaic technology capacity developed very fast with a CAGR of 81.8% (+226 MW) during period 2010-2015 reaching 238 MW. This technology exceeded since in 2012 (142 MW) the plan for year 2020 (139 MW). In 2015 this exceedance took place with 71% (+99 MW). Biomass installed capacity reached 63 MW in 2015 increasing with a CAGR of 13.3% (+45 MW) over the capacity in 2005. Despite of this increase the achieved biomass capacities were below the NREAP plans throughout period 2010-2015. Hydropower capacity in Slovenia increased with a CAGR of only 1.3% (+136 MW) since 2005 reaching 1115 MW in 2015. The achieved capacities of this technology during period 2013-15 were found to be below the NREAP plans. Slovenia reported only 5 MW for wind capacity in year 2015, an increase of only +1 MW since period 2013-14. Comparing with the expected NREAP capacities this development was slower throughout period 2010-2015.

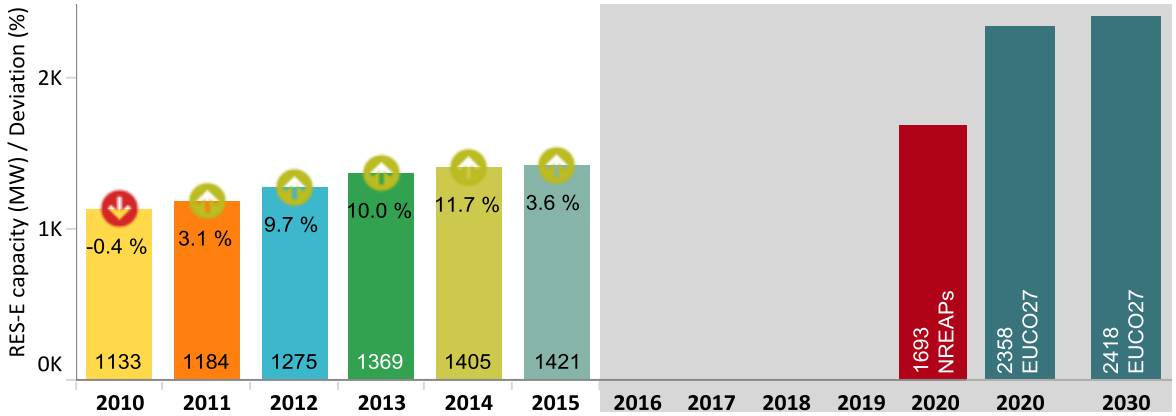
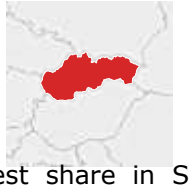


Figure 24 - 5. RES-E capacity development and deviation from NREAPs (2010-2015)– Expected capacity (2020-2030)

In 2020 the expected renewable electricity installed capacity is 1693 MW in which hydropower will share 80% followed by solar with 8%, biomass 6% and wind 6%.

The EUCO27 projection for 2020 net generation capacity from renewables in Slovenia is much higher than the NREAP plan, at 2358 MW. This projection is more in line with the current deployment of solar photovoltaic in Slovenia. According to this projection Slovenia is expected to have installed a capacity of 2418 MW from renewable energy in 2030.

25. Slovakia



Nuclear had the highest share in Slovakia's energy mix in 2015 together with gas and petroleum products whereas the share of renewables reached 9.6% (Figure 25). In 2015 gross inland consumption of energy in Slovakia totalled to 16.4 Mtoe, 1.5% (+245 ktoe) higher than the consumption in 2014. Primary energy consumption was 15.4 Mtoe in 2015, 6.1% below the 2020 energy efficiency target[81]. Final energy consumption reached 10.3 Mtoe being 14.4% above the 2020 energy efficiency target for this indicator. Gross final energy consumption increased during period 2014-2015 by 1.6% (+165 ktoe) amounting to 10.4 Mtoe. Energy intensity of the economy continues to decrease reaching 215 toe/Million Eur. Slovakia had an import dependence ratio at 58.7% in 2015. The import dependence ratio was higher for gas, at 95% in the same year. Greenhouse gas emissions continued to decline at 40.7 Mt CO_2 eq in 2014, 45.3% below the emissions in 1990. The decrease from 2005 took place with -21% compared with 2014 ESD target of 3.8%. Energy remained the main source of emissions with a share of 50.3% (20.5 Mt CO_2 eq). In the same year the role of renewable energy in the reduction of GHG emissions reached a net savings of 4.9 Mt CO_2 eq, lower than 5.7 Mt CO_2 eq in 2009.

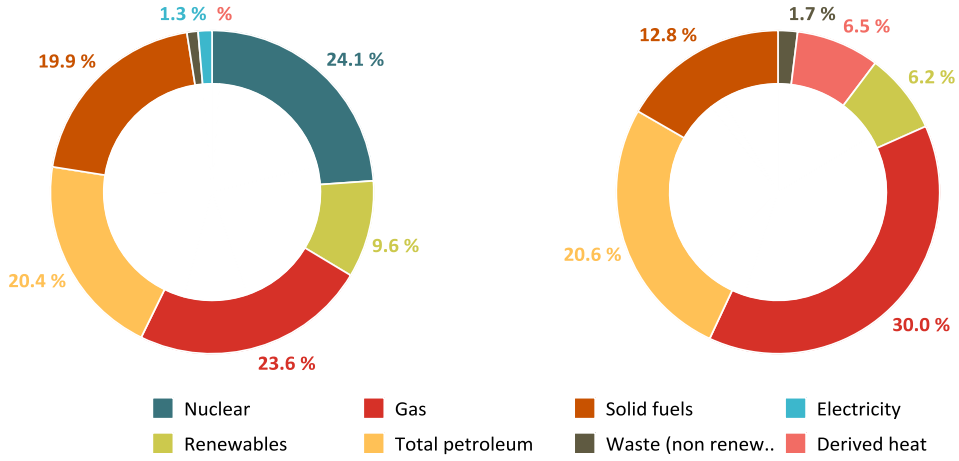


Figure 25. Breakdown of Gross Inland Consumption of Energy (left) - Final Energy Consumption (right) in SK, 2015

25.1 Final renewable energy consumption

Final renewable energy consumed in Slovakia increased to 1346.8 ktoe (56.4 PJ) in 2015 with a CAGR of 5.8% (+582 ktoe) from year 2005. Renewable electricity was the main form of renewable energy consumed in Slovakia in 2014 with a contribution of 46.4%. Heating/cooling and transport contributed respectively with 42% and 11.7%.

Figure 25-1 present the current trend of final renewable energy consumption in Slovakia and the deviations (in %) from the expected developments during period 2005-2015 as well as the 2020 NREAP plan and EUCO27 projections for 2020 and 2030. As shown in this figure the current development of final renewable energy consumption in Slovakia was above the plans only during period 2010-2012. The Slovakia NREAP plans were not fulfilled in period 2013-2015.

Final renewable energy consumption in Slovakia is expected to further increase to 1715 ktoe (71.8 PJ) until 2020. Heating/cooling sector will be the main source of renewable energy with 47.8% whereas the contributions of electricity and transport sectors will be respectively 40.1% and 12.1%. The EUCO27 scenario has projected a higher final renewable consumption in Slovakia for 2020, at 1891 ktoe (79.2 PJ), compared with its NREAP. For 2030 this projection reveals the final consumption of renewable energy at 1942 ktoe (81.3 PJ).

[81] Slovakia energy efficiency 2020 targets are 16.4 Mtoe in terms of primary energy consumption and 9.0 Mtoe as final energy consumption.

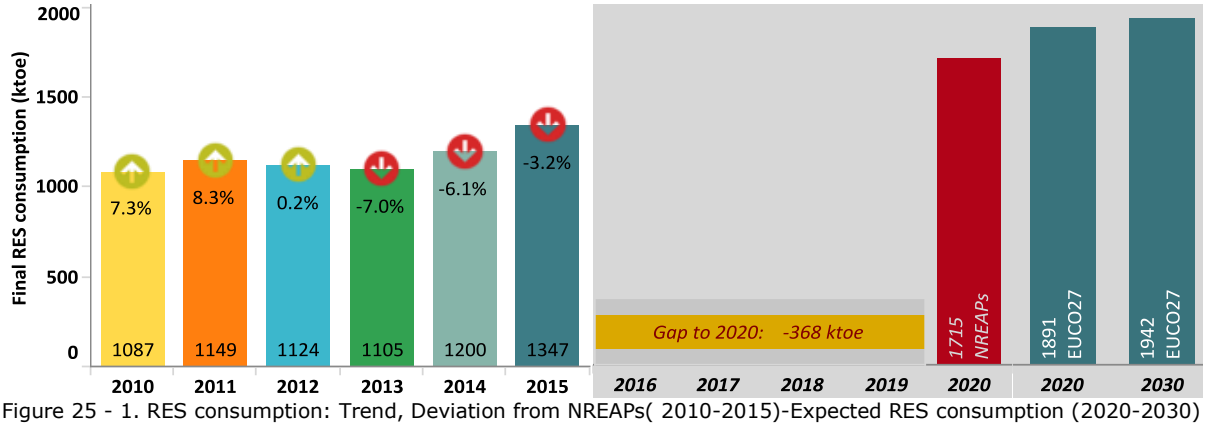


Figure 25 - 1. RES consumption: Trend, Deviation from NREAPs(2010-2015)-Expected RES consumption (2020-2030)

25.2 Renewable energy share

The overall renewable energy contribution in gross final energy consumption in Slovakia reached 11.7% in 2014 and 12.9% in 2015. The 2020 target that Slovakia has to reach for the overall renewable energy share is 14%. According to the EUCO27 scenario the overall renewable energy share in Slovakia is projected to reach 14.2% in 2020 and 16.4% in 2030.

Figure 25-2 shows the current trajectory of overall renewable energy share in Slovakia, the NREAPs trajectory, the Indicative trajectory as well as the Current trend forecast trajectory.

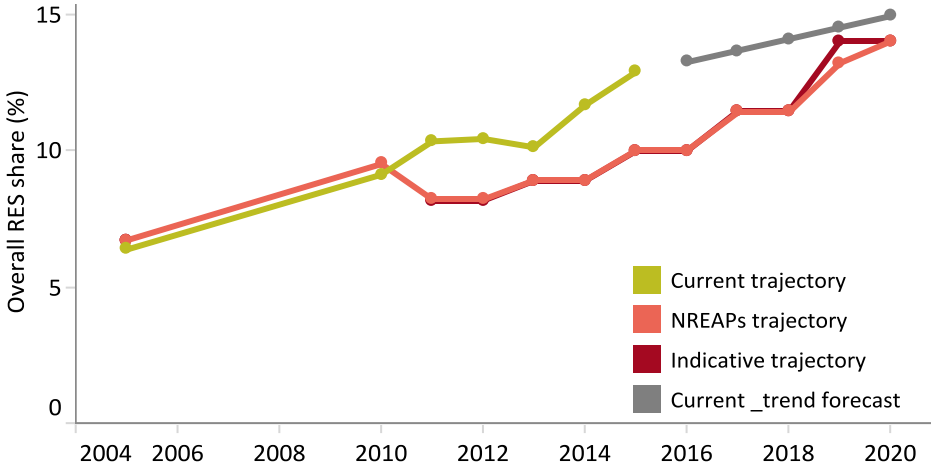


Figure 25 - 2. Overall RES share trajectories in SK: Current, NREAPs and Indicative - Current trend forecast, 2005-20

Overall renewable energy share in Slovakia remained above the NREAP and indicative trajectories throughout 2010-2015. However, additional efforts might be needed since the development in heating/cooling remained below expectations in the last 3 years of the period 2010-2015.

Renewable energy share in heating/cooling sector reached 8.9% in 2014 and 10.8% in 2015. The development of renewable energy share in this sector remained below the plans during period 2013-15. In 2020 the expected renewable energy share in this sector is 14.6%.

Renewable electricity share reached 22.9% in 2014 and 22.7% in 2015. Renewable energy share in this sector was found more or less in line with the NREAP planned trend throughout period 2010-2015. The expected 2020 share in this sector is 24%.

The share of renewable energy in transport sector reached 7.6% in 2014 and 8.5% in 2015. The development of renewable energy share in this sector was found above the planned trend throughout period 2010-2015. The share for year 2020 in this sector is set to 10%.

25.3 Final renewable electricity, heating/cooling and use in transport

Renewable electricity consumption in Slovakia reached 6575 GWh (565.4 ktoe) in 2015 growing with a CAGR of 4.1% (+2155 GWh) from 2005. Comparing with the expected development this indicator did not reached the plans throughout period 2010-2015. In 2015 hydropower covered 66.9% of final renewable electricity followed by solar photovoltaic with 22.4%, biomass with 9.9% and wind with 0.1%. In 2020 the renewable electricity consumption in Slovakia is expected to amount to 8000 GWh (28.8 PJ). The fast development of solar photovoltaic is likely to change the planned picture for 2020 in which hydropower is expected to reach a share at 67.5% followed by biomass at 21.4%, wind at 7%, solar photovoltaic at 3.8% and geothermal at 0.4%.

