J R C   R E F E R E N C E   R E P O R T S

Technical Assessment of the Renewable Energy Action Plans

Márta Szabó, Arnulf Jäger-Waldau, Fabio Monforti-Ferrario,Nicolae Scarlat,
Hans Bloem, Michel Quicheron, Thomas Huld, Heinz Ossenbrink

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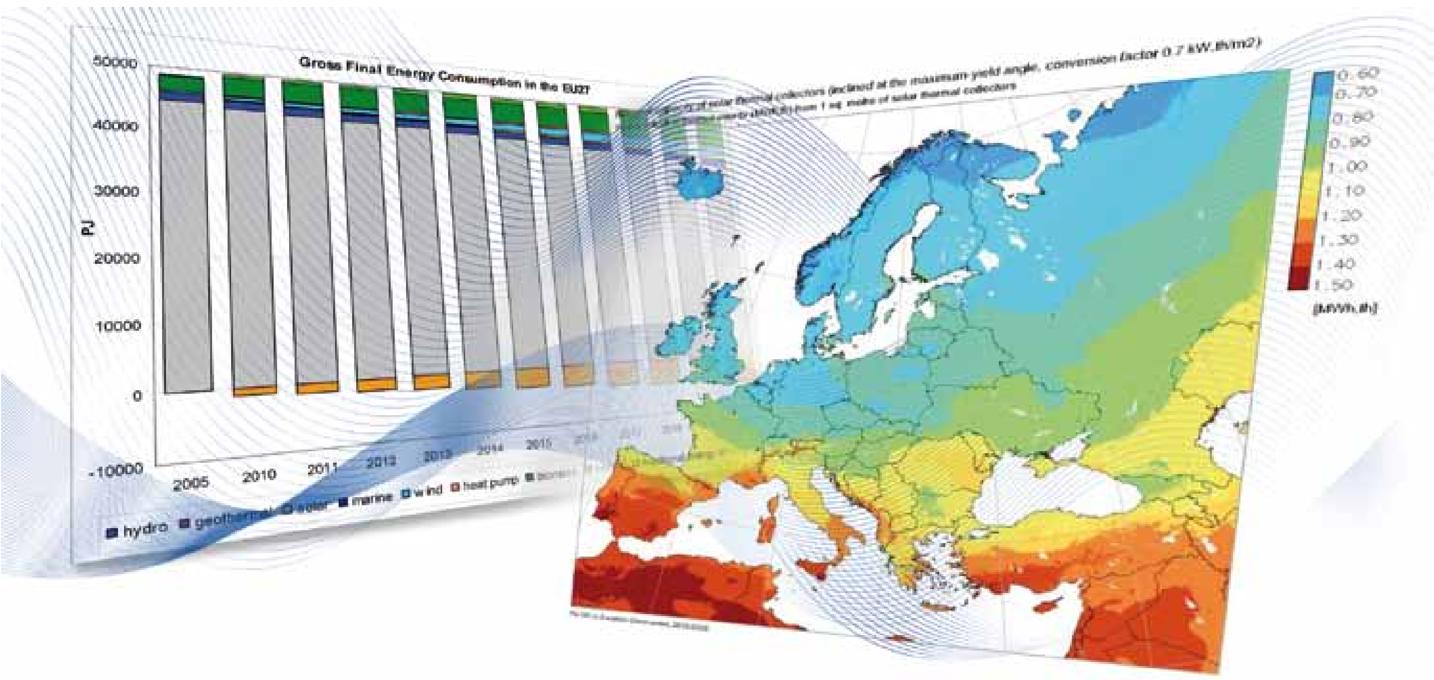

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Preface

Directive 2009/28/EC on the promotion of the use of energy from renewable energy sources (RES Directive) **not only set the mandatory** targets **for the European Union's Member States, but also drafted a trajectory how to reach the targets for each of them and** requires Member States to adopt a National Renewable Energy Action Plan (NREAP), setting out sectoral targets and measures for achieving these targets.

The National Renewable Action Plans were to be submitted to the European Commission by 30 June 2010 using a Template established in accordance with Article 4 of the Directive.

This report on the Technical Assessment of the National Renewable Energy Action Plans is based on the data provided by the Member States in their reports and gives an overview about the environmentally and economic competitive developments and potential in the different renewable energy technologies from the base year to the year 2020.

The opinion given in this report is based on the current information available to the author, and does not represent any official position of the European Commission.

The data used in this report consider the first submission of the NREAPs, the data in the resubmission phase – thus after the cut off date – have not been considered in this report.

Executive Summary

National Renewable Energy Action Plans (NREAP)[1] were to be adopted in accordance with Article 4(3) of Directive 2009/28/EC[2] in each Member State by the end of 2010. Each Member State were to set its national target for the share of energy coming from renewable energy sources consumed in electricity, heating and cooling, and the transport sector. The Member State was to provide a yearly target up to 2020, and explain how it would be reached.

The JRC conducted a technical assessment of the National Renewable Energy Action Plans. The assessment had three main goals:

1. to verify the achievement of an overall EU27 target of 20 % and the Member States targets,
2. to compare the proposed renewable resources with resource estimates, and
3. to make a comparative analysis between the data reported and the technically environmentally available and economically competitive resources. As a conclusion of the analysis, the possible risks (like capital, resources and technology risk) of the introduction and development of renewable energy technologies have been identified.

In order to assess the level of ambition to meet the national targets and to analyse the related risks, *a pool of reference data and indicators, established by different EU organisations and calculated based on JRC internal expertise,* have been introduced and used for each technology. Growth rate calculations are used to assess the planned development of the source and establish an evaluation benchmark.

The energy consumption contained in the NREAPs data were assessed and compared to the National Energy Efficiency Action Plans and other projections coming from the most recent modelling studies. The assessment followed the different renewable energy sources by sectoral breakdown, and in aggregate.

The total gross final energy consumption is expected to grow compared to 2005 in the EU 27 according to the NREAPs. Heating and cooling will represent the highest sectoral share in the gross final energy consumption, of 48 % by 2020. Energy consumption in electricity sector should grow by 7.1 % between 2010 and 2020, in the heating and cooling, and transport sector should decrease by -4.1 % and - 0.5 % respectively.

In 2010 the EU27 had a Renewable Energy Resource (RES) share of 11.6 % and in 2020 is projected to reach 20.7 %. The RES share is expected to reach 34 % in electricity sector, 11.7 % in transport sector, and 21.4 %in heating and cooling sector. In RES electricity, wind has the highest contribution followed by hydro and biomass. In RES Heating and Cooling, the main source is biomass with 81 %, also in RES transport with a share of 88 % (biodiesel 66% ethanol 22 %).

Biomass and biofuel accounts for almost 60 % of the RES mix (biomass represents 45 %; biofuels 12 %). Compared with the environmentally and commercially available biomass potential in the EU, the proposed targets for bioenergy and biofuels could be reached using domestic biomass in the EU27. However the bioenergy presented cannot be covered in all countries by the competitive resources available which can represent a resource risk.

In 2020 about 463 Petajoules (PJ) in biofuels are estimated to be imported by the MS in order to reach the 10% binding target; one third of the countries rely on import of biofuels. This represents 37% of the biofuel use in the EU in 2020. However, a part of this could come from internal EU trade and a part imported from other countries to the EU. Second generation biofuels may imply a technology risk.

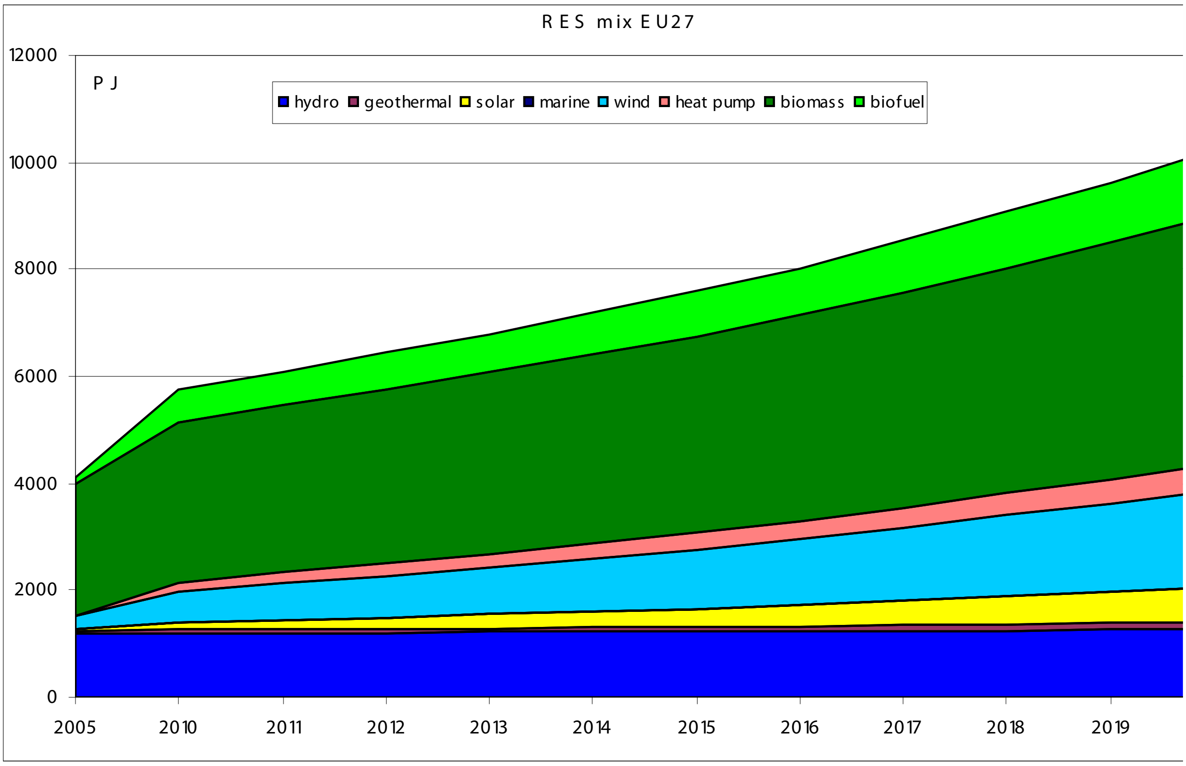
Hydro energy represents 12 % of the RES mix in 2020 in the EU27. Hydropower is a well-experienced technology with little remaining untapped potential and as a result almost no increase is expected.

Onshore wind contributes to the RES mix with 12% in 2020. The reported generation potential of 338,900 Gigawatt-hour (GWh) by 2020 represents 3.8 % of the competitive potential at l8,900 Terra-watt-hour (TWh). In the spread of onshore wind technology, grid development is needed.

The reported offshore wind energy by 2020 is 483 PJ in EU27, which represents 4.7 % of the renewable energy mix, with a yearly average growth of 30%. In a number of countries, offshore wind will not be introduced before 2015. In these countries no technology risk is expected as the installation is an

1 http://ec.europa.eu/energy/renewables/transparency_platform/action_plan_en.htm.

2 Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.



already established technology. However the late start of the installation may lead to a capital risk in achieving the 2020 targets.

In the PV technology the foreseen 84.4 GW installed capacity in EU27 by 2020 is 2.3 % of the potential (3,900 GW), which technically can be reached with the current support scheme. Some countries show a potential exploitation exceeding 10%. Almost all of the MS remain far under potential, sometimes by a factor of ten.

Solar thermal contribution of 2.4 % of the 20 % target for RES in 2020 is indicated, corresponding to 59 TWh. The NREAP data presented for the solar thermal share gives 73 TWh.

The highest average growth is expected in the Concentrated Solar Power (CSP), marine and offshore wind technologies; however these technologies start from relative low levels. In more EU Member States the late introduction of geothermal technology in electricity production, of CSP technology for solar electricity, of marine technology, and in some cases of onshore and offshore wind resources may lead to capital risk.

Some MS have indicated the possibility for statistical transfer (between Ms or 3rd counties) and rely on the exploitation of own resources. Some MS which would not achieve their targets, prescribed by the present trajectory, indicate the requirement for using this exchange. As an overall objective of 20% energy from renewable resources to be met by the sum of all MS targets, there is this possibility to negotiate such a statistical exchange.

According to the National Renewable Energy Action Plans of the Member States renewable energy should grow at a faster pace in the years up to 2020 than in the past and the EU will exceed the 20% target in 2020. Almost half of the Member States are planning to exceed their own targets and be able to provide surpluses for other Member States.

An important cornerstone to achieve the 2020 targets is the achievement of the ambitious energy efficiency targets, also laid down in the Action Plans. EU energy consumption in 2020 is projected to decrease to 95% of the 2005 level.

At the end of 2010 the European Union Member States estimated that about 640 TWh or 20% of electricity came from renewable energy sources out of which 310 TWh were non-hydro sources. To reach the 2020 targets renewable electricity should increase to 1,200 TWh in total and 850 TWh non-hydro sources, or 37 % of Europe's electricity mix. Overall, this would correspond to total annual growth rates of 6.5% and 10.6 for non hydro sources, which for most technologies seem very moderate.

In the Heating and Cooling sector at the end of 2010 the EU MS estimated that about 2,840 PJ or 12,5% came from RES. To reach the 2020 targets renewable Heating and Cooling should increase to 4,680 PJ, this would correspond to total annual growth rates of 5.1%, which for most technologies seem challenging.

In the transport sector 2020 targets, renewable transport fuels should increase to 1,380 PJ from 644 PJ in 2010, corresponding to total annual growth rates of 7.9%. This seems to be challenging as well.

Introduction

This report contains a technical assessment of the National Renewable Energy Action Plans (NREAP)[3], with special focus on:

- Establishing a database with the NREAP data;
- Comparing the proposed renewable resources with resource estimates done at the JRC;
- Verifying the achievement of an overall EU27 target of 20 %;
- Assessing the consistency of the energy reduction assumptions with the "National Energy Efficiency Plans", delivered by the MSs in 2009/2010, which have been also evaluated by the JRC;
- Identifying the possible risks of the introduction and development of RES technologies.

In accordance with Article 4(3) of Directive 2009/28/EC and of Council discussions of 23 April 2009 on the promotion of the use of energy from renewable sources, each Member State had to adopt a National Renewable Energy Action Plan and submit it to the Commission by 30 June 2010, using a template according to the Commission Decision of 30 June 2009.

However, due to a variety of circumstances, the delivery of MS NREAPs spanned a period from April 2010 to January 2011.

In the National Renewable Energy Action Plans, each Member State set its national target for the share of energy coming from renewable energy sources consumed in electricity, heating and cooling, and the transport sectors, and they have to update every second year up to 2020 These take into account the effect of energy efficiency related measures on final consumption of energy compared to the indicative trajectory. The Member States thus announce the excess or deficit production which can be used in the cooperation mechanism or in the statistical transfer.

The study uses a transparent approach to establish, develop and use reference data and indicators, in order to make a comparative analysis between the technically environmentally available, and

3 http://ec.europa.eu/energy/renewables/transparency_platform/action_plan_en.htm.

economically competitive resources and the data reported.

The report is structured as follows:

After the description of the objectives and the policy background, Chapter 2 describes the methodology and introduces the reference data, indicators and risk definitions, together with the calculations. The data from the NREAP tables were taken into account, correcting where necessary, miscalculations and misinterpretation.

Chapter 3 describes the results of the assessment about the development of the consumption and the renewable energy technologies from the base year to 2020, with a sectoral analysis for each technology.

Chapter 4 summarises the comparative analysis of the trajectory and RES share, followed by the summary in Chapter 5.

Cut-off Date of the Data / NREAPs Used

This report analyses the NREAP reports based on their initial submissions which concluded in January 2011, and without the follow-up Member States revisions. Member States received feedback and are now moving to deliver the requested clarifications and, in some cases, to resubmit their Action Plans; this feedback and clarifications are not included in this report.

The MS first submission was the focus of this analysis because

- this analysis gave a good feedback about the possible lack of clarifications and misinterpretation of the data requested and the calculations, and
- we wanted to have a picture the same status for each Member State – as the re-submission phase is still ongoing.

As the revision is still ongoing, our revised report will be available as soon all Member States revision will be submitted.

Use of Units

In this report the data are in PJ (Petajoules) and for electricity we use also Wh (Watt-hours), even though the NREAPs and the future reporting templates require Mtoe (Million tonnes of oil equivalent). Since 1 Jan 2010 (after the end of the transition period of the Directive 2009/9/EC) the only permissible energy units in the MS are “J” and “Ws”, with the extensions to “Wh”. Annex 7 refers to the conversion factors applied in the analysis.

1. Objectives of the work

- Check that the plan shows that the Member State is intending to comply with (a) its national overall target for 2020; (b) its target for renewable energy in transport in 2020; and (c) its indicative trajectory;
- Evaluation of the national renewable energy targets related to the availability of renewable energy resources and in terms of the technologies envisaged so as to establish an indicator-based assessment of targets;
- Resource analysis for Solar PV/Thermal/Thermodynamic, Wind, Bio-energy, and Geothermal, including the definition of indicators for exploitation;
- Comparison of the NREAP with the proposed National Energy Efficiency Plans, consistency checks and analysis by consumption type (electricity, heating & cooling, transport);
- Analysis of the assumptions concerning energy efficiency (in relation to the Energy Efficiency Action Plans) and of the assumptions concerning economic growth;
- Evaluation of how far the additional energy efficiency scenarios are taken into account in order to reach the national goals and trajectories;
- Establishment of figures of merit for the baseline data which will serve internally to the Commission for further references and modelling, including economic impact;
- Analysis of MSs' estimates of the share of renewable energy in transport, including expected bio-ethanol/biodiesel ratios, anticipated pathways and imports.

1.1 Policy aspects, Legislation

Directive 2009/28/EC on the promotion of the use of energy from renewable energy sources [1] (RES Directive) requires Member States to adopt a National Renewable Energy Action Plan (NREAP), setting out sectoral targets and measures for achieving these targets.

As a first step, all Member States prepared their NREAP forecast documents [2] and submitted them in accordance with Article 4(3) of the Directive. The analysis is summarised in the Renewable Energy Snapshots 2010 [3] .

According to the Directive, the share of the RES in overall energy consumption should be at least 20 % and the share of renewable energy in the transport sector at least 10 %, applying the adjusted calculation described in Article 3 of the RES Directive and the Template.

There are individual RES targets for the 27 EU Member States (see Table 31) with the exception that the RES target in the transport sector is set in all Member States at 10% each.

According to the Article 22 each Member State shall submit a report to the Commission on the progress in the promotion and use of energy from renewable sources by 31 December 2011, and every two years thereafter in order to measure compliance with the trajectory set out in the NREAPs and the overall progress towards 2020 targets.

1.2 Submission of NREAPs

The National Renewable Action Plans [4] were requeseted to be submitted to the European Commission by 30 June 2010 using a Template[4] [5] established in accordance with Article 4 of the Directive. All Member States submitted their NREAPs by the end of 2010, most in their national language. All the translated NREAPs were available by mid-May 2011.

Most of the MSs used this form properly and provided the complete set of requested data. The biggest discrepancy was in missing data for the gross final energy consumption under the Reference Scenario, the energy consumption and renewable data for the base year (2005), in some other cases in the correct calculation in Tables 3, 4a and 4b of the NREAPs, and presenting the hydro pump storage not counted in the RES hydro.

The submission is summarised in Table 1.

4 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32009D0548:EN:NOT.

Table 1: Submission history of the National Renewable Action Plans (according to the appearance on the Transparency Platform in the original languages) in 2010

02-Jul	05-Jul	07-Jul	08-Jul	13-Jul	15-Jul	28-Jul	06-Aug	10-Aug	23-Aug	22-Sep	15-Oct	28-Oct	02-Dec	07-Dec	09-Dec	03-Jan
UK	FI	AT	BG	MT	LT	CY	IT	PT	DE	RO	SK	LV	BE	EE	PL	HU
DK		ES			SI	EL			FR	CZ						
SE						IE			LU							
NL																

2. Methodology

The JRC based its assessment of the NREAPs on a pool of reference data and indicators, which has been established by different EU organisations and calculated based on JRC internal expertise. Taking into account these indicators and their projection until 2020 (2030), within a comparative analysis, the data from the NREAP have been assessed for their technical, environmental and commercial competitiveness.

As a general rule, the assessment followed the different renewable energy sources within the sectoral breakdown, and also in the aggregate. For each renewable source and sector, there was examined whether a policy (capital) risk, resource risk or technology risk existed during the time-scale considered by the NREAPs.

Furthermore, for the sake of consistency, the energy consumption contained in the NREAP data were assessed and compared to the NEEAP and other projections coming from the most recent modelling studies.

For the base year (2005) and 2010 a cross-check was made between the NREAP and available statistical data (EUROSTAT, EURObserver, IEA statistics, etc.). The inconsistencies have been recorded and noted in the MS assessments.

Data and information have been assessed using the technical expertise developed by scientific/technical networking through collaborations/contacts with EEA, IEA, OECD, EU projects, national institutions (thematic associations, research centres and universities) or European associations, as well the EurObserver barometers.

2.1 Definitions

Prior to the description of the methodology the following groups of definitions, related to the scenarios used in the NREAPs and the possible risk categories established during the assessment, need to be clarified:

Scenario definitions

In the NREAPs the Member States were requested to submit two scenarios for energy consumption up to 2020. As described in the (2009/548/EC) COMMISSION DECISION of establishing a Template for National Renewable Energy Action Plans under Directive 2009/28/EC,

the **Reference Scenario** takes into account/considers only the energy efficiency and saving measures adopted before 2009,

the **Additional Energy Efficiency Scenario** considers all energy efficiency and saving measures adopted after 2009.

The elaboration of the other parts of the NREAP is based on the additional energy efficiency scenario.

Risk definitions

Capital (economic) risk – a risk caused by the late start of introduction of a technology which has already large-scale commercial application, or introducing a not cost competitive technology.

Resource risk – a risk originated from the fact when the reported targets cannot be reached because there is not enough economically (cost competitive) and environmentally available potential.

In the case of biomass, the resource risk should be considered in association with the **biomass mobilisation risk**: the risk that the amount of mobilisation of biomass resources needed to bring the available resources from the production to the places where they could be conveniently transformed and exploited cannot be reached without a strong support scheme.

Technology risk – appears when the increase counts on a technology which is still in the development phase and has no large-scale commercialisation yet but a sudden take off in the growth rate is foreseen in the operation in a few years.

In the case of biomass resources the **reliance on import/import dependency** has been also analysed.

In some cases for a resource or technology more than one risk can be applied, rising to **combined risks**.

A later start of an already established technology means no technology risk, but could mean a capital risk in achieving the 2020 targets.

2.2 Indicators

Indicators have been introduced in order to assess the level of ambition to meet the national targets, and to help quantify the cost-effectiveness at a later stage. The envisaged technologies are assessed with the following simplified figures of merit:

2.2.1. Wind Energy indicators

The proposed quantities as fractions of the "Competitive Potential 2020", as described in the EEA Technical Report 6/2009 [Europe's onshore and offshore wind energy potential, p. 48 for onshore wind, p. 49, for offshore wind]. [6]

The values for this indicator are reported in Chapter 2.3.5.

2.2.2. Solar electricity (PV, CSP) indicators

The proposed quantities as a fraction of the MS total electricity consumption, adjusted by a coefficient for solar radiation yield averaged over the MS's area [14].

The values for this indicator are reported in Chapter 2.3.4.1.

2.2.3. Solar Thermal indicators

The proposed quantities as a fraction of 1 m²/capita, adjusted by a coefficient for solar radiation yield averaged over the MS area.

The values for this indicator are reported in Chapter 2.3.4.2

2.2.4. Bio-energy (gas, liquids, solids)

The proposed quantities as a fraction of total agricultural production, using a country average yield and agricultural area [7]

2.2.5. Hydro

The proposed quantities as the percentage of existing Hydro-capacity.

2.2.6. Other

For the marine, geothermal[5] resources the proposed quantities as a fraction of the country's R&D spending on the related technology/Capita.

2.3 Growth rate

For each energy source, the yearly and the compound average growth rates (CAGR) have been calculated during the reporting period. The growth rate calculations are used to assess the planned development of the source, establish an evaluation benchmark/threshold and analyse the risks related to each technology.

As an example, in the case of an already established technology, a yearly growth rate higher than 30 % could be considered as the indication of a possible resource or capital risk, i.e., that the support scheme can not adapt enough fast.

The growth rate assessment is reported in the 2.3.2 Chapter.

5 There is a European atlas of geothermal energy existing which assesses the theoretical under-ground temperatures as function of depth below ground-level. Neither the geographical coverage corresponds to EU27, nor any attempt is made to quantify the economic viability. Moreover, it covers land only.

2.4 Reference data

Unless otherwise stated, Eurostat data base year 2008/2009 was used for reference. As an indicative reference for 2020 for EU27, including energy efficiency, the EREC 2020 data [8] are used as enhanced by the 2008 statistics. This approach for detailing electricity, heating and cooling and transport sectors, fits the scope of the Directive better than the traditional industry / transport / tertiary sectoral approach.

2.4.1. Assessment of the energy consumption

The gross final consumption of energy from renewable sources should be calculated (on the basis of Article 5 of Directive 2009/28/EC) as the sum of: (a) gross final consumption of electricity from renewable energy sources; (b) gross final consumption of energy from renewable energy sources for heating and cooling; and (c) final consumption of energy in transport.

In order to assess the accuracy of the *gross final energy consumption,* as reported in Table 1 of the NREAPs for the period 2010-2020, it has been compared to information, based on past data (Eurostat final energy consumption), projections or expected savings reported in the National Energy Efficiency Action Plans (NEEAP). All data are converted into the same unit, ktoe.

Other sources of information used were:

- Final inland energy consumption reported in the National Energy Efficiency Action Plans[6];
- Energy efficiency potential under the Low Policy Intensity potential (LPI). It has been assessed whether this potential is taken into account in the Energy Efficiency Scenario of the NREAPs.
- PRIMES Energy Trends to 2030 and projections based on Eurostat data. The trend under the PRIMES reference scenario has been evaluated, as well as drawn a linear trend based on Eurostat final energy demand for the period 1997-2008[7] when there was a linear trend. Both have been compared with the Additional Energy Efficiency scenario of the NREAPs.

6 Differently from gross final energy consumption final inland energy consumption does not include the energy sector's own consumption and the distribution and transformation losses.

7 2008 is the last available year in Eurostat.

The trend in energy consumption reported in the NREAPs in 2015-2020, compared to the reference year 2005 has been looked as well.

References:

- Database of Energy Efficiency Potentials: http://eepotential.eu/esd.php [9], based on a study [10] commissioned by DG ENER (DG TREN) to a consortium coordinated by Fraunhofer Institute, the analysis of which relies mainly on the MURE simulation tool [11] (for MURE see http://www.mure2.com/)
- PRIMES energy trends: http://ec.europa.eu/energy/observatory/trends_2030/index_en.htm [12],
- NEEAPs: http://ec.europa.eu/energy/efficiency/end-use_en.htm [13]

Table 2 below shows the template which is used for each country, with some references to the definitions.

- The gross energy consumption as reported in the NREAP under the AEE (Additional Energy Efficiency) Scenario was compared with the final inland energy consumption reported in the National Energy Efficiency Action Plan;
- The gross energy consumption was evaluated as to what extent the additional energy efficiency scenario was taken into account to reach the national goals and trajectories, based on comparison with PRIMES data on energy demand and data on economic savings potentials per Member State;
- As far as energy consumption trends are concerned, a comparison was made with recent trends in final energy consumption, based on Eurostat data.

In all cases, a consistency test has been performed, i.e. verified that the order of magnitude is similar among the compared figures, if not the differences have been highlighted in our conclusions. For instance, we have compared the annual energy savings expected under the NEEAPs/ EE potential and the difference between the Reference Scenario and the EE Scenario reported in the NREAPs [23] .

Table 2: Methodology summary table for energy consumption

	2005	2010	2016		2020		
NREAP	base year		Ref. scenario	EE Scenario	Ref. scenario	EE Scenario	Note:
Gross final energy consumption (ktoe) (1) incl. own consumption of transformation sector network losses							EE scenario used for RE
EEpotential (end-use) LPI			2016		2020		Fraunhofer study for DG Ener
ktoe - Potential of energy savings in each use sectors							
		Annual energy savings expected by end (ktoe):					
NEEAP	ktoe	2010	2016		2020		
Final inland energy cons. 2001-2005 average 9% savings **target** by 2016							
PRIMES-EU Energy Trends to 2030			Baseline (BAU-NREAP ref.)	Reference (NREAP additional EE action)	Baseline (BAU-NREAP ref.)	Reference (NREAP additional EE action)	
			2015		2020		
Final energy demand (2)							
Eurostat	1997	2004	2005	2006	2007	2008	2016 2020
Final energy consumption - [ten00095] excludes deliveries for transformation, as well as own use of energy prod. ind. and network losses					Trend 5 y		Linear trend

(1) Article (2)(f) of Directive 2009/28/EC:
"gross final consumption of energy' means the energy commodities delivered for energy purposes to industry, transport, households, services including public services, agriculture, forestry and fisheries, including the consumption of electricity and heat by the energy branch for electricity and heat production and including losses of electricity and heat in distribution and transmission".
(2) Final energy demand sectors and energy branch net electricity demand includes consumption of electricity by final consumers and the energy branch; it excludes transmission and distribution losses, as well as own consumption by power plants.

In green there are highlighted the fields where the country data appear.

2.4.2. Resource analysis in electricity

The resources declared available in the NREAPs have been analysed according to their share among the RES in the given sector; the analysis starts with the one with the highest proportion and the highest growth rate.

For solar **PV** the technical potential is compared to the expected installed capacity by 2020, taking into account how much land area can be used for PV and what is the PV output.

References: PV GIS [14], PV Status Report 2010 [15], the RES Snapshots 2010 [3] and ECOFYS Reports [17] [31].

The **wind** contribution is evaluated based on the competitive generation potential reported by EEA.

References: Europe's onshore and offshore wind energy potential, EEA Technical Report No 6/2009. ISSN 1725-2237 [6] In the case of these intermittent sources, the share of demand is also evaluated based on the low winter/summer demand of electricity.

References: data from grid operators [18]

Biomass

The gross inland biomass consumption was estimated for 2010, 2015 and 2020. The estimated data were compared with the national data for the biomass primary production in 2005, 2007, 2008 and 2009, as reported by AEBIOM [19] and EurObserv'ER [22] and the biomass supply reported in the NREAPs for 2020 (Table 7a: Estimated biomass domestic supply in 2015 and 2020 (primary energy)).

The estimates of the gross consumption of biomass required for meeting the RES targets was compared with the environmentally compatible biomass potential available in each Member State, e.g. the biomass available for energy production in 2020, without increasing pressures on the environment, as established in the EEA report "How much bioenergy can Europe produce without harming the environment?" (EEA Report No 7/2006).

References

EEA, 2006. How much bioenergy can Europe produce without harming the environment? EEA Report No 7/2006. [7]

AEBIOM, European Biomass Statistics 2009. [19]

ECN and EEA, Renewable Energy Projections as Published in the National Renewable Energy Action Plans of the European Member States, 2010. [20]

Biomass Energy Europe – BEE project, http://www.eu-bee.com/default.asp?SivuID=24156 [21]

EurObserv'ER, The state of renewable energies in Europe 2010, 10th EurObserv'ER Report [22]

Hydro, Geothermal, Marine

In the case of hydro geothermal and marine energy only the growth rate were analysed without benchmark.

2.4.3. Resource analysis in heating and cooling

Biomass

Biomass availability is of key importance for meeting 2020 RES targets. Therefore, the main aim of this work was the assessment of biomass supply vs. biomass demand for meeting the NREAP proposed targets for the gross final energy consumption of biomass for electricity, heating and cooling and in transport. For this purpose, the gross inland biomass consumption in 2005, and expected for 2020, to meet the biomass targets was assessed, in comparison with the actual primary biomass production reported for 2005-2009 (AEBIOM and EurObserv'ER), the biomass resources expected to be available in 2020 and the national environmentally compatible biomass potential (EEA). This was used to identify the potential gaps in supply that can be covered by import or additional measures for increased mobilisation, if necessary.

The main steps of this work were:

1. calculation of gross final energy consumption of energy from biomass in electricity, heating and cooling and in transport sectors;
2. estimation of gross inland biomass consumption;
3. comparison against the actual primary biomass consumption in 2005, 2007, 2008 and 2009;
4. comparison against the national biomass potential;
5. identification of potential gaps in biomass supply against demand.

Heat pump

In the case of energy from heat pumps, a growth rate is evaluated.

A heat pump is a thermal conversion technology that consumes electricity (an apparatus uses thermal energy to perform the pumping work). It is mostly used in geothermal and aerothermal energy as energy sources. The heat produced might be considered as renewable heat. The heat produced, subtracted by the energy used to operate the heat pump, is considered as renewable heat according to Annex VII of the Renewable Energy Directive. Only heat pumps with a seasonal performance level above a certain level are considered as eligible.

The term "renewable heat" covers all heat that is the result of a conversion process of renewable resources or that contain renewable resources (waste or hybrid power plants). It is important to describe the conversion processes or systems, including the conversion efficiency and the renewable energy input resource.

Since the information and data come from different origins a lot of attention has to be given to accuracy of the data, conversion of parameter values and efficiencies of the heat conversion installations.

Electricity supply from fossil power plants with an efficiency of 40% requires a heat pump with at least a COP of 2.5 (the heat-pump technology is advancing a lot and a COP of 3 to 4 can be reached nowadays). In Scandinavian countries with a major supply of electricity from hydro-power plants and more and more wind, the situation is much different and would favour the use of air-to-water heat-pump systems. In this context it is important to consider the energy mix of the Member State and sometimes also the regional availability of energy. In that context double counting of renewable energy statistical data should be considered as renewable electricity is converted into renewable heat. [25] [26]

Solar thermal

The renewable solar thermal contribution is assessed based on the EurObserver data and the annual growth data by the RESTMAC project.

The installed EU average is approx. 45 kW_{th} per 1000 capita (2009) as it is presented in the Table 3.

Table 3: Overview of solar thermal installed capacity by EURObserver

	Population	EurObserver Installed	
	2008	2009	
	*1000	m² /1000 cap	kW(th) /1000 cap
Belgium	10,667	30.9	21.7
Bulgaria	7,640	4.8	3.4
Czech Rep	10,381	48.9	34.2
Denmark	5,476	87.3	61.1
Germany	82,218	157.8	110.4
Estonia	1,341	1.6	1.1
Ireland	4,401	27.2	19.0
Greece	11,214	360.5	252.4
Spain	45,283	40.5	28.3
France	61,876	30.8	21.6
Italy	59,619	33.4	23.4
Cyprus	789	873.9	611.7
Latvia	2,271	3.7	2.6
Lithuania	3,366	1.5	1.0
Luxembourg	484	40.1	28.1
Hungary	10,045	6.7	4.7
Malta	410	107.8	75.4
Netherlands	16,405	46.7	32.7
Austria	8,332	517.1	362
Poland	38,116	13.4	9.4
Portugal	10,618	41.8	29.3
Romania	21,529	5.3	3.7
Slovenia	2,026	76.9	53.8
Slovakia	5,401	19.3	13.5
Finland	5,300	5.3	3.7
Sweden	9,183	45.1	31.6
UK	61,186	7.7	5.4
EU27	**495,577**	**64**	**45**

References

EurObserveR, January 2010, http://www.eurobserver.org/pdf/2010_Eurostat_Comparison.pdf [28]

Potential of Solar Thermal in Europe. W. Weiss AEE, Austria. RESTMAC TREN/05/FP6EN [29]

Renewable Energy Snapshots 2010. EUR 24440 EN. ISBN 978-92-79-16287- [3]

Geothermal

In case of geothermal energy the growth rate were evaluated without benchmark.

2.4.4. RES in transport:

The contribution of RES in the transport sector was evaluated against the mandatory 10% target for the final energy from renewable sources consumed in transport, set at the same level for each Member State. The contribution of different RES sources was evaluated in the transport sector in comparison with the energy used in transport in 2005 and expected use until 2020. The total amount of energy consumed in transport includes petrol, diesel, and biofuels consumed in road and rail transport and electricity. The consumption of renewable electricity in road transport shall be considered to be 2.5 times the energy content of the input of electricity from renewable energy sources (Article 3(4) c) of Directive 2009/28/EC).

According to Directive 2009/28/EC, Member States may encourage the use of biofuels made from waste, residues, non-food cellulosic material, ligno-cellulosic material and algae, which give significant environmental advantages and additional benefits. The contribution made by biofuels produced from wastes, residues, non-food cellulosic material, and ligno-cellulosic material shall be considered to be twice that made by other biofuels.

2.5 Calculations

2.5.1. Solar electricity surface area, capacity, energy

Table 4 (next page) summarises the starting data and calculated results of PV potential in the various countries. The numbers are the expected energy output (kWh/year) for each kWp of PV installed, taking into account the land area of the country.

The urban areas in each country are also included. This area is the total area that is considered urban, thus it includes houses, roads, gardens, etc. The whole area cannot be covered with PV of course.

The land area which can be used for PV and solar installation was calculated as a percentage of the total land area, and is in general well below the urban area of the countries (except Finland). Calculating 6.66 m^2 installations on average per 1 kW capacity [17], the maximal potential PV installation can be expressed. These data are summarised in Table 24 in the chapter 2.3.4.1, which shows the installed capacity from the NREAPs as a percentage of the potential PV installation.

2.5.2. Share of demand for PV

The share of demand was calculated taking into account the lowest summer demand in the period of April-September during sunshine hours of electricity provided by the national grid operators. Results for the MS are summarised in Table 24.

2.5.3. Share of demand for wind energy

The share of demand for wind was calculated taking into account the lowest winter demand of electricity provided by the national grid operators. The input data and results are summarised in Table 26.

2.5.4. Solar thermal surface area, energy

Solar yield for glazed flat plate solar collector installations

To have an indication of the energy produced by solar thermal installations, data on solar irradiation are required. Figure 1 (based on JRC data [14]) below gives an indication of a 1 m^2 inclined at maximum yield while applying a conversion of 0.7 kW/m^2. This figure has to be considered as a maximum efficient figure of the installed system and does not include a load.

Table 4: Data for the calculation of the PV potential and share of demand

Country	Total land area	Land area suitable for PV[8]	Urban Area	Capita	PV output per kWp at optimum angle, urban areas kWh/year		
	km²	km²	km²	*1000	Min.	Avg.	Max.
BE	30,672	184	5,029.9	10,667	866.0	929.6	1007.6
BG	110,787	665	4,214.4	7,640	1005.9	1217.8	1388.4
CZ	78,865	473	3,450.9	10,381	838.6	945.6	1039.7
DK	43,384	260	2,063.7	5,476	841.2	945.1	1054.1
DE	357,516	2,145	20,988.1	82,218	825.5	936.0	1085.8
EE	45,426	273	415.5	1,341	813.5	867.7	898.8
IE	70,173	421	561.4	4,401	789.5	908.6	1066.7
EL	132,014	792	1,444.7	11,214	1200.0	1445.0	1667.0
ES	498,558	2,991	4,566.9	45,283	968.2	1470.7	1664.0
FR	549,182	3,295	15,931.9	61,876	858.0	1116.7	1515.3
IT	301,392	1,808	9,289.1	59,619	772.9	1326.0	1624.0
CY	9,360	56	98.0	789	1563.6	1629.8	1683.1
LV	64,592	388	477.7	2,271	817.8	890.2	992.6
LT	64,878	389	1,429.1	3,366	824.5	884.4	1011.0
LU	2,598	16	145.7	484	900.3	939.6	967.5
HU	93,010	558	4,432.7	10,045	991.6	1104.7	1159.2
MT	316	2	6.0	410	1572.1	1584.2	1599.2
NL	37,358	224	2,547.6	16,405	864.7	932.6	1020.7
AT	83,923	504	1,299.8	8,332	853.6	1026.9	1169.6
PL	311,895	1,871	7,552.3	38,116	833.6	937.2	979.7
PT	89,072	534	997.8	10,618	1270.7	1494.0	1648.6
RO	237,938	1,428	11,840.1	21,529	891.1	1132.7	1278.3
SI	20,273	122	410.3	2,026	931.6	1085.2	1249.7
SK	49,028	294	2,220.0	5,401	845.5	1020.7	1116.8
FI	337,781	2,027	1,317.6	5,300	765.3	837.9	895.5
SE	449,498	2,697	5,689.0	9,183	639.1	862.0	1050.8
UK	244,736	1,468	11,772.0	61,186	710.0	920.2	1121.0
EU27	**4,314,541**	**25,887**		**495,577**			

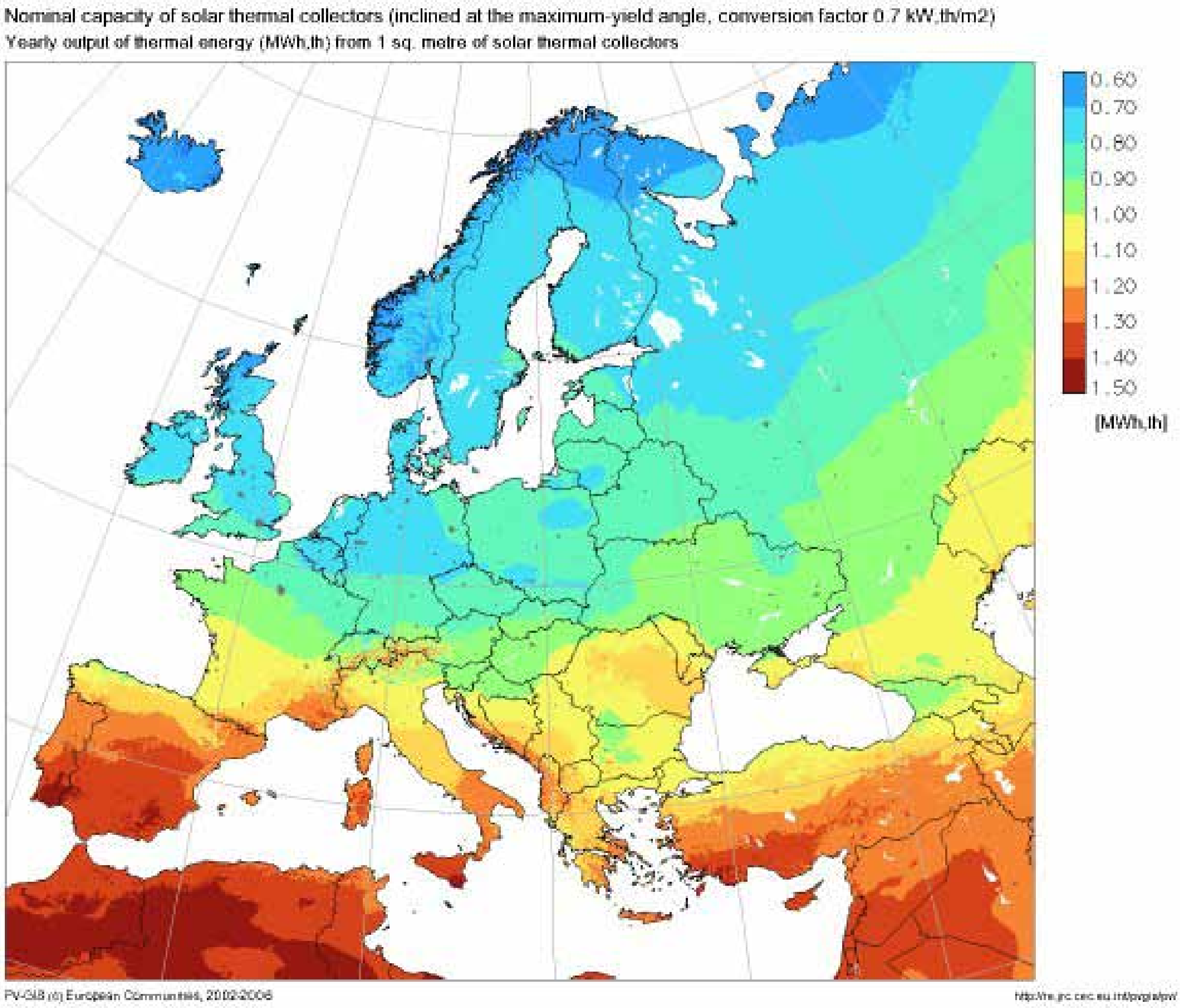


Figure 1: Nominal capacity of thermal collectors (Source JRC PVGIS)

The solar yield of the system, in practice, is lower than the one indicated[9] in the figure above that gives the collector capacity in MWh/m^2. One of the reasons is that the hot water produced has to be stored before it is used. Also the optimal inclination is never achieved in reality. Another reason is that seasonal impact on a fixed system has to be taken into account, as well as the usage variability. The annual system output that can be considered as useful hot water is approx. 60% ± 10%.

