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Glossary

Abbreviation	Explanation
CHP	Combined Heat and Power
DH	District Heating
DSO	Distribution System Operator
ECJ	European Court of Justice
EED	Directive 2012/27/EU: Energy Efficiency Directive
EIA	Environmental Impact Assessment
EPBD	Directive 2010/31/EU on the energy performance of buildings
ETS	Emissions Trading System
GHG	Greenhouse Gas
GW	Gigawatt
HP	Heat Pump
HVO	Hydrotreated Vegetable Oils
ILUC	Indirect Land Use Change
Ktoe	Kilotons of oil equivalent
kW	Kilowatt
kWp	Kilowatt Peak
NGO	Non-Governmental Organisation
NREAP	National Renewable Energy Action Plan
MS	Member States
Mtoe	Million tons of oil equivalent
MW	Megawatt
PV	Photovoltaic
R&D	Research and Development
RED	Directive 2009/28/EC
RES	Renewable energy sources
RES Directive	Directive 2009/28/EC
RES-E	Renewable energy sources in electricity
RES-HC	Renewable energy sources in heating and cooling
RES-T	Renewable energy sources in transport
RES-share	Renewable energy share (on gross final energy consumption)
ST	Solar thermal
TSO	Transmission System Operator
UCO	Used Cooking Oil
AT	Austria
BE	Belgium
BG	Bulgaria
HR	Croatia
CY	Cyprus
CZ	Czech Republic
DK	Denmark
EE	Estonia
FI	Finland
FR	France
DE	Germany
EL	Greece
HU	Hungary
IE	Ireland
IT	Italy

LV	Latvia
LT	Lithuania
LU	Luxembourg
MT	Malta
NL	Netherlands
PL	Poland
PT	Portugal
RO	Romania
SK	Slovakia
SI	Slovenia
ES	Spain
SE	Sweden
UK	United Kingdom
EU-28	EU-28

Abstract

The objective of this study is to provide technical assistance in the preparation of the 2016 Report on Renewable Energy, in preparation of the Renewable Energy Package for the period 2020-2030 in the European Union. Key findings are:

Renewable energy sources (RES) are deployed by all EU Member States in the electricity, heating & cooling and transport sectors. This study provides insights into the level of deployment and the utilisation of different RES technologies in the EU-28 including an outlook towards 2020, both overall and on the sector level. The average renewable energy share (RES share) in the EU-28 gross final energy consumption in 2013-14 was 15.5 %, exceeding the indicative trajectory for 2013/2014 set out in the Renewable Energy Directive (RED) by almost a third. According to preliminary estimates, a 16.4 % share for 2015 is also well above the 2015/2016 indicative trajectory set out in the RED.

Member States have addressed non-economic barriers since the introduction of the Renewables Directive. However, across Member States and sectors various non-economic barriers can still be found, for example due to permitting procedures. Such barriers hamper the deployment of renewable energies: they entail costs for project developers, lead to delays in deployment or can even prevent projects from being realised and thus reduce overall deployment. A range of measures is presented by sector for reducing non-economic barriers.

Synthèse

La présente étude vise à fournir une assistance technique pour l’élaboration du Rapport 2016 sur les énergies renouvelables en préparation du « paquet énergies renouvelables » pour la période 2020-2030 dans l’Union européenne. Ses principales conclusions sont les suivantes :

Les sources d’énergie renouvelables sont déployées par tous les États membres de l’Union européenne dans les secteurs de l’électricité, du chauffage et du refroidissement et des transports. Cette étude offre un aperçu du niveau de développement et d’utilisation des différentes technologies liées aux énergies renouvelables dans l’UE des 28 ainsi que des perspectives globales et sectorielles à l’horizon 2020. En 2014, la part moyenne des énergies renouvelables dans la consommation finale brute d’énergie de l’UE des 28 s’élevait à 15,5 %, dépassant de près d’un tiers la trajectoire indicative fixée par la directive sur les énergies renouvelables pour la période 2013/2014. En 2015, selon les estimations préliminaires, cette part s’élèverait à 16,4 %, ce qui est à nouveau bien au-dessus de la trajectoire indicative fixée pour 2015/2016.

Les États membres se sont employés à résoudre les obstacles non économiques depuis l’adoption de la directive sur les énergies renouvelables. Cependant, divers freins subsistent encore au sein des États et dans les différents secteurs, dus notamment aux procédures de délivrance de permis. Ces obstacles entravent le déploiement des énergies renouvelables de plusieurs façons : ils génèrent des coûts pour les développeurs de projets, entraînent des retards dans le déploiement et peuvent même empêcher la réalisation de certains projets limitant ainsi le déploiement global. Le présent rapport expose une série de mesures par secteur afin de réduire ces obstacles non économiques.

Executive Summary

The objective of this study is to provide technical assistance in the preparation of the 2016 Report on Renewable Energy, in preparation of the Renewable Energy Package for the Period 2020-2030 in the European Union. This assistance includes:

- data collection, analysis and assessment of the progress in deployment of renewable energy sources, and national measures promoting such deployment, in the 28 EU Member States on the basis of statistical data from Eurostat, Member State Renewable Energy Progress Reports submitted in 2015, other reports and studies, and own research (task 1);
- modelling of Member State and EU progress towards 2020 (task 1);
- an analysis of non-economic barriers and incentives for the deployment of RES (task 2).

Summary Task 1: Current and projected progress in deploying renewable energy sources

Renewable energy sources (RES) are deployed by all European Member States, at different levels and through a combination of different sources. The level of deployment and the utilisation of different renewable technologies can be explained by various factors, such as the political context and the geographic location. The latter not only influences the feasibility to utilise renewable energy sources due to the topography of a country, but also due to its climatic conditions.

The Reneweable Energy Directive (Directive 2009/28/EC; short: RED) provides, for the EU-28 and each Member State, legally binding target renewable energy shares (RES shares)[1] for 2020. From it, an indictative trajectory of renewable energy shares until 2020 can be derived by Member State and for the EU-28.

In view of this, in 2010, all Member States provided National Renewable Energy Action Plans (NREAPs) in which they laid out in detail how they excpect their RES deployment to develop until 2020 in order to meet these targets. The NREAPs depict, also on technology level, how Member States anticipated in 2010 their renewable energy trajectories to develop until 2020. Aggregating these individual NREAP anticipations helps to provide insights into the anticipated RES deployment on EU-28 level.

EU-28

The EU-28 RES share reached 16.0 % of gross final energy consumption in 2014, exceeding the indicative trajectory derived from the RED for 2013/2014 by almost a third. According to preliminary estimates, a 16.4 % share approximated for 2015 is also well above the 2015/2016 indicative trajectory set out in the RED.

Deployment of RES contributes to energy security by reducing the reliance on imported fossil fuels. It is estimated that the renewable energy consumption growth after 2005 has roughly avoided the import of about 64 Mtoe of fossil fuels in 2014 worth €18bn. Taking into account approximated 2015 renewable energy use would increase this value to about 71 Mtoe compared to 2005 levels.

The PRIMES EU Reference Scenario 2016 projects the EU-28 share of RES to be 21 % in 2020, which represents an upper bound projection of likely developments in the RES sector. This exceeds the 2020 target RES share of 20 %. The fossil fuel imports displaced by the projected RES consumption in 2020 are estimated at 136 Mtoe, amounting to approximately €42 bn.

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[1] Renewable energy shares are expressed as shares on gross final energy consumption and calculated according to specific calculation rules, also laid out in the Renewable Energy Directive.

The highest RES share can be found in the **electricity sector** where it grew by 1.3 percentage points per year between 2004 and 2014 and reached 27.5 % in 2014. The RES shares in the **heating and cooling sector** grew by 0.8 percentage points over the same period of time to 17.7 %. Approximated values for 2015 indicate that these historical trends are likely to continue. Both sectors exceeded the trajectory derived from NREAPs during the whole period. **Transport** is the only sector with a RES share target for 2020 under the RED (10 %). Of all sectors, it exhibited the slowest growth of RES with 0.5 percentage points on average per year from 2005-2014 and has slowed down markedly since 2011, when accounting rules for compliant biofuels in the RED changed. Its renewable energy share was 5.9 % in 2014 (and estimated at only 6.0 % in 2015). The transport sector thus fell short of the aggregated, planned NREAP trajectory in all years.

Differences between the three sectors are caused by their different CO_2 abatement costs and different sector structures.

The **electricity sector**, for example, benefits from long-standing political attention. Due to technological progress, favourable technologies already exhibit relatively low CO_2 abatement costs and are readily available. Investment decisions are relatively centralised, and do not depend as much on individual decisions as in the residential or transport sector.

Progress in **heating and cooling** is slower because consumption is higher on overall[2] and relatively decentralised with longer-term investment required. Ownership and decision making is more distributed than in electricity and up to today political attention has been lower. Naturally, the RES-share in the heating and cooling sector varies due to climatic conditions, benefiting from mild winters and efforts made by countries to reduce the heating and cooling consumption through incentives for energy efficient behaviour. Compared to renewable electricity, zero-carbon technologies are, to date, not as readily available, leading to higher abatement costs for CO_2 than in the electricity sector.

The relatively slow growth of RES in **transport** can mainly be explained by relatively high CO_2 abatement costs, long legislative debates and uncertainty about the future regulation of non-competitive alternative fuels.

The EU Reference Scenario 2016 projects sectoral RES shares in 2020 to stand at 35.5 % for electricity and 22 % for heating and cooling. This means that the EU-28 aggregation from anticipated NREAP trajectories for electricity and heating / cooling will be met if growth continues at current pace. The EU Reference Scenario 2016 also exceeds the binding target for RES in transport by one percentage point at 11 %, as by construction all Member States reach at least their renewable transport targets, while some Member States, based on already adopted policies, go beyond. However, the scenario shows a much steeper trajectory between 2015 and 2020, implying that decisively increased efforts are needed in order to meet the 2020 target.

Member State progress

All but one Member State (the Netherlands) exhibited average 2013/2014 RES shares which were equal or higher than their corresponding indicative trajectory derived from the Renewable Energy Directive.

According to preliminary estimates, 25 Member States exceeded their 2015/2016 indicative RED trajectories in 2015. Three Member States (France, the Netherlands and Luxembourg) exhibited

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[2] Thus more RES capacity has to be deployed for every additional percent of RES share.

2015 RES shares below their 2015/2016 indicative trajectory derived from the Renewable Energy Directive.

On a more forward-looking perspective, projections show that the EU as a whole would reach its 20% target by 2020. However, some Member States such as Ireland, Luxembourg, the Netherlands and the United Kingdom might have to reinforce cooperation with other Member States by using cooperation mechanisms such as statistical transfers to timely reach their national binding targets.

Preliminary estimates for 2015 indicate that thirteen Member States stayed below their planned NREAP trajectory in 2015. A closer analysis of the RES share evolution reveals that during the last years (2014 and 2015) the European trend was mainly initiated by the reduction of electricity consumption across the EU. The 2014 increase and the approximated growth for 2015 in the renewable electricity share mask weaker momentum than in the past. Most of the major European Union players that had decided to develop their renewable electricity sectors reduced their investment budgets.

In the heating and cooling sectors approximations for 2015 indicate that 25 Member States have exceeded their plans for that year. The evolution of heating and cooling demand each year not only depends on technological progress, the legal framework and willingness for change, but also on climatic conditions. For example, 2011 and 2014 were characterized by mild winters, which required lower heating consumption compared to other years. The same held true for 2015. During these years, the consumption of renewable heating and cooling dropped but not as much as overall heating and cooling consumption did. This is coupled with efforts made by countries to reduce the heating & cooling consumption through incentives which foster energy efficient behavior.

In the transport sector, 8 Member States are estimated to have been in line or above their anticipated NREAP trajectories in 2015. In general, the development of RES shares in the transport sector is much slower than in the other sectors due to its challenging nature: it currently exhibits relatively high mitigation costs and also faces political uncertainty. The development of biofuels, in the EU, for example, was impaired from 2013 onwards by the long legislative debate that lasted from October 2012 (adoption of the Commission's legislative proposal) to September 2015 (adoption of the ILUC Directive): The Renewable Energy and Fuel Quality Directives required the Commission to examine the potential impact of indirect land use on greenhouse gas emissions arising from increasing land use due to first generation biofuels' feedstock production, also called the ILUC effect[3]. The final text of the ILUC directive was adopted only on 9 September 2015. As a result of this lengthy process, Members States took national, uncoordinated stances on their incorporation rates of second generation biofuel developments. Some of them revised their incorporation rates of first generation biofuels.

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[3] ILUC effect: Indirect Land Use Change impacts from biofuels

Summary Task 2: Analysis of non-economic barriers

Across Member States and sectors various non-economic barriers can be found, for example due to permitting procedures.

RES-E

Overall in the electricity sector, non-economic barriers have been addressed by Member States since the introduction of the Renewables Directive. However, non-economic barriers still represent a relevant problem for the deployment of RES-E across the EU, and in most Member States several non-economic barriers persist. There are also still significant differences between Member States in terms of the implementation of measures to reduce non-economic barriers.

Non-economic barriers mainly result from the planning and permitting process. This is a key non-economic barrier for RES-E and is considered an important issue across Member States, even though the permitting regimes can differ significantly. Even in Member States where a well-established permitting regime is in place, the permitting for RES-E plants is a highly relevant issue.

Another issue is the grid integration of RES-E. This relates to the grid integration process for individual plants, yet increasingly also to the development of the overall grid capacity.

There is evidence that barriers in the planning and permitting process increase the costs of RES-E and reduce deployment. There are also new issues and conflicts emerging in the permitting process of RES-E projects, such as increasing environmental constraints and conflicts with other users, such as radar stations. These issues make it all the more important to make the permitting process as efficient as possible, so that such new conflicts do not increase the non-economic barriers that result from permitting.

Some barriers are more widespread than others and some measures have been implemented less than others across the EU. Yet it is important to note that the relevance of barriers and the impacts of measures also differ.

One-stop-shops for the permitting of renewables have not been implemented in the majority of Member States. One-stop-shops are generally an important element of administrative best practice and the absence of a one-stop-shop can increase the planning duration and also project costs.

Another measure that has not been implemented in a majority of Member States are automatic permissions after a deadline has passed. However, the positive impact of this measure is more controversial than in the case of one-stop-shops, especially if it is not limited to small-scale plants.

Permitting time limits have been implemented in the majority of Member States. Again, this is an important best-practice element of an efficient permitting regime. Without such a time limit applicants cannot be sure about when to expect a permit. This is especially problematic if an automatic degression of support rate is applied, which leads to a reduction of calculated project revenues due to project delays. Time limits can only be indicative, but they should still reflect an efficient permitting time and measures need to be in place to enable authorities to meet the time limits. Therefore, while time limits are important, the fact that a time limit is in place as such does not guarantee that there are no barriers left, but the proper implementation of the time limit and the corresponding administrative structure needs to be ensured.

A large majority of Member States has implemented facilitated procedures for small scale projects. Despite this progress, further provisions on the EU level may not just aim at introducing measures in individual Member States, but also at converging national provisions, so that a European-wide market is facilitated.

RES-HC

Deployment levels of RES-HC technologies as well as changes in deployment levels in recent years differ widely across Member States (see Task 1). In Task 2, we looked specifically at non-economic barriers affecting these deployment levels.

Our analysis found that *low public perception of RES-HC technologies* shows the greatest presence as a barrier affecting around 65% of Member States, closely followed by a *lack of reliable advice* and a *lack of skilled professionals* with 61% each. There are three barriers affecting around 50% of all EU Member States: *insufficient implementation of Art. 13(4) of the RED*, non-mandatory *RES use in public buildings* and a *lack of information*. Around 45% of Member States are affected by *complex procedures to facilitate grid access/ connection.* Three barriers affect 30% to around 40% of Member States, namely: *Insufficient accredited qualification and training programmes*, *split incentives*, as well as a *lack of compliance and quality control by the authorities*.

It is important to bear in mind that the frequency with which barriers are mentioned for the different Member States may only be a lower estimate. This is due to the fact that it was outside the scope of this study to conduct interviews in each Member State, as well as the fact that not all Member State progress reports address RES-HC non-economic barriers. Even though Member States are obliged to report on legal and other barriers that hamper the deployment of RES in Art. 22(1e), most limit the description of these barriers on RES-E without addressing RES-HC. In fact, less than half of all Member States report on non-economic RES-HC barriers in their progress reports. There is an obvious need for improvement here in order to assess non-economic RES-HC barriers more thoroughly.

The results of a semi-quantitative analysis of the deployment barriers show that all considered barriers have medium to medium-high effects. Even though individual barriers have different effects in different Member States, the results show that all barriers are considered to be more or less equally important on the overall EU level with no particular barrier dominating. On a Member State level, however, differences do exist, which should be taken into consideration when discussing individual Member State recommendations. The barrier *low public perception of RES-HC technologies*, for instance, is considered to have a low-medium effect in Germany and Lithuania, a medium effect in Austria, the Czech Republic and Finland, but a medium-high effect in Spain, Romania and the UK.

The assessment provides an important picture of where problems and barriers do exist. Some of these barriers have already been addressed by the RED, but in many cases the implementation and/or requirements could be improved. The perceived *lack of reliable advice* as well as the *lack of skilled professionals*, for instance, could be further addressed by strengthening Art. 14(3). Here the qualification/certification requirement should be extended to all professionals in the buildings sector in order to make sure that all of these professions develop a sensitivity towards the special requirements for RES-HC technologies.

Finally, it is important to note that the non-existence of binding EU-wide targets for RES-HC until 2030 is perceived to be a major barrier (Öko-Institut own research). Such targets would ensure that governments, developers, producers and other stakeholders can plan ahead and devise strategies on how to reach these targets. The lack of a comprehensive long-term strategy for RES-HC deployment in individual Member States is also highlighted as a barrier in various literature sources (cf. Öko-Institut own research). Additionally, many stakeholders and literature sources acknowledge the fact that financial barriers are the single most dominant barrier when it comes to deploying RES-HC technologies in the EU.

RES-T

In addition to the evaluation of the existing literature, research was conducted on the presence of non-economic barriers in the European Member States on the basis of the 2015 progress reports, other literature and stakeholder interviews, that were conducted in early 2016

The main non-economic barrier for further deployment of RES in transport is the missing regulatory framework for the post 2020 period (81%) and the discussions about significant changes of the regulation in the past (71%). Both increase the investment risk for producers and have been identified by literature and stakeholder interviews as the most relevant non-economic barrier for further renewable energy deployment in transport.

Missing public and consumer acceptance is another relevant non-economic barrier for RES deployment in transport. Various public and consumer concerns about biofuel use are indicated in more than 70% of the Member States. The most relevant concerns are the impact of biofuels on indirect land-use (36%) and the fear of damaged engines (43%). Both have been indicated as a relevant reason for non-deployment of biofuels in several Member States. Also the tank vs. food debate is mentioned as a public concern (30%). Stakeholders consider the low acceptance of biofuels as an important issue, yet less relevant than the investment risks which were stated above. However, the impact on deployment and the reasons for public concerns differ strongly between Member States.

Barriers for alternative technologies as well as for higher biofuel blends are also relevant. In 2014 RED (2009/28/EC) required that biofuels produced from wastes and and residues and non-food cellulosic and lingo-cellulosic material had to be counted twice for demonstrating compliance with supply obligations and for achieving the 10% target of renewable energy in transport (former Art. 21.2). This incentive has not been implemented into national legislation in seven Member States (25%). Implementation in all Member States would increase the market potential of advanced biofuels.

Standards for higher biofuel blends will be necessary if higher biofuel targets will be set for the post 2020 period. The lack of these EU-wide standards is a relevant barrier in 52% of the Member States and might become an issue for the post 2020 period. Other drive technologies such as methane and electric vehicles require a sufficient charging and fuelling infrastructure. Most Member States have not brought these technologies into focus in their transport sector strategy until recently. The lack of the required energy infrastructure for these technologies is considered as a barrier in almost 90% of Member States in which information about the infrastructure of alternative drive technologies was accessible. The potential lack of (domestic) sustainable feedstock has been identified in 36% of the Member States as a barrier for RES-T.

However, the RED (2009/28/EC) has been amended by the ILUC directive (2015/1513/EU) which was adopted on 9 September 2015 and entered into force on 5 October 2015. The main changes are the addition of a 7% limit for crop-based biofuels, the introduction of increased, new multipliers for renewable electricity in road transport and in rail transport, and an indicative target for advanced biofuels with a reference value of 0.5% of transport energy consumption. The ILUC directive introduced a positive list of feedstocks determining the types of fuels that benefit from this provision (Art. 21.2. was deleted). The Member States have time for transposition in national legislation until 10 September 2017.[4] No Member State has yet transposed all requirements of the ILUC directive [1] even though some countries transposed parts[5] of the ILUC directive. Thus, the impact of the ILUC directive cannot be considered in this report.

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[4] The national targets for advanced biofuels have to be implemented by April 2017.

[5] Spain has implemented the 7% limit for crop-based biofuels; Italy has set a national target for advanced biofuels. Denmark, France and the Netherlands proposed bills for advanced biofuel targets which have to be officially agreed on.

Résumé

La présente étude vise à fournir une assistance technique pour l'élaboration du Rapport 2016 sur les énergies renouvelables, en préparation du « paquet énergies renouvelables » pour la période 2020-2030, dans l'Union européenne. Cette assistance comprend :

- la collecte de données, l'analyse et l'évaluation des progrès concernant le déploiement des sources d'énergie renouvelables et les mesures nationales visant à promouvoir ce déploiement dans les 28 États membres de l'UE sur la base des données statistiques d'Eurostat, des rapports de situation sur les énergies renouvelables soumis en 2015 par les États membres, d'autres rapports et études sur les sources renouvelables en Europe (Tâche 1) ;
- la modélisation des progrès accomplis par les États membres et l'UE en vue d'atteindre les objectifs fixés pour 2020 (Tâche 1) ;
- une analyse des obstacles non économiques et des incitations au déploiement des sources d'énergie renouvelables (Tâche 2) ;

Résumé Tâche 1 : Progrès actuels et perspectives concernant le déploiement des sources d'énergie renouvelables

Les sources d'énergie renouvelables sont déployées par tous les États membres de l'Union européenne, à différents niveaux et au travers de différentes combinaisons des secteurs. Le niveau de déploiement et d'utilisation des différentes technologies renouvelables peut varier en fonction de facteurs tels que le contexte politique ou la localisation géographique. Ce dernier facteur influe sur la faisabilité de l'exploitation des sources d'énergie renouvelables, en fonction non seulement de la topographie mais aussi des conditions climatiques du pays.

La Directive sur les énergies renouvelables (Directive EnR 2009/28/CE) définit, pour l'UE dans son ensemble et pour chacun des États membres, des objectifs contraignants concernant la part d'énergie d'origine renouvelable dans le mix énergétique[6] à l'horizon 2020. Cela permet ainsi de fixer une trajectoire indicative pour chacun des États membres et pour l'ensemble de l'UE, jusqu'en 2020.

Ainsi, en 2010, tous les États membres ont soumis des plans d'action nationaux dans lesquels ils exposaient en détail leur projet de déploiement des énergies renouvelables afin d'atteindre les objectifs fixés pour 2020. Ces plans d'action illustrent aussi, sur le plan technologique, la manière dont les États membres ont anticipé, en 2010, le développement de leurs trajectoires énergétiques jusqu'en 2020. L'addition de ces prévisions individuelles contribue à donner un aperçu du déploiement prévu au niveau de l'UE des 28.

L'UE des 28

La part d'énergie renouvelable dans la consommation d'énergie finale brute a atteint 16% en 2014 dans l'UE des 28, dépassant ainsi de près d'un tiers la trajectoire indicative fixée par la Directive EnR pour 2013/2014. Selon les estimations préliminaires, la part de 2015 se situerait aux environs de 16,4%, soit un niveau une nouvelle fois bien au-dessus de la trajectoire indicative fixée pour 2015/2016.

Le déploiement des énergies renouvelables contribue à la sécurité énergétique en réduisant la dépendance vis-à-vis des combustibles fossiles importés. On estime que la croissance de la

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[6] La part d'énergie renouvelable est exprimée en fonction de la consommation d'énergie finale brute et calculée selon des règles de calcul spécifiques, également définies dans la directive sur les énergies renouvelables.

consommation d’énergie renouvelable a évité l’importation d’environ 64 Mtep de combustibles fossiles entre 2005 et 2014, soit l’équivalent de 18 milliards d’euros. En prenant en compte la consommation d’énergie renouvelable estimée en 2015, cette valeur passerait à environ 71 Mtep par rapport aux niveaux de 2005.

Le scénario de référence 2016 de l’UE basé sur le modèle PRIMES prévoit que la part des énergies renouvelables de l’UE des 28 atteindra 21% en 2020, ce qui représente une prévision haute de l’évolution probable du secteur des énergies renouvelables. Cela dépasse l’objectif de 20% fixé à cette date. Les importations de combustibles fossiles évitées grâce à la consommation d’énergie renouvelable projetée en 2020 sont estimées à 136 Mtep, soit environ 42 milliards d’euros.

C’est le **secteur de l’électricité** qui concentre la plus grosse part d’énergie renouvelable, celle-ci ayant augmenté de 1,3% par an entre 2004 et 2014, pour atteindre 27,5% en 2014. La part des énergies renouvelables dans le **secteur du chauffage et de la climatisation** a enregistré une croissance de 0,8% par an au cours de la même période, pour atteindre 17,7%. Les évaluations pour 2015 indiquent que ces tendances devraient se poursuivre. Ces deux secteurs sont en avance sur la trajectoire définie par les plans d’action nationaux durant l’ensemble de la période. Le secteur des **transports** est le seul secteur qui bénéficie d’un objectif à 2020 qui lui est propre (10%). C’est également le secteur qui a affiché la croissance la plus faible en matière d’énergie renouvelable de 2005 à 2014 avec une moyenne de 0,5% par an. Le secteur connaît un ralentissement marqué depuis 2011, année où les règles de comptabilité pour les biocarburants durables ont été modifiées dans la Directive EnR. En 2014, la part des énergies renouvelables s’élevait à 5,9% dans le secteur des transports (et n’était estimée qu’à 6% en 2015). Le secteur des transports a donc été en dessous de la trajectoire globale planifiée pour ces années.

Les différences entre ces trois secteurs s’expliquent par des divergences dans leurs coûts de réduction des émissions de CO_2 et dans leur structure sectorielle.

Le **secteur de l’électricité**, par exemple, bénéficie d’une attention politique de longue date. Du fait des progrès technologiques, les principales technologies présentent déjà des coûts de réduction des émissions de CO_2 relativement faibles. Les décisions d’investissement sont relativement centralisées et ne dépendent pas autant des choix individuels que dans le secteur résidentiel ou dans celui des transports.

Les progrès dans le secteur du **chauffage et du refroidissement** sont plus lents car la consommation globale y est plus élevée[7] et plus décentralisée, avec la nécessité d’investissements à plus long terme. La propriété et la prise de décision sont davantage réparties que dans le secteur de l’électricité et, jusqu’à présent, l’attention politique a été moins importante. Naturellement, la part des énergies renouvelables dans ce secteur varie en fonction des conditions climatiques, en étant impacté par les hivers doux et par les efforts déployés par les pays pour encourager l’efficacité énergétique et réduire la consommation de chauffage et de refroidissement. Par rapport à l’électricité renouvelable, les technologies sans carbone sont, à ce jour, moins facilement accessibles, ce qui entraîne des coûts de réduction des émissions de CO_2 plus élevés.

La croissance relativement lente des énergies renouvelables dans le secteur des **transports** s’explique principalement par des coûts de réduction des émissions de CO_2 assez élevés, de longs débats législatifs et une incertitude quant à la réglementation future des carburants alternatifs qui ne doivent pas entrer en concurrence avec les cultures alimentaires.

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[7] Ainsi, une plus grande capacité d’énergie renouvelable doit être déployée pour gagner un point de pourcentage.

Le scénario de référence 2016 de l'UE prévoit pour 2020 une part d'énergie d'origine renouvelable de 35,5% dans le secteur de l'électricité et de 22% dans le secteur du chauffage et du refroidissement. Cela signifie que, si la croissance se poursuit au rythme actuel, la somme des trajectoires nationales permettra à l'UE des 28 d'atteindre ses objectifs pour l'électricité ainsi que pour le chauffage et le refroidissement. Le scénario de référence 2016 dépasse également d'un point, à 11%, l'objectif contraignant fixé pour les énergies renouvelables dans les transports, puisque tous les États membres atteignent au moins leurs objectifs dans ce secteur et que certains États, s'appuyant sur des politiques adoptées précédemment, les dépassent. Cependant, le scénario montre une trajectoire beaucoup plus prononcée entre 2015 et 2020, ce qui implique la nécessité d'efforts accrus pour atteindre l'objectif de 2020.

Progrès enregistrés par les États membres

Tous les États membres sauf un (les Pays-Bas) ont affiché en 2013/2014 des parts moyennes d'énergie renouvelable égales ou supérieures à leur trajectoire indicative découlant de la Directive EnR.

Selon les estimations préliminaires pour 2015, 25 États membres ont dépassé leur trajectoire indicative 2015/2016. Trois États membres (France, Pays-Bas et Luxembourg) ont affiché des parts inférieures à leur trajectoire indicative 2015/2016 découlant de la Directive EnR. A moyen terme, les résultats de la modélisation indiquent que l'UE est capable d'atteindre son objectif de 20% d'énergies renouvelables à horizon 2020. Néanmoins, certains Etats-Membres tels que l'Irlande, le Luxembourg, les Pays-Bas ou le Royaume-Uni pourraient être amenés à renforcer leur coopération avec d'autres pays afin d'atteindre leur objectifs nationaux, à travers, par exemple, des mécanismes tels que les transferts statistiques.

Les estimations préliminaires pour 2015 indiquent que treize États membres sont restés en deçà de leur trajectoire prévue dans le plan d'action national pour cette même année. Une analyse plus approfondie de l'évolution de la part des énergies renouvelables montre qu'au cours des dernières années (2014 et 2015), la tendance européenne a été principalement initiée par la réduction de la consommation électrique. L'augmentation en 2014 et la croissance évaluée en 2015 de la part d'électricité renouvelable masquent une dynamique plus faible que par le passé. La plupart des acteurs majeurs de l'Union européenne qui avaient décidé de développer le secteur de l'électricité renouvelable ont réduit leurs budgets d'investissement.

Dans le secteur du chauffage et du refroidissement, les évaluations pour 2015 montrent que 25 États membres ont à cette date d'ores et déjà dépassé leurs plans. L'évolution de la demande en matière de chauffage et de refroidissement dépend non seulement des avancées technologiques, du cadre juridique et de la volonté de changement, mais aussi des conditions climatiques. Par exemple, les années 2011 et 2014 se sont caractérisées par des hivers doux, impliquant une diminution de la consommation de chauffage. Il en a été de même pour 2015. Au cours de ces années, la consommation d'énergie renouvelable pour le chauffage et le refroidissement a diminué mais pas autant que la consommation d'énergie globale dans ce même secteur. Cela s'ajoute aux efforts déployés par les pays pour réduire la consommation de chauffage et de refroidissement grâce à des incitations qui favorisent l'efficacité énergétique.

À fin 2015 dans le secteur des transports, on estime que huit États membres ont respecté ou dépassé la trajectoire prévue dans leur plan d'action. En général, le développement de la part des énergies renouvelables est beaucoup plus lent dans le secteur des transports que dans d'autres secteurs en raison de sa nature complexe. Ce développement présente actuellement des coûts d'atténuation relativement élevés et est également confronté à des incertitudes politiques. Par exemple, le développement des biocarburants dans l'UE a été compromis à partir de 2013 par le long débat législatif qui s'est tenu d'octobre 2012 (adoption de la proposition législative de la Commission) à septembre 2015 (adoption de la Directive CASI – ou ILUC en anglais) : les directives Energies renouvelables et Qualité des carburants requéraient que la Commission examine l'impact potentiel sur les émissions de gaz à effet de serre de l'utilisation accrue des terres pour produire des biocarburants de première génération. Ce phénomène est également nommé impact du changement indirect d'affectation des sols (CASI). Le texte final de la directive « ILUC » n'a été adopté que le 9 septembre 2015. Du fait de ce long processus, les États membres ont adopté des positions non coordonnées sur le taux national d'incorporation des biocarburants de seconde génération et certains d'entre eux ont révisé leurs taux d'incorporation des biocarburants de première génération.

Résumé Tâche 2 - Analyse des obstacles non économiques

Les États membres et les différents secteurs peuvent être confrontés à des obstacles non économiques, engendrés notamment par les procédures de délivrance de permis.

L'électricité d'origine renouvelable

Globalement, dans le secteur de l'électricité, ces obstacles ont été traités par les États membres depuis l'adoption de la directive sur les énergies renouvelables. Cependant, ils constituent toujours un problème important pour le déploiement de l'électricité d'origine renouvelable au sein de l'UE, et plusieurs d'entre eux subsistent dans la plupart des États membres. Il existe également des divergences significatives entre les États membres quant à la mise en œuvre des mesures visant à réduire ces obstacles non économiques.

Ces obstacles découlent principalement du processus de planification et de délivrance de permis. Il s'agit là d'une difficulté majeure pour le développement de l'électricité d'origine renouvelable, et ceci est considérée comme un problème important par les États membres, bien que les régimes de délivrance de permis diffèrent considérablement d'un pays à l'autre. Même dans les États disposant d'un régime bien établi, la délivrance d'un permis pour une centrale de production d'électricité renouvelable constitue un enjeu très important.

L'intégration de l'électricité d'origine renouvelable au réseau est également une question majeure. Cela concerne le processus d'intégration des centrales individuelles, mais aussi, de plus en plus, le développement de la capacité globale du réseau.

Il est évident que les obstacles liés aux processus de planification et de délivrance de permis augmentent les coûts de l'électricité d'origine renouvelable et réduisent son déploiement. De nouveaux enjeux et conflits apparaissent également dans ces processus, comme le renforcement des contraintes environnementales et l'accroissement des conflits avec d'autres utilisateurs, notamment les stations radars. Ces questions montrent qu'il est extrêmement important d'avoir mis en place un système d'autorisation le plus efficace possible, de sorte que ces nouveaux conflits ne viennent pas se surajouter aux obstacles non économiques découlant de la délivrance de permis.

Certains obstacles sont plus généralisés que d'autres et certaines mesures sont assez peu souvent mises en œuvre au sein de l'UE. Cependant, il convient de noter que l'impact varie en fonction des obstacles et des mesures.

Les guichets uniques facilitant la délivrance de permis pour les projets renouvelables n'ont pas été mis en œuvre dans la majorité des États membres. Ces guichets constituent pourtant un élément déterminant des bonnes pratiques administratives et leur absence risque d'augmenter la durée de traitement administratif ainsi que le coût des projets.

La délivrance automatique du permis après l'expiration d'un délai donné est également une mesure qui n'a pas été mise en œuvre dans la majorité des États membres. Toutefois, l'intérêt de cette mesure est plus controversé que celui des guichets uniques, surtout si elle ne se limite pas aux centrales de petite taille.

Des délais d'attribution de permis ont été mis en place dans la majorité des États membres. Encore une fois, il s'agit là d'une bonne pratique dans le cadre d'un système de délivrance de permis efficace. En l'absence d'un tel élément, les développeurs ne peuvent pas avoir une idée précise du temps qu'il leur faudra pour obtenir leur permis. Ceci est particulièrement problématique si une dégressivité automatique du taux de soutien s'applique, car un retard dans le projet peut entraîner une réduction des revenus évalués de ce projet. Les délais peuvent être indicatifs, mais ils doivent tout de même refléter une efficacité dans la délivrance des permis et des mesures doivent être mises en place afin que les autorités respectent ces délais. Par conséquent, bien que ces délais soient importants, leur mise en place ne garantit pas l'élimination de tout autre obstacle, mais il convient de veiller au respect de ces délais et à la bonne mise en œuvre de la structure administrative correspondante.

Une grande majorité des États membres a mis en place des procédures simplifiées pour les projets à petite échelle. Malgré cette avancée, d'autres dispositions au niveau de l'UE permettraient non seulement d'introduire des mesures dans les différents États membres, mais aussi de faire converger les dispositions nationales, de manière à favoriser un marché européen.

L'énergie renouvelable dans le secteur du chauffage et du refroidissement

Les niveaux de déploiement des technologies de chauffage et de refroidissement à partir de sources d'énergie renouvelables ainsi que leurs évolutions au cours des dernières années diffèrent considérablement d'un État membre à l'autre (voir Tâche 1). Dans la Tâche 2, les obstacles non économiques affectant ces niveaux de déploiement ont été plus particulièrement abordés.

L'analyse a révélé que la *faible sensibilisation de l'opinion publique vis-à-vis de ces technologies* demeurait le principal obstacle (pour environ 65% des États membres), suivi de près par le *manque de conseils fiables* (61%) et l'*insuffisance de professionnels qualifiés* (61%). Trois autres obstacles touchent près de 50% des États membres : *l'application insuffisante de l'article 13(4) de la Directive EnR*, *la non obligation de recourir aux EnR dans les édifices publics* et *le manque d'informations*. Environ 45% des États membres sont confrontés à des *procédures complexes d'accès ou de connexion au réseau*. Trois autres obstacles touchent entre 30 et 40% des États membres : *l'insuffisance de programmes de qualification et de formation agréés, le fractionnement des incitations,* ainsi que *le non-respect des dispositions et l'absence de contrôle de la qualité par les autorités.*

Il est important de garder à l'esprit que la fréquence à laquelle sont mentionnés ces obstacles dans les différents États membres ne peut donner qu'une estimation basse. Cela s'explique par le fait que les enquêtes réalisées dans chaque État membre n'entrent pas dans le cadre de la présente étude et que les obstacles non économiques au développement de l'énergie d'origine renouvelable dans le secteur du chauffage et du refroidissement ne sont pas toujours mentionnés dans les rapports de situation des États membres. Bien que ceux-ci soient tenus de signaler dans leur rapport, les obstacles réglementaires et non réglementaires au développement de cette énergie en vertu de l'article 22(1e), la plupart se limitent aux obstacles liés au développement de l'électricité renouvelable en laissant de côté le secteur du chauffage et du refroidissement. En réalité, moins de la moitié des États membres signalent des obstacles non économiques liés à ce secteur. Il y a un besoin d'amélioration évident dans ce domaine afin de pouvoir évaluer ces obstacles de façon plus approfondie.

Les résultats d'une analyse semi-quantitative portant sur les obstacles au déploiement attribuent à tous les obstacles examinés un impact évalué de « moyen » à « moyen-élevé ». Même si chacun d'eux a des effets différents selon les États, les résultats montrent qu'ils peuvent tous être considérés comme ayant plus ou moins la même importance au niveau de l'ensemble de l'UE, sans qu'aucun ne prime sur les autres. Cependant, au niveau des États membres, des différences réelles existent et doivent être prises en compte lors de l'examen des recommandations destinées à chaque pays. Par exemple, on estime que la *faible sensibilisation de l'opinion publique vis-à-vis des technologies liées au chauffage et au refroidissement* a un effet moyen-faible en Allemagne et en Lituanie, un effet moyen en Autriche, en République tchèque et en Finlande, mais un effet moyen-élevé en Espagne, en Roumanie et au Royaume-Uni.

L'évaluation donne un très bon aperçu des problèmes et des obstacles existants. Certains de ces obstacles ont déjà été abordés par la Directive EnR mais, dans de nombreux cas, la mise en œuvre ou les exigences pourraient être améliorées. Par exemple, le *manque de conseils fiables* et *l'insuffisance de professionnels qualifiés* pourraient être traités en renforçant l'Article 14(3). Les exigences en matière de qualification/certification pourraient être étendues à tous les professionnels du secteur du bâtiment de façon à s'assurer que ces professions développent une sensibilité vis-à-vis des exigences spécifiques liées aux technologies de chauffage et de refroidissement utilisant les énergies renouvelables.

Enfin, il convient de noter que l'absence d'objectifs contraignants à fin 2030 à l'échelle de l'UE dans le secteur du chauffage et du refroidissement est perçue comme un obstacle. La fixation de ces objectifs permettrait aux gouvernements, aux promoteurs, aux producteurs et autres parties prenantes de planifier et de concevoir des stratégies en vue d'atteindre ces objectifs. L'absence d'une stratégie exhaustive et à long terme en faveur du déploiement des énergies renouvelables dans le secteur du chauffage et du refroidissement dans les différents États membres est également un obstacle souligné dans différentes publications. De plus, de nombreuses parties prenantes et plusieurs auteurs de ces publications reconnaissent les obstacles financiers comme étant le principal frein au déploiement de ces technologies au sein de l'UE.

L'énergie renouvelable dans les transports

Les principaux obstacles non économiques au développement des énergies renouvelables dans les transports sont l'absence d'un cadre réglementaire pour l'après 2020 (81%) et les débats sur les modifications importantes de la réglementation intervenus dans le passé (71%). Ces deux éléments augmentent les risques pour les investissements des producteurs et ont été identifiés comme des obstacles non économiques majeurs.

La faible acceptation par le public et les consommateurs constitue également un obstacle non économique important. Plus de 70% des États membres soulignent les préoccupations du public et des consommateurs au sujet des biocarburants. Les préoccupations principales concernent l'impact des biocarburants sur le changement indirect d'utilisation des sols (36%) et la crainte d'endommager les moteurs (43%). Ces deux éléments ont été signalés comme des raisons pertinentes au non-développement des biocarburants dans plusieurs États membres. De même, le débat sur la concurrence entre carburant et alimentation figure comme un sujet de préoccupation publique (30%). Les professionnels du secteur considèrent la faible acceptation des biocarburants comme un sujet important, mais qui compte toutefois moins que les risques d'investissement mentionnés précédemment. Cependant, l'impact sur le développement et les motifs de préoccupation diffèrent fortement selon les États membres.

Les obstacles à la mise au point de technologies alternatives ainsi qu'à l'augmentation des taux d'incorporation des biocarburants doivent également être pris en compte. Les biocarburants de seconde génération, tels que définis dans l'annexe IX de la Directive EnR, seront comptés deux fois pour atteindre l'objectif de 10% d'énergie renouvelable dans les transports en 2020 (Art. 3(5f)). Sept États membres (25%) n'ont pas transposé cette incitation dans leur législation nationale. La mise en œuvre dans l'ensemble des États membres permettrait d'augmenter le marché potentiel des biocarburants de seconde génération.

Il sera nécessaire d'instaurer des normes concernant l'augmentation du taux d'incorporation des biocarburants si l'on veut fixer des objectifs plus ambitieux pour l'après 2020. L'absence de telles normes au niveau de l'UE est un obstacle significatif dans 52% des États membres et cela pourrait devenir un problème pour l'après 2020. D'autres technologies de propulsion (méthane, véhicules électriques) exigent une infrastructure de ravitaillement et de recharge suffisante. La plupart des

États membres n'ont placé que récemment ces technologies au centre de leur stratégie relative aux transports. L'absence de l'infrastructure énergétique requise pour ces technologies de propulsion alternatives est considérée comme un obstacle dans près de 90% des États membres dans lesquels ce type d'information était disponible. L'absence potentielle de matières premières durables (domestiques) a été identifiée dans 36% des États membres comme un obstacle au développement de l'énergie renouvelable dans les transports.

Toutefois, la Directive 2009/28/CE (EnR) a été modifiée par la directive 2015/1513/UE (ILUC), adoptée le 9 septembre 2015 et entrée en vigueur le 5 octobre 2015. Les principaux changements sont la fixation d'un plafonnement à 7% du taux d'incorporation des biocarburants produits à partir de cultures agricoles, l'introduction de coefficients multiplicateurs plus élevés pour l'électricité renouvelable dans le transport routier et ferroviaire et la fixation d'un objectif national d'incorporation minimale de 0,5% de biocarburants de seconde génération dans le mix énergétique des transports. Les États membres ont jusqu'au 10 septembre 2017 pour transposer cette directive dans leur législation nationale[8]. Plusieurs États membres l'ont transposée partiellement[9] mais aucun n'a encore transposé l'ensemble de ses dispositions [40], ce qui explique pourquoi l'impact de cette directive ne peut pas être pris en compte dans le présent rapport.

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[8] Les objectifs nationaux relatifs aux biocarburants de seconde génération doivent être mis en œuvre d'ici avril 2017.

[9] L'Espagne a mis en œuvre le plafonnement de 7% des biocarburants issus de cultures agricoles. L'Italie a fixé un objectif national pour les biocarburants de seconde génération. Le Danemark, la France et les Pays-Bas ont proposé des projets de loi concernant les objectifs d'incorporation des biocarburants de seconde génération qui doivent être officiellement approuvés.

1. Task 1: Current and projected progress in deploying renewable energy sources

This section provides information on how the EU-28 and its Member States are progressing with respect to the deployment of renewable energy sources (RES) in the sectors laid out in **Directive 2009/28/EC (RES Directive; RED).** The relevant sectors are renewable energies in heating and cooling (RES-H/C), electricity (RES-E) as well as transport (RES-T). The analysis breaks down renewable energy use in these sectors by technology. The main data sources for this are Eurostat SHARES 2014 ([2]), the Renewable Energy Progress Reports [3] submitted by Member States in 2011, 2013 and 2015 and Member States National Renewable Energy Action Plans [4]. Modelling results from the PRIMES EU Reference Scenario 2016 [5] complement the analysis for the year 2020. The data sources are documented in Section 3.5.

It should be noted that binding renewable energy targets for 2020 are laid out in the RED only. These targets refer to the overall share of gross final energy consumption from renewable sources (20 %) and in transport (10 %). The indicative RED trajectory for each Member State illustrates the path towards those targets as a set of biennial average indicative targets.

The RED does not contain indicative trajectories on sector or technology level. However, in 2010 Member States have laid out, in their National Renewable Energy Action Plans, in Tables 10-12 how they envisage the technological development towards reaching their individual 2020 targets. Taking into account these indicative NREAP trajectories can thus contribute towards assessing progress, too. By aggregating all 28 anticipated NREAP trajectories, progress on EU-28 level can be approximated. It should be noted that the anticipated NREAP trajectories derived in this manner are not legally binding. 2015 RES shares and renewable energy deployment were approximated by the EEA (date 04/10/2016)[10]. The nature of the 2015 values needs to be highlighted here: 2015 proxy estimates are done in order to gain insights into how 2015 renewable deployment may look like before the complete set of empirical information becomes available. The values are based on calculations which necessarily have a specific cut-off date after which no further information can be taken into account (31/07/2016). The approximated renewable energy shares have been consulted with European Member States. Therefore they reflect the best available and consulted knowledge to date (04/10/2016).

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[10] 2015 renewable energy shares are therefore consistent with [6] and [7].

Box 1-1 Disclaimers

NREAPs

In 2010 Member States have laid out, in their National Renewable Energy Action Plans,

- in Table 3 their expected renewable energy shares (overall, electricity, heating & cooling, transport) from 2010 to 2020 in percent;
- in Table 4a their expected renewable energy consumption (overall, electricity, heating & coolig, transport) in kilotons oil equivalent;
- in Tables 10-12 their expected deployment of renewable energy by technology in kilotons of oil equivalent (or gigawatt hours) for the sectors electricity, heating & cooling, transport.

Each aggregation of these individual datasets provides an approximation of an EU-28 planned NREAP trajectory in the corresponding area. However, reported values may not always be fully consistent (e.g. sometimes the sums from Table 10-12 may not correspond completely to what is reported on sector level in Table 4a and therefore no fully consistent EU-28 aggregation can take place).

Within this project data was taken into account as reported by Member States in order to reflect their opinion in 2010. Starting point for the data collection was the ECN database [8] and Member States National Renewable Energy Action Plans submitted in 2010 [4] including further information (provided as further_info_nreaps PDF files), as well as resubmissions of National Renewable Energy Action Plans.

The following gap-filling measures took place

Tables 10-12:

- Technology totals: in case a Member State did not report the sums of an individual technology (e.g. no reporting of biomass totals took place, but liquid, solid and gaseous biomass was reported) the main technology was calculated as the sum of its subcategories.
- Hydro totals: for several Member States pumped hydro was included in the sum and the values were subtracted in order to derive the EU-28 aggregation for hydro totals.

All aggregated NREAP trajectories considered below should therefore be only considered as an approximation with a certain degree of uncertainty.

In view of future reporting obligations it seems worthwhile to note that electronic reporting in standardised formats could provide value added for aggregation of consistent EU-28 information and facilitate better analyses also on Member State level.

Under the Monitoring Mechanism Regulation such formats exist, for example, for reporting on GHG emission projections and the corresponding parameters and assumptions. These electronic reporting files undergo a QA/QC procedure in close communication with Member States and within a specified time frame. Once this procedure is completed, an aggregation to EU-28 level takes place.

Projected progress

Projected progress is reported based on the EU Reference Scenario 2016 [5]

The figures for 2015 in the EU Reference scenario were estimations; in view if the new statistics some trends until 2020 may be different than projected if influenced by the change of the figures for 2015.

This scenario aims at projecting the expected energy system, transport and greenhouse gas emissions developments for the EU and its Member States based on current trends and adopted policies. As regards renewable energy developments, the scenario is built so that Member States at least reach their 2020 targets, unless they have made the decision to use flexibility mechanisms. In that respect, this scenario is most likely closer to the upper bound of the expected RES developments across the EU by 2020.

Member States were consulted on draft results. Comments were taken into account to the extent that they were dully justified and ensured coherence of projections across EU Member States. Some of the comments received implied difficulties in reaching a RES share equal to or above the RES targets for all Member States without considering a limited use for flexibility mechanisms. Moreover, since this publication, new and revised statistical data became available (e.g. Eurostat SHARES 2014 and preliminary estimated of 2015 deployment. Due to these developments trend breaks may occur between 2015 and 2020 values.

Finally, it must be recalled that the RES-T share presented in the EU Reference Scenario 2016 are based on the calculation method following the ILUC amendments to the RES Directive. As such, these are not directly comparable to the NREAP trajectories.

2015 data and connectivity of reporting streams

Approximated 2015 RES shares and deployment were kindly provided by the EEA (date 04/10/2016). The methodology is documented in EEA (2015): *Renewable energy in Europe – approximated recent growth and knock-on effects*, EEA Technical report No 1/2015. Methodological changes are documented in EEA (forthcoming): *Renewable energy in Europe 2017 – approximated recent growth and knock-on effects*.