The EUCO27 scenario for 2020 is broadly consistent with Slovakia NREAP, at 8157 GWh (701.5 ktoe) with hydropower projected at 66.8%, biomass at 26.4%, solar photovoltaic at 6.5% and wind at 0.3%. Under this scenario in 2030 Slovakia will reach 7724 GWh (664 ktoe) of renewable electricity in which hydropower will have a share at 72.3%, biomass at 8.4%, solar photovoltaic at 8.9%, and wind at 0.4%.

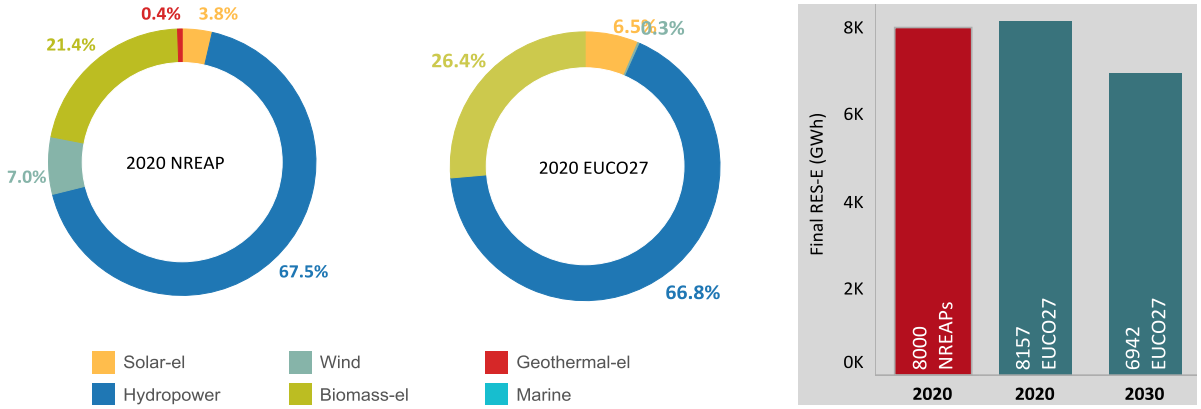


Figure 25 - 3. Final RES Electricity in Slovakia: NREAP plan (2020) – EUCO27 projections (2020-2030)

Renewable energy in heating/cooling in Slovakia reached 624.4 ktoe (26 PJ) in 2015 growing with a CAGR of 5.5% (+258 ktoe) since 2005. The development was fast enough to exceed the expected NREAP heat productions only in period 2010-12. In 2015 renewable heat/cold was almost totally biomass, 98.5%. The rest was covered: 0.9% solar thermal and 0.7% geothermal. In 2020 heat production from renewable sources in Slovakia is expected to reach 820 ktoe (34.3 PJ) in which biomass contribution is expected to reach 84.1% while geothermal, solar and heat pumps are expected to reach respectively 11%, 3.7% and 1.2%.

The use of renewable energy in transport reached 157 ktoe (6.6 PJ) in 2015 increasing with a CAGR of 24% (+139 ktoe) between 2005 and 2015. Comparing with expected NREAP uses Slovakia was over the plans throughout period 2010-2015. In 2015 biodiesel share reached 77% followed by bioethanol-bio/ETBE (14.6%) and renewable electricity (8.4%). The use of renewable energy in transport sector in 2020 is expected to be 207 ktoe (8.7 PJ) in which biodiesel use is expecting to reach 53.1% while the contribution of bioethanol-bio/ETBE will reach to 36.2%. Renewable electricity is expected to have a contribution of 8.2% and the rest (2.4%) will be other biofuels.

Table 25 - 1. Final renewable energy in SK: deviations from NREAP in electricity, heating/cooling and transport

	2010	2011	2012	2013	2014	2015
RES-el (ktoe)	-36	-11	-26	-39	-12	-52
RES-hc (ktoe)	94	87	26	-51	-85	-3
RES-tr (ktoe)	16	12	2	7	22	10
RES-el (%)	-7.6	-2.3	-5.0	-7.1	-2.2	-8.4
RES-hc (%)	20.8	18.4	5.2	-9.5	-14.4	-0.4
RES-tr (%)	17.3	13.2	2.4	6.4	18.5	6.8

25.4 Renewable energy technologies/sources

The main source of renewable energy in Slovakia in year 2015 was biomass with a 56.8% of contribution, followed by hydropower with 28.4%, biofuels with 10.8%, solar with 3.7%, geothermal with 0.32% and wind 0.03%. In 2020, the shares of biomass and hydropower in renewable energy mix in Slovakia are expected to decrease respectively to 49.3% and 27.35%. The rest will be covered by biofuels with 11.19%, geothermal with 5.45%, solar with 3.29%, wind with 2.84% and heat pumps with 0.59%.

In this section: (i) Figure 25-4 present the current (2009-2015) and NREAP projected trend (2016-2020) of energy from renewable technologies/sources in Slovakia. The annual increase/decrease (%) of these sources in these two periods is also available in this figure; (ii) Table 25-2 presents how the actual figures reported for renewable technologies/sources in Slovakia compared with what was planned for the NREAPs. Absolute differences are shown in ktoe.

Biomass for energy purposes developed with a CAGR of 7.6% (+393 ktoe) reaching 757.6 ktoe (31.7 PJ). Comparing with expected developments biomass use missed the NREAP values only during period 2013-14. Solar technology developed with a CAGR of 43% (+53.6 ktoe) between 2010 and 2015 reaching 49 ktoe (2.1 PJ). This technology was found over the NREAP plans throughout period 2010-2015. Biofuels use in transport sector reached 144 ktoe (6.0 PJ) in 2015 increasing with a CAGR of 29% (+133 ktoe) between 2005 and 2015. This use was found over the plans throughout period 2010-2015.

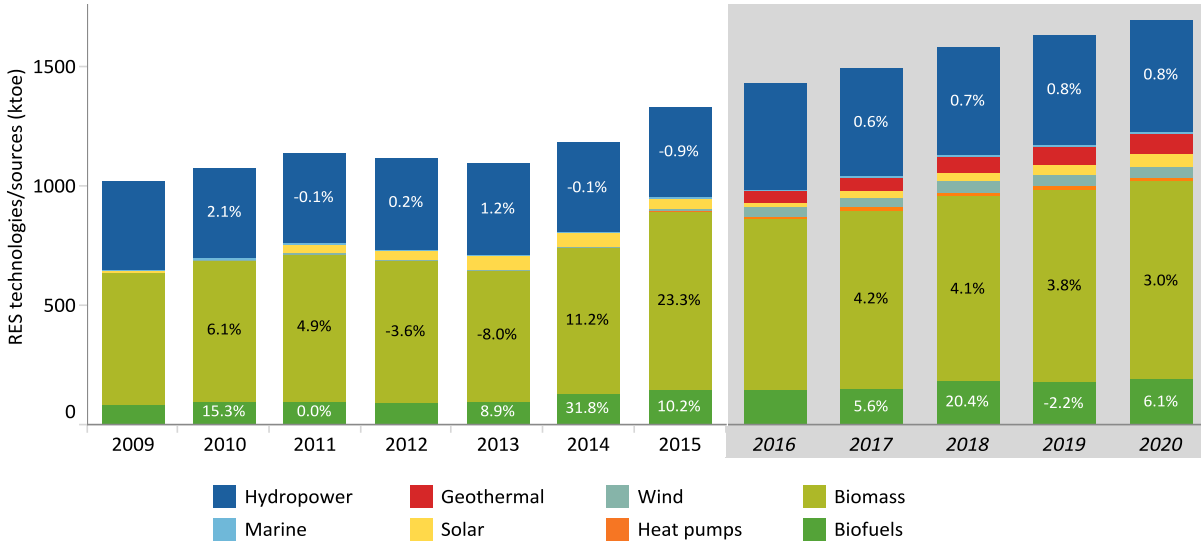


Figure 25 - 4. Annual growth of RE technologies in SK: Current (2009-2015) - NREAP planned (2016-2020)

Biomass electricity developed with a CAGR of 48.4% (+1630 GWh) during period 2005-2015 reaching 1662 GWh (143 ktoe). This development missed the NREAP plan only in year 2013. Solar photovoltaic had a renewable electricity contribution of 506 GWh in 2015 developing with a CAGR of 97.3% (+489 GWh) from year 2010. This technology exceeded the 2020 plan (300 GWh) since in 2011 (397 GWh). Hydropower increased very slightly its contribution between 2005 and 2015with a CAGR of only 0.05% (+21 GWh) reaching 4402 GWh (378.5 ktoer). Due to this slow deployment this technology missed the respective NREAP plans throughout period 2010-2015. Wind power contribution remained at low level reaching only 5.1 GWh (0.4 ktoe) in 2015. This technology missed the respective NREAP plans throughout period 2010-2015. Even that expected, no renewable electricity from geothermal technology was reported in Slovakia during period 2010-2015..

Biomass thermal reached 615 ktoe (25.7 PJ) increasing with a CAGR of 5.4% (+253 ktoe) between 2005 and 2015. Comparing with expected NREAP heat production this source missed the plans only during period 2013-14. Heat production from geothermal reached only 4.2 ktoe in 2015, 0.5 ktoe below the level in 2005. Comparing with expected NREAP productions

this technology met or was over the plans only in period 2010-2013. Solar thermal contribution increased to 5.5 ktoe in 2015 over 4.3 ktoe in 2005 enough to exceed the plans in period 2010-2014 but not in 2015. Even that projected no heat production from heat pumps took place in Slovakia in period 2010-2015.

Biodiesel use in transport sector reached to 121 ktoe (5.1 PJ) in 2015 increasing with a CAGR of 27% (+110 ktoe) during period 2010-2015. The use of biodiesel in this sector was found over the plans throughout period 2010-2015. The use of bioethanol/bio-ETBE reached 23 ktoe (1.0 PJ) in 2015 decreasing with a CAGR of -0.8% (-0.9 ktoe) between 2010 and 2015. This development was not fast enough to meet the expected use of this type of biofuel being under throughout period 2013-15. No use of other biofuels and Annex IX biofuels in transport sector took place in Slovakia during period 2010-2015. Renewable electricity use in transport sector reached 13 ktoe in 2015 with a CAGR of 6.4% (+6 ktoe) since 2005. This increase was enough to surpass the NREAP plans throughout period 2011-15. In 2015 Slovakia used 2.3% of its final renewable electricity in transport sector.

Table 25 - 2. Renewable energy technologies/sources in Slovakia – deviations from NREAP, 2010-2015, (ktoe)

	2010	2011	2012	2013	2014	2015
Hydropower	-38.8	-41.5	-42.8	-43.3	-45.6	-65.3
Wind	-0.2	-0.3	-9.9	-20.1	-20.1	-40.8
Solar-el	-1.1	26.4	25.3	38.5	38.4	29.8
Solar-th	2.3	2.1	2.4	1.6	0.8	-1.5
Geothermal-el	0.0	0.0	-2.4	-2.4	-2.4	-2.4
Geothermal-th	2.0	0.9	0.6	0.1	-23.8	-35.8
Biomass-el	4.5	4.2	3.5	-12.0	14.7	26.9
Biomass-th	89.9	85.3	24.4	-49.2	-57.6	38.7
Heat pumps	0.0	-1.0	-1.0	-3.0	-4.0	-4.0
Biodiesel	6.9	7.7	1.1	6.3	19.6	14.0
Bioethanol	8.8	4.0	0.8	-1.2	0.0	-7.1
Renewable electricity	-0.1	0.8	0.5	1.6	2.6	3.1

25.5 Renewable electricity installed capacity

The renewable electricity installed capacity in Slovakia amounted to 2379 MW in 2015 developing with a CAGR of 3.7% (+732 MW) between 2005 and 2015. In 2014 the hydropower presented 67.5% of renewable electricity installed capacity in Slovakia followed by solar with 22.4%, biomass with 9.9% and wind with only 0.2%.

Figure 25-4 present the current trend of renewable electricity installed capacity in Slovakia, the deviations (in %) from the expected developments during period 2005-2015, the 2020 NREAP plan and EUCO27 scenario projections for 2020 and 2030. As shown in this figure, Only in year 2010 and 2015 Slovakia didn't fulfil the NREAP planned capacities.

Solar photovoltaic capacity reached 533 MW in 2015 increasing with a CAGR of 94.8% (+514 MW) between 2010 and 2015. Comparing with the NREAP expectations this technology was over throughout period 2010-2015 exceeding since in 2011 the plan for 2020. Biomass installed capacity increased with a CAGR of 17.8% (+190 MW) between 2005 and 2015 reaching 236 MW. This source remained above the NREAP plans throughout period 2010-2015. Hydropower capacities in Slovakia stood at 1606 MW since in 2011. Comparing with expected NREAP capacities this technology was found to be under throughout period 2010-2015. Wind capacity reached only 4 MW in 2015, missing the respective planned capacities throughout period 2010-2015. Even that planned no geothermal capacities were introduced in Slovakia during period 2010-2015.

According to Slovakia NREAP in 2020 renewable electricity capacity is expected to have reached 2746 MW in which hydropower will remain the main source with 66.0% followed by wind (12.7%), solar photovoltaic (10.9%), biomass (10.2%) and geothermal (0.1%).