For example, an applicable solar yield for Denmark varies between 480 and 520 kWh/m^2/a, and is a more realistic and measured system output figure than 700-800 kWh/m^2/a from the graphically presented collector output.

The calculations are based on a solar yield derived from Figure 1 which is realistic for most MS, when compared with IEA data.

The energy conversion factors taken into account are summarised in Chapter 6.2.

Based on this information, a solar yield is defined for each MS as the following:

$A * G_{opt} * 0.7 * STCF$;
where
A is area in m^2
G_{opt} is the annual solar radiation at optimal inclination taken from JRC data (PVGIS) [14]
STCF is a solar thermal conversion factor.

8 0.6 % [17].

9 Yield is directly connected to the use (demand) because of the storage is limited.

The STCF – solar thermal conversion factor - includes factors that influence the uncertainty of this yield, ranging from the size of the country (averaging radiation data) until final energy consumption efficiency (multi-apartment buildings). However, the result gives estimation, with an uncertainty of up to 15% which can be improved. A harmonised and location-dependent calculation is required to obtain more reliable data for solar thermal end-use energy consumption.

2.5.5. Biomass supply vs. demand to meet the targets proposed by the NREAPs

The Member States reported on the expected contribution of biomass to the trajectory and 2020 targets in the electricity, heating and cooling and transport sectors (final energy consumption) in Tables 10a, 10b, 11 and 12 of the NREAPs. The gross final consumption of energy from renewable sources for heating and cooling was defined as the district heating and cooling produced from biomass, plus the consumption of energy from renewable sources in industry, households, services, agriculture, forestry and fisheries, for heating, cooling and processing purposes.

National biomass supply

The Template for National Renewable Energy Action Plans under Directive 2009/28/EC, as defined by Commission Decision C(2009) 5174-1, required MS to assess the supply of domestically available biomass as gross consumption and the need for imports in all relevant sectors (forestry, agriculture and fisheries and waste) (Table 7: Biomass supply in 2006 and Table 7a: Estimated biomass domestic supply in 2015 and 2020). The amount of raw biomass feedstock for biogas and biofuels had to be detailed as well.

Assessment of biomass resources required to reach the proposed targets for electricity, heating and transport

The gross inland consumption of biomass was determined on the basis of the expected gross final energy consumption of biomass for electricity production, in heating and cooling and in the transport sector, taking into account the actual efficiencies of energy conversion in each Member State. The calculation was based on the following formulas:

$$B_{req} = B_e + B_H + B_{biof}$$

$$B_e = B_{e\text{-}only} + B_{e\text{-}CHP}$$

$$B_{e\text{-}only} = E_e / \eta_e$$

$$B_{e\text{-}CHP} = E_{CHP} / \eta_{e\text{-}CHP}$$

$$B_e = E_e / \eta_e + E_{CHP} / \eta_{e\text{-}CHP}$$

$$B_H = B_{DH} + B_{house} + B_{ind}$$

$$B_{DH} = (H_{DH} - H_{CHP}) / \eta_{DH}$$

$$H_{CHP} = B_{e\text{-}CHP} * (\eta_{CHP\,-}\,\eta_{e\text{-}CHP})$$

$$B_{ind} = H - H_{DH} - B_{house}$$

$$B_H = [H_{DH} - (B_{e\text{-}CHP} * (\eta_{CHP\,-}\,\eta_{e\text{-}CHP})] / \eta_{DH} + B_{house\,+}\,B_{ind}$$

$$B_{req} = E / \eta_e + E_{CHP} / \eta_{e\text{-}CHP} + [H_{DH} - (E_{CHP} / \eta_{e\text{-}CHP} * (\eta_{CHP\,-}\,\eta_{e\text{-}CHP})] / \eta_{DH} + B_{house\,+}\,B_{ind\,+}\,B_{biof}$$

Where:

- B_{biof} - biomass for biofuels (NREAP)
- B_{DH} - biomass for district heating (estimate)
- B_e – biomass use for electricity production (estimate)
- $B_{e\text{-}CHP}$ – biomass use for electricity production in CHP (estimate)
- $B_{e\text{-}only}$ – biomass use for electricity only production (estimate)
- B_H - biomass for heating (estimate)
- B_{house} - biomass for households (NREAP)
- B_{ind} - biomass for industry and services (estimate)
- B_{req} – biomass required for energy production (estimate)
- E_{CHP} – electricity production in CHP plants (NREAP)
- E_e – electricity production in electricity only plants (NREAP)
- E_t – total electricity production (NREAP)

- H – heat production (NREAP)
- H_{CHP} - heat produced in CHP (estimate)
- H_{DH} - heat produced in District Heating (NREAP)
- η_{DH} - efficiency of energy conversion in DH (estimate)
- η_e - efficiency of electricity conversion;
- $\eta_{e\text{-}CHP}$ - efficiency of electricity conversion in CHP
- η_{CHP} - efficiency of energy conversion in CHP

η_{CHP} = 75% (JRC average estimate based on existing literature [32] [33] [34] [35][36])

η_{DH} = 80% (JRC average estimate based on existing literature [32] [33] [34] [35][36])

The efficiency of electricity conversion was assumed based on AEBIOM data of 2007.

BE	η_e = 29%	FR	η_e = 23%	AT	η_e = 27%
BG	η_e = 25%	IT	η_e = 23%	PL	η_e = 32%
CZ	η_e = 34%	CY	η_e = 25%	PT	η_e = 30%
DK	η_e = 25%	LV	η_e = 20%	RO	η_e = 25%
DE	η_e = 23%	LT	η_e = 20%	SI	η_e = 33%
EE	η_e = 30%	LU	η_e = 20%	SK	η_e = 30%
IE	η_e = 32%	HU	η_e = 28%	FI	η_e = 32%
EL	η_e = 32%	MT	η_e = 25%	SE	η_e = 28%
ES	η_e = 25%	NL	η_e = 27%	UK	η_e = 31%

The conversion factors taken into account are summarised in Chapter 6.2.

3. Assessment

3.1 Energy consumption

The projections of total energy consumption in the EU27 by 2020, taking into account the additional energy efficiency scenario[10], is 49,517.3 PJ (1,179 Mtoe), the reference scenario is 54,923.3 PJ (1,307.7 Mtoe) by 2020. The difference between these two scenarios is 9.8 %.

Between 2010 and 2020, the growth in energy consumption in the reference scenario is 8.3 % (from 50,713.3 PJ (1,207.5 Mtoe)), meanwhile under the additional energy efficiency scenario there is a slight decrease with -0.4 % of the value in 2010 (49,716.2 PJ (1,183.7 Mtoe)).

10 The additional energy efficiency scenario was not presented by Finland, the Netherlands and Slovenia. In these cases the reference scenario was taken into account.

Table 5: EU27 total gross final energy consumption in the REF and AEE scenario

	2005		2010		2020	
	PJ	Mtoe	PJ	Mtoe	PJ	Mtoe
REF scenario*	48804.46	1162.01	50713.33	1207.46	54923.32	1307.7
AEE scenario	48783.9	1161.52	49716.2	1183.72	49517.28	1178.98

Malta and Poland did not report the consumption data for REF scenario and for 2005

The energy consumption decreases compared to the base year in Austria, Germany, Denmark, Spain, France, Hungary, Italy, Luxembourg, the Netherlands, and UK. Between 2010 and 2020 only Germany, France and UK show less energy consumption (Table 6 and Table 10).

Table 6: Gross final energy consumption data comparison between 2005-2020 and 2010-2020 in PJ

	Energy consumption difference	
PJ	**between 2020-2005**	**between 2020-2010**
BE	129.9	32.9
BG	4.1	9.2
CZ	120.4	107.6
DK	-5.4	0.9
DE	-1,340.4	-1,109.1
EE	14.8	11.0
IE	58.8	48.1
EL	103.5	71.2
ES	-201.8	160.2
FR	-479.7	-381.4
IT	-343.7	52.1
CY	12.2	8.7
LV	23.3	32.0
LT	49.4	44.2
LU	-2.6	11.5
HU	-11.1	58.3
MT*	n.a.	4.2
NL	-133.8	12.3
AT	-21.0	58.1
PL*	n.a.	331.8
PT	-4.8	36.8
RO	115.9	185.4
SI	9.8	16.6
SK	43.1	24.1
FI	80.2	102.5
SE	197.9	132.0
UK	-589.8	-245.6
EU27	**733.3**	**-198.9**

**Malta and Poland did not report the consumption data for 2005*

The MS energy consumption data are available by sectoral breakdown in Table 7-9 and total in Table 10.

Table 7: Energy consumption in heating and cooling (PJ)

	Heating and cooling consumption in PJ				relative 2005=100%		
	2005	2010	2015	2020	2010	2015	2020
BE	915.8	915.8	915.8	915.8	100.0%	100.0%	100.0%
BG	190.8	188.7	190.6	194.8	98.9%	99.9%	102.1%
CZ	741.0	747.8	754.4	784.6	100.9%	101.8%	105.9%
DK	339.0	337.8	333.0	321.4	99.6%	98.2%	94.8%
DE	4907.4	4687.1	4350.7	3911.8	95.5%	88.7%	79.7%
EE	67.8	66.0	66.2	66.3	97.3%	97.6%	97.8%
IE	231.7	216.7	212.9	207.1	93.5%	91.9%	89.4%
EL	350.9	363.0	363.6	406.3	103.5%	103.6%	115.8%
ES	1690.7	1400.3	1321.0	1253.7	82.8%	78.1%	74.2%
FR	2895.9	2770.6	2645.3	2520.0	95.7%	91.3%	87.0%
IT	2877.0	2477.0	2523.4	2569.8	86.1%	87.7%	89.3%
CY	22.3	20.2	21.3	22.1	90.6%	95.5%	99.4%
LV	109.5	94.5	101.9	109.7	86.3%	93.0%	100.2%
LT	108.5	101.5	109.2	112.7	93.6%	100.7%	103.9%
LU	49.9	51.9	51.8	53.3	103.9%	103.8%	106.6%
HU	512.1	434.6	446.7	408.2	84.9%	87.2%	79.7%
MT*	n.a.	1.9	2.6	3.1	n.a.	n.a.	n.a.
NL	1194.3	1033.7	1034.0	1049.5	86.6%	86.6%	87.9%
AT	554.7	504.3	512.5	537.7	90.9%	92.4%	96.9%
PL*	n.a.	1360.8	1390.2	1457.4	n.a.	n.a.	n.a.
PT	332.9	306.0	323.7	344.3	91.9%	97.2%	103.4%
RO	788.7	663.1	738.0	769.3	84.1%	93.6%	97.5%
SI	96.2	83.8	86.3	85.2	87.1%	89.7%	88.6%
SK	258.8	250.8	240.7	235.7	96.9%	93.0%	91.1%
FI	586.7	588.4	630.0	642.6	100.3%	107.4%	109.5%
SE	554.0	606.8	659.7	712.5	109.5%	119.1%	128.6%
UK	2809.8	2520.0	2322.6	2163.0	89.7%	82.7%	77.0%
EU27	**23186.4**	**22793.0**	**22348.2**	**21857.8**	**98.3%**	**96.4%**	**94.3%**

**Malta and Poland did not report the consumption data for 2005*

Table 8: Energy consumption in Electricity

	Electricity consumption in PJ				relative 2005=100%		
	2005	2010	2015	2020	2010	2015	2020
BE	332.3	351.6	370.8	400.1	105.8%	111.6%	120.4%
BG	131.4	131.5	133.2	132.2	100.0%	101.3%	100.6%
CZ	252.6	253.5	281.3	303.7	100.4%	111.4%	120.3%
DK	133.0	130.5	135.8	136.4	98.2%	102.1%	102.6%
DE	2176.1	2180.9	2124.7	2029.3	100.2%	97.6%	93.3%
EE	31.0	34.8	37.1	39.4	112.3%	119.8%	127.1%
IE	98.3	103.9	110.7	118.1	105.6%	112.6%	120.2%
EL	230.4	212.6	220.8	247.3	92.3%	95.8%	107.3%
ES	1053.4	1052.4	1187.1	1355.3	99.9%	112.7%	128.7%
FR	1903.3	1925.7	1948.0	1970.3	101.2%	102.3%	103.5%
IT	1249.5	1289.6	1321.5	1353.5	103.2%	105.8%	108.3%
CY	15.7	19.4	23.0	26.6	123.8%	146.5%	169.3%
LV	24.4	24.5	27.1	31.3	100.5%	111.2%	128.4%
LT	41.4	38.3	44.0	50.1	92.5%	106.4%	121.1%
LU	23.8	23.1	22.8	23.9	96.8%	95.9%	100.4%
HU	151.6	154.4	173.0	185.6	101.8%	114.1%	122.4%
MT*	n.a.	9.0	10.2	11.3	n.a.	n.a	n.a
NL	434.6	446.3	470.8	490.6	102.7%	108.3%	112.9%
AT	240.5	236.6	244.3	267.8	98.4%	101.6%	111.4%
PL*	n.a.	508.2	550.2	613.2	n.a.	n.a	n.a
PT	191.4	198.7	213.2	233.0	103.8%	111.4%	121.7%
RO	193.2	224.7	237.5	266.0	116.3%	122.9%	137.7%
SI	53.4	50.2	54.3	56.4	94.0%	101.7%	105.5%
SK	101.3	103.3	112.6	120.4	102.0%	111.2%	118.8%
FI	316.3	317.1	344.8	367.1	100.3%	109.0%	116.1%
SE	545.5	549.7	554.0	558.3	100.8%	101.6%	102.4%
UK	1348.2	1331.4	1348.2	1360.8	98.8%	100.0%	100.9%
EU27	**11272.5**	**11901.8**	**12301.3**	**12748.1**	**105.6%**	**109.1%**	**113.1%**

**Malta and Poland did not report the consumption data for 2005*

Table 9: Energy consumption in Transport

	Transport consumption in PJ				relative 2005=100%		
	2005	2010	2015	2020	2010	2015	2020
BE	356.7	390.8	390.9	367.1	109.5%	109.6%	102.9%
BG	111.0	107.9	109.2	110.3	97.2%	98.4%	99.4%
CZ	252.3	257.4	270.0	278.0	102.0%	107.0%	110.2%
DK	174.1	176.0	182.8	181.9	101.1%	105.0%	104.5%
DE	2251.3	2198.9	2153.7	2028.7	97.7%	95.7%	90.1%
EE	31.3	33.1	36.5	39.2	105.8%	116.4%	125.2%
IE	164.3	191.7	216.4	241.4	116.7%	131.7%	146.9%
EL	275.9	274.2	262.6	266.1	99.4%	95.2%	96.5%
ES	1361.1	1296.8	1311.3	1330.6	95.3%	96.3%	97.8%
FR	1893.4	1919.4	1848.0	1768.2	101.4%	97.6%	93.4%
IT	1638.0	1556.3	1491.5	1426.8	95.0%	91.1%	87.1%
CY	28.6	30.2	31.2	32.3	105.6%	109.1%	112.6%
LV	41.2	46.0	50.4	54.6	111.6%	122.1%	132.3%
LT	47.6	56.0	64.1	72.8	117.7%	134.8%	153.0%
LU	101.5	87.6	92.9	98.0	86.3%	91.5%	96.6%
HU	166.5	171.5	206.7	224.7	103.0%	124.2%	134.9%
MT*	n.a.	6.4	6.7	6.9	n.a.	n.a	n.a
NL	476.7	491.4	479.6	446.6	103.1%	100.6%	93.7%
AT	375.7	350.1	351.7	353.4	93.2%	93.6%	94.1%
PL*	n.a.	705.6	747.6	835.8	n.a.	n.a	n.a
PT	261.4	253.7	251.2	241.2	97.1%	96.1%	92.3%
RO	173.8	198.5	225.9	236.4	114.2%	130.0%	136.0%
SI	64.1	72.9	77.2	82.0	113.7%	120.5%	128.0%
SK	73.2	93.3	102.9	115.4	127.4%	140.4%	157.5%
FI	177.2	169.3	172.2	171.4	95.5%	97.2%	96.7%
SE	313.9	322.8	331.7	340.7	102.9%	105.7%	108.5%
UK	1751.6	1700.4	1764.1	1754.7	97.1%	100.7%	100.2%
EU27	**12562.4**	**13157.9**	**13229.0**	**13105.0**	**104.7%**	**105.3%**	**104.3%**

**Malta and Poland did not report the consumption data for 2005*

Table 10: Energy consumption total

	Total consumption in PJ				relative 2005=100%		
	2005	2010	2015	2020	2010	2015	2020
BE	1604.8	1701.7	1725.2	1734.6	106.0%	107.5%	108.1%
BG	433.2	428.0	433.0	437.3	98.8%	100.0%	100.9%
CZ	1245.9	1258.7	1305.7	1366.3	101.0%	104.8%	109.7%
DK	692.0	685.6	697.0	686.5	99.1%	100.7%	99.2%
DE	9621.9	9390.5	8951.1	8281.5	97.6%	93.0%	86.1%
EE	130.1	134.0	139.8	144.9	103.0%	107.5%	111.4%
IE	535.1	545.8	570.2	594.0	102.0%	106.5%	111.0%
EL	909.3	941.6	934.5	1012.8	103.6%	102.8%	111.4%
ES	4277.5	3915.5	3972.9	4075.7	91.5%	92.9%	95.3%
FR	7000.9	6902.7	6716.2	6521.3	98.6%	95.9%	93.1%
IT	5931.5	5535.6	5561.7	5587.8	93.3%	93.8%	94.2%
CY	69.8	73.2	74.8	82.0	105.0%	107.3%	117.5%
LV	178.1	169.4	184.1	201.4	95.1%	103.3%	113.1%
LT	206.1	211.3	235.6	255.5	102.5%	114.3%	124.0%
LU	187.2	173.2	178.2	184.6	92.5%	95.2%	98.6%
HU	836.2	766.7	830.8	825.0	91.7%	99.4%	98.7%
MT*	n.a.	18.2	20.6	22.4	n.a.	n.a	n.a
NL	2256.1	2110.1	2123.3	2122.3	93.5%	94.1%	94.1%
AT	1159.6	1080.5	1096.7	1138.6	93.2%	94.6%	98.2%
PL*	n.a.	2574.6	2688.0	2906.4	n.a.	n.a	n.a
PT	822.4	780.9	800.1	817.6	94.9%	97.3%	99.4%
RO	1155.8	1086.2	1201.5	1271.7	94.0%	103.9%	110.0%
SI	213.8	206.9	217.8	223.6	96.8%	101.9%	104.6%
SK	428.4	447.4	456.2	471.5	104.5%	106.5%	110.1%
FI	1102.9	1080.7	1151.6	1183.1	98.0%	104.4%	107.3%
SE	1449.8	1515.7	1581.7	1647.7	104.5%	109.1%	113.7%
UK	6335.6	5991.5	5884.1	5745.8	94.6%	92.9%	90.7%
EU27	**48783.9**	**49716.2**	**49708.6**	**49517.3**	**101.9%**	**101.9%**	**101.5%**

**Malta and Poland did not report the consumption data for 2005*

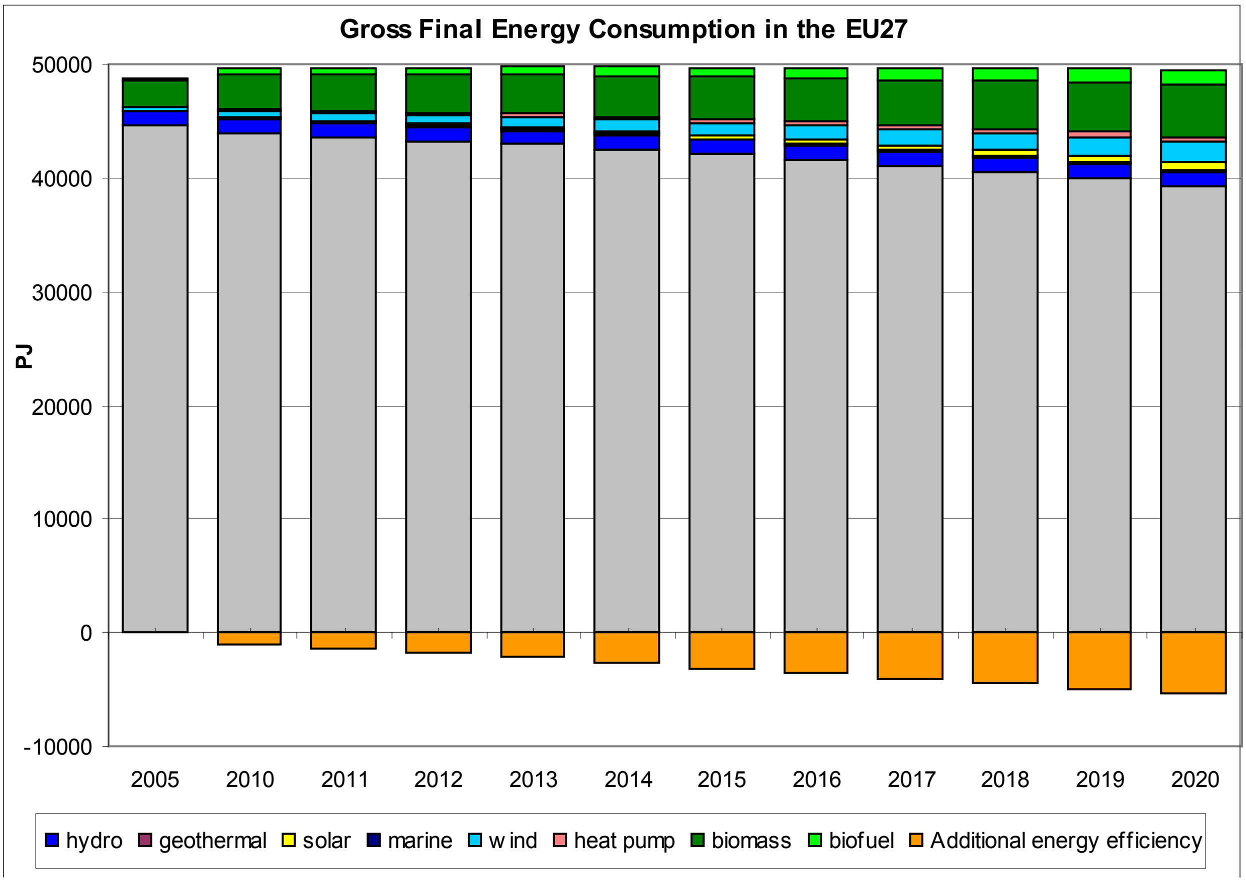


Figure 2: Energy efficiency and RES in energy consumption in EU27 between 2005 and 2020 (note: Malta and Poland did not report the consumption data for REF scenario and data for 2005)

Heating and cooling represents the highest sectoral share in the gross final energy consumption with 46 and 48 % in 2010 and 2020, respectively; the share of electricity and transport is almost even, with 25-27 % by 2010 and 27-27 % by 2020, respectively.

The heating and cooling sector shows a decrease from 22,793 PJ in 2010 to 21,858 PJ by 2020, the transport consumption is decreasing from 13,158 PJ (2010) to 13,105 PJ by 2020, whereas the electricity consumption is increasing, as presented in Table 11.

The total electricity consumption in EU 27, under the AEE scenario, is 11,901.8 PJ in 2010 and will grow to 12,748.1 PJ by 2020.

In the heating sector, a high decrease in consumption is expected in Germany, Spain, France and UK, while an increase is expected in Austria, Finland, Greece, Poland and Sweden, as shown in Table 7.

In the electricity consumption a decrease is expected only in Germany; in all the other MS an increase is foreseen (Table 8).

In transport consumption a decrease is expected in Germany, France, Italy and the Netherlands, all the other MS show an increase (Table 9).

Table 11: Gross Final energy consumption by sectoral breakdown in the Additional Energy efficiency scenario in EU27

in PJ	base year 2005 **	2010	2011	2012	2013	2014
heating and cooling	**23186.4**	**22793.0**	22700.4	22627.6	22545.2	22437.0
electricity	**11272.5**	**11901.8**	11986.4	12062.4	12151.8	12223.0
transport *	**12562.4**	**13157.9**	13160.1	13183.8	13209.2	13224.7

in PJ	2015	2016	2017	2018	2019	2020
heating and cooling	**22348.2**	22243.7	22141.6	22054.8	21958.4	**21857.8**
electricity	**12301.3**	12390.7	12475.4	12568.2	12657.4	**12748.1**
transport *	**13229.0**	13208.3	13187.7	13157.9	13142.4	**13105.0**

**as in Article 3(4)a (3)*
*** without MT and PL, these MS did not report data on the base year*

3.2 Assessment by sectors

Table 12: summarises the RES contribution in the different sectors in EU27.

Table 12: RES contribution in EU27 by sectoral breakdown

In PJ	2005	2010	2011	2012	2013	2014
RES Heating cooling	**2282.7**	**2842.6**	2976.6	3105.7	3249.3	3395.0
RES Electricity	**1711.0**	**2312.4**	2477.7	2648.7	2834.5	3021.5
RES Transport	**176.1**	**644.0**	703.4	759.2	783.4	853.9
RES Transport adjusted for calculating the transport share	**178.3**	**667.5**	733.1	799.5	828.4	904.9
TOTAL RES adjusted [2] (without double counting)	**4139.3**	**5750.6**	**6098.4**	**6450.2**	**6799.2**	**7194.7**

In PJ	2015	2016	2017	2018	2019	2020
RES Heating cooling	**3560.1**	3751.0	3956.5	4173.0	4431.4	**4684.8**
RES Electricity	**3198.5**	3395.7	3615.0	3840.4	4067.3	**4322.9**
RES Transport	**911.9**	978.8	1085.0	1162.4	1233.9	**1375.8**
RES Transport adjusted for calculating the transport share	**975.7**	1054.1	1173.1	1275.0	1366.9	1527
TOTAL RES[11] adjusted (without double counting)	**7588.8**	**8035.2**	**8556.3**	**9068.7**	**9615.5**	**10253.9**

The electricity RES contribution to the electricity consumption sector will be 4,323 PJ in 2020; this represents the 33.9 % of the energy use in the sector. The RES heating and cooling will be 4,684.8 PJ, covering 21.43 % of the sectoral use. The total contribution of RES in transport in 2020 in the EU, without double counting, will be 32.757 Mtoe, and 36.476 Mtoe (1,527 PJ) with multiple counting of electricity use in road transport and Article 21.2 Biofuels. Overall, this would represent 11.7% of the energy use in the transport sector, above the 10% binding target.

11 Without double counting: The electricity in transport is calculated only once.

Table 13: EU27 Total and sectoral RES share from 2005 to 2020

Share in the sector %	2005	2010	2011	2012	2013	2014
Heating and cooling	**9.84**	**12.47**	13.11	13.73	14.41	15.13
Electricity	**15.18**	**19.43**	20.67	21.96	23.33	24.72
Transport (as in Article 3(4)a (3) calculated)	**1.42**	**5.07**	5.57	6.06	6.27	6.84
Total RES Share	**8.5**	**11.6**	**12.3**	**13.0**	**13.7**	**14.5**

Share in the sector %	2015	2016	2017	2018	2019	2020
Heating and cooling	**15.93**	16.86	17.87	18.92	20.18	**21.43**
Electricity	**26.00**	27.41	28.98	30.56	32.13	**33.91**
Transport (as in Article 3(4)a (3) calculated)	**7.38**	7.98	8.90	9.69	10.40	**11.69**
Total RES Share	**15.3**	**16.2**	**17.2**	**18.3**	**19.4**	**20.7**

3.2.1. RES electricity

This chapter gives an overview about the RES electricity generation and electricity RES share in consumption. The development of the RES electricity, according to the NREAPs in absolute and relative terms, is summarised in Table 14.

Table 14: RES generation in Electricity

	Electricity RES generation in PJ				GJ/capita	relative 2005=100%		
	2005	**2010**	**2015**	**2020**	**2020**	**2010**	**2015**	**2020**
BE	6.5	16.8	47.1	83.5	7.83	257.2%	719.1%	1275.2%
BG	8.8	14.0	22.1	27.2	3.56	159.3%	251.5%	309.5%
CZ	11.3	18.3	35.1	42.1	4.06	162.4%	311.4%	373.5%
DK	35.7	44.8	62.5	74.4	13.59	125.6%	175.2%	208.4%
DE	222.7	379.1	569.2	783.4	9.53	170.3%	255.7%	351.9%
EE	0.4	2.2	4.9	6.9	5.15	564.0%	1267.0%	1786.2%
IE	8.9	21.2	35.9	50.2	11.41	238.1%	403.4%	564.4%
EL	20.9	28.3	61.3	98.5	8.78	135.4%	293.2%	471.3%
ES	194.2	303.5	400.8	541.8	11.96	156.3%	206.4%	279.0%
FR	256.9	297.0	395.0	534.5	8.64	115.6%	153.8%	208.1%
IT	198.9	231.3	286.0	347.2	5.82	116.3%	143.7%	174.5%
CY**	0.0	0.2	2.1	4.2	5.32	n.a.	n.a.	n.a.
LV	10.9	11.0	13.9	18.7	8.23	100.2%	127.3%	171.3%
LT	1.7	3.2	7.7	10.7	3.18	190.7%	466.1%	643.0%
LU	0.8	0.9	2.0	2.8	5.79	119.0%	262.7%	364.4%
HU*	n.a.	10.3	14.0	20.2	2.01	n.a.	n.a.	n.a.
MT*	n.a.	0.1	0.7	1.6	3.90	n.a.	n.a.	n.a.
NL	26.1	38.4	99.1	181.8	11.08	147.1%	379.4%	695.5%
AT	149.2	163.9	174.1	189.2	22.71	109.8%	116.7%	126.8%
PL	13.7	38.3	71.8	117.0	3.07	280.3%	524.7%	855.3%
PT	30.8	82.2	106.3	128.5	12.10	266.5%	344.7%	416.8%
RO	58.1	61.7	99.4	113.4	5.27	106.2%	171.0%	195.1%
SI	15.2	16.3	19.2	22.1	10.91	107.0%	126.5%	145.4%
SK	16.9	19.8	25.9	28.9	5.35	117.2%	153.5%	171.0%
FI	85.7	81.9	92.5	120.7	22.77	95.6%	108.0%	140.9%
SE	293.4	312.8	331.9	351.0	38.22	106.6%	113.1%	119.6%
UK	63.3	114.2	217.9	422.4	6.90	180.6%	344.5%	667.8%
EU27	**1730.9**	**2311.7**	**3198.6**	**4323.0**	**8.72**	**133.6%**	**184.8%**	**249.8%**

**Malta and Hungary did not report the RES generation data for 2005*

***Cyprus RES electricity data for 2005 was neglectable, so the % has not been calculated*

3.2.1.1. Electricity generation

According to the NREAPs, the RES contribution to electricity in EU27 will be 4,322.9 PJ (1,216.8 TWh), representing about 33.9 % of electricity production in 2020.

Wind energy has the highest contribution in the renewable electricity generation (41.3 %) by 2020, followed by hydro (29.3 %) and biomass with 19.4 %. Solar represents 8.6 %, geothermal 0.9 % and marine resource 0.5 %.

The hydropower is a well-experienced technology with little remaining potential, so almost no increase is expected.

The biggest increase is in wind generation, where the share in RES electricity grows from 25.7 % (2010) to 41.3 %; in absolute term the 2020 generation is three times more than in 2010 (Figure 3).

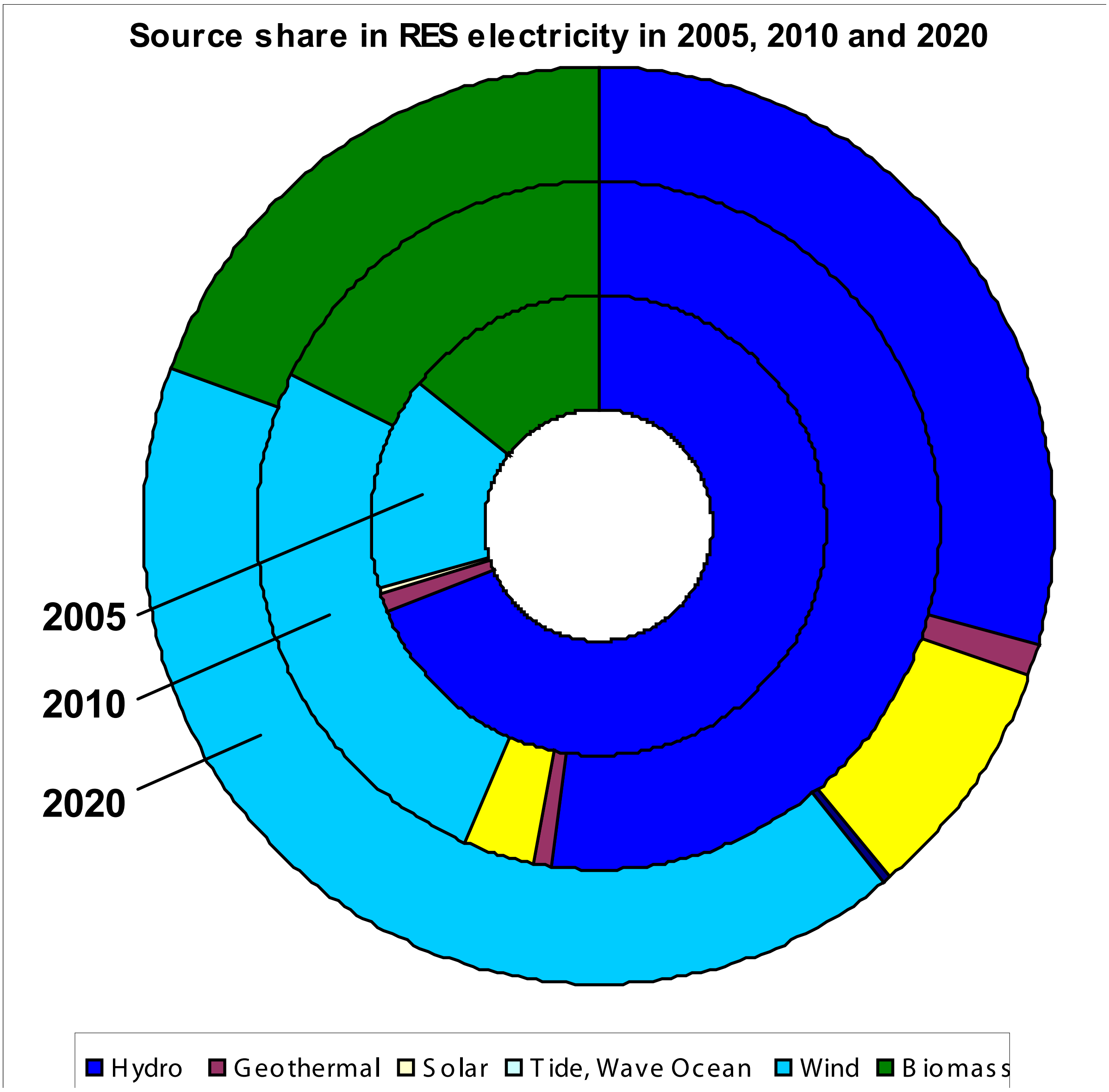


Figure 3: RES share in electricity in source breakdown

12 BE and FI did not reported separately the onshore and offshore wind, they only reported the total wind energy. That is why the sum of onshore and offshore is different from the total wind data.