The nature of the 2015 values needs to be highlighted: 2015 proxy estimates are calculated in order to gain insights into how 2015 renewable deployment may look like before the complete set of empirical information becomes available. The values are based on calculations which necessarily have a specific cut-off date after which no further information can be taken into account (31/07/2016). The proxy values have been consulted with European Member States. Therefore they reflect the best available and consulted knowledge to date (04/10/2016). For this project, 2015 data on technology level were collected from the detailed SHARES 2014 data files which were prolonged to include approximated values for the year 2015.

Note on connectivity of different reporting streams:

In the course of this project an attribution of technologies in the Eurostat SHARES structure to technologies as reported in NREAPs / Member States Progress Reports has been done as careful as possible. Due to the nature of the two different reporting streams it is however not possible to guarantee a completely perfect match at all instances and therefore comparisons for 2015 need to be interpreted as best possible estimates given the circumstances.

1.1. Progress in overall renewable energy shares

1.1.1. EU-28 progress

Summary

Current progress

The renewable energy share (RES share) in the EU-28 gross final energy consumption reached 16.0 % in 2014, exceeding the indicative trajectory for 2013/2014 set out in the Renewable Energy Directive (RED) by almost a third. According to preliminary estimates, a 16.4% share for 2015 is also well above the 2015/2016 indicative trajectory set out in the RED.

Deployment of RES contributes to energy security by reducing the reliance on imported fossil fuels. It is estimated that the renewable energy consumption growth after 2005 has roughly avoided the import of about 64 Mtoe of fossil fuels in 2014 (4.7 % of EU-28 fossil fuel imports), worth €18bn at 2014 prices. Taking into account approximated 2015 renewable energy use would increase this value to about 71 Mtoe compared to 2005 levels.

Projected progress

The PRIMES EU Reference Scenario 2016 projects the EU-28 share of RES to be 21 % in 2020, which represents an upper bound projection of likely developments in the RES sector. This exceeds the trajectory set out in the RED (20 % of gross final energy consumption) and is in line with the trajectories in the National Renewable Energy Action Plans (NREAPs).

The fossil fuel imports displaced by the projected RES consumption in 2020 are estimated at 136 Mtoe, or 10 % of the EU-28's current fossil fuel imports. This amounts to €42 bn (at projected, higher, energy prices). Taking it a bit further, in 2030 a projected 59 €bn could be avoided compared to 2005.

Current progress

EU-28 renewable energy shares (RES shares) calculated according to the methodology laid out in Directive 2009/28/EC (RES Directive; RED; [9]) are displayed in Figure 1-1 as green columns. Since 2004, these shares have been rising steadily, having started at 8.5 % of gross final energy consumption, at an average pace of 6.6 % per year.

In 2014, the share of renewable energy reached 16 % of gross final energy consumption. For 2015, RES shares are approximated to have been in the magnitude of 16.4 % of gross final energy consumption. The indicative trajectory as calculated from the RES Directive (RED indicative trajectory) defines average indicative targets for two years at a time as an average for each Member State. Taking Member State-specific information into account, one can derive indicative targets for the EU-28 as a whole. The derived current indicative target (2013/2014) for the EU-28 is 12.1 %. The average RES share of the EU-28 in 2013/2014 amounted to 15.5 %. Thus, the 2013/2014 target was exceeded by 3.4 percentage points. The indicative target for 2015/2016 is derived as 13.8 %. With an approximated RES share of 16.4 % in 2015 the EU has already exceeded the 2015/2016 indicative target. As the aggregated

extrapolation becomes steeper in the years ahead, efforts to keep on track may need to be intensified.

In 2010, Member States submitted National Renewable Energy Plans (NREAPs) which reflect the plan of each Member State for its renewable energy deployment development until 2020 in order to meet its 2020 target. These NREAPs were laid out six years ago and therefore could not anticipate developments which have occurred since then. The NREAP plans have no legally binding character, but with no other such information available they can be used to gain insight into what was expected back then and compare this to current and projected progress.

Due to several reasons (see Box 1-1) an aggregation to EU-28 level includes some degree of uncertainty. Therefore a comparison of progress against the NREAP plans always needs to be viewed as a rather rough comparison.

Since the Member States overall anticipated NREAP trajectories are in general[11] more stringent than their indicative RED trajectories, this constructed trajectory is higher than the indicative RED trajectory, as can be seen in Figure 1-1. EU-28 RES shares have been above the aggregated, planned NREAP trajectory every single year since 2010. In 2014 the planned NREAP trajectory was exceeded by 1.5 percentage points. Based on approximated values for 2015 it was exceeded by 1.1 percentage points.

Projected progress

Taking into account the results from the EU Reference Scenario 2016, 2020 RES shares are projected to reach 21 %, i.e. one percentage point more than required under the RED.

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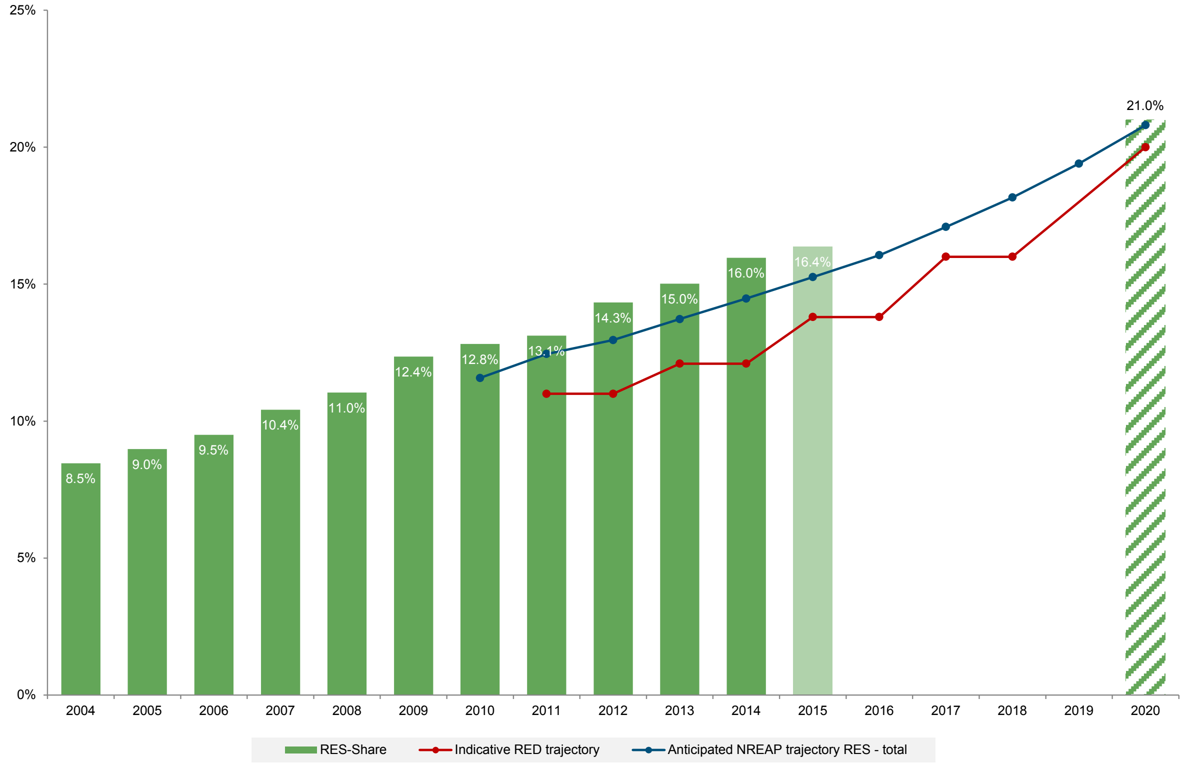
[11] For some Member States (Belgium, Greece, Finland, Luxembourg, Latvia, Romania, UK) and some years between 2011 and 2020, NREAP trajectories are lower than their RED indicative trajectories.

Figure 1-1: **EU-28 renewable energy shares vs. RED indicative trajectory and NREAP trajectory**



Source: [2, 5, 9]; calculated via aggregation of Table 4a and Table 3 of Member States NREAPs based on [8] and [4]Source: [2, 9]; aggregation of Table 3 of Member States NREAPs based on [8] and [4]

Note: 2015 values approximated by EEA (date: 4/10/2016).

1.1.2. Value of displaced fossil fuels and imports vs. 2005

The use of renewable energy sources contributes to energy security by displacing the use of fossil fuels that mostly have to be imported. The magnitude of this displacement and imports that were thereby avoided is determined using the methodology and the assumptions documented in Section 3.4.2. The calculation was carried out separately for each Member State to take into account country-specific energy import prices, fuel mixes and RES growth since 2005. The results were aggregated to provide insights into the magnitude of displaced imports on EU-28 level.

The avoided imports below are expressed as Mtoe and in billions of Euros (based on yearly average energy import prices in each Member State). They refer to those imports which were **avoided due to the growth in RES consumption compared to 2005**. For example, the figures for 2014 show that EU Member States avoided imports of fossil fuels in a magnitude of 18 billion Euros in that year (and at 2014 prices) due to the **growth of RES** between 2005 and 2014.[12]

Current situation

The EU-28 results are an aggregation of the 28 Member States. They show significant growth of annually avoided imports from 2009 to 2014: 23 Mtoe in solid fuels (mostly bituminous coal), 18 Mtoe in liquid fuels (mostly crude oil) and 23 Mtoe in gaseous fuels (mostly natural gas) (see Table 3-3). In general, there has been a continuous and almost linear upward trend for all three fuel categories, notwithstanding an anomaly in 2011 due to the change in accounting rules for biofuels in that year.[13] The value of these avoided imports is estimated at €18bn at 2014 prices.

For 2015, preliminary numbers based on proxy data[14] indicate a moderate increase, in line with the observed trend, for solid and gaseous fuels. This was caused mainly by the electricity sector (e.g. by the commissioning of large offshore wind parks in Germany and the UK) and small contributions from heating and cooling. Less than half an additional Mtoe of liquid fuels was avoided in transport.

Figure 1-2, below, illustrates the results in more detail for 2014. Avoided imports due to the growth of RES since 2005 were largest in absolute figures in Germany, the UK, Italy and Spain. Two thirds of these were enabled in the electricity sector, in which strong expansion of RES and the relatively low efficiency of thermal power plants displaced large amounts of imported fossil fuels, mainly coal and gas. Almost all of the avoided coal imports (96 %) were enabled in electricity, even though its share of consumption is only 27 % EU-wide, similar to that of industry, where less coal was displaced. Electricity also enabled 75 % of avoided gas imports, proportionate to consumption figures. Use of liquid fuels in electricity is negligible in most Member States such that most (62 %) of avoided imports there were caused by transport in 2014. The remainder can be attributed mostly to heating and cooling (3 % for solids, 15 % for liquids, and 21 % for gas) and the energy sector.

Due to a declining trend in fossil fuel prices, the value of these avoided imports was lower in 2015 than in 2014 (16 vs. 18 bn EUR) even though the absolute amount increased (see Annex 3.2). The largest contributor is a decrease in mean effective oil import costs (0.34 vs. 0.53 bn EUR/Mtoe). It

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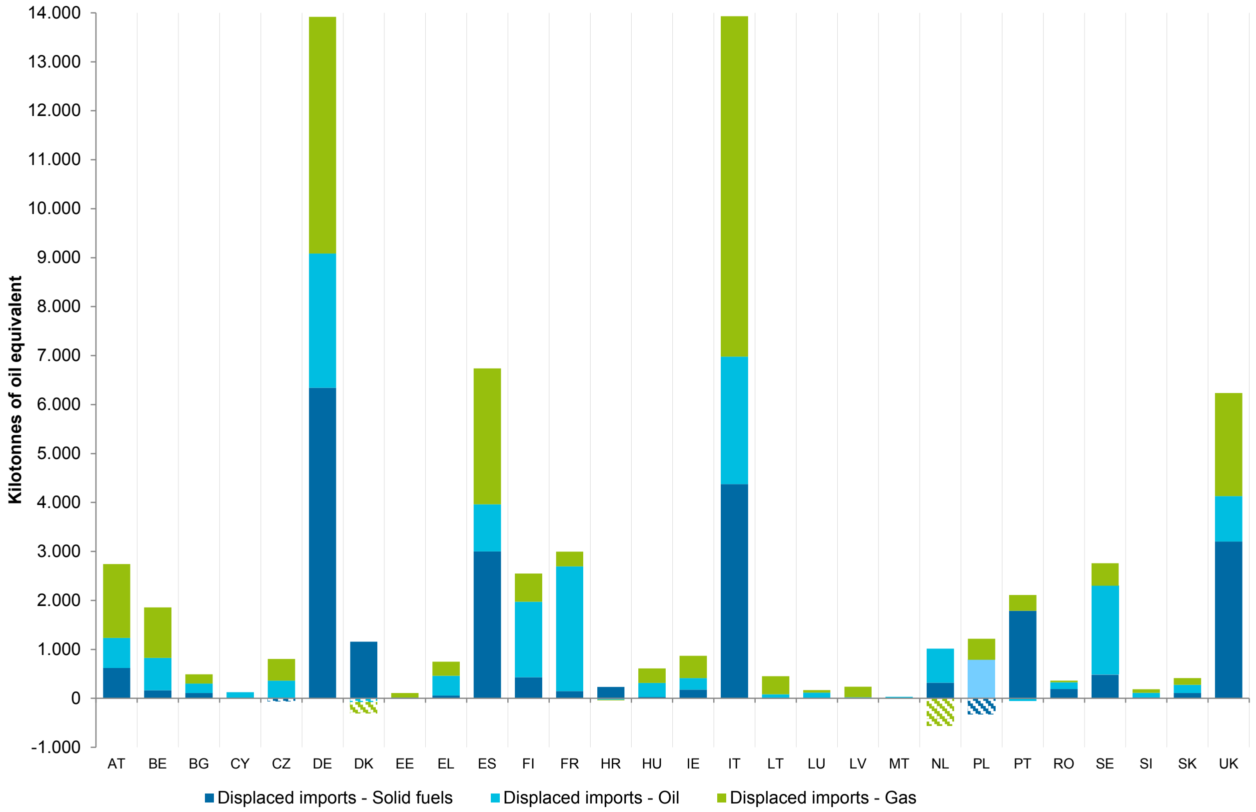
[12] Please note that the avoided imports refer to **RES capacity which was added between 2005 and the indicated years**. It has been estimated that roughly 30 billion Euros were avoided due to **total RES capacity** in 2010 (see [10, 11, 12]).

[13] Starting in 2011, only biofuels compliant with Art. 17 and 18 of the Biofuels Directive 2009/28/EC count towards RES consumption, decreasing reported biofuel use. This led to some accounting issues in several Member States who consume significant amounts of biofuels, such as France, which reported zero biofuel consumption in transport only in 2011, and Spain, which has been reporting zero biofuel consumption for all years since 2011.

[14] Results for 2015 carry uncertainty because currently only approximated RES data is available for 2015, as documented in Section 3.4.5.

can be expected that the value of avoided coal imports, which tend to be traded in longer-term contracts than oil or gas, will decline further in the coming years when lower prices become effective in the real cost of imports. Such fluctuations need to be kept in mind when interpreting and comparing value figures for avoided imports across years and methodologies.

Figure 1-2: Avoided fossil fuel imports (ktoe) per Member State in 2014 due to the growth of RES since 2005



Sources: Authors' own calculations based on [2, 13–16]

Notes: Most of the EU-28 Member States are net importers of fossil fuels, but several Member States are net exporters at times (In 2014 Denmark was a net exporter of liquid and gaseous fuels, the Netherlands for gas; the Czech Republic and Poland for solid fuels). The growth of renewable energy deployment in such Member States leads to increasing net exports, i.e. does not displace fossil fuel imports but rather domestic fossil fuel use. This is illustrated by a negative striped bar.

Projected situation

Figures for 2020 are derived from the results of the EU Reference Scenario 2016 [5] by way of the same methodology. Avoided imports for solid, liquid, and gaseous fuels are estimated at 44, 33, and 59 Mtoe, respectively, with a value of 6, 17, and 19 billion EUR (2013). In terms of quantities, this amounts very much to a continuation of the growth trend 2009–2014 for solid and liquid fuels (slightly less than double the 2014 figure), and a stronger increase for gaseous fuels (slightly more than double the 2014 figure).

The values of these quantities rise more steeply because prices in the scenario rise as well (almost three times the 2014 value for liquid and gaseous fuels, and more than double for solid fuels) and a unit of renewable energy can avoid more than one unit of fossil primary energy. This specifically becomes relevant and visiable as renewable electricity generation such as wind and solar PV are projected to increase in the future. Import shares are not expected to change drastically, leading to growth of total displaced fossil fuels (including domestic production) in about the same magnitude. By 2030 avoided imports are projected to be in the range of 58 billion Euro (2013).

While the EU Reference Scenario 2016 is most likely closer to the upper bound of the expected RES developments under a continuation of current policies across the EU by 2020 (see disclaimer in Box 1-1), the EUCO 27 scenario projects a scenario in which it is assumed that in 2030 an EU-wide RES share of 27% is reached. In this scenario, avoided imports in 2030 versus 2005 are projected at around 60 billion Euro (2013).

1.1.3. Member State progress

Summary

- The Renewable Energy Directive (RED) prescribes for each European Member State an individual and legally binding set of 2020 targets on the share of renewable energy sources (RES) in their gross final energy consumption. The RED also provides indicative trajectories for the period from 2011 to 2020. In 2010 Member States have provided anticipated renewable energy trajectories until 2020 which they reported in their individual National Renewable Energy Action Plans (NREAPs).

Current progress

- All but one Member State (the Netherlands) exhibited average 2013/2014 RES shares which were equal or higher than their corresponding indicative RED trajectory. According to EEA estimates (4/10/2016), 25 Member States already exceeded their 2015/2016 indicative RED trajectories in 2015. Three Member States (France, the Netherlands and Luxembourg) exhibited 2015 RES shares below their 2015/2016 indicative RED trajectory.

Projected progress

- In the EU Reference Scenario 2016 all but four Member States, namely Ireland, Luxembourg, the Netherlands and the United Kingdom (for the UK the distance from target is very small), are projected to meet their 2020 target set under the RED.

Current progress

Member State deployment of renewable energy sources varies as Member States exhibit individual characteristics such as the structure of the existing power plant fleet, the conditions of the buildings infrastructure, the level of energy efficiency and the level to which implemented policies and measures support the deployment of renewable energies, etc. Further they also face different “external” circumstances which influence the degree to which energy is used (such as climatic conditions due to geographical location).

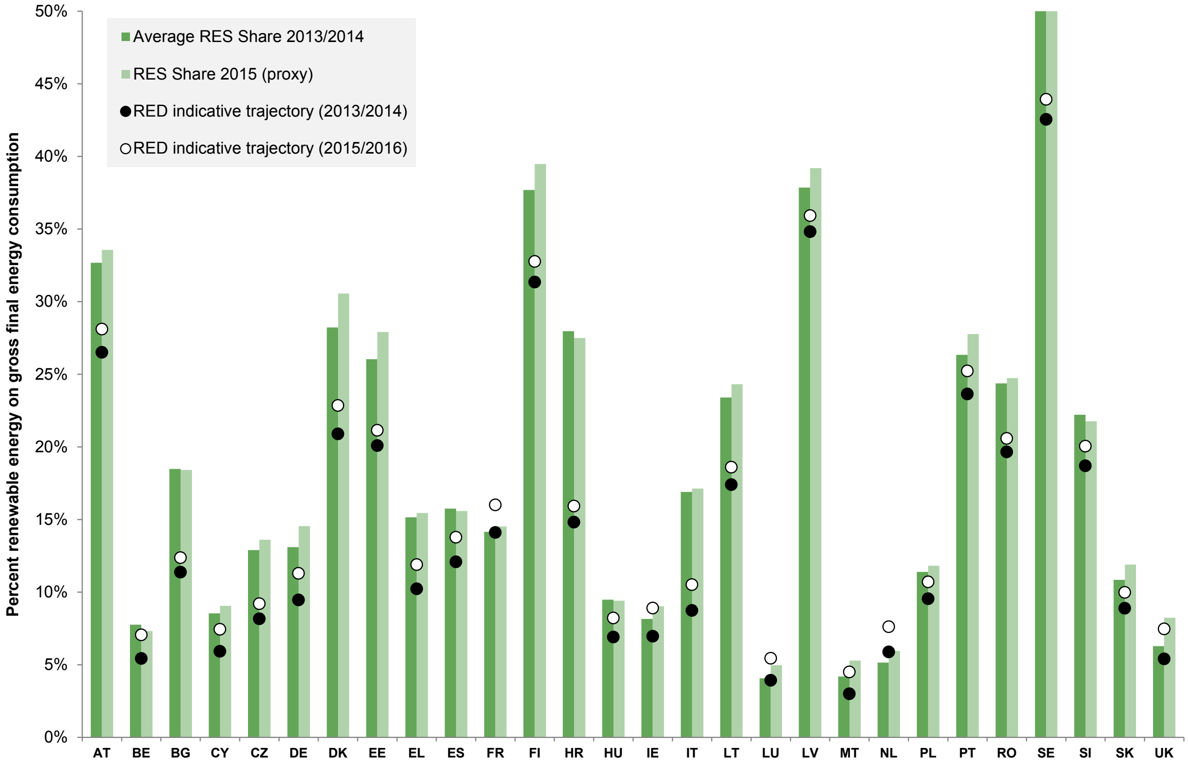
Taking into account RES shares and comparing them against the indicative trajectory laid out in the RED for each Member State helps to gain insight into whether the multitude of circumstances indicated above are accounted for sufficiently to meet these targets.

In general, the majority of the EU-28 Member States are making good progress towards their 2020 RES targets by exceeding also their indicative interim trajectory laid out in the RED.

All but one Member State (the Netherlands) showed average 2013/2014 RES shares which were equal or higher than their corresponding indicative RED trajectory. According to EEA estimates (4/10/2016), 25 Member States already exceeded their 2015/2016 indicative RED trajectories in

2015. Three Member States (the Netherlands, France and Luxembourg) exhibited 2015 RES shares below their 2015/2016 indicative RED trajectory (see Figure 1-3).

Figure 1-3: Member States current progress towards their 2013/2014 and 2015/2016 indicative RED targets



Source: [2, 9];

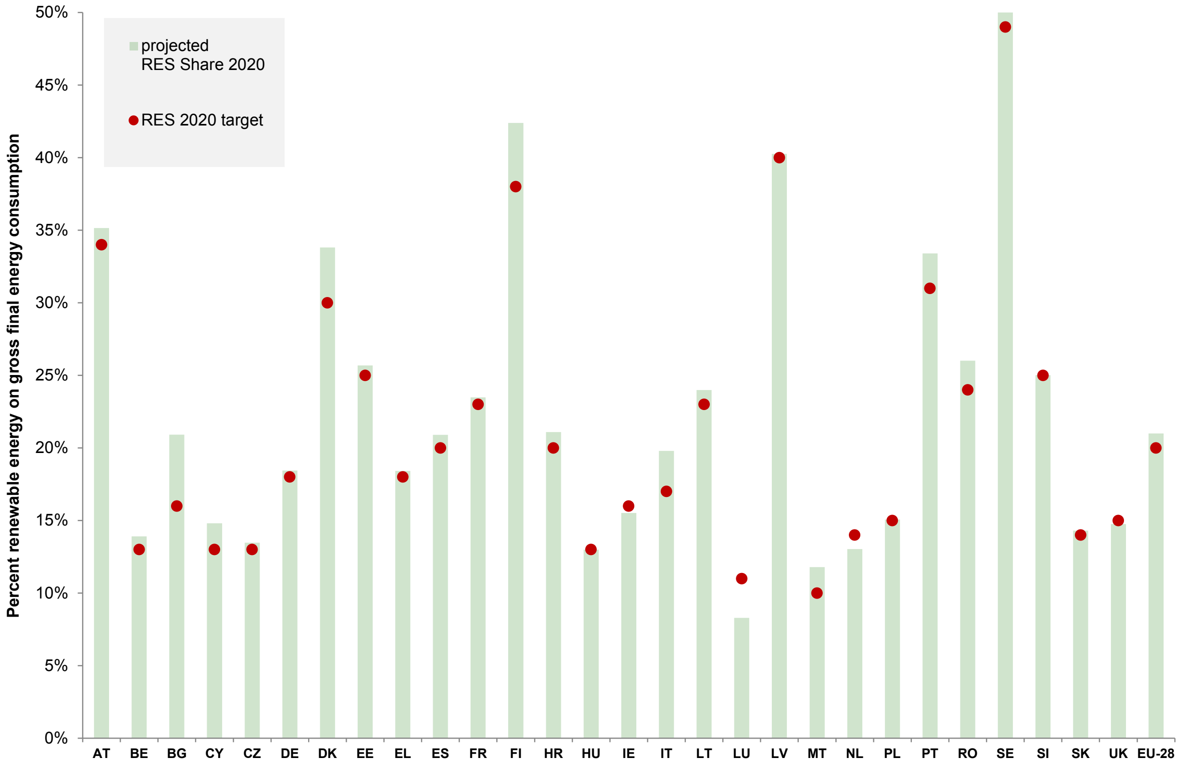
Note: 2015 values approximated by EEA (date: 4/10/2016)

Projected progress

The EU Reference Scenario 2016 projects the impacts of the implementation of current policies and market trends and represents independent projections informed by the NREAPs. It assumes the binding 2020 targets to be met. In the case of renewables, this means that both the overall RES target and the 2020 target in the transport sector are assumed to be met, by default. However, in case a Member State has indicated its intention to use flexibility mechanisms, this is taken into account. In addition, draft results were consulted with Member States. In some cases, comments received made it difficult for the Reference Scenario projections to exactly reach a renewable share in line with the 2020 target, de facto suggesting the limited use of flexibility mechanisms. In any case, EU Reference Scenario projections may be seen as **representing the upper bound** of likely developments in the renewable energy sector across Europe by 2020.

According to the Reference Scenario all Member States but Ireland Luxembourg, the Netherlands and the UK (for the UK the distance from target is very small) meet their national RES target without needing to use flexibility mechanisms (see Figure 1-4).

Figure 1-4: **Member States projected progress in 2020 compared to their 2020 RED targets**



Sources: [2, 5, 9]

1.2. Progress in deploying renewable energy by sector

1.2.1. EU-28 progress per sector

Summary

Current progress

The highest RES shares are located in the electricity sector where they grew by 1.3 percentage points per year between 2004 and 2014 and reached 27.5 % in 2014. The RES shares in the heating and cooling sector grew by 0.8 percentage points over the same period of time to 17.7 %. Approximated values for 2015 indicate that these historical trends are likely to continue. Both sectors exceeded the trajectory derived from NREAPs during the whole period.

Transport is the only sector with a RES share target for 2020 under the RED (10 %). Of all sectors, it exhibited the slowest growth of RES with 0.5 percentage points on average per year from 2005-2014 and has slowed down markedly since 2011, when accounting rules for compliant biofuels in the RED changed. Its renewable energy share was 5.9 % in 2014 (and estimated at only 6.0 % in 2015). The transport sector thus fell short of the aggregated, planned NREAP trajectory in all years.

Differences between sectors are caused by their different CO_2 abatement costs and different sector structures. The electricity sector benefits from long-standing political attention, relatively low CO_2 abatement costs due to significant technological progress and readily available technologies as well as investment decisions that are relatively centralised, i.e. do not depend on individual house or car owners.

Progress in heating and cooling is slower because consumption is higher overall (more RES capacity has to be deployed for every percent of RES share) and more decentralised with longer-term investment and distributed ownership than in electricity while political attention has been lower. The RES-share in the heating and cooling sector further depends on overall H&C consumption which is benefiting from mild winters and efforts made by countries to reduce the H&C consumption through incentives for energy efficiency behaviour. Compared to renewable electricity zero-carbon technologies are not as readily available. This leads to higher abatement costs for CO_2.

The relatively slow growth of RES in transport is mainly due to relatively high CO_2 abatement costs, long legislative debates and uncertainty about the future regulation of non-competitive alternative fuels.

Projected progress

The EU Reference Scenario 2016 projects sectoral RES shares in 2020 to stand at 35.5 % for electricity and 22 % for heating and cooling. This means that the NREAP-derived trajectories for electricity and heating / cooling will be met if growth continues in the current trajectory.

The Reference Scenario also exceeds the binding target for RES in transport by one percentage point at 11 %, as by construction all Member States at least reach their RES-T targets, while some Member States, based on already adopted policies, go beyond. However, the scenario shows a much steeper trajectory between 2015 and 2020, implying that decisively increased efforts are realised in order to meet the 2020 target.

The RES Directive does not contain an indicative trajectory for the sector (except for the transport sector) or technology level. However, using the information submitted by Member States in their NREAPs in 2010 [4], it is possible to construct an planned NREAP trajectory of EU-28 renewable energy shares by sector. This trajectory reflects the expectation of Member States for how their renewable energy deployment will develop. It has no legally binding character and the aggregation includes a certain amount of uncertainty. The methodology for accomplishing this aggregation is documented in Section 3.4.5.

Current progress

As can be seen in Figure 1-5, the highest absolute deployment in renewable energy from 2004 to 2014 on EU-28 level came from the heating and cooling sector, followed by the electricity sector. The highest RES shares and the largest growth however were located in the electricity sector where the renewable share grew by 1.4 percentage points per year between 2004 and 2014. The RES shares (compare Figure 1-6) in the heating and cooling sector grew by 0.8 percentage points over the same period of time, while the transport sector exhibited the slowest growth with 0.5 percentage points on average per year.

Between 2013 and 2014 renewable energy deployment in the heating and cooling sector declined by 1.8 Mtoe[15], while it increased by 4.0 Mtoe in the electricity sector. Renewable energy deployment in the transport sector grew by 1.2 Mtoe between 2013 and 2014.

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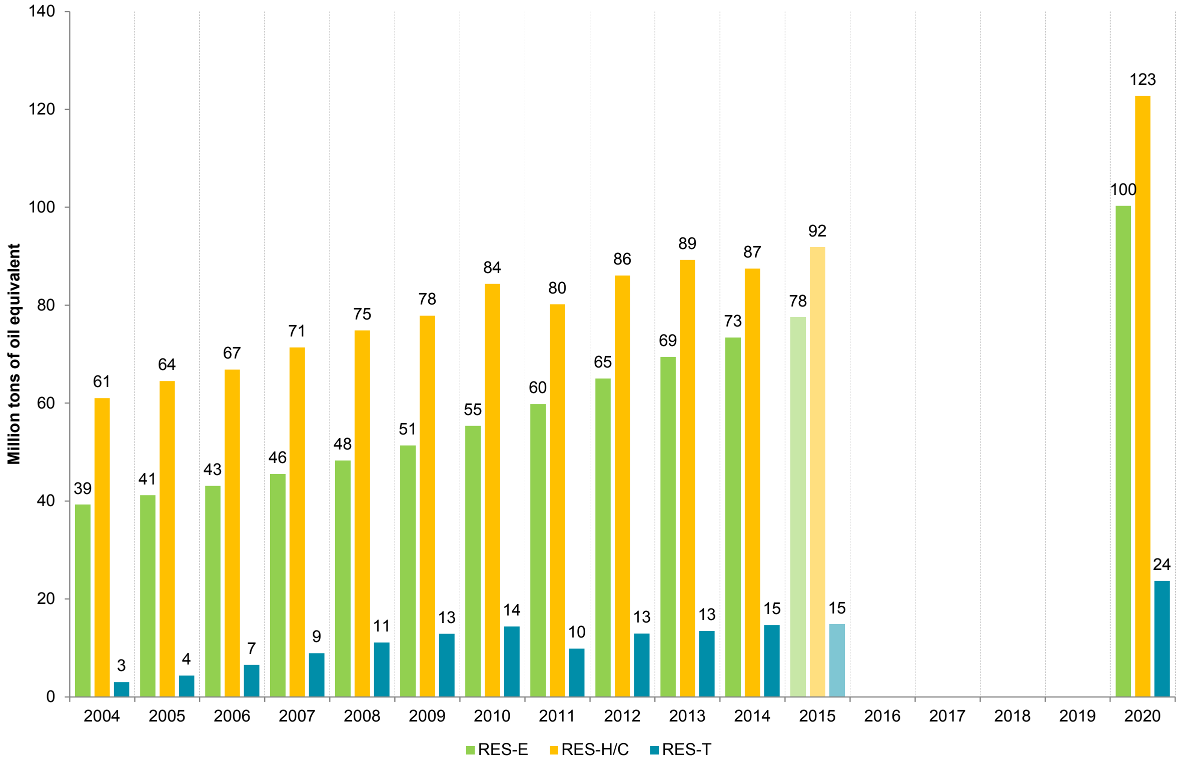
[15] Total gross final energy consumption in the heating and cooling sector also declined between 2013 and 2014, which was likely due to the mild winter throughout Europe.

Between 2014 and 2015 the following growth in the deployment of renewable energy sources has been approximated: a 5.6 % growth in deployment of renewable energies in electricity; 4.9 % growth in heating and cooling and 1.0 % growth in the transport sector. Thus, approximated values for 2015 indicate that the general historical trends are likely to continue.

Projected progress

In order to reach the 2020 target, the EU Reference Scenario 2016 projects sectoral RES shares in 2020 to stand at 35.5 % for electricity, 22 % for heating and cooling and 11 % for transport. The transport target is thus projected to be exceeded by 1 percentage point (compare Figure 1-6).

Figure 1-5: EU-28 renewable energy deployment by sector

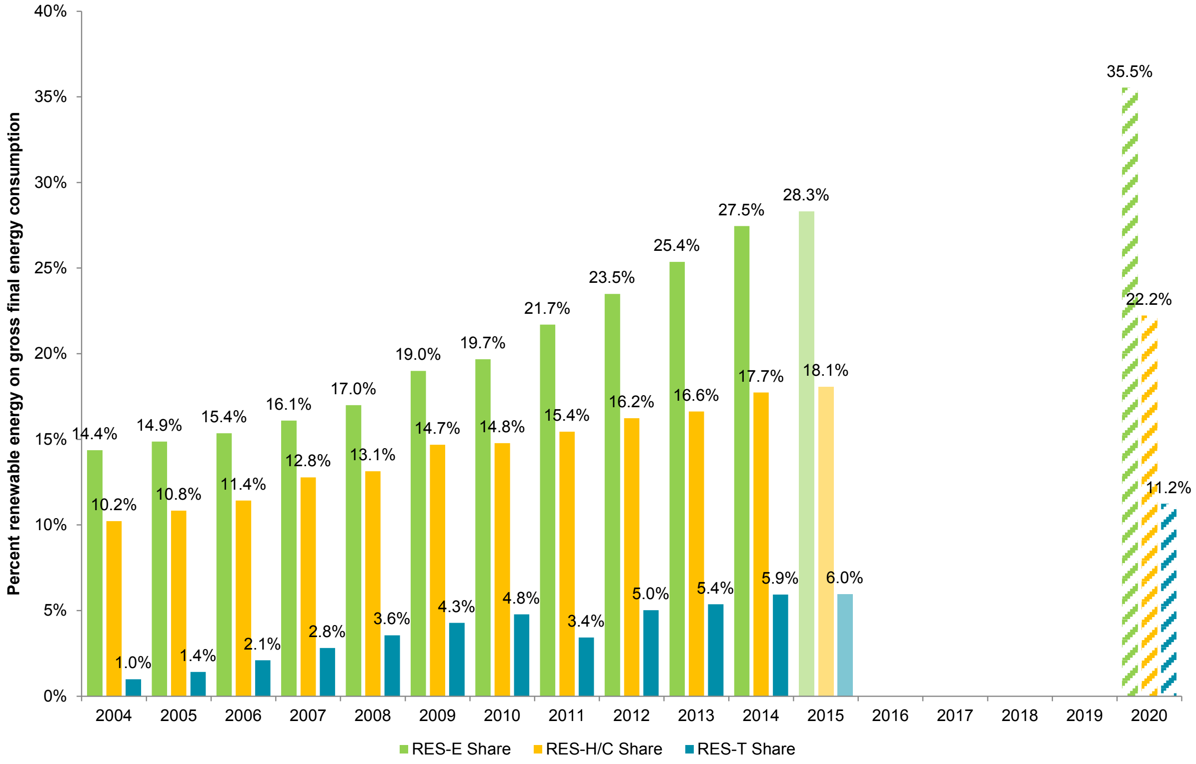


Source: [2, 5, 9]

Note: Renewable electricity in transport is included in the transport sector and not in the electricity sector. 2015 values approximated by EEA (date: 04/10/2016).

Please note that before 2011 all biofuels were counted as compliant biofuels, while starting in 2011 methodological changes arose which created a break in the time series.

Figure 1-6: EU-28 RES Shares by sector



Source: [2, 5, 9]

Note: Renewable electricity in transport is included in the transport sector and not in the electricity sector. 2015 values approximated by EEA (date: 04/10/2016).

Please note that before 2011 all biofuels were counted as compliant biofuels, while starting in 2011 methodological changes arose which created a break in the time series.

1.2.2. Electricity

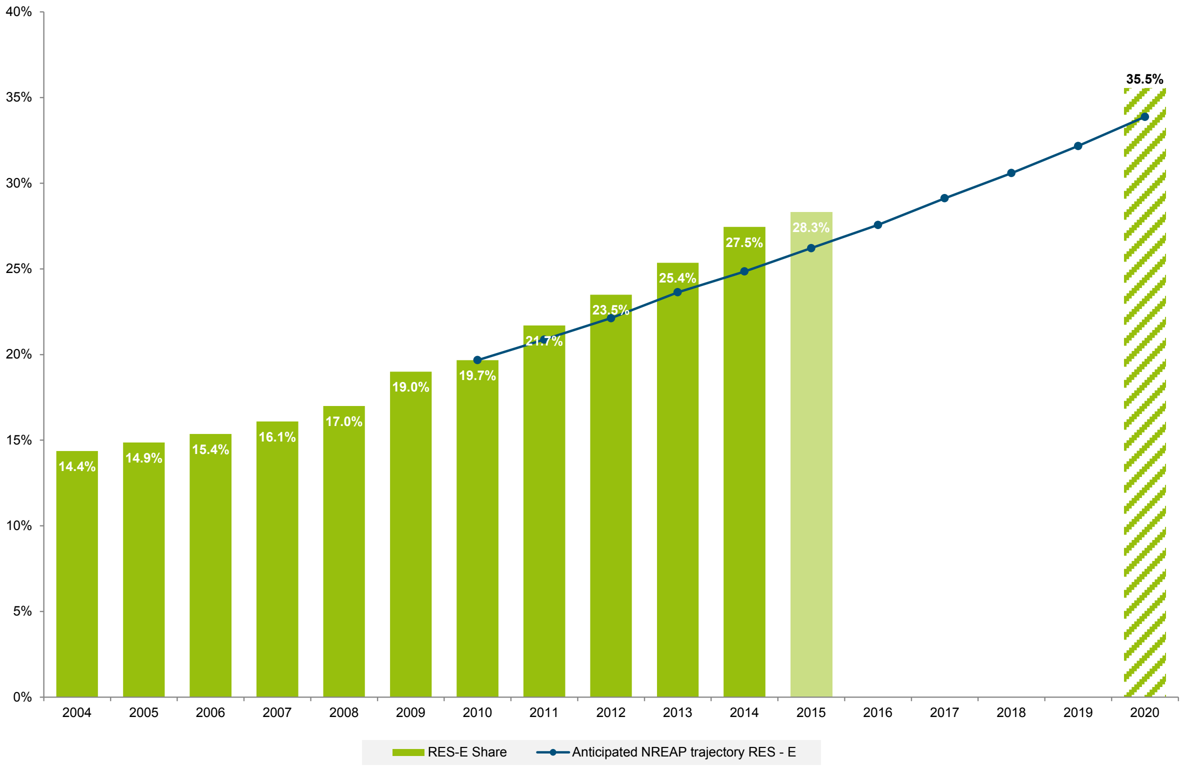
Current progress

The current 2014 share of renewable electricity on EU-28 level is 27.5 % of gross final energy consumption, while the aggregated EU-28 NREAP trajectory would indicate a target of 24.8 %. Thus the EU-28 as a whole was 2.6 percentage points ahead of its planned NREAP trajectory in 2014. In 2015 the EU-28 is approximated to stay ahead of its planned NREAP trajectory for electricity (compare Figure 1-7).

Projected progress

The EU Reference Scenario 2016 projects a RES share in electricity of 35.5 % in 2020 which is 1.4 percentage points above the aggregated EU-28 NREAP trajectory (33.9 %).

Figure 1-7: EU-28 current and projected progress in renewable energy shares in the electricity sector compared to NREAP trajectory



Source: [2, 5, 9]; own calculation based on Table 4a and Table 3 of Member States NREAPs based on [8] and [4]

Note: 2015 values approximated by EEA (date: 04/10/2016). 2020 values stem from the EU Reference Scenario 2016.

1.2.3. Heating and cooling

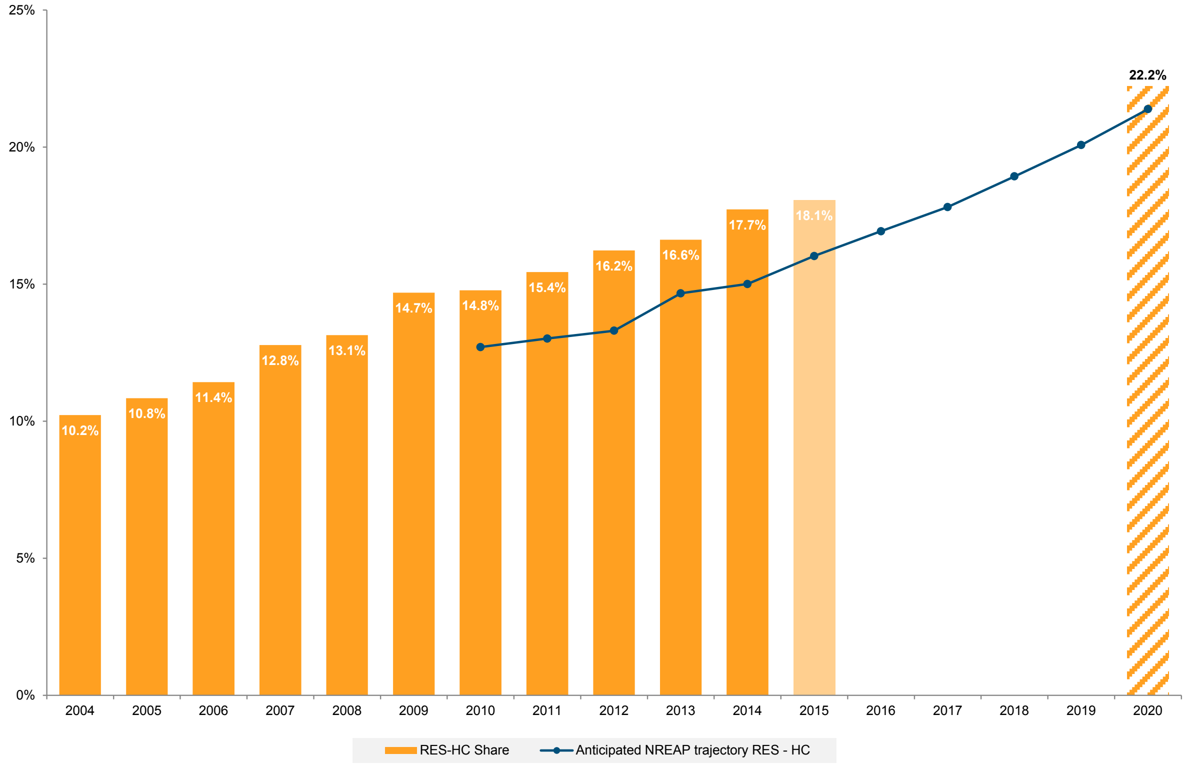
Current progress

The current 2014 share of renewable heating and cooling on EU-28 level is 17.7 % of gross final energy consumption, while the aggregated EU-28 NREAP trajectory would indicate a target of 15.0 %. In 2015 the EU-28 is approximated to stay ahead of its planned NREAP trajectory for heating & cooling (see Figure 1-8).

Projected progress

The EU Reference Scenario 2016 projects a heating and cooling RES share of 22.2 % in 2020 which is 0.8 percentage points above the aggregated EU-28 NREAP trajectory (21.4 %).

Figure 1-8: EU-28 renewable energy shares in heating & cooling vs. NREAP trajectory



Source: [2, 5, 9]; own calculation based on Table 4a and Table 3 of Member States NREAPs based on [8] and [4]

Note: 2015 values approximated by EEA (date: 04/10/2016).

1.2.4. Transport

Current progress

The 2014 share of renewable energy sources on transport on EU-28 level was 5.9 %[16] of gross final energy consumption, while the aggregated EU-28 NREAP trajectory would indicate a target of 6.7 %. Thus the EU-28 as a whole was 0.8 percentage points below its planned NREAP trajectory for transport in 2014. In 2015 the EU-28 is approximated to have stayed below its planned NREAP trajectory for transport, with a 6 % share of renewable energy. This confirms that rather slow progress is being made in this sector due to various difficulties including relatively high mitigation costs (see for example [17]) and political uncertainty, as a political agreement on the legal framework for addressing the ILUC impact of biofuels produced from crops grown on agricultural land was only proposed in 2012 and a cap on the share of these fuels was then adopted in 2015. [18, 19]

Projected progress

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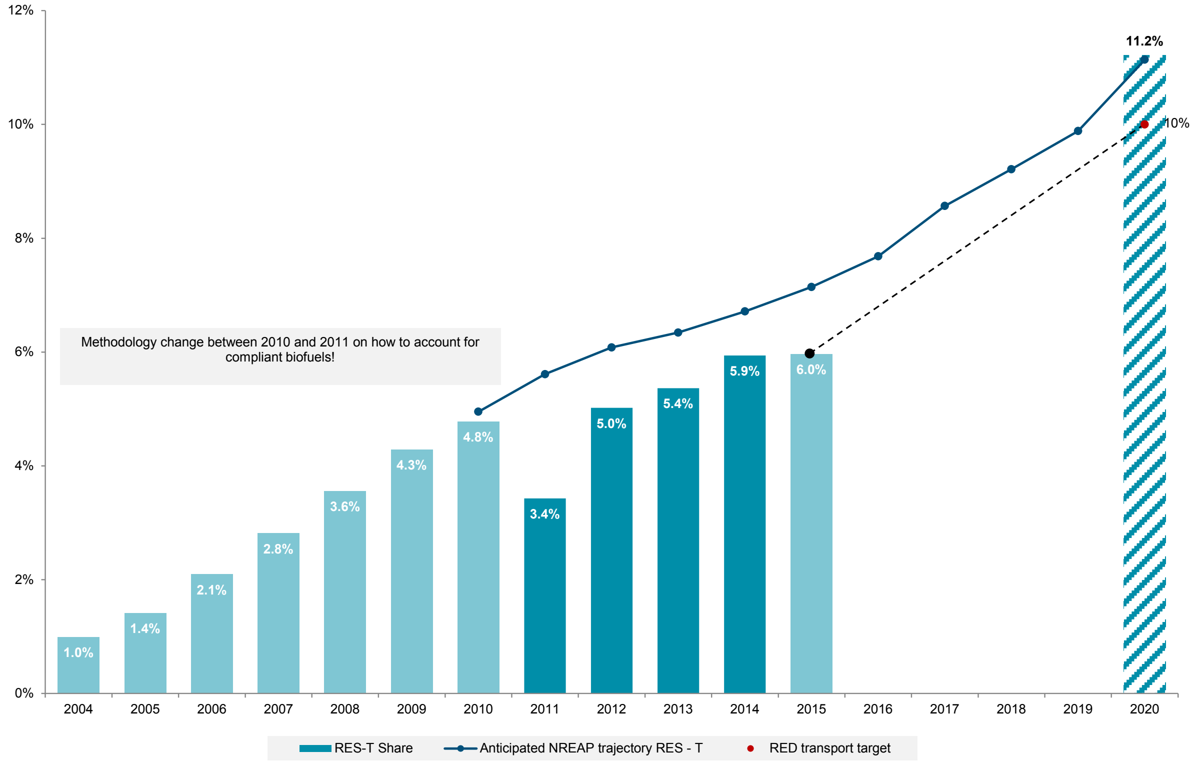
[16] To calculate transport RES shares in line with the RED, sector-specific rules apply in order to emphasise the difficulty of deploying RES in this sector. This is laid out in Article 21(2) of the RED: *The contribution made by biofuels produced from wastes, residues, non-food cellulosic material, and ligno-cellulosic material shall be considered to be twice that made by other biofuels.*

The EU Reference Scenario 2016 projects a transport RES share of 11.2 % in 2020 which is 0.1 percentage points above the aggregated EU-28 NREAP trajectory (11.1 %) and 1.2 percentage points above the 10 % target for this sector. It must also be recalled that the EU Reference Scenario 2016 calculates RES-T share on the basis of the ILUC amendments to the RES Directive. As such, these results are not directly comparable to the NREAP trajectory, which was based on an earlier version of the calculation method for the RES-T share.

Yet, current progress reveals that efforts between 2015 and 2020 will need to be increased to ensure that the transport target will be met (see dashed line in Figure 1-9).

Figure 1-9: EU-28 renewable energy shares in transport vs. NREAP trajectory and 2020 RED target



Source: [2, 5, 9]; own calculation based on Table 4a and Table 3 of Member States NREAPs based on [8] and [4]

Note: 2015 values approximated by EEA (date: 04/10/2016).

Please note, that before 2011 all biofuels were counted as compliant biofuels, while starting in 2011 methodological changes occurred.

1.2.5. Member State progress per sector

Summary

Electricity

Preliminary estimates for 2015 indicate that thirteen Member States stayed below their planned NREAP trajectory in 2015. A closer analysis of the RES share evolution revealed that during the last years (2014 and 2015) the European trend was mainly initiated by the reduction of electricity consumption across the EU. The 2014 increase and the approximated growth for 2015 in the renewable electricity share mask weaker momentum than in the past. Most of the major European Union players that had decided to develop their renewable electricity sectors reduced their investment budgets.

Heating & Cooling

Preliminary estimates for 2015 indicate that 25 Member States have exceeded their plans for the year. The evolution of heating and cooling demand each year is dependent on climatic conditions. For example, 2011 and 2014 were characterized by mild winters, which resulted in lower heating consumption compared to other years. Also 2015 was considered a rather warm year. During these years, the consumption of renewable heating and cooling also dropped but not as much as overall heating and cooling consumption. This is coupled with efforts made by countries to reduce the heating & cooling consumption through incentives which foster energy efficient behavior.