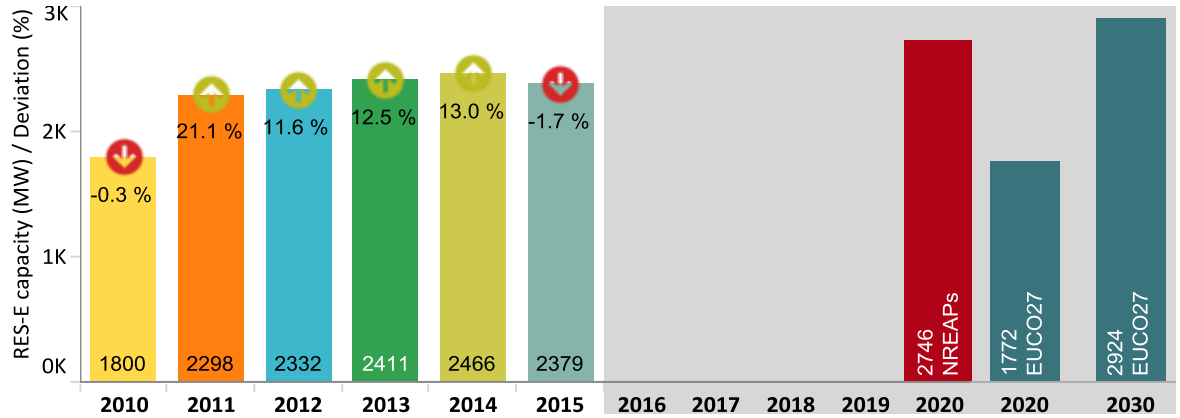


Figure 25 - 5. RES-E capacity development and deviation from NREAPs (2010-2015)– Expected capacity (2020-2030)

The EUCO27 projection for 2020 net generation capacity from renewables in Slovakia is much lower compared with NREAP, at 1772 MW, taking nevertheless in consideration the current share of solar photovoltaic that is missed by the NREAP plan. According to this projection Slovakia is expecting to have installed 2924 MW of renewable electricity capacity in 2030.

26. Finland

Renewables had the highest share in Finland's energy mix in 2015 followed by petroleum products and nuclear (Figure 26). In 2015 gross inland consumption of energy in Finland totalled to 33.1 Mtoe, 4.6% (-1615 ktoe) less than the consumption in 2014. Primary energy consumption was 32 Mtoe in 2015, 10.9% below the 2020 energy efficiency target[82]. Final energy consumption reached 24.2 Mtoe being 9.4% below the 2020 energy efficiency target for this indicator. Gross final energy consumption decreased during period 2014-2015 by 1.5% (-381 ktoe) amounting to 25.3 Mtoe. Energy intensity of the economy stood at 177.2 toe/Million Eur. Finland import dependence ratio in 2015 was 46.8% even that it overcome 100% for petroleum product and reached 99.7% for gas. After an increase during period 2001-2003 greenhouse gas emissions continued to decline at 61 Mt CO_2 eq in 2014, 15.6% below the emissions in 1990. Finland decreased more than the 2014 ESD target (-7.33%) the GHG emissions from year 2005, -14%. Energy remained the main source of emissions with a share of 54.6% (33.3 Mt CO_2 eq). In the same year the role of renewable energy in the reduction of GHG emissions reached a net savings of 43.2 Mt CO_2 eq, an additional of 6.0 Mt CO_2 since 2009.

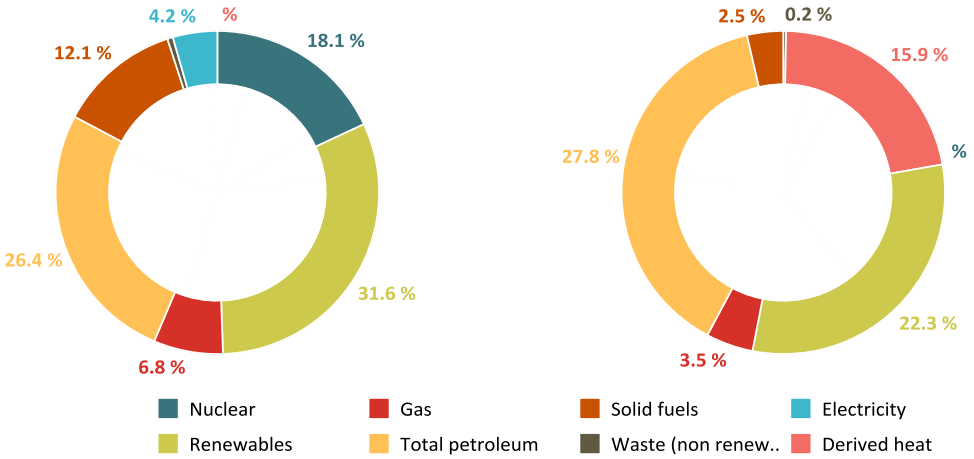


Figure 26. Breakdown of Gross Inland Consumption of Energy (left) - Final Energy Consumption (right) in FI, 2015

26.1 Final renewable energy consumption

Final renewable energy consumed in Finland amounted to 9955 ktoe (416.8 PJ) in 2015 increasing with a CAGR of 2.9% (+2439.5 ktoe). 71% of final renewable energy in Finland was originated from heating/cooling sector. The contributions of electricity and transport sectors stood respectively at 23.8% and 5.2%.

Figure 26-1 present the current trend of final renewable energy consumption in Finland and the deviations (in %) from the expected developments during period 2005-2015 as well as the 2020 NREAP plan and EUCO27 projections for 2020 and 2030. As shown in this Figure the current development of final renewable energy consumption in Finland was above the plans throughout period 2010 – 15.

The renewable energy consumed in Finland is expected to further increase to 10736 ktoe (449.5 PJ) until 2020. Contribution of sectors in the development of final renewable energy will change slightly in this year. Heating/cooling sector will remain the dominant sector but its relative share will reach 67.7% whereas electricity and transport sector will share respectively 26.7% and 5.6%.
The EUCO27 scenario has projected a lower final renewable consumption in Finland for 2020, at 9792 ktoe (410 PJ), compared with its NREAP. For 2030 this projection reveals the final consumption of renewable energy at 12738 ktoe (533.3 PJ).

[82] Finland energy efficiency 2020 targets are 35.9 Mtoe in terms of primary energy consumption and 26.7 Mtoe as final energy consumption.

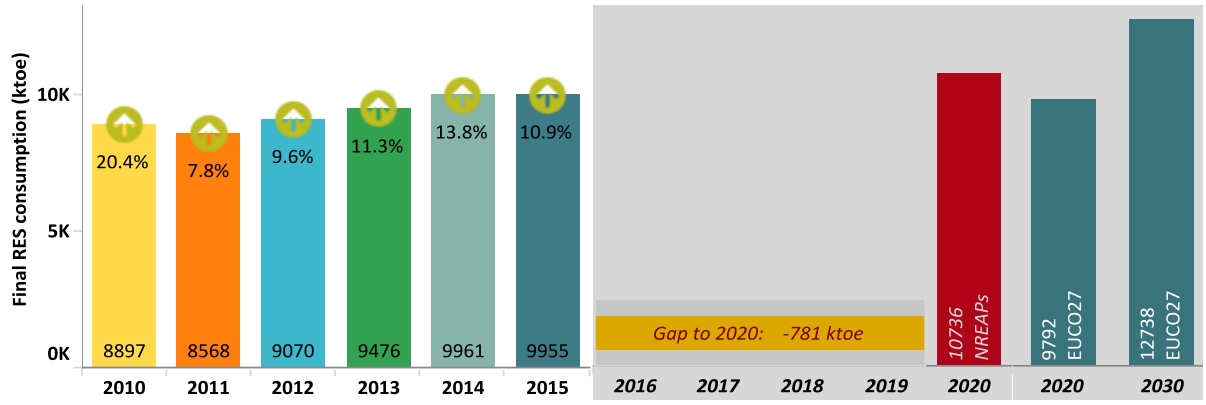


Figure 26 - 1. RES consumption: Trend, Deviation from NREAPs(2010-2015)-Expected RES consumption (2020-2030)

26.2 Renewable energy share

The overall renewable energy contribution in gross final energy consumption in Finland reached 38.7% in 2014 and 39.3% in 2015. The 2020 target that Finland has set in its NREAP is 38%. According to the EUCO27 scenario the overall renewable energy share in Finland is projected to reach 42.1% in 2020 and 52.8% in 2030.

Figure 26-2 shows the current trajectory of overall renewable energy share in Finland, the NREAPs trajectory, the Indicative trajectory as well as the Current trend forecast trajectory.

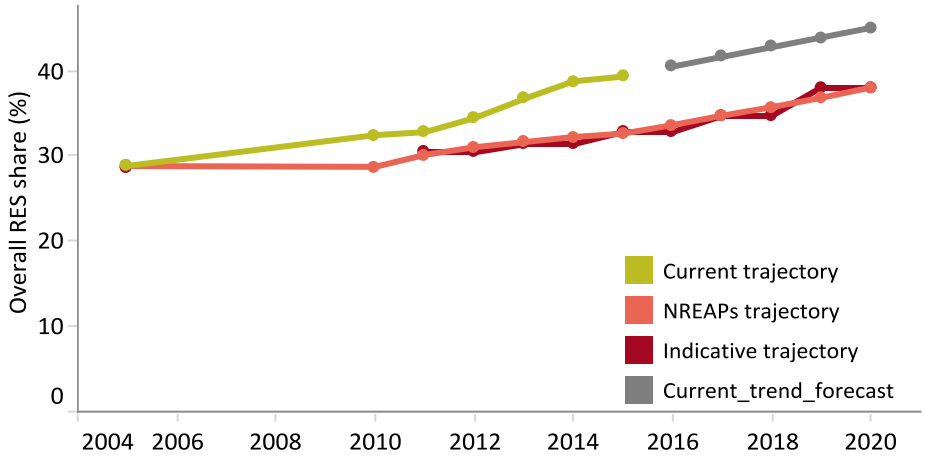


Figure 26 - 2. Overall RES share trajectories in FI: Current, NREAPs and Indicative - Current trend forecast, 2005-20

Overall renewable energy share in Finland remained above the NREAP and indicative trajectories throughout 2010-2015. Finland exceeded its overall renewable energy target for 2020 already in 2014. The fastest growth in renewable energy share took place in the heating/cooling and transport sectors, which exceeded the plans for 2020.

Development of renewable energy share in heating/cooling sector in Finland was fast reaching 51.9% in 2014 and 52.8% in 2015. Finland exceeded since in 2012 the 2020 plan (47%) for this share. In 2015 this exceedance was with 5.8 percentage points.

The development of renewable energy share in electricity sector resulted in a share of 31.4% in 2014 and 32.5% in 2015. This development was fast enough to exceed the expected NREAP shares throughout period 2010-2015. The 2020 plan in this sector is foreseen at 33%.

The share of renewable energy in transport sector reached 22% during period 2014-2015 after the significant decrease that took place during period 2011-12. In 2015 this indicator resulted higher compared with the 2020 plan (20%) for this sector.

26.3 Final renewable electricity, heating/cooling and use in transport

Renewable electricity consumed in Finland amounted to 27.6 TWh (2287.5 ktoe) in 2015 increasing with a CAGR of 1.6% (+3995 GWh) since 2005. The development of renewable electricity in Finland was over the NREAP plans throughout period 2010-2015. In 2015 hydropower share reached at 51.3% followed by biomass with 42.5%, wind with 7.2% and solar photovoltaic with 0.03%. In 2020 the renewable electricity consumption in Finland is expected to amount to 33.3 TWh (2866 ktoe) in which hydropower and biomass will share respectively 43.3% and 38.7% while wind contribution is expected at 18%.

The EUCO27 scenario for 2020 is broadly in line with Finland NREAP, at 29413 GWh (2444 ktoe). Hydropower contribution is projected at 48% followed by biomass at 33.6%, wind at 18.3% and solar photovoltaic at 0.02%. This scenario has projected that renewable electricity in Finland will reach 44336 GWh (3813 ktoe) in 2030 in which the share of biomass will be at 43.2%, hydropower at 34%, wind at 22.8%, and solar photovoltaic at 0.03%.