	2005				
	RES electricity		% of		
	in PJ	in TWh	RES el.	total RES	electricity
Hydro	1180.87	326.99	69.0	28.67	10.48
Geothermal	19.78	5.48	1.2	0.48	0.18
Solar electricity	6.60	1.82	0.4	0.16	0.06
PV	6.60	1.83	0.4	0.16	0.06
CSP	0.00	0.00	0.0	0.00	0.00
Marine	1.93	0.54	0.1	0.05	0.02
Wind total[12]	256.79	71.11	15.0	6.23	2.28
Onshore	241.40	66.84	14.1	5.86	2.14
Offshore	6.94	1.92	0.4	0.17	0.06
Biomass	245.09	67.87	14.3	5.95	2.17
Total RES el.	**1711.0**	**473.79**	**100.0**	**41.54**	**15.18**
Total RES	**4119.22**				
Total electricity	**11272.50**				

	2010				
	RES electricity		% of		
	in PJ	in TWh	RES el.	total RES	electricity
Hydro	1204.79	333.61	52.1	20.99	10.12
Geothermal	21.59	5.98	0.9	0.38	0.18
Solar electricity	76.90	21.29	3.3	1.34	0.65
PV	72.74	20.14	3.1	1.27	0.61
CSP	4.16	1.15	0.2	0.07	0.03
Marine	1.81	0.50	0.1	0.03	0.02
Wind total[12]	594.28	164.56	25.7	10.36	4.99
Onshore	557.02	154.24	24.1	9.71	4.68
Offshore	30.74	8.51	1.3	0.54	0.26
Biomass	413.02	114.37	17.9	7.20	3.47
Total RES el.	**2312.4**	**640.31**	**100.0**	**40.30**	**19.43**
Total RES	**5738.65**				
Total electricity	**11901.8**				

	2020				
	RES electricity		% of		
	in PJ	in TWh	RES el.	total RES	electricity
Hydro	1265.04	350.30	29.3	12.36	9.92
Geothermal	39.27	10.87	0.9	0.38	0.31
Solar electricity	373.19	103.34	8.6	3.64	2.93
PV	301.10	83.37	7.0	2.94	2.36
CSP	72.09	19.96	1.7	0.70	0.57
Marine	21.64	5.99	0.5	0.21	0.17
Wind total[12]	1786.07	494.57	41.3	17.44	14.01
Onshore	1237.77	342.74	28.6	12.09	9.71
Offshore	483.08	133.77	11.2	4.72	3.79
Biomass	837.73	231.97	19.4	8.18	6.57
Total RES el.	**4322.9**	**1197.04**	**100.0**	**42.22**	**33.91**
Total RES	**10239**				
Total electricity	**12748.1**				

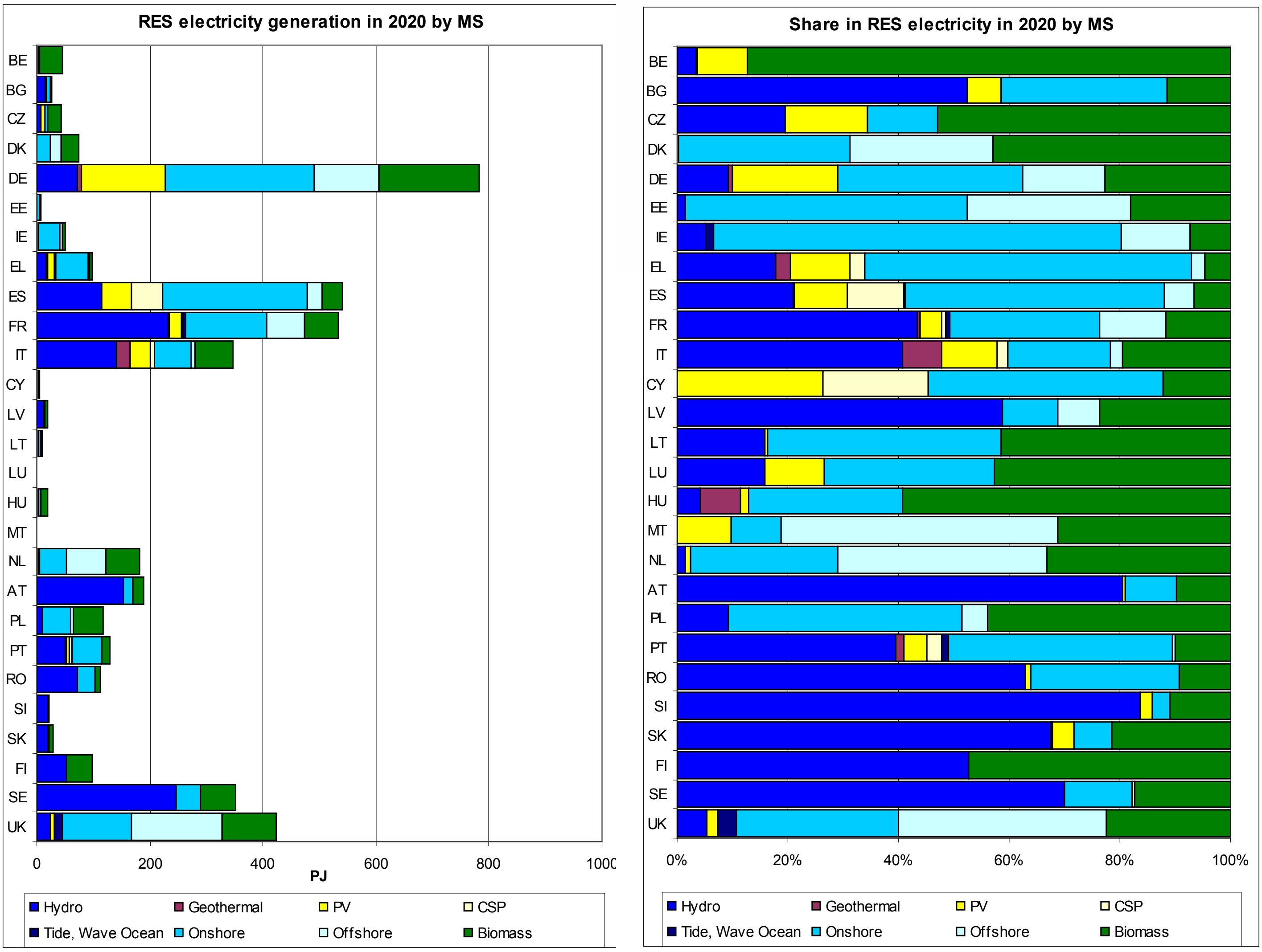


Figure 4 (left and right): RES electricity generation in MS - breakdown by source in 2020

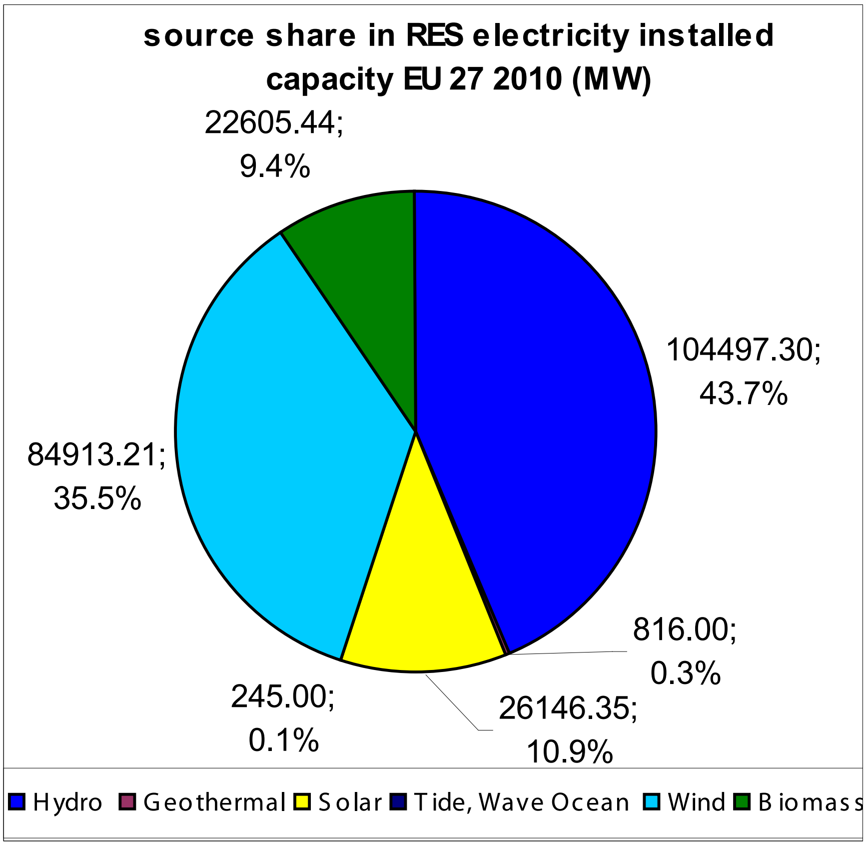
Leading countries

In terms of RES electricity output Germany is the leading MS with 783.4 PJ which represents 18 % of the total RES electricity in EU27. Spain, France and UK have RES electricity generation over 400 PJ; these three countries contribute with almost 35 % of the RES electricity in EU27. Sweden and Italy, with an amount of around 350 PJ, represent 16.2 %. These six MSs give 69 % of the RES electricity in EU27.

3.2.1.2. Capacity development

According to the NREAPs, the RES electricity capacity in EU27 will be 464,088 MW in 2020, growing from 239,223.3 MW in 2010 and 160,284.7 MW in 2005.

Wind energy has the highest part in the renewable electricity capacity (46 %) by 2020, followed by hydro (24.2 %) and solar (19.7 %); marine has 0.5 % and geothermal 0.3 %.



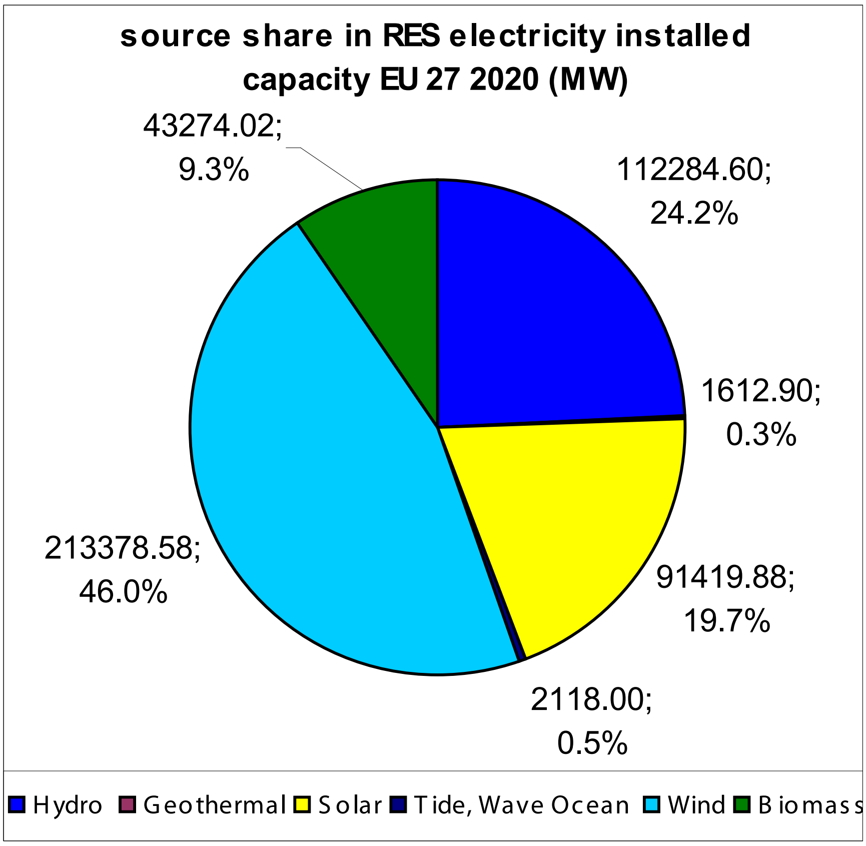


Figure 5: RES share in electricity capacity in source breakdown

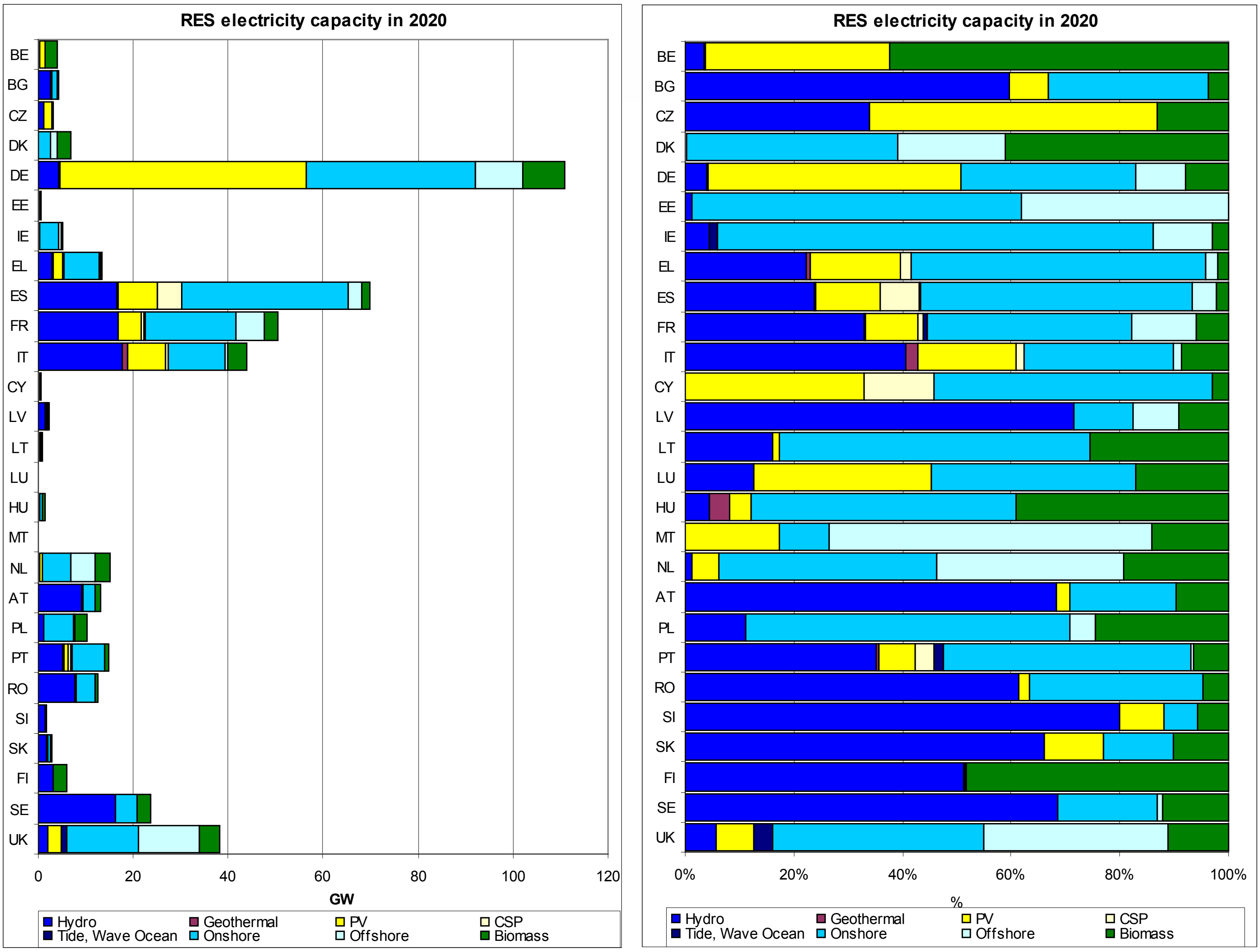


Figure 6: RES electricity capacity in MS breakdown by sources in 2020

Leading countries in electricity capacity

Germany is the leading MS with the highest RES installed capacity in electricity with 110.9 GW, which represents 13.9 % of the total RES capacity by 2020 in EU27. In Spain, France, UK the RES installed capacity is over 40 GW; these three countries contribute with 35.4 % to the RES electricity installed capacity by 2020 in EU27. Sweden and Italy, with an amount higher than 20 MW, represents 13.4 %. These six MSs should have 72.7 % of EU27's RES electricity installed capacity by 2020.

The leading countries with the highest additionally installed capacities are Germany, UK, Spain, France and Italy. However, Sweden is among the countries with the highest installed RES capacity. This is reached already during the years at the beginning, as there is minor development within the additional installations (Figure 7).

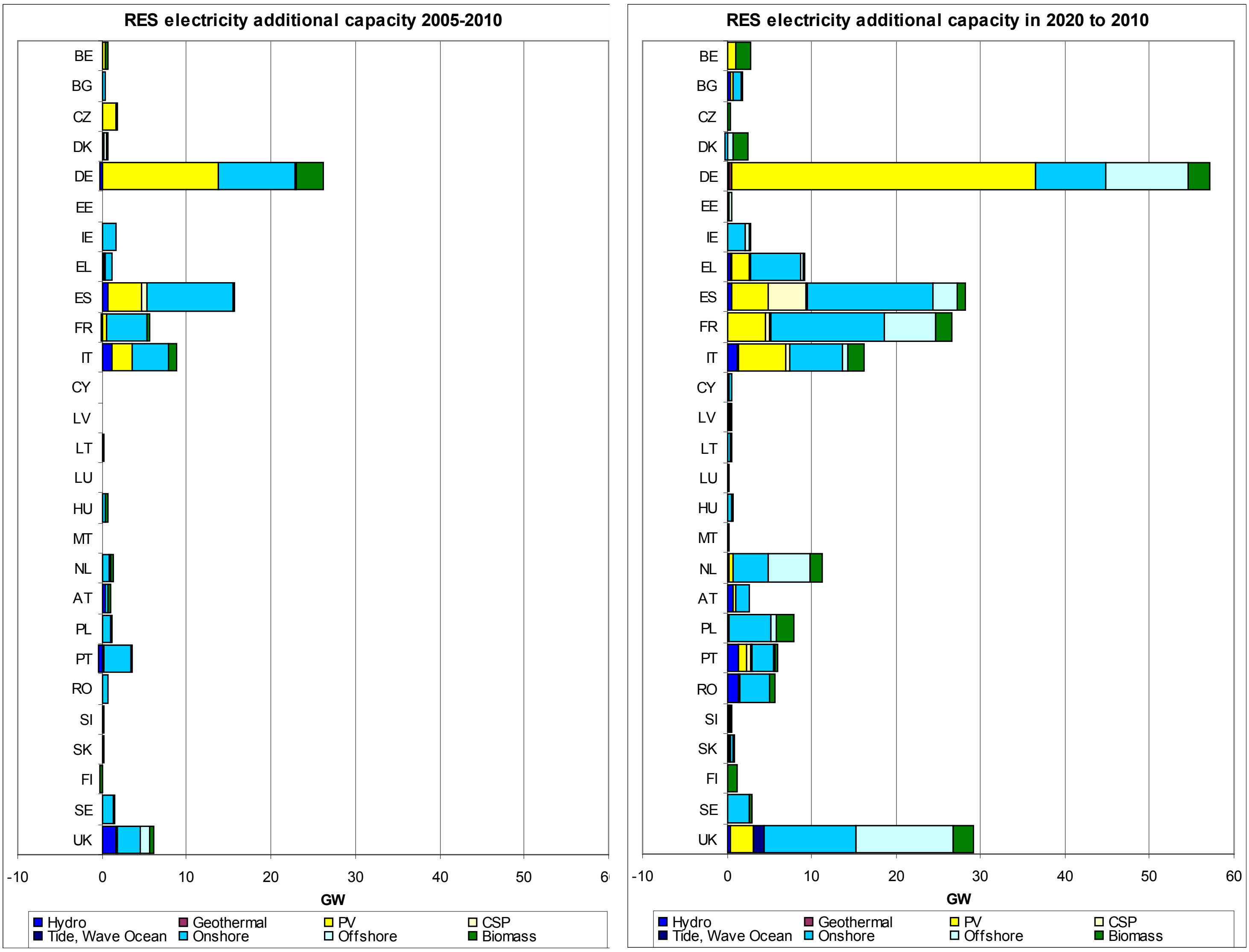


Figure 7: Additional RES electricity capacity growth between 2005-2010 and 2010-2020

Table 15: EU27 RES electricity total installed capacity in MW

2005	2010	2020	2005-2010		2010-2020	
			Additional	Share of 2005	Additional	Share of 2010
160,284.7	239,223.3	464,088	78,938.6	49.3 %	224,864.7	94 %

In the newly installed capacities between 2005 and 2010, onshore wind had the highest share with 52.9 %, followed by PV 29.5 %, and biomass 8.7 %. Between 2010 and 2020 onshore wind has 37 %, PV 26.2 %, offshore wind 17.2 %, biomass 9.2 %. hydro 3.5 % and CSP 2.8 %. Marine and geothermal represent only 0.8 % and 0.4 %.

The additional capacity between 2005 and 2010 is 78,938.6 MW and almost triples (285 %) within the years between 2010 and 2020 to 224,864.7 MW.

The highest PV capacity development between 2010 and 2020 in Germany (35,969 MW) is 61 % of the total PV capacity development in EU27 (58,866.5 MW).

The highest onshore wind additional capacity development is in ES (14,845 MW), FR (13458 MW) and UK (10,850 MW). These countries represent 47 % of the 83,265.6 MW onshore wind additional capacity in EU27 (Figure 7).

The offshore wind additional capacity development 2010-2020 is the highest in the UK (11,600 MW) and in Germany (9,850 MW); these two countries represent 55.3 % of the 38,783 MW offshore additional capacities in EU27.

As can be seen in Figure 7, between 2005 and 2010 Germany, France and Portugal have a decreased installed capacity in hydro resource and Finland in biomass. Between 2010 and 2020, only Denmark has a decrease in onshore installed capacity.

3.2.1.3. Electricity RES share in consumption

In the European Union the RES share in the electricity consumption grows from 15 % in the base year to almost 34 % by 2020. In terms of highest RES share

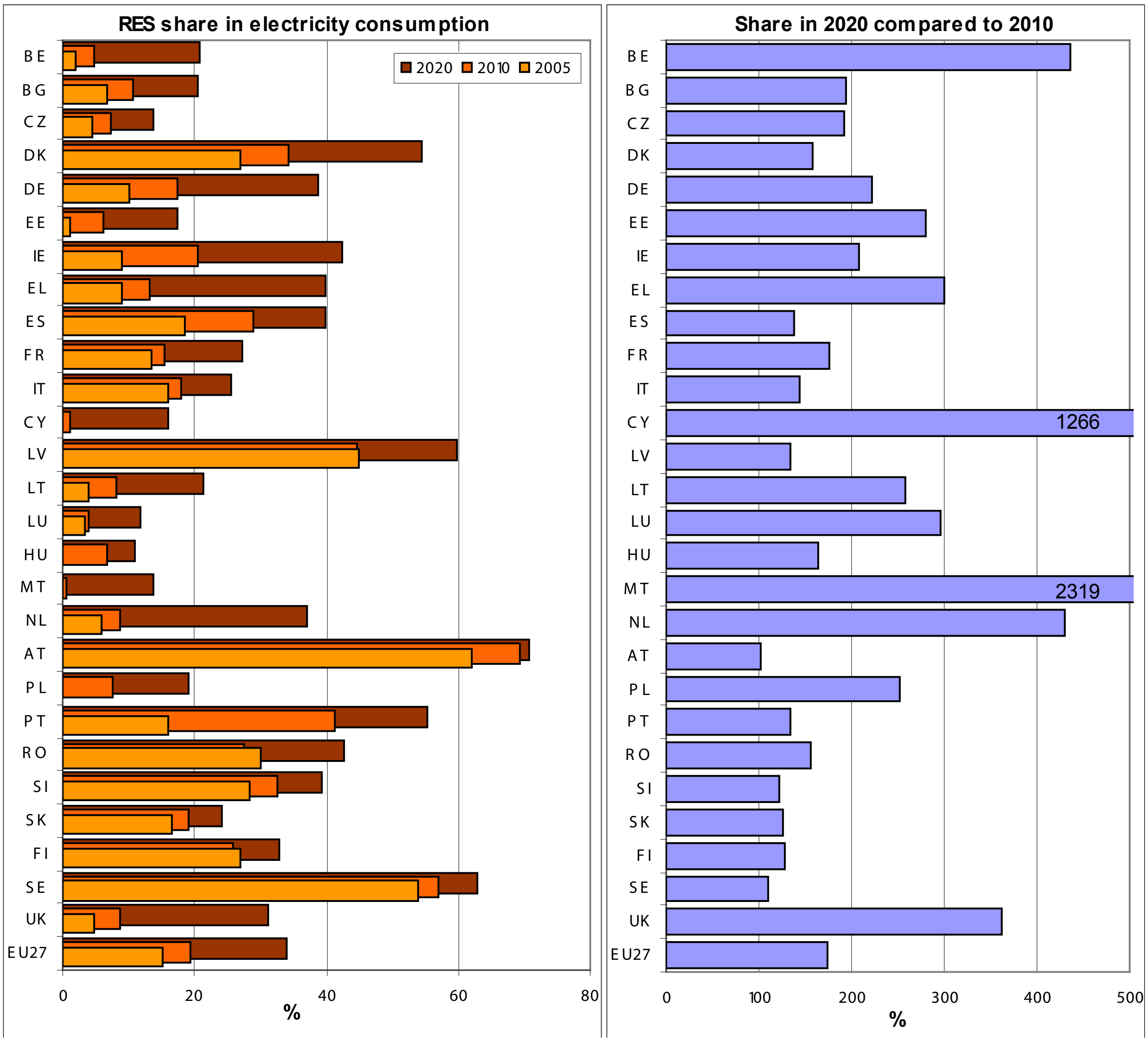


Figure 8: Share of RES in electricity consumption

in electricity Austria is the leading MS, where the RES share in electricity consumption is predicted to reach more than 70 % by 2020. More than 50 % of the electricity consumption will be covered by RES in Sweden, Latvia, Portugal and Denmark.

The highest development in the share in the electricity consumption is in Ireland, Greece, Germany, the Netherlands, UK, Cyprus and Malta between 2010 and 2020, compared to growth between 2005 and 2010.

3.2.2. RES Heating and Cooling

This chapter gives an overview about the RES in the Heating and Cooling sector and its share in consumption. (Table 16).

Table 16: RES in heating and cooling

	Heating and cooling RES in PJ				GJ/capita	relative 2005=100%		
	2005	2010	2015	2020	2020	2010	2015	2020
BE	20.6	32.2	60.3	108.7	10.19	156.2%	292.4%	527.6%
BG	30.4	31.1	39.6	46.3	6.06	102.3%	130.2%	152.3%
CZ	59.0	76.1	99.1	112.2	10.81	128.9%	167.9%	190.2%
DK	78.5	103.6	119.3	127.2	23.23	131.9%	152.0%	162.0%
DE	323.7	421.3	510.9	606.1	7.37	130.2%	157.8%	187.2%
EE	21.2	25.7	26.3	25.5	19.02	121.2%	124.0%	120.2%
IE	8.1	9.2	18.9	24.8	5.64	114.0%	233.7%	305.7%
EL	44.8	53.3	65.0	80.1	7.14	119.0%	145.2%	179.0%
ES	149.1	158.1	185.0	237.5	5.24	106.0%	124.1%	159.3%
FR	394.7	467.2	631.7	828.7	13.39	118.4%	160.1%	210.0%
IT	80.5	161.7	254.6	439.2	7.37	200.8%	316.2%	545.4%
CY	1.9	3.3	4.2	5.2	6.59	170.8%	222.0%	271.8%
LV	46.8	42.8	49.6	58.7	25.85	91.6%	106.0%	125.5%
LT	28.9	28.0	37.5	44.1	13.10	96.9%	130.0%	152.9%
LU	0.8	1.1	2.4	4.5	9.30	130.1%	290.3%	550.5%
HU*	n.a.	38.9	43.9	78.2	7.78	n.a.	n.a.	n.a.
MT*	n.a.	0.1	0.2	0.2	0.49	n.a.	n.a.	n.a.
NL	30.1	38.1	58.0	91.5	5.58	126.4%	192.5%	303.9%
AT	134.9	153.6	159.9	175.5	21.06	113.8%	118.5%	130.0%
PL*	n.a.	167.2	190.3	248.7	6.52	n.a.	n.a.	n.a.
PT	105.8	94.0	103.4	105.3	9.92	88.9%	97.7%	99.5%
RO	133.7	118.4	126.0	169.6	7.88	88.6%	94.3%	126.9%
SI	19.4	18.7	23.6	26.2	12.93	96.1%	121.4%	134.6%
SK	15.2	19.0	26.3	34.4	6.37	125.2%	173.7%	227.1%
FI	232.3	219.2	266.3	305.3	57.60	94.4%	114.6%	131.5%
SE	297.5	346.0	394.4	442.8	48.22	116.3%	132.6%	148.8%
UK	20.0	21.8	64.6	260.4	4.26	109.1%	323.6%	1305.1%
EU27	**2277.9**	**2849.5**	**3561.3**	**4687.0**	**9.46**	**125.1%**	**156.3%**	**205.8%**

**Hungary Malta and Poland did not report the RES generation data for 2005*

Renewable heating and cooling will make a total contribution of 4,685 PJ (111.2 Mtoe) in 2020 in the EU, according to the NREAPs.

3.2.2.1. Heating and Cooling generation

Biomass has the major contribution in renewable heating and cooling (81.1 %) followed by 10.9 % of heat pumps, 5.7 % of solar and 2.4 % of geothermal by 2020. The biggest increase is in solar energy, which in 2020 will be 4.7 fold more than in 2010 (437 % from 60.8 PJ to 266 PJ), the share in H&C increases from 2 % (2010). The geothermal energy is 3.8 times more than in 2010, with the share increasing from 1 % to 2.4 %. Heat pump triples between 2010 and 2020, with the share almost doubling, growing from 5.9 to 10.9 %.

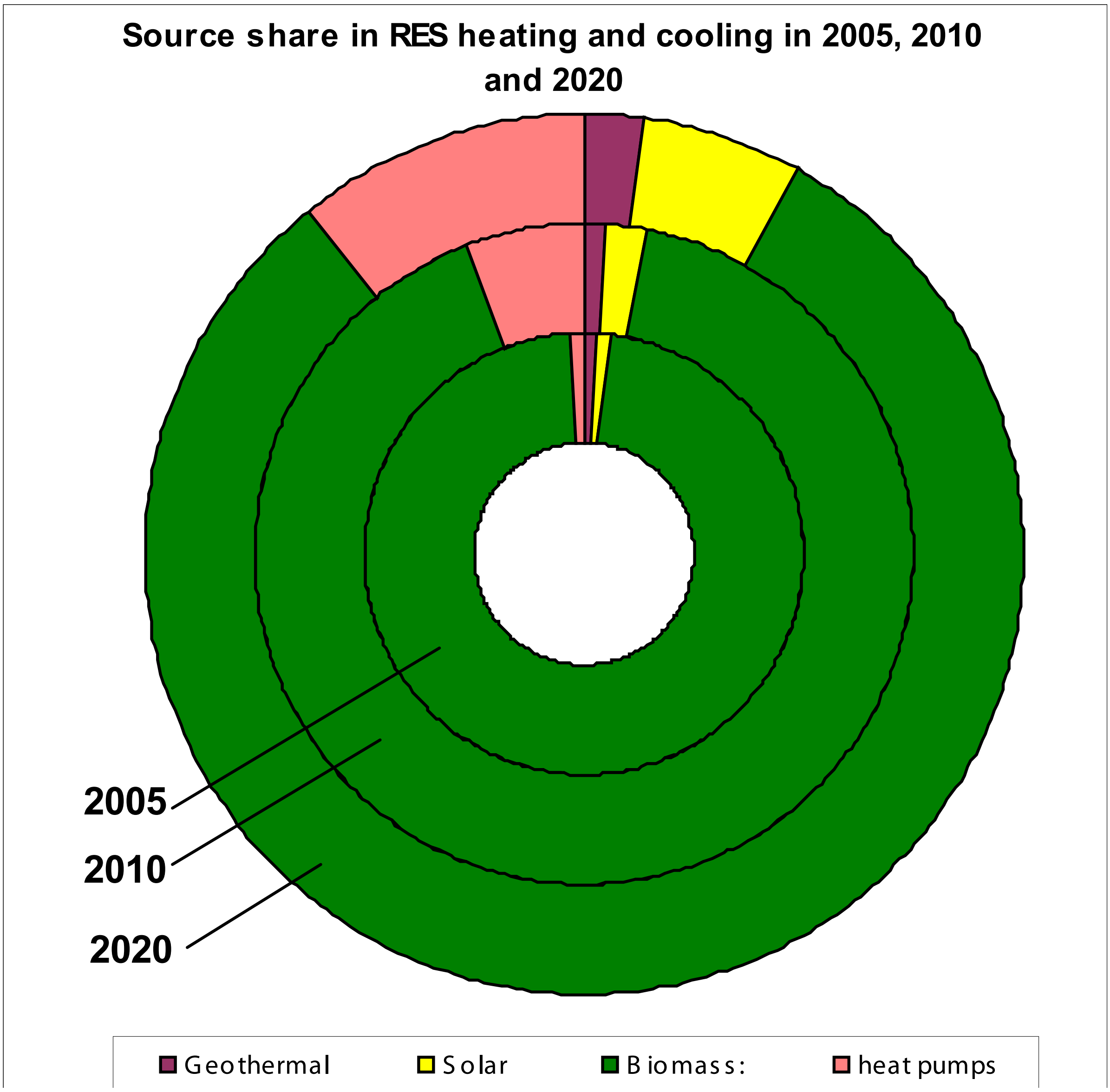


Figure 9: RES in heating and cooling in source breakdown

Biomass will still have the major contribution for heating and cooling, with 3,798.2 PJ (90.5 Mtoe), with a share decreasing from 97% in 2005 to 81.1 % in 2020.

Biomass heating and cooling generation in 2020 is 1.5 times more than in 2010, however the share decreased 10 % between 2010 and 2020 from 91.1 %. (Figure 9)

	2005			
	RES in H&C	% of		
	in PJ	RES H&C	total RES	H&C
Geothermal	18.06	0.79	0.44	0.08
Solar thermal	28.47	1.25	0.69	0.12
Biomass	2,210.33	96.83	53.66	9.53
Heat pump	25.83	1.13	0.63	0.11
Total RES H&C	**2,282.7**	**100**	**55.42**	**9.84**
Total RES	**4,119.22**			
Total H&C	**23,186.4**			

	2010			
	RES in H&C	% of		
	in PJ	RES H&C	total RES	H&C
Geothermal	28.31	1.00	0.49	0.12
Solar thermal	56.00	1.97	0.98	0.25
Biomass	2,589.61	91.10	45.13	11.36
Heat pump	168.64	5.93	2.94	0.74
Total RES H&C	**2,842.6**	**100**	**49.53**	**12.47**
Total RES	**5,738.65**			
Total H&C	**22,793.0**			

	2020			
	RES in H&C	% of		
	in PJ	RES H&C	total RES	H&C
Geothermal	110.13	2.35	1.08	0.50
Solar thermal	266.03	5.68	2.60	1.22
Biomass	3,798.22	81.08	37.10	17.38
Heat pump	510.37	10.89	4.98	2.33
Total RES H&C	**4,684.8**	**100**	**45.75**	**21.43**
Total RES	**10,239**			
Total H&C	**21,857.8**			

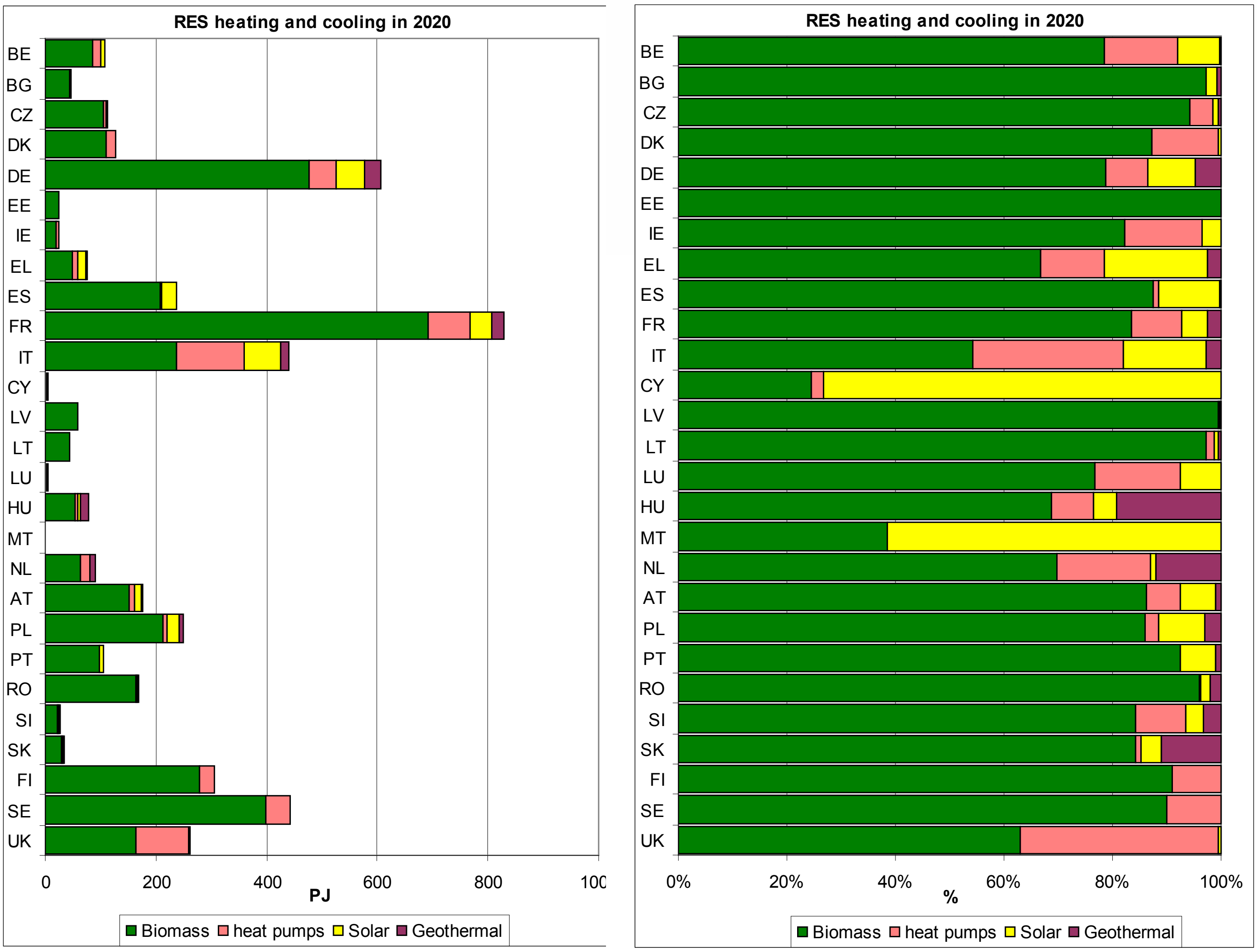


Figure 10: RES H&C breakdown by source in MSs in 2020

Leading countries

France is the leading MS in the terms of H&C generation from RES with 829 PJ (almost 20,000 ktoe), which represents 17.7 % of the total RES H&C in EU27. The RES H&C generation in Germany, Sweden and Italy is over 400 PJ (10,000 ktoe); these three countries contributing with almost 32 % of the RES H&C in EU27. Finland, UK, Poland and Spain with an amount higher than 200 PJ (5,000 ktoe) representing 22.5 %. These eight MSs give 72 % of the RES Heating and Cooling in EU27 by 2020.

3.2.2.2. Heating and Cooling RES share in Consumption

In the EU the RES share in the Heating and Cooling consumption grows from 9.8 % in the base year to almost 23.5 % by 2020 (Figure 11). Sweden has the highest RES share in H&C, where the RES share in the H&C consumption is foreseen to reach more than 62 % by 2020. In Latvia and Finland more than 40 % of the consumption will be covered by RES in H&C.

The highest share development is in France, Hungary, Italy, Slovakia, UK, Ireland, Belgium, the Netherlands and Luxembourg. The RES proportion will be reduced in H&C in Estonia, Portugal and Malta between 2005 and 2020.

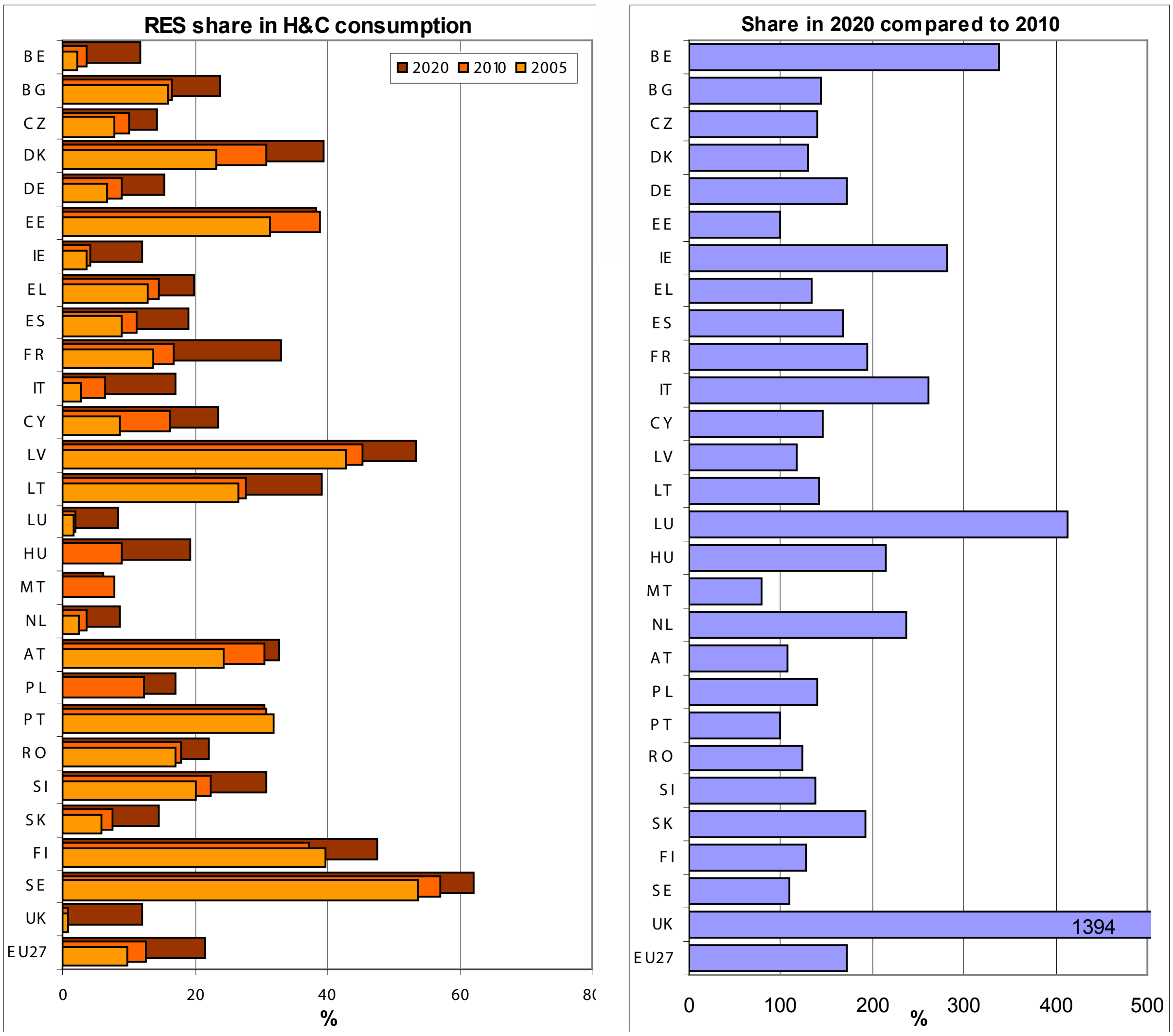


Figure 11: Share of RES in Heating & Cooling consumption

3.2.3. RES Transport

This chapter gives an overview about the RES transport generation and transport RES share in consumption. The development of the RES transport, according to the NREAPs, in absolute and relative terms, is summarised in Table 17.