Transport

Preliminary estimates indicate that 8 Member States are estimated to have been in line or above their planned NREAP trajectories in 2015. In general, the development of RES-T shares is much slower than in the other sectors due to the challenging nature of the sector, which currently exhibits relatively high mitigation costs and political uncertainty. The development of biofuels in the EU was impaired from 2013 onwards by the long legislative debate that lasted between October 2012 and September 2015 on the impact of conventional food and feed-crop based biofuels on indirect land use change and accociated GHG emissions. The final approved text of the ILUC directive was adopted only on 9 September 2015. As a result of this lengthy process, Members States took national, uncoordinated stances on their incorporation rates of second generation biofuels developments and some of them revised their incorporation rates of first generation biofuels.

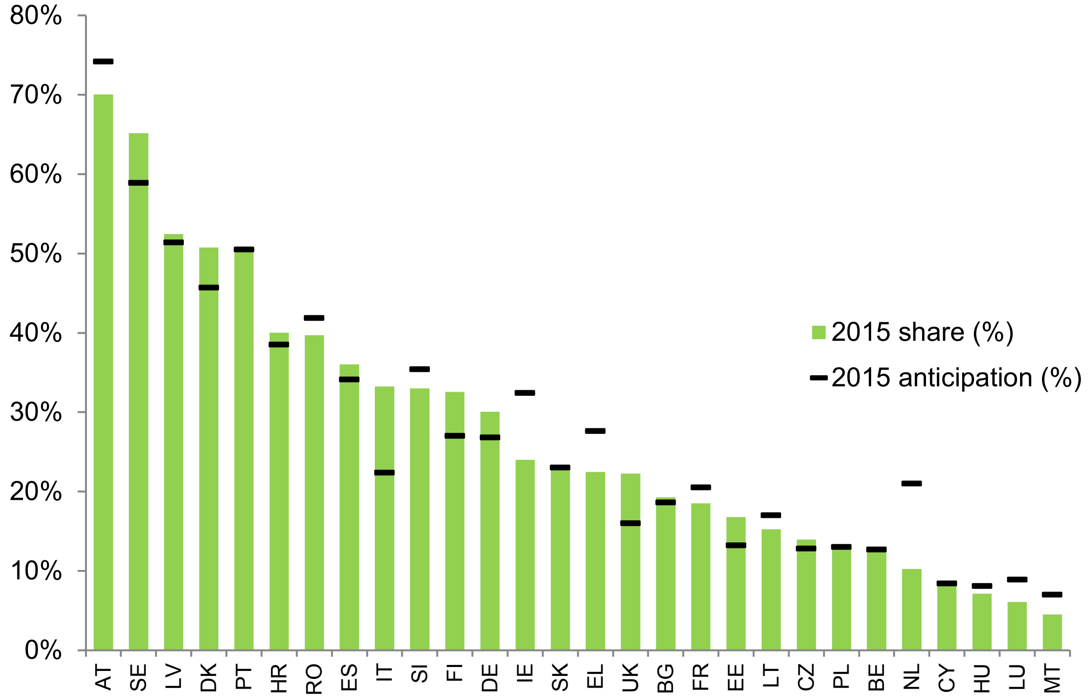
1.2.6. Electricity

According to Member States' NREAPs, more than one third of the EU-28 electricity consumption will come from renewable energy sources in 2020. The share of renewable energy sources in electricity is anticipated to reach approximately 34% in 2020.

According to these reports, during the period 2010-2015, the European Union saw a significant development of the RES-E share in almost all Member States. Over these years, the RES-E share rose from 19.7% in 2010 to 27.5% in 2014 and the expected share for 2015 is around 28 %. Thus the EU-28 as a whole is ahead of its planned NREAP trajectory in 2014.

Figure 1-12 presents the estimated 2015 situation for each Member State regarding their RES-E share and their planned NREAP trajectory. Member States are ranked according to their approximated 2015 RES-E share.

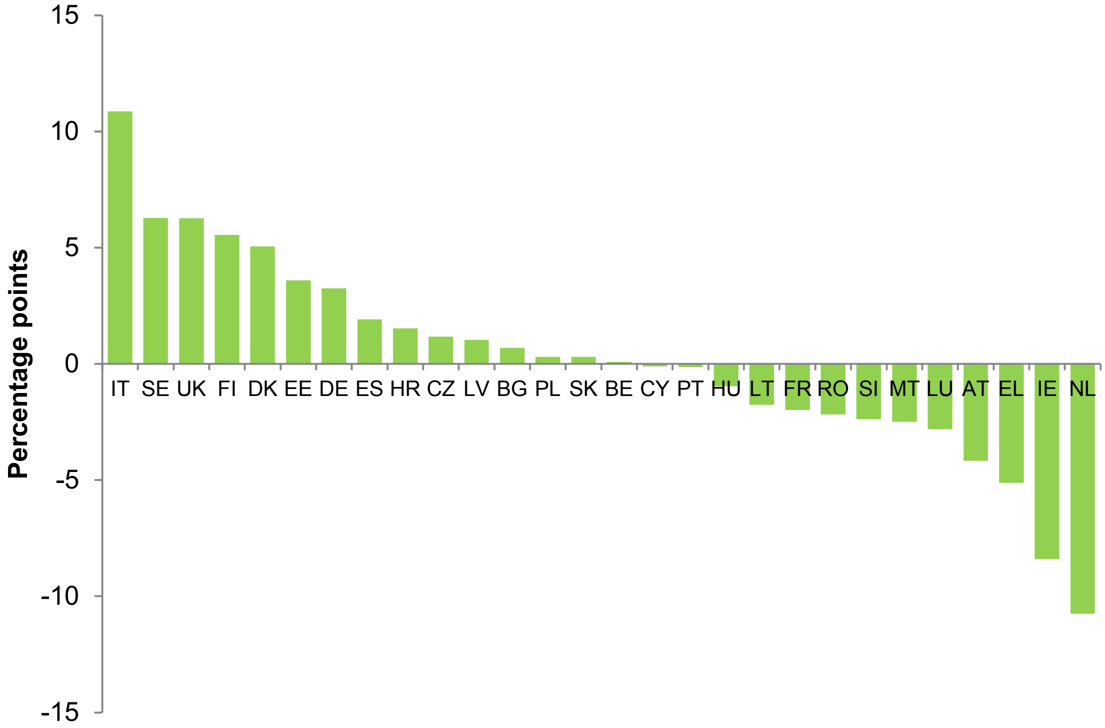
Figure 1-10: Member States approximated 2015 RES-E share compared to their anticipated 2015 trajectory



Source: Member States' NREAPs Table 3 for 2015 anticipated share – EEA (date: 4/10/2016) for estimated 2015 share

Thirteen countries are expected to have stayed below their planned NREAP trajectory in 2015. The figure below presents a classification of the EU-28 Member States according to their deviation of the estimated share from the anticipated target for RES-E share in 2015. This figure shows that the most significant achievements are estimated for Italy, Sweden and the UK (see Figure 1-11).

Figure 1-11: **Deviation of approximated 2015 share from 2015 anticipated share for RES-E**



Source: calculated from EEA (date: 4/10/2016) and NREAPs table 3

A decrease in the European electricity demand

A closer analysis of the RES share evolution has revealed that during the last years (2014 and 2015) the European trend was mainly initiated by the reduction of electricity consumption across the EU. While the renewable electricity share grew quite clearly in 2014, it was caused by dwindling demand for electricity across the European Union. Data from Eurostat SHARES illustrate that gross electricity consumption continued to drop between 2013 and 2014 (by 2.4 %, from 279.6 to 272 Mtoe), more than between 2012 and 2013 (when it dropped by 1%). The effect of the drop in requirements is significant, for while total electricity consumption was stable, the renewable electricity share increased only by 1.2 points. This disparity between the rise in the numerator and fall in the denominator, confirms the European Union electricity production trend placing less reliance on conventional sources (coal, natural gas, nuclear and oil).

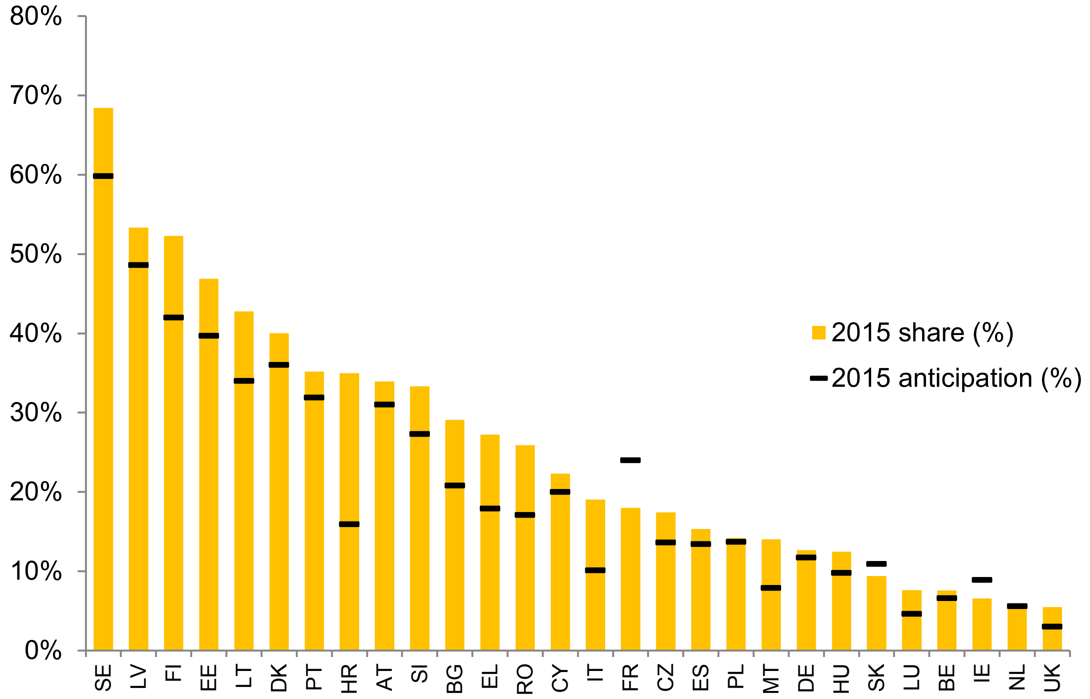
Thus the 2014 increase and the expected growth for 2015 in the renewable electricity share mask the weaker momentum of the past. Most of the major European Union players which had decided to develop their renewable electricity sectors slashed their investment budgets. This may initially come as a surprise since certain sectors such as wind energy and solar power have become competitive with the conventional sectors, with much lower production costs than during the large-scale expansion drive in the middle of the last decade.

1.2.7. Heating & Cooling

In the European Union, the share of renewable energy in heating and cooling (H&C) consumption went up from 15 % in 2010 to 18 % in 2015. This share is above the aggregated planned NREAP trajectory. The final anticipated objective for 2020 is around 21 %.

The figure below presents the gap between estimated 2015 RES-HC consumption and 2015 planned trajectory per Member State. Member States are ranked according to their estimated 2015 RES share in H&C.

Figure 1-12: Member States approximated 2015 RES-HC share compared to their anticipated 2015 trajectory

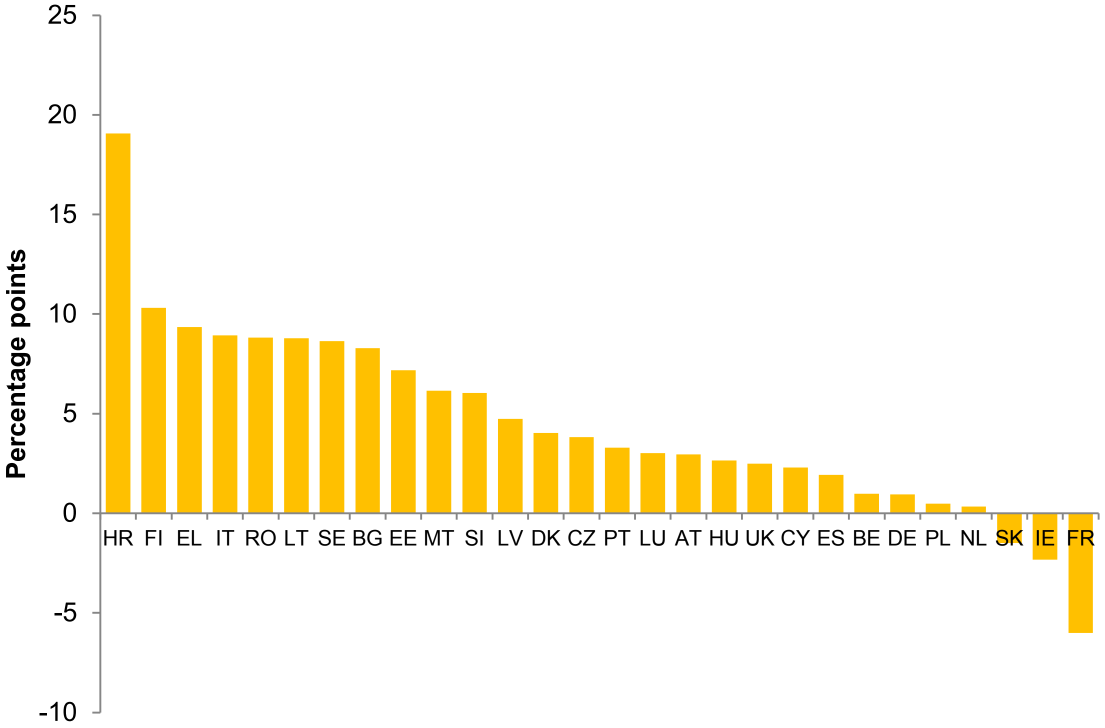


Source: Member States' NREAPs Table 3 for 2015 anticipated share – EEA (date: 4/10/2016) for estimated 2015 share

25 Member States are estimated to have exceeded their anticipations for the year 2015.

The following graph offers a picture of the situation in 2015. It shows the spread between the estimated renewable energy consumption in heating & cooling and what had been anticipated in the NREAPs. A group of 11 countries is estimated to be at least five points above their anticipation for 2015.

Figure 1-13: Deviation of approximated 2015 deployment from 2015 planned NREAP trajectory



Source: calculated from EEA (date: 4/10/2016) and NREAPs Table 3

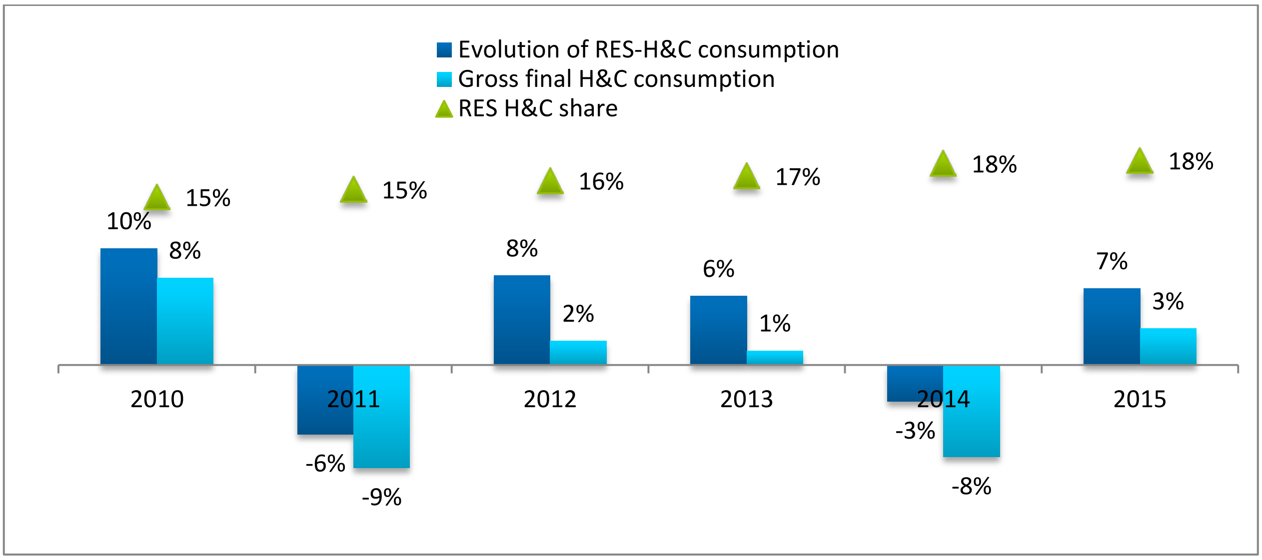
A global decrease in heating and cooling consumption

RES-HC is dependent of the overall heating and cooling consumption trend. The abnormally warm years of 2014 and 2015 with their exceptionally mild winters reduced heating needs over much of Europe (specifically in the Nordic countries, Western and Central Europe). Moderate temperatures therefore led to lower fuel consumption overall, starting with natural gas and heating oil, and also solid biomass whose use of firewood fell. Electricity generation is less dependent on the vagaries of climate, with the exception of a few countries like France and Sweden where electric heating technologies are prominent energy sources.

The rise of the share of RES-HC consumption relies on two streams. The consumption of RES-HC rose 4 % from 2010 to 2014 in parallel to a reduction of 14% of the total H&C consumption. Therefore the numerator of the ratio increased while the denominator decreased (see Figure 1-14).

As indicated above, the evolution of heating and cooling demand each year is dependent on winter temperatures. As an example, 2011 and 2014 were characterized by mild winters, which resulted in lower heating consumption compared to other years. During these years, the consumption of renewable heating and cooling also dropped but not as much as overall heating and cooling consumption. This is coupled with efforts made by countries to reduce the heating and cooling consumption through incentives which foster energy efficient behavior. It is estimated that the consumption of RES-HC increased on the EU-level by 7 % between 2014 and 2015. Moreover, the RES-HC consumption is estimated to have reached 91.7 Mtoe in 2015 which represents an increase of 11% since 2010.

Figure 1-14: **RES-HC and gross final H&C consumption trends in the EU-28 (2010-2015)**



Source: Eurostat SHARES 2014 (2010-2014) and EEA (date 4/10/2016)

1.2.8. Transport

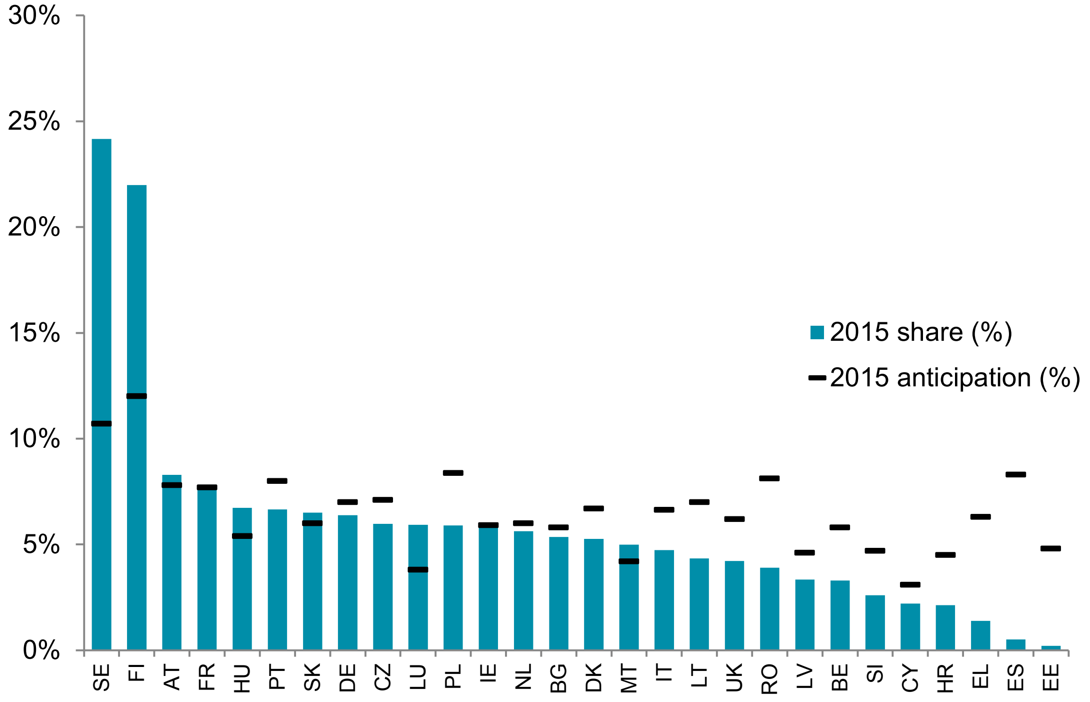
As already mentioned in this report, the current 2014 share of renewable energy sources in transport on EU-28 level is 5.9 % of gross final energy consumption, while the aggregated EU-28 NREAP trajectory, including electricity, would indicate a target of around 6.7 %. Thus the EU-28 as a whole was below its planned NREAP trajectory for transport in 2014.

In 2015 the EU-28 is approximated to have stayed around 6.5 Mtoe below its planned NREAP trajectory for transport.

In the past, the EU-28 was always below its planned NREAP trajectory. RES-T share rose from 4.8% in 2010 to 5.9% in 2014, and the expected share for 2015 is estimated around 6% as compared to more than 7% according to the planned NREAP trajectory. However, the European Union saw some progress of the RES-T share in almost all Member States.

The following figure presents the approximated 2015 situation for each EU-28 Member State regarding their RES-T share and their planned trajectory from their NREAP. Member States are ranked according to their estimated 2015 RES-T share.

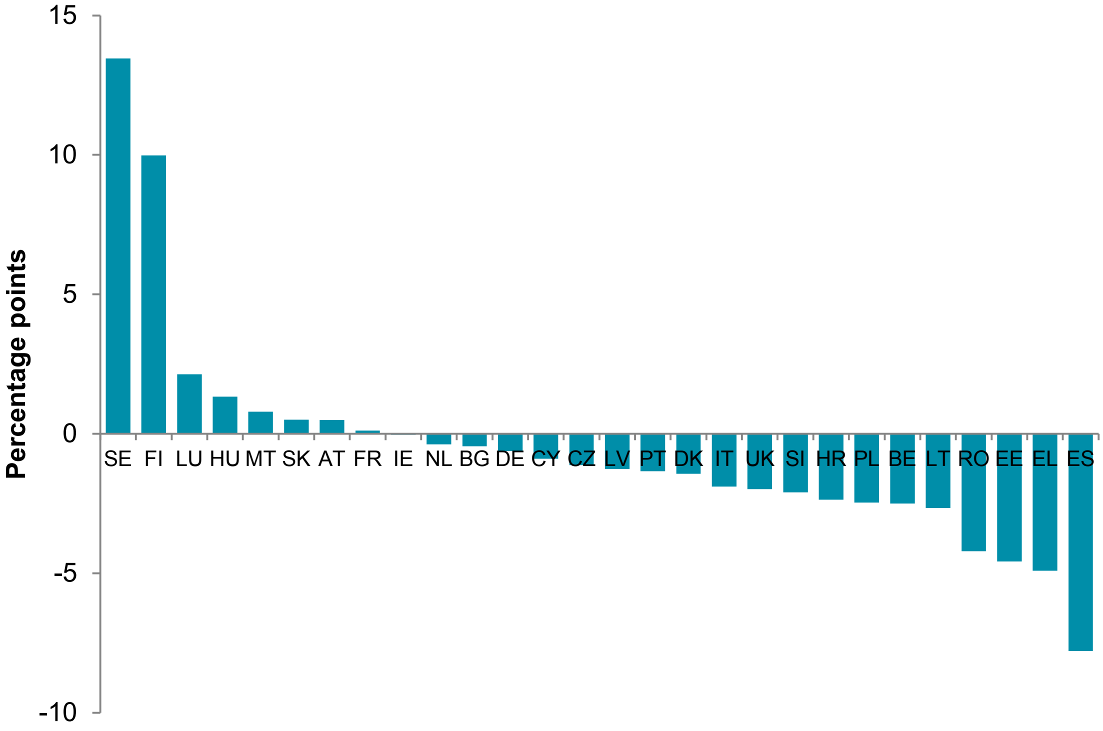
Figure 1-15: **Member States 2015 RES-T share compared to their anticipated 2015 trajectory**



Source: Member States' NREAPs table 3 for 2015 anticipated share – EEA (date: 4/10/2016) for estimated 2015 share

The figure below represents the deviation of MS as compared to their target share for RES-T in 2015. Eight countries are estimated to be in line or above their anticipated NREAP trajectories.

Figure 1-16: Deviation of actual 2015 share from 2015 target share for RES-T (in percentage points)[17]



Source: Calculated from EEA (date 4/10/2016) and NREAPs table 3

In 2013, biofuel consumption suffered from its first drop since the implementation of the first biofuels directive in 2003. The development of biofuels in the EU was impaired by the long legislative debate on the the impact of conventional biofuels produced from food and feed-crops on indirect land use change. The debate resulted in the adoption of the ILUC directive on 9 September 2015. The main effect of the new directive which amends both the directive on petrol and diesel fuel quality and the Renewable Energy Directive is to limit the contribution of biofuels produced from cereal, sugar and oilseeds on farming land to the renewable energy targets to 7 % of transport energy consumption. The overall 10 % renewable energy target in transport is retained, while the remaining 3% can only be obtained through electric mobility or by using biofuel produced from specific feedstocks that benefit from double accounting (listed in Annex IX of the directive). The directive also stipulates that every Member State sets an indicative national target for incorporating “advanced biofuels” (Annex IX, Part A) by 6 April 2017.

As a result of this lengthy process, Members States took national uncoordinated stances on their incorporation rates of second generation biofuels developments, while some revised their incorporation rates of first generation biofuels.[18]

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[17] The value for Spain is based on the volume of biodiesel consumed without taking into account the sustainability criteria, otherwise Spain would have had no biofuels to report since they have not implemented a valid certification system yet.

[18] This contextual information is taken from the EurObserv’ER barometers 2014, 2015, 2016.

1.3. Progress in deploying renewable energy technologies

1.3.1. Progress in EU-28 renewable energy deployment by technology

Summary

Electricity

In 2015, the largest contributions to renewable energy shares within the RES-E sector are estimated to have stemmed from hydropower, onshore wind and biomass. The strongest performer in terms of growth was onshore wind at a steady rate of 1.6 Mtoe of added consumption per year during 2010–2015. Photovoltaics have been a mixed bag with a growth peak in 2011 and 2012, but lower growth rates each year since then (now at less than 1 Mtoe/a). The growth of onshore wind and photovoltaics is driven by specific Member States and their particular support schemes. Biomass has been growing slowly but steadily, at 0.8 Mtoe/a, while growth in hydro, geothermal, and other sources has been negligible.

Heating & Cooling

The largest contribution to renewable heating and cooling by far stems from biomass. However, biomass consumption remained fairly constant in 2010–2015, mainly due to the fact that in many Member States biomass use is dominated by traditional technologies (e.g. wood stoves), where growth rates are low or even negative. Smaller contributions are made by heat pumps, solar thermal, and geothermal energy. The strongest performer in terms of growth were heat pumps at close to 1 Mtoe of added consumption every year. Growth in geothermal energy consumption has been negligible in relation to overall H&C consumption, while solar thermal has shown slow growth of about 0.1 Mtoe per year.

Transport

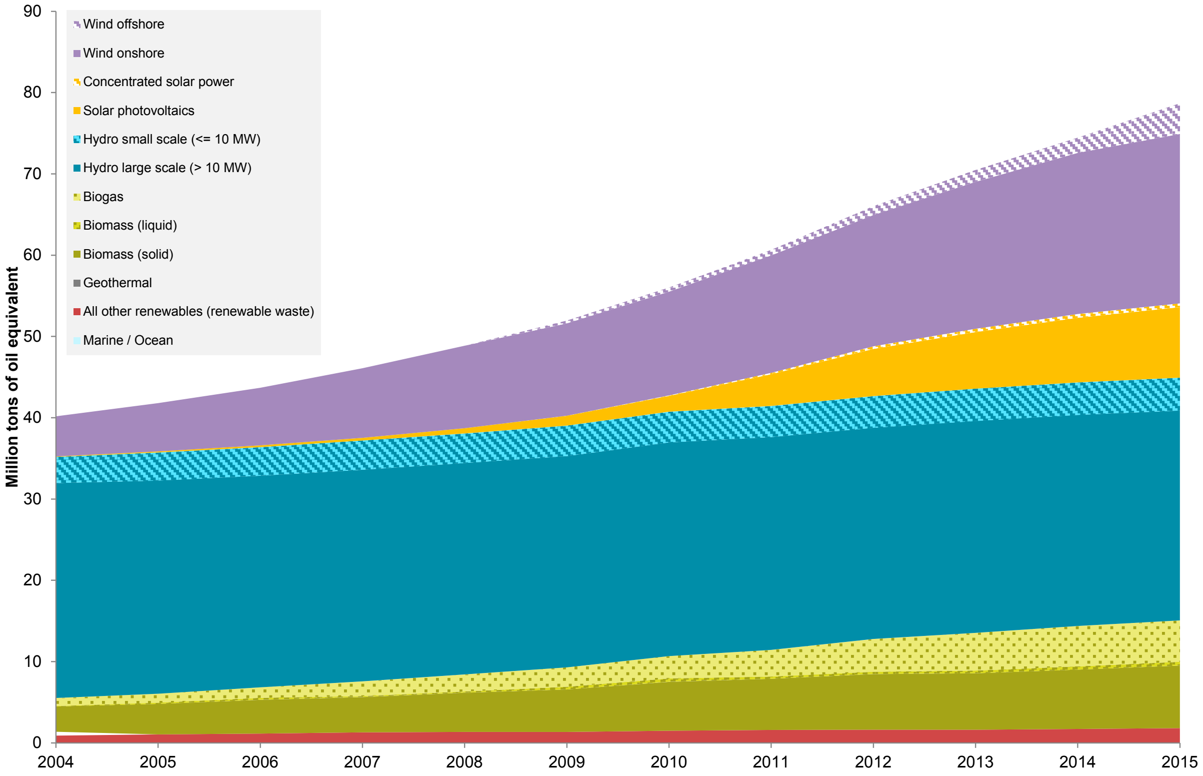
Road transport is the largest consumer of transport energy, and biofuels remain the largest source of renewable energy in this sector. The largest contributions to RES-T consumption are thus made by biodiesel and bioethanol. Both technologies had been growing steadily until 2011, when accounting rules for compliant biofuels changed. They have not shown a significant growth trend after that. Renewable electricity grew, albeit very slowly, at a rate of about 0.1 Mtoe per year over the 2010–2015 period. Its situation remains difficult: Until recently, electricity for cars had not yet been available in road transport, and to date remains a rather costly alternative source of energy. Furthermore, the associated infrastructure for electric road mobility still needs to be expanded for a more comprehensive uptake. However, because of the hiatus in biofuel growth, renewable electricity has been able to slightly increase its share in RES-T over the past years.

The EU-28 actual renewable energy deployment by technology from 2004- 2014/5 is shown in Mtoe in Figure 1-17 for electricity, Figure 1-18 for heating & cooling and Figure 1-19 for transport. Table 3-2 in the Annex summarises the results shown.

Table 3-1 in the Annex provides information on approximated 2015 deployment compared to the 2015 aggregated anticipated EU-28 NREAP trajectory.[19] Further insights about the deployment of the several technologies mentioned below are provided in Annex 3.1.1, 3.1.2, 3.1.3 where the deployment is displayed in relation to the aggregated, anticipated EU-28 NREAP trajectory.

1.3.2. Electricity

Figure 1-17: EU-28 renewable electricity production by source



Source: Aggregated from [2, 9];

Note: 2015 values approximated by EEA (date: 04/10/2016).

Hydropower plants still generate the largest share of electricity from renewable energy sources, while its share of total **renewable** gross final energy consumption declined from 74 % in 2004 to 40 % in 2014 and an approximated 38 % in 2015. This is due to the expansion of the deployment of other renewable energy sources, most prominently wind and solar photovoltaics, but also due to a lack of further eligible sites. As can be seen in Table 3-2 in the Annex, the actual contribution is rather steady at around 30 Mtoe (normalised large- and small-scale hydro together). Information on

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[19] The nature of the 2015 values needs to be highlighted here: 2015 proxy estimates are calculated in order to gain insights into what 2015 renewable deployment may look like before the complete set of empirical information becomes available. The values are based on calculations which necessarily have a specific cut-off date after which no further information can be taken into account (31/07/2016). The proxy values used in this report have been consulted with European Member States and have been revised according to Member States' comments. Therefore they reflect the best available and consulted knowledge to date (04/10/2016).

how normalised hydropower electricity generation compares to the EU-28 planned NREAP trajectory is highlighted in Figure 3-1 and Figure 3-2 in the Annex. In 2015, the contribution of normalised hydropower is approximated to have stayed at a level of 30 Mtoe. These figures also emphasise the relatively stable nature of deployment of hydro across the years.

The deployment of normalised **wind power** for electricity generation more than quadrupled (from 5 Mtoe to 21.7 Mtoe) over the period of 2004-2014. Onshore wind deployment has remained rather close to the anticipated EU-28 NREAP trajectory throughout the years (Figure 3-3). The deployment of wind power for 2015 is approximated to have been 24.6 Mtoe; an increase of 13.8 % compared to 2014.

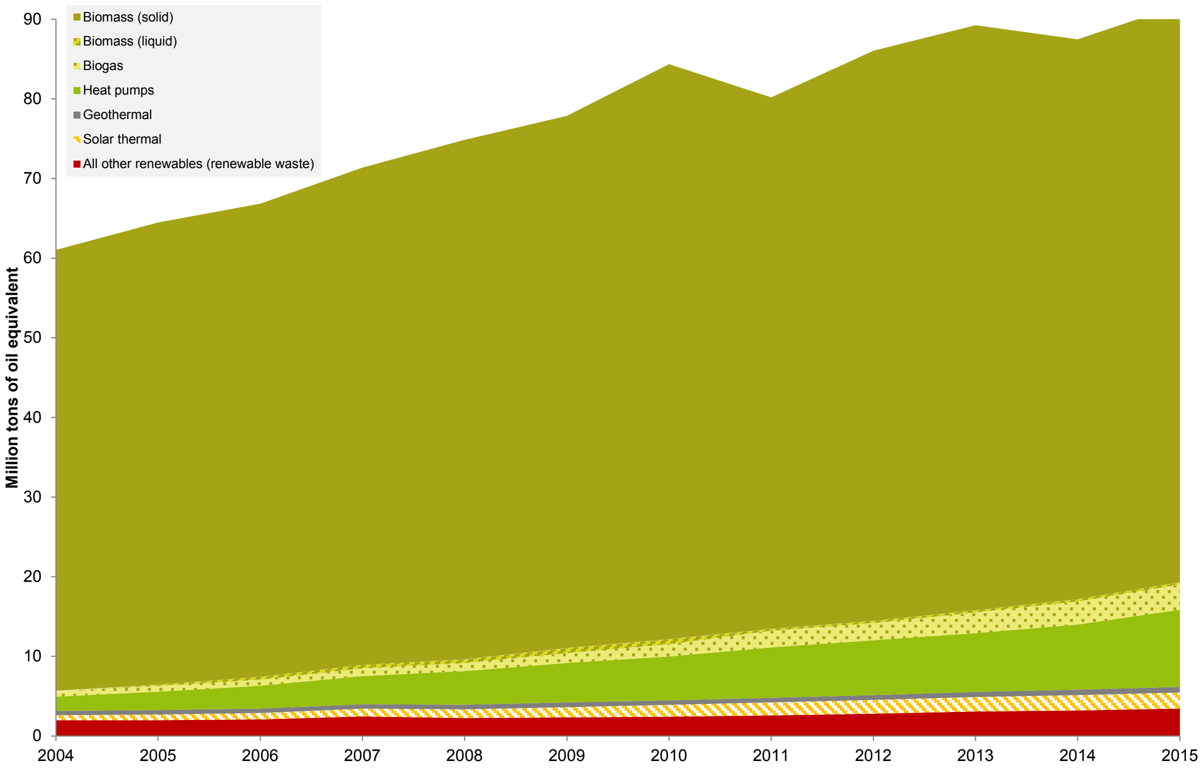
The deployment of **solar power** in electricity generation grew from 0.1 Mtoe to 8.4 Mtoe over the period of 2004-2014 (on average over 63 % increase per year). **Solar** electricity generation has increased rapidly in the past and in 2014 accounted for 11 % of all **renewable** electricity. Also, in 2014 the electricity generated from solar photovoltaic energy remained the third most important contributor to the electricity production from renewable sources. In 2013 its deployment had surpassed that of solid biomass for the first time. Figure 3-5 highlights the steep increase in deployment of this energy carrier, compared to the aggregated anticipated EU-28 NREAP trajectory, which was surpassed by deployment in any given year. With an approximated electricity generation from solar sources of 9.1 Mtoe in 2015 this trend is estimated to continue, and electricity generation in 2015 is estimated to have been 9 % higher than in 2014.

The share of **solid renewables** (wood and other solid biomass, excluding renewable wastes) grew from 1.1 % (3.1 Mtoe) in 2004 to 2.7 % (7.3 Mtoe) in 2014. In 2015 solid renewables are approximated to have been deployed at a level of 7.7 Mtoe; i.e. growing by 5.4 % between 2014 and 2015.

The deployment of **biogas and bioliquids** combined, both deployed at negligible levels in 2004 (1.0 Mtoe and 0.1 Mtoe), reached 2.0 % (5.0 Mtoe and 0.4 Mtoe) of total gross final electricity consumption in 2014. In 2015 biogas is approximated to have been deployed at a level of 5.5 Mtoe, while bioliquids will have contributed around 0.5 Mtoe.

1.3.3. Heating and cooling

Figure 1-18: EU-28 renewable heating and cooling production by source



Source: Aggregated from [2, 9];

Note: 2015 values approximated by EEA (date: 04/10/2016).

Solid biomass continued to remain by far the largest contributor to renewable heat production in 2014. In this year, 70.3 Mtoe (14.2 % of total gross final energy in heating & cooling) of total gross final energy consumption in heating and cooling stemmed from this energy source. Figure 3-8 highlights that deployment has surpassed the aggregated anticipated EU-28 NREAP trajectory in any given year. For 2015 a further increase to 72.5 Mtoe is approximated.

The deployment of **heat pumps** steadily increased from 1.8 Mtoe in 2004 to 8.2 Mtoe in 2014 (see also in comparison to EU-28 planned NREAP trajectory in Figure 3-9). In 2015 a further increase of 1.5 Mtoe to a level of 9.7 Mtoe is approximated.

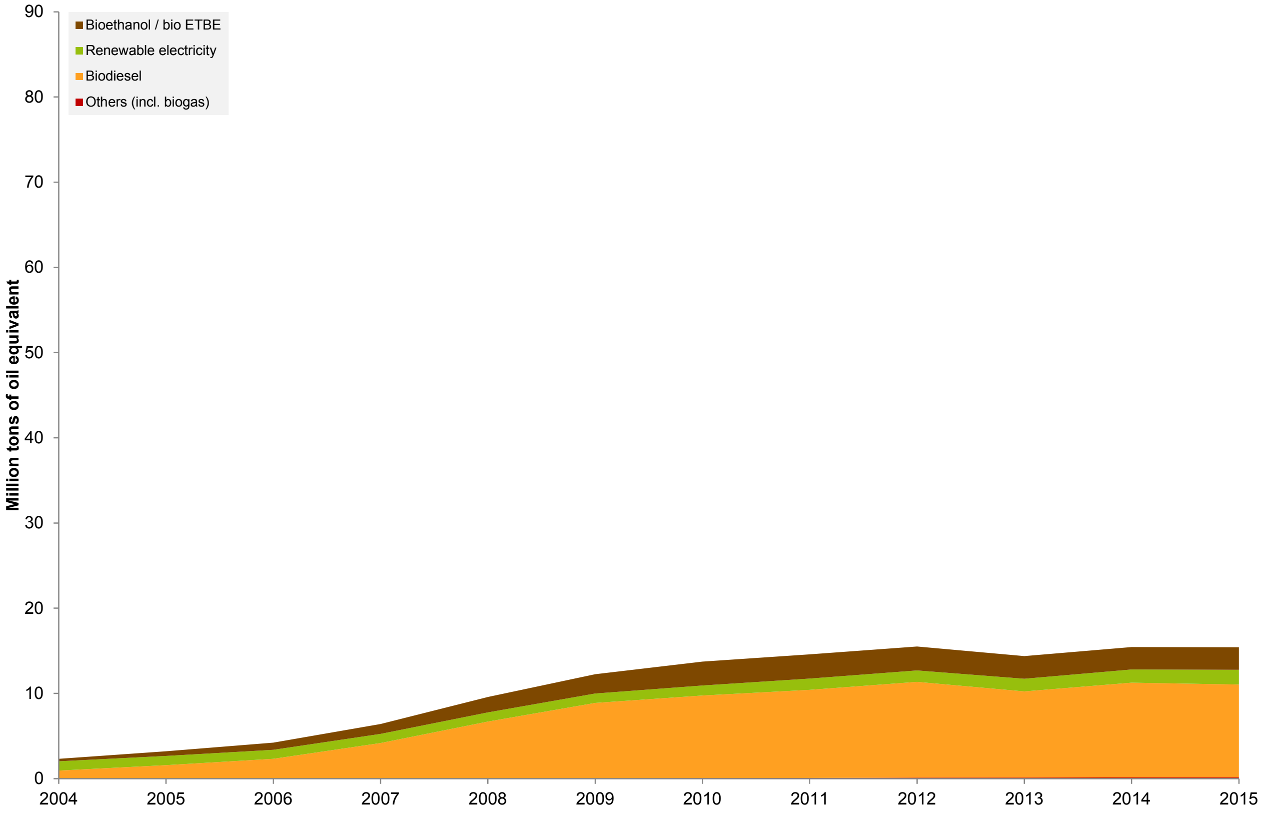
Renewable waste deployment amounted to 3.2 Mtoe (or 0.7 %) in 2014 and is approximated to increase slightly to 3.4 Mtoe in 2015.

While the share of **biogas** in heating and cooling was negligible in 2004 (0.7 Mtoe or 0.1 %), in 2014, 2.9 Mtoe (0.6 %) of heat was produced from **biogas**. The deployment of biogas compares well to the planned NREAP trajectory – the trajectory has been surpassed at increasing levels since 2010 (see Figure 3-10). Based on approximated 2015 values (3.2 Mtoe), this trend is expected to continue.

Solar thermal heat production, with 1.9 Mtoe in 2014, still contributes relatively little to renewable energy use in the heating and cooling sector and is approximated to have increased only slightly to 2.0 Mtoe in 2015.

1.3.4. Transport

Figure 1-19: EU-28 renewable energy in transport, by source



Source: Aggregated from [2, 9]

Note: 2015 values approximated by EEA (date: 04/10/2016).

Renewable energy deployment in the transport sector has seen less progress than in the electricity and heating and cooling sectors. The EU share of renewable energy in transport reached 5.9 % in 2014 (compare Figure 1-9). 2015 approximations indicate a 6.0 % share.

The most prominent source of renewable energy in transport remains **biodiesel** with an actual deployment of 11.1 Mtoe (3.8 % of total gross final energy consumption in transport) in 2014. The deployment, however, still lags behind what is indicated in the planned NREAP trajectory. The same holds true for approximated 2015 deployment (10.9 Mtoe) (compare Figure 3-12).

Bioethanol / bio ETBE was the second largest contributor of renewable energy sources to the transport sector in 2014 (2.6 Mtoe or 0.9 % of total gross final energy consumption in transport). The deployment, however, still lags behind what is indicated in the planned NREAP trajectory. The same holds true for approximated 2015 deployment (3.1 Mtoe). (compare Figure 3-11)

In 2014, **renewable electricity** contributed 1.5 Mtoe (0.5 %) to gross final energy consumption in transport (see Figure 3-13). Over the period of 2004-2014 this contribution remained rather stable, with the lowest deployment at 0.3 % (2006-2008) and the highest at 0.5 % (2012-2014) of total gross final energy consumption in transport. In 2015 a deployment of 1.7 Mtoe is approximated.

Other renewable energy sources (including biogas) do not play a prominent role in the transport sector on EU-28 level, but are deployed at visible levels in some Member States (e.g. in Sweden and Finland).

The share of biofuels produced from **wastes, residues, ligno-cellulosic and non-food cellulosic material**[20] in the EU biofuel mix has increased from 1% in 2009 to an approximated 23% in 2015. This development is mostly driven by the United Kingdom, Germany, Finland and Sweden[21].

1.3.5. Contribution of the building sector in exporting renewable energy generated on buildings (as defined in Article 13.4. of the Renewables Directive) to the energy sector (EU-28)

Both the RES Directive [9] and the Energy Performance of Buildings Directive [20] encourage the building sector to install RES capacities in and on buildings; thus the building sector is contributing to the fulfilment of RES targets in each of the Member States.

In this section the contribution of the building sector to exporting renewable energy to the energy sector is approximated. For the analysis only those buildings are deemed relevant that mainly serve another purpose than the production of energy (e.g. excluding the power house of a hydropower plant). This includes, for instance, residential buildings or commercial/industrial buildings in which people are living and/or working. If for such buildings a RES device is installed on the roof or façade or a conversion plant (e.g. a boiler) is installed within the building then it is accounted for in the analysis. The use of renewable sources to produce industrial process heat is not accounted for under the building category.

For the analysis two input factors are relevant:

a) the share of the overall RES capacity (per technology) installed on or in residential and commercial buildings, respective to the electricity and heat generation from these plants and

b) the share of the respective RES generation that is consumed within the building (self-consumption) respective to the share of RES generation that is fed into the grid and thus physically exported to the energy system.

The analysis has been conducted based on the combination of the best data available from the other working steps and beyond. The methodology for deriving estimates of the building sector's RES share follows the following approach:

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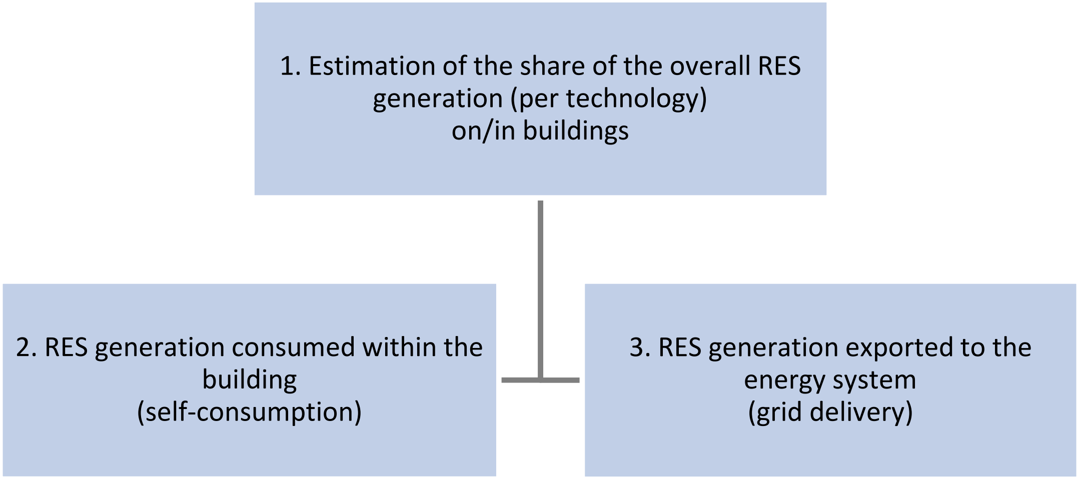
[20] Former Article 21(2) of Directive 2009/28/EC

[21] Eurostat and EEA 2015 proxies

Figure 1-20: Analytical approach towards determination of RES generated in the building sector which is exported to the energy sector



Source: Authors' own representation

The approach is described further in Section 3.4.6. Table 3-4 summarises the results on the EU-28 level. It is important to note that all estimates carry a considerable margin of error, since the data availability is at best patchy, and a considerable number of assumptions need to be made.

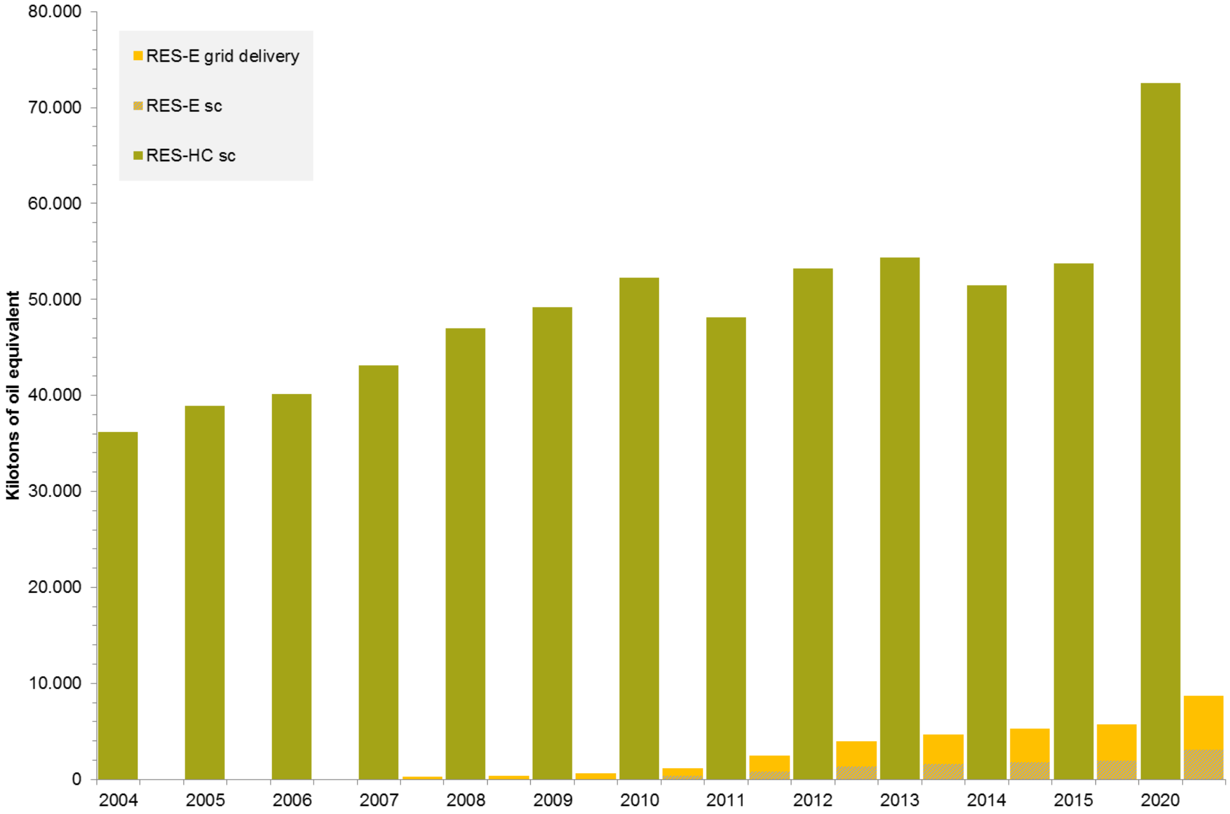
Current situation

In 2015 an estimated volume of about 53.7 Mtoe of RES-H/C was generated in or on buildings (see Table 3-4). This corresponds to about 59 % of the overall RES-H/C generation in 2015. RES-H/C production on/in buildings involves heat and cold from biomass, solar thermal and heat pumps (see Figure 1-20). It is assumed that the whole amount of RES-H/C generation is consumed within the building (self-consumption), neglecting the small share of RES-H/C generation produced on/in buildings that is fed into a heating network (e.g. a solar collector installed on a building connected to a local district heating grid). In 2015 an estimated volume of about 5.7 Mtoe RES-E (stemming from solar PV) was generated on buildings, corresponding to about 7 % of overall RES-E generation. It is assumed that about 1.9 Mtoe of solar PV goes into self-consumption, as defined in the analysis (see description of the methodology in Section 3.4.7.2).