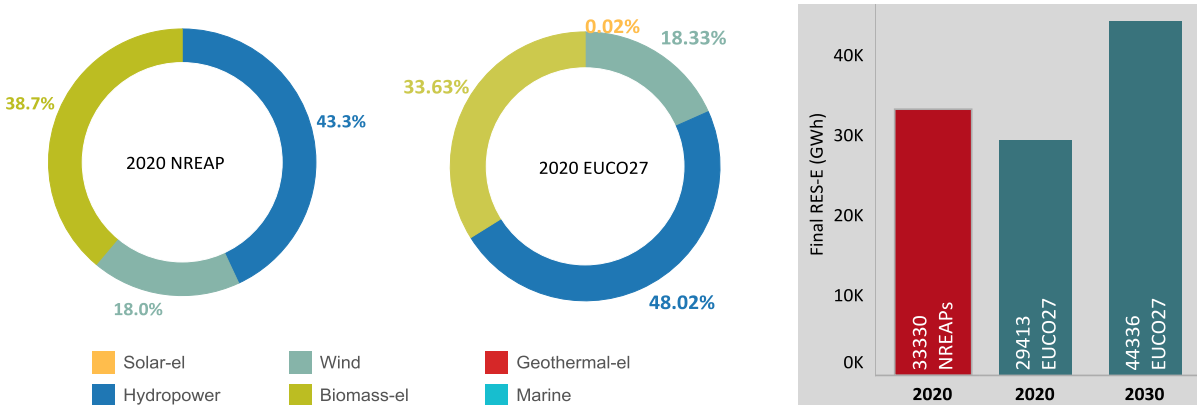


Figure 26 - 3. Final RES Electricity in Finland: NREAP plan (2020) – EUCO27 projections (2020-2030)

Renewable energy in heating/cooling in Finland reached 7069.4 ktoe (296 PJ) in 2015 increasing with a CAGR of 2.6% (+1596 ktoe) since 2005. The development of renewable energy in this sector was fast enough to exceed the expected NREAP heat productions throughout period 2010-2015. Biomass was the main source with a share equal to 94.2% followed by heat pumps (5.78%) and solar thermal (0.02%). In 2020 the heat production from renewable energy source sin Finland is expected to reach 7270 ktoe (304.4 PJ) in which the contribution of biomass is expected to decrease to 90.9% while the heat pump will take the rest 9.1%

The use of renewable energy in transport reached 514.6 ktoe (21.5 PJ) in 2015 developing with a CAGR of 42.5% (+500 ktoe) since 2005. The use of renewable energy in this sector missed the planned NREAP uses throughout period 2010-2013. In 2015 biodiesel covered more than 83% of the renewables used followed by bioethanol/bio-ETBE (12.7%), renewable electricity (3.6%) and other biofuels (0.3%). The use of renewable energy in transport sector in 2020 is expected to be 600 ktoe (25.1 PJ) in which the use of bioethanol/bio-ETBE will dominate with a contribution of 71.7% while biodiesel and renewable electricity are expected to reach respectively 21.7% and 6.7%.

Table 26 - 1. Final renewable energy in FI: deviations from NREAP in electricity, heating/cooling and transport

	2010	2011	2012	2013	2014	2015
RES-el (ktoe)	219	168	145	185	161	168
RES-hc (ktoe)	1,360	713	954	895	881	739
RES-tr (ktoe)	-71	-263	-302	-119	115	75
RES-el (%)	11.2	8.2	6.9	8.7	7.5	7.6
RES-hc (%)	26.1	12.7	16.3	14.8	14.2	11.7
RES-tr (%)	-30.7	-93.9	-94.5	-33.0	28.6	17.0

26.4 Renewable energy technologies/sources

Biomass was the main renewable energy source in Finland in 2015 with a contribution of 76.9% followed by hydropower with 12.4%, biofuels with 5.0%, heat pumps with 4.1%, wind with 1.7% and solar with 0.02%. In 2020, the share of biomass in final renewable energy in Finland is expected to decrease to 72.2%, followed by hydro with 11.6%, heat pump with 6.2%, biofuels with 5.2% and wind with 4.8%.

In this section: (i) Figure 26-4 present the current (2009-2015) and NREAP projected trend (2016-2020) of energy from renewable technologies/sources in Finland. The annual increase/decrease (%) of these sources in these two periods is also available in this figure; (ii) Table 26-2 presents how the actual figures reported for renewable technologies/sources in Finland compared with what was planned for the NREAPs. Absolute differences are shown in ktoe.

Between 2005 and 2015 biomass use for energy purposes in Finland increased with a CAGR of 2.0% (+1403 ktoe) reaching 7643 ktoe (320 PJ). Comparing with expected developments these uses were found to be over the NREAP plans throughout period 2010-2015. Even that not planned in Finland NREAP solar technology for electricity and heating/cooling reached 2.3 ktoe (0.1 PJ) in 2015 increasing with a CAGR of 12.6% (+1.6 ktoe) since 2005. After the period 2011-12 where "no use" of compliant biofuels in Finland transport sector took place, in year 2015 transport sector in this MS experienced the use of 496 ktoe (20.8 PJ) biofuels that surpassed the NREAP plans only period 2014-2015.

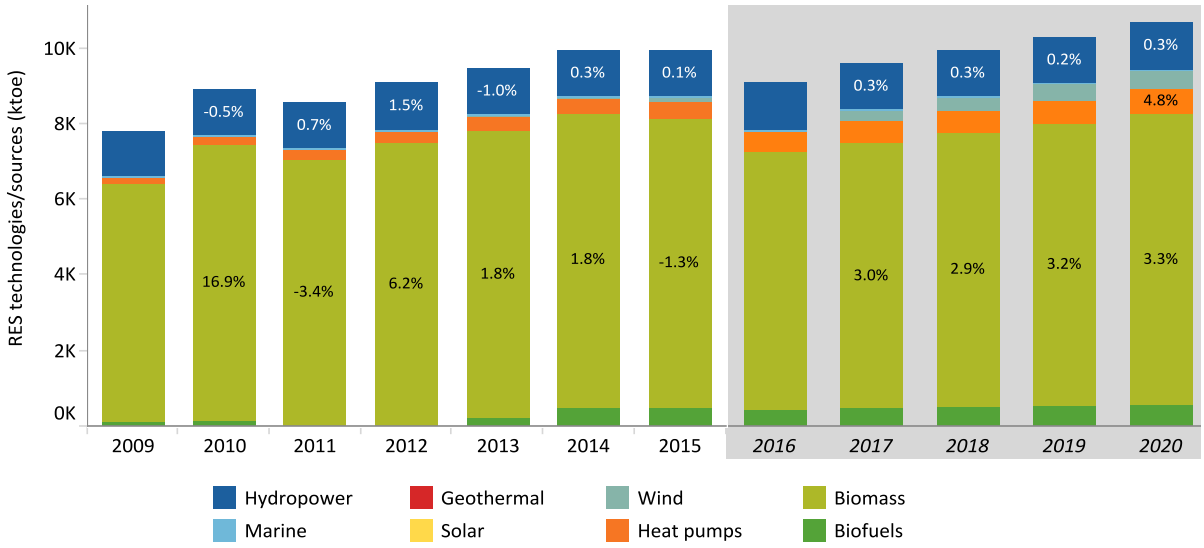


Figure 26 - 4. Annual growth of renewable energy technologies in FI: Current (2009-2015)-NREAP planned 2016-2020

Biomass use for electricity purposes reached 11432 GWh (983 ktoe) in 2015 developing with a CAGR of 1.9% (+1920 GWh) since 2005. Biomass use in this sector was found over the NREAP plans throughout period 2010-2015. Wind technology developed since 2005 with a CAGR of 29.2% (+1831 GWh) reaching 1985 GWh (171 ktoe) in 2015. Despite of this increase, wind technology remained throughout period 2010-2014 under the expectations set in Finland NREAP surpassing the plan only in year 2015. Even that not planned Finland reported on solar photovoltaic throughout period 2010-2015. In 2015 the contribution of this technology reached an amount of 9.5 GWh (0.8 ktoe). Over period 2005-2015 hydropower increased slightly with a CAGR of only 0.2% (+237 GWh) reaching 14148 GWh (1217 ktoe). This slow progress affected its negative deviation from the NREAP contributions remaining under those throughout period 2010-2015, except for year 2012.

The heat coming from the use of heat pumps developed fast during period 2005-2015 with a CAGR of 23% (+357 ktoe) reaching 408 ktoe (17 PJ). Nevertheless this technology remained under the NREAP expectations throughout period 2010-2015. Biomass thermal reached 6660 ktoe (279 PJ) in 2015 increasing with a CAGR of 2.1% (+1238 ktoe) over the contribution in year 2005. This development was fast enough to surpass the NREAP plans throughout period

2010-2015 as well as to exceed the 2020 plan since in year 2014. The contribution of solar thermal in this sector increased very slowly reached at the level of only 1.5 ktoe in 2015 even than no heat was expected form this technology according to Finland NREAP.

Biodiesel use in transport sector amounted to 429.5 ktoe (18 PJ) in 2015 increasing with a CAGR of 47% (+366 ktoe) over 2010 use. Nevertheless this development was slower than planned in the NREAP surpassing the plans only in period 2014-2015. Bioethanol/bio-ETBE use in transport sector in Finland decreased with a CAGR of -3.9% (-14 ktoe) during period 2010-2015 reaching 64.5 ktoe (2.7 PJ). Due to this development bioethanol/bio-ETBE missed the expected used throughout period 2011-15. While no use of other biofuels is planned in Finland NREAP this biofuel category reached 2.0 ktoe in 2015 from 0.9 ktoe in 2013. The use of Annex IX biofuels registered 458 ktoe (19.2 PJ) in 2015. The use of renewable electricity in transport followed an increasing trend since 2005 with a CAGR of 2.3% (+4.0 ktoe) reaching 19 ktoe (0.8 PJ), remaining nevertheless under the NREAP plans throughout period 2010-2015. In 2015 Finland used in this sector only 0.8% of its final renewable electricity.

Table 26 - 2. Renewable energy technologies/sources in Finland – deviations from NREAP, 2010-2015, (ktoe)

	2010	2011	2012	2013	2014	2015
Hydropower	-26.0	-17.2	1.1	-11.1	-7.9	-6.2
Wind	-3.1	-16.2	-29.8	-27.0	-13.1	40.0
Solar-el	0.4	0.5	0.5	0.6	0.7	0.8
Solar-th	0.9	1.0	1.1	1.2	1.4	1.5
Biomass-el	248.0	200.8	172.9	222.5	181.9	133.5
Biomass-th	1,358.7	755.4	1,037.9	991.6	1,031.8	859.7
Heat pumps	-0.1	-43.5	-84.7	-97.4	-102.1	-121.7
Biodiesel	-86.6	-180.0	-210.0	-84.1	155.2	129.5
Bioethanol	8.6	-80.0	-90.0	-34.1	-40.4	-55.5
Other biofuels	0.0	0.0	0.0	0.9	1.5	2.0
Renewable electricity	-2.6	-2.8	-2.5	-1.5	-1.7	-1.3

26.5 Renewable electricity installed capacity

Renewable electricity installed capacity in Finland reached 6053 MW in 2015 increasing with a CAGR of 2.3% (+122 MW) over the 2005 capacity. Hydropower installed capacity covered 53.6% of final renewable electricity capacity in Finland in year 2015 and the rest was biomass (29.6%), wind (16.6%) and solar photovoltaic (0.3%).

Figure 26-4 present the current trend of renewable electricity installed capacity in Finland, the deviations (in %) from the expected developments during period 2005-2015, the 2020 NREAP plan and EUCO27 scenario projections for 2020 and 2030. As shown in this figure, the installed renewable electricity capacity in Finland missed the NREAP plans throughout period 2011-2014. Only in year 2010 and 2015 Finland fulfilled the NREAP planned capacities.

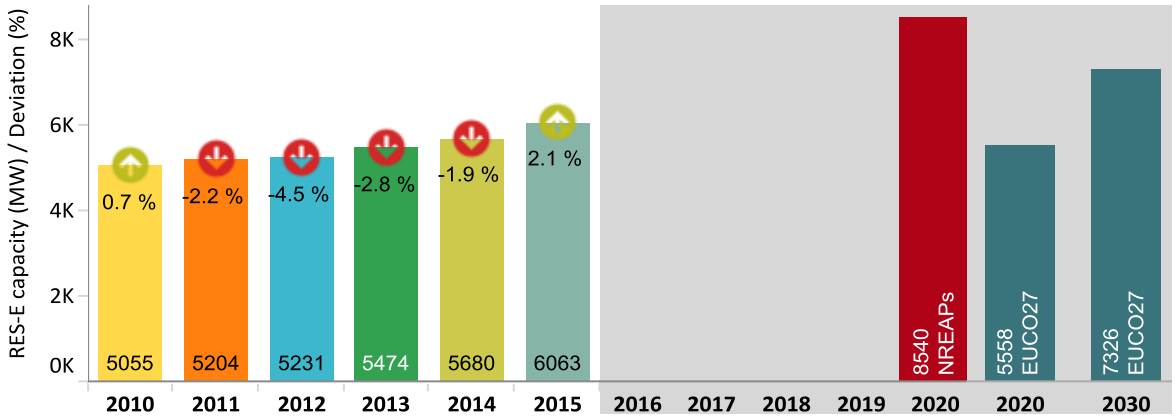


Figure 26 - 5. RES-E capacity development and deviation from NREAPs (2010-2015)– Expected capacity (2020-2030)

Wind technology installed capacity increased with a CAGR of 28.5% (+923 MW) during period 2005 and 2015 reaching 1005 MW. Nevertheless this technology missed the expected NREAP capacities throughout period 2011-15. Biomass capacity in Finland remained at the level of 1794 MW since 2013. This development was slower than what was expected according to NREAP throughout period 2010-2015. According to its NREAP Finland has planned to introduce the photovoltaic technology for electricity production in 2017. Nevertheless this technology was introduced since in 2005 with 5 MW reaching 15 MW in 2015.

In 2020 renewable electricity installed capacity is expected to reach 8540 MW in which hydropower will have a 36.3% contribution followed by biomass with 34.19%, wind power with 29.27%, solar and marine with 0.12% each.