Table 17: RES in Transport

	Transport RES in PJ				GJ/capita	relative 2005=100%		
	2005	2010	2015	2020	2020	2010	2015	2020
BE	0.7	14.8	22.9	37.2	3.49	2151.8%	3317.6%	5404.5%
BG*	n.a.	1.3	4.8	8.6	1.13	n.a.	n.a.	n.a.
CZ	0.4	10.5	19.1	29.0	2.79	2777.8%	5055.6%	7677.8%
DK	0.4	1.8	11.2	12.2	2.23	466.7%	2955.6%	3222.2%
DE	87.7	157.5	146.1	257.9	3.14	179.6%	166.6%	294.1%
EE	0.2	0.0	1.5	3.8	2.83	27.8%	972.2%	2500.0%
IE	0.1	5.7	12.7	21.7	4.93	8628.7%	19193.6%	32973.9%
EL	0.1	4.6	16.5	26.6	2.37	9166.7%	32750.0%	52833.3%
ES	15.4	75.7	113.2	163.2	3.60	492.4%	736.2%	1061.4%
FR	22.8	121.7	135.0	170.6	2.76	532.7%	591.0%	746.7%
IT	13.4	50.0	85.7	121.8	2.04	374.2%	641.5%	911.6%
CY*	n.a.	0.7	1.0	1.6	2.03	n.a.	n.a.	n.a.
LV	0.3	1.8	2.2	3.5	1.54	600.0%	757.1%	1185.7%
LT	0.2	2.3	4.6	7.1	2.11	1536.1%	3072.2%	4708.3%
LU	0.1	1.8	3.5	9.5	19.63	2066.7%	4014.3%	10766.7%
HU	0.2	6.3	11.2	22.5	2.24	3000.0%	5320.0%	10700.0%
MT*	n.a.	0.2	0.9	2.1	5.12	n.a.	n.a.	n.a.
NL	0.3	13.4	24.8	38.0	2.32	3987.5%	7387.5%	11312.5%
AT	8.6	23.7	26.5	36.0	4.32	275.1%	308.3%	417.6%
PL	1.8	41.2	57.8	84.8	2.22	2281.4%	3200.0%	4693.0%
PT	0.5	12.6	19.6	22.5	2.12	2508.3%	3883.3%	4458.3%
RO	1.7	10.9	17.2	23.1	1.07	635.9%	998.5%	1346.2%
SI	0.2	1.9	3.6	8.5	4.20	1176.9%	2210.3%	5197.4%
SK	0.3	3.8	6.2	8.7	1.61	1125.0%	1837.5%	2587.5%
FI	0.8	10.1	18.5	25.2	4.75	1200.0%	2200.0%	3000.0%
SE	12.1	22.2	32.3	42.3	4.61	183.3%	266.7%	350.0%
UK	7.9	47.5	113.5	187.8	3.07	602.1%	1437.2%	2378.7%
EU27	**176.0**	**644.0**	**912.0**	**1375.8**	**2.78**	**365.8%**	**518.1%**	**781.5%**

**Malta, Bulgaria and Cyprus did not report RES transport generation data for 2005*

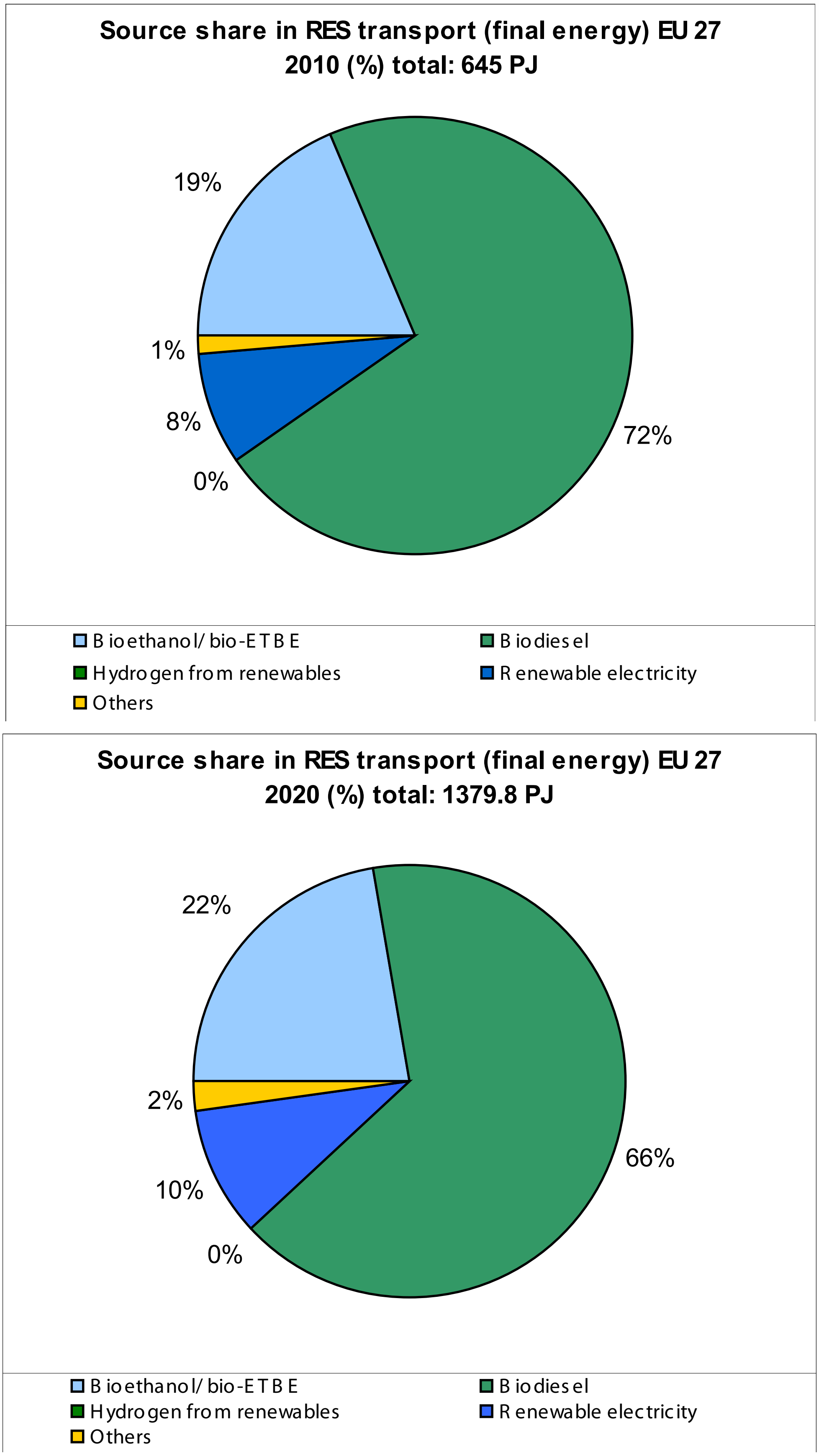


Figure 12: RES share in transport sector in source breakdown

	2005			
	RES transport	% of		
	in PJ	RES transport	total RES	transport
Bioethanol/ bio-ETBE	22.17	12.59	0.54	0.18
Biodiesel	99.87	56.72	2.41	0.79
Hydrogen from renewables	0	0.00	0.00	0.00
Renewable electricity	45.5	25.84	1.10	0.36
Others	8.34	4.74	0.20	0.07
Total RES transport	**176.06**	100.00	4.25	1.40
total RES	**4,119.22**			
Total transport	12,562.4			
Total RES transport adjusted to the target	178.3			

	2010			
	RES transport	% of		
	in PJ	RES transport	total RES	transport
Bioethanol/ bio-ETBE	120.56	18.72	2.10	0.92
Biodiesel	460	71.43	8.00	3.50
Hydrogen from renewables	0	0.00	0.00	0.00
Renewable electricity	54.58	8.47	0.95	0.41
Others	8.86	1.38	0.15	0.07
Total RES transport	**644.01**	100.00	11.20	4.89
total RES	**5,738.65**			
Total transport	13,157.9			
Total RES transport adjusted to the target	667.5			

	2020			
	RES transport	% of		
	in PJ	RES transport	total RES	transport
Bioethanol/ bio-ETBE	306.15	22.25	2.99	2.34
Biodiesel	906.47	65.89	8.84	6.92
Hydrogen from renewables	0.1	0.01	0.00	0.00
Renewable electricity	131.88	9.59	1.29	1.01
Others	31.19	2.27	0.30	0.24
Total RES transport	**1,375.8**	100.00	13.42	10.50
total RES	**10,239**			
Total transport	13,105			
Total RES transport adjusted to the target	1532			

The total contribution of RES in 2020 in the EU, without double counting the electricity in transport, will be 1,375.8 PJ (32.757 Mtoe) as is shown in Table 17, and 1,532 PJ (36.476 Mtoe) with multiple counting of electricity use in road transport and Article 21.2 Biofuels (Table 12). Overall, this would represent 11.7% of the energy use in the transport sector, above the 10% binding target.

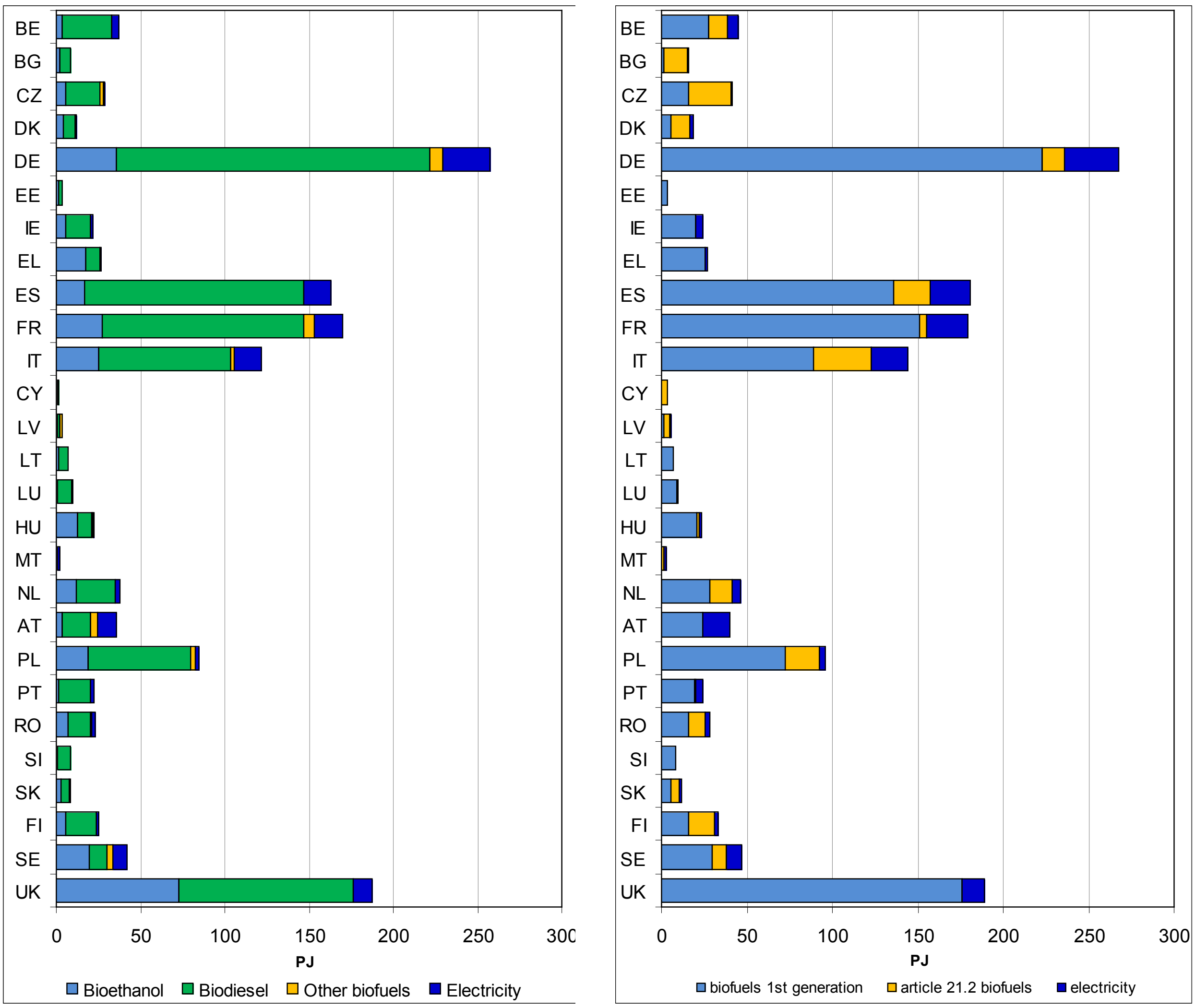


Figure 13: RES use in Transport with single counting and multiple counting

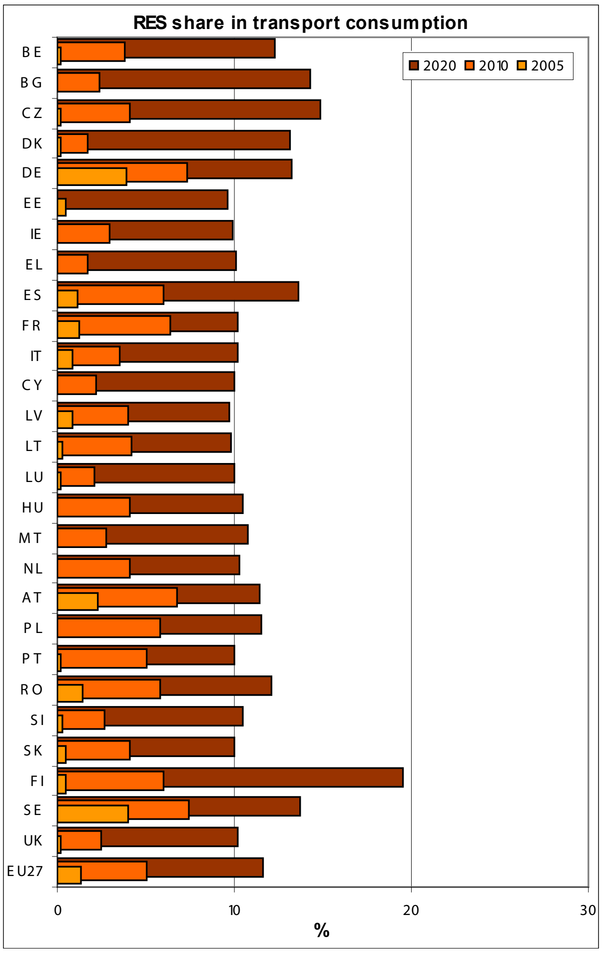
The renewable electricity in transport is expected to increase from 45.3 PJ (1.1 Mtoe) in 2005 to 131.5 PJ (3.1 Mtoe) in 2020. Of this, the renewable electricity in road transport should have a significant increase, rising from 0.5 PJ (12 ktoe) in 2005 to 29.3 PJ (701 ktoe) in 2020. Thus, if considering multiple counting, biofuels should represent 89.8% of the total RES used in transport, renewable electricity in road transport should be 1.9% and biofuels should be 7.3% from wastes, residues, non-food cellulosic and lingo-cellulosic material in transport.

3.2.3.1. Transport RES share in consumption

In the EU the RES share in the transport consumption grows from 1.4 % in the base year of 2005 to almost 11.6 % by 2020 (Figure 14). Finland has the highest RES share in transport, more than 19 % of the consumption.

Latvia, Estonia and Ireland are below; Slovakia, Portugal and Lithuania are around the 10 % RES share in transport. All the other MSs are well above the 10 % RES share.

The highest share development is in Estonia, Malta, Denmark, Bulgaria and Greece between 2010 and 2020.



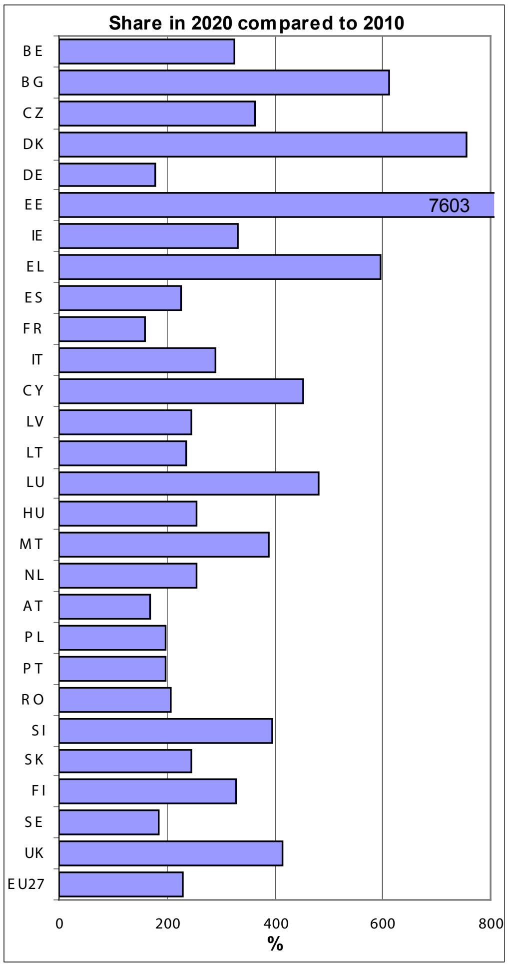


Figure 14: RES share in Transport consumption

3.3 Assessment by RES

This chapter reports on the assessment of the renewable energy sources, first in the RES mix in EU27, then the detailed assessments source by source.

3.3.1. Generation/RES mix in EU27

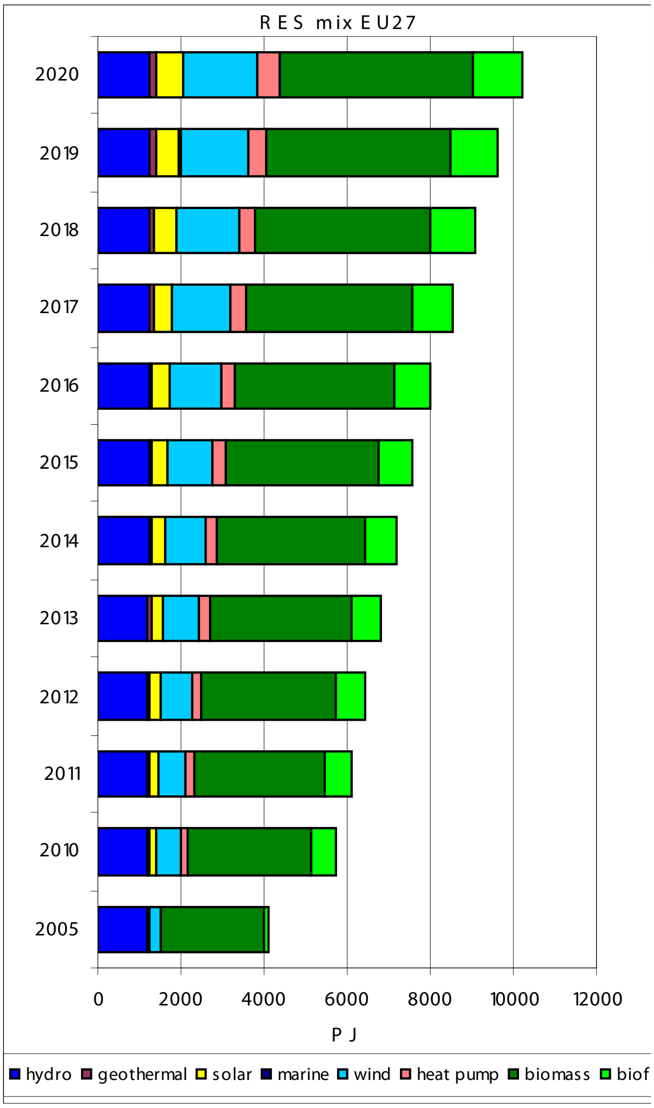
The RES generation mix in EU27 is presented in absolute and relative terms in Table 18 and Figure 15 from 2005 to 2020.

Table 18: Resource share in RES in EU27 in 2005, 2010 to 2020

	2005*		2010		2020		CAGR 2020/ 2010
	RES generation in PJ	% of total RES	RES generation in PJ	% of total RES	RES generation in PJ	% of total RES	
Hydro	1,180.87	28.6	1,204.79	21.0	1,265.04	12.3	0.5
Geothermal	37.84	0.9	49.89	0.9	149.40	1.5	11.6
Solar total	35.04	0.8	132.90	2.3	639.22	6.2	17.0
Solar electricity	6.60	0.2	76.90	1.3	373.19	3.6	17.1
PV	6.60	0.2	72.74	1.3	301.1	2.9	15.3
CSP	0	0.0	4.16	0.1	72.09	0.7	33.0
Solar thermal	28.47	0.7	56.00	1.0	266.03	2.6	16.9
Marine	1.93	0.0	1.81	0.0	21.64	0.2	28.2
Wind total**	256.79	6.2	594.28	10.3	1,786.07	17.4	11.6
Onshore	241.40	5.9	557.02	9.7	1,237.77	12.1	8.3
Offshore	6.94	0.2	30.74	0.5	483.08	4.7	31.7
Heat pump	25.83	0.6	168.64	2.9	510.37	5.0	11.7
Biomass	2,455.41	59.5	3,002.62	52.3	4,635.95	45.2	4.4
Biofuel	130.56	3.2	589.43	10.3	1,243.93	12.1	7.8
Total RES	**4,124.27**	100.0	**5,744.38**	100.0	**10,251.62**	100.0	**6.0**

** MT and HU did not report the RES generation data for 2005*

*** BE and FI did not reported separately the onshore and offshore wind, they only reported the total wind energy. That is why the sum of onshore and offshore is different from the total wind data*



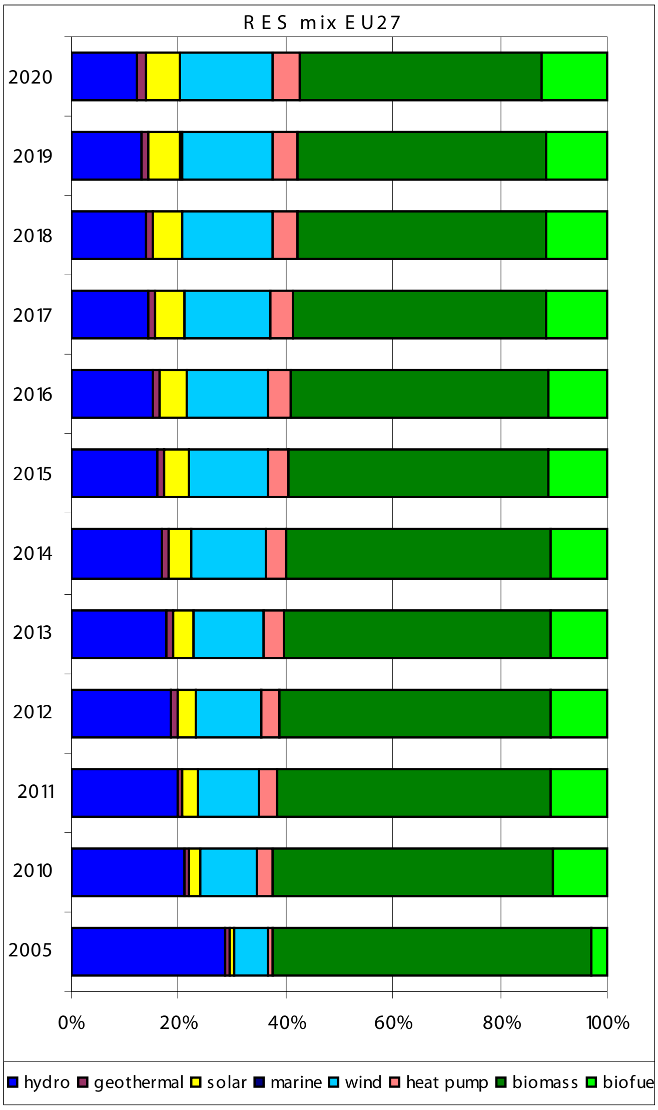


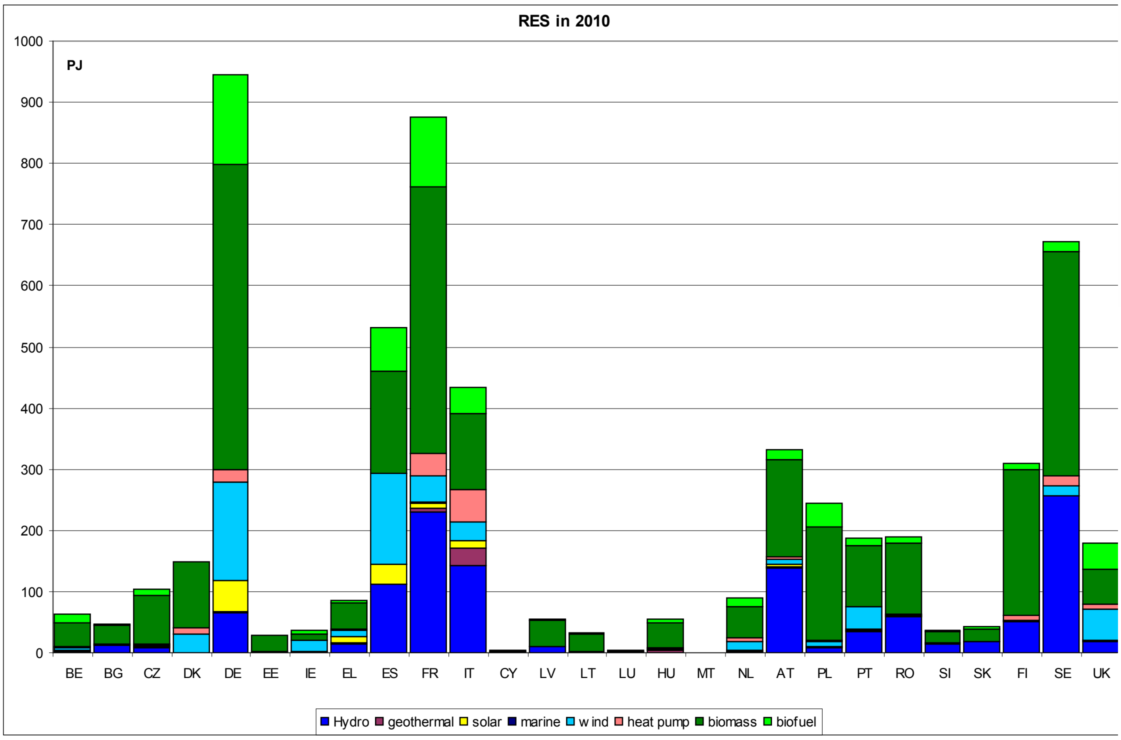
Figure 15: RES mix in EU27 in 2020

Biomass represents the highest share within renewables. The share decreases, starting from the base year, with 59.5 %, arriving to 45 % in 2020, as can be seen in Figure 15 and Table 18.

Hydro had the second highest share in the base year (28.6%), but decreases to 12.3% by 2020, although the amount of hydro resources stays almost stable during the reporting period.

Wind energy development is also relevant, as it is with biofuels. Onshore wind and biofuels both arrive to a 12.1 % RES share by 2020.

Figure 16 and Figure 17 give an overview about the amount of the share of the renewable sources in the Member States by 2010 and by 2020.



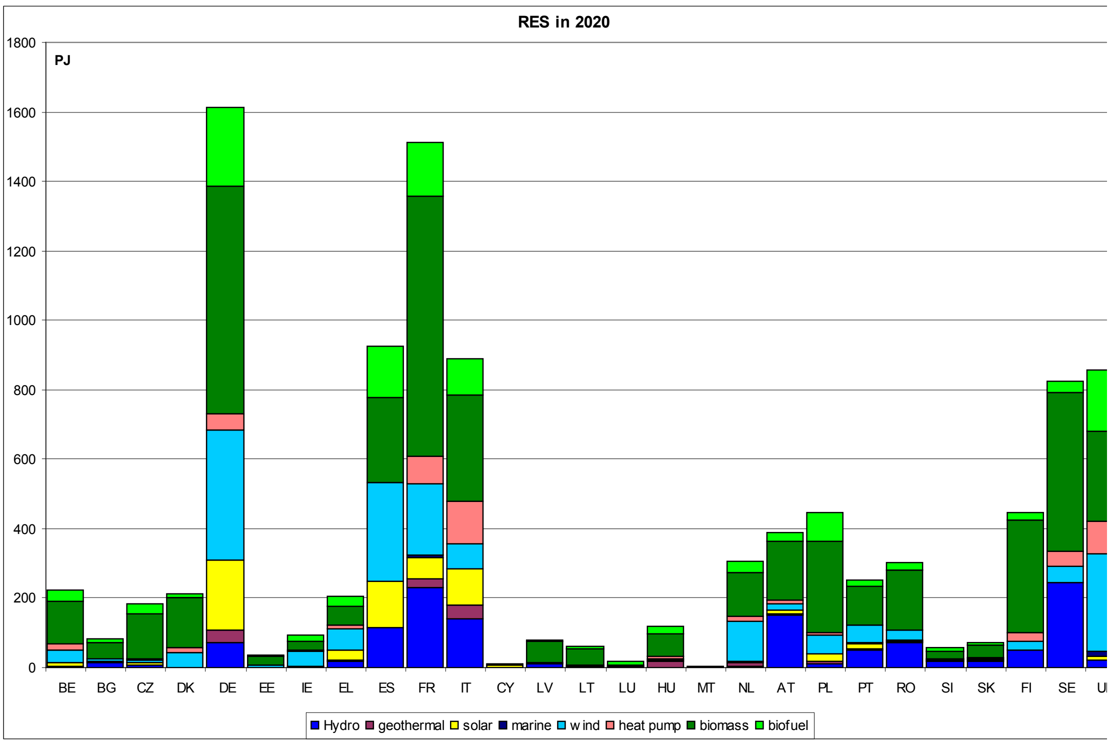
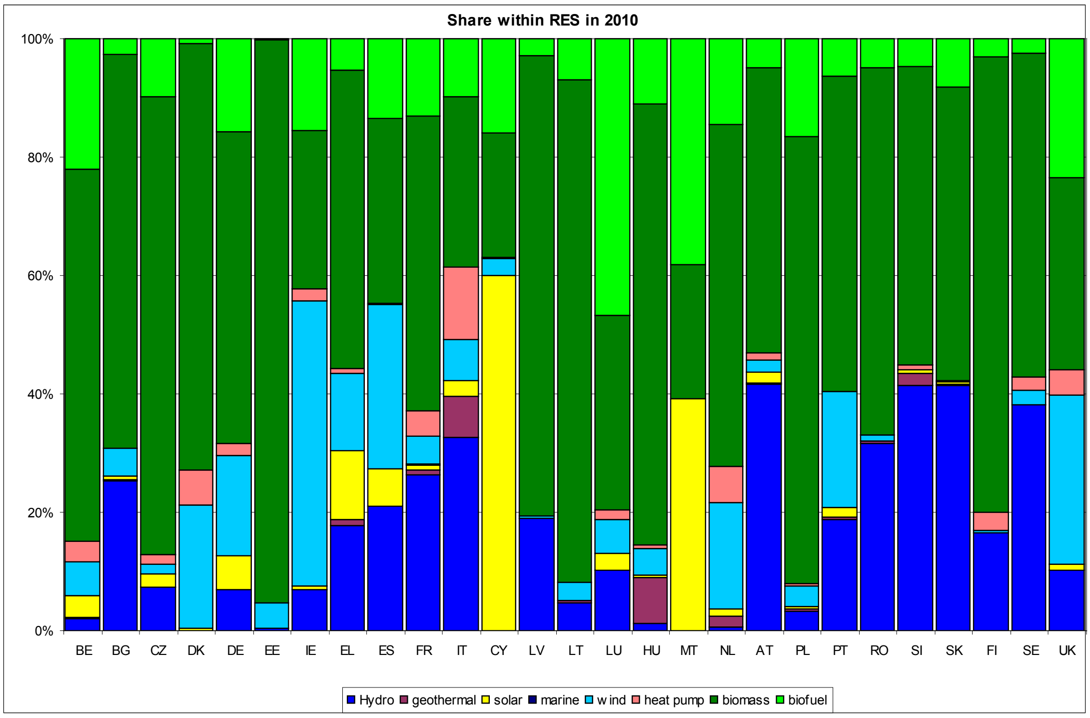


Figure 16: Composition of the different RES in the Member States by 2010 and by 2020 in PJ



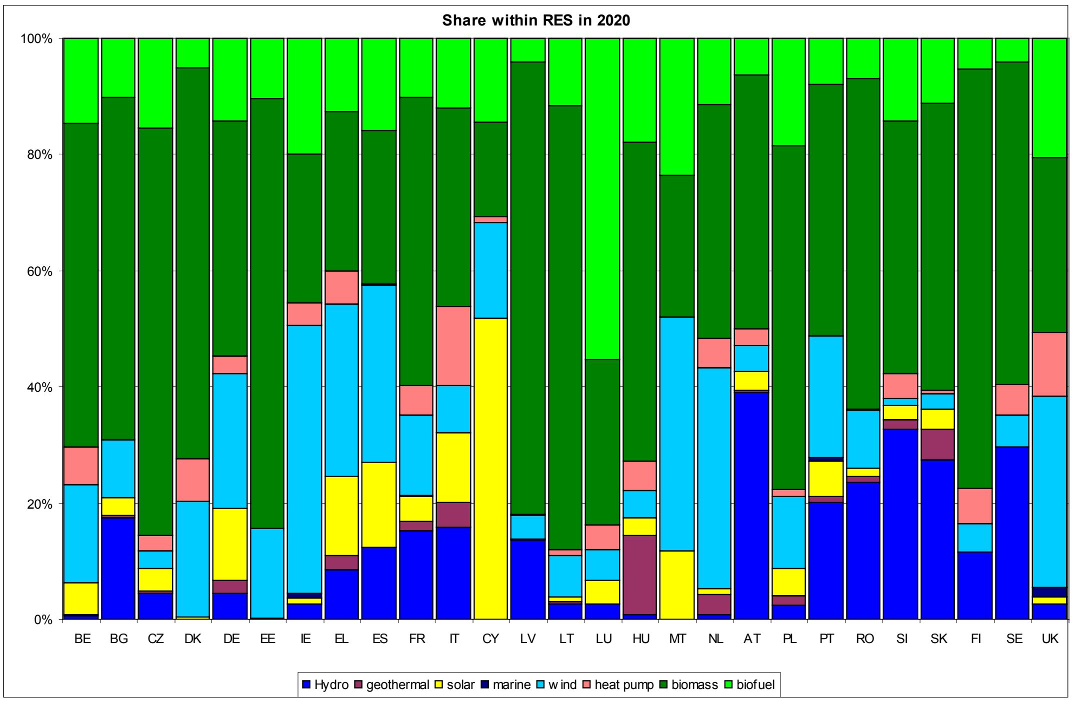


Figure 17: Relative share of the different RES in the total RES in the Member States in 2010 and 2020

3.3.2. Assessment of growth rate

The growth rate calculations are used to assess the risk of the different technologies and resources, and the assessment of development. Table 19, 20, Table 21 and Figure 18 summarise the calculations for EU27. We refer to these figures in the related chapters.

Table 19: Yearly growth rate of energy production from renewable resources in EU27

%	2005 2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Hydro	2.0	-0.1	0.4	0.5	0.6	0.3	0.3	1.0	0.5	0.6	0.8
Geothermal$_{th+e}$	31.6	10.7	9.5	11.3	11.9	9.6	14.3	12.3	13.3	10.3	12.7
Solar	279.3	38.0	21.3	17.5	15.4	14.4	14.4	13.3	12.9	12.1	12.2
electricity	1070.2	48.5	25.0	17.9	15.1	13.3	12.6	11.6	10.9	10.6	10.3
PV	1001.9	43.5	20.7	15.7	13.9	12.4	11.5	10.6	9.9	9.3	8.9
CSP	n.a.*	134.9	70.7	34.4	22.8	18.6	19.0	17.2	16.4	16.7	16.5
thermal	96.7	23.7	15.3	16.8	16.0	16.4	17.7	16.2	16.1	14.5	15.0
Marine	- 6.4	0.2	14.5	13.6	15.2	14.9	95.1	53.1	34.6	33.7	28.9
Wind	131.4	15.6	14.1	13.7	12.6	11.1	10.9	10.5	10.1	8.7	9.2
onshore	130.7	13.9	11.2	9.5	9.5	8.5	6.8	6.3	6.7	5.4	5.7
offshore	343.2	36.8	49.0	55.4	34.3	26.6	30.7	28.1	22.5	19.1	19.4
Heat pump	553.0	16.9	14.9	10.3	10.2	10.5	11.0	10.5	10.9	10.1	11.9
Biomass	24.2	4.3	3.9	4.7	4.3	4.2	4.6	4.7	4.5	5.3	4.4
Biofuel	357.9	9.2	7.9	2.6	9.1	6.6	7.0	10.9	7.0	5.9	11.4
Total RES	**41.0**	**6.3**	**5.8**	**5.5**	**6.0**	**5.5**	**5.9**	**6.5**	**6.0**	**6.0**	**6.6**

** in 2005 there is no CSP reported*

-: means decrease

Table 20: RES generation CAGR to 2010

CAGR %	2010 to 2005	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Hydro	0.4	-0.1	0.1	0.3	0.3	0.3	0.3	0.4	0.4	0.5	0.5
Geothermal$_{th+e}$	5.7	10.9	10.3	10.6	11.0	10.7	11.3	11.4	11.6	11.5	11.6
Solar	30.6	38.1	29.4	25.1	22.8	21.1	20.0	19.0	18.2	17.5	17.0
electricity	63.5	48.5	36.2	29.5	26.0	23.3	21.5	20.0	18.8	17.9	17.1
PV	61.6	43.5	31.6	25.8	22.9	20.8	19.2	17.9	16.9	16.0	15.3
CSP	n.a.*	134.9	100.2	74.3	60.4	51.0	45.1	40.7	37.4	35.0	33.0
thermal	14.5	23.7	19.5	18.4	18.0	17.7	17.7	17.5	17.3	17.1	16.9
Marine	-1.3	0.2	7.1	9.1	10.7	11.5	22.4	26.4	27.4	28.1	28.2
Wind	18.3	15.6	14.8	14.3	14.0	13.4	13.0	12.6	12.3	11.9	11.6
onshore	18.2	13.9	12.5	11.4	11.0	10.5	9.9	9.4	9.0	8.6	8.3
offshore	34.7	36.8	42.8	46.3	43.6	40.1	38.5	36.9	35.0	33.2	31.7
Heat pump	45.5	16.9	15.9	13.9	13.1	12.5	12.3	12.0	11.9	11.7	11.7
Biomass	4.1	4.1	4.1	4.2	4.2	4.2	4.2	4.3	4.3	4.4	4.4
Biofuel	36.0	9.2	8.6	6.5	7.2	7.1	7.1	7.6	7.5	7.4	7.7
Total RES	**6.9**	**6.2**	**6.0**	**5.7**	**5.8**	**5.7**	**5.7**	**5.9**	**5.9**	**5.9**	**6.0**

** in 2005 there is no CSP reported*

-: means decrease

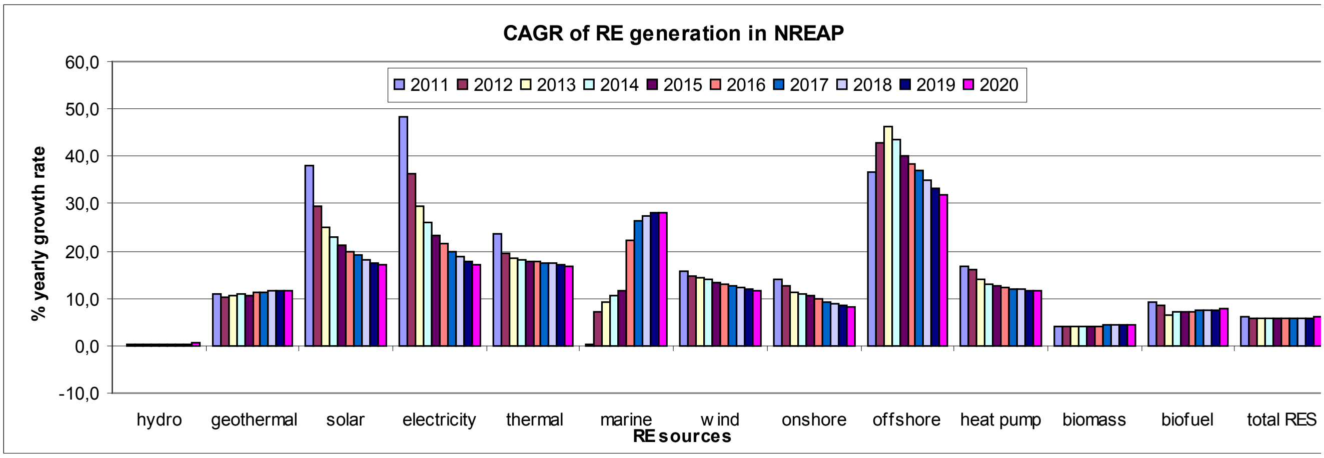


Figure 18: CAGR of the RES according the NREAPs for EU27

Table 21: RES capacity CAGR in electricity to 2010

%	2005 2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Hydro	0.7	0.5	0.8	0.8	0.8	0.7	0.7	0.8	0.7	0.7	0.7
Geothermal	1.9	3.4	3.9	4.4	4.9	5.0	5.1	5.2	6.0	6.2	7.1
Solar	63.7	29.1	23.3	20.5	18.6	17.3	16.2	15.3	14.5	13.9	13.3
PV	62.9	26.8	21.5	19.1	17.5	16.3	15.4	14.5	13.9	13.2	12.7
CSP	n.a.	122.9	81.7	60.7	48.5	41.2	36.6	33.2	30.6	28.7	27.2
Tide, Wave Ocean	0.4	0.0	3.2	4.7	7.1	8.7	16.5	20.2	22.7	23.7	24.1
Wind	16.0	13.3	12.6	11.9	11.4	11.0	10.7	10.8	10.1	9.9	9.7
onshore	15.5	12.2	11.1	10.1	9.5	9.1	8.6	8.7	7.9	7.6	7.3
offshore	30.0	38.5	44.8	48.3	45.0	41.3	39.6	37.8	35.7	33.7	32.2
Biomass	7.6	5.8	6.7	8.1	7.7	7.4	7.3	7.0	6.9	6.8	6.7
Solid	6.3	4.0	6.1	8.5	8.1	7.7	7.5	7.2	7.0	6.9	6.7
Gas	15.2	7.7	7.6	7.7	7.9	7.8	7.8	7.6	7.5	7.6	7.6
liquid	23.1	12.6	10.8	8.5	7.4	6.7	6.2	5.9	5.6	5.3	5.1
Total	**8.3**	**7.4**	**7.7**	**7.6**	**7.4**	**7.2**	**7.2**	**7.2**	**6.9**	**6.8**	**6.9**

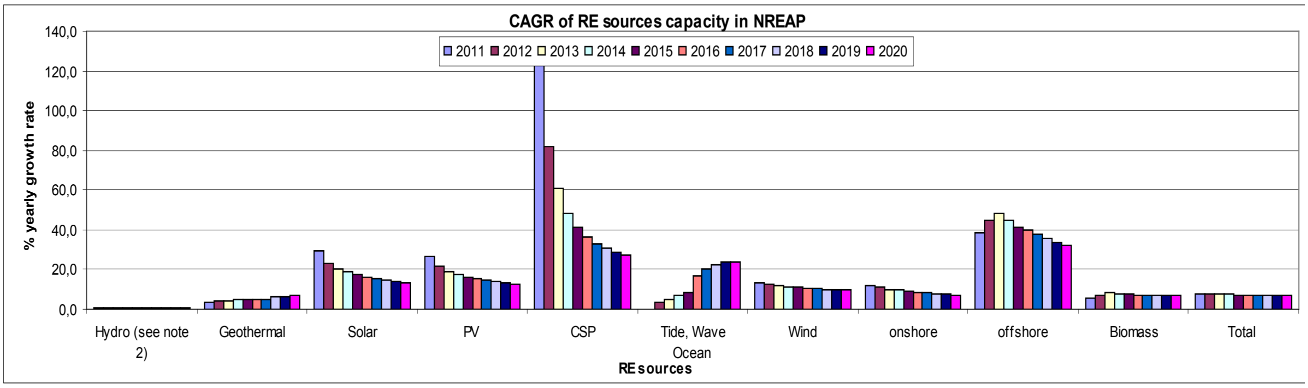


Figure 19: CAGR of the RES electricity capacity according to the NREAPs for EU27

3.3.3. Hydro

In the case of Ireland, France, UK and Lithuania the pump storage was included in the reported hydro data; in this report the pumping data are excluded.