Projected situation

RES-HC generation in or on buildings in 2020 is estimated to amount to approx. 72.6 Mtoe, corresponding to about 59 % of overall RES-HC generation. For RES-E an estimated volume of approx. 8.7 Mtoe will be generated by rooftop solar PV corresponding to about 8 % of overall RES-E generation. Assuming that in 2020 about 5 % of all buildings with rooftop PV will be equipped with a battery system, self-consumption will be in the range of 3.1 Mtoe.

Figure 1-21: EU-28 renewable energy generation on/in buildings



Sources: Authors' own calculations based on [2], [21], [22], [23–27], [28], [29], [30], [31], [32], [33], [34]

1.3.6. Progress in Member State renewable energy deployment by technology

Summary

Hydropower

According to preliminary estimates, in 2015, the EU-28 was on track with its aggregated planned NREAPs trajectory. The five countries with the most hydropower (Sweden, France, Italy, Austria and Spain) are approximated to have had a share of 70 % of all hydropower in the EU-28. As hydropower capacities are only slowly evolving across Europe, rainfall patterns primarily determine annual changes in hydroelectricity production. Despite the low total growth rate anticipated up to 2020 at the EU level, the importance of hydropower may grow, because it brings flexibility that allows the integration of high levels of renewables.

Onshore wind power

In 2015, preliminary estimates indicate the EU-28 onshore wind power generation to have been slightly below the aggregated planned NREAP trajectory. The largest contributions are approximated to have come from Germany and Spain. Onshore wind is a rather mature and lower-cost RES technology. The NREAPs indicate that onshore wind could increase to over 30 Mtoe in 2020. Although most Member States offer sufficient financial support for onshore wind generation, its deployment is often slowed down by barriers other than cost, such as spatial planning issues and long lead times for administrative and grid access procedures. Conflict with civil and military radars is also a rising issue for the technology development in most of the Member States.

Photovoltaic

In 2015, solar photovoltaic electricity production is approximated to have reached over 8 Mtoe, which was already more than the level expected for 2020 according an aggregation of NREAPs. Preliminary estimates indicate that in 2015, 38 % of European solar PV electricity was produced in Germany. Italy and Spain are approximated also with large shares, 22 % and 8 %, respectively. PV electricity generation has grown faster than the rate assumed in the NREAPs. The considerable growth in solar PV electricity has been driven by rapid technological progress, cost reductions and the relatively short project development times.

Biomass

Electricity generation from biomass on EU-28 level grew from around 9 Mtoe in 2010 to an approximated 13 Mtoe in 2015. However, this technology failed to reach the level planned for that year according to an aggregation of individual NREAPs. New projects are announced regularly accross EU-28 Member States and it is expected that the development of major biomass and co-firing plants will continue over the next few years. Solid biomass has had to compete with other, less expensive, RES technologies (like photovoltaic or wind power) and more and more projects have to deal with tensions over the use of wood raw material (between wood furniture industry or paper industry).

On the biogas side, the technology has developed faster than expected, especially in Germany and Italy. However, given policy changes, that growth is expected to slow down in the coming years. Though the status of European renewable urban waste development varies strongly by Member State, one could say that the Nordic countries: Sweden, Denmark, Finland and the Netherlands lead the way in developing this sector.

Renewable heating and cooling

Geothermal

With output approximated at 700 ktoe in 2015, geothermal technology deployment was below the NREAPs anticipated trajectory. Due to their high natural potential, three countries (Italy, France and Hungary) are leading European geathermal H&C production. The deployment of this technology is quite slow mainly due to very high capacity expenditures.

Biomass

Biomass remains the most important source of renewable energy for heating. The consumption of renewable heat originating from biomass increased from 74.4 Mtoe in 2010 to 75.9 Mtoe in 2015. Most biomass heat generation takes place in decentralised units. To realise the expected NREAP levels of solid biomass for 2020, a growth rate of only 1 % per year over the remaining period would be sufficient.

Heat pumps

In 2015, renewable energy from heat pumps reached a 9.7 Mtoe level, exceeding the indicative trajectory from NREAPs (7.3 Mtoe). Italy is the leading country, although most heat pumps sold in the country are primarily used for cooling. Although the European market of heat pumps has been slowing down since 2013, it should increase in the coming years. This will be achieved thanks to the revival of the housing market. Moreover, due to the influence of European directives, many countries are adopting constraining thermic regulations, which are encouraging the installation of heat pumps.

Solar thermal

The production of renewable heat from solar thermal technology reached a 2 Mtoe level in 2015 and widely failed by far to keep up with the expectations in the NREAPs (3 Mtoe). The market of solar thermal has been shrinking since 2009. The annual capacity installed in 2015 was below what had been installed in 2006. The overall turmoil of solar is not only due to warm winters and low prices of oil and gas. It is also stricken by the competition with other renewable technologies such as heat pumps or solar photovoltaic.

Renewable transport fuels

Biodiesel

Biodiesel is the main biofuel used for transport in the EU, representing an approximated 80 % of the total use of biofuels in transport in 2015. Despite this leading position, biodiesel is expected to have failed reaching the expected deployment anticipated by the NREAps trajectory for 2015 (10.9 Mtoe instead of 14.4 Mtoe). The main consumers of biodiesel are France, Germany and Italy, with over 1 Mtoe consumed each since 2009 already.

2013 showed a drop in biofuels consumption, which can be linked to the European legislative context. In 2014 the consumption resumed its growth with a 9.5 % increase. The provisional estimations for 2015 indicate a stagnation.

Bioethanol

The bioethanol / ETBE share of all biofuels consumption was around 20 % in 2015. Compared to the NREAPs anticipated trajectory, the technology failed by far the level expected in 2015 (2.6 Mtoe instead of 4.9 Mtoe). Main consumers in 2015 are estimated to have been Germany, the UK and France, followed by Spain, Sweden, Poland and the Netherlands.

1.3.7. Electricity

The following paragraphs present the results for the main RES used: Hydro, offshore and onshore wind, photovoltaic and solid biomass, as well as marine / ocean.

Hydropower

Hydropower is comprised of two distinct sub-sectors defined by a capacity threshold.

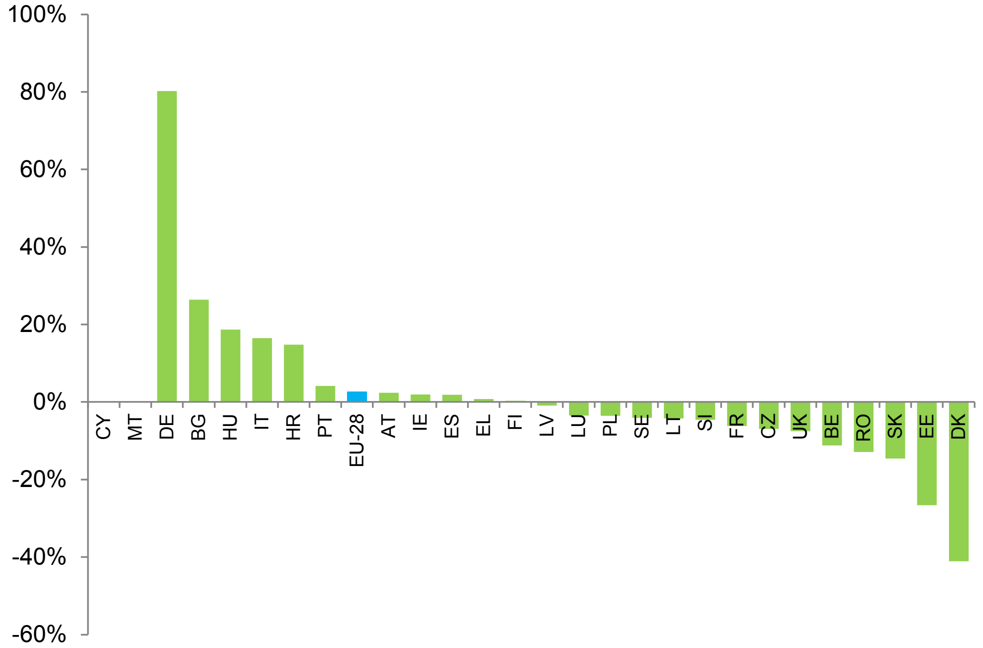
- small hydro whose plants capacity are under or equal to 10 MW
- large hydro whose plants capacity are above 10 MW

Large hydro is the most mature RES-E technology, with the majority of its potential already being exploited in most Member States. Thus, most countries have planned rather low growth rates regarding this technology. Nevertheless, large hydro is the most important RES-E technology in Europe and several countries such as France, Italy or Austria base large parts of their RES-E production on it.

For about a decade, the development potential of small hydropower has been pressured by the European Water Framework Directive and the designation of listed areas with Natura 2000 protection. According to ESHA (the European Small Hydraulic Association), these regulations halved the sector’s economic development in some countries. Yet small hydropower plays an important role in the electricity supply system, for not only is it a renewable energy, but it is competitive at that. It also contributes to grid stability, as its plants are designed to respond immediately to fluctuations in electricity demand.

A handful of European Union countries are responsible for small-scale hydroelectricity generation. Sweden, France, Italy, Austria and Spain together contribute around 70 % of all hydropower production in the EU-28.The top six (Italy, Germany, France, Austria, Spain and Sweden) together account for 81 % of EU output and the top three together for 53 %.

Figure 1-22: **Deviation of approximated 2015 deployment from 2015 anticipated NREAP trajectories for hydro power (normalised; excluding pumping)**



Source: calculated from EEA (date 4/10/2016) and NREAPs Table 10b

The approximated 2015 hydro production in total was led by Sweden, followed by France, Italy and Austria. Ten Member States are estimated to have exceeded their planned NREAP trajectories in 2015. Most of them (except for Austria, Italy and Germany) are not significant countries regarding their hydro power capacity and production. France and Sweden are estimated to have lied below their anticipation, but as hydro production is deeply linked to the climate conditions, the picture may be different in the following years.

Onshore wind power

Onshore wind is a rather mature and thus lower-cost RES technology, and therefore takes on a significant role in the NREAPs of the large majority of Member States. During the 2010-2014 period, the development of wind power in Europe increased from 9 300 MW newly installed in 2010 to 12 520 MW in 2015.[22] This sector has become the second in terms of electricity production in the EU-28. In 2015, wind power generation is estimated at 24.6 Mtoe compared to 29.8 Mtoe for total hydropower, which remains the most important sector. However, 2010 was a turning point for the international wind energy business, because China became the first on the worldwide market. Since 2010, the gravity centre of the wind power market has lied in Asia, where the major part of the investments have been made. Thus, while there were 12,520 MW of capacity newly installed in the EU-28 in 2015, Asia reached a figure of more than 33,600 MW (including 30,500 MW for China alone). The biggest producers of onshore wind electricity in 2015 are estimated to have been Germany, Spain, the UK and France. Three of them are estimated to have remained slightly below their 2015 planned figures. Seven countries are estimated to have been above their planned trajectory in 2015 regarding electricity generation from onshore wind, six are estimated to have been more or less in line and 16 Member States below their anticipations. Since this technology is

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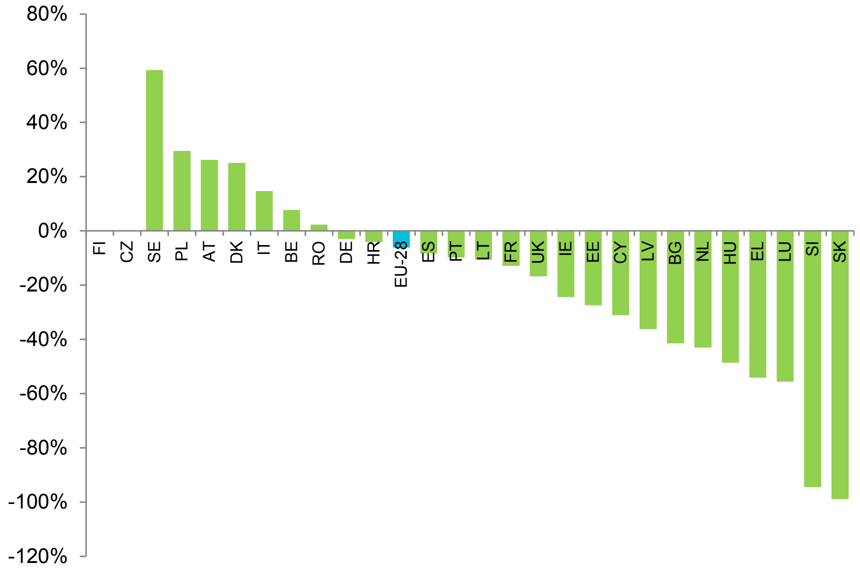
[22] 2016 EurObserv'ER wind power barometer

rather a mature and lower-cost RES technology, it is mainly non-economic barriers which hamper further development of onshore wind. Issues are for example found with respect to spatial planning, conflict with civil and military aviation constraints, long lead times for administrative and grid process procedures as well as local opposition and social acceptance. Such non-economic barriers are, for example, the major reason for the delay in development in France and the UK. In the Netherlands the technology-neutral support scheme –amond other reasons- led to lower deployment of onshore wind due to a focus of investments on low-cost renewable heating options.

Figure 1-23: Deviation of estimated 2015 deployment from 2015 planned NREAP trajectory for onshore wind



Sources: calculated from EEA (date 4/10/2016) and NREAPs table 10b

Offshore wind power

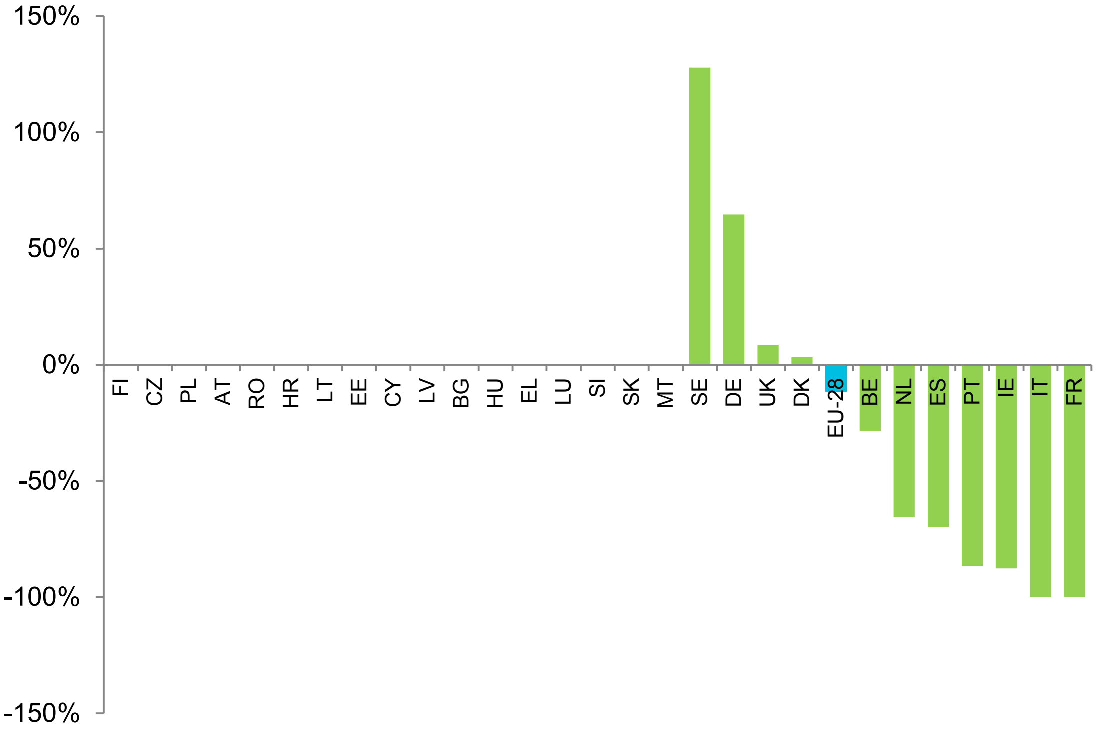
In 2009, only six European countries owned offshore installations for a total 352 ktoe electricity production. As of 2015, 10 countries have offshore wind farms and are approximated to produce ten times more than in 2009 (3,783 ktoe).

In 2015, the European Union offshore wind energy installation increased by 3,004 MW. This would put the EU's installed offshore capacity to date at 11,001 MW by the end of 2015, which equates to 8.8 % of its total wind energy capacity. Only three EU countries – Germany, the UK and the Netherlands – added to their offshore wind energy capacity in 2015. These countries provide a long term strategy for offshore wind combined with stable support schemes and reasonable planning for grid connection procedures.

11 Member States included anticipated offshore wind trajectories in their NREAPs: Sweden, Belgium, the Netherlands, Portugal, Finland, Germany, Denmark, Ireland, Spain, France, and the UK. Two countries (Sweden and Germany) are estimated to have been clearly above their planned trajectory, but the Swedish ambitions were quite moderate compared to the other countries in 2020. The UK and Denmark are also estimated to have been above their anticipated 2015 deployment.

Over the last years, offshore wind has met obstacles leading to slower-than-planned deployment. Average production costs on implemented plants are higher than expected and grid connections problems have led several countries, such as Germany, to scale down their medium term plans for offshore wind development. Like in 2012, France has reported zero generation for 2015 despite having planned 515 ktoe in 2014. France mainly supports offshore wind through feed-in tariffs allocated in tender procedures. The process is running behind its schedule and the country should achieve half of its target by 2020.

Figure 1-24: Deviation of estimated 2015 deployment from 2015 planned NREAP trajectory for offshore wind



Sources: calculated from EEA (date 4/10/2016) and NREAPs table 10b

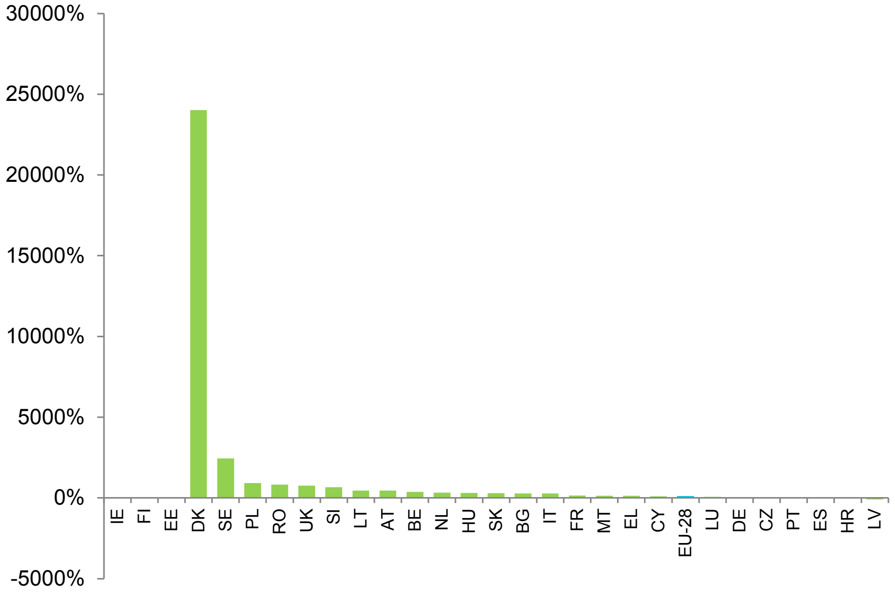
Photovoltaic

For the photovoltaic (PV) sector, the considered period was marked by a strong growth even if 2012-2014 slowed down the dynamic of the years 2009-2011. In 2009, European PV energy generation was 1,200 ktoe. Six years later, the production is estimated at over 9,000 ktoe.

The development of PV was faster than expected in most Member States, leading to a great majority of Member States exceeding their anticipations. Denmark is estimated to have produced 62 ktoe of PV electricity in 2015. Even though this is a small amount, it already puts the country far beyond its planned annual production of 0.3 ktoe in 2020. By far the largest producer in 2015 is estimated to have been Germany with 3,305 ktoe in 2015, followed by Italy (1,965 ktoe) and Spain (711 ktoe).

Thanks to very significant costs reductions and incentive support national policy, the PV sector became in 2011 the leading electricity generating capacity installer in the European Union with a yearly capacity added to the grid of 21,528.9 MW. This was double the additional capacity installed via new gas-fired power plants (9,718 MW), while it dwarfs the capacity of new coal-fired (2,200 MW), oil-fired (700 MW) and nuclear power plants (331 MW) for the same year.[23] However, 2012 marked a turning point. The European market started to decline due to several factors: the first is that many leading PV countries (such as Italy and Greece) have opted to curb its development. Thus several markets that only recently crossed the one-gigawatt threshold are losing speed, if not ground to a halt. The governing politicians quote the main cause as being their determination to cap the increase in the price of electricity and make renewable energies easier to integrate into their electricity mix.

Figure 1-25: Deviation of estimated 2015 deployment from 2015 planned NREAP trajectory for photovoltaic



Sources: calculated from EEA (date 4/10/2016) and NREAPs table 10b

After a three year slump, 2015 ended with 7.2 GW[24] of new grid connected capacity, marking a slight increase compared to the previous year. However the installation are far from the levels of

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[23] 2015 EurObserv'ER Photovoltaic barometer

[24] 2015 EurObserv'ER Photovoltaic barometer

21.9 GW and 17.5 GW respectively witnessed in 2011 and 2012 reported by Eurostat. As European PV market actors do not anticipate a quick recovery, hopes are more oriented towards medium term effects of self-consumption phenomenon. According to Solar Power Europe, which represents the interests of the European photovoltaic sector, the European market is currently in transition, changing from a market whose growth was driven by the implementation of guaranteed feed-in tariffs to a new market structure, where “prosumers” (producing consumers) will use solar electricity for self-consumption in residential, commercial or industrial sectors. The plummeting cost of solar power offers consumers new opportunities, as they have every interest in producing their own electricity for less than the price charged by the grid.

Biomass

Biomass energy is comprised of three subsectors:

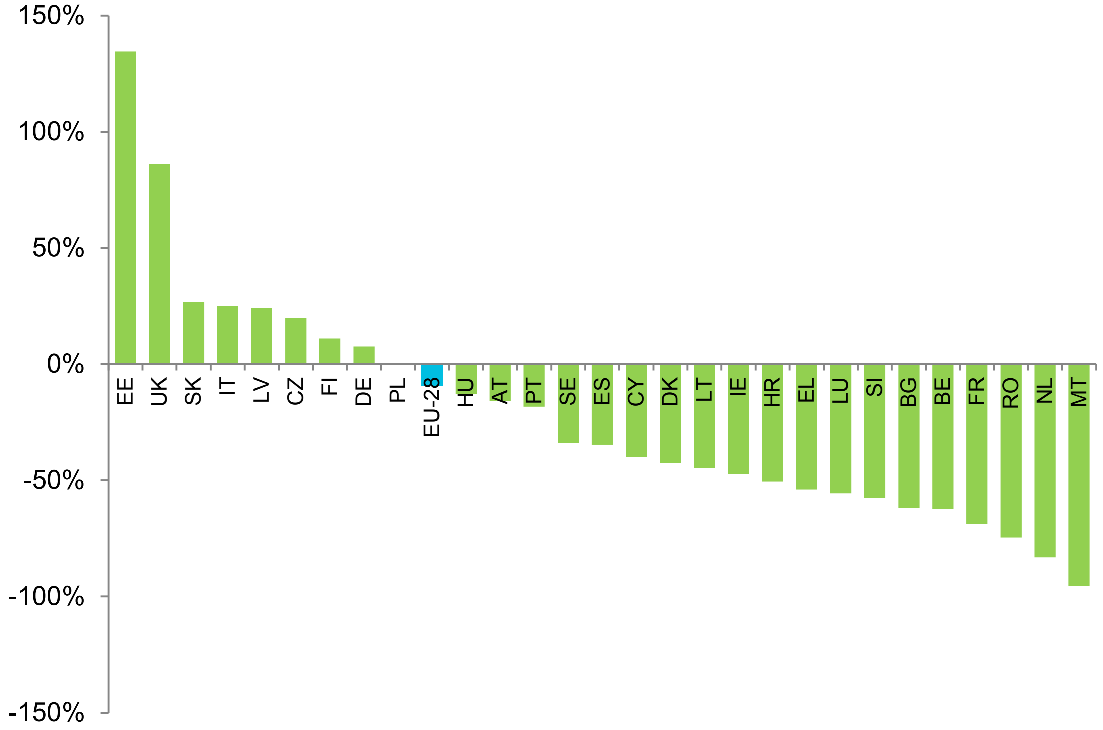
- solid biomass: this sector includes all solid organic components to be used as fuels like wood, wood waste (wood chips, sawdust, etc.), wood pellets, black liquors, straw, bagasse, animal waste and other plant matter and residues;
- renewable urban waste: these technologies are treating the biodegradable part of household waste by incineration. This sector excludes the energy recovered from non-renewable municipal waste (plastic packaging, etc.);
- biogas: these technologies are treating biodegradable part of wastes through anaerobic digesters or landfill direct capture.

Eight Member States are estimated to exceed their 2015 anticipations. In most of the European countries, biomass energy growth during the last years was mainly due to biogas rather than solid biomass. Solid biomass has had to compete with other less expensive RES technologies (like photovoltaic or wind power), and more and more projects have to deal with tensions over the use of wood raw material (between wood furniture industry or paper industry). However, by converting a number of coal fired power plants to biomass, the UK has become the European Union’s top-ranked solid biomass electricity producer in next to no time. According to the 2015 EurObserv’ER wood energy barometer, the UK generated 13.9 TWh in 2014, up from 9.9 TWh in 2013 (40.4 % more), a remarkable achievement, given that solid biomass electricity output was only 4.6 TWh in 2010.

For biogas, for a number of years, most of the EU’s primary energy production spread has generally been dominated by the farm biogas category, whose share has constantly risen in comparison with the landfill and sewage plant biogas categories. Prime examples are Germany, Italy, Austria, the Netherlands, Belgium and the Czech Republic.

The status of European renewable urban waste development varies strongly by Member State. The Nordic countries: Sweden, Denmark, Finland and the Netherlands lead the way in developing this sector. Municipal waste-to-energy recovery levels are very low by comparison in countries such as France, where many old-generation design plants were primarily built to process waste rather than recover energy. Central and Southern European countries in particular have invested very little in recovering energy from their household refuse.

Figure 1-26: Deviation of estimated 2015 deployment from 2015 planned NREAP trajectory for biomass



Sources: calculated from EEA (date 4/10/2016) and NREAPs table 10b

Other technologies

Geothermal

Geothermal power is generated by geothermal energy. Technologies include dry steam power stations, flash steam power stations and binary cycle power stations. The geographic potential, (e.g. the availability of steam) plays a large role in the affordability of geothermal power generation.

Only 12 Member States anticipated the deployment of geothermal electricity in their NREAPs. In 2015 only 10 Member States anticipated that they would generate geothermal electricity to some extent (Italy, Portugal, Germany, Austria, Hungary, Slovakia, France, Greece, Czech Republic, Croatia). Of these, four Member States (Italy, Portugal, Germany, Austria) actually deployed geothermal electricity generation, albeit at levels below their anticipations, ranging from around -3 % (Italy) to -81 % (Austria).

Only Italy has already been deploying geothermal for electricity production since 2005, also because of its favourable geographic conditions. If these conditions are not given, the costs of geothermal technology are rather high since it involves deep drilling in order to utilise the geothermal heat. To date Germany also deploys geothermal for electricity production, albeit at a very limited level and below what was anticipated in 2010.

Marine / ocean

Only a few Member States (Spain, France, Ireland, the Netherlands, Portugal, the United Kingdom) anticipate the deployment of marine / ocean technology in their NREAPs. Only three anticipated NREAP trajectories foresee deployment for 2015, namely these for for France, Italy and Portugal. In the past only France and the UK were implementing this technology. While the UK is thus estimated to exceed its anticipation for 2015 (0.17 ktoe vs. 0 ktoe), France's deployment of 41 ktoe is less than what was anticipated in its NREAP (68 ktoe).

This technology is not yet mature, and currently consists mostly of pilot plants (Portugal, the UK). France has already been deploying marine/ocean technology for some time but has not increased electricity production from this technology in a significant manner.

Concentrated solar power

Only six Member States anticipated in their NREAPs the deployment of concentrated solar power with only Spain deploying concentrated solar power, albeit below its anticipations from 2010. Concentrated solar power needs favourable conditions in order to make it a viable technology; it needs direct sunlight; while solar photovoltaic can also operate under less favourable conditions. This may contribute to the rather low current and anticipated future deployment.

1.3.8. Heating & Cooling

Four different technologies are contributing to the rise of RES-HC in the EU. Biomass installations are by far the most important technology category in RES-HC, and it is estimated that they contributed roughly 76 Mtoe in 2015. Heat pumps are estimated to have delivered around 10 Mtoe, while solar thermal installations are estimated to have produced 2 Mtoe, and geothermal close to 1 Mtoe on the EU level. In the following, Member State deployment of these technologies is assessed.

Geothermal

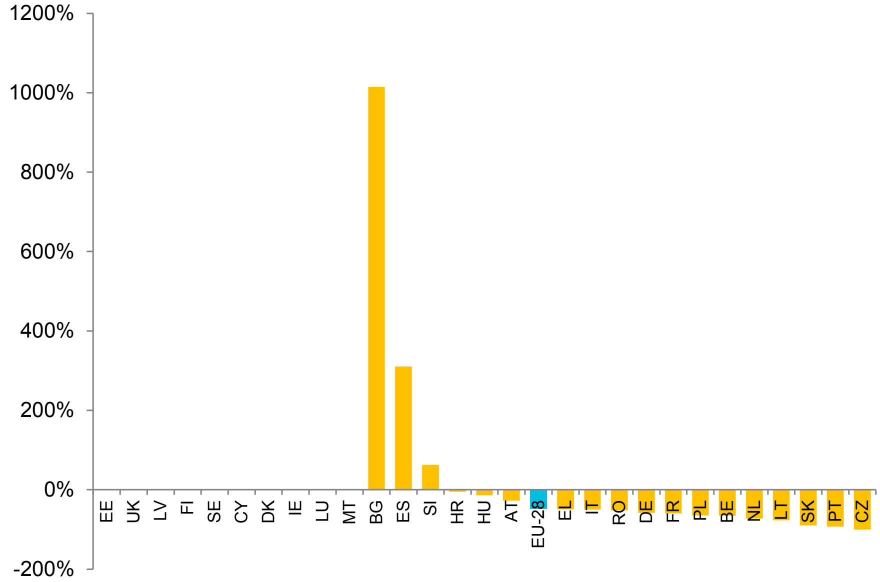
Direct uses of geothermal energy can provide heat for different applications. Geothermal heat can supply heating networks and also be used to heat swimming pools, greenhouses and fish farms. Renewable energy output from geothermal heat applications (the direct uses of heat excluding heat pumps), are estimated at close to 1 Mtoe on the EU level in 2015. This output may be somewhat underestimated in a few countries that have yet to monitor the energy output of specific geothermal applications, such as their use of hot geothermal water for heating swimming pools. Due to a very high natural potential, Italy is the leading country of this sector with an estimated 130 ktoe consumed in 2015.

The two countries that are estimated to exceed their anticipations in 2015 the most (Bulgaria and Spain) exhibit relatively low 2020 targets (less than 10 ktoe). According to EGEC (European Geothermal Energy Council) data, the geothermal capacity identified in 17 European Union countries specifically for heating networks was about 1,300 MWth at the end of 2014. However, these new installations are not enough to stop geothermal heat's current development from falling below the anticipations set out in the NREAPs.

With output approximated at 700 ktoe in 2015, the EU was below its aggregated anticipated 2015 trajectory.

Member States are implementing much stronger incentive policies to remedy the situation, in a legislative environment stabilized to promote geothermal heat. Article 14 of the Energy Efficiency Directive (2012/27/EU) asks each Member State to carry out and notify to the Commission, a comprehensive assessment of the potential for the application of high-efficiency cogeneration and efficient district heating. They may eventually be encouraged to reconsider their potential geothermal fields.

Figure 1-27: Deviation of estimated 2015 deployment from 2015 planned NREAP trajectory for geothermal



Source: calculated from 2015 EEA (04/10/16) and NREAPs Table 11

Biomass

Biomass is supposed to be the main contributor to renewable heating and cooling policies. Biomass is generated by three technologies. The first is solid biomass which includes solid organic components like wood, wood waste, wood pellets, black liquors, straw, bagass, animal waste, plant matter and residues. The second is biogas, which is mostly based on anaerobic digesters and the third is renewable municipal waste that is incinerated. Of these three pillars, solid biomass is the resource that covers most of the EU’s energy requirements.

Since the beginning of 2000, biomass consumption has been rising. According to the 2015 EurObserv’ER biomass barometer, some countries such as Austria, Poland, Italy, Slovenia and Estonia had already reached their anticipated trajectory for 2020 in 2015.

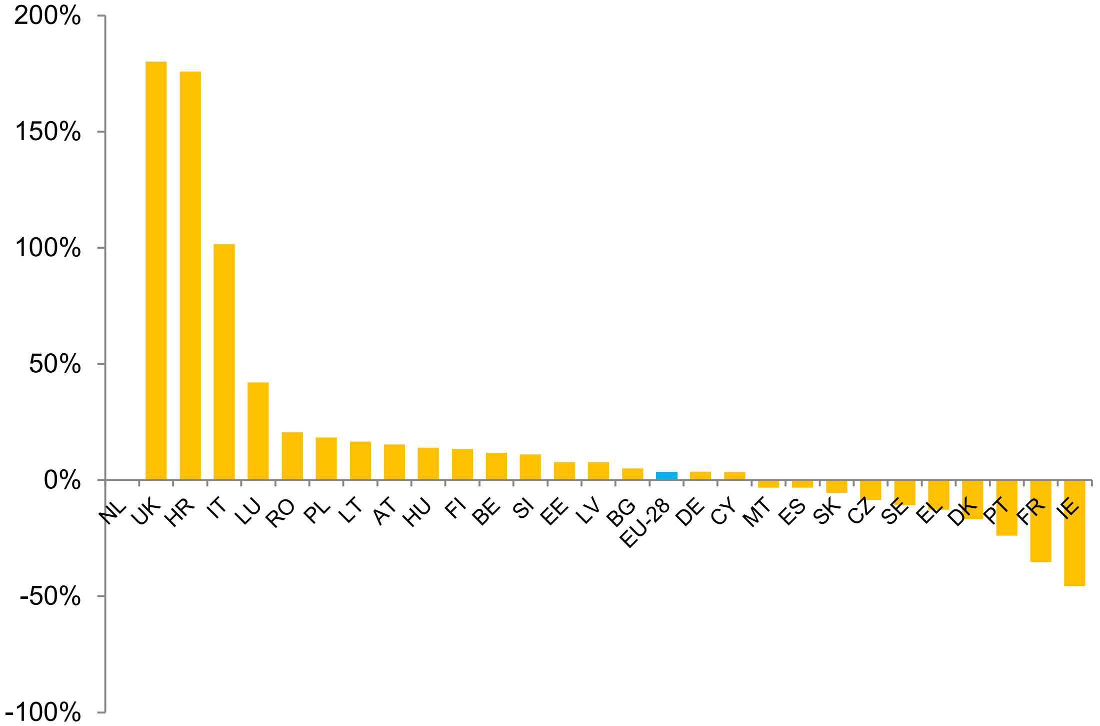
Since 2010, this rise has slowed down and seems to have stabilised since 2012, mostly because of the solid biomass market. The phenomenon is explained by mild winters and by efforts made towards energy efficiency. These two trends also apply to overall H&C energy consumption; therefore it does not negatively impact the achievement of NREAP anticipations. The decrease mostly comes from the market of the heat directly consumed by end-users, while the figures for biomass consumption for district heating did not plummet. Moreover, some countries such as France still have to establish their national strategy regarding forest management before developing a strong policy regarding biomass consumption in H&C.

Although consumption decreased in 2014 for solid biomass (70.3 Mtoe), its production decreased even more sharply, which means the rate of imports increased. These imports are mostly based on pellets even though the EU remains the leading pellet producer and consumer in the world, with

Italy being its first consumer followed by Germany. For 2015 it is approximated that solid biomass has been consumed at a level of about 72.5 Mtoe.

The figure below shows that many Member States consumed more biomass than anticipated in their NREAP. Although ten EU countries did not meet their expectations, the spread between actual deployment and what had been anticipated is not as large as for other technologies.

Figure 1-28: Deviation of estimated 2015 deployment from 2015 planned NREAP trajectory for biomass



Source: calculated from EEA (4/10/2016) and NREAPs Table 11

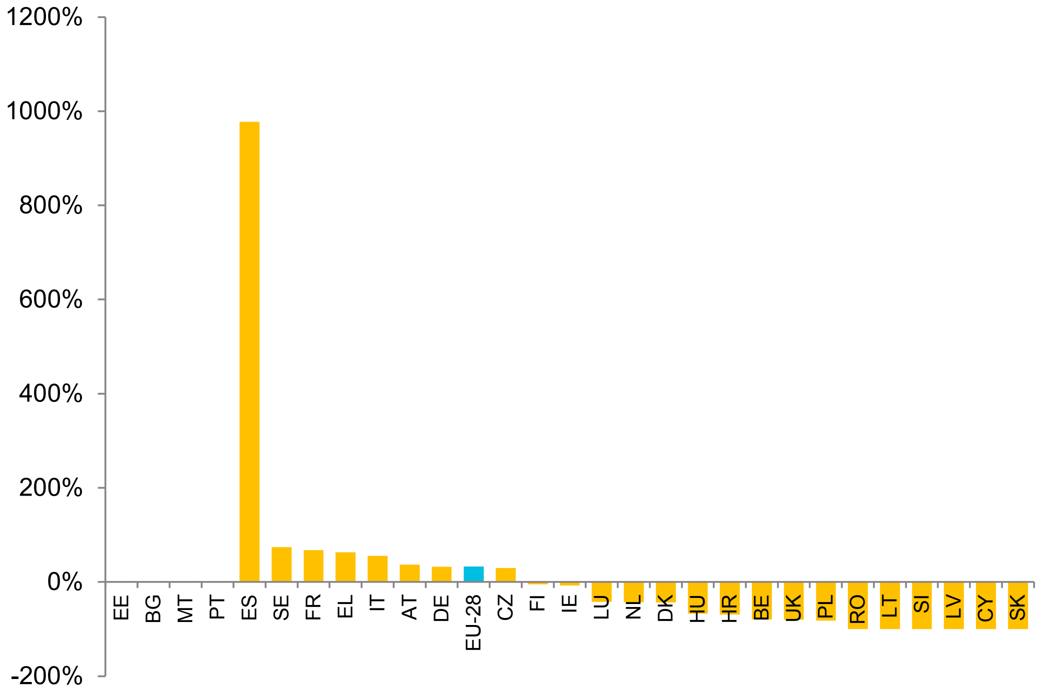
Heat pumps

Heat pumps are the second pillar of the success of renewable heating and cooling. Heat pumps can be differentiated both by the energy source used (ground, water, air), by the types of heating unit used (fan-coil unit, underfloor heating, low or high temperature radiators) as well as their application. Heat pumps can be used for heating and also for cooling. Air-based heat pumps represent nearby 95 % of the market in EU.

The EU-28 is estimated to have exceeded the aggregated, planned 2015 anticipation. The aggregated, planned trajectory is around 7,293 ktoe while it is approximated that 9,697 ktoe of heat pumps were consumed. Heat pumps markets vary from one EU country to another. Heat pumps are popular in northern countries while they have a potential of progression in other countries. Italy is a country that shapes the figures of the heat pumps market. Indeed, as the figures of heat pumps sold in Italy decreased in 2014, it was enough to compel a decrease in the EU figures. Nevertheless, Italian figures regarding heat pumps are specific as they include heat pumps specifically dedicated to cooling, which is not the case in other European countries.

Although the European market of heat pumps has been slowing down since 2013, it is expected to increase in the coming years. This will be achieved thanks to the revival of the housing market. Moreover, due to the influence of European directives, many countries are adopting constraining thermic regulations, which are encouraging the installation of heat pumps. As an example, in 2013, Denmark banned oil and gas heating for new constructions and will extend this ban to areas covered by district heating networks in 2016. In France, the heat pumps market skyrocketed after the implementation of a thermal regulation in the beginning of 2013. On the industry side, all of the major heating appliance manufacturers and air-conditioning specialists have integrated heat pumps into their catalogues.

Figure 1-29: Deviation of estimated 2015 deployment from 2015 planned NREAP trajectory for heatpumps



Source: calculated from EEA (date 4/10/2016) and NREAPs Table 11

Solar thermal

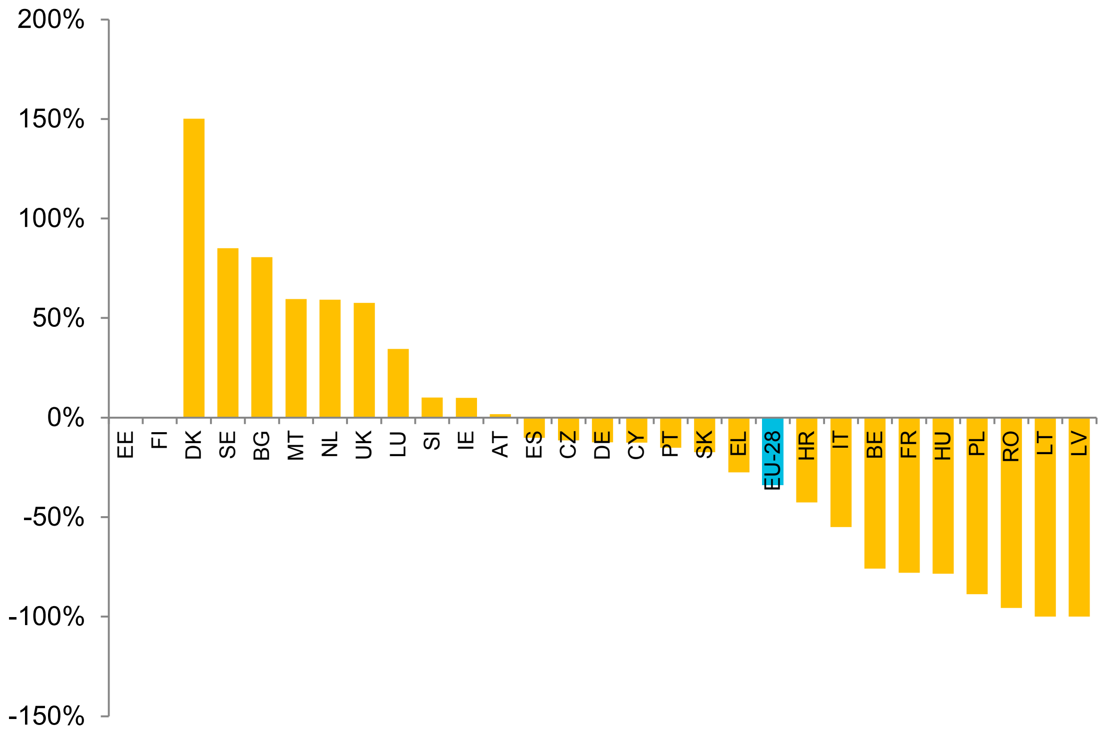
Solar thermal was also supposed to be an important pillar of H&C, but the sector did not meet the expectations. The aggregated anticipated 2015 trajectory is around 3 Mtoe of solar thermal consumption and it is approximated that the EU consumed 2 Mtoe.

The market for solar thermal has been shrinking since 2009. The annual capacity installed in 2015 was below what had been installed in 2006. Only Poland and Denmark witnessed some growth, in the latter country thanks to heat networks. The overall turmoil of solar is not only based on warm winters and low prices of oil and gas. It is also stricken by the competition with other renewable technologies such as heat pumps or solar photovoltaic. With respect to solar photovoltaic solar thermal competes with a renewable energy technology targeted at a different sector, and for a different application. However, both technologies compete for the same resource, namely rooftops.

The cost of the technology and long payback periods of solar thermal technology are also complicated to manage, also being coupled with a downgraded image of solar thermal in the public. Main producers of solar thermal heat are above all Germany, followed by Spain, Greece, Austria, Italy and France.

As shown in the figure below, 16 EU countries, including the major producers, are estimated to have been below their anticipations in 2015. According to the 2016 EurObserv'ER solar thermal barometer, the 2020 anticipation for the EU-28 could be missed by more than 50% if nothing is done to reverse the current trend.

Figure 1-30: Deviation of estimated 2015 deployment from 2015 planned NREAP trajectory for solar thermal



Source: calculated from EEA (date 4/10/2016) and NREAPs Table 11

1.3.9. Transport

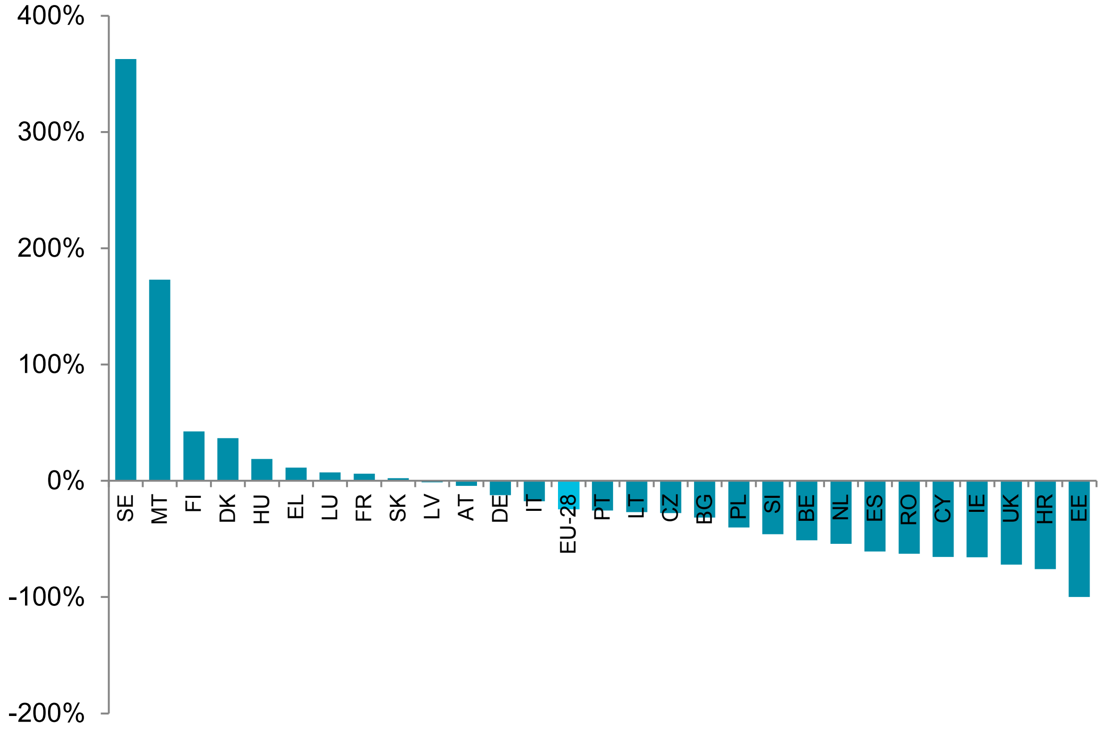
Biodiesel

Biodiesel is the main biofuel used for transport in the EU, representing an approximated 80 % of total use of biofuels in transport in 2015. This share tends to slightly diminish to the benefit of RES electricity. 2013 shows a drop in biofuels consumption, which can be linked to the European legislative context. In 2014 the consumption resumed its growth with a 9.5 % increase. The provisional estimations for 2015 show a stagnation.

The main consumers of biodiesel are France, Germany and Italy, with each having consumed over 1 Mtoe since 2009.

The graph below shows the Member States' deviations from their anticipated trajectories for 2015. Nine Member States reached or exceeded their anticipations for 2015, and 3 (Germany, Italy and Portugal) are estimated to have a gap equal to or less than 20 %. Notable is the large gap for Spain, which was one of the main consumers until 2013, when the government decided to decrease the incorporation rate very strongly in order to reduce the price of fuel and thus bring respite to the Spanish economy. One Member State (Estonia) has never reported any biodiesel consumption.