The EUCO27 projections for 2020 and 2030 net generation capacity from renewables in Finland are found lower than the 2020 NREAP plan, maintaining the achieved share of solar photovoltaic in this capacity.

27. Sweden

Renewables had the highest share (42.2%) in Sweden's energy mix in 2015 together with nuclear (Figure 27). In 2015 gross inland consumption of energy in Sweden totalled to 45.5 Mtoe, 5.7% (-2735 ktoe) less than the consumption in 2014. Primary energy consumption was 43.7 Mtoe in 2015, 0.7% above the 2020 energy efficiency target[83]. Final energy consumption reached 31.8 Mtoe being 5.0% above the 2020 energy efficiency target for this indicator. Gross final energy consumption increased during period 2014-2015 by 1.3% (+445 ktoe) amounting to 33.9 Mtoe. Energy intensity of the economy decreased to 111 toe/Million Eur. Sweden had an import dependence ratio at 30% in 2015. Nevertheless the import dependence ratio for petroleum products (105.4%), gas (99.1%) and solid fuels (92.3%) remained high. After an increase during 1994-96 greenhouse gas emissions continued to decline at 56.7 Mt CO_2 eq in 2014, 22.6% below the emissions in 1990. Sweden decreased more than 2014 ESD target (-8.43%) its GHG emissions compared with 2005 (-18%). Energy remained the main source of emissions with a share of 37.7% (21.4 Mt CO_2 eq). In the same year the role of renewable energy in the reduction of GHG emissions reached a net savings of 14.8 Mt CO_2 eq, an additional of 1.5 Mt CO_2 since 2009.

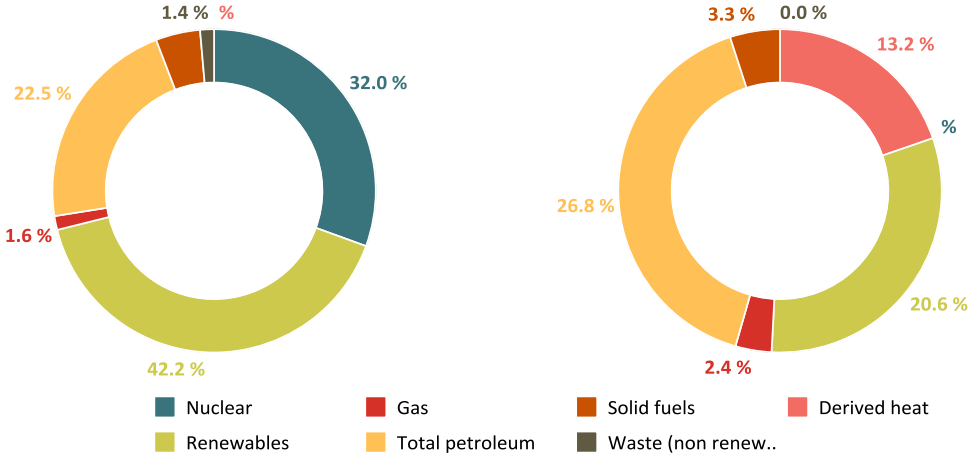


Figure 27. Breakdown of Gross Inland Consumption of Energy (left) - Final Energy Consumption (right) in SE, 2015

27.1 Final renewable energy consumption

Final renewable energy consumed in Sweden has gone up since 2005 with a CAGR of 2.6% (+4208 ktoe) reaching 18774 ktoe (786 PJ). 51% of final renewable energy in Sweden was coming from heating/cooling sector and the rest from electrciity (42%) and transport (7%).

Figure 27-1 present the current trend of final renewable energy consumption in Sweden and the deviations (in %) from the expected developments during period 2005-2015 as well as the 2020 NREAP plan and EUCO27 projections for 2020 and 2030. As shown in this figure the current development of final renewable energy consumption in Sweden was above the plans throughout period 2010 – 2015

Renewable energy consumed in Sweden is expected to further increase to 19914 ktoe (833.8 PJ) until 2020. The contribution of sectors will change slightly: heating/cooling 52.9%, electricity 42% and transport 5.1%.

The EUCO27 scenario has projected a lower final renewable consumption in Sweden for 2020, at 18196 ktoe (762 PJ), compared with its NREAP. For 2030 this projection reveals the final consumption of renewable energy at 20371 ktoe (853 PJ).

[83] Sweden energy efficiency 2020 targets are 43.4 Mtoe in terms of primary energy consumption and 30.3 Mtoe as final energy consumption.

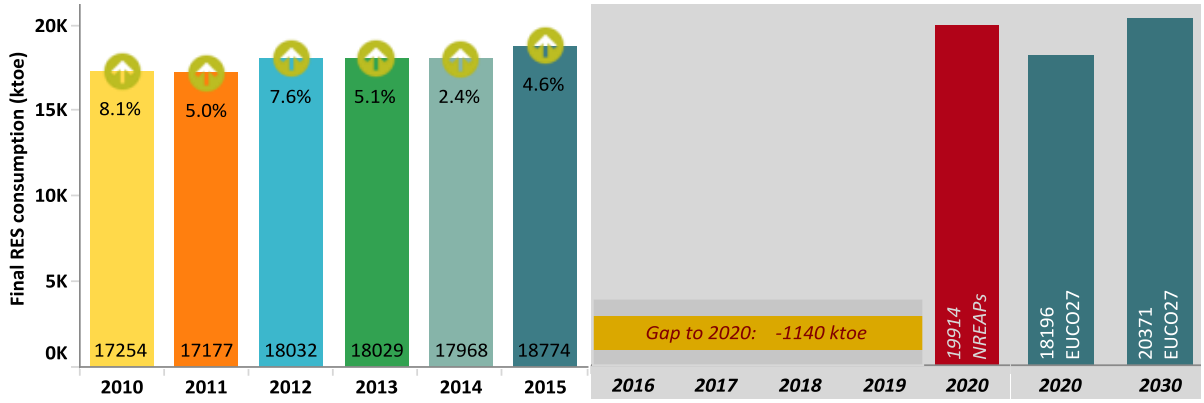


Figure 27 - 1. RES consumption: Trend, Deviation from NREAPs(2010-2015)-Expected RES consumption (2020-2030)

27.2 Renewable energy share

Sweden reached in 2014 an overall renewable energy share equal to 52.5% of its gross final energy consumption increasing then further to 53.9% in 2015. According to the EUCO27 scenario the overall renewable energy share in Sweden is projected to reach 56.7% in 2020 and 66.4% in 2030.

Figure 27-2 shows the current trajectory of overall renewable energy share in Sweden, the NREAPs trajectory, the Indicative trajectory as well as the Current trend forecast trajectory.

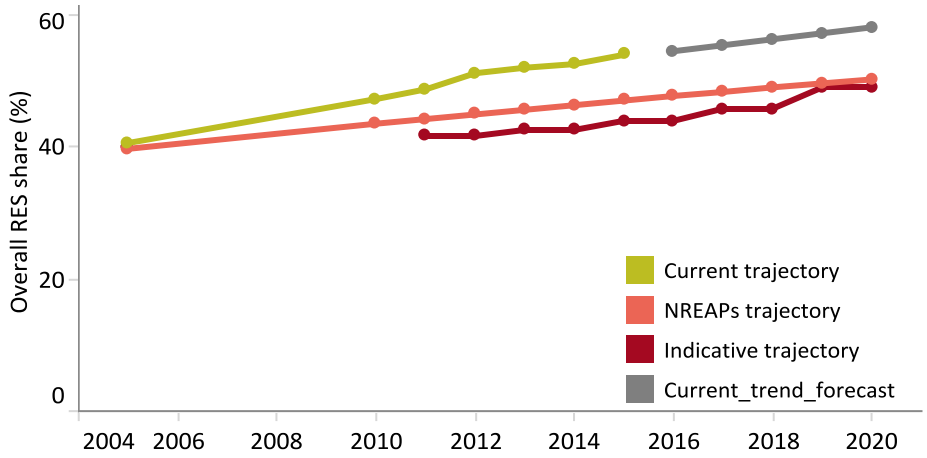


Figure 27 - 2. Overall RES share trajectories in SE: Current, NREAPs and Indicative - Current trend forecast, 2005-20

Overall renewable energy share in Sweden remained above the NREAP and indicative trajectories throughout 2010-2015. Sweden already exceeded the planned 2020 target of 50.2 % in 2012, when it achieved 51.1%. Sweden also exceeded the 2020 plans on overall renewable energy share in all sectors. Sweden needs to revise the share of renewable energy in three sectors in order to keep pace with the current development of renewable energy in these

The development of renewable energy share in heating/cooling sector was determinant in the development of overall renewable energy share in Sweden during period 2010-2015. Sweden exceeded since in 2011 (62.2%) the expected 2020 plan share (62.1%) in this sector. In 2015 (68.6%) the exceedance from 2020 plan was with 6.5 percentage points.
Renewable energy share in electricity sector reached 63.2% in 2014 and 65.8% in 2015 exceeding the 2020 planned share (62.9%) in this sector.
Renewable energy development in transport sector happened also very fast reaching 21.1% in 2014 and 24% in 2015. Renewable energy in this sector exceeded since in 2012 (14.8%) the 2020 planned share (13.8%). In 2015 the exceedance from the planned 2020 share was with +10.2 percentage points

27.3 Final renewable electricity, heating/cooling and use in transport

Renewable electricity consumption in Sweden amounted to 91.6 TWh (7878 ktoe) in 2015 developing with a CAGR of 1.8% (+14.8 TWh) since 2005. In 2015 hydropower share reached at 72.8% followed by wind (15.4%), biomass (11.7%) and solar photovoltaic (0.1%).

Comparing with the expected NREAP developments renewable electricity in Sweden missed the plans only in year 2014 exceeding in 2015 by 1.2% (+1126 GWh) the plan for year 2020 (90.5 TWh). According to Sweden NREAP in 2020 the contribution of hydropower is planned to reach 69.9%, biomass 17.2%, wind 12.85% and solar photovoltaic 0.004%.

The EUCO27 scenario for 2020 is broadly in line with Sweden NREAP, at 106.8 TWh (9184 ktoe). Hydropower contribution is projected at 67% followed by biomass at 19.3%, wind at 13.6% and solar photovoltaic at 0.1%. This scenario has projected that renewable electricity in Sweden will reach 134.6 TWh (11.6 Mtoe) in 2030 in which the share of hydropower will be at 52.5%, wind at 32.4%, biomass at 15.1%, and solar photovoltaic at 0.1%.

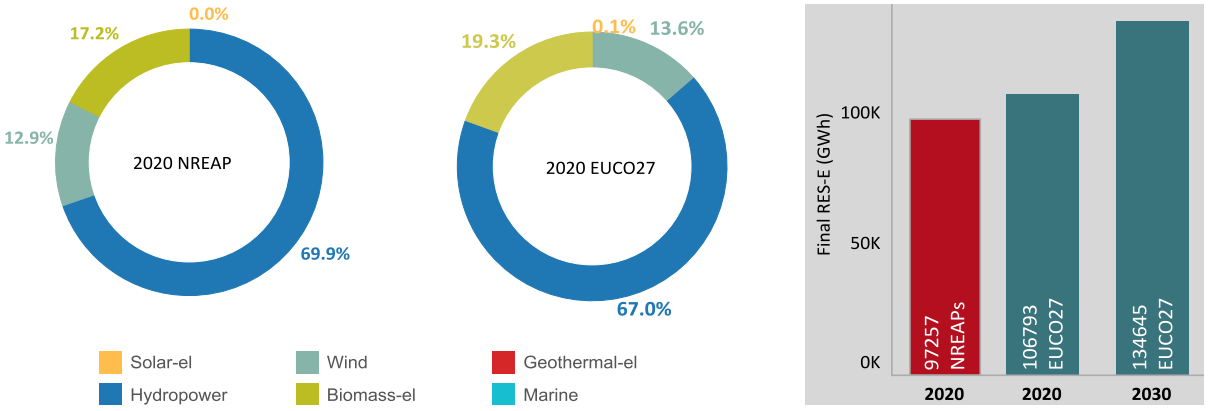


Figure 27 - 3. Final RES Electricity in Sweden: NREAP plan (2020) – EUCO27 projections (2020-2030)

Renewable energy in heating/cooling in Sweden amounted to 9581 ktoe (401 PJ) in 2015 increasing since 2005 with a CAGR of 2.2% (+1910 ktoe). The development of renewable energy in this sector was faster than planned in the NREAP throughout period 2010-2015. In 2015 biomass reached a share of 87.4% followed by heat pump with 12.5% and solar thermal with 0.1%. In 2020 renewable heat/cold in Sweden is expected to reach 10542 ktoe (441.4 PJ) in which biomass will share 90% followed by heat pumps with 9.9% and solar thermal with only 0.1%.

The use of renewable energy in transport reached 1315 ktoe (55 PJ) in 2015 increasing with a CAGR of 16.3% (+1025 ktoe) since 2005. The use of renewable energy in this sector was found to be over the expected use throughout period 2010-2015. In 2014 biodiesel share reached at 70.8% followed by bioethanol-bio/ETBE (10.8%), renewable electricity (10.5%) and other biofuels (7.9%). In 2020 it is expected a use of 1008 ktoe (42.2 PJ) renewable energy in which bioethanol/bio-ETBE is expected reach 46.1%, followed by biodiesel with 24.9% and the rest will be renewable electricity (19.6%) and other biofuels (9.3%).