There were no detailed hydropower data for Bulgaria, Ireland, and the Netherlands and UK introduced different sizing in the reporting template.

The hydropower is a well-experienced technology with little remaining potential, so almost no increase is expected. The hydroenergy resource stays nearly constant through 2010-2020. The share of hydropower decreases from 21 to 12 % (Table 18).

The leading countries remain the same from 2005 to 2020. Sweden and France have the highest amount of hydroenergy resources, with more than 200 PJ (245.3 and 239.7), Italy and Austria around 150 PJ (141.8 and 152.1) and Spain higher than 100 PJ (114 PJ). These five countries represent the 70 % of the total hydro energy of EU27.

Table 22: Comparative data for the hydro resources for the 27 MSs (RES Electricity Installed capacity in 2020)

	EUROSTAT 2008 MW					NREAP 2010 MW					NREAP 2020 MW					W/ capita
	<1 MW	1 MW -10 MW	>10 MW	Pumping	Total	<1 MW	1 MW -10 MW	>10 MW	Pumping	Total	<1 MW	1 MW -10 MW	>10 MW	Pumping	Total	
BE	9	50	52	1307	**111**					**112.3**					**140**	13
BG	39	191	1890	864	**2120**					**2090**					**2549**	334
CZ	151	141	753	1147	**1045**	162	142	743		**1047**	194	147	743		**1084**	104
DK	5	4	0	:	**9**	0	10	0		**10**	0	10	0	0	**10**	0
DE	561	842	2104	6494	**3507**	507	987	2558	6494	**4052**	564	1043	2702	7900	**4309**	813
EE	5	0	0	:	**5**	6	1.2			**7.2**	6,.6	1.2		300	**7.8**	1
IE	23	20	196	292	**239**	18	20	196		**234**	18	20	196	0	**234**	23
EL	44	114	18823	699	**18981**	29	154	3054	700	**2537**	39	216	4276	1580	**2951**	48
ES	267	1605	11232	5347	**13104**	242	1603	16842	2546	**16141**	268	1917	20177	5700	**16662**	8,224
FR	445	1604	2319	4303	**4368**	441	1647	19333	4800	**16621**	483	1807	21206	6800	**16696**	369
IT	437	2105	11190	7544	**13732**	444	2250	13886	2399	**14181**	650	3250	13900	2600	**15200**	3,454
CY	:	:	:	:	**0**	0	0	0	0	**0**	0	0	0	0	**0**	0
LV	24	1	1511	:	**1536**	24	1	1511		**1536**	27	1	1522		**1550**	26
LT	8	90	760	115			26	100.8		**126.8**	40	100.8	0	140.8	**17**	5
LU	2	38	0	1100	**40**	2	36	0	1100	**38**	3	41	0	1300	**44**	91
HU	4	10	37	:	**51**	3	9	39		**51**	6	22	39		**67**	6
MT	:	:	:	:	**0**	0	0	0	0	**0**	0	0	0	0	**0**	0
NL	0	0	37	:	**37**					**47**					**203**	495
AT	454	725	7040	4285	**8219**	455	726	7053	4285	**8234**	497	794	7707	4285	**8998**	1,080
PL	74	183	672	1406	**929**	102	178	672		**952**	142	238	772		**1152**	70
PT	31	361	3634	1029	**4026**		410	4524	1036	**3898**		750	8798	4302	**5246**	138
RO	61	292	6009	:	**6362**	63	324	6026		**6413**	109	620	7000		**7729**	728
SI	117	37	873	:	**1027**	118	37	916		**1071**	120	57	1176	0	**1353**	147
SK	25	65	1542	916	**1632**	25	55	1542	916	**1622**	60	122	1630	916	**1812**	84
FI	31	285	2786	:	**3102**	30	280	2750		**3060**	30	280	2790	0	**3100**	2,312
SE	101	815	15436	85	**16352**	140	765	15402	43	**16264**	140	765	15412	43	**16274**	3,013
UK	65	108	1456	2744	**1629**	640		1070		**1710**	1060		1070		**2130**	35
EU27	**2992**	**9604**	**89682**	**40322**	**102278**	**3451**	**9661**	**98218**	**24319**	**102055**	**4457**	**12101**	**111217**	**35726**	**109642**	

Slovenia and Austria have the highest hydro share within renewables electricity with 83 and 80 %, followed by Sweden, Slovakia and Romania (69.9, 67.5 and 63.0 %) (Figure 4).

Austria has the highest hydro share within renewables in 2020, with 39.1 % (Figure 16 and Figure 17), Slovenia has 32 %, Sweden 29.6%, Slovakia 27.3 % and Romania 23.5 %.

The biggest relative change, compared to 2010, in hydro energy is expected in the Netherlands, where the hydro energy generation will be more than five-fold in 2020, as shown in Figure 20. The amount of hydro energy in Italy, Ireland and Denmark remains stable, in Sweden it will decrease by 5 %.

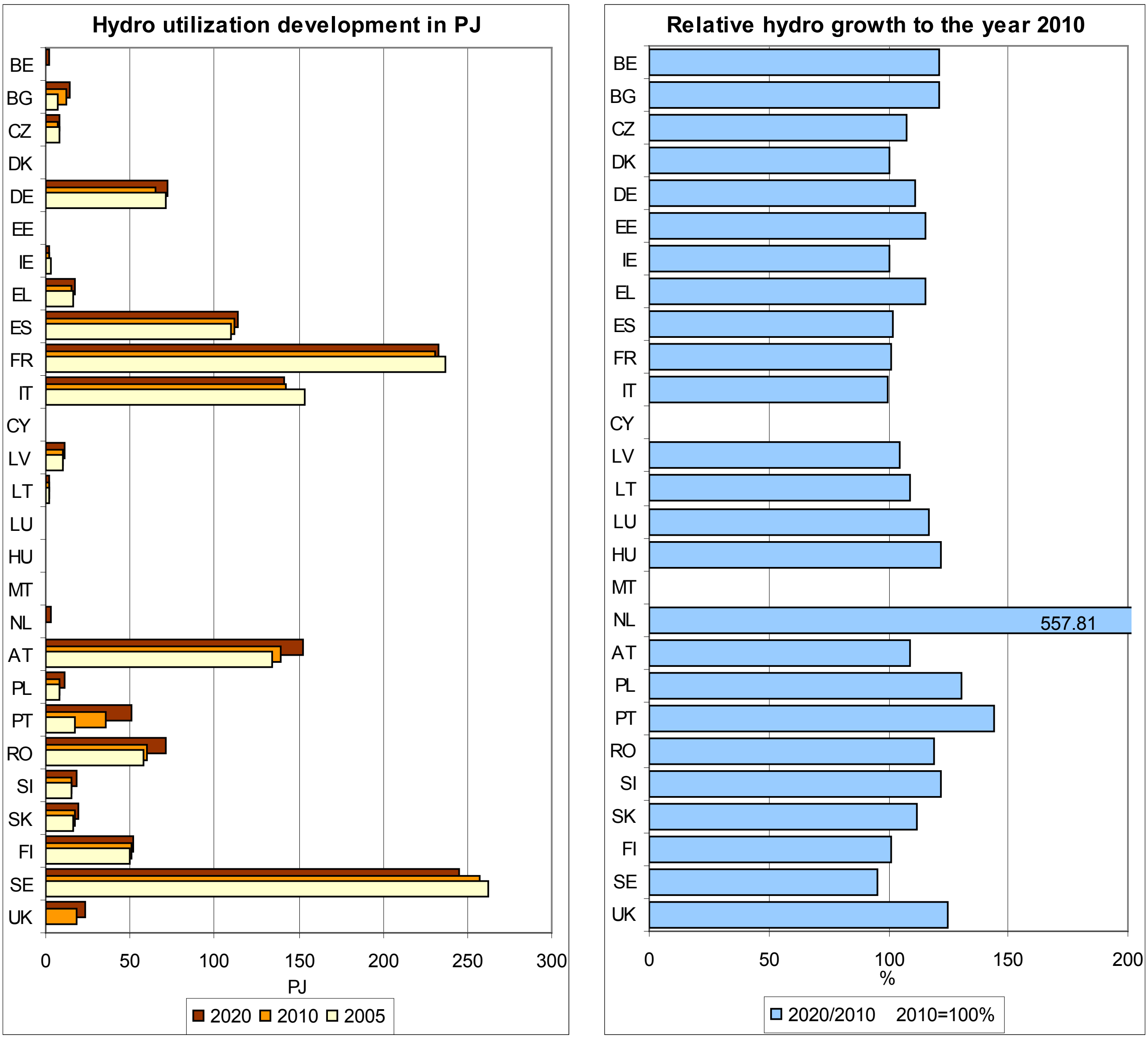


Figure 20: The hydro energy development between 2005 and 2010

3.3.4. Solar energy

The solar resource (thermal and electricity together) quadruples from 2010 to 2020 (132.9 PJ to 639.22 PJ). The share increases from 2 to 6 % (Table 18).

The leading countries with the highest solar energy generation by 2020 are Germany (201.8 PJ), Spain (134.2) and Italy (107.6). By 2020, these three countries represent 70 % of the total solar energy of EU27. France and Greece have 63.8 and 27.9 PJ. Germany maintains its leading role from 2005 on. Greece grows with the least intensity among those countries.

Cyprus has the highest solar share within renewables in 2020 with 51.9 % (Figure 17), Spain 14.5 %, Greece 13.7 %, Italy 12.1 % and Malta 11.8 %.

The biggest relative change, compared to 2010, in solar energy is expected in Poland, where the solar energy generation will be more than twenty-fold in 2020. Sweden has almost no growth in solar energy, Denmark grows by one and a half, and Austria, Cyprus and Malta double the solar energy generation from 2010 to 2020.

3.3.4.1. Solar electricity

The solar electricity generation (PV and CSP) in the EU27 is almost five times more in 2020 than in 2010 (76.5 PJ to 373.2 PJ). The share increases from 3.3 to 8.63 % (Figure 3).

Cyprus has the highest solar share within renewables electricity with 45.4 %; Spain and Germany have 19.8 and 19.1 %, respectively, followed by the Czech Republic, Greece, Italy and Luxembourg with 14.8, 13.2, 11.8 and 10.8 %, respectively (Figure 4).

The leading countries with the highest solar electricity generation by 2020 are Germany with around 150 PJ, Spain with 107 PJ, and Italy with 40.1 PJ. By 2020 these three countries represent 80 % of the total electricity of EU27. Germany maintains its leading role from 2005 on.

The biggest relative change in solar electricity, compared to 2010, is expected in Cyprus, where the solar electricity generation is forecasted to be more than eighty-fold in 2020; in the UK more than fifty-fold, and Hungary reported more than forty-fold. Denmark doubles its solar electricity, Sweden and the Czech Republic almost triple solar electricity generation from 2010 to 2020.

PV

Cyprus has the highest PV share within renewables in 2020 with 10.2 % (Figure 4, Figure 16 and Figure 17). Germany has 9.3 %, Malta 6.75 %, Spain 5.6 %, Greece 5.1 %. Italy and the Czech Republic have 3.9 and 3.4 %.

Table 23: PV electricity and NREAP comparison

	PV output per kWp at optimum angle, urban areas			NREAP 2010					NREAP 2020				
	Min.	Avg.	Max.	installed capacity	PV generated electricity		Calculated potential min	Calculated potential max	installed capacity	PV generated electricity		Calculated potential min	Calculated potential max
	kWh/year			MW	PJ	GWh	GWh	GWh	MW	PJ	GWh	GWh	GWh
BE	866.0	929.6	1007.6	350	1.10	304.0	303	353	1340	4.11	1139.0	1160	1350
BG	1005.9	1217.8	1388.4	9	0.04	12.0	9	13	303	1.64	454.0	305	421
CZ	838.6	945.6	1039.7	1650	2.09	578.0	1384	1715	1695	6.23	1726.0	1421	1762
DK	841.2	945.1	1054.1	3	0.01	2.0	2.5	3	6	0.01	4.0	5	6.3
DE	825.5	936.0	1085.8	15784	34.30	9499.0	13030	17138	51753	149.47	41389.0	42723	56193
EE	813.5	867.7	898.8	0	0.00	0.0	0	0	0	0.00	0.0	0	0
IE	789.5	908.6	1066.7	0	0.00	0.0	0	0	0	0.00	0.0	0	0
EL	1200.0	1445.0	1667.0	184	0.87	242.0	221	307	2200	10.44	2891.0	2640	3667
ES	968.2	1470.7	1664.0	4021	23.17	6417.0	3893	6691	8367	51.70	14316.0	8101	13923
FR	858.0	1116.7	1515.3	504	2.21	613.0	432	764	4860	21.35	5913.0	4170	7364
IT	772.9	1326.0	1624.0	2500	7.10	1967.0	1932	4060	8000	34.85	9650.0	6183	12992
CY	1563.6	1629.8	1683.1	6	0.02	6.5	9	10	192	1.12	309.0	300	323
LV	817.8	890.2	992.6	0	0.00	0.0	0	0	2	0.01	4.0	1.6	2
LT	824.5	884.4	1011.0	1	0.00	0.0	1	1	10	0.05	15.0	8.2	10
LU	900.3	939.6	967.5	27	0.07	20.0	24	26	113	0.30	84.0	102	109
HU	991.6	1104.7	1159.2	0	0.01	2.0	0	0	63	0.29	81.0	62	73
MT	1572.1	1584.2	1599.2	4	0.02	6.2	6.4	6.5	28	0.15	42.7	44	45
NL	864.7	932.6	1020.7	92	0.26	73.0	80	94	722	2.06	570.0	624	737
AT	853.6	1026.9	1169.6	90	0.31	85.0	77	105	322	1.11	306.0	275	377
PL	833.6	937.2	979.7	1	0.00	1.0	0.8	1	3	0.01	3.0	2.5	3
PT	1270.7	1494.0	1648.6	156	0.83	230.0	198	257	1000	5.33	1475.0	1271	1649
RO	891.1	1132.7	1278.3	0	0.00	0.0	0	0	260	1.16	320.0	232	332
SI	931.6	1085.2	1249.7	12	0.04	12.0	11	15	139	0.50	139.0	129.5	174
SK	845.5	1020.7	1116.8	60	0.11	30.0	51	67	300	1.08	300.0	254	335
FI	765.3	837.9	895.5	0	0.00	0.0	0	0	0	0.00	0.0	0	0
SE	639.1	862.0	1050.8	5	0.01	1.4	3.4	5.6	8	0.01	4.0	5	8.4
UK	710.0	920.2	1121.0	50	0.14	40.0	35.5	56	2680	8.09	2240.0	1901	3004

Taking into account that[13] in EU27 3887 GW **PV** can be installed, the 84.4 GW installed capacity by 2020 is 2.3 % of the potential which, with the current support scheme, technically can be reached.

The data summarised in Table 24 show the installed capacity from the NREAPs as a percentage of the potential PV installation.

The average value for Europe is 2.3 %, with some countries showing a potential exploitation close or over 10% (Germany uses around 16 % of the potential, Malta almost 10 %), Belgium and Luxembourg around 4.8 %, and several other countries with exploitation smaller than 1%.

Table 24: PV benchmark potential and share of demand

Country	Total land area km²	Land area suitable for PV[14] km²	Max potential PV installation GW[15]	PV in NREAP MW	% of the potential	Low summer demand of electricity[16] GW	Highest share of PV in demand %	Capita *1000	kW/capita potential	W/capita NREAP
BE	30,672	184.03	27.63	1,340	4.85	6.32	15.89	10,667	2.6	125.6
BG	110,787	664.72	99.81	303	0.30	2.57	8.86	7,640	13.1	39.7
CZ	78,865	473.19	71.05	1,695	2.39	4.72	26.92	10,381	6.8	163.3
DK	43,384	260.30	39.08	6	0.02	2.10	0.21	5,476	7.1	1.1
DE	357,516	2,145.10	322.09	51,753	16.07	35.56	109.17	82,218	3.9	629.5
EE	45,426	272.56	40.92	0	0	0.51	0.00	1,341	30.5	0.0
IE	70,173	421.04	63.22	0	0	1.60	0.00	4,401	14.4	0.0
EL	132,014	792.08	118.93	2,200	1.85	3.33	52.92	11,214	10.6	196.2
ES	498,558	2,991.35	449.15	8,367	1.86	18.95	35.32	45,283	9.9	184.8
FR	549,182	3,295.09	494.76	4,860	0.98	32.09	11.36	61,876	8.0	78.5
IT	301,392	1,808.35	271.52	8,000	2.95	21.58	27.80	59,619	4.6	134.2
CY	9,360	56.16	8.43	192	2.28	0.34	42.73	789	10.7	243.3
LV	64,592	387.55	58.19	2	0.00	0.41	0.36	2,271	25.6	0.9
LT	64,878	389.27	58.45	10	0.02	0.71	1.05	3,366	17.4	3.0
LU	2,598	15.59	2.34	113	4.83	0.36	23.41	484	4.8	233.5
HU	93,010	558.06	83.79	63	0.08	2.87	1.64	10,045	8.3	6.3
MT	316	1.90	0.28	27.88	9.79	0.92		410	0.7	68.0
NL	37,358	224.15	33.66	722	2.15	8.11	6.68	16,405	2.1	44.0
AT	83,923	503.538	75.61	322	0.43	3.73	6.47	8,332	9.1	38.6
PL	311,895	1,871.37	280.99	3	0.00	9.62	0.02	38,116	7.4	0.1
PT	89,072	534.43	80.25	1,000	1.25	3.59	20.92	10,618	7.6	94.2
RO	237,938	1,427.63	214.36	260	0.12	4.05	4.81	21,529	10.0	12.1
SI	20,273	121.64	18.26	139	0.76	0.84	12.37	2,026	9.0	68.6
SK	49,028	294.17	44.17	300	0.68	2.25	10.01	5,401	8.2	55.5
FI	337,781	2,026.69	304.31	10	0.00	5.50	0.14	5,300	57.4	1.9
SE	449,498	2,696.99	404.95	8	0.00	9.41	0.04	9,183	44.1	0.9
UK	244,736	1,468.42	220.48	2,680	1.22	21.50	9.97	61,186	3.6	43.8
EU27	**4,314,541**	**25,887.25**	**3,886.97**	**84,345.88**	**2.17**			**495,577**	**7.8**	**170.3**

13 Calculated based on the PVGIS and ECOFYS Study 25,887 km2 area can be used for PV in the EU27 which means 3,887 GW PV installation.

14 0.6 % [17].

15 6.66 m2 = 1 kW capacity.

16 Summer demand between the period of April-September during sunshine hours, winter period between October and March.

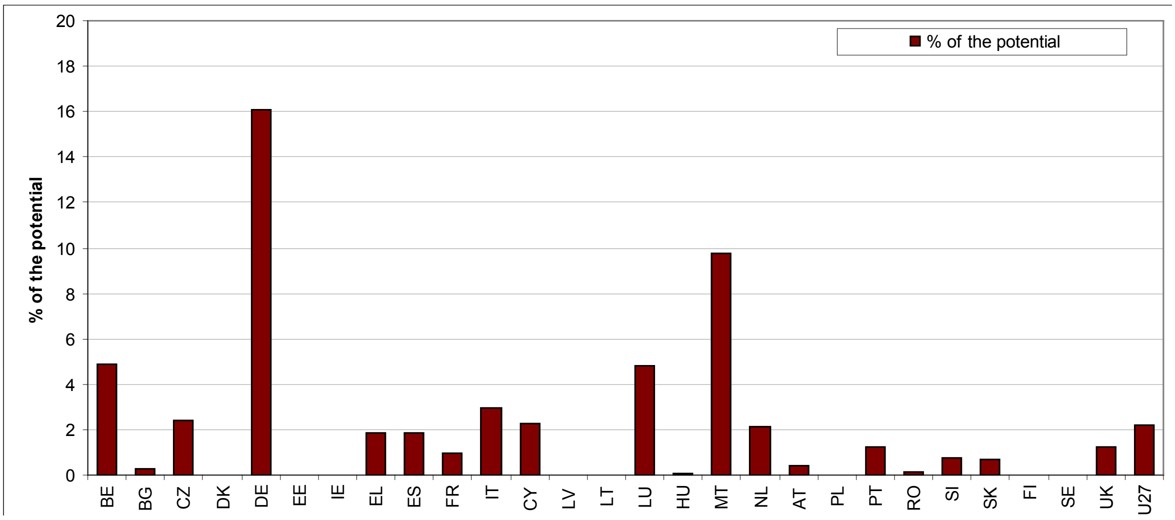


Figure 21: Use of PV as % of the benchmark potential by 2020

The highest share of demand of PV is in Germany, followed by the Netherlands, Spain, Greece and Cyprus (Figure 21).

Figure 22 shows the share of PV in the low summer demand. For those countries where the share is higher than 40 % substantial take care of integration and balancing is required.

The countries underestimate their potential and are careful with their PV proposals.

The **Czech Republic** was the third largest market in Europe for photovoltaic systems, with more than 1.3 GW of new installations in 2010, reaching a cumulative nominal capacity of 1.8 GW and exceeding their own target of 1.65 GW set in the National Renewable Action Plan for 2020.

PV share in low summer demand

The highest PV share of low summer demand is in Germany, the Netherlands, Spain and Greece. In Germany this share is higher than 100 % (Figure 22).

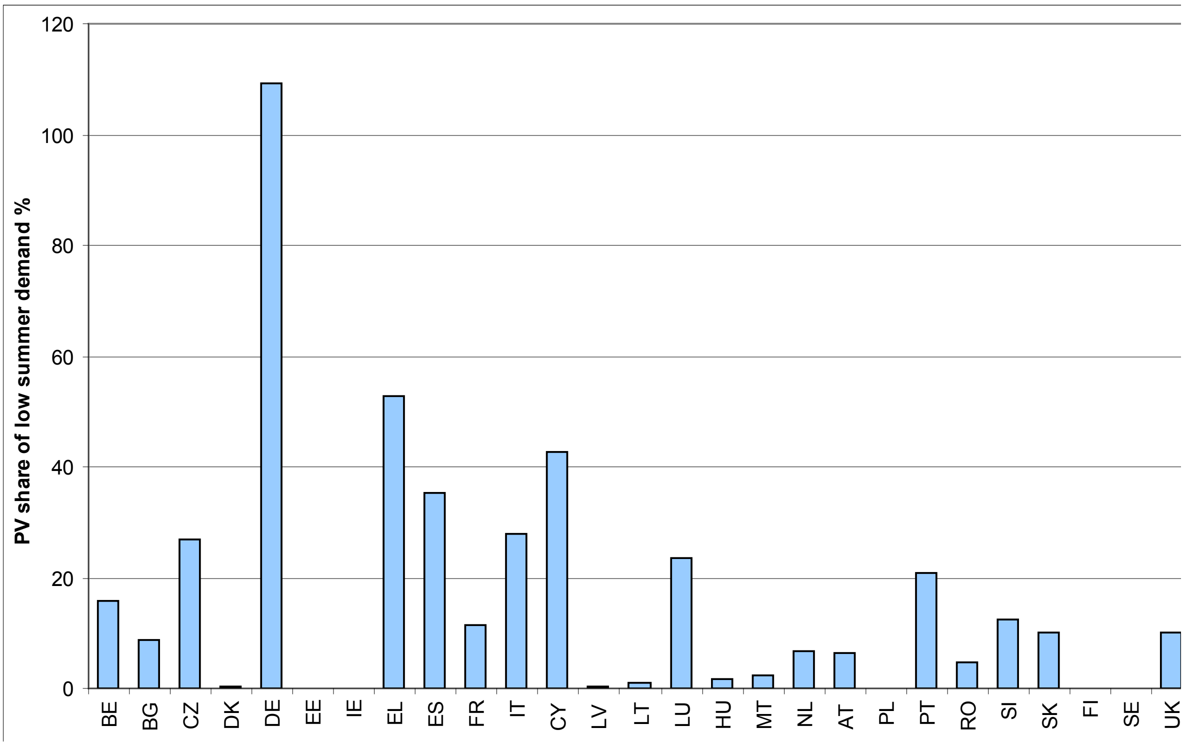
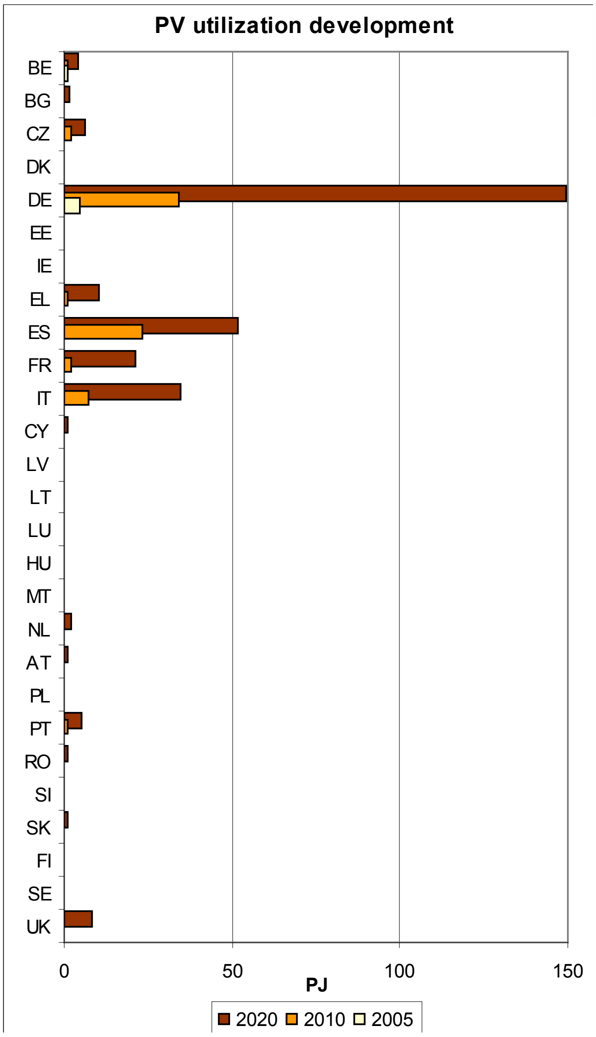


Figure 22: PV share of low summer demand in 2020

Leading countries

In terms of PV utilization Germany maintains its leading position since 2005 and has the highest production in PV energy by 2020, with an amount of 149.5 PJ, representing the 50 % of the total PV energy production in EU 27 (301.1 PJ). Spain, Italy, France and Greece contribute with 51.7 PJ, 34.9 PJ, 21.35 PJ and 10.5 PJ. These countries account for approx. 90 % of the PV production in EU 27.



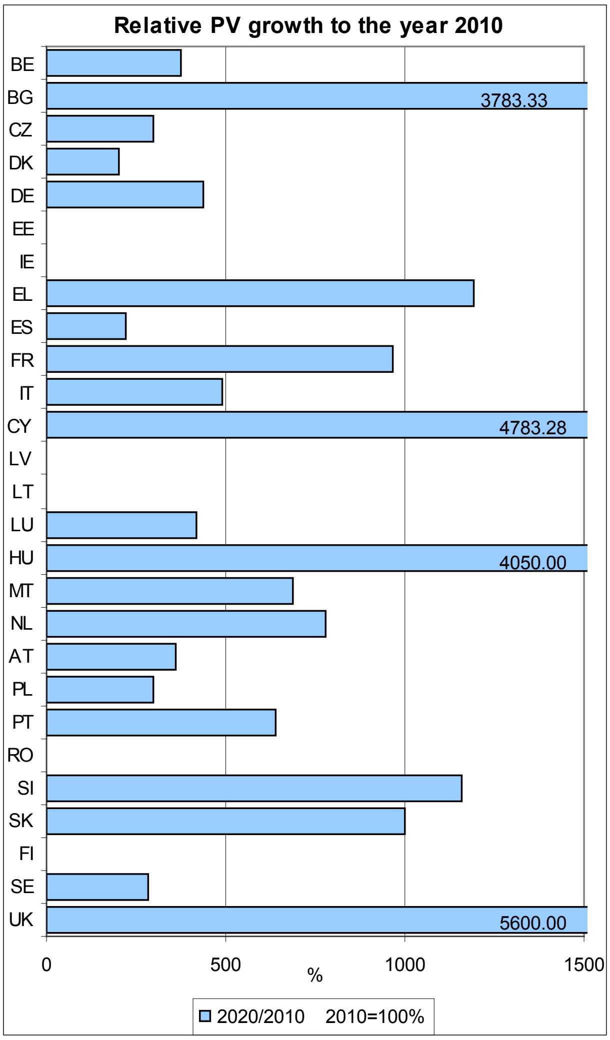


Figure 23: Solar PV utilization development

The biggest relative change in PV electricity, compared to 2010, is expected in UK, Cyprus, Hungary and Bulgaria, (Figure 23).

Concentrated Solar Power (CSP)

The **CSP** energy reported in the NREAPs by 2020 is 72.09 PJ in EU27, which represents 0.7 % of the renewable energy mix (Table 18).

The CSP generation share reported in the NREAPs will reach 19.3 % of solar electricity by 2020 and the share of the RES electricity 1.7 %, with a yearly average growth of 28 %. By 2010 the CSP technology is present only in Spain, with an amount of 4.13 PJ, and Italy with 0.03 PJ. In all the other Member States the technology is introduced later. From a technical and resource point of view there is no risk, however, the later introduction can mean a capital risk.

Leading countries

Spain, Italy, France, Greece and Portugal presented CSP technology by 2020 with an amount of 55.45 PJ, 6.14 PJ, 3.61 PJ, 3.51 PJ and 0.81 PJ. Spain alone represents 77 % of the total CSP electricity production in EU 27.

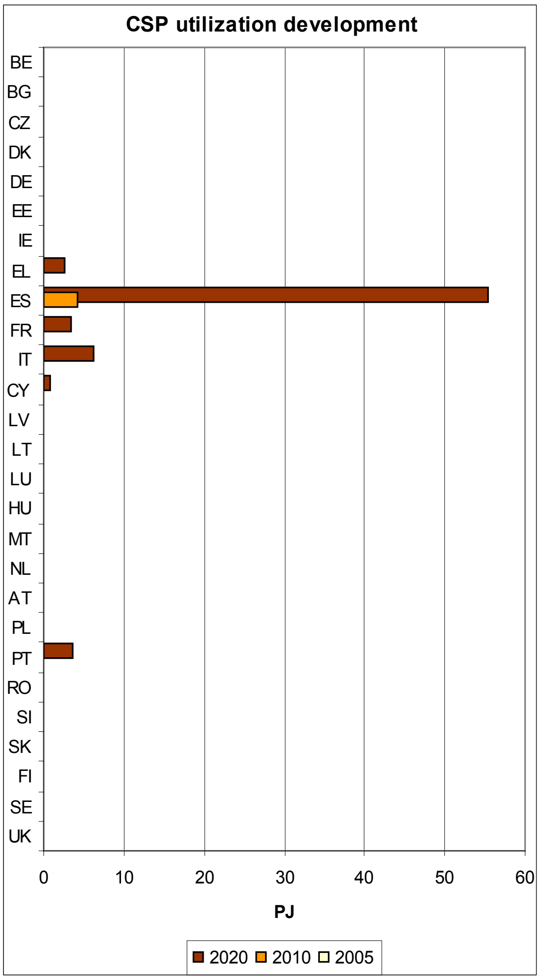
The highest CSP share within the renewables electricity is in Cyprus and Spain with 19.1 % and 10.2 %. (Figure 4).

Also Cyprus and Spain have the highest CSP share within renewables in 2020 with 7.36 % and 6 % (Figure 17).

The biggest relative change in CSP energy, compared to 2010, is expected in Italy, as can be seen in Figure 24.

Table 25: Indicators for the CSP technology

Country	GJ/capita
EL	0.04
ES	27.37
FR	0.08
IT	1.39
CY	1.03
PT	0.09



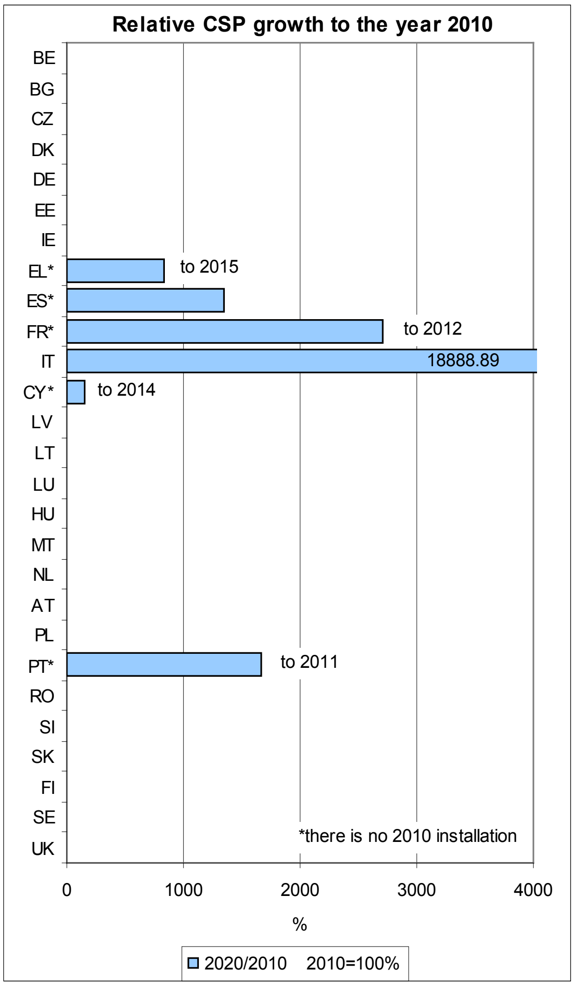


Figure 24: CSP utilization development

3.3.4.2. Solar thermal

In 2005 EREC (European Renewable Energy Council) [26] presented an ambitious target of 1m2/habitant in Europe by 2020, corresponding to 700 kWth/1000 capita. EREC reports a minimum target of 91 GWth by 2020 as well.

The potential in EU has been studied by RESTMAC [29] along three scenarios. The BAU shows a 7 % annual growth from 2006 onwards, while the AMD requires a 15 % annual growth and the RDP a 26 % growth. The latter corresponds to 12 % of the share for solar thermal of an increase of RE (referred to 8.5 % in 2005).

The AMD scenario indicates a solar thermal contribution of 2.4 % of the 20 % target for RES in 2020, corresponding to 59 TWh. The NREAP data presented for the solar thermal share gives 73 TWh, mainly due to ambitious growth in Italy, France and Poland, besides the continuing growth in Germany and Spain.

Along these lines, a solar thermal potential may be defined as 15% annual growth. The Figure 25 shows the expected growth per 1000 inhabitants. The ambitious growth for the next 10 years of some countries like Italy and Poland is notable.

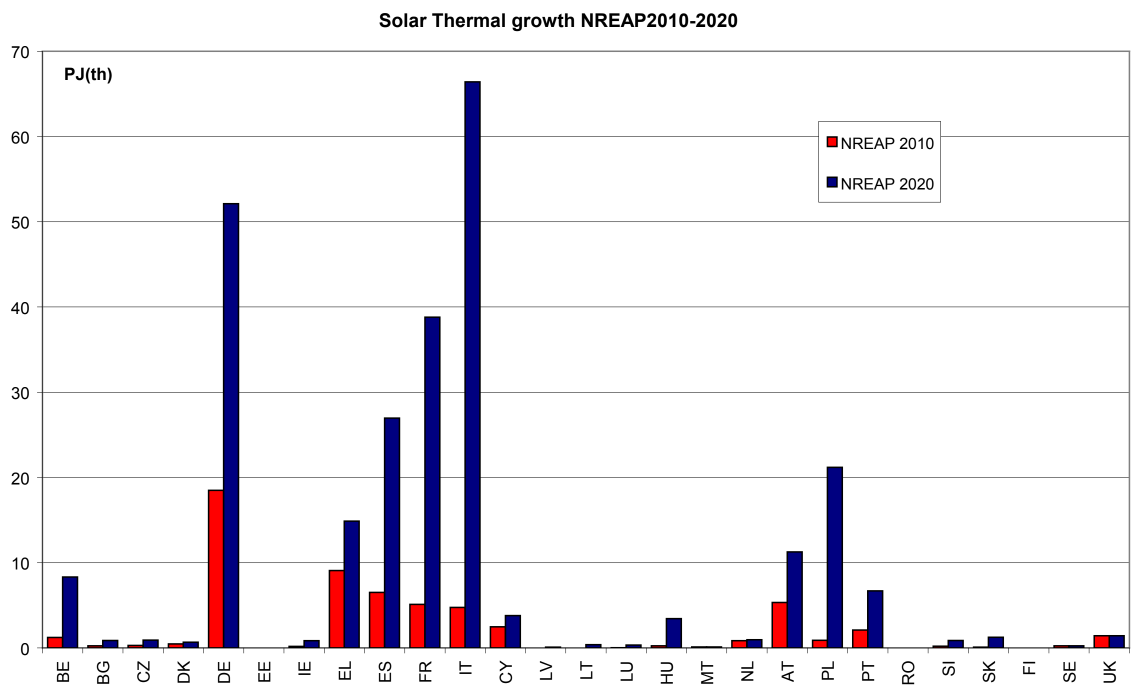


Figure 25: Growth in ten years for solar thermal energy, based on NREAP data by Member States

EU27	IEA 2008	NREAP 2010	NREAP 2020
Solar Thermal Energy [GWh$_{(th)}$]	12569	16695	73011

In the solar thermal market an increase can be observed from data available for EU27. All data in GWh(th)

Notes: IEA data taken for all buildings; residential, public and services, other applications excluded. The JRC solar yield is applied to calculate the solar thermal energy for each individual country. NREAP data has been taken to have an impression of the growth in EU27.

The annual growth, according to this data, 2008-2009 is 2344 GWh(th) and for 2009-2010 is 1781 GWh(th). According to the NREAPs, the growth in the next ten years is 56316 GWh(th) on average every year about 5632 GWh(th). This means that growth will have to pick up considerably in those Member States such as Italy, Poland and France that have indicated strong growth (→500%) for the next decennium. See Figure 25 also.

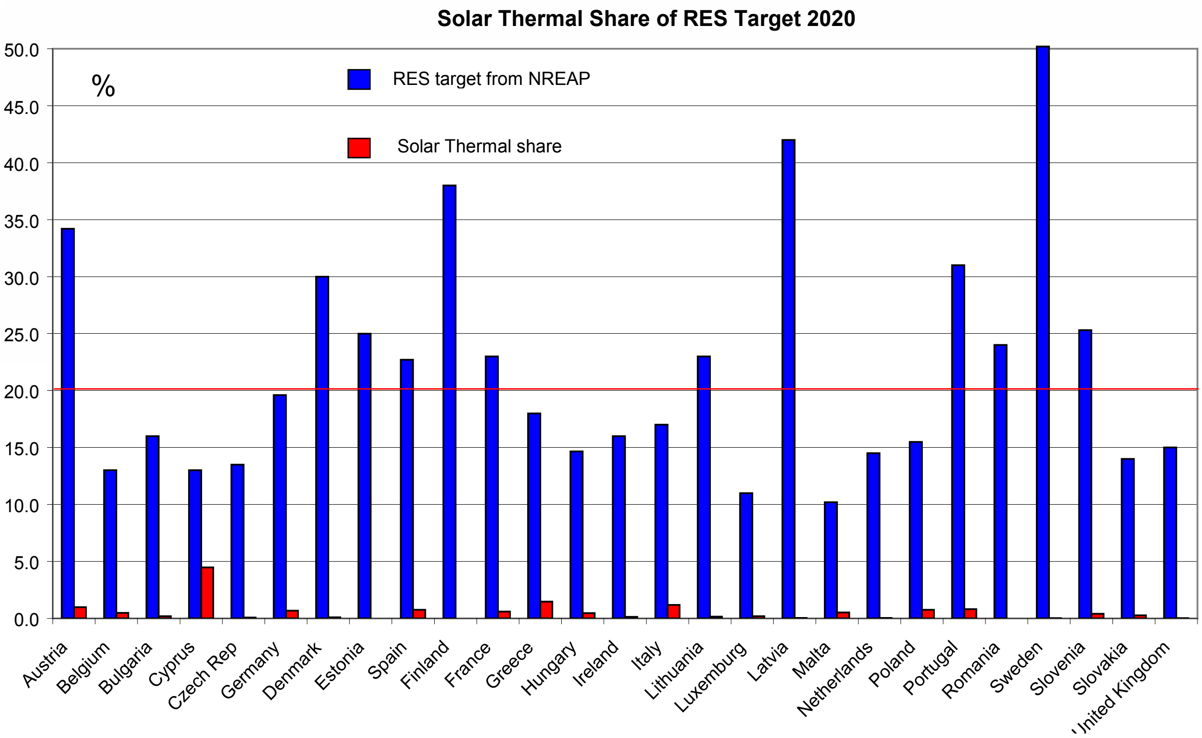


Figure 26: Share of RES and solar thermal energy to final energy consumption by 2020

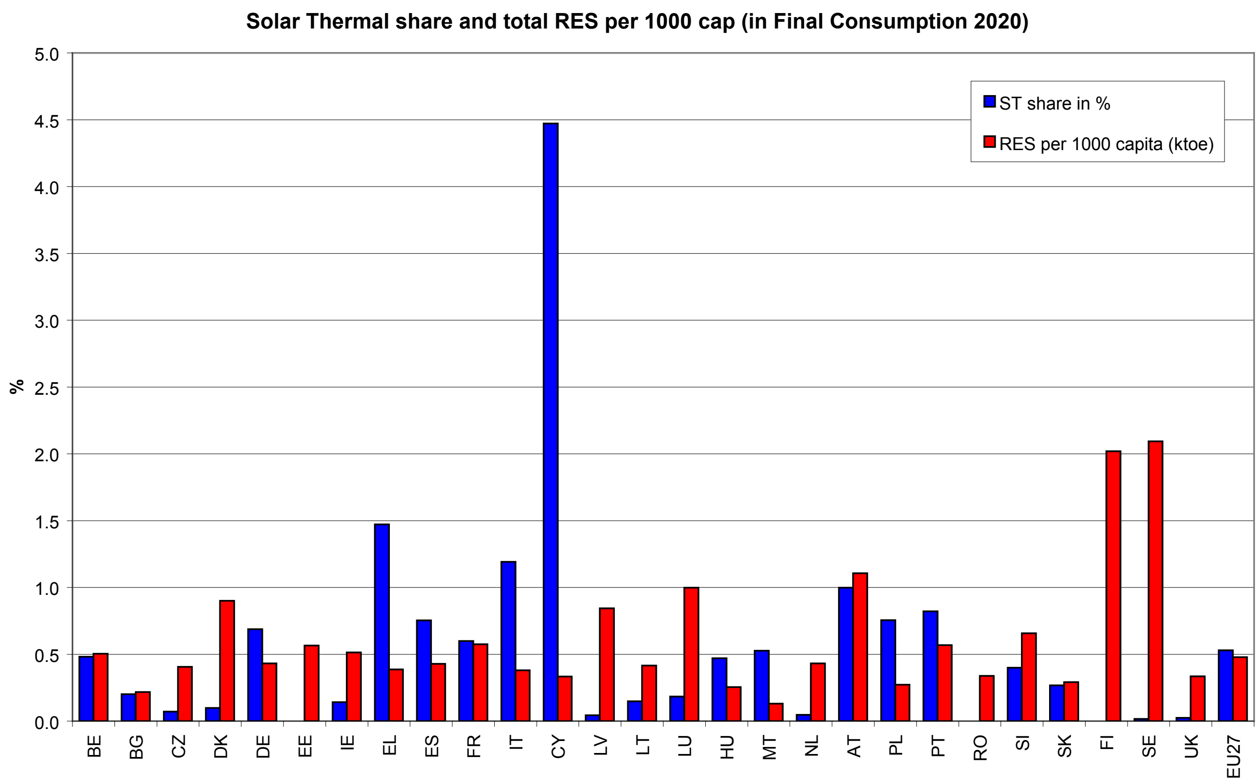


Figure 27: Solar thermal share (%) and RES (in ktoe) per 1000 inhabitants to the final energy consumption by 2020 (based on NREAP data from Member States)

Several Northern-EU countries have mainly biomass and only little solar thermal contributions.