Figure 1-31: Deviation of estimated 2015 deployment from 2015 planned NREAP trajectory for biodiesel



Source: calculated from EEA (date 4/10/2016) and NREAPs Table 12

Bioethanol / ETBE

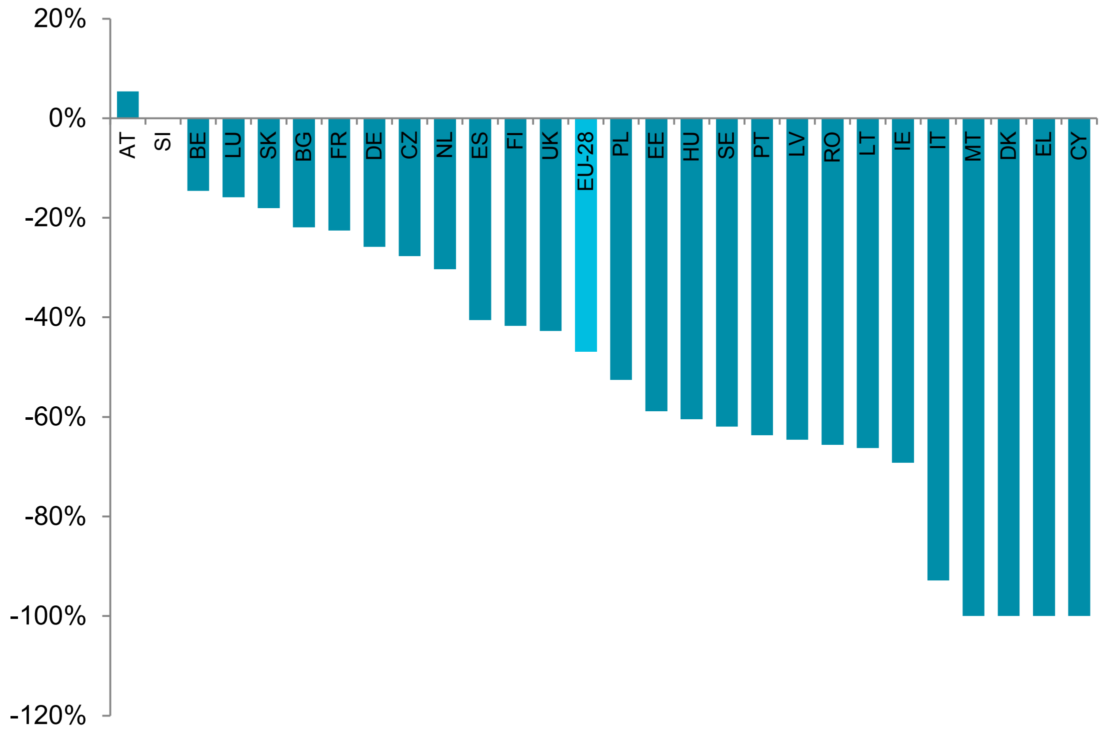
The bioethanol / ETBE share of all biofuels consumed was stable between 2010 and 2012, when it represented around 20 % of all biofuels and then started to decrease in 2013, reaching 19 % in 2014. First estimations show that the level in 2015 should be around 20 %.

In absolute terms, consumption of bioethanol increased from 2010 to 2012 with total biofuels consumption and then decreased in 2013 and 2014.

Main consumers in 2015 are estimated to have been Germany, the UK and France, followed by Spain, Sweden, Poland and the Netherlands.

The graph below shows the situation of each Member State as regards its planned trajectory for 2015. Of all Member States, only one (Austria) is estimated to have met its anticipated trajectory set out in the NREAP. Another four Member States, Slovenia, Belgium, Luxembourg and the Slovak Republic are less than 20 % below their anticipations. This leaves 23 Member States 20 % or more below their anticipations.

Figure 1-32: **Deviation of estimated 2015 deployment 2015 planned NREAP trajectory for bioethanol / ETBE**

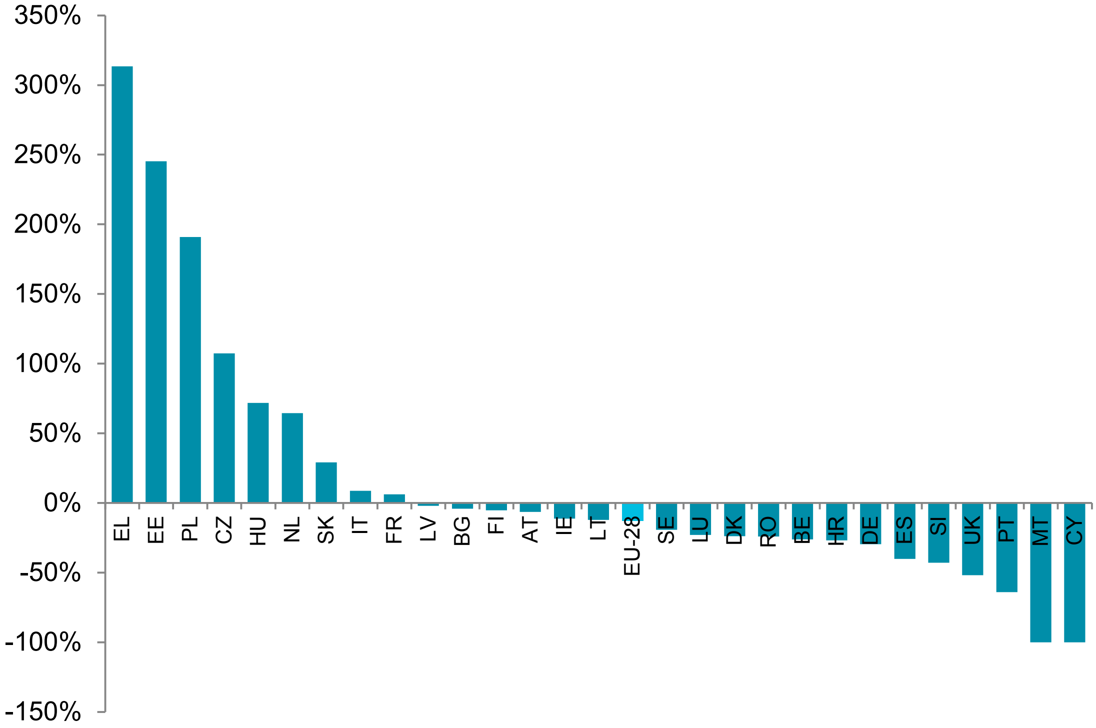


Source: calculated from EEA (date 4/10/2016) and NREAPs Table 12

RES-Electricity

The EU-wide use of renewable electricity in the transport sector increased over the 2010-2015 period, with close to 1.2 Mtoe in 2010 and an estimated 1.8 Mtoe in 2015. Countries that are approximated to have had the highest volume of energy use in 2015 are Italy, France and Germany, followed by Austria, Sweden and Spain, which are approximated to have used over 130 ktoe each. Countries such as Greece, Estonia, Poland, Czech Republic, Hungary or Netherlands, which have largely exceeded their planned NREAP trajectory are quite small consumers, where RES-E in transport deployment was below 50 ktoe in 2015. Nine countries are estimated to have exceeded their planned NREAP trajectory, with Italy and France as large consumers being among them. It should be noted that most of the renewable electricity in transport is currently consumed by rail transport.

Figure 1-33: Deviation of estimated 2015 deployment from 2015 planned NREAP trajectory for RES-electricity used in transport



Source: calculated from EEA (date 4/10/2016) and NREAPs Table 12

2. Task 2: Analysis of non-economic barriers

In this chapter non-economic barriers for RES deployment in European Member States are analysed in electricity, heating and cooling as well as the transport sector.

A non-economic barrier can hamper the deployment of renewable energies, irrespective of the present economic situation. Non-economic barriers can entail costs for project developers and can lead to delays in deployment or can even prevent projects from being realised and thus reduce overall deployment. Key examples are inefficient permitting or grid connection procedures.

The chapter is structured as follows: It first provides an overview of non-economic barriers in the EU-28. For the electricity sector the development of barriers over time is shown, while for RES-HC and RES-T the focus is on the current situation (Section 2.1). This is based on the Member States' progress reports and previous studies, complemented by stakeholder interviews. The (quantitative) effects of non-economic barriers are analysed in Section 2.2. Based on these sections, Section 2.3 provides EU level recommendations.

2.1. Overview of non-economic barriers in the EU-28

This chapter contains an overview of the different non-economic barriers that are present in the 28 EU Member States in the electricity, heating and cooling and transport sectors, as well as the development over time for the electricity sector.

The analysis shows that non-economic barriers persist across sectors and Member States.

2.1.1. RES-E

2.1.1.1. Summary

Overall in the electricity sector, non-economic barriers have been addressed by Member States since the introduction of the Renewables Directive. However, non-economic barriers still represent a relevant problem for the deployment of RES-E across the EU, and in most Member States several non-economic barriers persist. There are also still significant differences between Member States in terms of the implementation of measures to reduce non-economic barriers.

Non-economic barriers mainly result from the planning and permitting process. This is a key non-economic barrier for RES-E and is considered an important issue across Member States, even though the permitting regimes can differ significantly. Even in Member States where a well-established permitting regime is in place, the permitting for RES-E plants is a highly relevant issue.

Another issue is the grid integration of RES-E. This relates to the grid integration process for individual plants, yet increasingly also to the development of the overall grid capacity.

There is evidence that barriers in the planning and permitting process increase the costs of RES-E and reduce deployment. As the Member State analysis has shown, there are also new issues and conflicts emerging in the permitting process of RES-E projects, such as increasing environmental constraints and conflicts with other users, such as radar stations. These issues make it all the more important to make the permitting process as efficient as possible, so that such new conflicts do not increase the non-economic barriers that result from permitting.

Some barriers are more widespread than others and some measures have been implemented less than others across the EU. Yet it is important to note that the relevance of barriers and the impacts of measures also differ.

One-stop-shops for the permitting of renewables have not been implemented in the majority of Member States. One-stop-shops are generally an important element of administrative best practice and the absence of a one-stop-shop can increase the planning duration and also project costs.[25]

Another measure that has not been implemented in a majority of Member States are automatic permissions after a deadline has passed. However, the positive impact of this measure is more controversial than in the case of one-stop-shops, especially if it is not limited to small-scale plants.

Permitting time limits have been implemented in the majority of Member States. Again, this is an important best-practice element of an efficient permitting regime. Without such a time limit applicants cannot be sure about when to expect a permit. This is especially problematic if an automatic degression of support rate is applied, which leads to a reduction of calculated project revenues due to project delays. Time limits can only be indicative, but they should still reflect an efficient permitting time and measures need to be in place to enable authorities to meet the time limits. Therefore, while time limits are important, the fact that a time limit is in place as such does not guarantee that there are no barriers left, but the proper implementation of the time limit and the corresponding administrative structure needs to be ensured.

A large majority of Member States has implemented facilitated procedures for small scale projects. Despite this progress, further provisions on the EU level may not just aim at introducing measures in individual Member States, but also at converging national provisions, so that a European-wide market is facilitated.

Figure 2-1 shows the development of various non-economic barriers for RES-E. When interpreting the relative shares of Member States where a specific barrier was present, it is important to take into account that for some barriers in some Member States no information was available and that this changes over time.

The maximum barrier presence of 100% therefore refers not to the presence in all 28 Member States but to the presence in all Member States for which information on this barrier could be found, which is typically less than 28 Member States. In Table 2-3, Table 2-4 and Table 2-5 the number of Member States with missing information on administrative barriers from 2010 to 2014 is shown.

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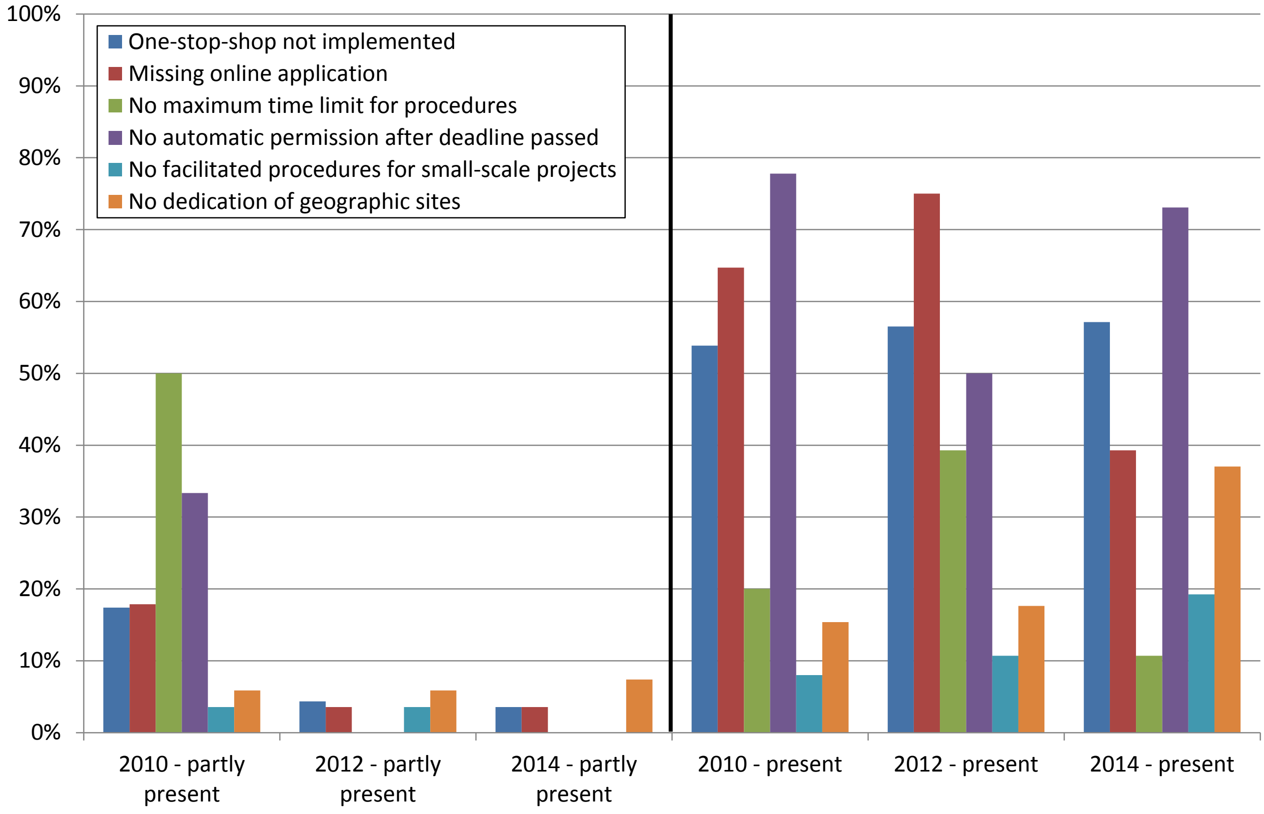
[25] See Chapter 2.2.1.1.

Figure 2-1: Overview of administrative barriers present in European Member States from 2010 to 2014 (in %)



Source: Based on [35, 36], Member State progress reports from 2015; Interviews, other sources, authors' own depiction

Different developments can be observed. Especially the development of the barriers "missing online application" and "no maximum time limit for procedures" stands out, as these barriers were reduced effectively in comparison to the earlier years. Other barriers such as the "absence of a one-stop-shop" and an "automatic permission after a deadline" on the other hand have increased rather than decreased. A reason for this can be increased data availability for 2014 and therefore information over the presence of a barrier that could have been present in earlier years, but was not reported.

Table 2-1 shows an overview of the non-economic barriers that are present in the European Member States in 2014. The results were derived from the 2015 Member States progress reports, as well as interviews that were conducted in the scope of this study in the first quarter of 2016 as well as other sources. The data in this table is labelled as 2014, but for some barriers the table is based on more up-to-date information.

A barrier in a specific Member State is indicated by a dot in the corresponding cell. If a measure for renewable integration was not present in a Member State, this was interpreted as the presence of the corresponding barrier. A grey fill indicates that no information was available for the study.

Table 2-1: Presence of non-economic barriers for RES-E in European Member States in 2014

	Administrative Procedures						Grid Integration			
	One stop shop not implemented (Art. 22(3)a)	Online application not possible	No maximum time limit for procedures	No automatic permission after deadline (Art. 22(3)b)	No facilitated procedures for small scale producers	No identification of geographic sites (Art. 22(3)c)	Lack of communi-cation	Lack of grid capacity/Different development of grid and renewables	Long lead times	No obligation to connect/re-inforce the grid
AT Austria	●		●	●		●		●		
BE Belgium (Brussels)				▨		▨	▨	(●)	(●)	
BE Belgium (Flanders)		(●)						(●)		
BE Belgium (Walloon)				▨		(●)	(●)	(●)	(●)	
BG Bulgaria					●		●	●		
CY Cyprus	●	●		●			●		●	
CZ Czech Republic	●			●			●	●	●	
DE Germany								●		
DK Denmark	(●)							●		
EE Estonia	●				●	●	●		●	
EL Greece				●			●	(●)		(●)
ES Spain	●	●		●		●	●	●	●	
FI Finland	●	●	●	●						
FR France				●			●	●	●	
HU Hungary	●			●			●	●	●	●
HR Croatia	●	●		▨		(●)	●	(●)	●	
IE Ireland	●			●			●			
IT Italy		●		●		●	●	●	●	▨
LT Lithuania	●					▨				
LU Luxembourg				●	▨		●		●	
LV Latvia	●	●		●	●	●	●			
MT Malta				●					●	
NL The Netherlands								●		
PL Poland	●	●		●		●	●	●		
PT Portugal	●			●			●			
RO Romania	●	●		●	●	●			●	
SI Slovenia	●	●	●	●	●	●			●	
SK Slovakia	●	●		●		●		●	●	
SE Sweden					▨		▨	●		
UK United Kingdom		●		●		●		●	●	

Source: Based on Member State progress reports from 2015; interviews, [37], other sources, authors' own compilation;

● = Barrier is present in this Member State; (●) = Barrier is partly present in this Member State; Grey = No information.

2.1.1.2. Methodology

This chapter describes the methodology that was applied for the evaluation of the development of non-economic barriers in administrative procedures as well as the grid integration process for RES-E in the EU-28 on the basis of historic and current information. A detailed description of the methodology can be found in Section 3.6. Besides the Member State progress report from 2015, as well as the conducted survey in the scope of this study, the following studies were evaluated to describe this development:

- *Renewable energy progress and biofuels sustainability*, which was conducted by Ecofys et al. in 2012 [36].
- *Renewable energy progress and biofuels sustainability*, which was conducted by Ecofys et al. in 2014 [35].
- *Integration of electricity from renewables to the electricity grid and to the electricity market – RES-Integration*, which was conducted by Eclareon & Öko-Institut e.V. in 2012 [38].
- *Assessment of non-cost barriers to renewable energy growth in EU Member States – AEON*, which was conducted by ECORYS et al. in 2010 [39].

The data that was used in these studies is from the years 2009 [39], 2010 [36, 38] and 2012 [35], respectively.

The main sources for this chapter are the studies conducted by Ecofys et al. in 2012 and 2014, which are this study's predecessors and which evaluated the Member States' progress reports from 2011 and 2013. As for grid integration, the RES-Integration and the AEON study were used to complement the information that could be derived from the 2014 Ecofys study.

In their evaluation Ecofys et al. defined different measures and corresponding barriers on the basis of Articles 13, 16 and 22 of the Directive 2009/28/EC. These were used to evaluate the Member States progress reports. Article 22[26] of the RED introduces an obligation for Member States to report information on certain measures. These measures are the following:

- Establishing of a single administrative body for processing of authorisation of renewable projects (one-stop-shop),
- Providing automatic approval of planning and permitting applications of renewable projects,
- Indication of geographical locations suitable for renewable projects.

Measures that were derived from Article 13 "Administrative procedures, regulation and codes" and taken over to this study for which no obligation to report is present are the following:

- Online application for the renewable support scheme
- Maximum time limit for administrative procedures
- Facilitated procedures for small-scale projects

Other measures considering the integration of renewables to the grid were derived from Article 16 "Access to and operation of the grid". Due to differences between preceeding studies it was

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[26] See Directive 2009/28/EC [40] Article 22 "Reporting by the Member States" (3), (a) to (c).

necessary to adapt or compile measures and information to ensure comparability between the different studies. Detailed information on this can be found in Chapter 3.6. Measures that are viewed in this study are:

- Lack of stakeholder communication in the grid connection process
- Lack of grid capacity/Different development of grid and renewables
- Long lead times of the grid connection process
- No obligation to connect/reinforce the grid

To describe the presence of barriers in 2010, information from the aforementioned studies was evaluated. In [36] Table 28 summarises the situation of measures in administrative procedures. As for grid integration barriers, information was taken from the RES-Integration study [38], which acted as the basis for the grid integration chapter in the 2012 Ecofys study. Information on barriers can be found on page 27 of the RES-Integration study. In the AEON study that contained data for 2009, information can be found in the tables on pages 93, 95 and 96.

For the year 2012, the information on administrative procedures from [35] can be found in Table 20 in the form of Member State progress in administrative procedures. For the presence of barriers in the grid integration process, Table 41 was used as a basis. In contrast to the previous Ecofys study, it is based on the progress reports as well as additional expert knowledge.

It has to be noted that for the study [35] the methodology was changed, considering the evaluation of measures with an obligation to report in Member State progress reports, based on Article 22 of the renewable directive. In contrast to the study [36] which included the category “no information” in the case that no information was given on a measure, this category was discontinued. The absence of information therefore was counted as the absence of a measure, which could be interpreted as the presence of a barrier.

Moreover it may be the case that a measure was already implemented before the progress reports were written, as in the case of the German Federal Immission Control Act (Bundes-Immissionsschutzgesetz)[27] and related regulations in Germany, which also cover permitting of renewable projects and have not been mentioned in progress reports since 2011. This has not been checked in detail for all the progress reports.

In addition to the evaluation of the development of barriers based on the aforementioned studies, the current status of barriers was evaluated based on:

- the 2015 progress reports
-)A literature review, including the Keep on track! Project.
- Stakeholder interviews carried out by the consortium

2.1.1.3. Administrative Barriers

This chapter addresses the main non-economic barriers that RES-E developers face in European Member States. A description is shown in Table 2-2 below.

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[27] Further information on the Bundes-Immissionsschutzgesetz can be found under: http://germanlawarchive.iuscomp.org/?p=315

Table 2-2: Description of different non-economic barriers in EU Member States

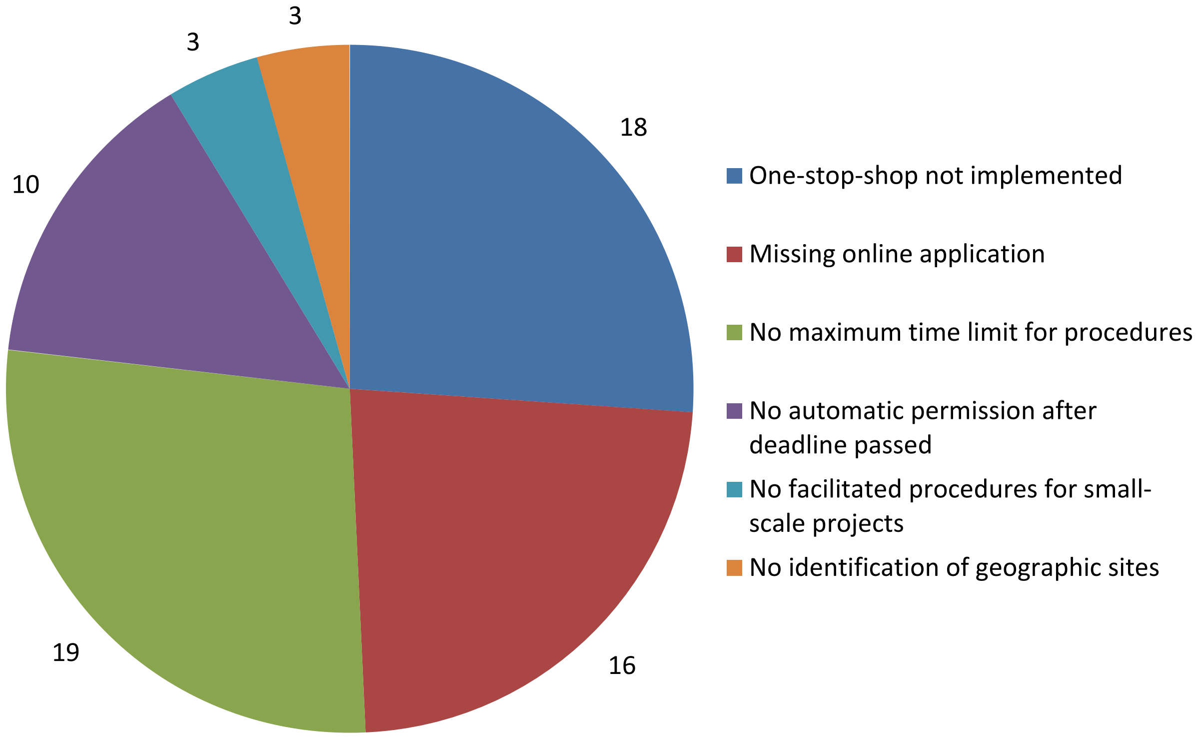
Barrier	Description
One-stop-shop not implemented	It is not possible to apply for necessary permissions and the participation in the support scheme at one single authority.
Missing Online Application	Applicants cannot apply for permissions via an online application. Application via mail is necessary.
No maximum time limit for procedures	There are no time limits for authorities to deal with applications.
No automatic permission after deadline has passed	Although a deadline might be in place there is no permission of applications if authorities do not comply with it.
No facilitated procedures for small-scale projects	Small-scale projects face the same procedures as large projects.
No identification of geographic sites	Geographic plans do not contain sites for the construction of renewable projects.

Source: Based on [35, 36],authors' own

These barriers are taken from [36] as well as [35]. Both studies evaluated the presence of these barriers in EU Member States on the basis of the progress reports towards the 2020 EU renewable energy targets that were published 2010 and 2012. The data thus refers to these years.

For Belgium [36] and [35] evaluated non-economic barriers for each of the individual jurisdictions. To fit the scope of [38] and this study, this information was evaluated and compiled to generate a single information for this Member State.

Figure 2-2: Administrative barriers present in European Member States in 2010



Source: Based on [36],authors' own illustration

Table 2-3: No information on administrative barriers in European Member States in 2010

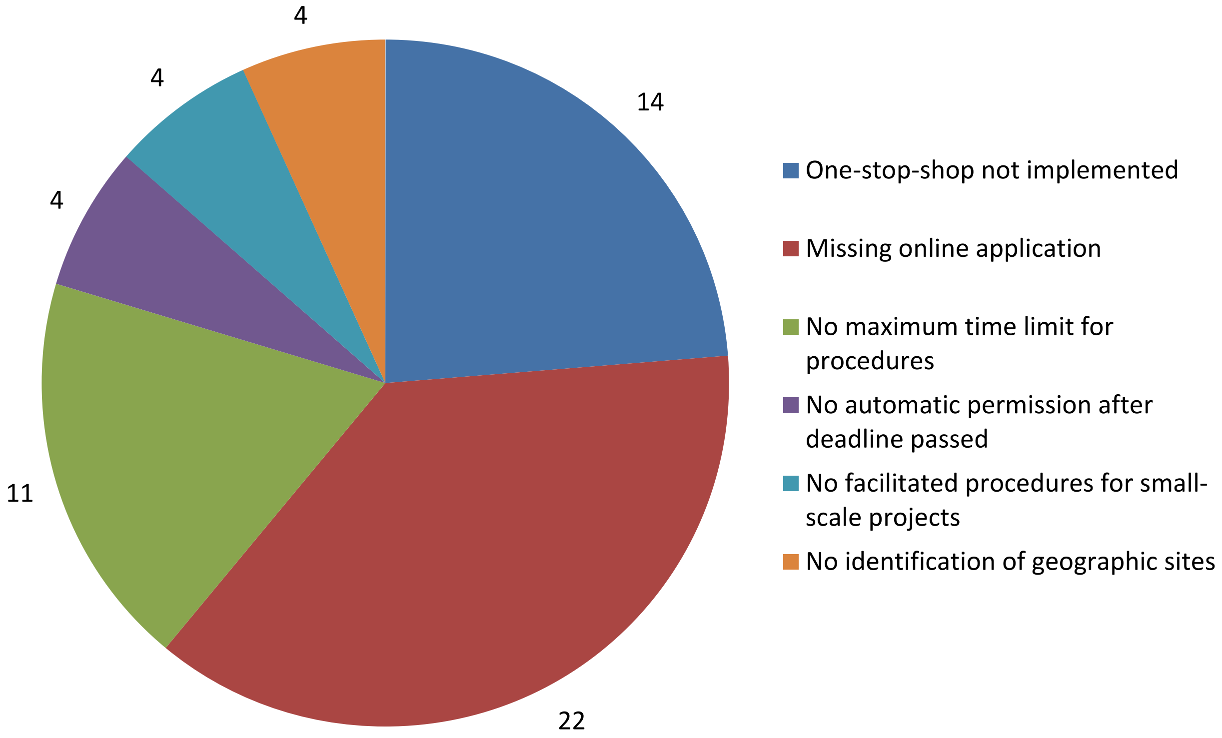
Barrier	Number of Member States without information
One-stop-shop not implemented	2
Missing online application	11
No maximum time limit for procedures	3
No automatic permission after deadline passed	18
No facilitated procedures for small-scale projects	3
No identification of geographic sites	15

Source: Based on [36], authors' own compilation

The pie chart in Figure 2-2 shows the presence of different barriers in European Member States. The number next to each area shows the number of Member States in which a barrier was present or partly present in 2010. Barriers which were present more often than others in Europe are thus reflected by large pie sections. Especially the barriers "One-stop-shop not implemented", "Missing online application" and "No maximum time limit for procedures" are present in the majority of Member States in 2010.

As mentioned above, data could not be collected for all Member States. This has to be taken into account. This is especially the case for “Missing online application”, “No automatic permission after deadline passed” and “No identification of geographic sites”. For many Member States the barrier “No automatic permission after the deadline has passed” was present. Even though a large number of Member States did not report information on this barrier, it was present in ten Member States. The barriers “No facilitated procedures for small-scale projects” and “No identification of geographic sites” were not as relevant as other barriers.

Figure 2-3: Administrative barriers present in European Member States in 2012



Source: Based on [35], authors’ own illustration

Table 2-4: No information on administrative barriers in European Member States in 2012

Barrier	Number of Member States without information
One-stop-shop not implemented	5
Missing online application	0
No maximum time limit for procedures	0
No automatic permission after deadline passed	20
No facilitated procedures for small-scale projects	0
No identification of geographic sites	11

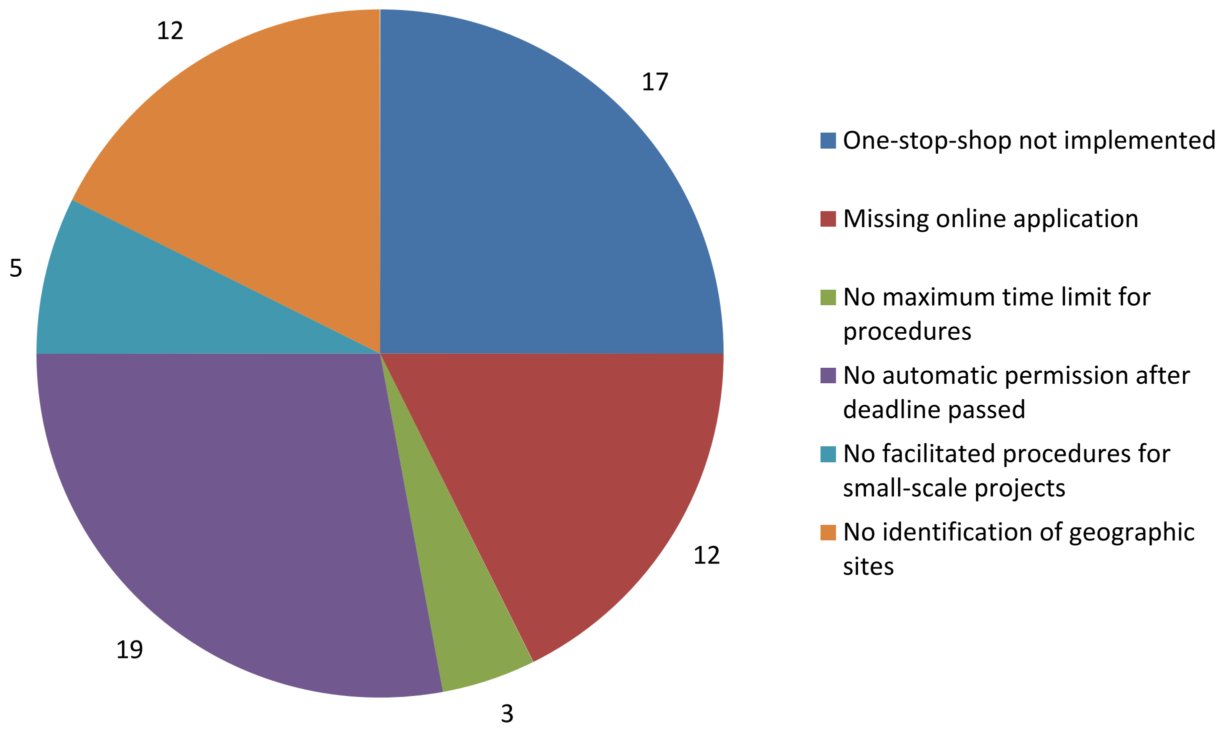
Source: Based on [35], authors’ own compilation

Figure 2-3 describes the presence of the same barriers in 2012. Compared to 2010 the main barriers in Europe in 2012 are still “One-stop-shop not implemented”, “Missing online application” and “No maximum time limits for procedures”.

The barrier “Missing online application” experienced an increase from 2010 to 2012, which can be explained by an increasing number of Member States where the barrier was reported as present, instead of “no information”.

In contrast to 2010, the barrier “No automatic permission after deadline has passed” was reported in fewer Member States. From ten Member States in 2010, the presence of this barrier decreased to four Member States in 2012. At the same time, the number of Member States that did not provide information on this barrier increased. As in 2010 the barriers “No facilitated procedures for small-scale projects” and “No identification of geographic sites” are not as widespread as other barriers.

Figure 2-4: Administrative barriers present in European Member States in 2014



Source: Authors' own depiction

Table 2-5: No information on administrative barriers in European Member States in 2014

Barrier	Number of Member States without information
One-stop-shop not implemented	0
Missing online application	0
No maximum time limit for procedures	0
No automatic permission after deadline passed	1
No facilitated procedures for small-scale projects	2
No identification of geographic sites	1

Source: Authors' own compilation

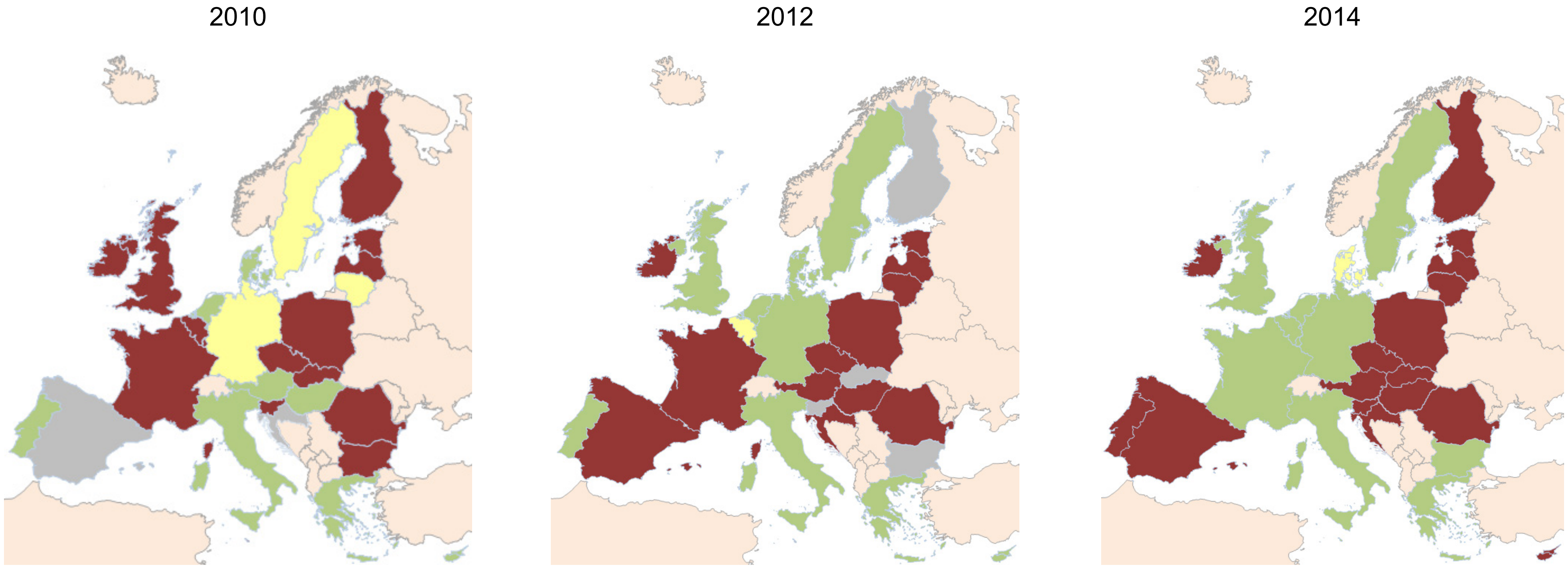
Figure 2-4 shows the presence of different barriers in the European Union in 2014. The major barriers in this year are a missing one-stop-shop, a missing online application and the lack of an automatic permission after a deadline has passed. Other barriers like a missing dedication of geographic sites, no maximum time limit or no facilitated procedures for small-scale projects are less common in the EU.

The following maps show the development of non-economic barriers in the context of administrative procedures in Europe from 2010 to 2014.

Overall an improvement can be observed from 2010 to 2014. As for individual barriers, there are barriers that are reduced over time, but also barriers that become more relevant.

If a barrier is absent, the Member State has a green colour; if it is present, the colour is red. In the Member States that are yellow-coloured the barrier is partly present. Partly means that the barrier is only present for certain actors or in certain parts of the country. If a Member State is coloured grey, there was no information available on this barrier in that Member State.

Figure 2-5: Development of the barrier "One-stop-shop not implemented" from 2010 to 2014

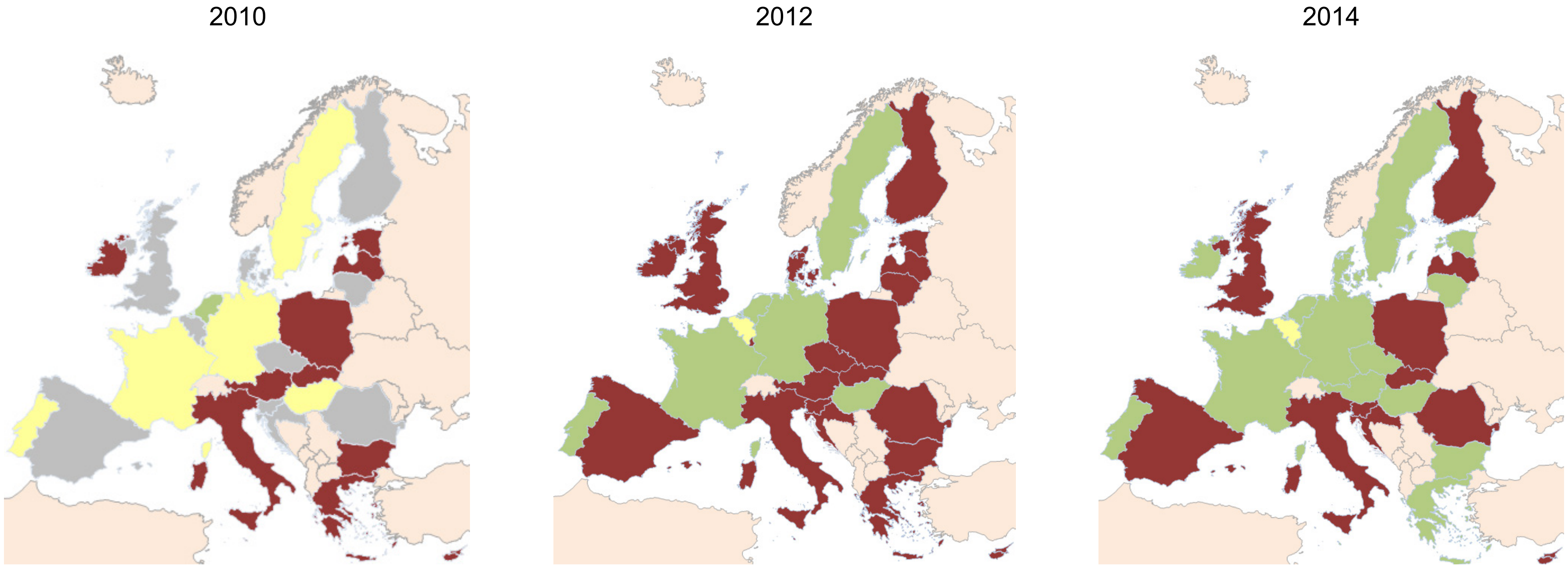


Source: Based on [35, 36], authors' own illustration

Red – Barrier is present; Green – Barrier is not present; Yellow – Barrier is partly present; Grey- No information available

In Figure 2-5 the development of the barrier "One-stop-shop not implemented" is shown. In 2010 submitting an application to a single authority was possible especially in countries in Southern Europe. The majority of states in Eastern Europe as well as the UK, Ireland, Belgium and France had not implemented a one-stop-shop. Some Member States in which this barrier was partly present in 2010, such as Germany or Sweden, had implemented a one-stop-shop by 2012. In 2014 the situation hardly changed. In Eastern Europe a one-stop-shop is hardly possible in contrast to Member States in Central Europe.

Figure 2-6: Development of the barrier “Missing online application” from 2010 to 2014

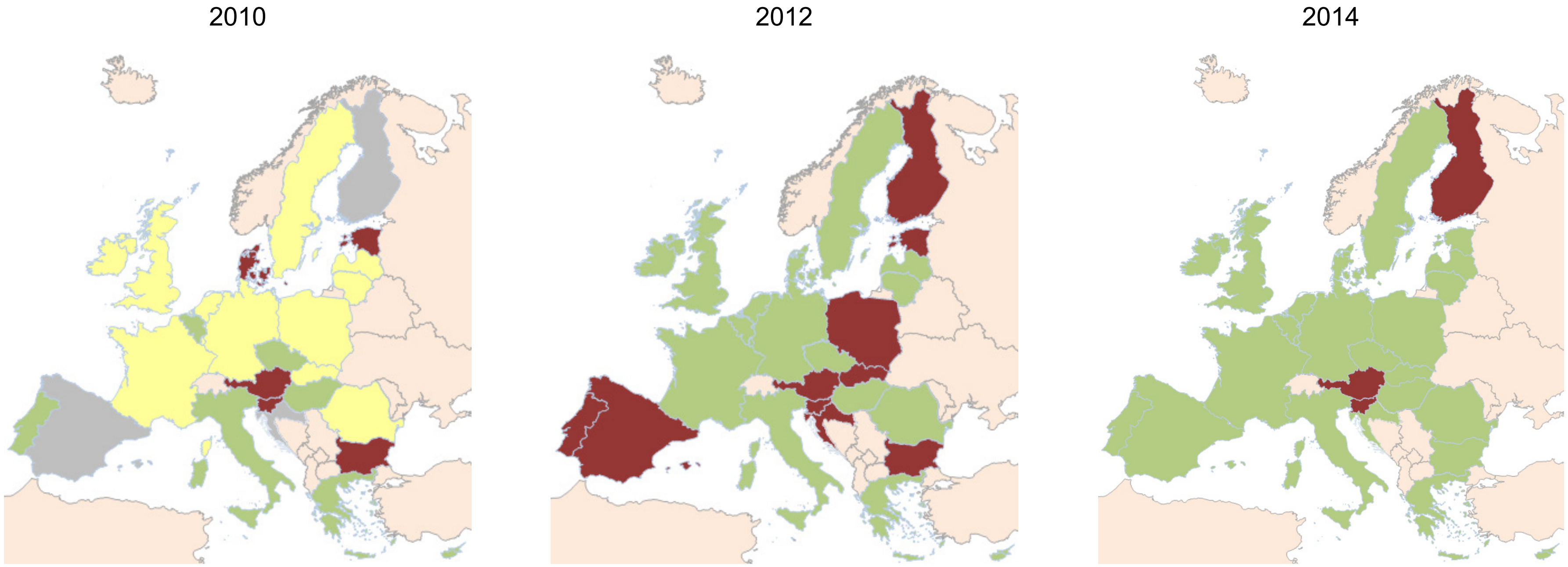


Source: Based on [35, 36], authors’ own illustration

Red – Barrier is present; Green – Barrier is not present; Yellow – Barrier is partly present; Grey- No information available.

The development of the barrier “Missing Online Application” is shown in Figure 2-6. In 2010 an online application was not possible in the large majority of Member States for which information was available. In 2012 the situation had improved for countries in which this barrier was partly present in 2010. It is likely that the introduction of an online application was already in progress but had not yet been fully implemented. Member States that did not provide the possibility of an online application in 2010 had not implemented this option in 2012. In 2014 a slight improvement can be seen compared to 2012: Austria and Bulgaria among others had implemented an online application.

Figure 2-7: Development of the barrier "No maximum time limit for procedures" from 2010 to 2014

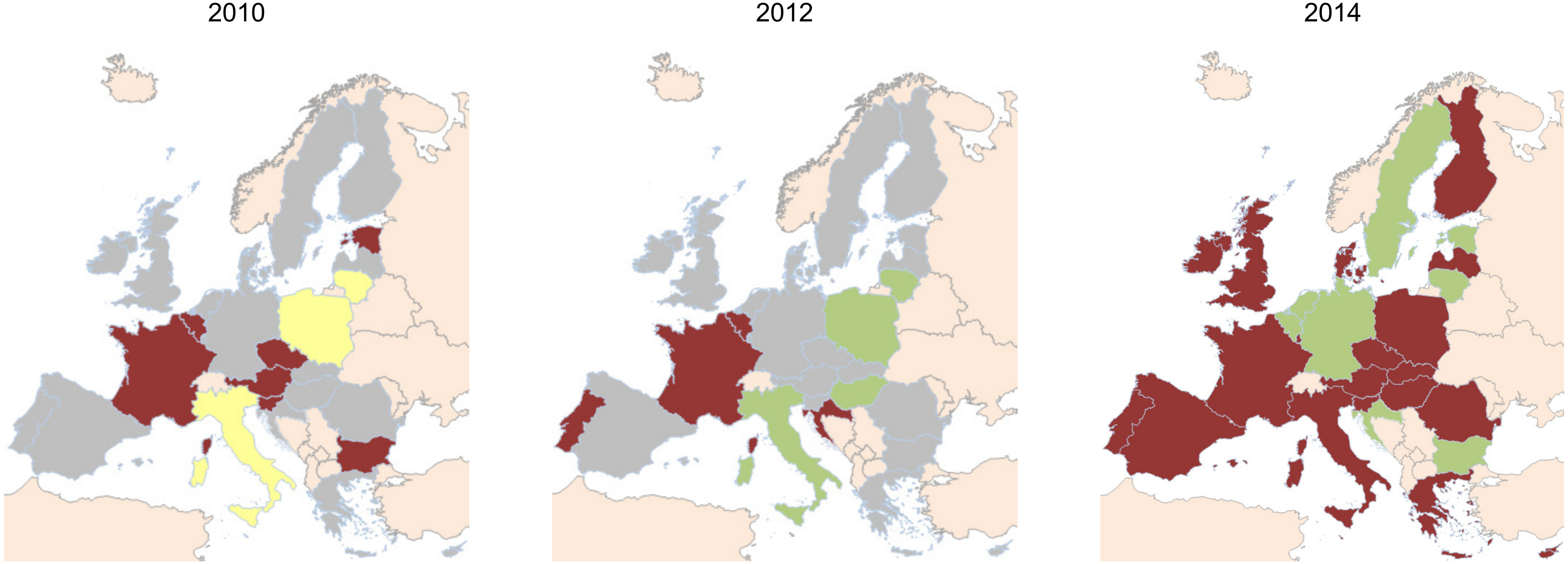


Source: Based on [35, 36], authors' own illustration

Red – Barrier is present; Green – Barrier is not present; Yellow – Barrier is partly present; Grey- No information available

Figure 2-7 shows the development of the barrier "No maximum time limit for procedures". In 2010 this barrier was present or partly present in almost all Member States in Central and Eastern Europe. It was not present among others in Portugal, the Czech Republic and Italy. Member States which reported that this barrier was partly present in 2010 managed to overcome this barrier by 2012, with the exception of Poland and Slovakia. States that either did not provide information in 2010 or reported the presence of this barrier were still facing it in 2012, e.g. Austria or Spain. Compared to 2010 and 2012, the situation had improved in 2014. Almost all states provide maximum time limits for procedures. Only a small number of states did not implement such limits.

Figure 2-8: Development of the barrier "No automatic permission after deadline passed" from 2010 to 2014

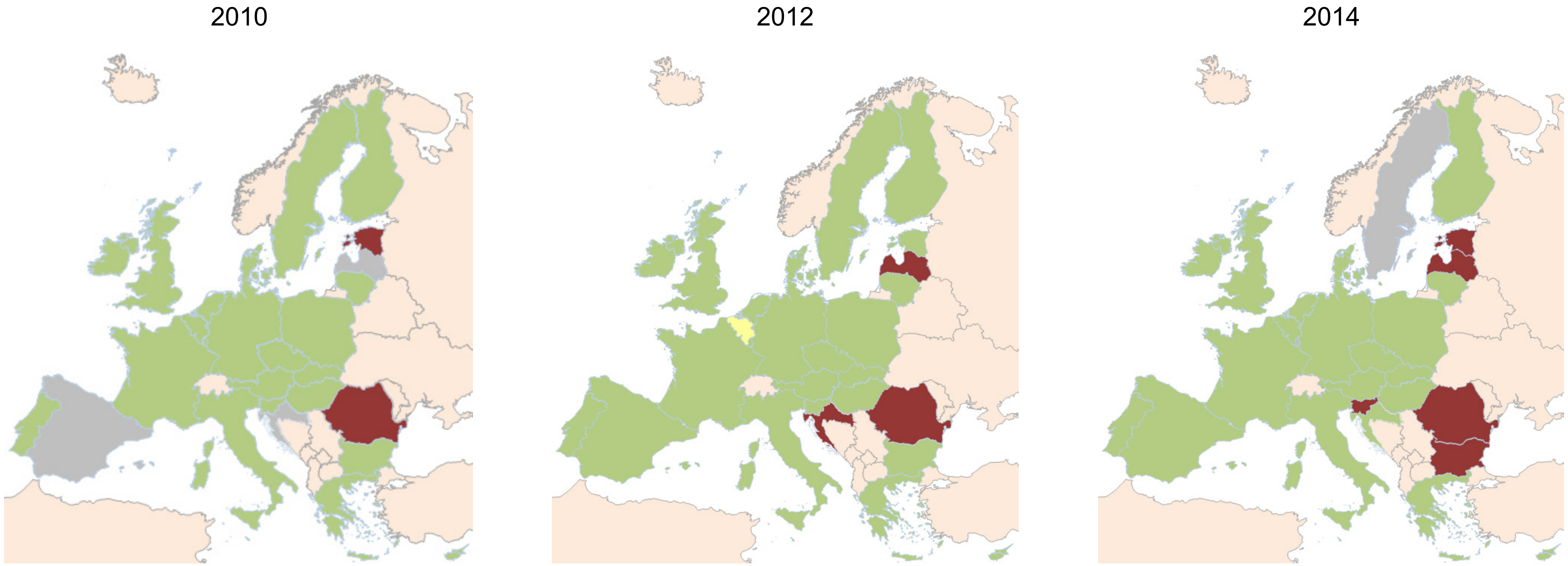


Source: Based on [35, 36], authors' own illustration

Red – Barrier is present; Green – Barrier is not present; Yellow – Barrier is partly present; Grey- No information available

The development of the barrier "No Automatic Permission after Deadline Passed" can be seen in Figure 2-8. Little data was available on this barrier both in 2010 and 2012. In those cases in which information was available in 2010, Member States either did not or only partly implement this mechanism. For Member States that partly implemented this process in 2010, it was fully realised in 2012; namely in Italy, Poland and Lithuania. In 2014 almost all Member States provided information but were not able to implement the possibility of an automatic permission after a deadline has passed. Only a small number of states realised this possibility, e.g. Germany or Belgium.