Table 27 - 1. Final renewable energy in SE: deviations from NREAP in electricity, heating/cooling and transport

	2010	2011	2012	2013	2014	2015
RES-el (ktoe)	50	50	142	55	-160	98
RES-hc (ktoe)	1,229	689	1,003	521	178	190
RES-tr (ktoe)	14	81	134	306	406	547
RES-el (%)	0.7	0.7	1.9	0.7	-2.1	1.3
RES-hc (%)	14.9	8.1	11.5	5.8	1.9	2.0
RES-tr (%)	2.6	14.0	21.5	45.6	56.3	71.2

27.4 Renewable energy technologies/sources

In 2015 biomass was providing half of final renewable energy in Sweden followed by hydropower with 30.8% wind with 6.5%, heat pumps with 6.4%, biofuels with 6.3% and solar technology with only 0.1%. In 2020, the share of biomass in renewable energy mix is expected to increase to 55%, followed by hydro with 30%, wind with 6%, heat pumps with 5% and biofuels with 4%.

In this section: (i) Figure 27-4 present the current (2009-2015) and NREAP projected trend (2016-2020) of energy from renewable technologies/sources in Sweden. The annual increase/decrease (%) of these sources in these two periods is also available in this figure; (ii) Table 27-2 presents how the actual figures reported for renewable technologies/sources in Sweden compared with what was planned for the NREAPs. Absolute differences are shown in ktoe.

Solar technology in electricity and heating/cooling sectors developed since 2005 with a CAGR of 12.4% (+13.5 ktoe) reaching 19.6 (0.8 PJ) ktoe in 2015. This technology developed faster than planned throughout period 2010-2015 exceeding since in 2007 the 2020 plan (6.3 ktoe). Biomass use for electricity and heat/cold in Sweden reached 9296 ktoe (389 PJ) in 2015 increasing with a CAGR of 1.9% (+1574 ktoe) over the 2005 use. The development of biomass used for electricity and heat in Sweden was not at the expected level surpassing the plans only in year 2010 and 2012. Biofuels in Sweden increased their use in transport sector with a CAGR of 21.6% (+1011 ktoe) during period 2005-2015 reaching 1177 ktoe (49.3 PJ). Their use was found over the expected NREAP uses throughout period 2010-2015.

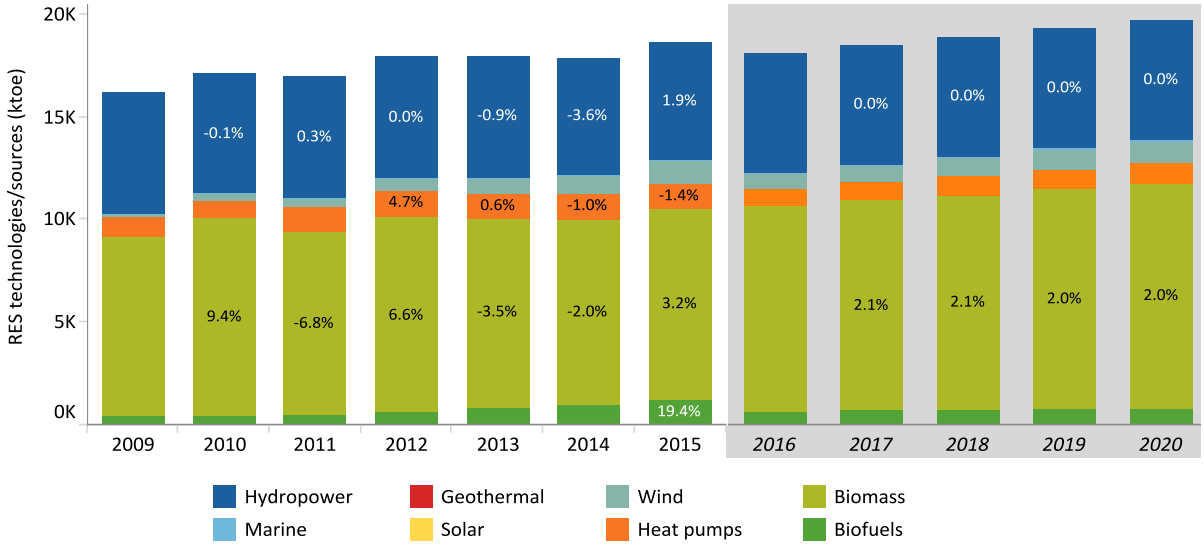


Figure 27 - 4.Annual growth of renewable energy technologies in SE: Current (2009-2015)-NREAP planned 2016-2020

Solar photovoltaic was the technology with the highest relative increase between 2005 and 2015 with a CAGR of 46.5% (+95 GWh) since 2005 reaching 97 GWh (8.3 ktoe). The development of this technology met since in 2008 the very low 2020 plan (4 GWh). In year 2015 this technology was more than 24 times higher than the 2020 plan. Renewable electricity from wind power reached 14117 GWh (1214 ktoe) in 2015 increasing with a CAGR of 31.6% (+13211 GWh) over the 2005 level. Comparing with NREAP planned level wind technology was over the plans throughout period 2011-15. Biomass use of electricity purposes in Sweden developed with a CAGR of 3.7% (+3247 GWh) since 2005 reaching 10737 GWh (923.4 ktoe) in 2015. This source developed faster than planned during period 2010-12 but slower in period 2013-15. Renewable electricity coming from hydropower followed a decreasing trend with a CAGR of -0.3% (-1753 GWh) between 2005 and 2015. The decrease was deeper during period 2013-15 in which this technology remained behind the NREAP plans.

No changes were planned in heat production from solar thermal in Sweden NREAP up to 2020. Nevertheless the heat production from this technology remained above these plans throughout period 2010-2015 reaching the level of 11.3 ktoe (0.5 PJ) in 2015. It exceeded since in 2007 (8.6 ktoe) the 2020 plan (6 ktoe). Heat pumps reached 1196 ktoe (50 PJ) in 2015 increasing with a CAGR of 7.4% (+610 ktoe) since 2005. This technology remained above the NREAP plans throughout period 2010-2015 exceeding since in 2011 the plaqn for year 2020 (1045 ktoe). In 2015 the use of biomass for heat production increased with a CAGR of only 1.7% (+1295 GWh) since 20015 reaching 8373 ktoe (351 PJ). The use of biomass for heat production was faster than what was expected from the Sweden NREAP only in years 2010 and 2012 missing the plans in other years of period 2010-2015.

Biodiesel use in transport sector increased with a CAGR of 59.6% (+923 ktoe) between 2005 and 2015 reaching 931 ktoe (39 PJ). In comparison with NREAP planned values the use of biodiesel in Sweden was higher throughout period 2010-2015. The use of bioethanol/bio-ETBE in transport sector experienced a decrease with a CAGR of -1.0% (-15 ktoe) between 2005 and 2015 reaching 142 ktoe (6 PJ). Due to this downward trend the uses of this biofuel sub-category remained below the NREAP plans throughout period 2010-2015. Other biofuels (biogas and vegetable oils) were used at the level of 103.6 ktoe (4.3 PJ) in Sweden in 2015 increasing with a CAGR of 35.3% (+80.8 ktoe) over the use in 2010. This development was faster than planned throughout period 2011-15. The use of Annex IX biofuels reached 544.3 ktoe (22.8 PJ) in 2015 remaining over the NREAP plans throughout period 2011-15. In 2011 the use of this biofuels category met the 2020 plan (94 ktoe) and in 2015 it almost 6 time-fold this plan. The use of renewable electricity in transport sector in Sweden increased with a CAGR of only 1.1% between 2005 and 2015 reaching 138 ktoe (5.8 PJ). This development was not fast enough to meet the expected NREAP levels during period 2010-2015. In 2015 Sweden used in this sector 1.8% of its final renewable electricity.

Table 27 - 2. Renewable energy technologies/sources in Sweden – deviations from NREAP, 2010-2015, (ktoe)

	2010	2011	2012	2013	2014	2015
Hydropower	0	22	24	-29	-236	-127
Wind	-85	2	87	179	275	470
Solar-el	1	1	1	3	4	8
Solar-th	4	5	5	5	5	5
Biomass-el	134	25	29	-98	-209	-254
Biomass-th	656	-103	269	-151	-436	-313
Heat pumps	569	745	729	667	586	498
Biodiesel	99	112	221	393	551	761
Bioethanol	-32	-82	-80	-103	-150	-216
Other biofuels	-17	13	21	32	33	37
Renewable electricity	-36	-20	-28	-20	-33	-35

27.5 Renewable electricity installed capacity

The renewable electricity installed capacity in Sweden reached 26452 MW in 2015 increasing with a CAGR of 3.2% (+7085 MW) over the 2005 capacity. The development of renewable electricity installed capacity in Sweden was faster than planned in the NREAP exceeding by 0.9% (+215 MW) in 2012 the 2020 planned capacity of 23786 MW. In 2015 this exceedance was with 11.2% (+2666 MW).

In 2015 the hydropower presented 61.4% of renewable electricity installed capacity in Sweden followed by wind with 22.1%, biomass with 16.2%, and photovoltaic with only 0.4%.

Figure 27-5 present the current trend of renewable electricity installed capacity in Sweden, the deviations (in %) from the expected developments during period 2005-2015, the 2020 NREAP plan and EUCO27 scenario projections for 2020 and 2030. As shown in this figure the installed renewable electricity capacity in Sweden surpassed the NREAP plans throughout period 2010-2015.

The development of solar photovoltaic since 2005 took place with a CAGR of 38.5% (+100 MW) reaching 104 MW. This technology exceeded since in 2008 the low capacity planned for year 2020 (8 MW). In 2015 this exceedance was with a factor of 13 (+96 MW). Wind installed capacity increased with a CAGR of 28.0% (+5347 MW) during period 2005-2015 amounting to 5840 MW. This technology exceeded in 2014 the planned capacity for year 2020 by 12% (+550 MW). Biomass capacity in Sweden increased with a CAGR of 5.2% (+1710 MW) between 2005 and 2015 reaching 4278 MW. This source exceeded since in 2009 the plan for year 2020. In 2015 the exceedance was with 46.8% (+1364 MW). Hydropower capacity in Sweden increased and decreased within period 2005-14 exceeding in 2011 and 2013 the 2020 plan. Nevertheless this technology decreased during period 2014-2015 reaching 16230 MW missing the plans for this period.

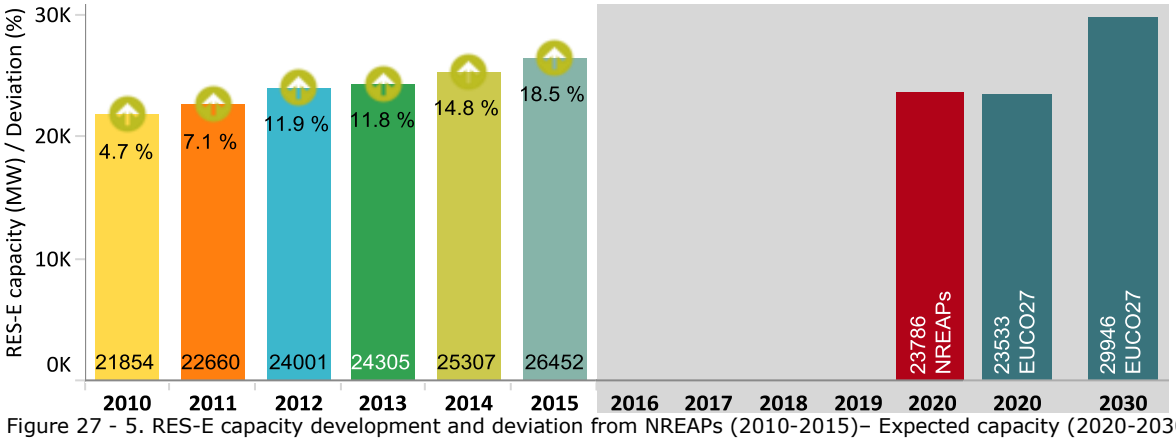


Figure 27 - 5. RES-E capacity development and deviation from NREAPs (2010-2015)– Expected capacity (2020-2030)

In 2020 Sweden has planned to reach a net generation capacity from renewables equal to 22786 MW in which hydropower will still maintain the main contribution with 68.6% followed by wind with 19.12%, biomass with 12.25% and photovoltaic with 0.03%.

The EUCO27 projection for 2020 is in line with the NREAP plan, at 23533 MW, maintaining the current share of solar photovoltaic in this capacity. According to this projection Sweden is expected to have reached a capacity of 29946 MW from renewable energy sources in 2030.