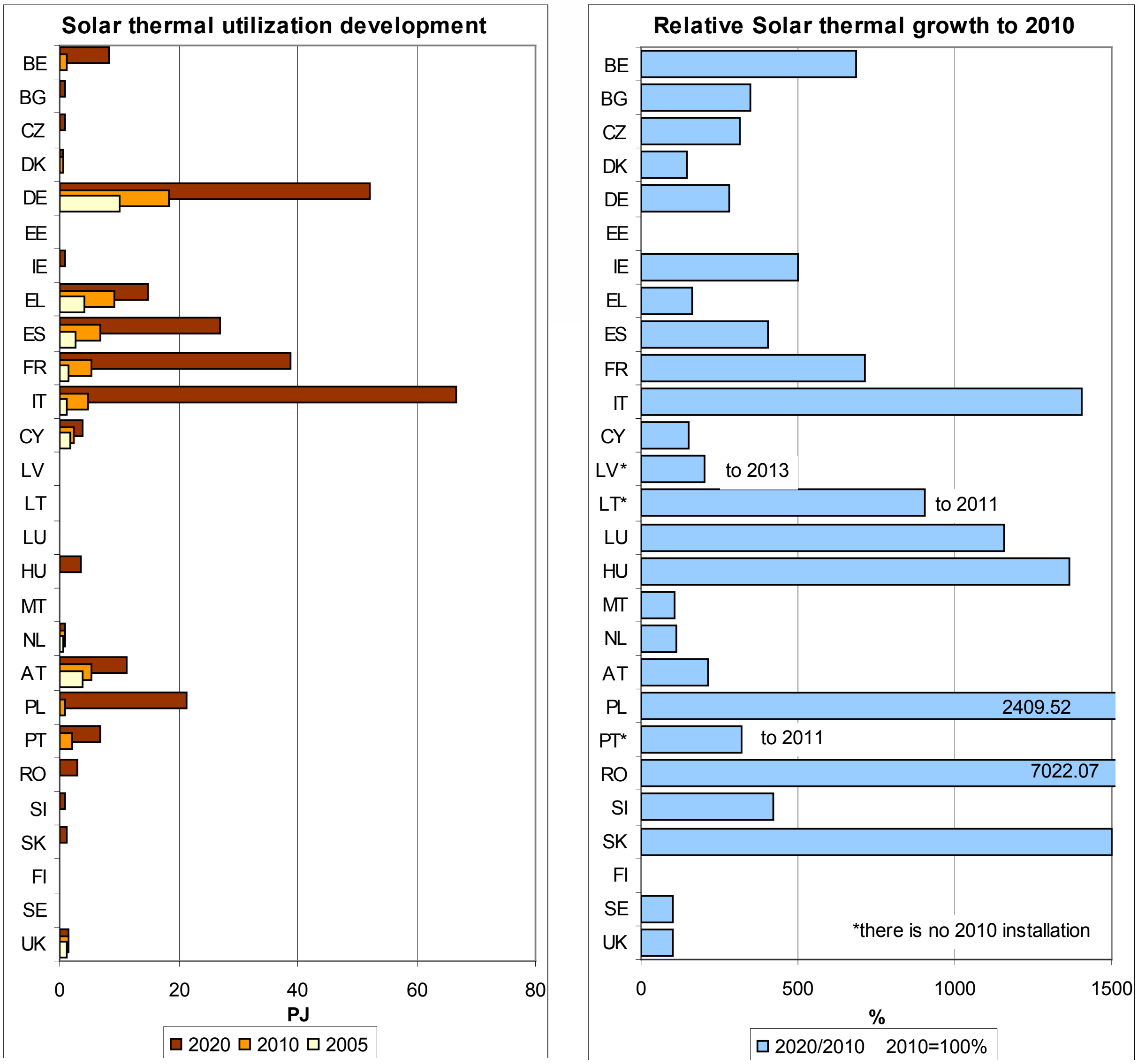


Figure 28: Solar thermal utilization development

The solar thermal energy reported in the NREAPs by 2020 is 266.03 PJ in EU27, which represents 2.6 % of the renewable energy mix quadrupling between 2010 and 2020 (Table 18).

Italy, Germany, France, Spain and Poland have the highest production in solar thermal energy by 2020 (with an amount of 66.5 PJ, 52.1 PJ, 38.8 PJ, 27 PJ and 21.2 PJ); these five countries represent 77 % of the total solar thermal production in the EU27. Germany, Austria and Greece were the leading countries in 2005.

The highest geothermal share within the renewables H&C, with 73.2 and 61.6 %, are Cyprus and Malta (Figure 10).

The highest solar thermal share within renewables in 2020 belongs to Hungary with 34.5 % (Italy 7.5 %, and Greece 7.3 % (Figure 16 and Figure 17),

The biggest relative change, compared to 2010, in geothermal energy is expected in Poland and Romania, where the geothermal energy generation will be more than seventy- and twenty-fold in 2020, respectively (Figure 28). In Malta, UK, Sweden and the Netherlands the solar thermal amount remains stable.

3.3.5. Wind

The wind resource (onshore and offshore together) triples from the year 2010 to 2020 (594.28 PJ to 1786.1 PJ). The share increases from 10.3 to 17.4 % (Table 18).

The leading countries with the highest wind energy generation by 2020 are Germany (377.15 PJ), UK (282.66 PJ), Spain (282.61 PJ) and France (209.1 PJ). By 2020, these four countries represent 64 % of the total wind energy of EU27. The Netherlands has 117 PJ. Germany maintains its leading role from 2005 onward.

Ireland and Estonia have the highest wind share within renewables electricity, with 86.1 % and 80.3 %; UK, Netherlands and Greece have 66.9, 64.4 and 61.6 %, followed by Malta, Denmark and Spain with 58.8, 56.2 and 52.2 % (Figure 4).

Ireland also has the highest wind share within renewables in 2020 with 46.1 % (Figure 16 and Figure 17), Malta has 40.2 %, the Netherlands, UK and Spain have 38, 32.9 and 30.5 % (Greece 29.7 %, Germany 23.3 % and Portugal 20.8 %).

The biggest relative change in wind energy, compared to 2010, is expected in Slovenia and Slovakia. In Spain wind energy will not even double the wind energy generation and in Denmark and Portugal the growth is less than one and a half.

No diversification has been reported for onshore/offshore wind resources in the NREAPs of Belgium and Finland.

The total wind capacity will be 213.4 GW in 2020, growing from 84.9 GW in 2010. The onshore wind capacity changes from 81 GW in 2010 to 164.5 GW in 2020, and the offshore from 2.5 GW 2010 to 41.3 GW in 2020.

Wind yearly growth rate changes from 15.6 % to 9.2 %. Offshore wind has the second highest yearly growth rate (higher than 30 % till 2016) until 2020 and the growth increases until 2013.

Wind has the highest capacity proportion in the RES electricity production in 2020 in Estonia, with almost 99 % and in Ireland with 91 %, in the Netherlands; wind capacity share in the UK, Malta and Poland reaches 74.5, 72.9, 68.5 and 64.3 %.

Offshore wind has the highest proportion in wind capacity in Malta, UK and the Netherlands with 86.7, 46.6 and 46.3 % in 2020.

Wind has the highest capacity proportion in the RES electricity production in 2010 in Estonia with almost 95.3 %, Cyprus and Ireland with 87.2 and 87 %, in Denmark, UK, the Netherlands and Lithuania, wind has a capacity share of 77.7, 59.6, 58.6 and 52.5 %, respectively.

Offshore wind has the highest proportion in wind capacity in UK and Denmark with 25.6 and 18.4 % in 2010.

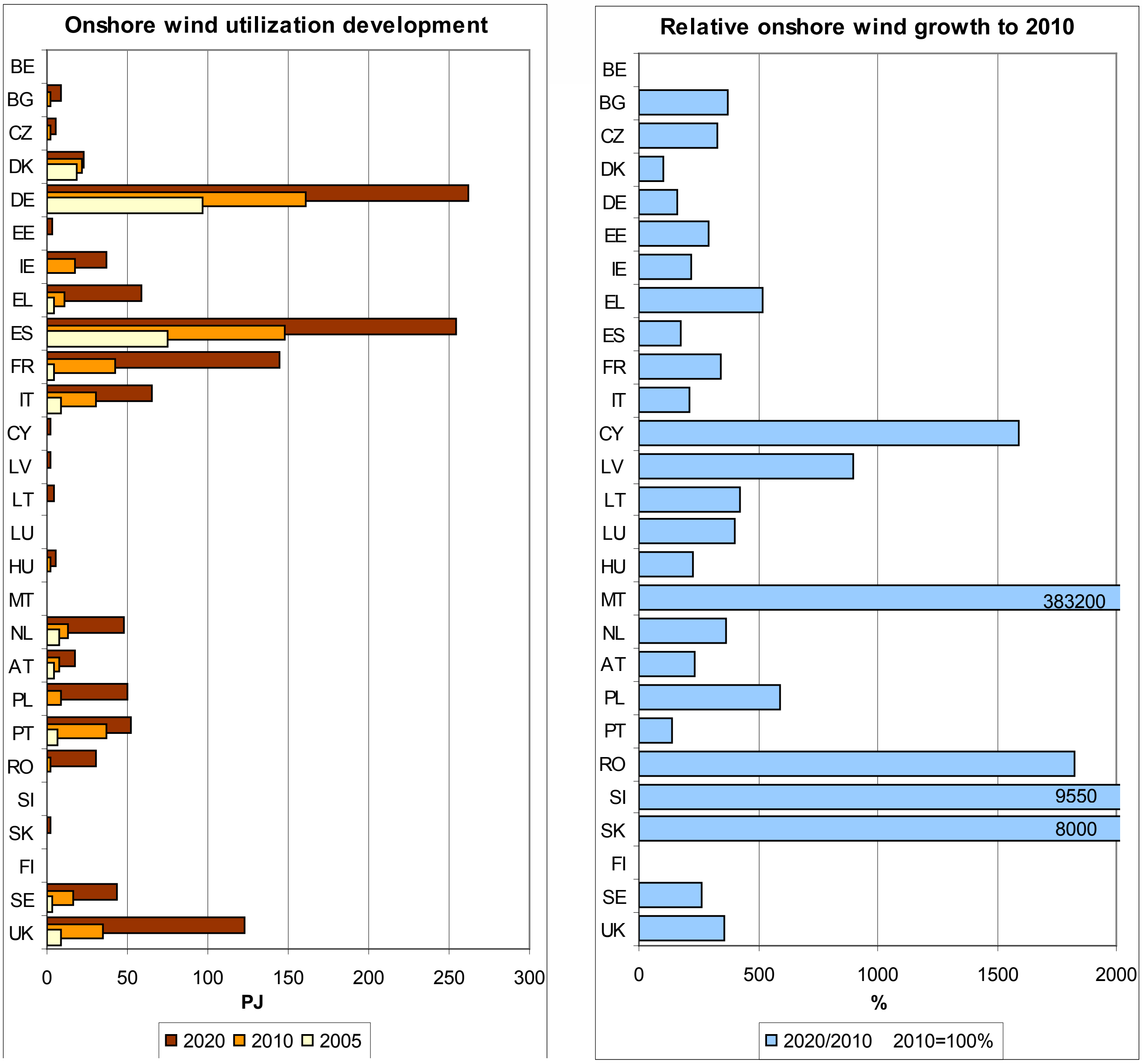
3.3.5.1. Onshore wind

The EU27 NREAPs described 164.5 GW **onshore wind** installed in 2020 (with a share of 77.1 % of the total wind energy installed capacity by 2020).

In the Czech Republic, Hungary, Luxembourg, Slovakia and Slovenia no competitive wind resources are available. Malta and Slovenia will not introduce onshore wind before 2014. In these countries, starting from a later installation of an already established technology, this means no technology risk, however it can mean a capital risk in achieving the 2020 targets.

The reported yearly generation potential of 338,879 GWh by 2020 is 3.8 % of the 8,919 TWh **onshore wind** competitive[17] generation potential. This is from a resource and technical point of view feasible.

17 Taking into account the [EEA Report], the competitive is cost class with average production cost lower than 5.5 cent/kWh.



(BE and FI did not report separately the onshore and offshore wind resources)
Figure 29: Onshore wind utilization development

Table 26: Wind capacity and electricity share of demand in 2020 summary table for the MSs

	NREAP installed capacity 2020 MW			W/capita in 2020			Demand share		
	Onshore	offshore	total	Onshore	offshore	total	2010 Low winter demand GW	availability	Share of demand %
BE	n.a.	n.a.	4320	n.a.	n.a.	404.99	6.98	90	55.73
BG	1256	0	1256	164.40	0.00	164.40	3.09	90	36.54
CZ	743	0	743	71.57	0.00	71.57	5.18	90	12.91
DK	2621	1339	3960	478.63	244.52	723.16	2.55	90	139.93
DE	35750	10000	45750	434.82	121.63	556.45	34.82	90	118.24
EE	400	250	650	298.28	186.43	484.71	0.60	90	97.34
IE	4094	555	4649	930.24	126.11	1056.35	1.87	90	223.75
EL	7200	300	7500	642.05	26.75	668.81	3.90	90	173.08
ES	35000	3000	38000	772.92	66.25	839.17	9.47	90	361.06
FR	19000	6000	25000	307.07	96.97	404.03	34.91	90	64.46
IT	12000	680	12680	201.28	11.41	212.68	20.03	90	56.97
CY	300	0	300	380.23	0.00	380.23	0.35	90	77.14
LV	236	180	416	103.92	79.26	183.18	0.55	90	68.45
LT	500	0	500	148.54	0.00	148.54	0.69	90	70.64
LU	131	0	131	270.66	0.00	270.66	0.40	90	29.48
HU	750	0	750	74.66	0.00	74.66	3.09	90	21.82
MT*	14.45	95	109.45	35.24	231.71	266.95	0.18	90	53.83
NL	6000	5178	11178	365.74	315.64	681.38	2.40	90	419.18
AT	2578	0	2578	309.41	0.00	309.41	3.43	90	67.59
PL**	6150	500	6650	161.35	13.12	174.47	10.68	90	51.41
PT	6800	75	6875	640.42	7.06	647.49	3.80	90	162.70
RO	4000	0	4000	185.80	0.00	185.80	4.33	90	83.12
SI	106	0	106	52.32	0.00	52.32	0.37	90	26.14
SK	350	0	350	64.80	0.00	64.80	2.41	90	13.09
FI	n.a.	n.a.	2500	n.a.	n.a.	471.70	7.71	90	29.20
SE	4365	182	4547	475.33	19.82	495.15	14.20	90	45.88
UK	14890	12990	27880	243.36	212.30	455.66	23.60	90	106.32
EU 27	**164491.5**	**41324**	**213378.5**	**331.92**	**83.39**	**430.57**			

**and ** MT and Poland included also a category named "small wind", it was taken into account as onshore wind*

Table 27: Comparative table for competitive wind resources for the 27 MSs by 2020

	NREAP 2020 GWh			kWh/capita			EUROSTAT in 2006	EEA Generation potential of wind energy on land by 2020 TWh		
	On-shore	Off-shore	total	On-shore	Off-shore	total	TWh	Not compe-titive	Most likely compe-titive	Compe-titive
BE	n.a.	n.a.	10474	n.a.	n.a.	981.91	0.36	371	53	12
BG	2260	0	2260	295.81	0.00	295.81	0.02	540	14	34
CZ	1496	0	1496	144.11	0.00	144.11	0.05	687	1	0
DK	6391	5322	11713	1167.09	971.88	2138.97	6.11	0	65	687
DE	72664	31771	104435	883.80	386.42	1270.22	30.71	3376	384	258
EE	974	563	1537	726.32	419.84	1146.16	0.08	419	111	142
IR	10228	1742	11970	2324.02	395.82	2719.84	1.62	0	7	1308
EL	16125	672	16797	1437.93	59.93	1497.86	1.7	261	54	251
ES	70502	7753	78255	1556.92	171.21	1728.13	23.02	2316	170	263
FR	39900	18000	57900	644.84	290.90	935.74	2.15	3951	733	576
IT	18000	2000	20000	301.92	33.55	335.46	2.97	983	57	112
CY	499	0	499	632.45	0.00	632.45	na	48	8	4
LV	519	391	910	228.53	172.17	400.70	0.05	614	154	85
LT	1250	0	1250	371.36	0.00	371.36	0.01	703	13	30
LU	239	0	239	493.80	0.00	493.80	0.06	30	0	0
HU	1545	0	1545	153.81	0.00	153.81	0.04	557	0	0
MT*	38	216	254	92.68	526.83	619.51	0	0	0	7
NL	13372	19036	32408	815.12	1160.38	1975.50	2.73	217	158	158
AT	4811	0	4811	577.41	0.00	577.41	1.72	463	3	7,.3
PL	13160	1500	14660	345.26	39.35	384.62	0.26	3437	134	112
PT	14416	180	14596	1357.69	16.95	1374.65	2.93	601	13	63
RO	8400	0	8400	390.17	0.00	390.17	0.001	1103	19	38
SL	191	0	191	94.27	0.00	94.27	na	106	0	0
SK	560	0	560	103.68	0.00	103.68	0.006	323	0	0
FI			0	n.a.	n.a.	0.00	0.16	4016	204	198
SE	12000	500	12500	1306.76	54.45	1361.21	0.99	3900	528	620
UK	34150	44120	78270	558.13	721.08	1279.21	4.23	0	447	3961
EU 27	**338879**	**133766**	**472645**	**683.81**	**269.92**	**953.73**	**81.977**	**29022**	**3330**	**8919**

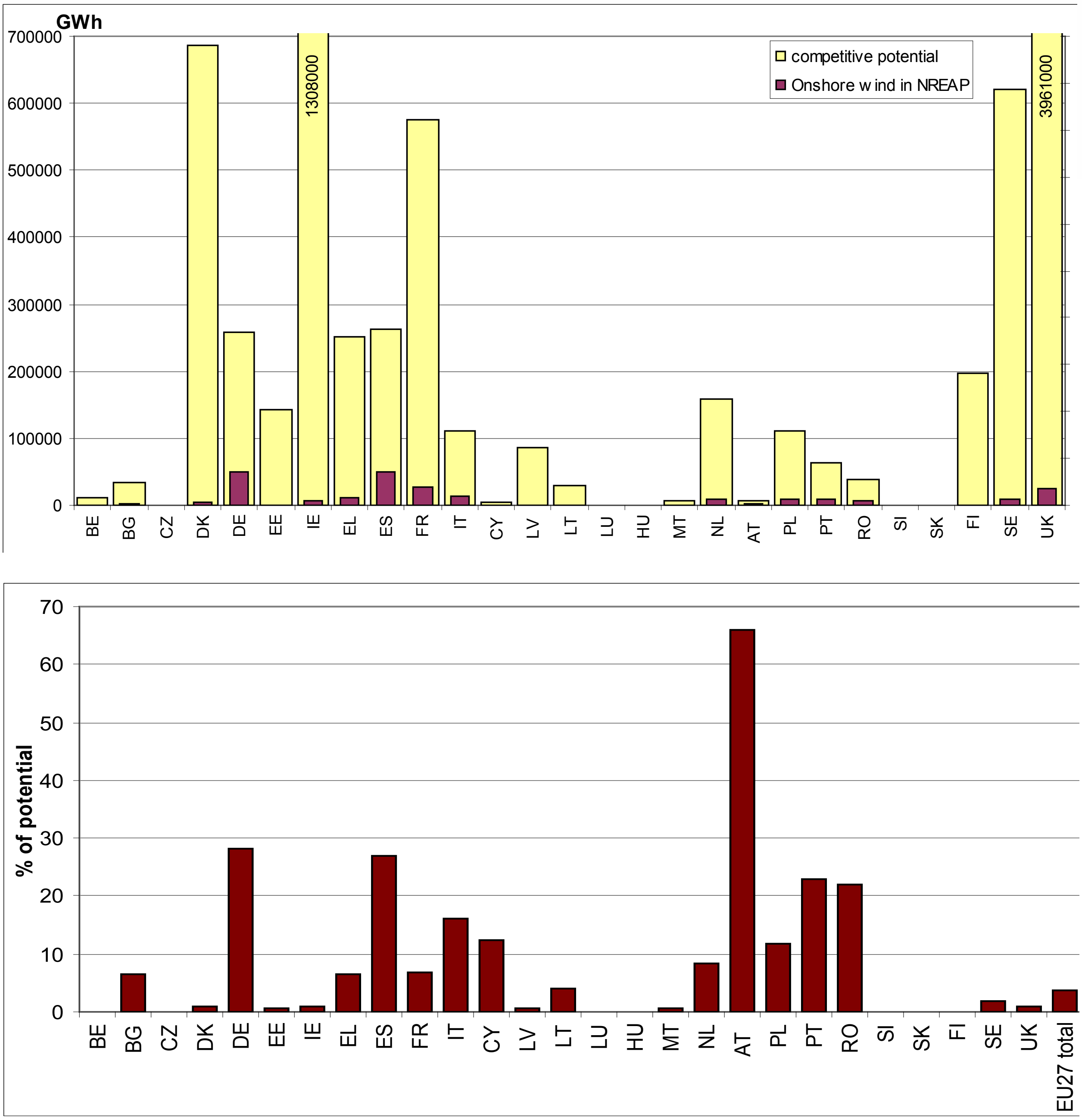


Figure 30: Use of onshore wind % of the environmental and commercial competitive benchmark potential by 2020 (EEA) by 2020

Share of demand

The highest grid share of wind is in the Netherlands, Spain, Ireland and Greece. In Denmark Portugal and Germany, UK and Estonia a grid share is still higher than 100 % (Figure 31). This means, and it was expressed also by the Member States, that grid capacity development or storage has to be solved in the Member States.

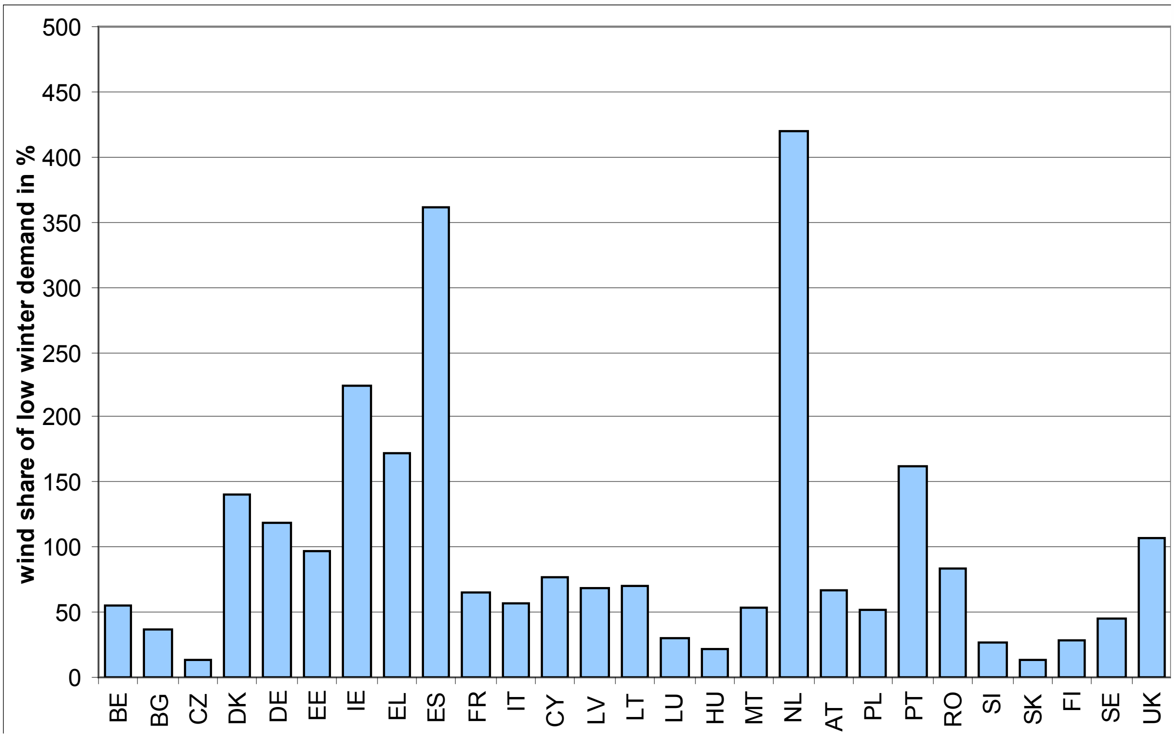


Figure 31: Possible wind electricity generation in the % of low winter demand in 2020 in EU27

The **onshore wind** energy reported in the NREAPs by 2020 is 1237.8 PJ in EU27, which represents 12.1 % of the renewable energy mix (Table 18).

The onshore wind generation share reported in the NREAPs will reach 70 % of the wind electricity by 2020 and the share of the RES electricity 28.6 % (Figure 3), with a yearly average growth of 8.4 %.

Leading countries

Germany and Spain presented the highest onshore wind energy production by 2020, with an amount of 262.4 PJ and 254.6 PJ, and represent 41.8 % of the total onshore wind electricity production in EU 27. With France and the UK (144.1 PJ and 123.3 PJ) together, these four countries give 63.4 % of the onshore wind energy.

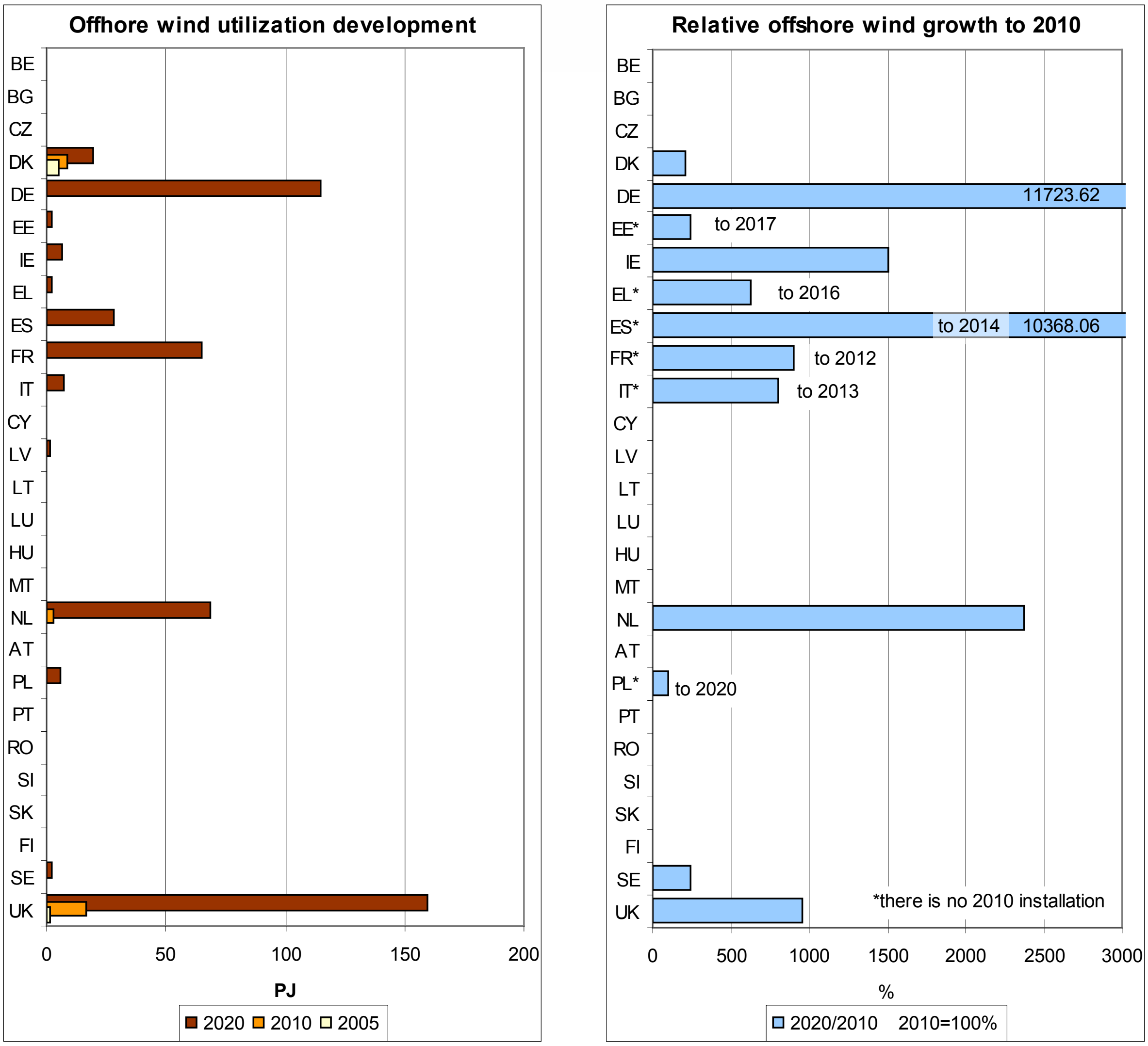
The highest onshore wind share within the renewables electricity is in Ireland, Greece and Estonia with 73.55 %, 59.1 % and 50.9 % (Figure 4). Spain, the Czech Republic, Lithuania, Poland and Portugal have 47 %, 42.5 %, 42.3 %, 42.3 % and 40.5 %.

Ireland has the highest onshore wind share within the renewables in 2020, with 39.4 %, Greece, Spain and Portugal have 28.5 %, 27.5 % and 20.5 % (Figure 16 and Figure 17).

The biggest relative change in onshore energy, compared to 2010, is expected in Slovenia, Slovakia, Romania and Cyprus, as shown in Figure 29.

3.3.5.2. Offshore wind

EU27 reported 41.324 GW **offshore wind** energy capacity potential in 2020 (with a share of 19.4 % in the wind energy installed capacity by 2020. However, it strongly depends on how competitive are the costs.



(BE and FI did not report separately the onshore and offshore wind resources)

Figure 32: Offshore wind development

Estonia, Latvia, Portugal and Spain will not introduce offshore wind before 2015, and Poland will start only in 2020. In these countries, starting from later installation with an already established technology, it means no technology risk, however can mean a capital risk in achieving the 2020 targets.

The **offshore wind** energy by 2020, reported in the NREAPs, is 483.08 PJ in EU27, which represents 4.7 % of the renewable energy mix (Table 18).

The offshore wind generation share reported in the NREAPs will reach 30 % of the wind electricity by 2020 and the share of the RES electricity 11.2 % (Figure 3), with a yearly average growth of 29.2 %.

Leading countries

UK and Germany presented the highest offshore wind energy production by 2020 (with an amount of 159.3 PJ and 114.74 PJ), and represent 56.7 % of the total offshore wind electricity production in EU27.

With France and the Netherlands (65 PJ and 68.75 PJ) together these four countries give 84.4 % of the offshore wind energy.

The highest offshore wind share within the renewables electricity is in Malta, the Netherlands and UK with 50 %, 37.8 % and 37.7 % (Figure 4). Estonia and Denmark have 29.4 % and 25.8 %.

Malta has the highest offshore wind share within the renewables in 2020, with 34.1 %, the Netherlands, the UK and Denmark have 22.3 %, 18.54 % and 9.04 % (Figure 16 and Figure 17).

The biggest relative change in offshore energy, compared to 2010, is expected in Germany and the Netherlands, as shown in Figure 32.

3.3.6. Geothermal

The geothermal energy by 2020, reported in the NREAPs, is 149.74 PJ in EU27, which represents 1.5 % of the renewable energy mix. It triplicates between 2010 and 2020 (Table 18).

Table 28 Indicator for the geothermal technology

Country	R&D Million EUR [30]		Geothermal energy in the NREAPs in PJ	
	2009	2010	2010	2020
BE	..	..	0.134	0.344
BG	0	0	0.042	0.378
CZ	0.732	..	0.000	0.630
DK	2.126	..	0.000	0.000
DE	13.95	9.889	1.526	34.785
EE			0.000	0.000
IE	0.432	..	0.000	0.000
EL	..	..	1.008	4.800
ES	..	..	0.160	1.482
FR	7.141	..	7.063	22.715
IT	2.014	5	29.831	36.977
CY	0	0	0.000	0.000
LV			0.000	0.000
LT			0.126	0.210
LU	..	..	0.000	0.000
HU	..	..	4.242	16.475
MT			0.000	0.000
NL	0.102	..	1.638	10.878
AT	0.371	..	0.805	1.687
PL	..	..	0.966	7.476
PT	..	..	1.009	2.812
RO			1.050	3.360
SI			0.756	0.840
SK	0.465	0.498	0.126	3.888
FI	..	..	0.000	0.000
SE	..	..	0.000	0.000
UK	4.906	1.369	0.000	0.000

Italy, Germany, France and Hungary have the highest production in geothermal energy by 2020 (with an amount of 36.98 PJ, 34.79 PJ, 22.72 PJ and 16.47 PJ). These four countries represent 74 % of the total geothermal energy production in EU 27. In 2005 France and Italy had the highest geothermal utilisation.

Hungary has the highest geothermal share in the renewables in 2020 with 13.7 % (Figure 17), Slovakia has 5.5 %, Italy 4.1 % and the Netherlands 3.5 %.

Hungary and Italy have the highest geothermal share in the renewables electricity, with 7.3 and 7 % (Figure 4); Hungary, the Netherlands and Slovakia have the highest geothermal share in the renewable Heating and Cooling (Figure 10), with 19.2 %, 11.9 % and 11 %.

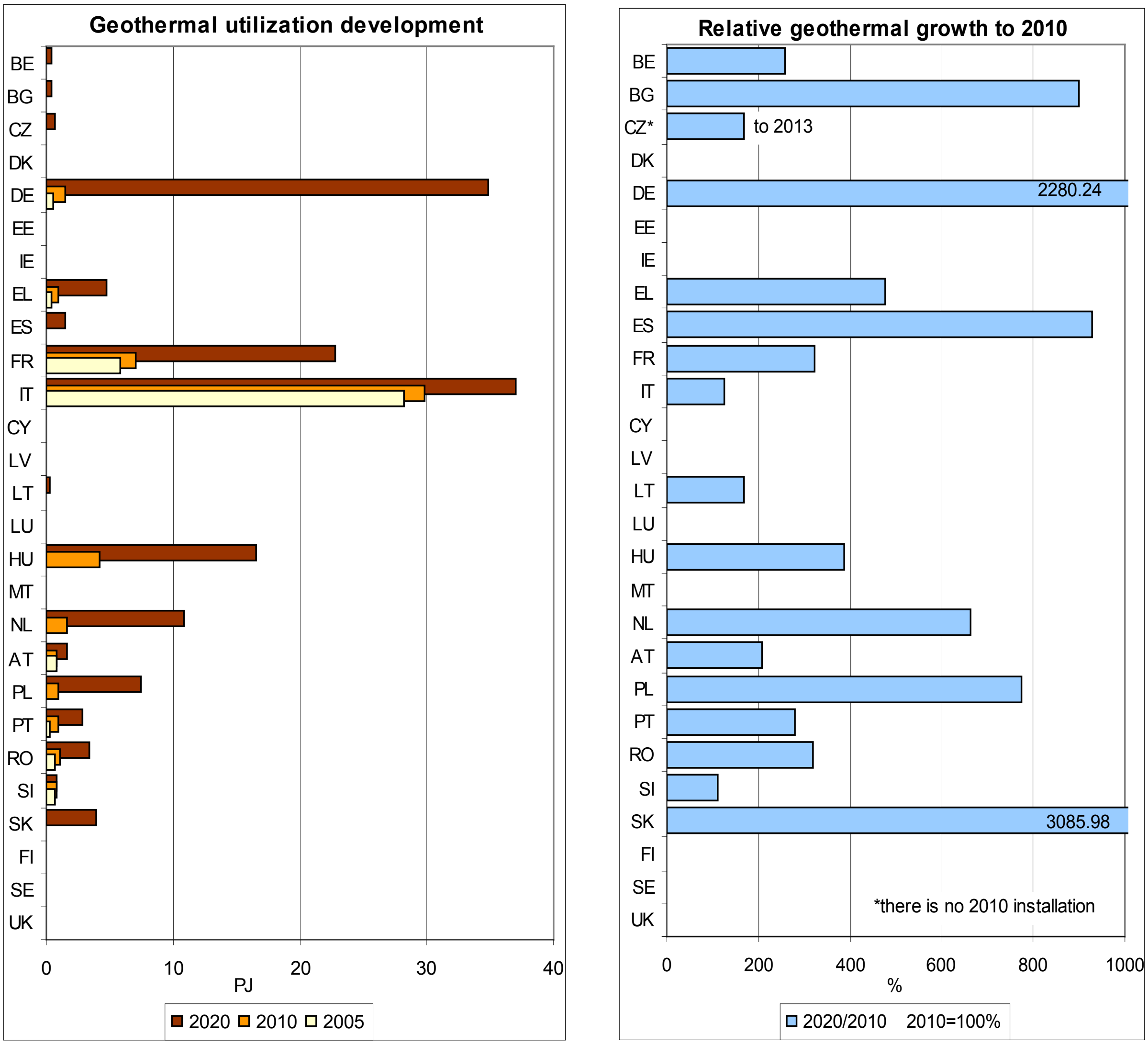


Figure 33: Geothermal utilization development

The biggest relative change in geothermal energy, compared to 2010, is expected in Slovakia and Germany, where the geothermal energy generation will be more than thirty- and twenty-fold in 2020, as shown in Figure 33. In Slovenia geothermal utilization will not change.

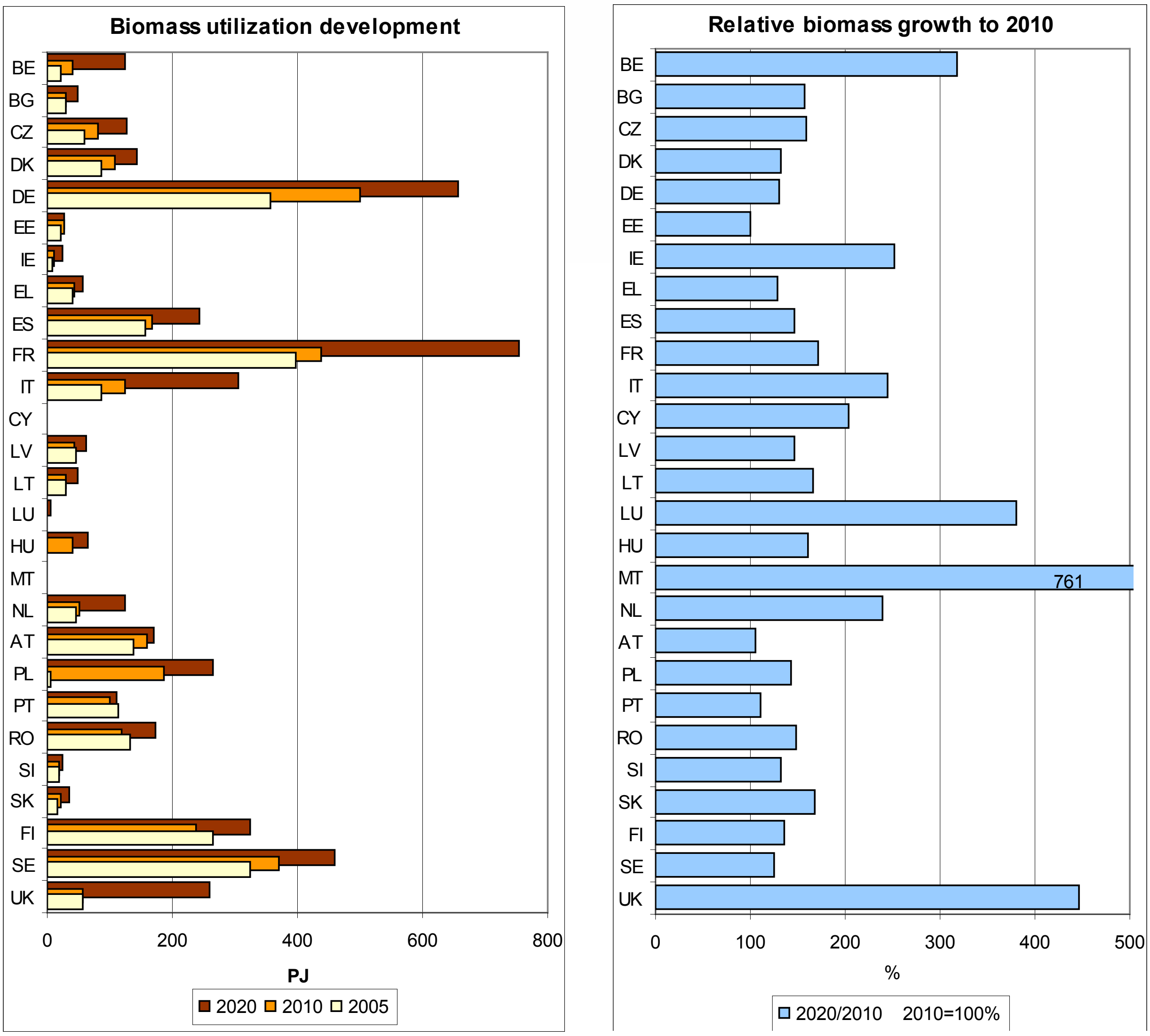


Figure 34: Final energy from biomass - development

3.3.7. Biomass

According to the NREAPs, use of biomass electricity, heating and cooling and biofuels in transport is estimated at about 5,880 PJ (140 Mtoe) as final energy in 2020, including biofuels with 1,243.9 PJ. Biomass represents 45.2 % and biofuels 12.1 % of the renewable energy mix (Table 18).