Figure 2-9: Development of the barrier “No facilitated procedures for small-scale projects” from 2010 to 2014

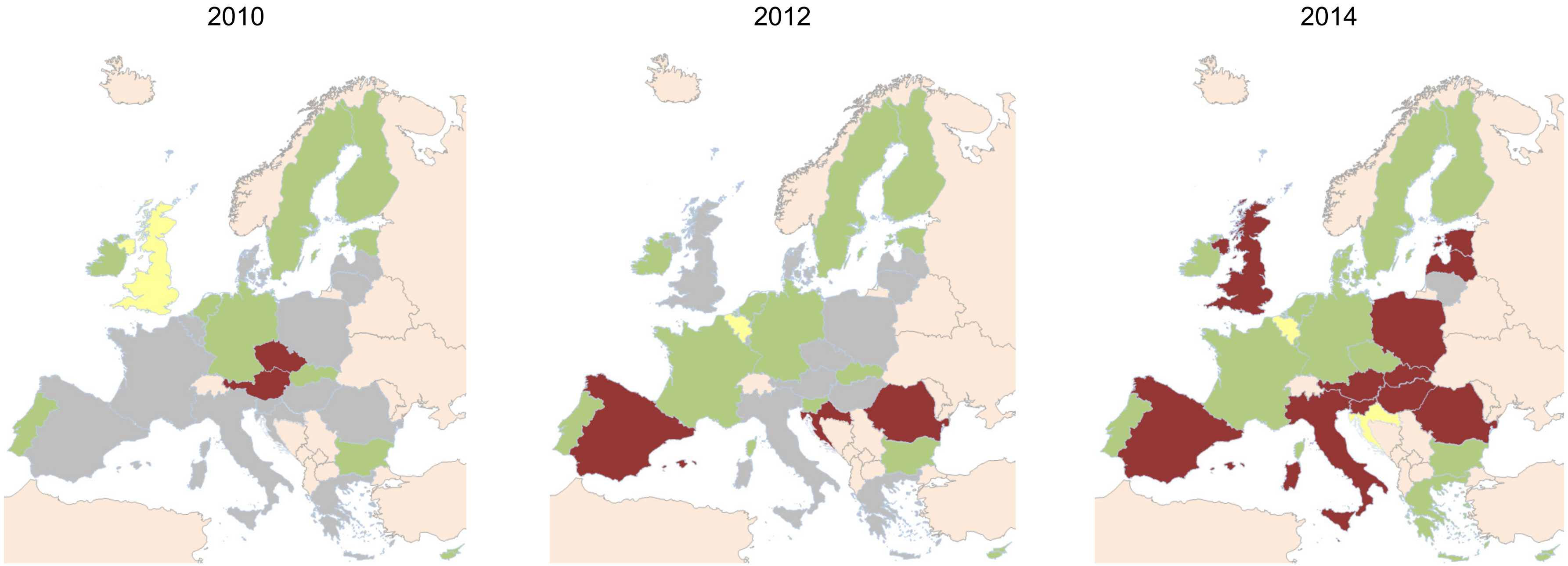


Source: Based on [35, 36], authors’ own illustration

Red – Barrier is present; Green – Barrier is not present; Yellow – Barrier is partly present; Grey- No information available

The development of the barrier “No Facilitated Procedures for Small-Scale Projects” is shown in Figure 2-9. Facilitated procedures for small-scale projects were implemented in 2010 and 2012 in almost all Member States. Estonia managed to implement facilitated procedures in 2012. Latvia and Croatia did not provide information in 2010 and reported the absence of facilitated procedures in 2012. Estonia managed to improve the situation in 2012. Romania did not provide this option neither in 2010 nor in 2012. Similar to 2012, in 2014 there were facilitated procedures for small-scale projects in almost all Member States, with the exception of Romania, Bulgaria, Slovenia, Estonia and Latvia.

Figure 2-10: Development of the barrier "No identification of geographic sites" from 2010 to 2014



Source: Based on [35, 36], authors' own illustration

Red – Barrier is present; Green – Barrier is not present; Yellow – Barrier is partly present; Grey- No information available

Figure 2-10 shows the development of the barrier "No identification of geographic sites". In 2010, little information was available on this barrier. The barrier was reported only for a few Member States, namely the Czech Republic, Austria and the United Kingdom (the latter reported the barrier as partly present). It is not possible to evaluate the development of this barrier in these Member States between 2010 and 2012, because no information was available in 2012. States that identified geographic sites in 2010 did so in 2012 as well. Spain, Croatia and Romania reported in 2012 that they did not identify geographic sites for renewables. In 2014 a larger number of states provided information. Many European Member States in Central and Northern Europe did provide geographic sites for renewable projects. Member States that did not provide information were Spain, Italy and Member States in Eastern and Southeastern Europe.

2.1.1.4. Grid Integration

This section compares the development of barriers to the grid integration of renewables. After a general examination of the presence of these barriers in Europe, individual barriers and their developments will be examined more closely. Therefore the following cross-Member State comparison focuses on the main barriers that are shown in Table 2-6.

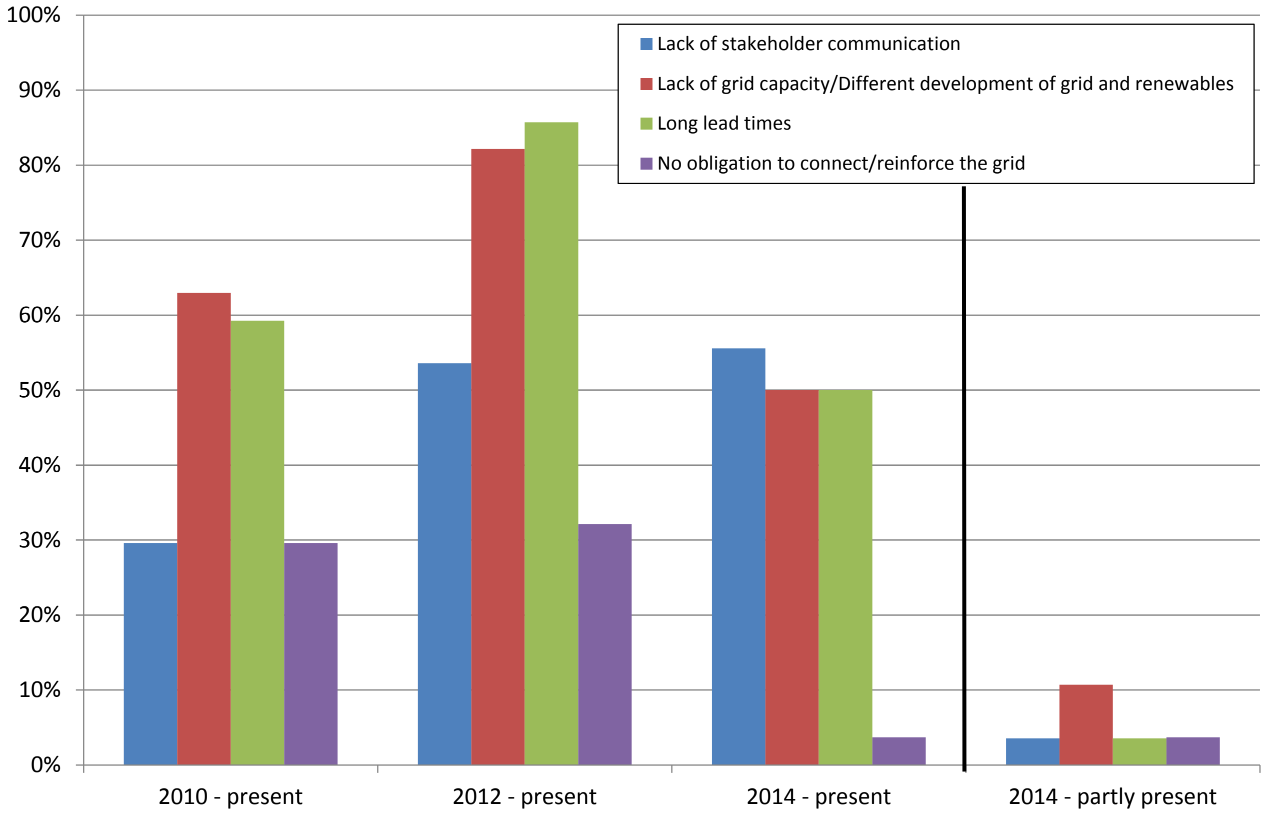
For this chapter the main sources are the studies [38] and [35]. The study [36], which was the forerunner study to [35], made use of the data from the study [38] as regards grid integration. Therefore [36] is not taken into account.

Table 2-6: Description of different grid integration barriers in EU Member States

Barrier	Description
Lack of stakeholder communication in the grid connection process	The communication between grid operators and developers is not functioning well.
	There is not enough capacity for the integration of renewables into the grid. The development of RES-E capacity and grid capacity happens at a different pace.
Long lead times	Until the connection to the grid is realised projects face long lead times.
No obligation to connect/reinforce the grid	The grid operator does not have an obligation to connect new power plants to the grid or to reinforce/expand the grid.

Source: Based on [35, 38], authors' own compilation

Figure 2-11: Overview of barriers for grid integration present in European Member States from 2010 to 2014

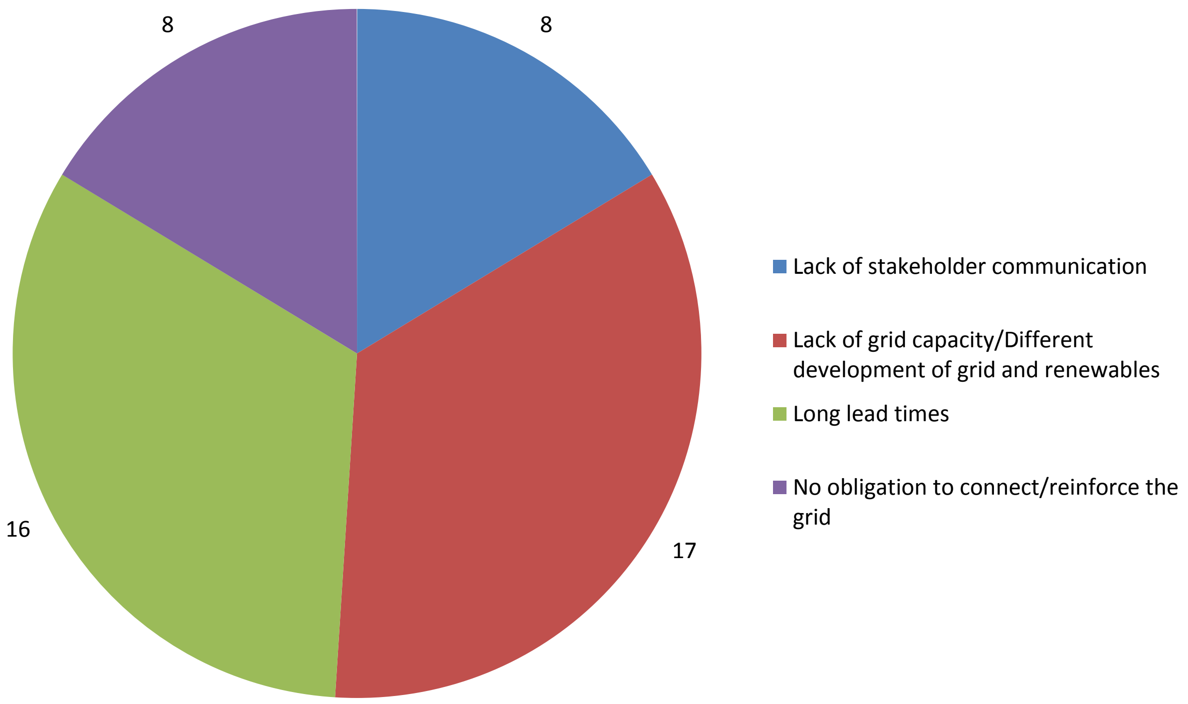


Source: RES Integration 2012, Ecofys 2014; authors' own

Figure 2-11 shows the development of the main barriers for grid integration from 2010 to 2014. When interpreting the relative shares of Member States which faced this barrier, it is important to take into account that information was not available for all Member States on all barriers. Therefore, 100% of Member States does not necessarily represent 28 Member States for all barriers. Table 2-7, Table 2-8 and Table 2-9 contain information on the number of Member States for which no information on barriers to grid integration could be raised in the years 2010, 2012 and 2014.

It can be seen that the number of states that faced the barriers “Lack of Stakeholder communication”, “Lack of grid capacity/Different development of grid and renewables” and “Long lead times” increased between 2010 and 2012. The number of states that faced “No obligation to connect/reinforce the grid” remained on an almost constant level from 2010 to 2012. In 2014 the presence of almost all barriers could be reduced in comparison to 2012 with exception of the barrier “Lack of stakeholder communication”.

Figure 2-12: Barriers for grid integration present in European Member States in 2010



Source: Based on [38], authors' own illustration

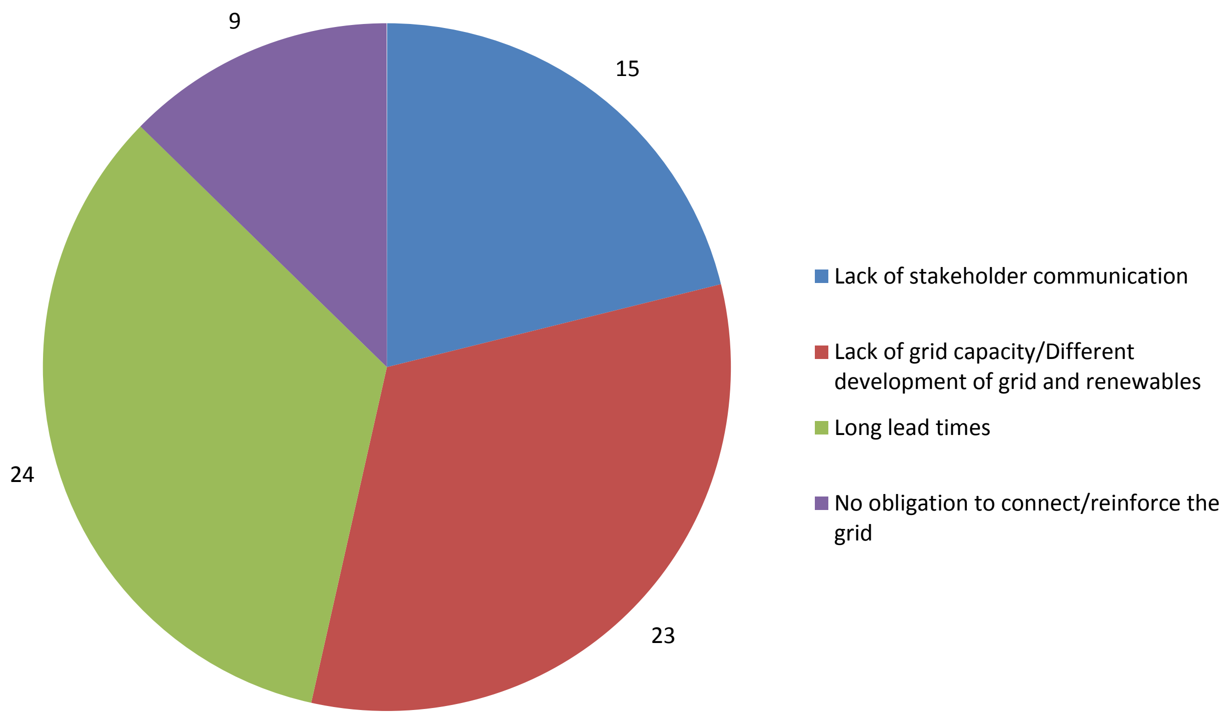
Table 2-7: No information on grid integration barriers in European Member States in 2010

Barrier	Number of Member States without information
Lack of stakeholder communication	1
Lack of grid capacity/Different development of grid and renewables	1
Long lead times	1
No obligation to connect	1

Source: Authors' own compilation

Figure 2-12 shows the presence of barriers in Member States that reported the barrier. The barriers "Lack of grid capacity" as well as "Long lead times" were the most crucial ones in the year 2010. They were present in 17 and 16 Member States, respectively. The barriers "Lack of stakeholder communication" and "Lack of grid capacity" were present in only eight Member States.

Figure 2-13: **Barriers for grid integration present in European Member States in 2012**



Source: Based on [35], authors' own illustration

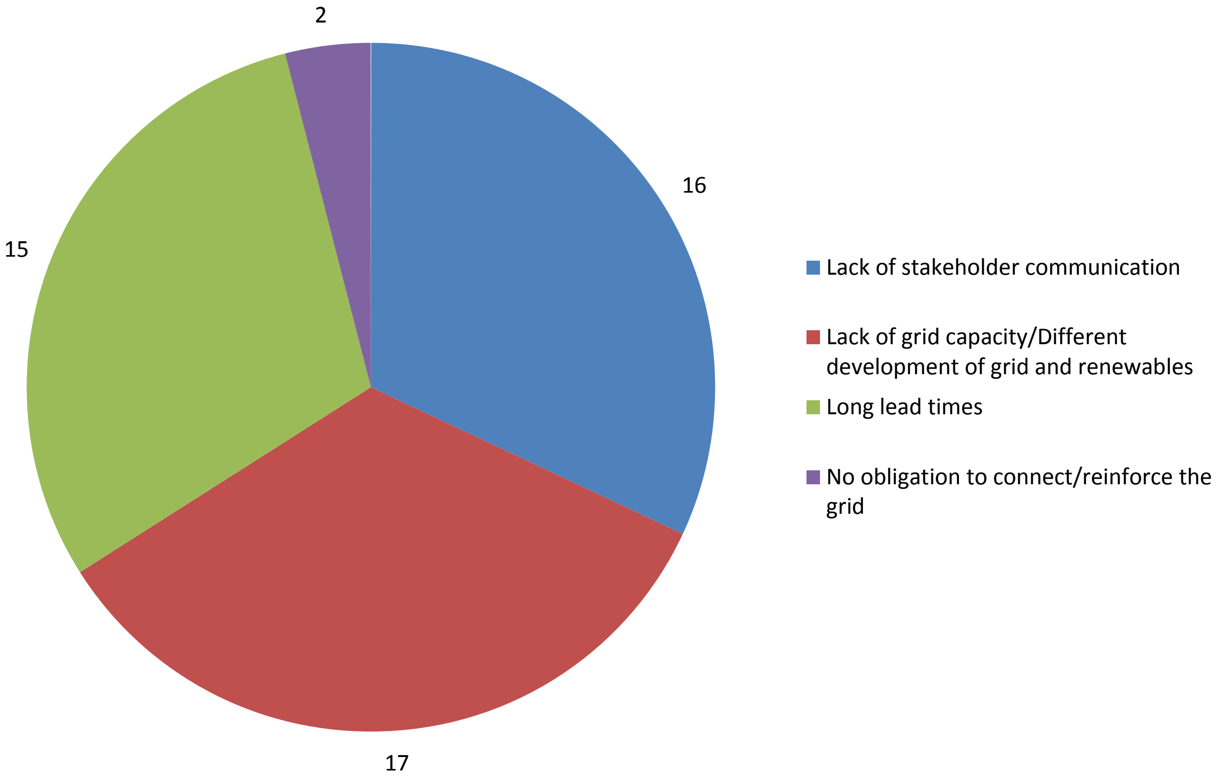
Table 2-8: **No information on grid integration barriers in European Member States in 2012**

Barrier	Number of Member States without information
Lack of stakeholder communication	0
Lack of grid capacity/Different development of grid and renewables	0
Long lead times	0
No obligation to connect	0

Source: Authors' own compilation

Figure 2-13 shows the presence of barriers in European Member States in 2012. The barriers "Lack of grid capacity" and "Long lead times", which were already prevalent in 2010, were even more so in 2012. The barrier "Lack of stakeholder communication" increased in 2012 compared to 2010. The least relevant barrier was "No obligation to connect", with only nine Member States.

Figure 2-14: Barriers for grid integration present in European Member States in 2014



Source: Authors' own illustration

Table 2-9: No information on grid integration barriers in European Member States in 2014

Barrier	Number of Member States without information
Lack of stakeholder communication	1
Lack of grid capacity/Different development of grid and renewables	0
Long lead times	0
No obligation to connect	1

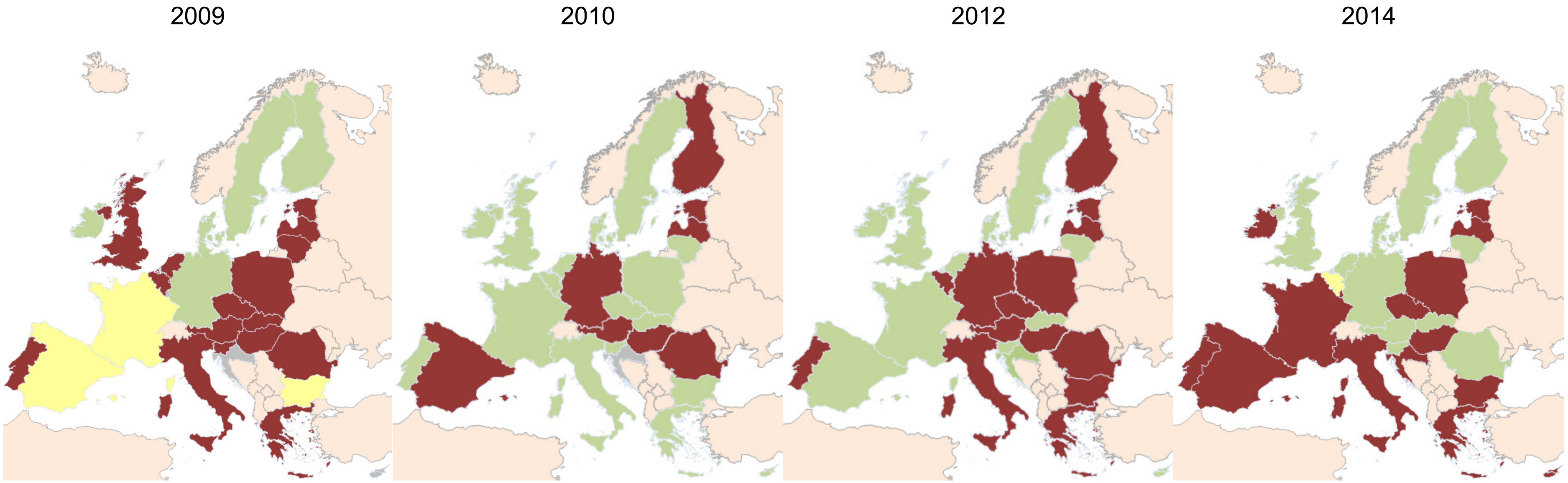
Source: Authors' own compilation

Figure 2-14 shows the number of Member States in which the barriers could be found in the European Union in 2014. Almost all barriers are significantly present, except for the lack of an obligation to connect. The barrier "Lack of stakeholder communication" appears in 16 and the barrier "Long lead times" appears in 15 Member States. "Lack of grid capacity/Different development of grid and renewables" can be found in 17 Member States. "No obligation to connect" can be found in only two Member States and therefore seems to be less relevant.

The following maps show the development of non-economic barriers in the context of grid integration in the European Union from 2010 to 2014. As was shown in the previous figures, there is no overall uniform trend for grid related barriers in Europe, depending on the barrier their relevance can both increase and decrease. For 2012, more barriers have been reported than for 2010. Between 2012 and 2014, all barriers have been reduced, except for lack of stakeholder communication.

If a barrier is absent, the Member State has a green colour; if it is present, the colour is red. In the Member States that are yellow-coloured the barrier is partly present. Partly means that the barrier is only present for certain actors or in certain parts of the country. If a Member State is coloured grey, there was no information available on this barrier in that Member State.

Figure 2-15: Development of the barrier “Lack of stakeholder communication” from 2009 to 2014

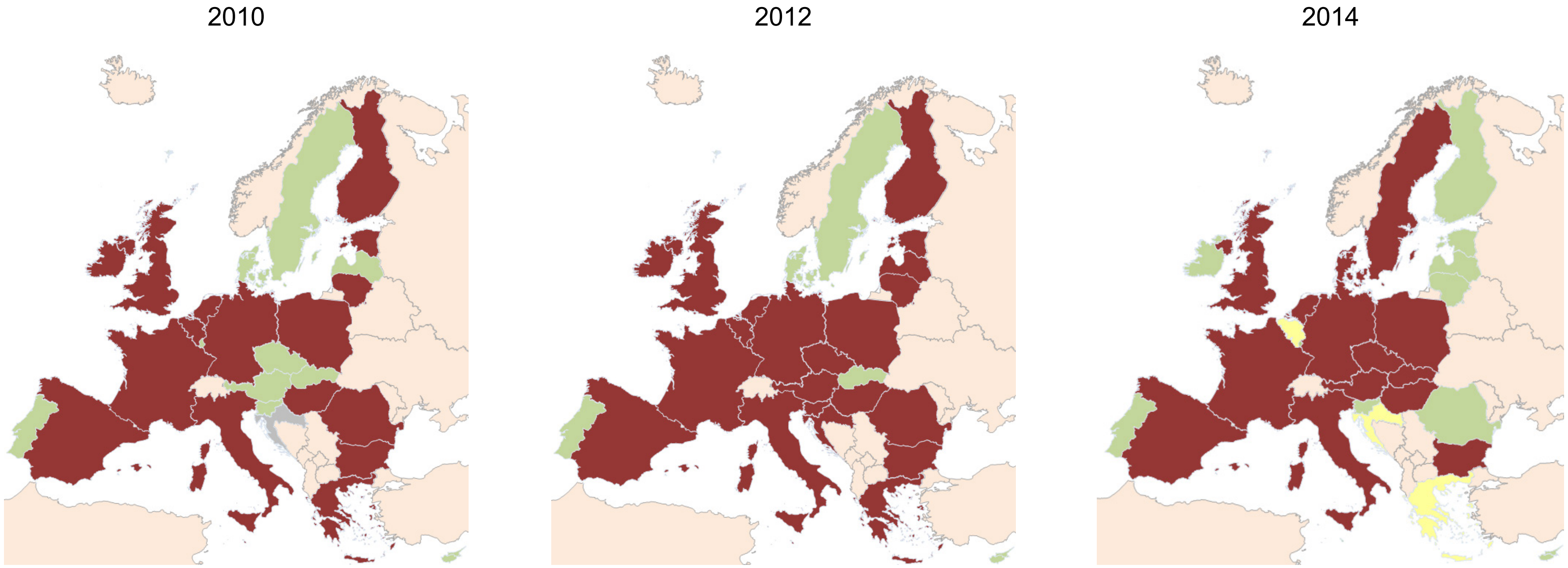


Source: Based on [35, 38, 39], authors’ own illustration

Red – Barrier is present; Green – Barrier is not present; Yellow – Barrier is partly present; Grey- No information available

Figure 2-15 shows the development of the barrier “Lack of stakeholder communication” from 2009 to 2014. In 2009 many Member States faced this barrier. There were only five Member States in which the interaction of stakeholders in the grid connection process was not perceived as problematic; these were Germany, Denmark, Finland, Sweden and Ireland. In the following year the situation improved for many Central and Eastern European states. This situation could be maintained in the same states or worsened in some Member States in 2012. Negative developments with regard to this barrier could be observed in Poland, the Czech Republic, Greece and Bulgaria. In 2014 the situation improved especially in Eastern European Member States. Some Member States like France and Spain where the barrier was not present in 2012 faced this barrier in 2014. This may reflect the increasing number of RES projects that represent a challenge for the existing grid.

Figure 2-16: **Development of the barrier "Lack of grid capacity/Different development of grid and renewables" from 2010 to 2014**



2010

2012

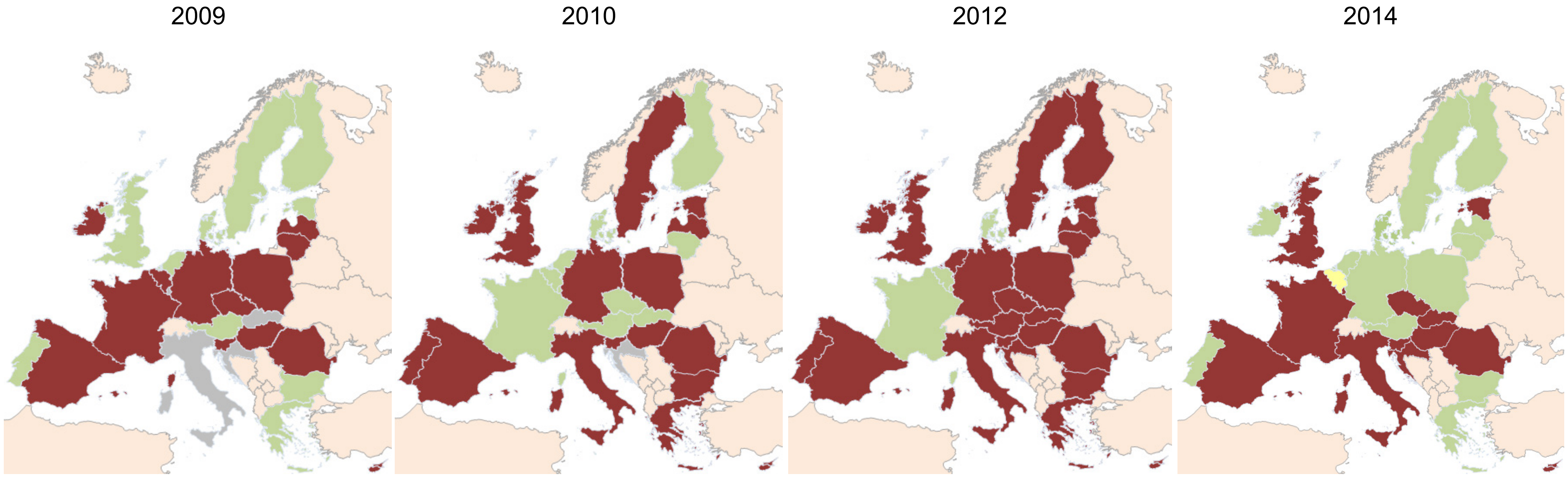
2014

Source: Based on [35, 38], authors' own illustration

Red – Barrier is present; Green – Barrier is not present; Yellow – Barrier is partly present; Grey- No information available

The development of the barrier "Lack of grid capacity" can be seen in Figure 2-16. In 2010 the majority of Member States reported this barrier. The exceptions were central and Eastern European states such as Czech Republic, Slovakia, Austria and Slovenia, as well as Portugal, Denmark, Sweden and Latvia. In 2012 little change can be observed. In some states like for example Latvia this barrier started to become relevant. In 2014, the barrier is still relevant in the majority of Member States. Also Member States that did not experience this barrier in 2012 did so in 2014, e.g. Denmark. One reason for the development of this barrier can be a significant expansion of renewables with which grid expansion could not keep up.

Figure 2-17: Development of the barrier “Long lead times” from 2009 to 2014

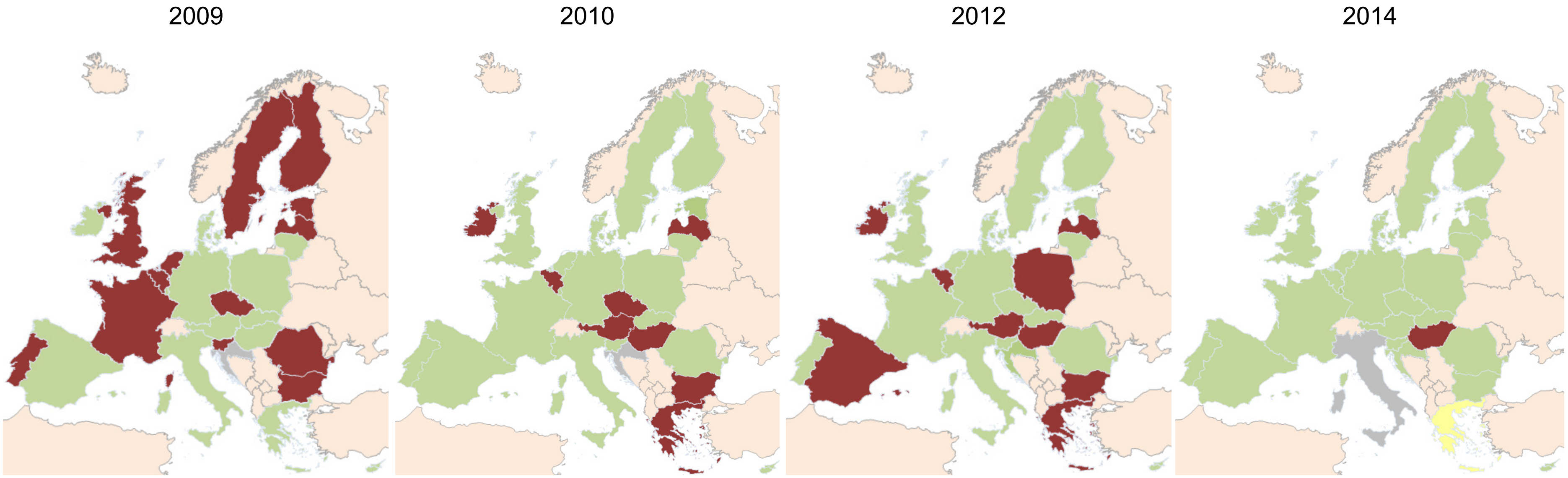


Source: Based on [35, 38, 39], authors’ own illustration

Red – Barrier is present; Green – Barrier is not present; Yellow – Barrier is partly present; Grey- No information available

The development of the barrier “Long lead times” from 2009 to 2014 is shown in Figure 2-17. In all of the depicted years this barrier was present all over Europe in the majority of Member States. In 2009 as for 2010 only for a small number of Member States the absence of this barrier was reported. An improvement could be observed in central as well as in Eastern European Member States such as the Czech Republic and Slovakia. In 2012, the barrier became relevant in an even larger number of Member States, with only a small number of excpetions for example France, Belgium and Denmark. In 2014 the barrier became less of an issue in some European Member States such as Poland, Germany, Finland and Sweden among others in Central and Eastern Europe.

Figure 2-18: Development of the barrier “No obligation to connect/reinforce the grid” from 2009 to 2014



Source: Based on [35, 38, 39], authors’ own illustration

Red – Barrier is present; Green – Barrier is not present; Yellow – Barrier is partly present; Grey- No information available

Figure 2-18 shows the development of the barrier “No obligation to connect.” 2009 shows a mixed picture across the EU. In 2010 the situation improved and stayed on a similar level in 2012. Some states were not able to improve the situation from 2010 to 2012, e.g. Austria, Ireland, Greece, Bulgaria and Latvia. The situation improved further in 2014 when the absence of an obligation to connect was only present in, Hungary as well as partly in Greece.

2.1.2. RES-HC

Deployment levels of RES-HC technologies as well as changes in deployment levels in recent years differ widely across Member States (see Task 1). In this section we look specifically at non-economic barriers affecting these deployment levels. Table 2-10 shows an overview of the non-economic barriers that are present in the European Member States in 2014.

Less than half of all Member States report on non-economic RES-HC barriers in their progress reports. There is an obvious need for improvement here in order to assess non-economic barriers more thoroughly. In Art. 22(1e) Member States are obliged to report on legal and other barriers that hamper the deployment of RES. Most Member States, however, limit the description of these barriers in their progress reports on RES-E without addressing RES-HC. This point is also addressed in our policy recommendations in Chapter 2.3.3.10 below.

The frequency with which barriers are mentioned for the different Member States in Figure 2-19 may only be a lower estimate. This is due to the fact that it was outside the scope of this study to conduct interviews in each Member State, as well as the fact that not all progress reports address RES-HC non-economic barriers. In fact, the table cells highlighted in grey show, that it was not possible in many cases to gather information regarding certain barriers. In the best case, this may indicate that a given barrier is not present, or perceived to be a barrier at all. In the worst case, it indicates that this barrier is present, but has not been acknowledged yet. *Split incentives,*[28] for instance, could fall into the former category since countries with high rates of home ownership would not necessarily experience them as a barrier. The *lack of compliance and quality control by the authorities*, however, might only be considered a barrier once a Member State has implemented a sufficient amount of RES-HC deployment programmes, which are in turn worth assessing and controlling by the authorities. Therefore, this barrier falls into the latter category.

Nonetheless, the assessment provides an important picture of where problems and barriers do exist. Some of these barriers have already been addressed by the RED, but in many cases the implementation and/or requirements could be improved. As is detailed below in Section 2.3.3 the perceived *lack of reliable advice* as well as the *lack of skilled professionals*, for instance, could be further addressed by strengthening Art. 14(3). Here the qualification/certification requirement should be extended to all professionals in the buildings sector in order to make sure that all of these professions develop a sensitivity towards the special requirements for RES-HC technologies.

Figure 2-19 shows the percentage of Member States in which barriers exist. *Low public perception of RES-HC technologies* shows the greatest presence as a barrier affecting around 65% of Member States, closely followed by a *lack of reliable advice* and a *lack of skilled professionals* with 61% each. There are three barriers affecting around 50% of all EU Member States: *insufficient implementation of Art. 13(4) of the RED*, non-mandatory *RES use in public buildings* and a *lack of information*. The next barrier affecting around 45% of Member States is *complex procedures to facilitate grid access/ connection.* Three barriers affect 30% to around 40% of Member States, namely: *Insufficient accredited qualification and training programmes*, *split incentives*, as well as a *lack of compliance and quality control by the authorities*.

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[28] Split incentives refer to situations where, for instance, the landlord is responsible for renewing the heating device, but does not have any incentive to do so, since the tenants get the benefits from having the improved technology (and consequently lower energy bills). Put differently: if the tenants would like to switch to RES-HC technology, they may be stopped by their landlord, who is unwilling to renew the system, since this involves extra costs for the landlord, but no savings for him over time.

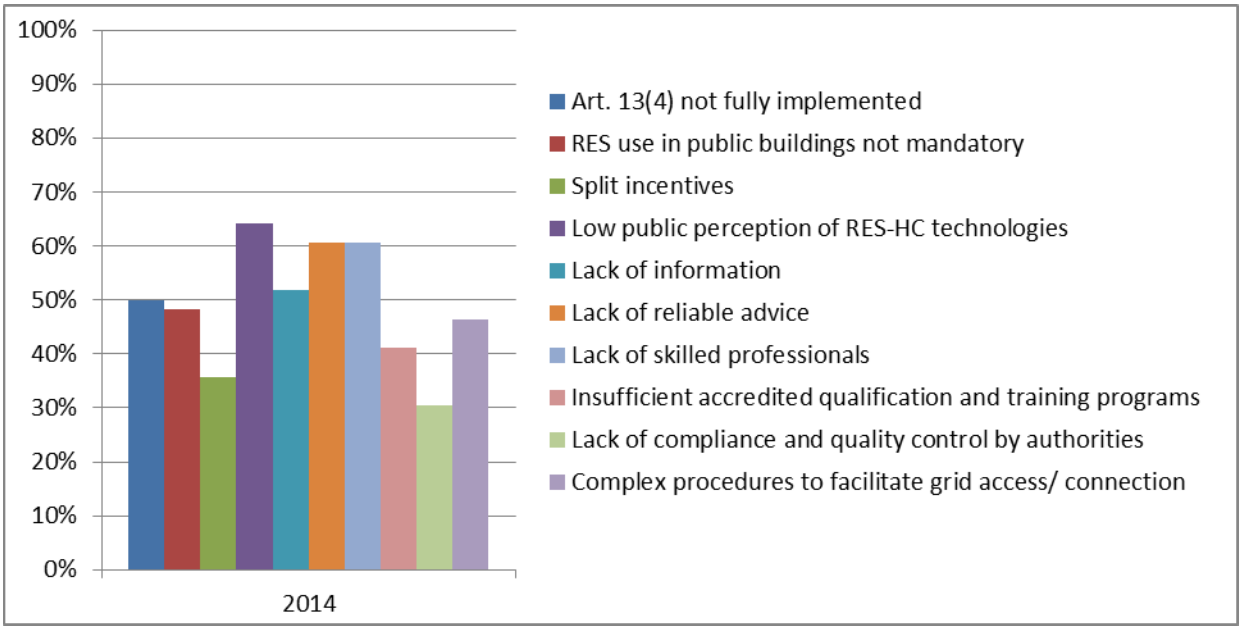
Table 2-10: Overview of non-economic barriers for RES-HC in European Member States and 2015 progress reports

		Buildings			Information and perception		Quality				Administration/ grid connection
		Art. 13(4) not fully implemented	RES use in public buildings not mandatory	Split incentives	Low public perception of RES-HC technologies	Lack of information	Lack of reliable advice	Lack of skilled professionals	Insufficient accredited qualification and training programs	Lack of compliance and quality control by authorities	Complex procedures to facilitate grid access/ connection
AT	Austria	●	▨	●	(●)		(●)	(●)		▨	(●)
BE	Belgium (Brussels)			▨	(●)						▨
BE	Belgium (Flanders)	●		▨	(●)					▨	▨
BE	Belgium (Walloon)		▨	▨	(●)						(●)
BG	Bulgaria	●			●	●					●
CY	Cyprus	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
CZ	Czech Republic	●	●	(●)	●		●	(●)			(●)
DE	Germany	(●)		●		(●)	(●)	(●)	▨	(●)	
DK	Denmark			●		●	(●)	(●)			
EE	Estonia	●	●	▨	(●)	●	▨	(●)	(●)	▨	●
EL	Greece	▨	▨	▨	(●)	(●)	(●)	(●)	▨	▨	▨
ES	Spain	(●)		▨	●	●	●	●	●	●	●
FI	Finland	●	●	(●)	(●)	(●)	(●)	(●)		▨	(●)
FR	France		●		●	●		●	●	●	●
HU	Hungary	●	●	▨	●	●	●	●	●	▨	●
HR	Croatia	●	●	●	●	●	●	●	●	●	●
IE	Ireland	▨	▨	▨	▨	▨	(●)	●	●	▨	▨
IT	Italy			▨	●	●	●	●		●	●
LT	Lithuania	(●)	●	▨		●	●	●	●	▨	(●)
LU	Luxembourg		●	▨	●						
LV	Latvia	(●)	●	●	●		●	●	●	●	●
MT	Malta	▨	(●)	●			●	●	●		
NL	The Netherlands		▨	▨	●					▨	▨
PL	Poland	●	●	▨	●		●				
PT	Portugal	●	▨	▨	●	●	●	●	●	●	▨
RO	Romania	●	●	●	●	●	●	●	●	●	▨
SI	Slovenia			●	●		●			▨	●
SK	Slovakia	●	●	▨	●	●	●	●	●	●	●
SE	Sweden		▨	▨				(●)			
UK	United Kingdom	●	●	●	●	●	●	●			●

Source: Based on Member State progress reports from 2015; interviews, other sources, authors' own compilation;

● = Barrier is present in this Member State; (●) = Barrier is partly present in this Member State (e.g. only for a certain RES-HC technology); Grey = No information.

Figure 2-19: Distribution of non-economic barriers 2014



Source: Member States progress reports 2015, survey and stakeholder interview results as well as [37]

It is surprising to see that *low public perception of RES-HC technologies* scores highest amongst all analysed non-economic barriers across the EU. Even though many Member States have started information campaigns on renewables addressing their benefits, people do not seem to have warmed much to RES-HC technologies. There may be several reasons for this. Some interviewees have indicated that past programmes for promoting renewable energy sources (often RES-E) have had adverse effects due to poor implementation or spiralling costs associated with frequent changes of programme specifications. This negative image subsequently spread to all RES technologies. Failed projects with negative side effects also stick in the public's mind (e.g. failed geothermal drilling projects which may cause minor earthquakes or rising ground leading to building demolition). In the case of solar thermal, its intermittency or the perceivedly poor yields in the more northern Member States may lead to people thinking twice before deciding to install the technology. The fact that not all installers are familiar with all RES-HC technologies (which is a barrier in itself) may also affect public perception. Since having a warm home is a basic human need, people may not like the idea of trying something new, when they know that the old (often fossil fuel-based) technology works well and is mostly cheaper to install.

Concerning the impact that the different non-economic barriers have on RES-HC deployment, a subset of six barriers was assessed in more detail (see Chapter 2.2.2). These barriers are:

- *low public perception of RES-HC technologies*
- *lack of information*
- *lack of reliable advice*
- *lack of skilled professionals*
- *split incentives*
- *complex procedures to facilitate grid access/ connection*

The results of the semi-quantitative analysis of these barriers, based on answers from survey and interview participants, show that all of them are considered to have medium to medium-high effects (or 6-7 points based on a 1-10 points system where 1 = low effect and 10 = high effect). Even though individual barriers have different effects in different Member States, the results show that all six barriers are considered to be more or less equally important on the overall EU level with no particular barrier dominating. On a Member State level, however, differences do exist (see Chapter 2.2.2), which should be taken into consideration when discussing individual Member State recommendations. The barrier *low public perception of RES-HC technologies*, for instance, is considered to have a low-medium effect in Germany and Lithuania, a medium effect in Austria, the Czech Republic and Finland, and a medium-high effect in Spain, Romania and the UK.

Finally, one must not forget to mention that the non-existence of binding EU-wide targets for RES-HC until 2030 is perceived to be a major barrier by most of the interviewed stakeholders. Such targets would ensure that governments, developers, producers and other stakeholders can plan ahead and devise strategies on how to reach these targets. The lack of a comprehensive long-term strategy for RES-HC deployment in individual Member States is also highlighted in various literature sources (e.g. [37]) as well as the conducted interviews. Additionally, many stakeholders and literature sources acknowledge the fact that financial barriers are the single most dominant barrier when it comes to deploying RES-HC technologies in the EU.

2.1.3. RES-T

In addition to the evaluation of the existing literature, research was conducted on the presence of non-economic barriers in the European Member States on the basis of the 2015 progress reports, other literature and stakeholder interviews, that were conducted in early 2016.

Figure 2-20 shows the share of Member States in which non-economic barriers were identified. However, it is important to take into account that for some barriers in some Member States no information was available (marked in grey in Table 2-11) and the relative share only considers the total number of Member States of which information was accessible for this study. A more detailed description of the barriers and their effects is given in the Chapter 2.2.3.

The main non-economic barrier for further deployment of RES in transport is the missing regulatory framework for the post 2020 period (81%) and the discussions about significant changes of the regulation in the past (71%). Both increase the investment risk for producers and have been identified by literature and stakeholder interviews as the most relevant non-economic barrier for further renewable energy deployment in transport.

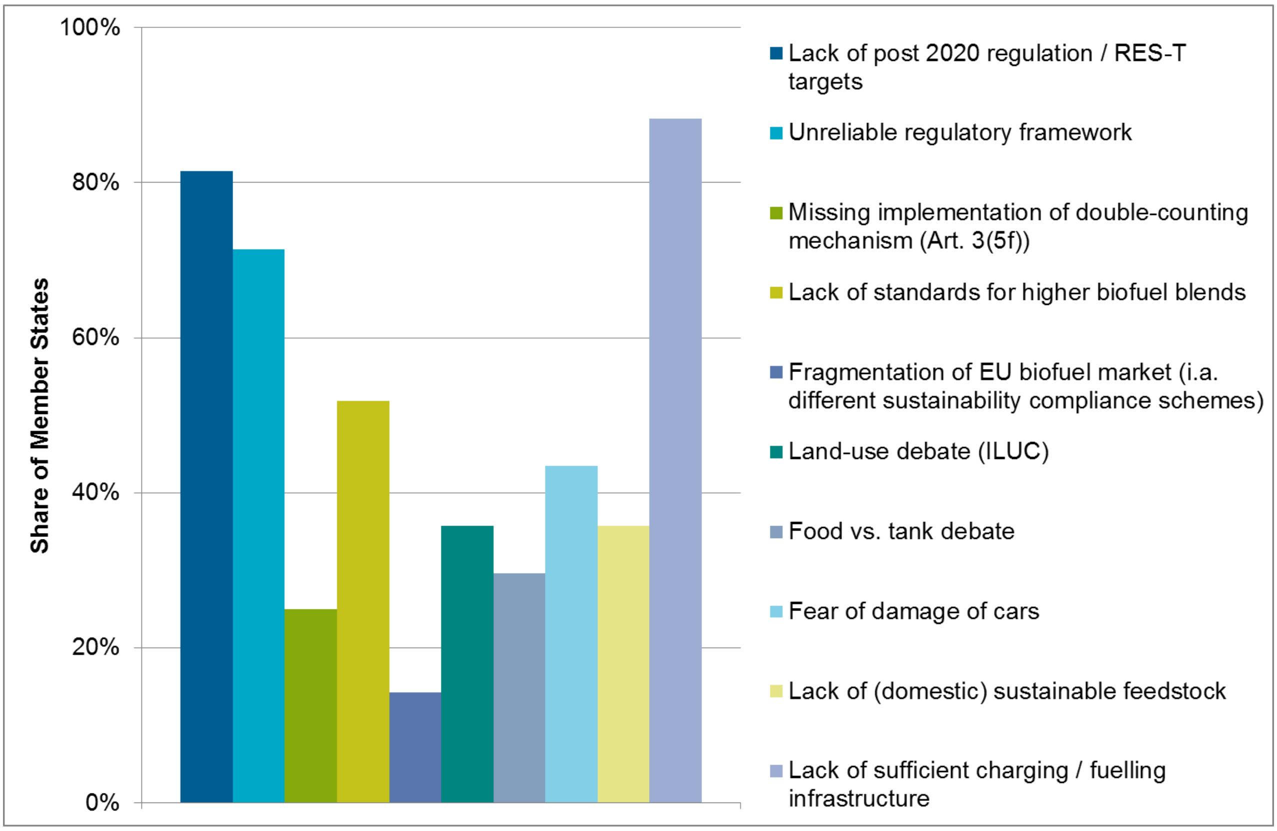
Missing public and consumer acceptance is another relevant non-economic barrier for RES deployment in transport. Various public and consumer concerns about biofuel use are indicated in more than 70% of the Member States. The most relevant concerns are the impact of biofuels on indirect land-use (36%) and the fear of damaged engines (43%). Both have been indicated as a relevant reason for non-deployment of biofuels in several Member States. Also the tank vs. food debate is mentioned as a public concern (30%). Stakeholders consider the low acceptance of biofuels as an important issue, yet less relevant than the investment risks which were stated above. However, the impact on deployment and the reasons for public concerns differ strongly between Member States.