28. United Kingdom

Petroleum products had the highest share in UK's energy mix in 2015 together with gas whereas the share of renewables reached 7.7% (Figure 28). In 2015 gross inland consumption of energy in UK totalled to 190.7 Mtoe, 0.5% (+1038 ktoe) higher than the consumption in 2014. Primary energy consumption was 183 Mtoe in 2015, 3.0% above the 2020 energy efficiency target[84]. Final energy consumption reached 130.3 Mtoe being 0.9% above the 2020 energy efficiency target for this indicator. Gross final energy consumption increased during period 2014-2015 by 1.5% (+1921 ktoe) amounting to 131.1 Mtoe. Energy intensity of the economy decreased to 94.3 toe/Million Eur, 1.6% less than in 2014. Import dependence ratio for UK increased over the years reaching 37.4% in 2015. UK passed from an exporter of petroleum products and gas to an importer with a ratio respectively of 36.4% and 41.8%. Greenhouse gas emissions continued to decline at 556.7 Mt CO_2 eq in 2014, 31.5% below the emissions in 1990. UK decreased by 23% its GHG emissions from 2005, more than the 2014 ESD target (-9.03%). Energy remained the main source of emissions with a share of 55.7% (310 Mt CO_2 eq). In the same year the role of renewable energy in the reduction of GHG emissions reached a net savings of 44.4 Mt CO_2 eq, an additional of 33 Mt CO_2 since 2009.

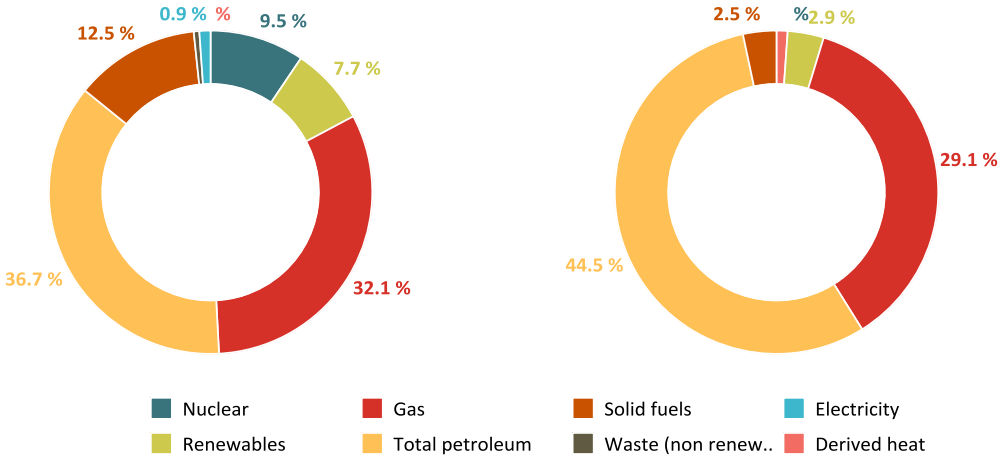


Figure 28. Breakdown of Gross Inland Consumption of Energy (left) - Final Energy Consumption (right) in UK, 2015

28.1 Final renewable energy consumption

The renewable energy consumed in United Kingdom increased with a CAGR of 18% between 2005 and 2015 reaching 10889 ktoe (456 PJ). More than 63% of final renewable energy consumed in the UK is in the form of renewable electricity whereas the rest was renewable heating/cooling (27.4%) and transport (9.6%).

Figure 28-1 present the current trend of final renewable energy consumption in United Kingdom and the deviations (in %) from the expected developments during period 2005-2015 as well as the 2020 NREAP plan and EUCO27 projections for 2020 and 2030. As shown in this figure the current development of final renewable energy consumption in United Kingdom was above the plans throughout period 2010 – 2015

Renewable energy consumed in United Kingdom is expected to further increase until 2020 with a CAGR of 13.7% to reach 20734 ktoe (868 PJ). The contribution of transport sector is expected to increase to 21.6% whereas the shares of electricity and heating/cooling sectors will be respectively 48% and 29.9%. The EUCO27 scenario has projected a higher final renewable consumption in UK for 2020, at 24166 ktoe (1013 PJ), compared with its NREAP. For 2030 this projection reveals the final consumption of renewable energy at 31401 ktoe (1315 PJ).

[84] UK energy efficiency 2020 targets are 172.6 Mtoe in terms of primary energy consumption and 129.2 Mtoe as final energy consumption.

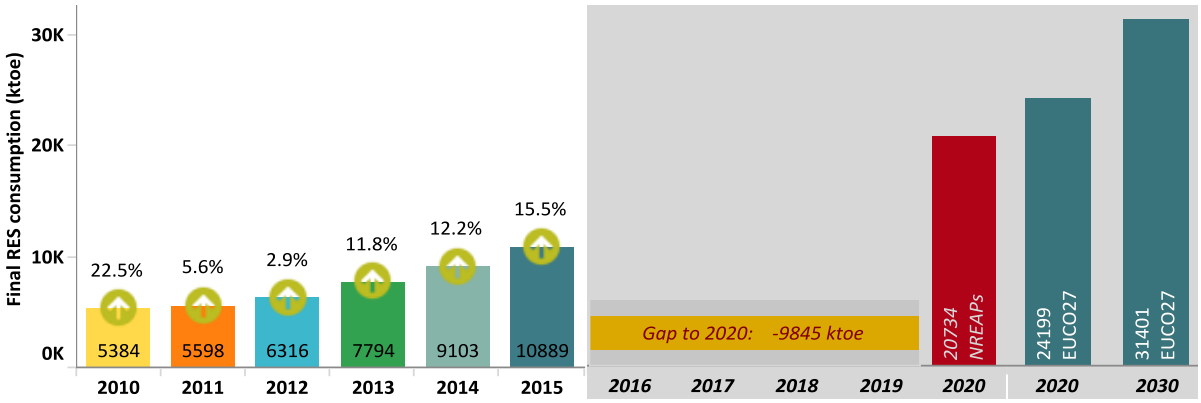


Figure 28 - 1. RES consumption: Trend, Deviation from NREAPs(2010-2015)-Expected RES consumption (2020-2030)

28.2 Renewable energy share

The overall renewable energy contribution in gross final energy consumption in United Kingdom reached 7.1% in 2014 and 8.2% in 2015. The 2020 target that United Kingdom has to reach for the overall RES share is 15%. According to the EUCO27 scenario the overall renewable energy share in the UK is projected to reach 14.7% in 2020 and 20% in 2030.

Figure 28-2 shows the current trajectory of overall renewable energy share in the United Kingdom, the NREAPs trajectory, the Indicative trajectory as well as the Current trend forecast trajectory.

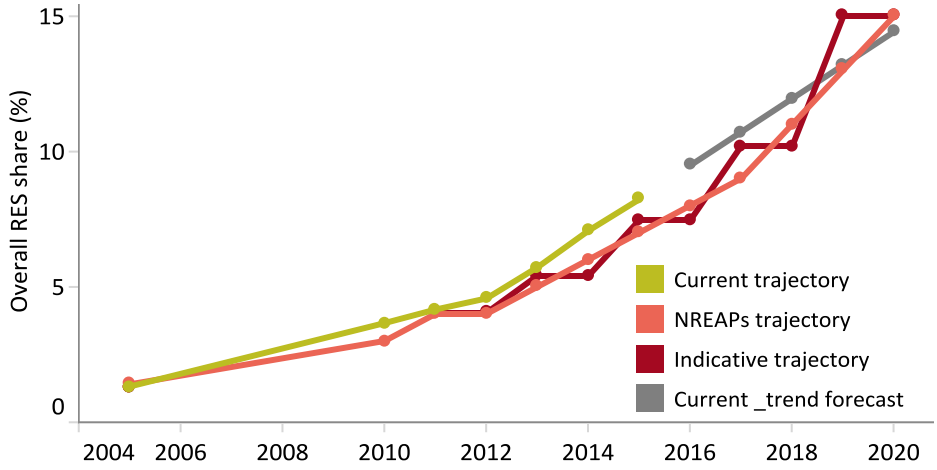


Figure 28 - 2. Overall RES share trajectories in UK: Current, NREAPs and Indicative - Current trend forecast, 2005-20

Overall renewable energy share in the United Kingdom remained broadly in line with the NREAP and indicative trajectories throughout 2010-2015. Even though renewable electricity deployment has progressed fast and renewable heating/cooling remained above the planned trend, the UK might fall behind expectations when it comes to meeting its 2020 target.

Renewable electricity share reached 17.9% in 2014 and 22.4% in 2015. This share exceeded the expected only in period 2013-15. The 2020 plan for renewable energy share in this sector is foreseen to reach 31%.

Renewable energy share in heating/cooling sector reached 4.7% in 2014 and 5.5% in 2015. This development was faster than the NREAP projected one throughout period 2010-2015. The 2020 plan for this sector is 12%.

The share of renewable energy in transport sector was found at 5.3% in 2014 and 4.7% in 2015. This development was more or less in line with the plans in period 2011-14 but below in year 2015. The 2020 planned share in this sector is expected to reach 10.3%.

28.3 Final renewable electricity, heating/cooling and use in transport

Renewable electricity consumption in United Kingdom increased with a CAGR of 17% (+63.2 TWh) reaching 79.9 TWh (6869 ktoe) in 2015 since 2005. This development was enough to exceed the NREAP planned values only in period 2013-15. In 2015 wind was the main source wth 47.1% followed by biomass with 36.8%, solar photovoltaic with 9.5% and hydropower with 6.7%. In 2020 the renewable electricity consumption in United Kingdom is expected to reach 117 TWh (10.1 Mtoe) in wich wind power is expected to have a share at 67%, f biomass at 22.4%, hydropower at 5.4%, marine at 3.4% and solar at 1.9%.

The EUCO27 scenario has projected a higher final renewable electricity for 2020 compared with the United Kingdom NREAP, at 160.9 TWh (13.8 Mtoe). Wind contribution is projected at 59.3%, biomass at 31.7%, solar photovoltaic at 5.6%, hydropower at 3.3% and marine at 0.1%. This scenario has projected that renewable electricity in the United Kingdom will reach 195.7 TWh (16.8 Mtoe) in 2030 in which wind share is projected at 56.2%, biomass at 36.4%, solar photovoltaic at 4.6%, hydropower at 2.7% and marine at 0.1%.

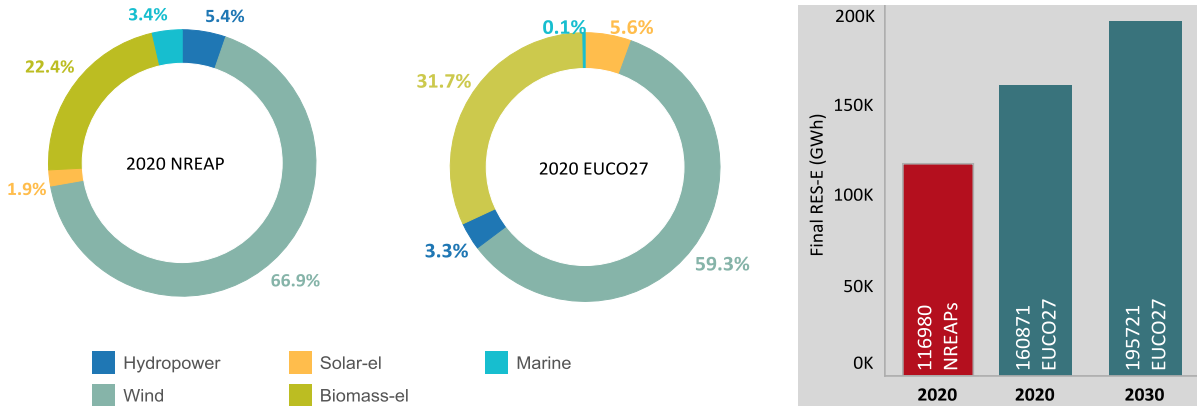


Figure 28 - 3. Final RES Electricity in United Kingdom: NREAP plan (2020) – EUCO27 projections (2020-2030)

Renewable energy in heating/cooling in United Kingdom increased with a CAGR of 19.4% (+2472 ktoe) during 2005-2015 reaching 2979 ktoe (125 PJ). Comparing with expected development renewable heat/cold in UK was found above the NREAP plans throughout period 2010-2015. In 2014 biomass contribution was 94%, the rest was heat pumps (4.3%) and solar thermal (1.7%). In 2010 the heat/cold production from renewable energy sources is expected to reach 6202 ktoe (259.7 PJ) in which biomass is expected share 63.1% and the rest will be heat pumps (36.3%) and solar thermal (0.5%).

The use of renewable energy in transport reached 1042 ktoe (43.6 PJ) in 2015 increasing with a CAGR of 24.2% (+923 ktoe) since 2005. Comparing with respective NREAP planned values the use of renewable energy in this sector was lower throughout period 2011-15. In 2015 biodiesel share reached at 51.4% followed by bioethanol/bio-ETBE 39.3% and renewable electricity 9.4%. The use of renewable energy in transport sector in 2020 is expected to be 4472 ktoe (187.2 PJ). In 2020 biodiesel use in transport sector is expected to have a share of 55.1% while bioethanol/bio-ETBE and renewable electricity are expected to reach respectively to 39% and 6%.