Latvia, Lithuania, Estonia, Finland and the Czech Republic have the highest biomass share (without biofuels) within the renewables in 2020 with 77.9 %, 76.4 %, 74 %, 72.1 % and 70.1 % (Figure 17).

The biggest relative change in biomass energy, compared to 2010, is expected in Malta, UK, Luxembourg and Belgium, as can be seen in Figure 34.

The NREAPs estimate that 5,384.2 PJ (128.6 Mtoe) domestic biomass will be available for energy production in 2020 in EU27. This will come mainly from biomass from forestry with 2,851.2 PJ (68.1 Mtoe), biomass from agriculture and fisheries with 1,695.7 PJ (40.5 Mtoe) and biomass form waste 837.4 PJ (20.0 Mtoe). In comparison, the European Environment Agency [7] estimated the available biomass potential for the EU25 at 9,839.0 PJ (235 Mtoe): 39.2 Mtoe from forestry, 95.7 Mtoe from agriculture and 99.9 Mtoe from waste.

According to AEBIOM, in 2007 EU27 used about 41,198 PJ (98.4 Mtoe) biomass: 1,394.2 PJ (33.3

Mtoe) for bio-electricity, 2,574.9 (61.5 Mtoe) heating and cooling and 329.8 PJ (7.877) Mtoe biofuels. The primary energy consumption of biomass in EU27 further increased to about 4,132.4 PJ (98.7 Mtoe) in 2008 (of which 2,989.4 PJ (71.4 Mtoe) solid biomass, 334.9 PJ (8.0 Mtoe) biogas, 314.0 PJ (7.5 Mtoe) MSW and 494.0 PJ (11.8 Mtoe) biofuels) and 4,350.0 PJ (103.9 Mtoe) in 2009 (of which 3,089.9 PJ (73.8 Mtoe) solid biomass, 347.5 PJ (8.3 Mtoe) biogas, 322.4 PJ (7.7 Mtoe) MSW and 586.2 PJ (14 Mtoe) biofuels) (according to EurObserv'ER, 2010).

For 2005, on the basis of the NREAP data, we estimate that EU27 used PJ 3,165.2 PJ (75.0 Mtoe) biomass, of which 954.6 PJ (22.8 Mtoe) for electricity, 2,202.3 PJ (52.6 Mtoe) for heating and cooling and 3.1 Mtoe biofuels. Based on the NREAPs, we estimate that 7,594.9 PJ (181.4 Mtoe) biomass will be required in 2020 to reach the proposed targets: 6,355.6 PJ (151 Mtoe) for electricity, heating and cooling and 1,240.9 PJ (29.6 Mtoe) for biofuels.

Thus, compared with the available biomass potential in the EU, estimated by the EEA in 2006, the proposed targets for bioenergy and biofuels could be reached using domestic biomass. Different countries use the biomass potential to a different extent (Figure 35).

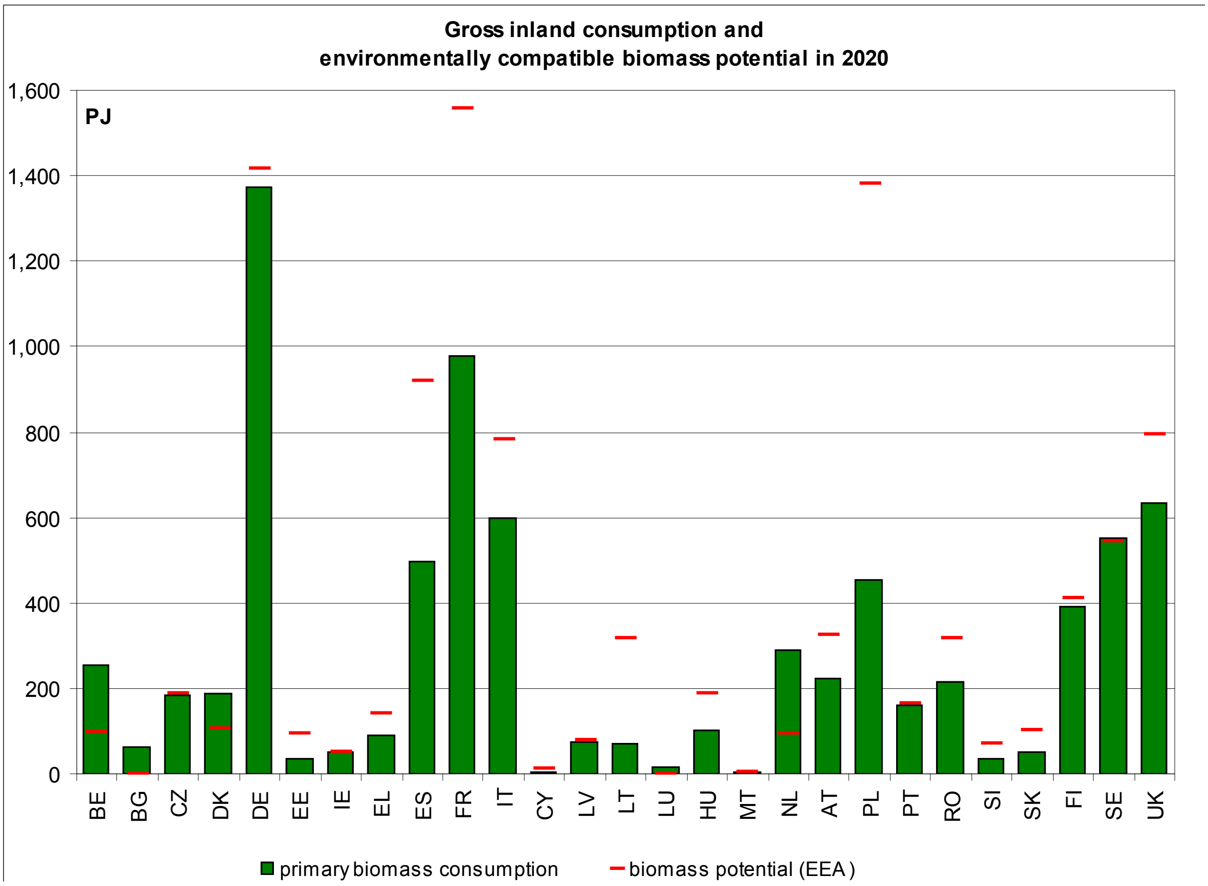


Figure 35: Primary biomass consumption and biomass potential

Thus, the expected biomass consumption to reach the proposed targets is higher than the estimated biomass potential for Belgium, Denmark and the Netherlands, where biomass import should play an important role. For other MSs, the expected biomass consumption is close to the estimated biomass potential (Czech Republic, Germany, Finland, Sweden, Ireland, Latvia and Portugal), which means that there is no large margin for increase. In several MSs, the biomass consumption could be further increased, since there is still large biomass potential unused (Austria, Greece, Spain, France, Lithuania and Romania), while in a few others (Estonia, Lithuania, Poland, Slovenia and Slovakia) the expected biomass consumption to reach the targets is less than 50% of biomass potential.

Leading countries

The most important contribution of biomass for electricity, heating and cooling and biofuels shall be in Germany with 1,371 PJ (32.8 Mtoe), France with 977.0 PJ (23.3 Mtoe), UK with 634.1 PJ (15.1 Mtoe), Italy with 599.6 PJ (14.3 Mtoe), Sweden with 553.0 PJ (13.2 Mtoe) (Figure 35).

3.3.7.1. Biomass electricity

The contribution to electricity made by bioenergy will be 837.7 PJ (231,971 GWh) in 2020, representing 19.4 % of RES electricity. The biomass electricity is expected to increase from 245.1 PJ (69,039 GWh) produced in 2005 to 837.73 PJ (231,971 GWh) in 2020, 3.4 times more than in 2005 (592.63 PJ (162,932 GWh) increase), see Figure 3.

Compared with almost 954.6 PJ (22.8 Mtoe) biomass used in 2005 for electricity production, 1,394.2 PJ (33.3 Mtoe) biomass was used in 2007 (AEBIOM), about 3,177.8 PJ (75.9 Mtoe) of biomass is expected to be used for electricity generation in 2020.

The contribution to electricity made by solid biomass will be 155,246 GWh, biogas will produce 63,978 GWh and bioliquids will produce 12,747 GWh of electricity in 2020. A share of renewable electricity (53.6% of bio-electricity) or 124,231 GWh will be produced by means of CHP in 2020. In comparison, an amount of 32,598 GWh of electricity was produced in CHP plants in 2005 (47.2% of bio-electricity).

Leading countries

Germany should remain the leading MS with the highest electricity generation from biomass with 49,457 GWh, which represents 21.3% of the total biomass electricity in EU27. The next important electricity producers will be UK (26,160 GWh), Italy (18,780 GWh), France (17,171 GWh), Sweden (16,753 GWh) and the Netherlands (16,639 GWh). The first three leading countries in bio-electricity production (Germany, UK and Italy) will contribute with almost 40.7% to the electricity generation in EU27, while the first five (Germany, UK, Italy, France, Sweden and the Netherlands) will have a share of 55.3% in bio-electricity production in EU27 (Figure 36).

The leading countries in electricity generation in CHP are expected to be Germany (20,791 GWh), France (17,171 GWh), Sweden (16,754 GWh), Finland (12,340 GWh), Denmark (8,838 GWh) and the Netherlands (8,289 GWh).

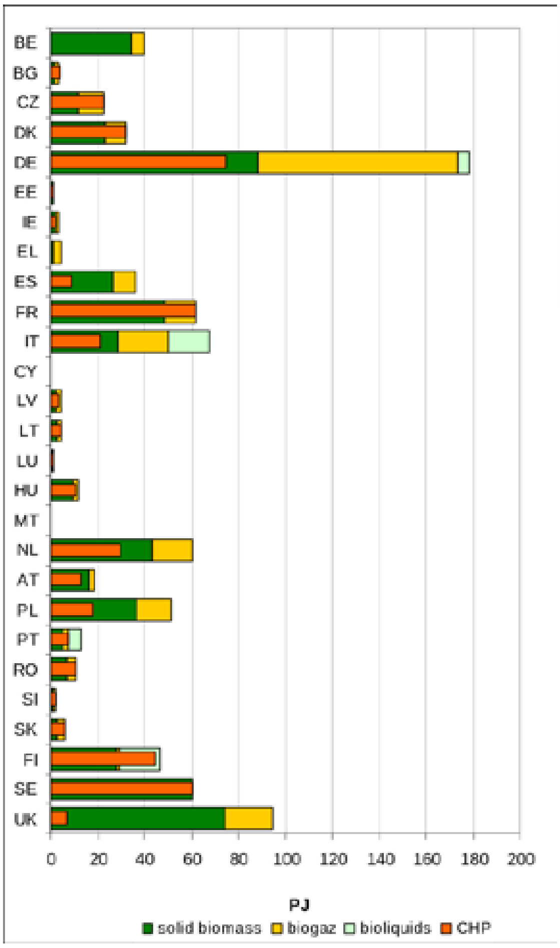


Figure 36: Bioelectricity production in 2020

3.3.7.2. Biomass Heating

In biomass heating, solid biomass will provide 3,391.2 PJ (81.0 Mtoe), biogas will provide 187.1 PJ (4.5 Mtoe) and bioliquids will provide 209.3 PJ (5.0 Mtoe) of heating and cooling in 2020. According to the NREAPs submitted by all MSs, the proposed target will mean an increase in the use of heating and cooling from biomass from 2,210.3 PJ (52.6 Mtoe) in 2005 to 3,798.2 PJ (90.5 Mtoe) in 2020, e.g. an increase of 70%.

The contribution of biomass from district heating plants is expected to have a more than three-fold increase. District heating using biomass directly for heat from DH installations will increase from 244.8 PJ (5.8 Mtoe) in 2005 to 743.6 PJ (17.8 Mtoe) in 2020 and biomass from district heating will have a share of 18.1% in biomass heating.

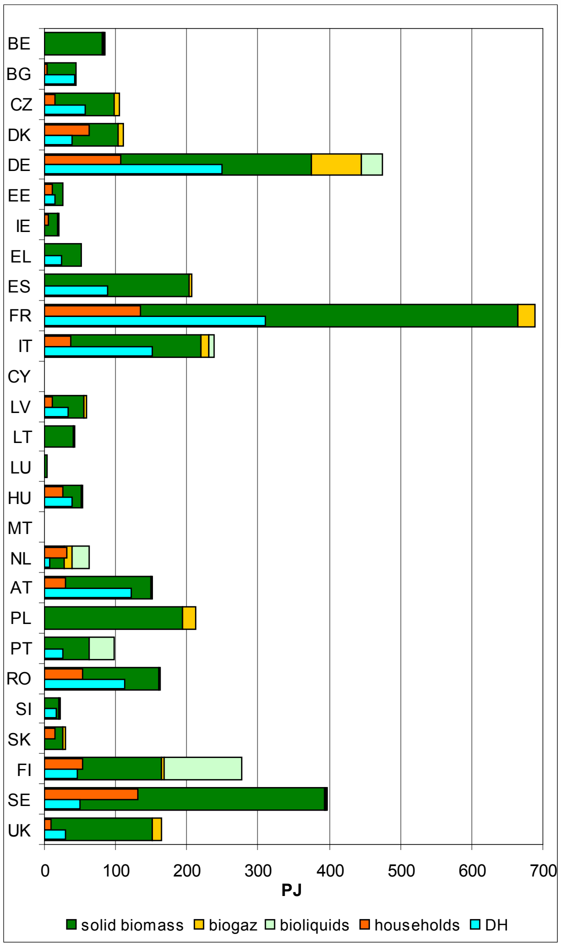


Figure 37: Biomass heating and cooling in 2020

Biomass is used largely in households for heating in fireplaces and stoves. The contribution of biomass used in households is expected to have a limited increase from 1,138.9 PJ (27.2 Mtoe) in 2005 to 1,464.5 PJ (35.0 Mtoe), to represent 37.7% of the biomass used for heating in 2020, compared with 25.5% share of biomass used in households.

Leading countries

France is the leading MS with the highest heating and cooling generation from biomass with 668.8 PJ (16,455 ktoe), which represents 18.2 % of the total H&C from biomass in EU27. The next important electricity producers will be Germany (475.3 PJ or 11,355 ktoe), Sweden (397.3 PJ or 9,491 ktoe), Finland (276.7 PJ or 6,610 ktoe), Italy (237.3 PJ or 5.670 ktoe) and Poland (207.2 PJ or 4,950 ktoe) (Figure 37). The first three leading countries in bio-electricity production (France, Germany and Sweden) will contribute with almost 41.2% to the heating and cooling from biomass in EU27, while the first five (France, Germany, Sweden, Finland, Italy and Poland) will have a share of 54.8% in biomass heating and cooling production in EU27.

From the point of view of biomass use in households, France will have the leading role in 2020, with 134.0 PJ (3,200 ktoe) representing 18.0% of the biomass use in households. Other leading MSs in the use of biomass in households are Sweden with 131.5 PJ (3,141 ktoe) Germany with 107.2 PJ (2,560 ktoe), Denmark with 62.2 PJ (1,486 ktoe), Romania with 54.4 PJ (1,300 ktoe) and Finland with 52.8 PJ (1,260 ktoe). The first three countries (France, Sweden and Germany) will use just more than 50% of the biomass used in households in EU27.

District heating with biomass will be mainly used in France with 309.8 PJ (7,400 ktoe), representing 18.2% of the district heating and cooling in EU27. Other MSs with important district heating using biomass will be Germany with 250.2 PJ (5,975 ktoe), Italy with 151.6 PJ (3,620 ktoe), Austria with 121.6 PJ (2,905 ktoe) and Romania with 112.0 PJ (2,676 ktoe). The first three countries (France, Germany and Italy) will have a share of 48.2% of the district heating production from biomass.

3.3.8. Biofuel

The final energy from biofuel by 2020, reported in the NREAPs, is 1,240 PJ in EU27, which represents 12.1 % of the renewable energy mix. (Table 18).

The yearly average growth is 6.62 %, however does not show a stable increase or decrease, it is very variable, which can mean a policy and capital risk.

Leading countries

Germany, UK, France, Spain and Italy presented the highest amount in biofuel by 2020, and altogether they represent 65.5 % of the total final biofuel production in EU 27.

Luxembourg, Malta, UK and Ireland have the highest biofuel share within the renewables in 2020 with 55.2 %, 23.5 %, 20.6 % and 20 % (Figure 16 and Figure 17).

The biggest relative change compared to 2010 in biofuel is expected in Estonia, Denmark and Bulgaria, as can be seen in Figure 38.

Of the biofuels use estimated at 1,239.9 PJ (29.615) Mtoe in 2020, the greatest contribution in 2020 is expected from biodiesel with 906.5 PJ (21.583 Mtoe), followed by bioethanol/bio-ETBE with 306.2 PJ (7.289 Mtoe) and other biofuels (such as biogas, vegetable oils, etc.) with 31.2 PJ (0.743 Mtoe). According to the NREAPs submitted by all MSs, the contribution of hydrogen will be only 0.1

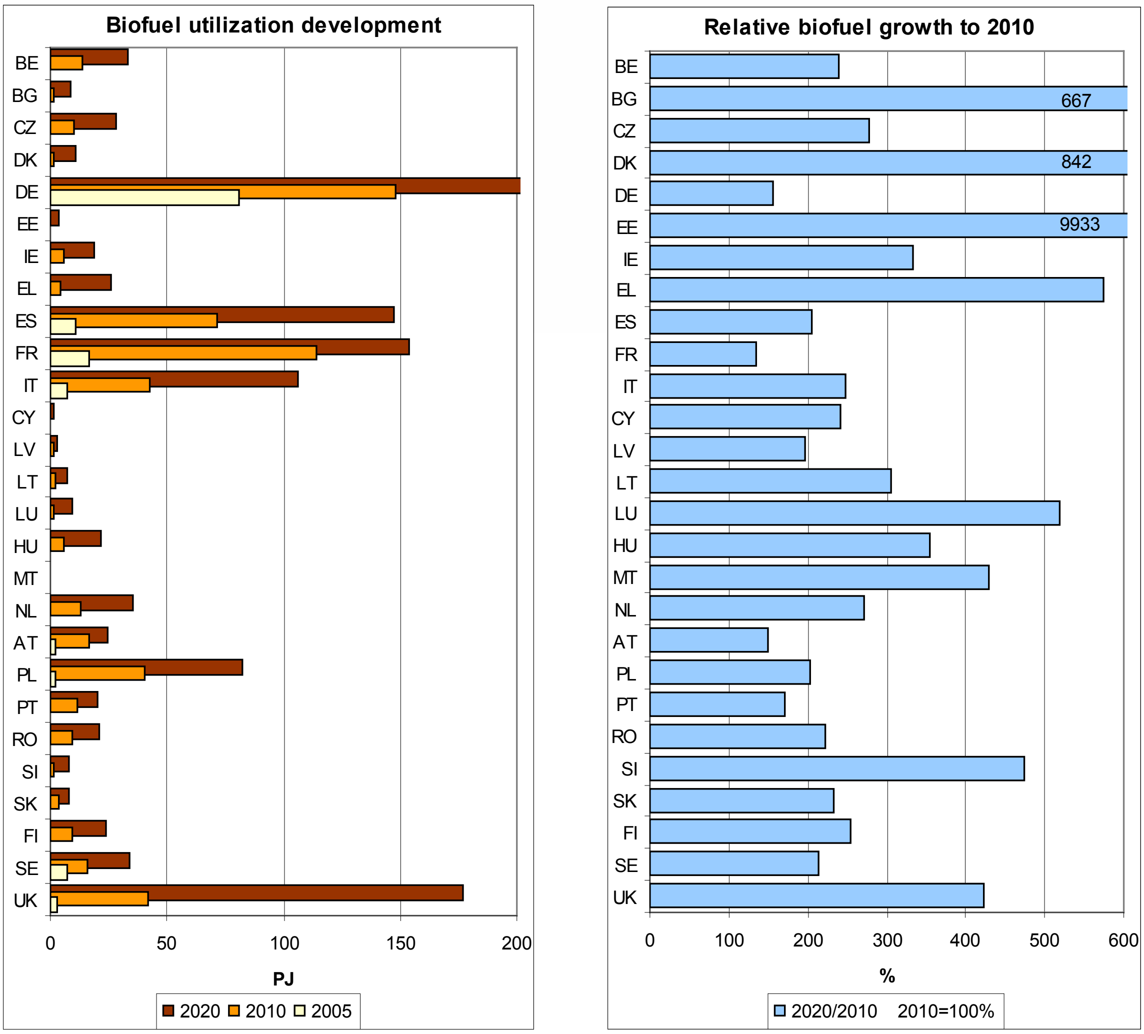


Figure 38: Biofuel utilization development

PJ (2.4 ktoe). Article 21(2) biofuels will contribute by 111.7 PJ (2.7 Mtoe), representing about 9% of the biofuel consumption in EU27 in 2020. Electricity is expected to have a contribution of 131.5 PJ (3.1 Mtoe) in 2020, of which 29.3 PJ (0.7 Mtoe) in non-road transport. In comparison, according to the NREAPs, biofuel consumption was 130.0 PJ (3.1 Mtoe) in 2005. Biofuel consumption further increased to 333.6 PJ (8.0 Mtoe or 2.6%) in 2007, 427.9 PJ (10.2 Mtoe or 3.4%) in 2008 and 506.5 PJ (12.1 Mtoe or 4.4% of energy use in transport) in 2009, according to EurObserv'ER.

Leading countries

The use of biofuel in transport should increase to 1,240 PJ (29.7 Mtoe). The leading countries in the field of biofuel consumption will be Germany with 229.1 PJ (5,473 ktoe), UK with 176.1 PJ (4,205 ktoe), France with 153.2 PJ (3,660 ktoe), Spain with 146.7 PJ (3,504 ktoe), Italy with 105.9 PJ (2,530 ktoe) and Poland with 82.4 PJ (1,968 ktoe). The main biodiesel users will be Germany with 186 PJ (4443 ktoe), Spain with 129.8 PJ (3,100 ktoe), France with 119.3 PJ (2,850 ktoe), UK with 103.1 PJ (2,462 ktoe), Italy with 78.7 PJ (1,880 ktoe) and Poland with 60.8 PJ (1,451 ktoe). The main bio-ethanol users should be Germany with 35.9 PJ (857 ktoe), UK with 73.0 PJ (1743 ktoe), France with 27.2 PJ (650 ktoe), Italy with 25.1 PJ (600 ktoe), Sweden with 19.5 PJ (465 ktoe) and Poland with 18.9 PJ (451 ktoe) (Figure 39).

The use of biofuels from wastes, residues, non-food cellulosic material and lignocellulosic material (Article 21.2 biofuels) is expected to reach 106 PJ and a share of 9.0% of the biofuel use in the EU in 2020. Several countries, however, do not expect to have any contribution from biofuels from wastes, residues, non-food cellulosic material and lignocellulosic material (Austria, Estonia, Greece,

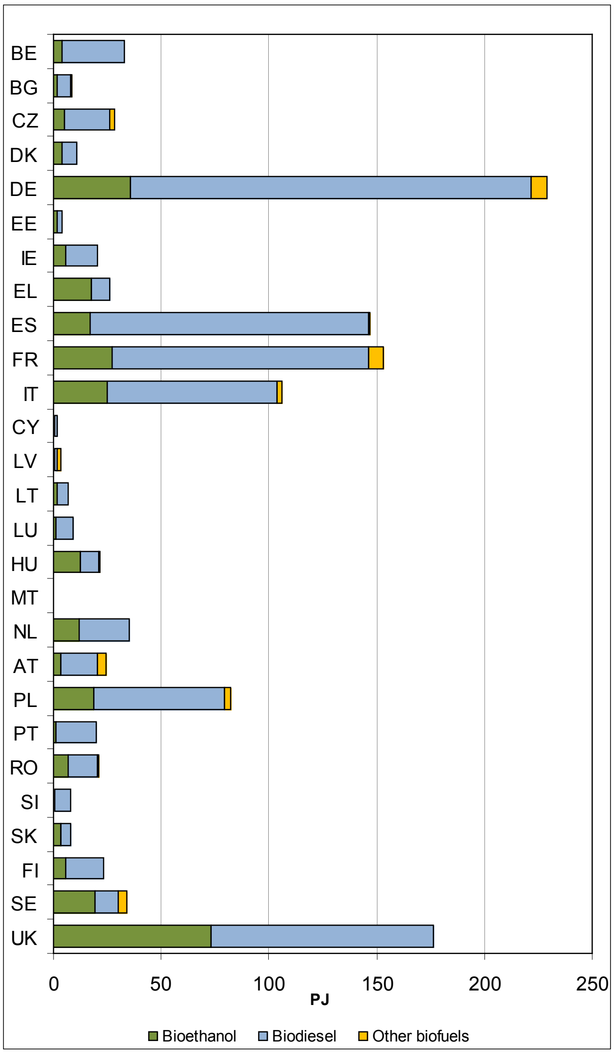


Figure 39: Biofuel use in transport

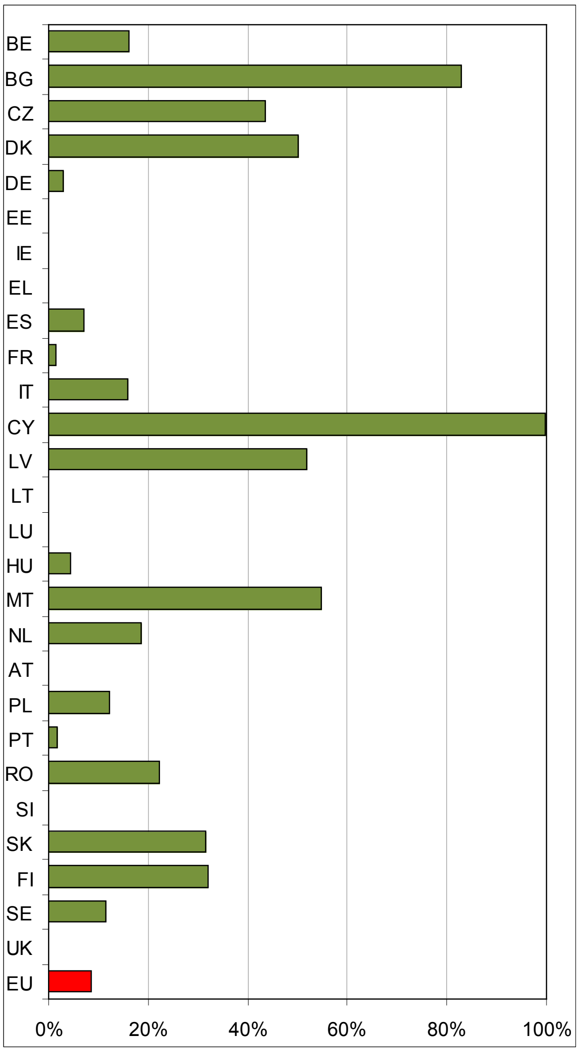


Figure 40: Share of Biofuels Article 21.2 in total biofuel use in transport

Lithuania, Luxembourg, Slovenia and UK) while others should have a negligible consumption (Germany, France, Ireland, Portugal). Cyprus expect to have the entire consumption of biofuels coming from Article 21.2 Biofuels (Figure 40).

The NREAP data show that in 2020 about 463.3 PJ (11.1 Mtoe) biofuels should be imported by the MSs in order to reach the 10% binding target. This should represent 37.4% of the biofuel use in the EU in 2020. However, a part of this could come from internal EU trade and a part should be imported from other countries to the EU. The share of biofuels import at the level of MSs is expected to vary from 0% in several countries (Belgium, Estonia, Finland, Hungary, Lithuania, Poland, Portugal, Romania, Slovenia and Slovakia) to 100% import in other countries (Denmark and Luxembourg). However, a number of countries should import more than 50% of their expected consumption of biofuels (Cyprus, Germany, Ireland, Malta, the Netherlands and UK). It is not clear how much biofuel should be domestically produced in the EU and how much should be imported from outside the EU; a part of this import could be internal EU trade and a part of it should be imported from other countries to the EU (Figure 41).

3.3.9. Marine technology

The marine energy (ocean, tide, waves) reported in the NREAPs by 2020 is 21.64 PJ in EU27, which represents 0.2 % of the renewable energy mix. Between 2010 and 2020, the amount becomes twenty times more (Table 18).

Six countries, UK, France, Portugal Ireland, Spain and Italy, reported production in marine energy by

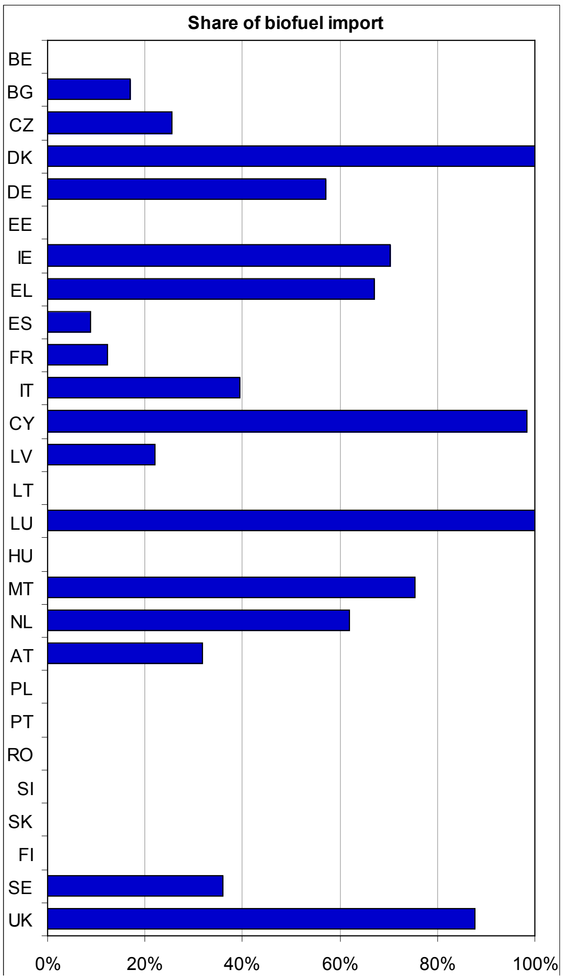


Figure 41: Import share of total biofuel in transport

2020, the highest amount is in the UK and France with 14.26 and 4.15 PJ; these two countries represent the 85 % of the total marine energy production in EU 27 (UK alone the 66 %). France was the only Member State with marine energy in 2005 and 2010.

UK, Ireland and Portugal have the highest marine energy share within the renewable electricity, with 3.4, 1.5 and 1.2 % (Figure 4).

UK and Italy have the highest marine share within the renewables in 2020 with 1.7 % and 0.9 % (Figure 16 and Figure 17).

There is not a large scale marine industry at the moment, only prototypes and the capability that the sector grows has to be proved. There is a technology and therefore also a capital risk as well.

The biggest relative change in marine energy, compared to 2010, is expected in Portugal and Spain, as can be seen in Figure 42 (next page).

Table 29: Indicator for the marine technology

Country	R&D Million EUR [30]		Marine energy in the NREAPs in PJ	
	2009	2010	2010	2020
DK	6.30	2.24	0.000	0.000
DE	2.76	0.76	0.000	0.000
IE	3.88	..	0.000	0.831
ES	0.21	0.12	0.000	0.794
FR	2.19	..	1.806	4.153
IT	..	..	0.000	0.018
NL	0.31	..	0.000	0.000
AT	0.24	..	0.000	0.000
PT	0.04	..	0.004	1.578
SE	1.12	8.64	0.000	0.000
UK	9.02	35.82	0.000	14.265

3.3.10. Heat pumps

Heat pump is a conversion technology, considering it as a renewable energy source can only be if the support energy is coming from RES, otherwise not. The NREAP template gave an indication and calculation method, the template should have been filled in accordingly. In the assessment data have been taken from the template as they have been provided by MSs, in the assessment no correction and weighting has been applied.

The heat pump energy reported in the NREAPs by 2020 is 510.37 PJ in EU27, which represents the 5 % of the renewable energy mix. Between 2010 and 2020 the amount triplicates (Table 18).

The highest energy production by heat pump is in Italy, UK, France, Germany and Sweden with 121.8, 94.67, 77.7, 48.1 and 43.9 PJ. These five countries represent almost the 76 % of the total heat pump energy production in EU 27.

UK, Italy, the Netherlands and Luxembourg have the highest heat pump energy share within the renewable heat with 36.3, 27.4, 17.3 and 15.7 % (Figure 10).

Italy and UK have the highest heat pump share within the renewables in 2020 with 13.6 % and 11 % (Figure 17).

The biggest relative change in heat pump energy, compared to 2010, is expected in Hungary, Greece, UK and Luxembourg, where the heat pump energy generation will be more than twenty- and ten-fold in 2020, as shown in Figure 43.

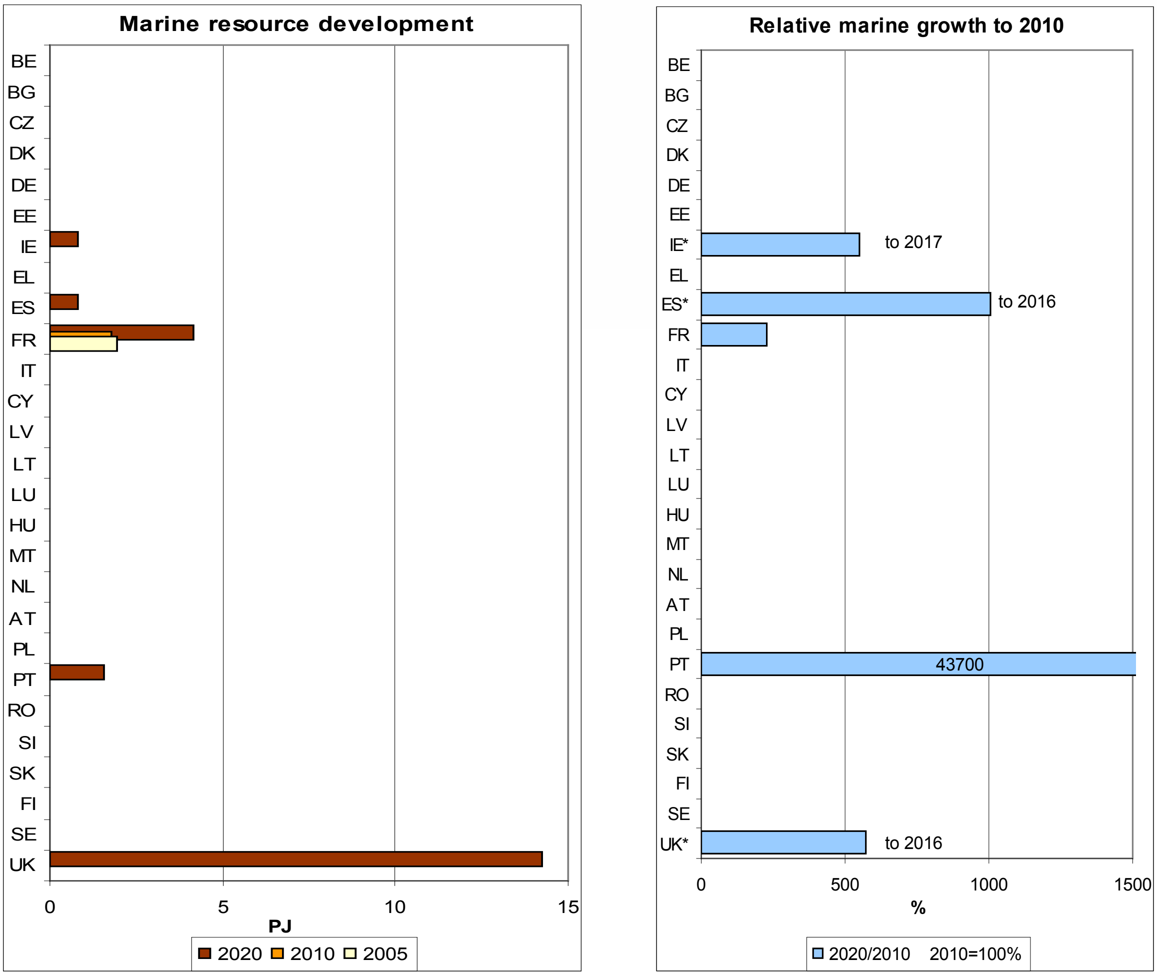


Figure 42: Marine resource development

** deployment starts later than 2010*

3.4 Risk assessment

During the assessment of the NREAPs, the possible risk factors of the RES technologies by Member State have been identified and summarised in Table 30. These risks can mean difficulties for the Member States in achieving the set targets. The definition of the different risk categories (resource risk, technology risk, policy (capital) risk, mobilisation risk and import dependency risk) can be found in Chapter 1.1 "Definitions". There are also some factors emphasised, which is still a barrier in the spread of a certain technology (like grid development, or big variability in the development).

Some risks can appear also as a consequence of another risk, therefore in some technologies more than one risk category can be identified, this means a combined risk. For example, in the case of a technology – even if from a resource point of view it can be achievable, if the industry does not develops because there is no market the long-term technical improvement has to be proved. There can be a technology and therefore also a capital risk as well.

In the case of a later start of an already established technology a capital risk appears, the starting year of the technology has been also presented in the table.

Table 30 summarises also the main risks for EU27 total. As a conclusion it can be stated that:

- Capital risks due to the late introduction appear in more EU Member States in the geothermal technology in electricity production (from 2013), in CSP technology for solar electricity (2014-2015), marine technology (2015-2016), and in some cases the onshore and offshore wind resources (around 2014-2015).

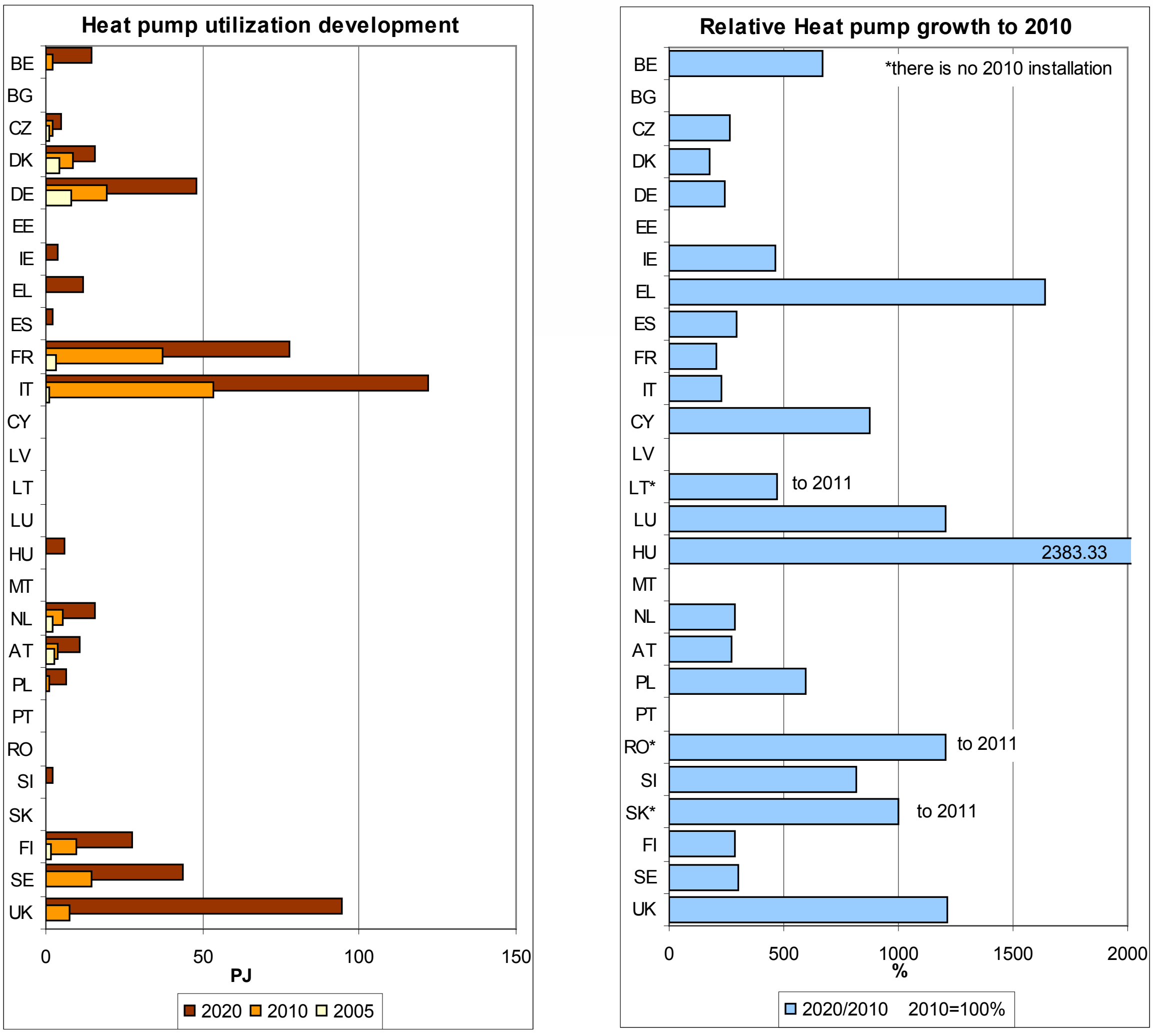


Figure 43: Heat pump utilization development

- For all not yet commercial available technology there is an economic risk once the technology is ready.
- Marine technology has first a technology risk because the technology is not yet commercially available; as a consequence, the planned late introduction of the technology might fail or be hampered if competing RES technologies have already achieved much cheaper levelled cost of electricity, this means also capital risk for this technology.
- Especially in the spread of onshore wind technology, grid development is needed.
- Resource risk appears in some MSs in the case of biomass. This means that the bioenergy presented cannot be covered by the environmentally and commercially competitive resources available by 2020.
- In the case of biofuels, one third of the countries rely on import. In order to reach the targets these MSs have import dependency.
- Second generation biofuel has technology risk.