Barriers for alternative technologies as well as for higher biofuel blends are also relevant. Advanced biofuels shall be counted twice for achieving the 10% target of renewable energy in transport in 2020 (Art. 3(5f), former Article 21(2)). This incentive has not been implemented into national legislation in seven Member States (25%). Implementation in all Member States would increase the market potential of advanced biofuels.

Differing schemes for sustainability compliance had created a fragmentation of the EU wide biofuel market during the introduction phase of the RED. Voluntary verification schemes which are valid in all Member States are the main sustainability verification type by now and the preferred option for the biofuel industry. Still, some stakeholders have the impression of a fragmentation of the EU market due to differing verification procedures, varying sustainability standards and double-counting mechanisms (14%), but the relevance of these issues for biofuel deployment has diminished over time.

Standards for higher biofuel blends will be necessary if higher biofuel targets will be set for the post 2020 period. The lack of these EU-wide standards is a relevant barrier in 52% of the Member States and might become an issue for the post 2020 period. Other drive technologies such as methane and electric vehicles require a sufficient charging and fuelling infrastructure. Most Member States have not brought these technologies into focus in their transport sector strategy until recently. The lack of the required energy infrastructure for these technologies is considered as a barrier in almost 90% of Member States in which information about the infrastructure of alternative drive technologies was accessible. The potential lack of (domestic) sustainable feedstock has been identified in 36% of the Member States as a barrier for RES-T.

Figure 2-20: Distribution of non-economic barriers for RES-T



Source: Based on Member State progress reports from 2015; Interviews, other sources, authors' own depiction

The RED (2009/28/EC) has been amended by the ILUC directive (2015/1513/EU) which was adopted on 9 September 2015 and entered into force on 5 October 2015. The main changes are the addition of a 7% limit for crop-based biofuels, the introduction of increased and new multipliers for renewable electricity in road transport and in rail transport. Additionally an indicative 0.5% target for advanced biofuels as a reference for national targets in the transport sector energy mix is added (to be set by April 2017).

The Member States have time for transposition in national legislation until 10 September 2017.[29] No Member State has yet transposed all requirements of the ILUC directive [1] even though some countries transposed parts[30] of the ILUC Directive. The missing implementation of the ILUC Directive has not been part of either Figure 2-20 or Table 2-11.[31]

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[29] The national targets for advanced biofuels have to be implemented by April 2017.

[30] Spain has implemented the 7% limit for crop-based biofuels; Italy has set a national target for advanced biofuels. Denmark, France and the Netherlands proposed bills for advanced biofuel targets which have to be officially agreed on.

[31] For a detailed description on how to read tables on non-economic barriers see Chapter 2.1.1.1.

Table 2-11: Overview of non-economic barriers for RES-T in European Member States and 2015 Progress Reports

	Investment Risk			Standards / Certification		Public / Consumer Acceptance				
	Lack of post 2020 regulation / RES-T targets	Unreliable regulatory framework	Missing implementation of double-counting mechanism (Art. 3(5f))	Lack of standards for higher biofuel blends	Fragmentation of EU biofuel market (i.a. different sustainability compliance schemes)	Land-use debate (ILUC)	Food vs. tank debate	Fear of damage of cars	Lack of (domestic) sustainable feedstock	Lack of sufficient charging / fuelling infrastructure
AT Austria	●	●		●		●	●	●		●
BE Belgium	●	●		●		●				●
BG Bulgaria	●	●	●	●			▨	●		●
CY Cyprus	●	●					●	▨	●	▨
CZ Czech Republic	●	●	●							●
DE Germany	●	●	●	●		●	●	●		●
DK Denmark	●			●					●	●
EE Estonia		●		●				▨		●
EL Greece	●							▨	●	▨
ES Spain	●	●	●	●				●		●
FI Finland	●			●	●					●
FR France	●	●			●			●		▨
HU Hungary		●		●			●	▨		●
HR Croatia	●	●		●					●	●
IE Ireland	●	●						▨		▨
IT Italy	●	●								●
LT Lithuania										▨
LU Luxembourg	●	●	●	●		●	●			
LV Latvia	●	●	●			●		●		▨
MT Malta	▨	●		▨		●			●	
NL The Netherlands		●					●		●	●
PL Poland	●			●				●		▨
PT Portugal				●		●			●	●
RO Romania	●							●	●	▨
SI Slovenia	●	●				●			●	●
SK Slovakia	●	●		●	●			●	●	▨
SE Sweden	●		●			●	●			▨
UK United Kingdom	●	●			●	●	●	●		▨

Source: Based on Member State progress reports from 2015; interviews, other sources, authors' own compilation;

● = Barrier is present in this Member State; (●) = Barrier is partly present in this Member State; Grey = No information.

2.2. Analysis of effects of non-economic barriers

Non-economic barriers can have different effects on RES. They can:

- increase the costs of RES (thus turning into an economic barrier),
- delay RES projects and thus slow down the deployment of RES, and
- prevent the development of RES projects and thus reduce RES deployment.

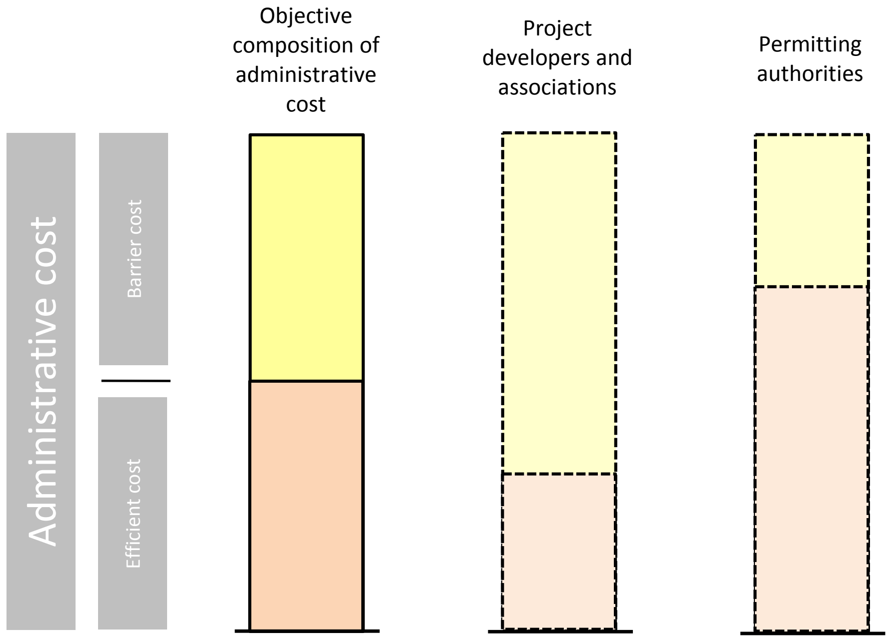
These effects are interrelated, as for example increased costs can reduce overall deployment and persistent delays in project development can lead to project cancellations and thus also threaten overall deployment.

Overall, it is difficult to assess the quantitative effects of non-economic barriers. Firstly, it is difficult to collect information on such quantitative effects, both from the literature and from interviews. Secondly, it is also difficult to distinguishthe share of overall costs of, for example, administrative procedures that can be attributed to unnecessary and inefficient parts of these procedures and that can therefore be defined as the cost of a barrier.

The following Figure 2-21 shows in a stylised way how the overall administrative costs can be split into two elements. Firstly, the administrative costs that are incurred if permitting processes are designed and implemented as efficiently as possible (efficient cost), and secondly the cost element that results from an inefficient design and implementation of these processes (barrier cost) and that thus increases the overall costs above the efficient level.

In practice, it is difficult to differentiate the efficient cost and the barrier cost. Different types of stakeholders, namely project developers and permitting authorities, tend to have different views as to whether a process can still be called efficient or whether a barrier is present.

Figure 2-21: Cost structure of administrative cost (stylised illustration)



Source: Authors' own illustration

This section structures information on the various effects, provides data from the literature, combines it with MS specific data from the interviews and offers an interpretation of the available data.

The data shows that all of the effects mentioned above can be observed.

The focus is on RES-E. For this sector, the chapter provides evidence that shows the cost and deployment impact of non-economic barriers.

For RES-HC and RES-T a qualitative ranking of the relevance of barriers is provided.

2.2.1. RES-E

Even without a collection and analysis of comprehensive data, there is some evidence that non-economic barriers increase the costs of RES-E and reduce deployment. For both aspects, evidence will be presented in the following two sections.

The focus is on administrative costs and delays resulting from the planning and permitting process. This is a key non-economic barrier for RES-E across Member States. As for grid integration, this also represents a barrier for RES-E, which is increasingly due, however, to the development of the overall grid capacity rather than the connection process for individual plants. This can have a significant deployment impact, which is, however, difficult to evaluate within the scope of this study.

2.2.1.1. Impact of non-economic barriers on costs

Firstly, non-economic barriers can influence the costs of individual projects and thus also the overall costs of RES deployment.

Please note that in principle administrative costs should be included in the financial support level for RES-E.[32] Even if administrative costs are inefficient and include additional costs due to non-economic barriers, this should normally be reflected in higher tariff levels. If this is the case, the overall costs of RES deployment are increased, but RES deployment itself should not be affected, at least not as a result of the economics of individual projects. If tariff levels are set in an administrative process, the question is whether these costs are taken into account. If they are set in a competitive process (e.g. through auctions), these costs may be included in the bids of individual market participants. However, inefficient cost elements that are due to non-economic barriers can also introduce a new risk, especially if the costs of non-economic barriers differ within one economic regime (e.g. within one MS).

Depending on the technology, the relative role of costs of non-economic barriers can vary.

Administrative cost levels: Wind

The following graph shows the administrative costs of wind generation in European Member States in 2010. For wind generators, the cost of non-economic barriers on average only account for a small part of overall costs of between 1.5 and 4.5 % [42]. Some interviewees have confirmed that for wind projects the key problem resulting from non-economic barriers is not a cost increase, because administrative costs account only for a small part of overall costs, but rather delays and potential failure of projects.

These administrative costs can only partly be interpreted as the cost of a barrier, as there will always be some administrative cost. One approach to evaluate the costs of the actual barrier would be to examine the cost differences between countries, as these indicate how far Member States are away from best practice.

While the data below shows average costs, there can typically be a large variation of costs between projects, which can be due to the projects themselves, but also result from differences in the way permitting processes are implemented in different regions within one Member State [43].

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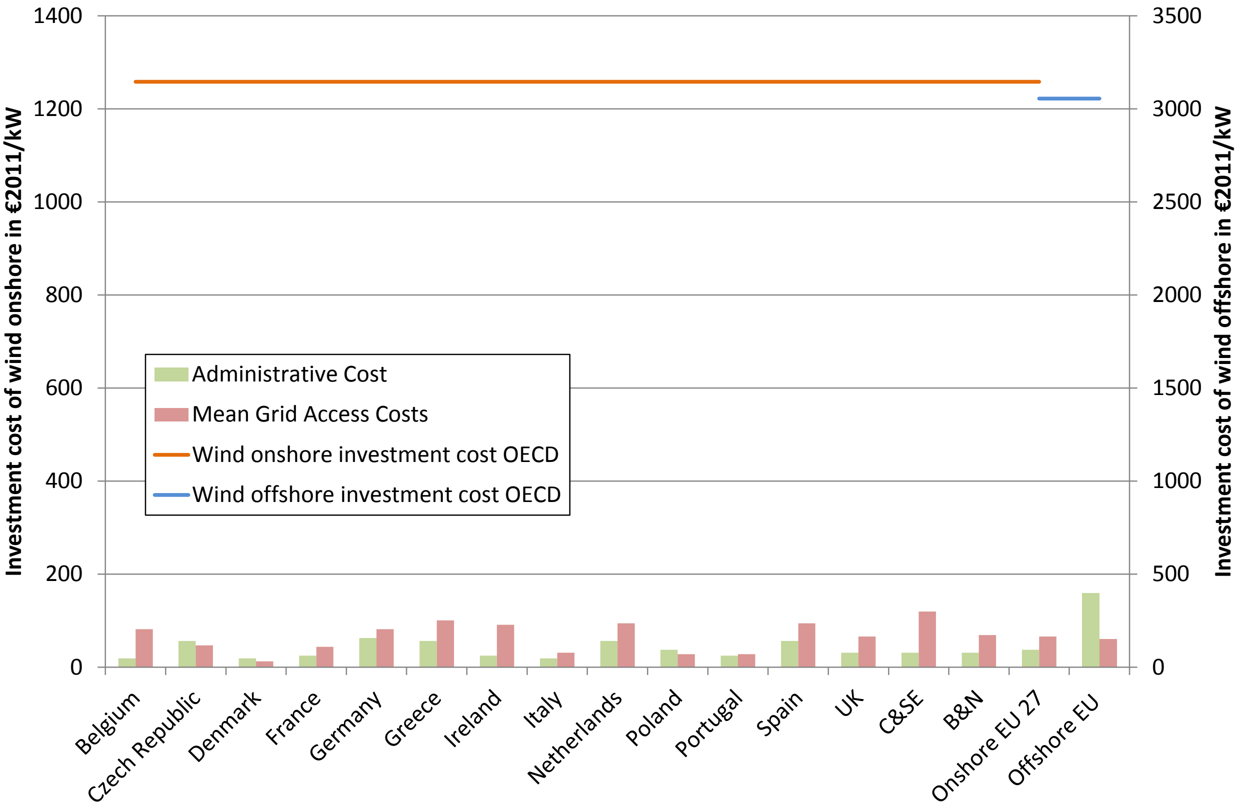
[32] *“There can be a variety of reasons for differences in support levels. […]Differences can also stem from […] different level of administrative costs (…).”* [41], p.18.

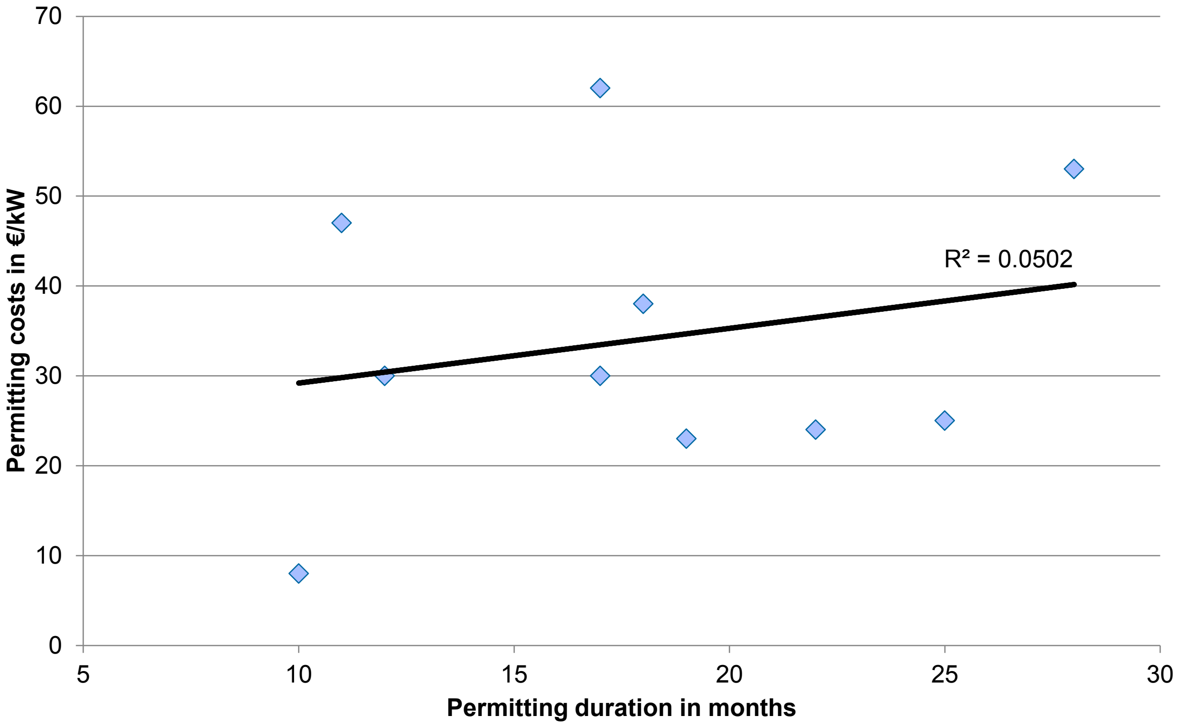
Figure 2-22: Administrative and mean grid access cost of wind systems in European Member States in 2010



Source: Based on [42, 44], authors' own illustration

For the case of wind in Germany, there is a detailed assessment available of planning and permitting costs in different federal states as well as the duration of these process steps. The following graph shows the average permitting duration in months as well as the permitting costs in EURO/kW for different federal states, based on the data provided by projects that participated in a survey.

Figure 2-23: **Permitting costs of wind projects in Germany and permitting duration in 2014**



Source: Based on [45], authors' own illustration

Although the dataset that has been available for this analysis does not allow for any representative conclusions to be drawn, not the least because the amount of data differs significantly between federal states, it still supports the following arguments:

- There are significant differences between federal states in permitting durations.
- There are also relevant differences between federal states in permitting costs. This is partly due to varying permitting fees [46], but according to interviews with project developers, differences also result from implicit permitting costs, e.g. staff costs that project developers incur.
- In this small sample, the permitting duration can only explain a small part of the cost differences (r^2=0,0502).
- Some of this may be explained by factors that are external to the permitting process as such (e.g. different levels of conflicts regarding available sites). However, given the fact that federal states play a strong role in permitting in Germany, it is very likely that the various approaches to permitting impact on the duration and costs.
- Germany generally has a well-functioning permitting regime and the overall permitting regime is the same across Germany, with the federal states responsible for implementation based on different administrative structures. The fact that such differences still occur indicates that the actual implementation of this regime plays a relevant role.

While in the German example presented above the differences in permitting costs can only to a smaller extent be explained by duration of the process, there is also evidence that the duration significantly influences costs.

For the case of Lithuania, one wind developer interviewed estimates that the planning costs could be reduced by roughly 50 % if the processes were better organised.

IEA-RETD published an evaluation of the cost impacts on the net present value of delays in obtaining the permit, whatever the reason for this delay is: political, site access, environmental or grid connection reasons [47]. Their assumptions, based on a series of interviews with project developers, for the model included additional regulatory costs and also an accounting of the impact on the cost of the financing scheme. The following assumptions have been made:

- A one-year delay results in 50 % of additional regulatory costs and a 0.25 % increase in the cost of debt.
- A five-year delay results in 20 % of additional annual regulatory costs and a 1.00 % increase in the cost of debt.

For wind power, the French wind power association estimates that non-economic barriers currently account for around 15 % of the overall project development costs. This includes the effect of the constraints imposed by the military, the high number of appeals from wind power opponents, the cost burden resulting from the administrative procedures and the delay for grid connection.

Administrative cost levels: PV

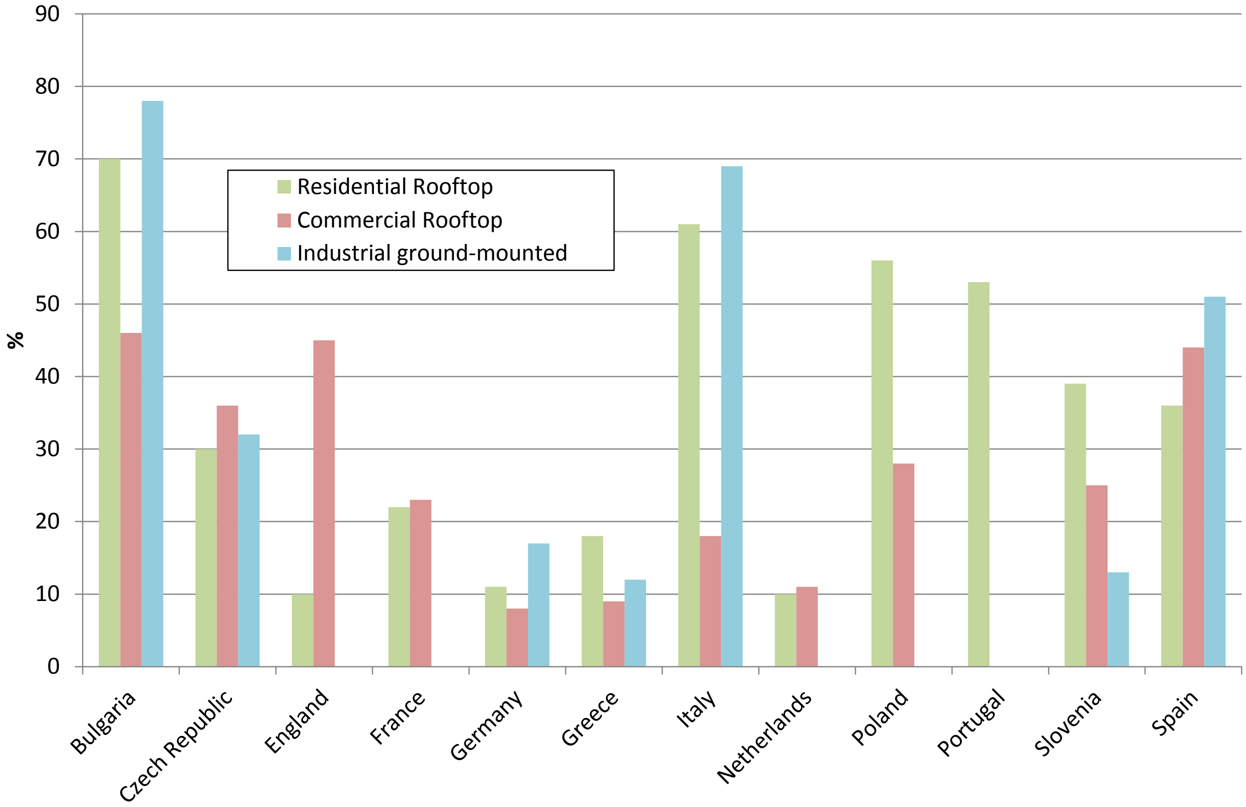
The following Figure 2-24 shows the administrative costs of PV generation in European Member States in 2011 as a share of overall development costs. Again, there are significant differences between Member States, which indicates that there are relevant barriers.

The hypothesis that the large differences between Member States are due to a significant extent to costs resulting from barriers is also confirmed by a study conducted by [48]. They show that so called PII costs (permitting, inspection and interconnection) for residential PV in Germany, which also has low costs in the analysis shown in the figure below, amount to only 0.03 $/W and are thus 0.21 $/W lower than in USA. They explain the low costs in Germany as follows (page 222):

"In Germany, local permits (structural, electrical, aesthetic) and inspection by county officials are not required for the construction of residential PV systems. Incentive applications are done quickly online on one unified national platform – all respondents of the German survey reported zero labor hours for this activity, suggesting that this is done by the owner of the PV system and no facilitation of the installer is required. In addition, no permit fee is required in Germany, while residential permitting fees in the United States average $ 0.09/W. As result, the only sizable PII activity in Germany is the actual interconnection process to the distribution grid."

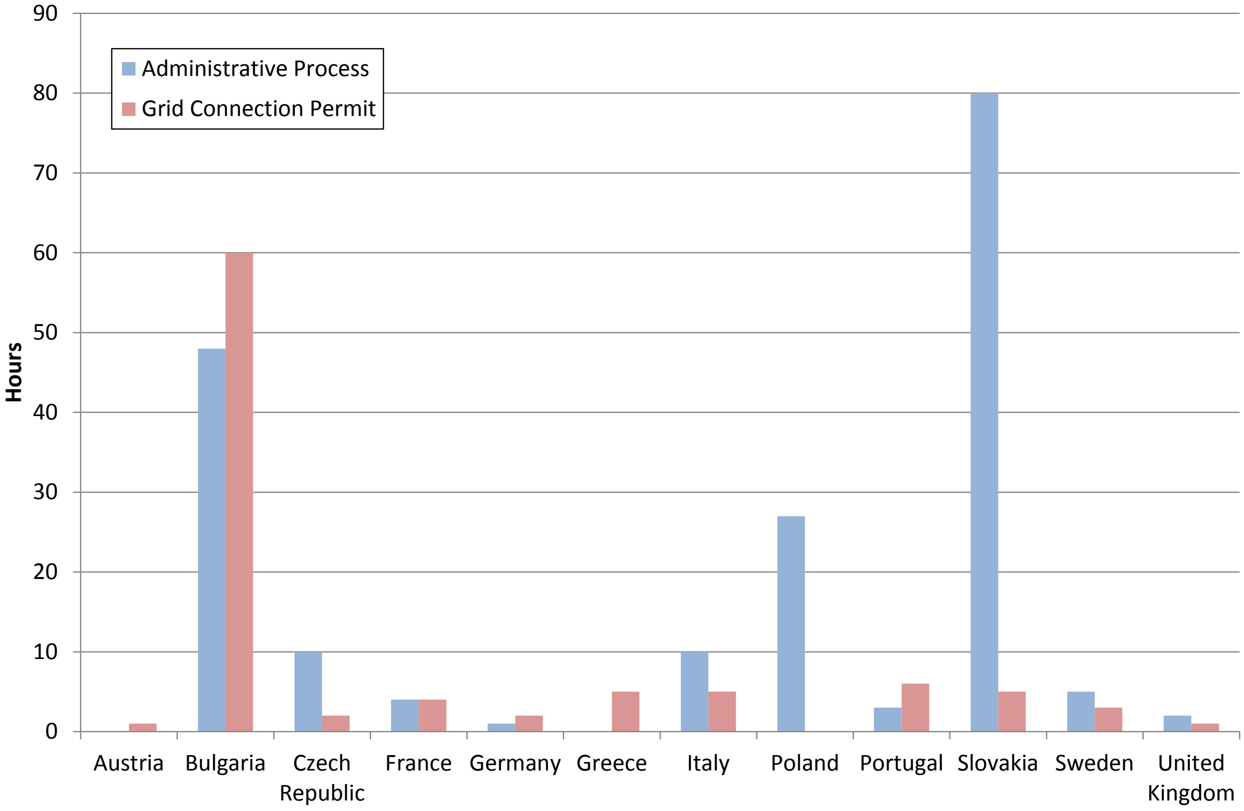
Similarly, concerning the current situation in Lithuania, the Lithuanian Solar Energy Association stated in an interview that overall administrative costs currently account for approximately 12 percent of overall project costs. The association further stated that of these 12 percent, 10 percentage points are currently still due to what they consider administrative barriers, while only 2 percentage points would be left if any unnecessary administrative burdens would be avoided. As a consequence, the overall costs for PV investment could be reduced by 10 percent if permitting became more efficient. This estimate for Lithuania, although not entirely comparable, is in the same range as the cost comparison between Germany and the USA.

Figure 2-24: Administrative cost of PV systems in European Member States as a share of development cost (excluding equipment) in 2012



Source: Based on [49], authors' own illustration

Figure 2-25: Legal administrative and legal grid connection labour requirements in EU Member States for residential PV systems in 2013, in hours



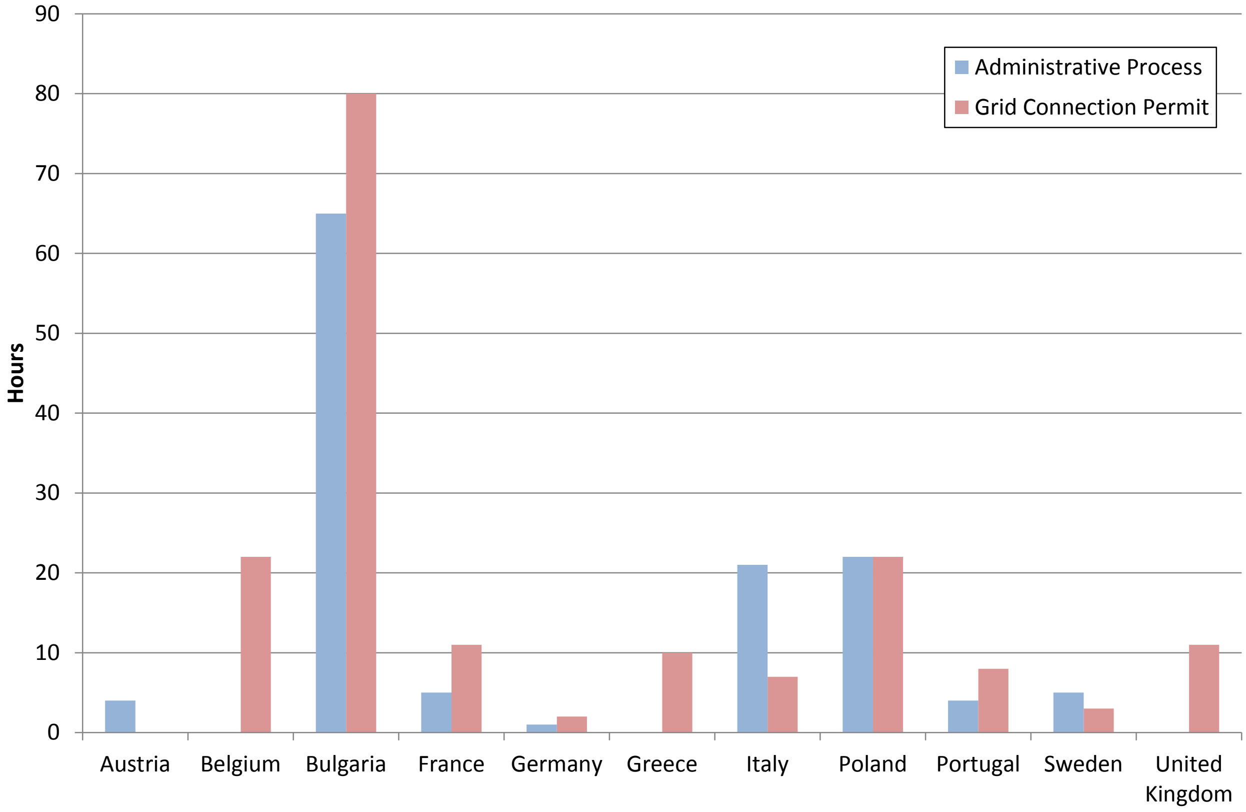
Source: Based on [50], authors' own illustration

Figure 2-25 shows the amount of time (measured in person-hours) invested for complying with legal-administrative requirements during both the administrative permitting and the grid connection process for a residential PV system with three kWp. The figure is based on data from the PV Grid database, which evaluates the duration of different legal processes for the integration of PV systems in European Member States.

As can be seen in the figure, there are significant differences between Member States. In the majority of Member States that have been covered, the legal requirements can be finalised in up to 10 hours. The exceptions are Bulgaria, Poland and Slovakia where project developers need significantly more time to deal with the required paperwork.

The absence of a bar indicates the absence of information for the particular state and permitting process.

Figure 2-26: **Legal administrative and legal grid connection labour requirements in EU Member States for commercial PV systems in 2013 in hours**

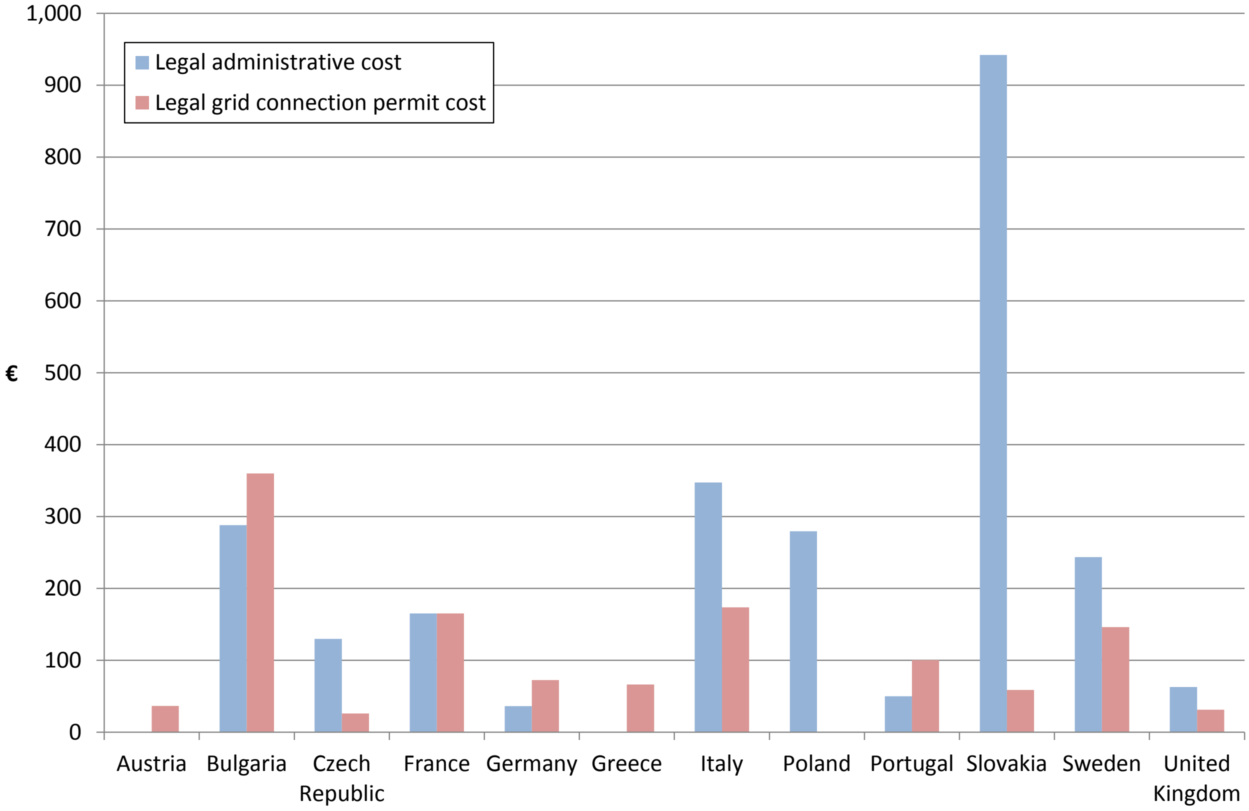


Source: Based on [50], authors' own illustration

Figure 2-26 shows different requirements for legal processes within the scope of administrative procedures and the grid connection permit for commercial PV projects with a capacity of 50 kWp. Again, there are significant variations.

The absence of a bar indicates the absence of information for the particular state and permitting process.

Figure 2-27: Legal administrative cost and legal grid connection permit costs in EU Member States for residential PV systems in 2013

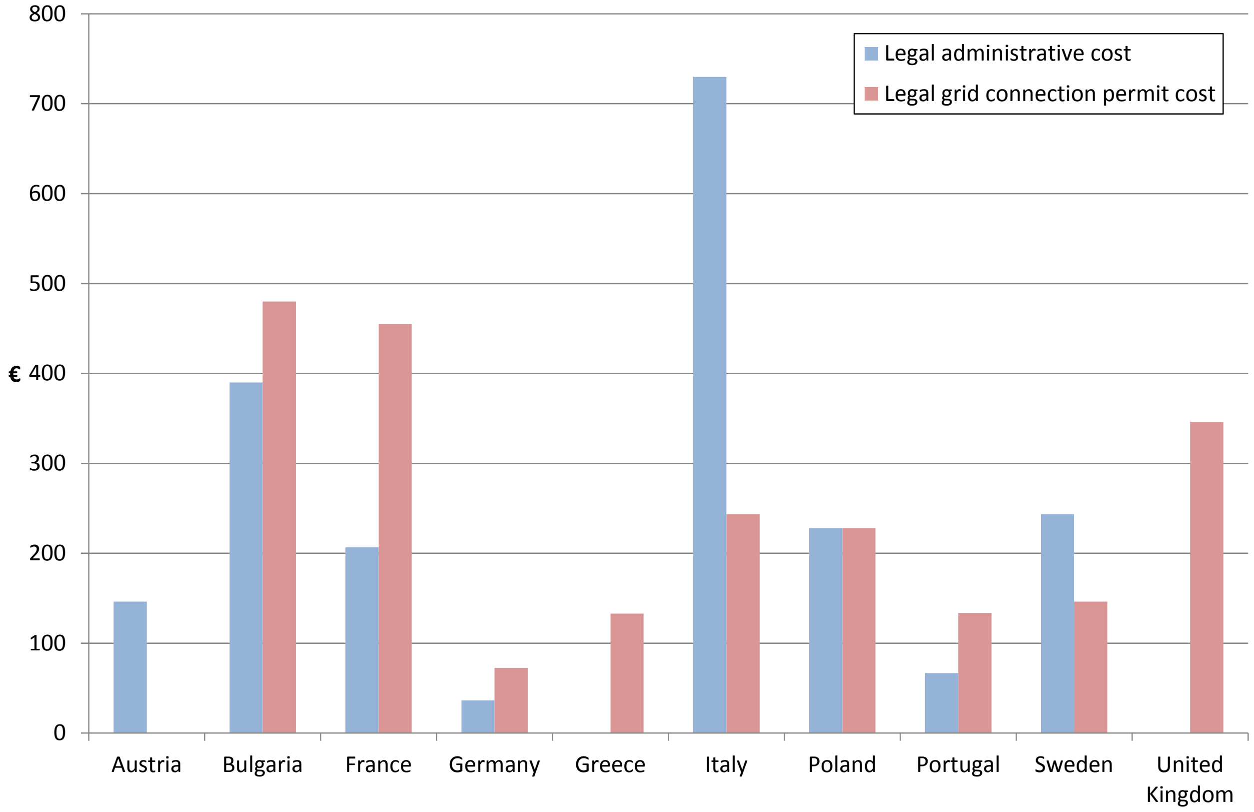


Source: Based on [50, 51], authors' own illustration

Figure 2-27 shows legal administrative cost and legal costs to acquire a connection permit for residential PV systems with a capacity of three kWp in 2013 for several European Member States. The different costs were derived from the durations that can be found in the PV grid database and that are shown in Figure 2-25 and Figure 2-26 as well as from the labour costs shown in Figure 3-15 in the appendix. There are still significant differences in terms of the costs.

When compared with the average project costs in Europe, which are in the range of 3,300 and 3,700 €/kWp (excluding VAT) for residential systems [52], it becomes clear that administrative and grid connection costs are only a smaller share of the overall project costs. An exception in this respect is Slovakia.

Figure 2-28: Legal administrative cost and legal grid connection permit costs in EU Member States for commercial PV systems in 2013



Source: Based on [50, 51], authors' own illustration

Figure 2-28 shows the legal administrative costs and the legal costs for acquiring a connection permit for commercial PV systems with a capacity of 50 kWp in 2013 for European Member States. These costs vary between Member States. The highest cost for grid connection can be found in Bulgaria and the highest cost for administrative procedures can be found in Italy.

When compared with the average project costs in Europe, which are in the range of 1,800 and 2,000 €/kWp (excluding VAT) for commercial systems [52], it becomes clear that administrative and grid connection costs are only a smaller share of the overall project costs. An exception in this respect is Bulgaria.

The absence of a bar indicates the absence of information for the particular state and permitting process.

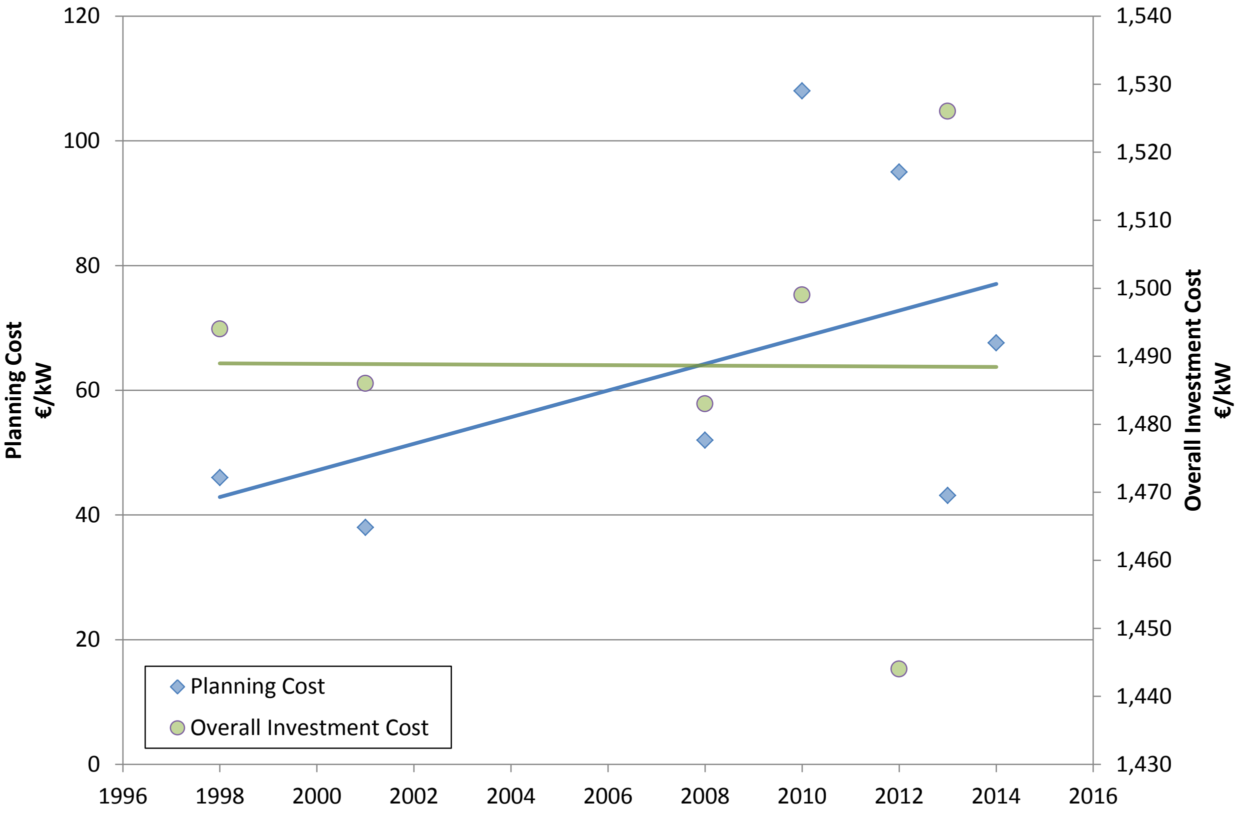
Development of administrative costs over time: Wind

A further question is how the administrative costs and the barrier costs have developed since 2010 under the influence of the European RED.

Irrespective of the technology-specific relative share of administrative costs, it can be argued for both wind and PV that if technology costs decrease, the relative share of the administrative costs including the barrier costs increases. In this case, it will therefore become more important to address any costs resulting from non-economic barriers.

The following graph shows the development over time for wind projects in Germany, based on several studies. In this case, planning costs include both planning and permitting costs. It is worth noting that while this graph shows average amounts, there is typically a large variation of costs between projects.

Figure 2-29: Development of planning and overall investment costs of wind projects in Germany since 1998



Source: Based on [45, 46, 53], authors' own illustration

The graph shows that overall planning costs have been increasing since wind deployment started to take off. This is despite the fact that in this period the necessary planning and permitting infrastructure has been built up (e.g. permitting authorities with the necessary know-how, permitting guidelines), which should facilitate cost reduction. This is due to increasing efforts that are required from project developers especially for the environmental impact assessment and for securing suitable sites [53, 54]. This situation has not changed in the meantime and two project developers interviewed in Germany have confirmed that there are increasing costs.

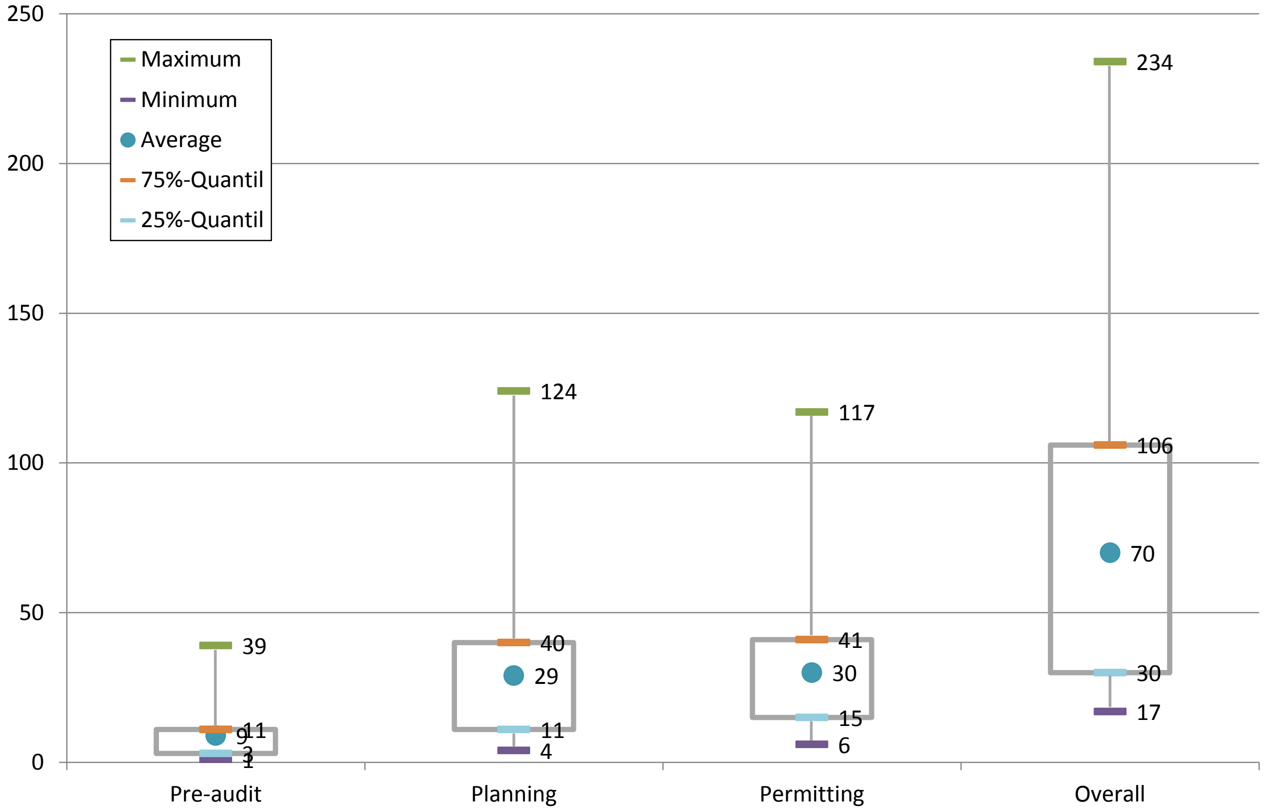
This development shows that if barriers are reduced, it does not necessarily mean that costs will be reduced, too. Generally speaking, the reason for this is that the efficient administrative efforts may also increase, e.g. because available sites become scarcer and site conditions become more difficult, i.e. with higher environmental constraints or conflicts with other usages, which will extend the planning and permitting process. There can therefore be two potentially parallel developments: A reduction of barriers on the one hand and a cost increase in efficient processes on the other hand. It is all the more important to make processes as efficient as possible, e.g. in terms of time limits and a one-stop-shop, not least in order to be prepared for more difficult permitting processes.

The data that shows the development of these costs over time is not available for other Member States. However, the factors that can explain the cost increase are also present in other countries, namely increasing conflicts and constraints on the availability of sites. This has been confirmed by interviewees across Member States (Öko-Institut own research). Given that these factors lead to a cost increase in Germany with a well-established planning and permitting process, they are even more likely to lead to a cost increase or at least prevent a cost decrease in other Member States. In other words: If a high or even increasing level of conflicts in the permitting process meets a still inefficient permitting structure (e.g. without time limits and a one-stop-shop), the cost increase is likely to be even more significant. Looking at Figure 2-21, it can be argued that rising conflicts and constraints affect both the efficient costs and the barrier costs and have therefore a higher impact if the barrier costs are still significant.

Costs in different phases of the overall permitting process: Wind

It is important to note, also with regard to possible policy measures to overcome barriers, that it is not just the permitting process as such that causes costs, but also the planning phase. These two phases should be differentiated. The following figure shows the costs for these two phases plus the pre-audit phase, including the cost ranges for Germany.

Figure 2-30: Costs of wind projects in Germany in the year 2014



Source: Based on [45], authors' own illustration

It shows that the costs in the planning phase are at least as important as the costs in the permitting phase. There can generally be barriers present in both phases, and some of the costs in both phases can be due to barriers. This indicates that it is not sufficient to just address the permitting phase.

The impact on revenues

Delays in permitting not only increase costs; they can also lead to reduced revenues. This is the case if the remuneration is reduced over time. This is especially critical in Member States with an automatic reduction mechanism for remuneration levels, whereby payments for new installations are adjusted on a regular basis, either through predetermined or responsive tariff degressions. Examples include Germany[33] (see figure below), Italy[34] and France[35], or in Member States with high regulatory uncertainty and frequent changes.

Changes in the NPV “due to delayed economic benefits” have also been analysed by IEA-RETD [47].

As for automatic adjustment mechanisms it can be expected that the number of Member States with such a mechanism will increase in the future, as this is seen as one way of making support mechanisms more efficient. Even with non-automatic adjustments which are implemented in most MS, significant delays can become a problem if, for example, tariffs are adjusted on an annual basis and delays extend beyond a year. If Member States switch to auctioning schemes, there can be a tariff reduction through a reduction of maximum bid limits that are also likely to occur on a more regular basis.