Table 28 - 1. Final renewable energy in UK: deviations from NREAP in electricity, heating/cooling and transport

	2010	2011	2012	2013	2014	2015
RES-el (ktoe)	-302	-404	-175	334	879	1,680
RES-hc (ktoe)	1,211	1,031	1,151	1,319	1,180	1,439
RES-tr (ktoe)	80	-328	-797	-827	-1,067	-1,660
RES-el (%)	-11.1	-12.7	-4.9	8.2	19.2	32.4
RES-hc (%)	223.0	160.4	148.5	138.5	98.7	93.4
RES-tr (%)	7.1	-22.4	-45.6	-42.3	-45.8	-61.4

28.4 Renewable energy technologies/sources

Biomass was the main renewable energy source in United Kingdom with a 49.4% contribution in its final renewable energy in 2015, followed by wind with 30%, biofuels with 8.8%, solar with 6.5%, hydropower with 4.2% and heat pumps with 1.2%. In 2020, the share of biomass in renewable energy mix is expected to be dominated by wind technology (33%) followed by biomass (30%), biofuels (20%), heat pumps (11%), hydropower (3%), marine (2%) and solar (1%).

In this section: (i) Figure 28-4 present the current (2009-2015) and NREAP projected trend (2016-2020) of energy from renewable technologies/sources in United Kingdom. The annual increase/decrease (%) of these sources in these two periods is also available in this figure; (ii) Table 28-2 presents how the actual figures reported for renewable technologies/sources in United Kingdom compared with what was planned for the NREAPs. Absolute differences are shown in ktoe.

Solar technology for electricity and heating/cooling increased with a CAGR of 37% (671 ktoe) during 2005-2015 time spans reaching 701 ktoe (29.3 PJ) in 2015. This development was faster than planned throughout period 2005-2015 exceeding since in 2014 the 2020 expected plan (226.6 ktoe). Biomass use for energy production in United Kingdom increased with a CAGR of 15.5% (+4069 ktoe) during period 2005-2015 reaching 5328 ktoe (223 PJ). The development of this source was found over the expected NREAP projections throughout period 2010-2015. Biofuels use in transport sector had the fastest development during period 2005-2015 increasing with a CAGR of 30% (+876 ktoe) reaching 944.3 ktoe (39.5 PJ). Nevertheless this development was slower than the NREAP projected one missing the plans throughout period 2011-15.

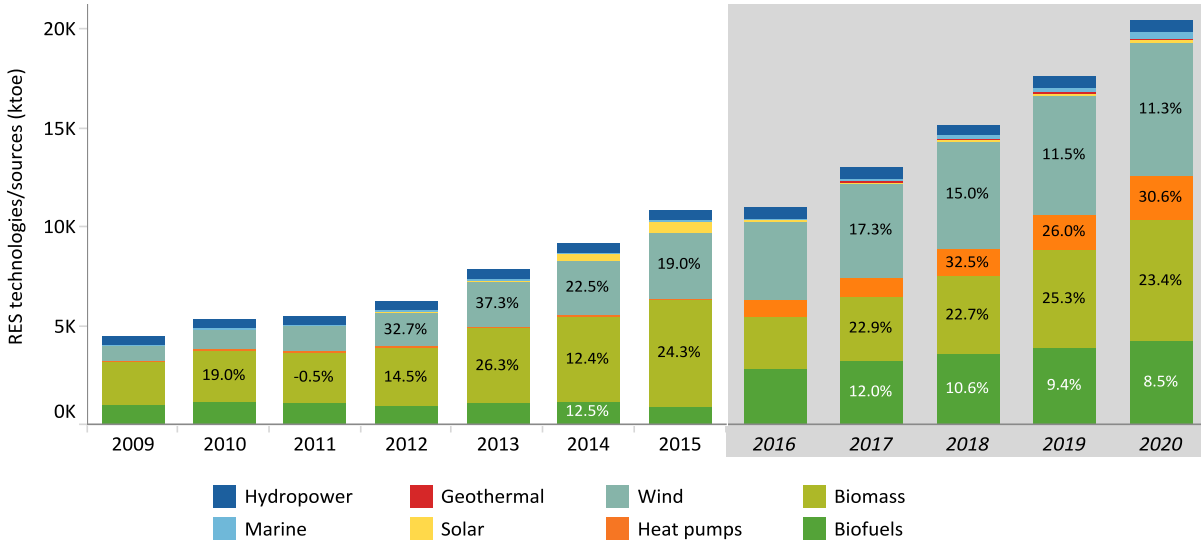


Figure 28 - 4. Annual growth of RE technologies in UK: Current (2009-2015) - NREAP planned (2016-2020)

Solar photovoltaic technology experienced the fastest increase during period 2005-2015 with a CAGR of 98% (+7553 GWh) reaching 7561 GWh. This technology was above the NREAP plans throughout period 2010-2015 exceeding since in 2014 the plan for year 2020 (2240 GWh). Wind power developed with a CAGR of 29.6% (+34.8 TWh) between 2005 and 2015 reaching 37.6 TWh (3235 ktoe). Nevertheless this technology didn't developed fast enough to meet the expected NREAP plans throughout period 2010-2015. The development of biomass electricity in the UK during period 2005-2015 took place with a CAGR of 12.4% (+20.3 TWh) reaching 29.4 TWh (2527 ktoe). The development of this source was above the NREAP projections throughout period 2011-15. Renewable electricity coming from hydropower in United Kingdom developed with a CAGR of 1.2% (+622 GWh) between 2005 and 2015 reaching 5315 GWh (457 ktoe). This development was slower than what was planned in the NREAP throughout period 2010-2015. A contribution of only 2 GWh (0.2 ktoe) in 2015 was found to come from marine technology even that no plans are in place according to the UK NREAP. This increase took place with a CAGR of 52% (+1.97 GWh) since year 2005.

The development of solar thermal in the UK took place with a CAGR of 5.6% (+21 ktoe) between 2005 and 2015 reaching 50.7 ktoe (2.1 PJ). This technology remained over the NREAP plans throughout period 2010-2015. Biomass used for heating/cooling purposes in United Kingdom increased during period 2005-2015 with a CAGR of 19.4% reaching 2800 ktoe (117.2 PJ). This development has been over the expected NREAP projections throughout period 2010-2015. United Kingdom has set a very ambitious 2020 plan of 2254 ktoe (94.4 PJ) for heat pump use in heating/cooling sector. Despite of this the development of heat pump technology in United Kingdom has been under the NREAP projections throughout period 2010-2015. It increased with a CAGR of 32.8% (+96 ktoe) since 2010 reaching only 126.8 ktoe (5.3 PJ) in 2015. While no developments were expected in geothermal source United Kingdom reported a level of 0.8 ktoe (0.03 PJ) throughout period 2010-2015.

Bioethanol/bio-ETBE use in transport sector during 2005-2015 increased with a CAGR of 25.3% (+366 ktoe) reaching 409 ktoe (17.1 PJ). This use was found above the NREAP expected levels throughout period 2010-2013 whereas in period 2014-2015 this source missed the respective plans. Biodiesel use increase during 2005-2015 with a CAGR of 35.4% (+509 ktoe) reaching 535 ktoe (22.4 PJ). Nevertheless this development has been under the expected NREAP levels throughout period 2010-2015. While no contribution was expected for the use of biofuels from wastes, residues, ligno-cellulosic material, their use grew to 587 ktoe (24.6 PJ) in 2015. The use of renewable electricity in transport increased with a CAGR of 6.9% (+47 ktoe) during period 2005-2015 reaching 98 ktoe (4.1 PJ). Despite of this increase the use of renewable electricity in UK transport sector remained below the plans throughout period 2010-2015. In 2015 only 1.4% of final renewable electricity in UK is used in transport sector.

Table 28 - 2. Renewable energy technologies/sources in United Kingdom – deviations from NREAP, 2010-2015, (ktoe)

	2010	2011	2012	2013	2014	2015
Hydropower	-18	-9	-13	-27	-35	-36
Wind	-249	-428	-378	-172	-135	-156
Solar-el	0	11	96	137	295	574
Solar-th	5	10	14	14	16	17
Geothermal-th	1	1	1	1	1	1
Biomass-el	-35	23	119	396	755	1,299
Biomass-th	1,300	1,134	1,287	1,665	1,596	1,842
Heat pumps	-155	-173	-201	-246	-315	-421
Biodiesel	-32	-404	-875	-924	-921	-1,283
Bioethanol	186	153	177	184	-53	-283
Renewable electricity	-74	-77	-84	-86	-88	-94
Marine	0	0	0	1	0	0

28.5 Renewable electricity installed capacity

United Kingdom more than six-folded the renewable electricity installed capacity during period 2005-2015 reaching 29464 MW over 4451 MW in the baseline year. In 2015 wind capacity shared 49% of final renewable electricity installed capacity in United Kingdom followed by solar photovoltaic with 31%, biomass with 14% and hydropower 6.0%.

Figure 28-5 present the current trend of renewable electricity installed capacity in United Kimgdom, the deviations (in %) from the expected developments during period 2005-2015, the 2020 NREAP plan and EUCO27 scenario projections for 2020 and 2030. As shown in this figure, the installed renewable electricity capacity in United Kingdom surpassed the NREAP plans throughout period 2010-2015.

The fastest progress in year 2015 over 2005 capacity was made in solar photovoltaic that increased with a CAGR of 96% (+9176 MW) reaching 9187 MW, more than triple of 2020 plan (2680 MW). The development of wind technology took place with a CAGR of 25% (+12726 MW) between 2005 and 2015 reaching 14291 MW. This development was fast enough to exceed the planned capacities only during period 2012-15. Biomass installed

capacity more than tripled during 2005-13 reaching 4223 MW in 2015. This deployment was fast enough to surpass the NREAP plans throughout period 2011-15. Hydropower capacity reported increased with a CAGR of 1.6% (+258 MW) between 2005 and 2015 reaching 1759 MW. Due to the fact that United Kingdom compiled the Table 10a of its NREAP in a different way from the established template the achieved installed capacity during period 2010-2015 was found below these plans. While no marine installed capacity was planned in the NREAP since in 2009 United Kingdom reported a capacity of 1 MW for this technology that increased to 4 MW in 2015.

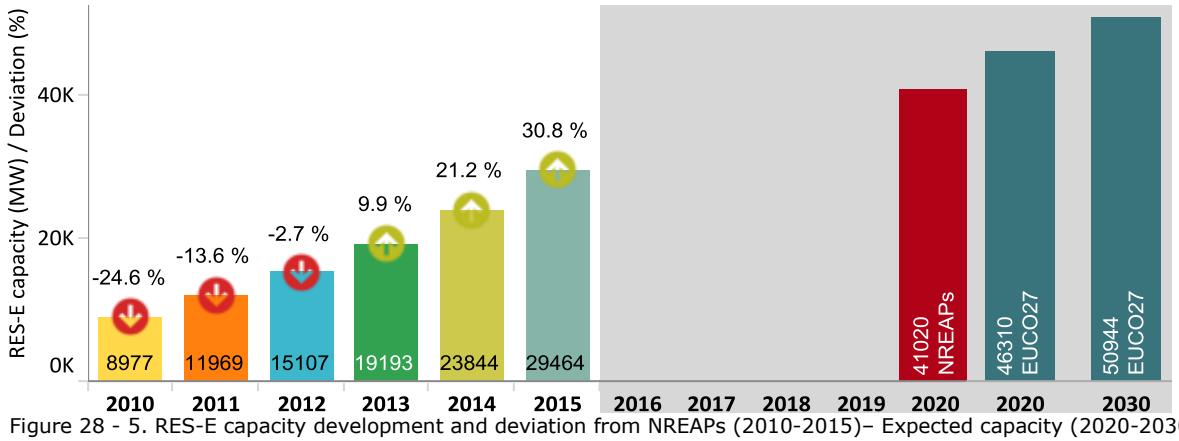


Figure 28 - 5. RES-E capacity development and deviation from NREAPs (2010-2015)– Expected capacity (2020-2030)

A capacity of 41020 MW is expected to be reached in United Kingdom in year 2020 in which wind technology will cover more than two-third of final renewable energy installed capacity in United Kingdom. The fast development of solar photovoltaic is expected to change the relative shares of renewables within the renewable electricity installed capacity.

The EUCO27 projection for 2020 of net generation capacity of renewables is higher than the NREAP plan, at 46310 MW, taking into consideration the achieved share of solar photovoltaic. According to this projection the United Kingdom is expected to have installed 50944 MW of renewable electricity in 2030.

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Abbreviations

ETBE – Ethyl Tertiary Butyl Ether
EU – European Union
GW – Gigawatt
GWh – Gigawatt-hour
H/C – Heating /cooling sector
ktoe – kilo-tonnes oil equivalent
Mtoe – Mega-tonnes oil equivalent
MS – Member States
NREAPs – National renewable energy action plans
PR – Renewable Energy Progress Reports
PV – Solar photovoltaic
PJ – Petajoule
RES – Renewable Energy Sources
RES-H/C- Renewable Energy Sources in Heating/Cooling sector
RES-E – Renewable Energy Sources in Electricity sector
RES-T – Renewable Energy Sources in Transport sector
SHARES - SHort Assessment of Renewable Energy Sources
TWh- Terrawatt-hour

Units

1 Mtoe = 41.868 PJ = 11.63 TWh
1 ktoe = 41.868 TJ = 11.63 GWh
1 PJ = 0.278 TWh = 0.024 Mtoe
1 TWh = 3.6 PJ = 0.086 Mtoe
1 TJ = 277.8 MWh

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