Table 30: Risk of RES (P – capital risk, T - technology risk, R - r
I– reliance on import/import dependency, M-mobilisatio

MS	consumption	RES					
		Hydro	Geothermal		Solar		
			electricity	H&C	PV	CSP	TH
BE			**P** late introduction 2018				**P**
BG		**P** 2017; 2020		**P, T** (2011 and 2016)	**P** 2010-2013		
CZ			**P** 2013				
DK							
DE							
EE							
IE							
EL	**O**		2014			**P** 2015	
ES			**P** late 2018	2015			
FR	Ref scen too high					**P** 2012	
IT							High growth 1300 %
CY						**P** 2014	
LV							
LT							Late

esource risk, G – grid development needed, O – overambitious,
n, V – variable growth rate)

MS	RES								
	Marine	Hydrogen	Wind		Heat pump	Biomass			Biofuel
			Onshore	Offshore		resources	Electr.	H&C	
BE						**R**			
BG						**P** 2016; CHP higher than bioenergy			
CZ			**P** there is no competitive resource			M			
DK				**G**		**R**			**I**
DE				**G**					**V, I**
EE			No EEA data about competitive **G**	**P** 2016					
IE	**T** **P** late		**G**	**G**		**R, M**			**I**
EL			**G**	**G** **P** late 2017					
ES	**T => P**			**P** 2014 **G**		**M**			**P** 2010 **I**
FR	**T => P**		**P** from 2012 **G**	**P** from 2012 **G**					
IT	**T** **P** 2016		**G**	**G** **P** 2013					
CY						**R**			**I**
LV				**P** 2016	From 2013	**M**		**V**	
LT						Measures needed for increase biomass plant capacity	**V**		

MS	consumption	RES						
		Hydro	Geothermal		Solar			
			electricity	H&C	PV	CSP	TH	
LU							High growth 1000 %
HU			**P** late start 2013 2016,2018 growth				High growth 1200%
MT							
NL		**T** eval					
AT	O						
PL				**P** 2019-2020	**P** 2010; 2017		High growth 2300%
PT						**(T) P** high growth rate	
RO							
SI							
SK							High growth 1400%
FI							
SE	O						
UK							
EU27 total			**P** late 2013 2018			**P** 2014-2015	

MS	RES								
	Marine	Hydrogen	Wind		Heat pump	Biomass			Biofuel
			Onshore	Offshore		resources	Electr.	H&C	
LU			**P** there is no competitive **P** 2010/2011		**P** 2015				**I**
HU			**G** **P** there is no competitive		**R** growth 46 %		**V**	**V**	
MT			**P** 2014-2017 **G**			**R**		**V**	**I**
NL						**R, I**			**I**
AT									
PL			**G**	**G** **P** Start 2020	**R** 18 %				
PT	**T** **P** 2015		**G**	**G** **P** 2015		**M**		**V**	
RO								**V**	
SI			**P** there is no competitive **P** 2015;2019						
SK			**P** there is no competitive **P** 2012;2013;2015		**R** 38 %				
FI			**P** On- offshore is not separately			Underestimated **M**	**V**	**V**	
SE			**G**	**G**		**T** operating hours growth from 3000 to 7500 IMPORTS needed **M**			
UK	**T => P** **P** 2016		**G**	**G**				**V**	**I**
EU27 total	**T => P** 2015-2016		**P** 2015 **G**	**G** P 2014- 2015-2016	**R** high growth rate	**T, R, M,**			IMPORT

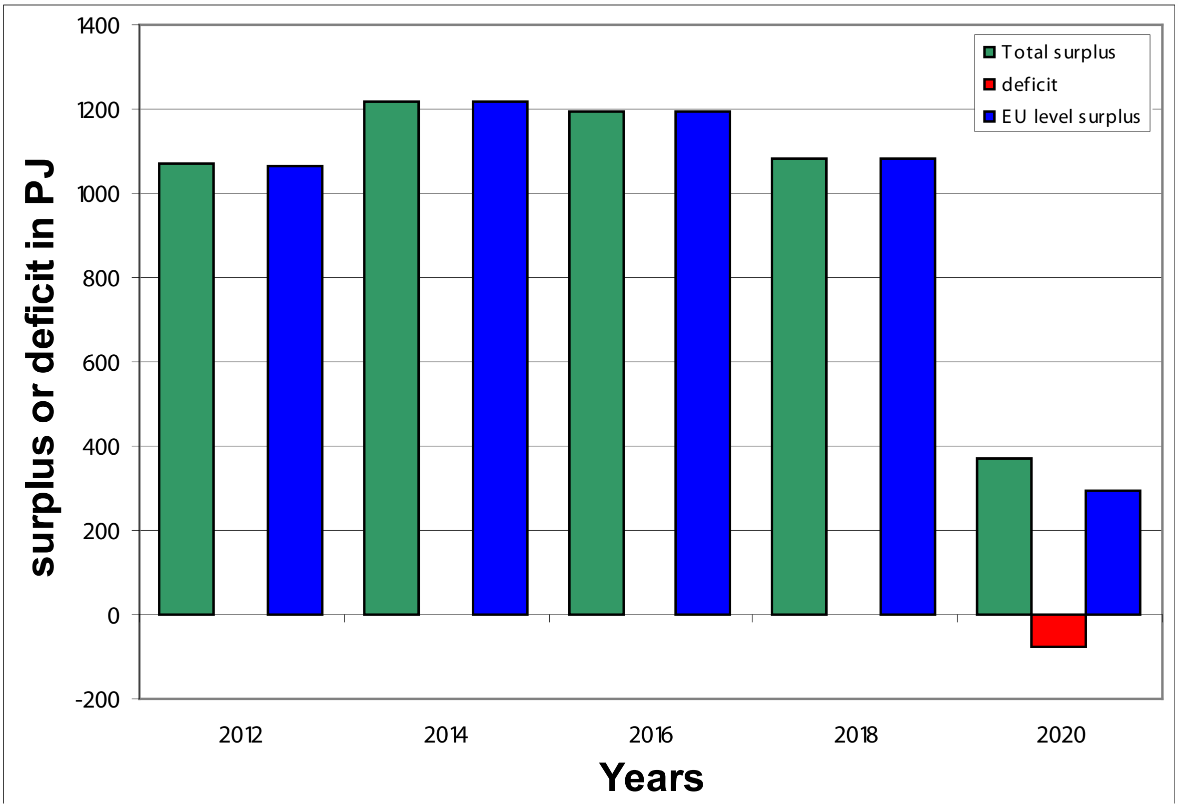


Figure 44: The RES surplus or deficit between 2010 an 2020 in EU27

4. Trajectory and RES share

This chapter presents a comparison of the trajectory and the RES share in the NREAPs.

Most of the EU Member States are optimistic about the way to meet their target from only domestic action and resources (even more optimistic than in the forecast documents). The NREAP documents of the Member States forecast that the EU in 2020 will exceed the 20 % Renewable Energy consumption target with 0.7 %. From the NREAP analysis it can be expected that probably each year the EU will reach a net surplus also in the interim period until 2020, as presented in Figure 44.

RES Surplus

RES surplus compared to the targets appears for 20 Member States by the year 2020, as presented in Figure 45. Germany and Spain have the highest percentage in relative values with 2.7 % - only by taking into account the Additional Energy efficiency Scenario. Germany and Spain have the highest surplus in absolute term with 128.325 PJ(3.065 Mtoe) and 110.95 PJ (2.65 Mtoe) respectively.

RES Demand

Seven Member States – Finland, Estonia, Belgium, Ireland, Luxembourg, Italy, UK – show RES **deficit** compared to the targets in 2020, the highest deficit proportion (-2.1 %) is in Italy, representing the highest absolute deficit with a -57.066 PJ (-1.363 Mtoe).

Interim trajected RES surplus and deficit to the targets

Only one country shows interim deficit: Luxembourg, all the other MSs forecasted **surplus** compared to the **interim** targets within the period between 2010 and 2018.

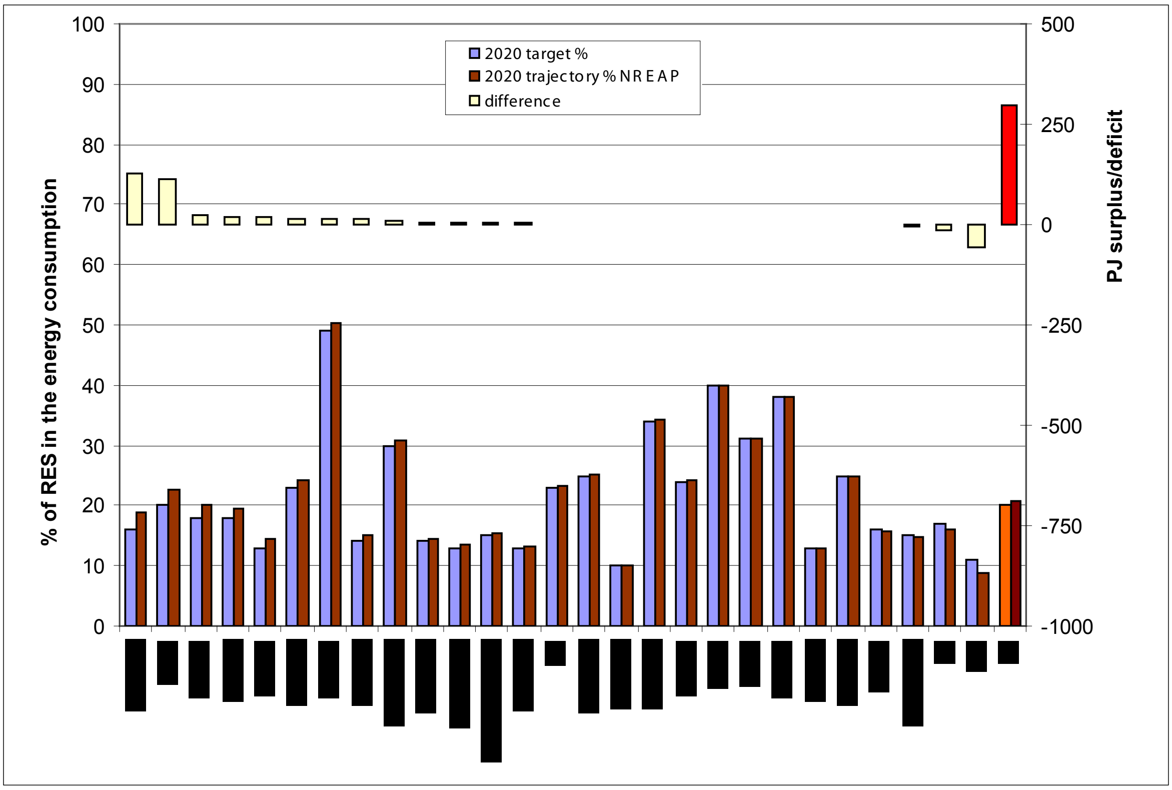


Figure 45: The indicative and NREAP share of the Renewable Energies in EU27 by 2020

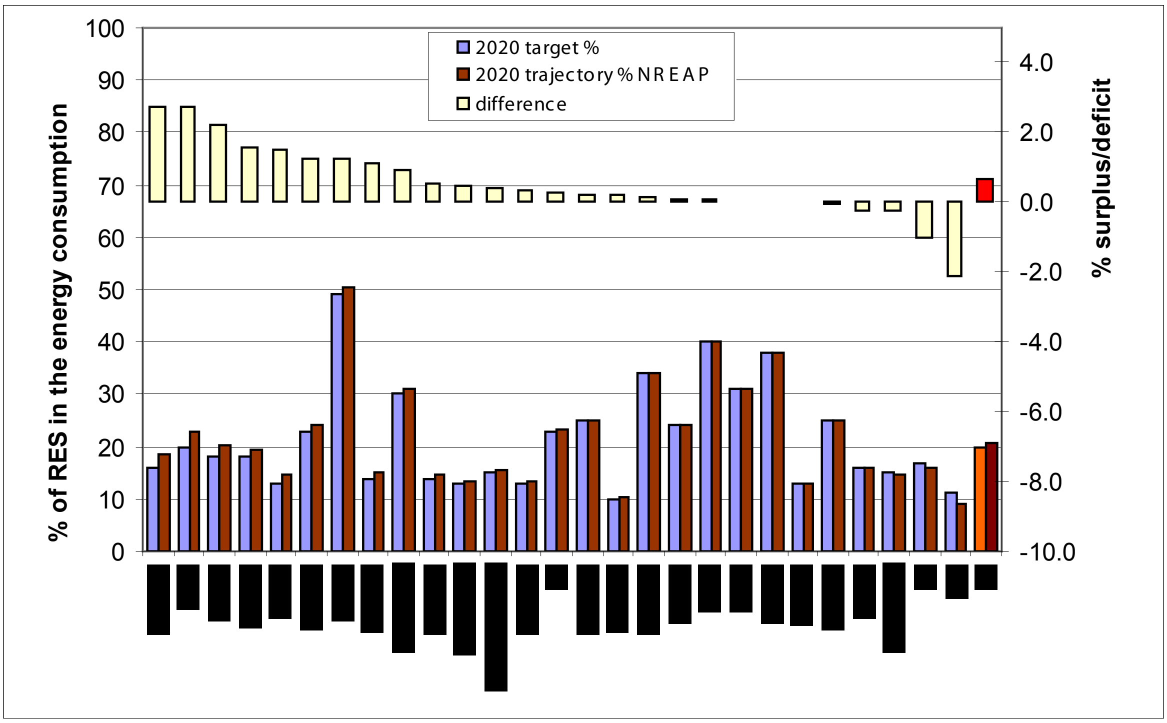


Figure 46: The indicative share of the Renewable Energies and NREAP RES surplus or deficit in EU 27 by 2020

Table 31: The interim trajected RES Surplus or deficit to the targets in the MSs

PJ	2012	2014	2016	2018	2020	2020 target % trajectory	2020 target % NREAP	difference
BE	13.33	22.23	24.54	25.59	-0.15	25	24.9	-0.1
BG	6.06	13.09	17.81	16.05	11.94	14	15.1	1.1
CZ	32.83	39.11	37.38	29.60	4.92	15	15.4	0.4
DK	34.45	46.37	38.85	27.17	6.53	14	14.5	0.5
DE	295.75	297.46	270.24	250.06	128.33	16	18.7	2.7
EE	2.97	3.95	3.25	2.63	-0.08	13	13.0	0.0
IE	17.67	22.29	18.90	13.72	-1.34	16	15.8	-0.2
EL	24.97	36.49	40.01	35.75	22.18	18	20.2	2.2
ES	150.50	174.29	179.68	174.25	110.97	20	22.7	2.7
FR	128.94	173.43	185.56	158.87	17.06	13	14.5	1.5
IT	94.95	99.90	82.69	49.33	-57.08	11	8.9	-2.1
CY	1.63	2.36	1.98	1.83	0.36	24	24.1	0.1
LV	1.26	0.49	0.75	0.77	0.12	40	40.1	0.1
LT	2.73	6.79	9.32	10.42	3.20	13	13.4	0.4
LU	-0.95	-0.41	-0.92	-1.65	-3.89	15	14.8	-0.2
HU	10.90	8.59	7.95	17.94	12.62	23	24.3	1.3
MT	0.12	0.49	0.49	0.68	0.05	31	31.0	0.0
NL	21.31	39.36	44.94	47.12	11.15	30	31.0	1.0
AT	54.92	49.70	41.17	28.63	2.03	23	23.3	0.3
PL	47.24	49.88	47.40	41.67	12.35	49	50.2	1.2
PT	38.64	34.06	32.52	28.38	0.38	34	34.2	0.2
RO	2.57	1.55	1.52	1.91	1.43	25	25.2	0.2
SI	1.77	2.93	4.02	3.94	0.47	10	10.2	0.2
SK	9.65	12.72	14.78	14.02	5.28	13	13.4	0.4
FI	6.87	8.85	9.79	12.08	-0.04	38	38.0	0.0
SE	62.98	68.12	65.52	54.77	20.36	18	19.6	1.6
UK	3.19	5.15	15.70	36.83	-13.66	17	16.0	-1.0
EU 27 total	1067.25	1219.24	1195.84	1082.33	295.52	**20**	**20.7**	**0.7**
Total surplus	1068.21	1219.65	1196.76	1083.99	371.75			
deficit	-0.95	-0.41	-0.92	-1.65	-76.23			

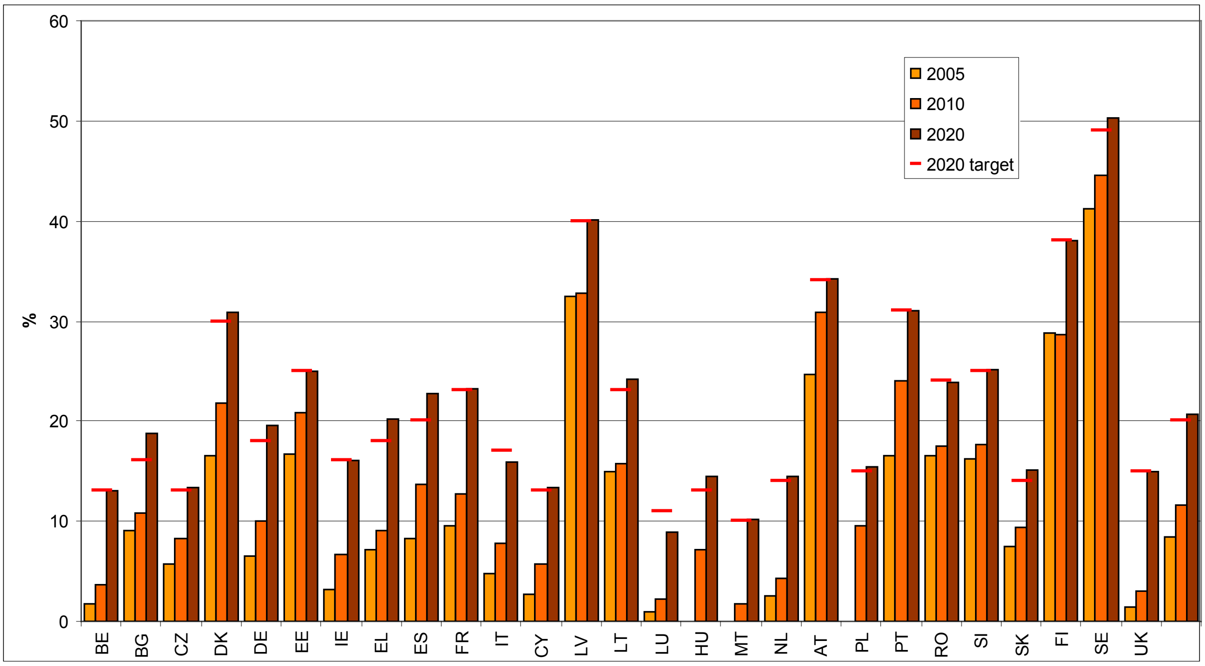


Figure 47: The share of RES in the total consumption by 2020 in EU27

4.1 Statistical transfer NREAP

In the NREAPs ten MSs reported surplus for the cooperation mechanism during the years until 2020 (Bulgaria, Germany, Denmark, Spain, Estonia, Greece, Ireland, Malta, Poland, Slovakia). Interim surplus was reported by Italy and Lithuania, however Italy reported a need for the cooperation mechanism by 2020. Luxembourg and UK expect support from the cooperation mechanism throughout the years and also by 2020.

5. Conclusion

According to the provisions of the Directive and the transmission of the templates, the National Renewable Energy Action Plans had to be submitted on 30 June 2010. However, due to a variety of circumstances, the delivery spanned the period April 2010 to February 2011. The JRC was asked by DG ENERGY to assist in the technical assessment of this large amount of data (some of the NREAPs consist of more than 100 pages). The focus in this work is the following:

- Consistency of the energy reduction assumptions with the "National Energy Efficiency Plans", delivered by the MSs in 2009/2010, which have been also evaluated by the JRC.
- Subsequent verification of the achievement of an overall EU27 target of 20%.
- Comparison of the proposed renewable resources with resource estimates done at the JRC.

Taking into account the planned actions to reduce energy consumption (- 3% compared to 2005), Europe would achieve a share of 20.7% of renewable sources by 2020, and a share of 11.7% of renewable energy for transport, if consumption would be reduced by 11% compared to 2005 levels. By 2020, only a few countries would lag behind their own national targets, however to a level which easily could be covered by the "burden-share" facility. Overall, the share of renewable sources would amount to 34% (up from 15%) for electricity generation, 21% (up from 10%) for the provision of heat and cooling, and 12% (up from 1.4%) for transport.

Most of the NREAPs indicate no reduction in electricity consumption by 2020, instead an increase, in contrast to their own National Energy Efficiency Action Plans

The plans indicate that the share of electricity from renewables would increase to 34% and be larger than the estimated share of nuclear energy in electricity generation (30%). Also renewable sources for heat show a similar increase of 71% over the ten-year period 2010-2020. Biofuels in the NREAPs are planned to be more than doubled.

Share of Renewable Energy Sources as of NREAPs; relative

	2005	2010 (from NREAP)	2020	2020/2010
Electricity	15.2%	19.4%	33.9%	+75%
Heat & Cooling	9.8%	12.5%	21.4%	+71%
Transport	1.4%	5.1%	11.7%	+129%
All sectors	8.5%	11.6%	20.7%	+78%

However, the following table shows the additional renewable sources in absolute terms, with the electricity generation exhibiting the strongest growth in energy terms.

Share of Renewable Energy Sources as of NREAPs; absolute [Mtoe]

	2005	2010 (from NREAP)	2020	2020-2010
Electricity	40.7	55.0	103.0	+48
Heat & Cooling	54.4	67.7	111.5	+43.8
Transport	3.1	14.0	29.4	+15.4
All sectors	98.5	137	244.1	+107.1

From the NREAP one can draw the conclusion that most Member States opt for Biomass as a source to achieve their national targets, which is planned to take over 57% of all renewable resources by 2020, as shown in the table below. 140 Mtoe of Biomass is 55 Mtoe (65%) more than estimated for 2010, and includes the additional 17 Mtoe of Biofuels for Transport, and an additional 10 Mtoe for Electricity generation.

Technology Pathways in 2020 according to NREAPs

	NREAP 2020 Energy [Mtoe]	Share of RES	RES Share of Energy Consumption
Hydro	30.1	12.4%	2.6%
Wind	42.5	17.4%	3.6%
Solar	15.2	6.3%	1.3%
Geothermal	15.2	6.3%	1.3%
Biomass	140	57.2%	11.9%
Other	1	0.4%	0.0%
	244	**100.0%**	**20.7%**

Assessment of available resources

The pathways the MSs envisage to achieve their national targets need a comparison with the potential for renewable energy sources in each country, in order to contribute to the recommendations the European Commission may feed back into the NREAPs. The JRC's Resource Assessment is currently limited to the major contributing technologies, namely Wind, Solar and Biomass, as for Hydro energy, practically no increase is foreseen.[18] Based on the estimate of resources, the JRC proposes some significant indicators which allow to get an overview on how strong a MS makes best use of its own resources.

Solar (JRC PV-GIS)

As a resource map, the JRC PV-GIS system is used, which, based on a detailed geographical information system (both satellite and ground-based data are used) can model the yields for all solar technologies (Photovoltaic, Concentrating Solar Power, Solar Thermal) with high resolution (100x100 m grid).

As an indicator, the per-capita density of solar panels (m2/cap) was chosen, ranging from 1.5 m2 in northern Europe to 8 m2/cap in southern Europe, both for solar PV and CSP, as well as for solar thermal. This is significantly less than half of the current roof areas and takes into account making the best use of investment.

Almost all of the Member States remain far behind this potential, sometimes even by a factor of ten. In particular, the sunniest countries exploit their potential to a much lesser extent than mid-European countries. Some countries the solar sector already achieved its 2020 target in 2010 due to a good incentive system. The considerable decrease of costs of solar technologies has not yet been sufficiently taken into consideration during the time of preparation of the NREAPs.

Wind (EEA assessment Report)

The basis for the resource assessment is a comprehensive study of the European Environmental Agency, which was calculating, also using a Geographical Information System, the wind energy potential in Europe, which is both environmentally compatible and already now cost-competitive (<60€/MWh). The report has a comprehensive table of such potential for all EU27. Our indicator is the ratio of the planned wind-capacity to these maximum values. As the EEA report put the competitive potential for wind energy in Europe onshore (not offshore), only onshore data of the plans have been used for the indicators.

18 For Geothermal energy the status of resource assessment is very fragmented.

Even though some of the windier Member States take up the opportunity to foresee a higher share of wind energy in their electricity supply, they foresee for 2020 to use only below 10% of this competitive potential. Only Austria targets 60% of its competitive potential.

Biomass

There are a variety of studies, but in order to be on the environmental impact issue on the conservative side, we chose again studies from EEA, enhanced where required by our own studies, in particular regarding sources for Biofuels.

Energy from Biomass can be generated by many pathways, can be converted to solid, liquid or gaseous forms and then used for combustion in transport and electricity generation, or for heating and cooling. Moreover, as sources, many agricultural and waste residuals can be used, together with woodchips from short rotation forestry, Biogas from manure and, most importantly, direct grown feedstock for direct ethanol or diesel production.

Consequently, there cannot be one single resource assessment, as the underlying assumptions depend on each other, and in particular on mechanisms which shift the agriculture for food or fuel balance. The indicators reveal that the proposed fraction of Biomass-based energy will almost certainly exceed the limits, given by current food production or use of wooden resources. Consequently, a large amount of the Biomass resources will need to be imported (otherwise more food would need to be imported).

Possibilities for exchange mechanism

Some of the MSs has indicated the possibility for statistical exchange and rely on the exploitation of own resources. Some Member States which would not achieve their targets, prescribed by the trajectory, indicate the requirement for this exchange, but with no detail. As an overall objective of 20% energy from renewable resources to be met by the sum of all MSs' targets, there is this possibility to negotiate such a statistical exchange.

The strong focus on Bioenergy

A more detailed assessment of the envisaged use of biomass for energy production is still required and pending, taking into account the problems indicated as before. This should allow to assess more precisely the impact on the agricultural system in Europe, the availability of 2nd generation Biofuel plants and the consequences for agricultural exports/imports. From the NREAPs, one can already, as of now, determine the most probable ratio between bio-ethanol and bio-diesel production (about 3:1).

Transport Targets by Biofuels and Electric / H2 vehicles

From the NREAPs one can deduce that there is very little scope for renewable sources of energy for transport other than rail. If 2.5 % of the current fleet of passenger cars in Europe (~200 Mio.) were to be powered by electricity from renewable resources, one percentage point of the 10% target for transport energy would be replaced by renewable electricity. However, current policies on electro-mobility and the rapid progress of Li-based battery technology may well lead to the required amount of 5 Mio cars.

6. List of references

[1] Directive 2009/28/EC on the promotion of the use of energy from renewable energy sources

[2] NREAP Forecast Documents: http://ec.europa.eu/energy/renewables/transparency_platform/forecast_documents_en.htm

[3] Renewable Energy Snapshots 2010. EUR 24440 EN. ISBN 978-92-79-16287-

[4] National Renewable Energy Action Plans: http://ec.europa.eu/energy/renewables/transparency_platform/action_plan_en.htm

[5] (2009/548/EC) COMMISSION DECISION of establishing a template for National Renewable Energy Action Plans under Directive 2009/28/EC http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32009D0548:EN:NOT

[6] Europe's onshore and offshore wind energy potential, EEA Technical Report No 6/2009. ISSN 1725-2237

[7] How much bioenergy can Europe produce without harming the environment? EEA Report No 7/2006

[8] EREC Renewable Energy Roadmap 20% by 2020

[9] http://eepotential.eu/esd.php

[10] Study on the Energy Savings Potentials in EU Member States, Candidate Countries and EEA Countries Final Report for the European Commission Directorate-General Energy and Transport EC Service Contract Number TREN/D1/239-2006/S07.66640. Karlsruhe/Grenoble/Rome/Vienna/Wuppertal, 15. March 2009, revised

[11] MURE simulation tool http://www.mure2.com/

[12] PRIMES energy trends: http://ec.europa.eu/energy/observatory/trends_2030/index_en.htm

[13] NEEAPs: http://ec.europa.eu/energy/efficiency/end-use_en.htm

[14] PVGIS solar irradiation maps. http://re.jrc.ec.europa.eu/pvgis/cmaps/eu_opt/

[15] Arnulf Jager-Waldau: PV Status Report 2010. Research, Solar Cell Production and Market Implementation of Photovoltaics JRC 59708, Scientific and Technical report , EUR 24344 EN – 2010, ISBN 978-92-79-15657-1

[16] Renewable Energy Snapshots 2010. EUR 24440 EN. ISBN 978-92-79-16287-

[17] ECOFYS study: http://www.ecofys.nl/com/publications/documents/Report_global_potential_of_renewable_energy_sources_a_literature_assessment.pdf

[18] grid operator data: https://www.entsoe.eu/index.php?id=137

[19] AEBIOM, European Biomass Statistics 2009

[20] ECN and EEA, Renewable Energy Projections as Published in the National Renewable Energy Action Plans of the European Member States, 2010

[21] Biomass Energy Europe – BEE project, http://www.eu-bee.com/default.asp?SivuID=24156

[22] EurObserv'ER, The state of renewable energies in Europe 2010, 10th EurObserv'ER Report

[23] DIRECTIVE 2006/32/EC on energy end-use efficiency and energy services (ESD)

[24] CEN standard heat pump as in EN 15316-4.2

[25] EGEC European Geothermal Energy Council www.egec.org

[26] K4RES-H. Key Issues for Renewable Heat in Europe http://www.erec-renewables.org/projects

[27] Solar Thermal Markets in Europe 2008. European Solar Thermal Industry Federation www.estif.org/statistics/st_markets_in_europe_2009/

[28] EurObserve'ER,January 2010, http://www.eurobserver.org/pdf/2010_Eurostat_Comparison.pdf

[29] Potential of Solar Thermal in Europe. W. Weiss AEE, Austria. RESTMAC TREN/05/FP6EN

[30] http://wds.iea.org/WDS/TableViewer/dimView.aspx?ReportId=1399

[31] Role and Potential of Renewable Energy and Energy Efficiency for Global energy Supply. Climate Change 18/2009. Environmental Research of the German Federal Ministry of the Environment

[32] Faaij, A.P.C., 2006. Bio-energy in Europe: changing technology choices, Energy Policy 34 (2006) 322 – 342

[33] Koop K., Koper M., Bijsma R., Wonink S., Ouwens J.D., 2010. Evaluation of improvements in end-conversion efficiency for bioenergy production

[34] Siemons R., Bio-energy's role in the EU energy market. A view of developments until 2020. BTG Report to the European Commission, 2004

[35] Thornley, P., Upham, P., Huang, Y., Rezvani, S., Brammer, J. & Rogers, J., Integrated assessment of bioenergy technology options, Energy Policy, 37 (2009) 890-903

[36] US Environmental Protection Agency, 2007. Biomass combined heat and power catalogue of technologies

7. Annex

7.1 Glossary

Gross final energy consumption – represents the energy supplied in industry, transport, households, the service sector, including the public sector, agriculture, forestry and fishery, including the electricity and heat consumed by the energy sector for the electricity and heat production and losses of electricity and heat in distribution and transfer (as defined in the RES Directive).

Final energy consumption is the total energy consumed by end users, such as households, industry, agriculture, transport, services, others. It is the energy which reaches the final consumer and excludes that which is used by the energy sector itself.

Gross inland energy consumption is the total energy demand of a country or region, which is necessary to satisfy inland consumption of that entity.

Primary energy consumption is the total consumption of a country or region, of energy that has not been subjected to any conversion or transformation process after extraction, that is the energy contained in raw fuels as well as other forms of energy received as input to a system.

Biomass potential: the amount of biomass which is available for energy production in a country of region. Various types of biomass potentials can be distinguished: theoretical, technical, economic, implementation and environmentally or ecologically sustainable potentials.

Nominal capacity of solar thermal collectors - Nominal Capacity of glazed flat plate collectors and evacuated tubular collectors are the instantaneous thermal output of the collector under specific operation conditions: 1000 W/m^2, 20 °C.

Specific Nominal Capacity of a collector is the nominal capacity divided by its exposed aperture (absorber) area.

7.2 Units and conversion factors

General conversion factors for energy

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

7.3 Detailed RES figures, tables

	2005*	2010	2011	2012	2013	2014
Hydro	1180.87	1204.79	1203.53	1208.09	1213.97	1221.08
Geothermal	37.84	49.89	55.35	60.69	67.63	75.73
Solar total	35.04	132.90	183.48	222.67	261.77	302.26
Solar electricity	6.57	76.90	114.19	142.68	168.26	193.70
PV	6.60	72.74	104.41	125.99	145.83	166.16
CSP	0.00	4.16	9.78	16.69	22.43	27.54
Solar thermal	28.47	56.00	69.29	79.98	93.51	108.57
Marine	1.93	1.81	1.81	2.08	2.36	2.72
Wind total	256.79	594.28	686.84	783.44	891.12	1003.34
onshore	241.40	557.02	634.32	705.07	772.04	845.62
offshore	6.94	30.74	42.07	62.67	97.41	130.84
Heat pump	25.83	168.64	197.13	226.59	249.96	275.52
Biomass	2455.41	3002.62	3126.16	3250.84	3397.04	3535.87
Biofuel	125.51	583.71	637.33	687.86	705.86	769.87
Total RES	**4119.22**	**5738.65**	**6091.63**	**6442.25**	**6789.70**	**7186.38**

** MT and HU did not report the RES generation data for 2005*

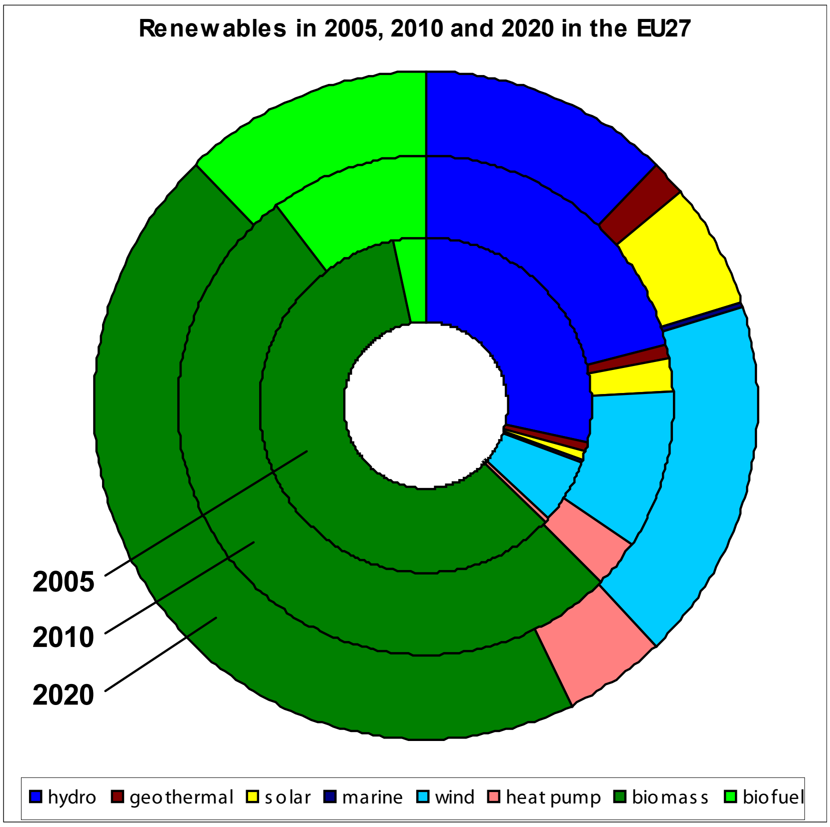


Figure 48: RES breakdown by source in EU27 from 2005 to 2020 in PJ

	2015	2016	2017	2018	2019	2020	CAGR 2020/2010
Hydro	1225.10	1228.91	1240.94	1246.90	1254.68	1265.04	0.5
Geothermal	83.04	94.78	106.37	120.34	132.66	149.40	11.6
Solar total	345.91	396.00	448.97	507.20	569.25	639.22	17.0
Solar electricity	219.43	247.04	275.72	305.88	338.29	373.19	17.1
PV	186.77	208.17	230.16	252.86	276.40	301.10	15.3
CSP	32.66	38.87	45.56	53.02	61.89	72.09	33.0
Solar thermal	126.48	148.96	173.25	201.32	230.96	266.03	16.9
Marine	3.12	6.09	9.32	12.55	16.78	21.64	28.2
Wind total	1114.56	1236.05	1365.82	1504.05	1634.87	1786.07	11.6
onshore	917.92	980.07	1041.45	1110.72	1170.51	1237.77	8.3
offshore	165.66	216.54	277.28	339.76	404.61	483.08	31.7
Heat pump	304.42	338.01	373.59	414.19	455.98	510.37	11.7
Biomass	3682.44	3846.86	4026.45	4208.20	4434.50	4635.95	4.4
Biofuel	820.97	878.58	975.12	1043.22	1105.22	1231.31	7.8
Total RES	**7579.54**	**8025.28**	**8546.59**	**9056.65**	**9603.94**	**10239.00**	**6.0**

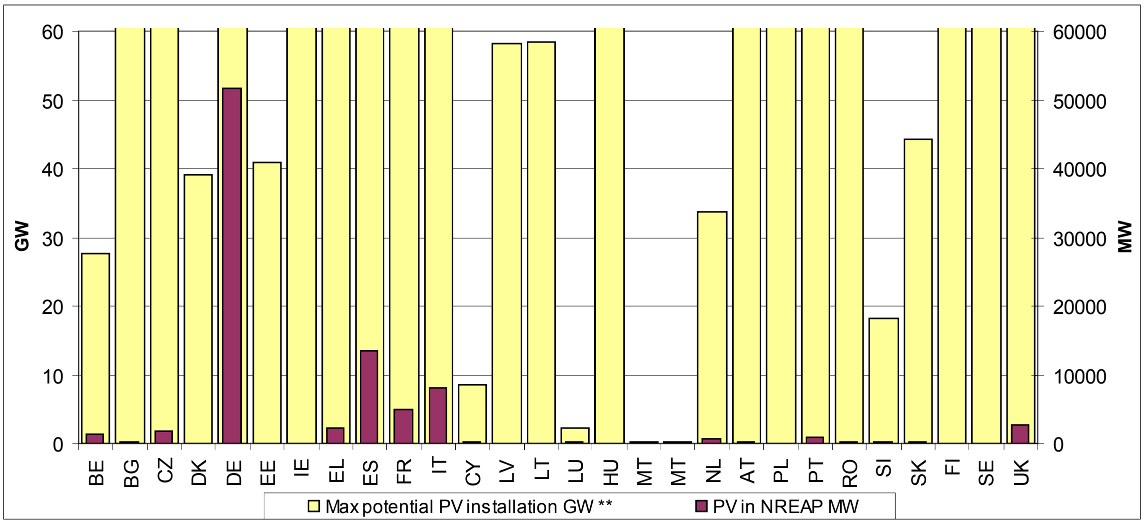


Figure 49: PV potential and NREAP data in 2020 by the Member States

7.4 Abbreviations

NREAP – National Renewable Energy Action Plan

NEEAP – National Energy Efficiency Action Plan

MS – Member State

H&C – Heating and Cooling

AEE – Additional Energy Efficiency Scenario

REF – Reference Scenario

ESTIF – European Solar Thermal Industry Federation

EEA – European Environment Agency

AEBIOM – European Biomass Association

EREC - European Renewable Energy Council

CHP – Combined Heat and Power

CSP – Concentrated Solar Power

CAGR – Compound Annual Growth Rate

AMD – Advanced Market Deployment Scenario

BAU – Business as Usual scenario

RESTMAC – EU RES Technology Marketing Campaigns

RDP – Full R&D and Policy scenario

COP – Coefficient of Performance

LPI - Low Policy Intensity

STCF - solar thermal conversion factor

7.5 List of Tables

7.6 List of figures

European Commission

EUR 24926 EN – Joint Research Centre

Title: **Technical Assessment of the Renewable Action Plans**

Authors: Márta Szabó, Arnulf Jäger-Waldau, Fabio Monforti-Ferrario, Nicolae Scarlat, Hans Bloem, Michel Quicheron, Thomas Huld, Heinz Ossenbrink

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Abstract

The JRC Reference report is a summary of an analysis on the evaluation and overview of the National Renewable Energy Action Plans (NREAP) from the technical and resource feasibility point of view including the verification of comparability across member states, and consistency with the National Energy Efficiency plans.

The report summarize the results of the analysis on the evaluation about the foreseen national renewable energy targets related to availability renewable energy resources and in terms of technologies envisaged, with establishing an indicator-based assessment of targets, consistency checks and analysis by consumption type (electricity, heating & cooling, transport), evaluation of how far the additional energy efficiency scenarios are taken into account to reach the national goals and trajectories. The goal of the analysis and the report was also to establishment of figures of merit for the baseline data which can serve for further references and modeling, including economic impact.

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