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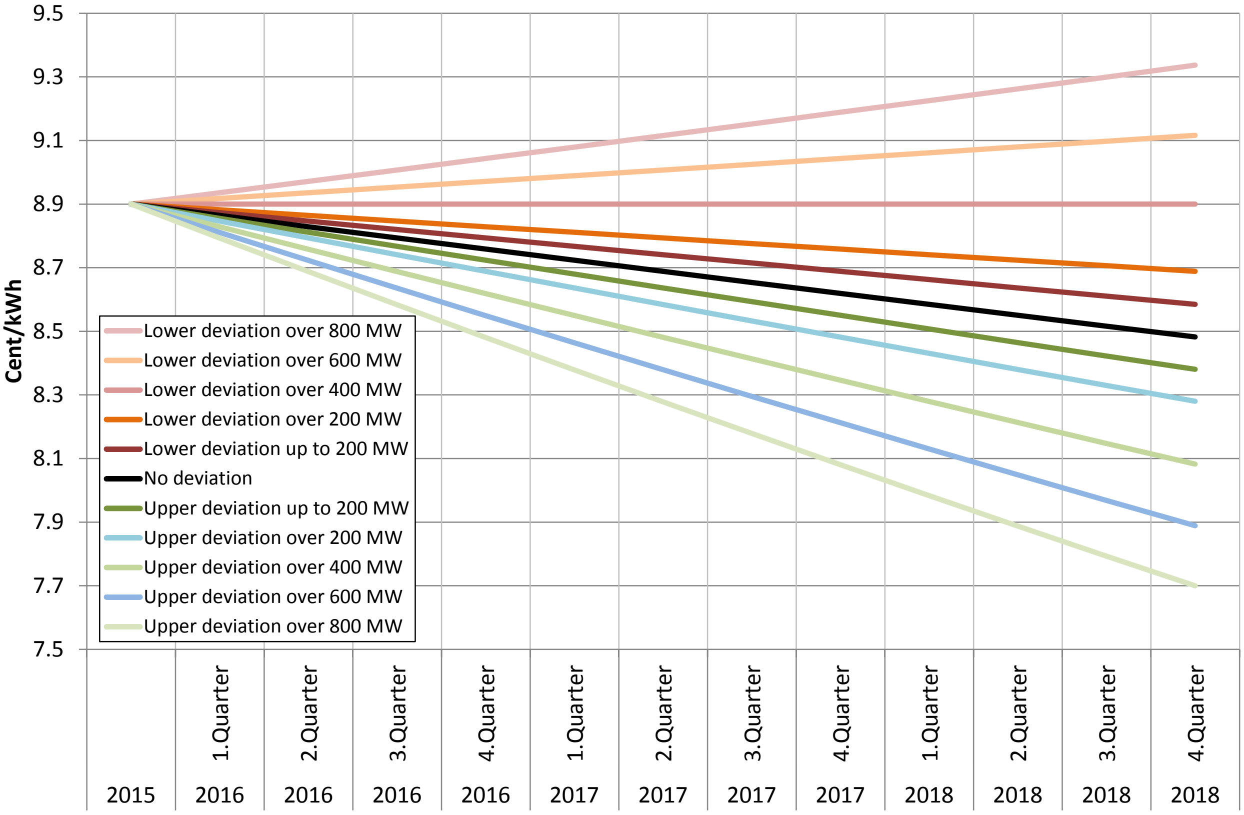
[33] See §28-31 in Erneuerbare Energien Gesetz 55.

[34] See Art. 7, c. 1 or Art. 3, c. 4 in [56] for technologies other than PV.

[35] See Art. 8 in [57].

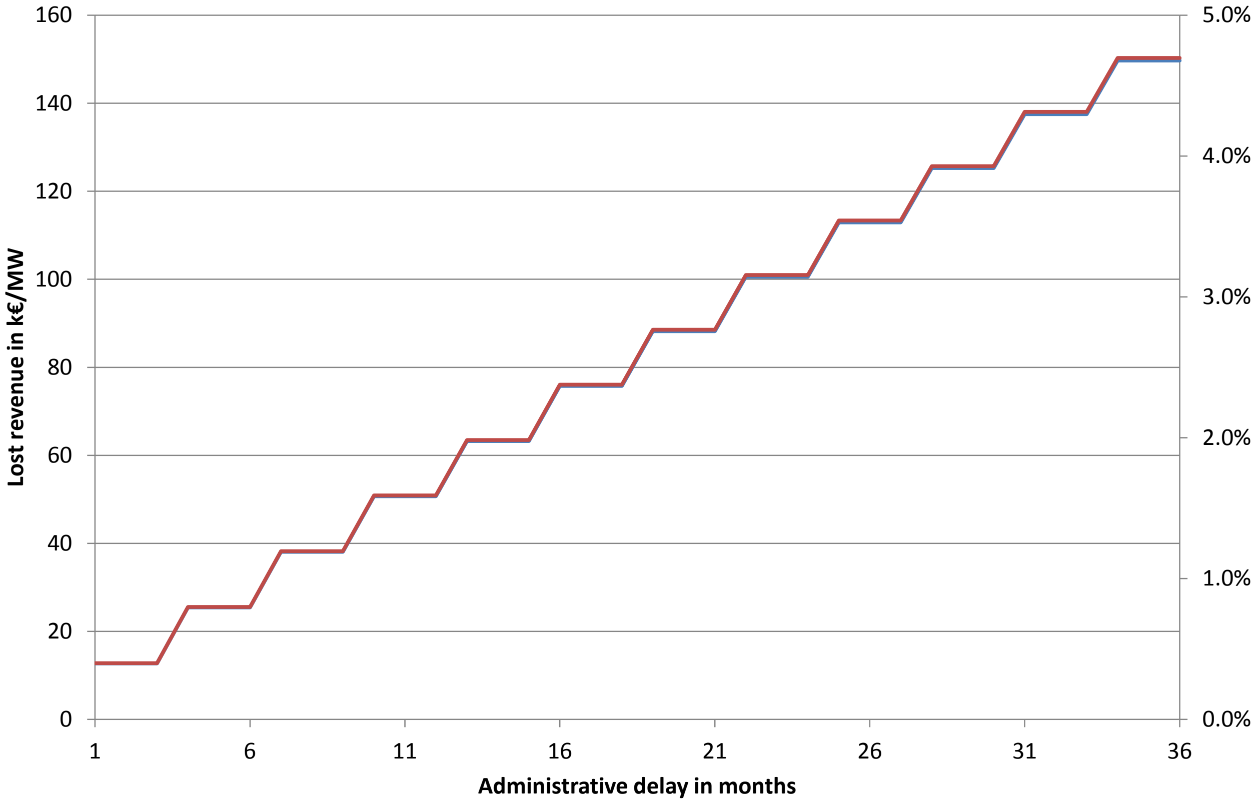
Figure 2-31: Degression of the German feed-in tariff for wind power plants depending on time and quarterly installed wind capacity



Source: Erneuerbare Energien Gesetz (EEG) [55], authors' own illustration

Figure 2-31 shows different possible developments of the initial support level for wind power projects in Germany from 2015 onwards. The support level is subject to, firstly, a basic automatic degression of 0.4 % each quarter that can, secondly, vary depending on the deviation of the installed capacity from the annual capacity goal of 2,400 to 2,600 MW. If more capacity was installed, the degression increases. If less capacity was installed, the degression is slowed down or in extreme cases the support rate increases. In this way the wind expansion shall be controlled and the annual target shall be reached as precisely as possible. The delay of a project because of long administrative procedures almost always, therefore, has an impact on the project revenue.

Figure 2-32: **Lost revenue for a 1 MW wind project as a result of administrative delays in k€/MW**



Source: [55], authors' own illustration.

In Figure 2-32 the development of the lost revenue is depicted as a function of administrative delays. The German example represents the total project revenue of a 1 MW wind power plant[36] project over the support duration of 20 years [55]. Total project revenue is calculated on the basis of the standard EEG support rate with a 1% discount rate. Due to the support rate reduction that is applied each quarter, a delay of six months in project approval can lead to a reduction of the total project revenue of up to 0.8% depending on the beginning of the planning phase. In absolute numbers this would amount to approximately € 25,000. A delay of one year would cause a loss of around € 50,000.

This example is based on a wind turbine with a capacity of 1 MW. For other turbines the development of lost revenues may vary.

The impact of an administrative delay can vary depending on the support policy that is implemented in a Member State. Another mechanism for financing renewable projects is tradeable green certificates. The price of a certificate is defined by supply and demand and with increasing renewable capacity the price of certificates tends to decrease over time.

In Romania renewable projects are financed through this type of support scheme. Romania has been facing volatile regulatory conditions and the renewable support policy has been changed

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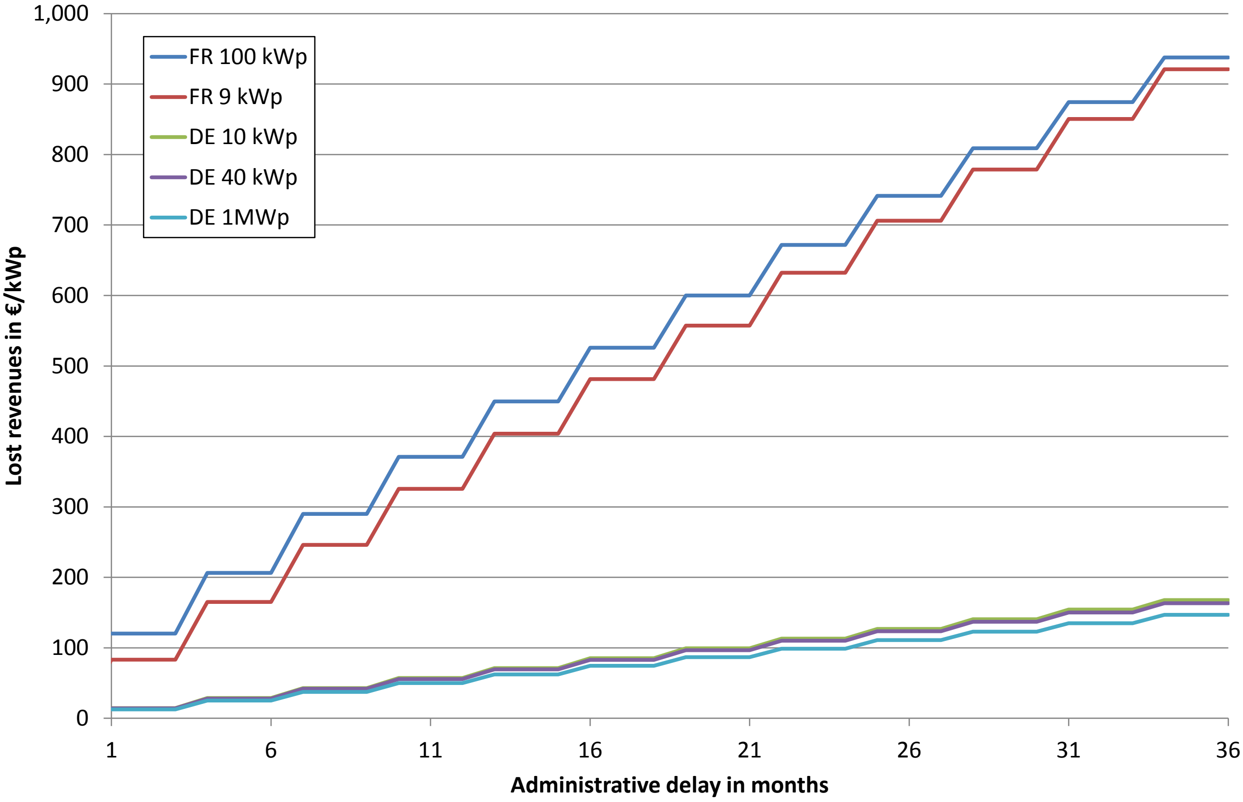
[36] Turbine: Enercon E-58/10.58; yearly generation: 2916 MWh. [58].

three times in the last four years. Besides the “natural” degression of certificate prices, a change of support policies can have a severe impact on the financial situation of operating projects and projects that are in the process of realisation. A change in the green certificate policy reduced the amount of necessary certificates for electricity suppliers, which resulted in an oversupply of green certificates in the market. This led to a reduction of the certificate price from 120 to 140 €/MWh in 2012 to 45 to 55 €/MWh in 2014, which represents a 62 % decrease.

A wind project that consisted of nine turbines finished construction in 2012 and was ready for operation. Procedures for dealing with the application of this project for the support scheme took until mid-2014. Due to the strong decline in certificate prices, this project had to face annual losses of € 7.2 million, which led to the decision of the plant operators to stop operating and to mothball the plant [59].

Figure 2-33: Lost revenue for PV projects in Germany and France in €/kWp



Source: [55, 57]

Figure 2-33 shows a comparison between the revenue losses that French and German PV projects face for an administrative delay of up to 36 months. Both examples show the lost revenues over the 20 year support duration of PV projects in both Member States and are calculated with a 1% discount rate. The impact is considerably larger for French projects due to the higher support rates, which are around 20 €cent/kWh, and their average quarterly reduction of around 2%. In Germany a regular decrease of 0.5% each quarter is considerably smaller and support rates are around 12 €cent/kWh.

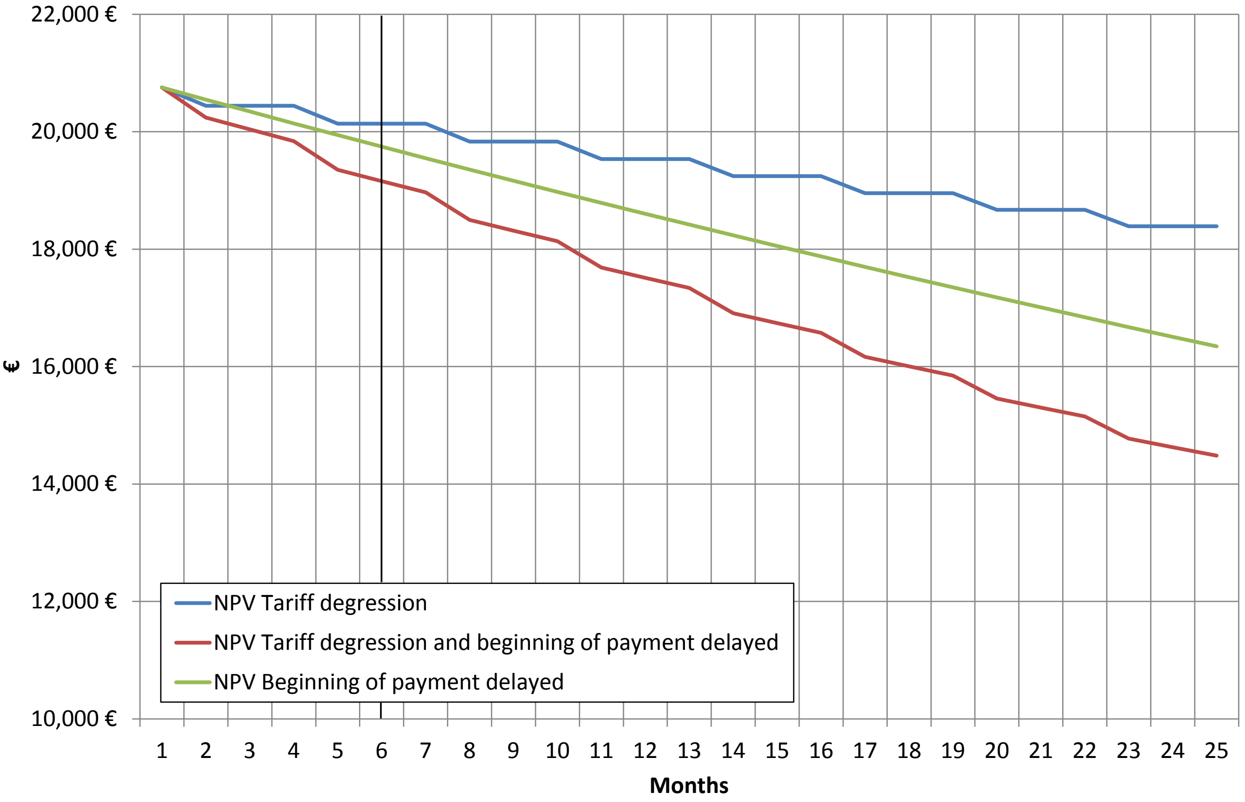
Therefore, the impact of a six-month delay in administrative procedures creates losses of around 28€/kWp for a German 10 kWp system. A French 9 kWp system, on the other hand, faces losses of 165€/kWp.

Impact of project delays on the overall project value

Besides the tariff degression described above, a delay caused by permitting procedures can also reduce the overall project value.

At the end of 2015, an evaluation report pointed out that the average permitting duration in France was 259 days for projects which benefited from the one-stop-shop procedure, instead of 431 days for other projects[37].Looking at the effects of the one-stop-shop observed in the French example and how the reduced permitting time affects the tariff degression and the net present value, the following can be observed. The revenue reduction due to permitting delays is affected both by a tariff degression and the effect on the net present value of the revenue stream due to the delay, as shown in the following picture for a 9 kW PV plant. Discounted costs are not included. In this example, discounted revenues decrease by 9 percent if a six month delay occurs, corresponding to the permitting time reduction that could be achieved with the one-stop-shop in France.

Figure 2-34: Effect of delays on the discounted revenue stream



Source: Own calculation

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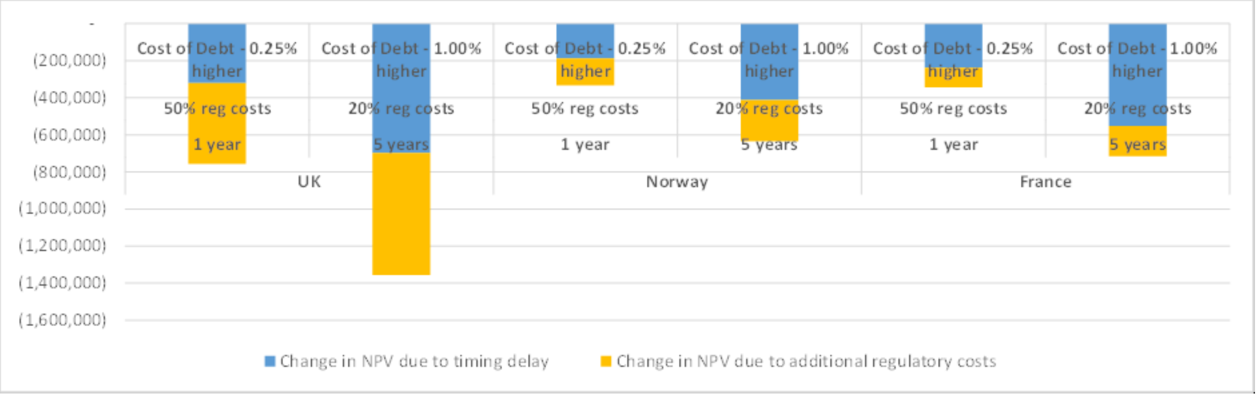
[37] See "Le Journal de l'Éolien - n°19 May 2016" and the report "Evaluation des expérimentations de simplification en faveur des entreprises dans le domaine environnemental - décembre 2015"

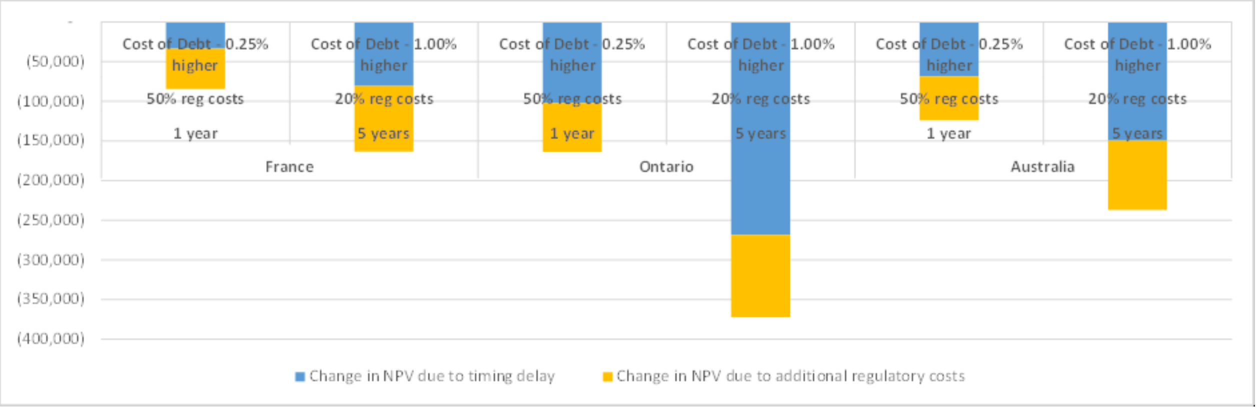
A more comprehensive NPV calculation is provided by the IEA-RETD RE-Delay report [47] for different technologies, including wind onshore and offshore as well as PV.

Figure 2-35: NPV (USD) decreases for onshore wind because of permitting delays



Source: [47]

Figure 2-36: NPV (USD) decreases for solar because of permitting delays



Source: [47]

The values shown in Figure 2-37 were also calculated with the RE-DELAY model [60].[38] The output of the model is the economic benefit of a project depending on administrative delays, which consist of the economic impact of the investment and the economic impact of permanent jobs created by a project. As can be seen in the figure, decreasing benefits result from administrative delays. Depending on the Member State a different value can be observed. In the UK the economic impact of a project is larger, but also decreases at a higher rate. In France the initial value and its reduction are lower. A factor with a large impact is the salary of jobs related to the project, which are higher in the UK compared to France. Therefore a larger economic impact of the project and administrative delays can be observed in this Member State.

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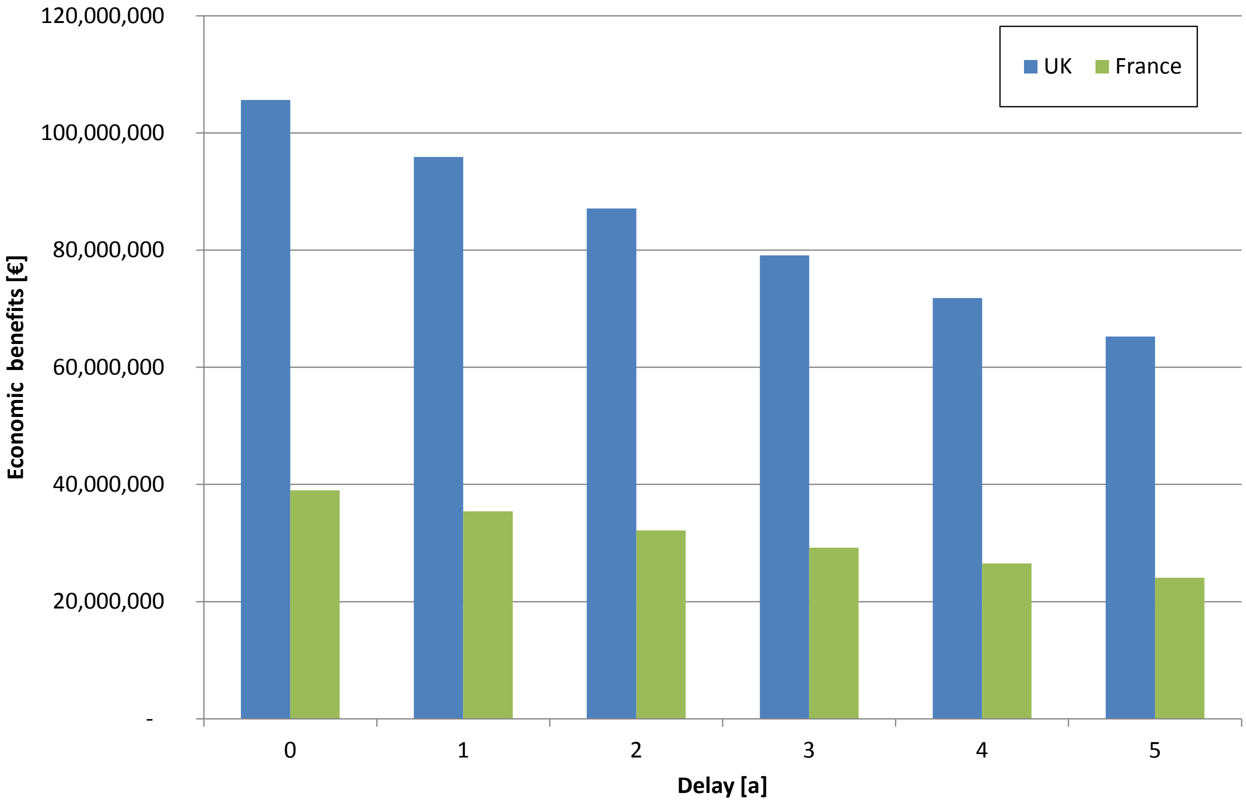
[38] The model assumes an inflation of 2% and a discount rate of 10%.

Figure 2-37: Reduction of economic benefits of a 100 MW wind project in UK and France depending on administrative delays



Source: [60]

2.2.1.2. Impact of non-economic barriers on deployment

Besides the cost of RES-E, non-economic barriers can also influence the deployment of RES-E. It is necessary to distinguish between individual projects that could not be realised due to non-economic barriers and the effect of non-economic barriers on the overall deployment.

Relation between overall RES-E cap and non-economic barriers

In many Member States, where targets are interpreted as a maximum rather than a minimum that should be reached, overall RES-E capacity is capped or at least some form of quantity control has been introduced.

Such limits are, for example, in place in the following Member States:

- Czech Republic;
- Portugal;
- Austria, where delays in deployment for individual projects are mainly due to the overall cap rather than non-economic barriers like a particularly tedious permitting process for wind;
- Lithuania, where project developers complain about non-economic barriers, but at the same time the 2020 target and the resulting cap in the support scheme have already been reached;

- Germany, where development corridors have been introduced and the support level is adjusted according to the actual development relative to the corridor, see section "**The impact on revenues**".

For an overview, see www.res-legal.eu. For an overview of Member States that have fulfilled their targets, see Figure 1-10.

In these cases, there may be non-economic barriers in place that in principle also affect the deployment volume. However, if the cap is reached or quantity control mechanisms have been activated (e.g. an adaption of remuneration levels to the deployment levels relative to a pre-defined corridor), non-economic barriers do not reduce deployment below what is considered the maximum. There can be barriers for individual projects, but overall targets can still be reached.

It is rather difficult in these cases to analyse how non-economic barriers affect overall deployment. However, reducing non-economic barriers is still relevant, even in these cases, to reduce costs (see above) and if targets are increased and the cap is lifted. Under auction schemes there is also an overall cap, and it is explicit that the most cost-efficient project(s) should win, regardless of the number of projects presented. At the same time, auctions also make it more important that projects that succeed in the auction do not fail due to non-economic barriers, which would typically expose them to penalty payments.

Differences between regions with the same economic conditions as an indicator for non-economic barriers

One way of detecting the impact of non-economic barriers on deployment is to look at deployment levels in different regions that are:

a) subject to similar primary energy conditions

b) where economic conditions do also not differ significantly or are the same,

c) while at the same time there is room for different non-economic barriers between these regions.

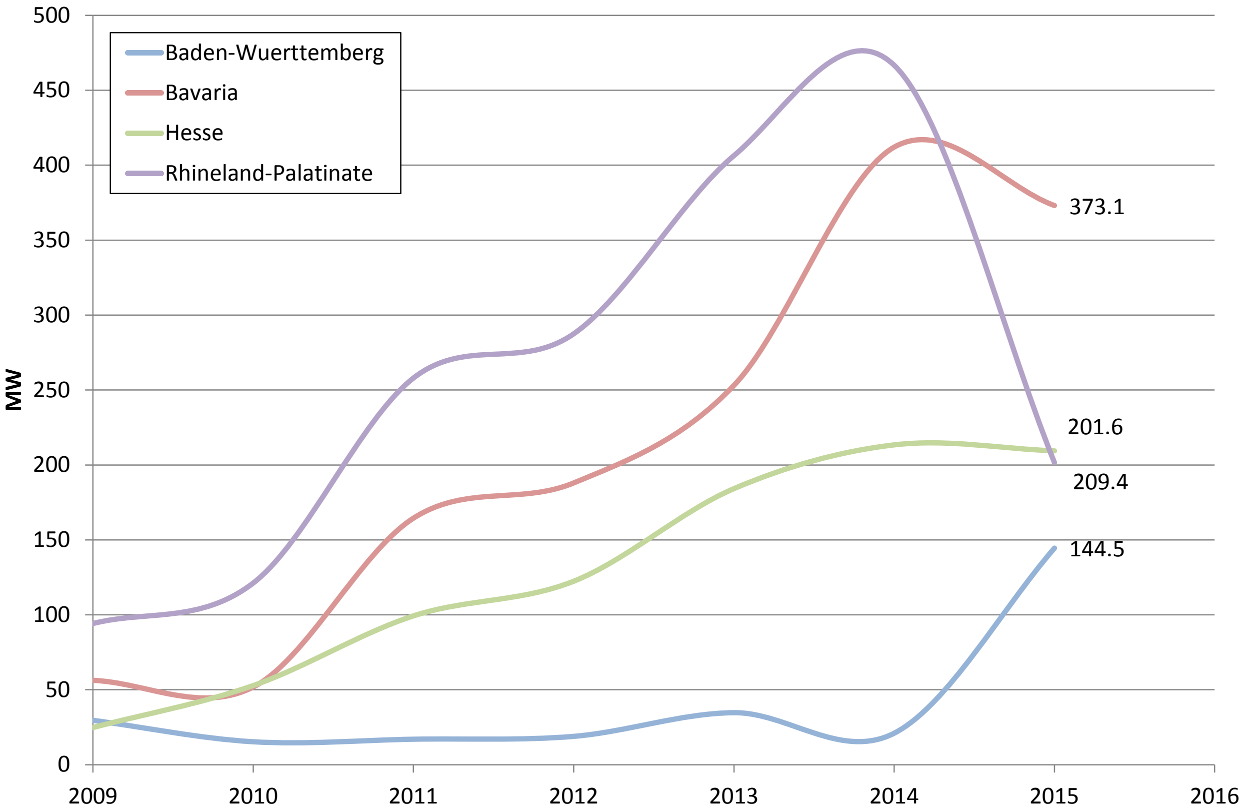
If these conditions are met and deployment differs between these regions, then the different deployment may be traced back to different non-economic barriers, thus providing evidence for the impact of non-economic barriers on deployment.

Based on this approach, Germany and its federal states can be seen as a testing ground for the impact of non-economic barriers on RES deployment.

Under the German feed-in law, RES-E projects across the country are subject to the same economic regime. Primary energy conditions vary by federal states depending on the technology, but there are still federal states with similar conditions and the economic regime at least partly compensates for these differences. Therefore, from a mere economic perspective, deployment rates should not differ significantly, at least not between states with similar primary energy conditions. While there is also a harmonised general permitting regime, spatial planning and the implementation of permitting are under the responsibility of the federal states. Therefore, it is highly plausible to ascribe different deployment levels to different administrative procedures rooted in different policy approaches on a federal level. As [61] have pointed out, *"the political orientation of state governments have explanatory power for regional incentives to expand (restrict) wind power"*. It should be noted that "regional incentives" in this context mainly refers to the regional approach to reducing non-economic barriers.

The following figure shows the annual deployment of wind generation in MW in four federal states in the south of Germany. It clearly shows that there are significant differences in deployment levels between different federal states. Especially Baden-Wuerttemberg lags behind even though it has generally good wind conditions and has been included in scenarios where wind generation in Germany is only located at sites with the best wind conditions [62]. The differences in deployment rates can therefore be traced back to non-economic barriers.

Figure 2-38: Annually installed wind capacity in different German federal states since 2009

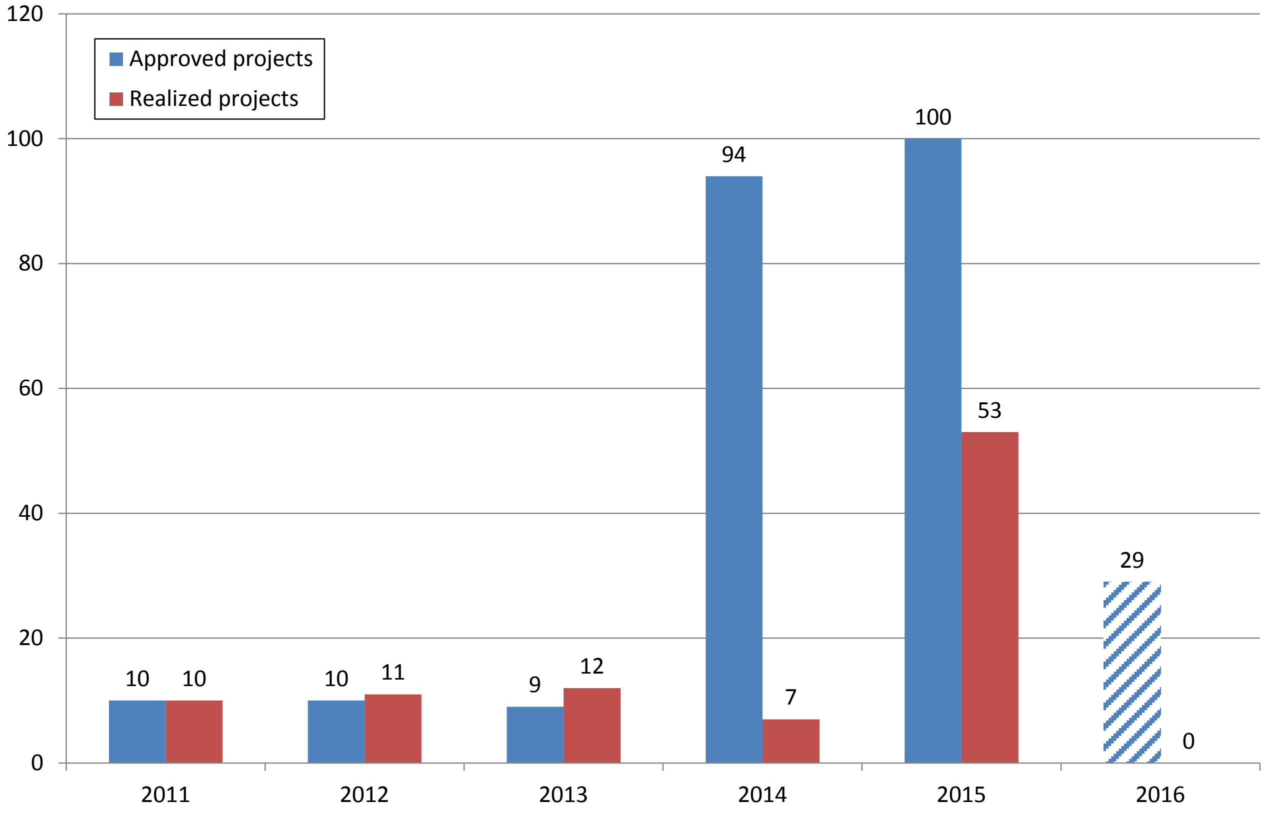


Source: Based on [63],[64–70], authors' own illustration

The impact of non-economic barriers is not only demonstrated by the low deployment levels in the past, but also by the fact that in 2015 the newly installed capacity increased substantially in Baden-Wuerttemberg after it had been stable at very low levels for many years. Moreover, the number of permits (see Figure 2-39) for wind plants in Baden-Wuerttemberg has also been increasing recently.

This is due to a policy change that started in 2011 and that has mainly addressed non-economic barriers. The general legal framework that is in place on a federal level "*is substantiated in concrete land utilisation and urban land-use planning (Flächennutzungs- und Bebauungsplanung) and final permitting (based on the provisions of the Federal Immission Control Act)*" [61]. In Baden-Wuerttemberg, the policy change has been particularly reflected in a new spatial planning approach that has been introduced for wind energy. Before, the state-level spatial planning law limited wind deployment to areas in which wind plants were explicitly allowed by regional planning. In all other areas it was prohibited. In practice, only a limited number of priority areas with good wind conditions were defined. Under the new regime, it is no longer possible to define exclusion zones; only priority areas are possible. Moreover, municipalities have the possibility of defining wind areas outside these priority areas within their land utilisation planning competences.[39]

Figure 2-39: Number of approved and realised projects in Baden-Wuerttemberg from 2011 to the first quarter for 2016



Source: [71]

Besides spatial planning rules, another key issue used to be the permitting process and especially the long permitting process. Under the general federal regime, there was a one-stop-shop in place, as well as permitting time limits, but there was a lack of political support and various uncertainties in the permitting process, e.g. with regard to the required studies and documents. With a new wind energy ordinance,[40] the state government confirmed its political support for wind energy, provided better guidance for permitting authorities, removed a number of uncertainties (e.g. it clarified that wind energy is allowed in forest areas) and declared that there are no general height restrictions in place.

A further case in point is the development in the German federal states of Bavaria and Schleswig-Holstein which also shows that a key barrier for overall deployment can be spatial planning and the number of sites that are made available.

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[39] Gesetz zur Änderung des Landesplanungsgesetzes, 22. May 2012, Gesetzblatt für Baden-Wuerttemberg, 8, 2012.

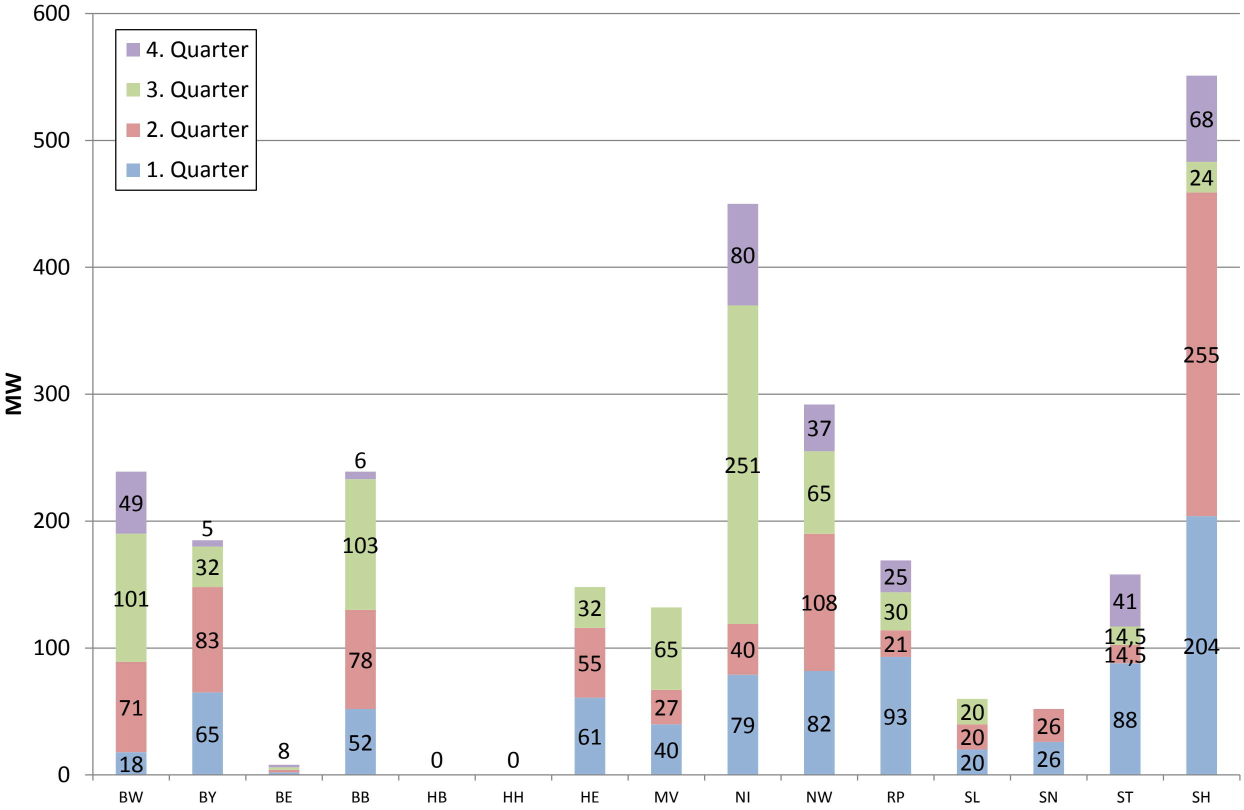
[40] Windenergieerlass Baden-Wuerttemberg - Gemeinsame Verwaltungsvorschrift des Ministeriums für Umwelt, Klima und Energiewirtschaft, des Ministeriums für Ländlichen Raum und Verbraucherschutz, des Ministeriums für Verkehr und Infrastruktur und des Ministeriums für Finanzen und Wirtschaft. 09. May 2012 – Az.: 64-4583/404

In Bavaria (BY in the figure below), where wind deployment has been relatively strong in the past, a new regulation passed in November 2014 which provides that the distance between a wind generator and residential areas needs to be a least 10 times the height of the plant. As a consequence, the number of potential sites was reduced considerably to 1.7 % of the total state area, assuming a height of 200 meters and a required distance of 2 km, compared to 19.1 % if the required distance is only 800 meters [72].

This also has led to a significant reduction of permits for new plants, which came about for the first time in the second half of 2015, when the number of permits was only just above one fourth of the permits issued in the first half of the year [73].

Similarly, changes in state planning law have significantly reduced the number of permits issued in the state of Schleswig-Holstein (SH in the figure below) in the second half of 2015 to one fifth of the permits issued in the first half of the year.

Figure 2-40: Approved wind projects in German federal states by quarter in 2015



Source: Based on [74], authors' own illustration.

Interestingly, even in Germany which generally has a well-established permitting regime in place and a relatively positive environment towards renewables, such significant differences can be observed, e.g. wind deployment in Baden-Wuerttemberg was virtually brought to a halt and wind permits in Bavaria decreased to one fourth in the second half of 2015 compared to the first half of the year. Both developments are due to non-economic barriers, especially spatial planning rules, but also permitting practices. Therefore, it seems reasonable to assume that in other Member States in which higher variations in non-economic barriers can occur, such barriers also have a relevant impact on RES-E deployment that may even be higher or more difficult to overcome.

Similar regional differences can be observed in other Member States, too, where the subnational level plays an important role in permitting. For example, in Italy the ease of implementing renewable energy projects also varies between regions, depending on the regional permitting policy. According to one stakeholder, wind projects face significant difficulties, especially in Sardinia and Sicily. According to the same stakeholder, in Trentino-South Tyrol the permitting procedures are considered particularly good, especially in the case of hydropower, which has a large potential in the region.

As another example, the Keep-on-track project reports that *"administrative and permitting procedures are deemed very complex in Spain. The barrier is caused mainly by the fact that competences for the permission & connection of RES-E plants are highly dispersed between the State, regional (autonomous communities) and local/municipal level. According to the Windbarriers project, grid connection lead-times are estimated at 34 weeks, with differences at regional level with lower and upper limits of 3 and 120 weeks. Most of this time is imputable to the administrative processes, and to the varying attitudes and resources put in place by the Spanish Regional Administrations."*

Further evidence on the deployment effects of non-economic barriers

In some cases, there is evidence that certain technologies cannot be developed at all due to non-economic barriers. Examples of this are administrative procedures for small-scale projects in Romania. Small-scale projects with low kW capacities are subject to the same administrative procedures as power plants with a capacity of up to 1 MW. All projects in this range face an administrative process that is designed for the larger ones. While for projects with larger capacities these procedures may be reasonable they are prohibitive for small-scale projects. A project developer that is experienced with the realisation of small-scale projects stated that under the current regulation it is not feasible for small-scale technologies to be integrated to the system.

Also, in Slovakia stakeholders report a strong barrier with regard to grid connection of RES-E. DSOs have refused all wind projects and most PV projects due to a lack of grid capacity. The MS has declared a connection moratorium for new renewable energy plants with a generating capacity of more than 10 kW.

Moreover, there is further evidence from Member States that various issues that have come up in the planning and permitting process have blocked certain volumes of RES-E deployment.

In 2014, it was reported that *"Renewable UK believes that consent applications for more than 12 GW of projects in the UK are currently subject to aviation objections, while German wind federation BWE believes more than 4 GW is blocked because of air-traffic safety concerns. In France, up to 6.5 GW is affected by proximity to a military radar or low-altitude training zone, according to the renewable energy trade association SER"*[41]

In France, constraints imposed from the military represent a significant barrier that blocks wind deployment. Between 2012 and 2015 this constraint has quickly become one of the most relevant non-economic barriers for the wind sector in France. Despite a dialogue between the wind sector and the government, the situation has not really changed. According to the French wind energy association at the end of 2015, 7 GW of wind have been blocked in the country.

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[41] http://www.windpowermonthly.com/article/1323568/wind-radar-learn-co-exist (last accessed on 29.03.2016).

Similarly, in Germany, the wind association reports that in 2015 a total 247 planned wind projects (1,422 plants) with an installed capacity of 4.12 GW have been blocked due to problems with both military and civil radar stations. Two years before, 208 projects with an installed capacity of 3,345 MW were affected. Similarly, an increasing number of projects are affected by weather radar systems and by the requirement to keep a minimum distance to Omnidirectional Radio Range systems.[42] According to a wind developer, Omnidirectional Radio Range systems are currently blocking 2-3 GW of wind deployment in Germany. The problem is not just the required distance as such, but also the fact that the required distance keeps changing during the process.

However, what is even more relevant than these “technical” concerns are environmental issues. According to [46], this is the key risk for wind projects in Germany, both in terms of delays and project cancellation. According to an interview in Austria, between 30 and 50 percent of wind projects in Austria cannot be realised due to environmental issues, mainly related to bird protection.

Even if overall deployment is not affected, there is various evidence that project development is delayed both in the planning and permitting process and that this goes beyond what can be considered as good practice. To what extent this also affects deployment as projects will be cancelled at some time is difficult to evaluate. There is some evidence that delays can also lead to a cancellation of projects. This is shown in the Romanian example above (see section “**The impact on revenues**”) and has also been confirmed by some interviewees. Delays certainly contribute to the cost increase described above.

According to project developers, the different phases described above (section: **Costs in different phases of the overall permitting process**) are not just relevant in terms of costs, but delays and project cancellations can occur in all these phases [46].

In Germany, despite increasing experience, the duration of the planning and permitting phase has not decreased over the last decade. This indicates that there are also factors that are not related to an inefficient planning and permitting procedure, but still lead to an extension of the planning and permitting phase. This is shown in the following figure, even though it is not based on comprehensive data.

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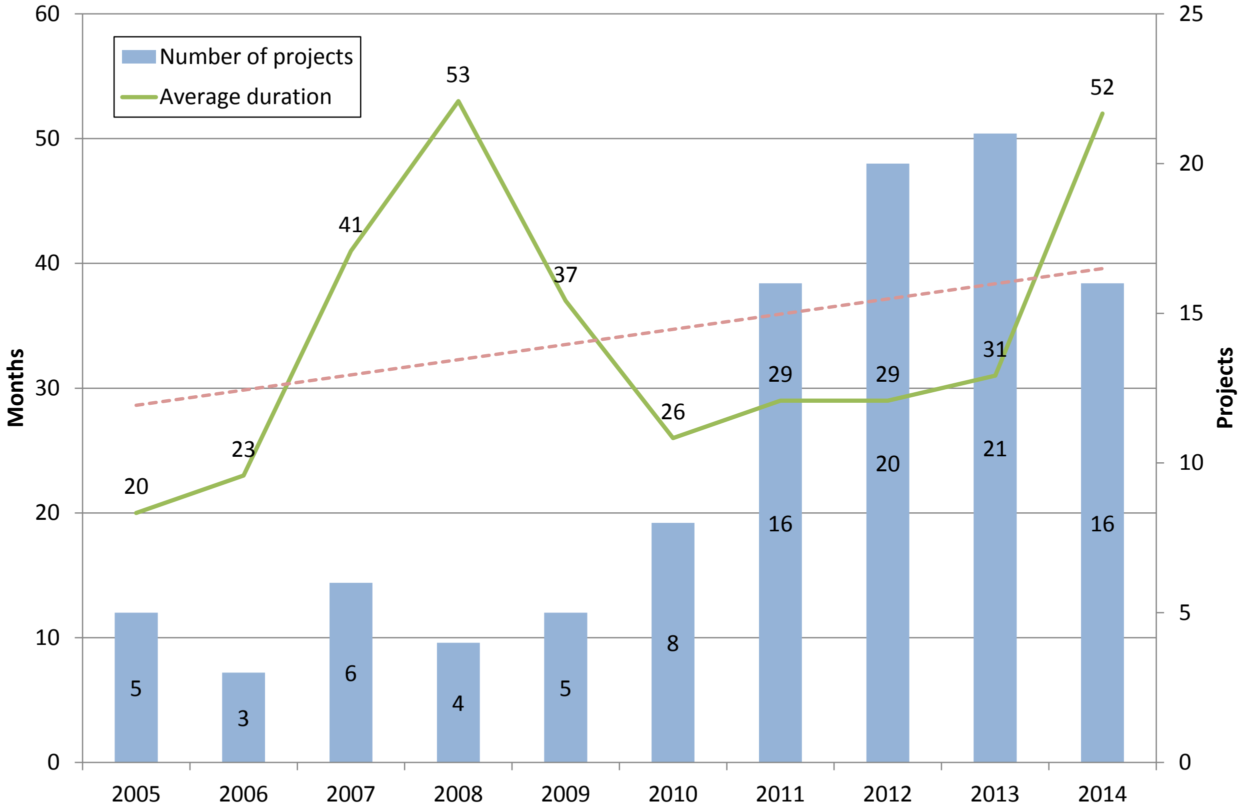
[42] https://www.wind-energie.de/presse/pressemitteilungen/2015/deutlich-mehr-windenergieprojekte-durch-belange-der-flugsicherung-und (last accessed on 31.03.2016)

Figure 2-41: Duration of planning and permitting procedure for German wind projects from 2005 to 2014



Source: Based on [45], authors' own illustration

There can be different reasons for lengthy procedures, some related to a lack of staff on the part of the permitting authorities, and some related to environmental constraints or other constraints due to, for example, aviation [45].

For Lithuania it has been reported in interviews with PV developers and the PV association that the permitting process for PV plants has been reduced, but is still relatively long. The permitting process even for rooftop plants used to take seven to eight months in 2013, and it has now been reduced to approximately three months. Larger plants still take more time. According to the interviewees, this could be further simplified and sped up, so that one month for small-scale plants and two months should be the upper limit.

For the UK, there is evidence that "*local authorities are not always respecting deadlines for the determination of planning applications (currently projects <50MW). While decisions should be taken within 16 weeks (…), in reality, it can easily take up to several years. For larger projects determined under the Planning Act 2008, deadlines are respected a lot more*" [47].

2.2.2. RES-HC

For RES-HC the dominant barrier – as mentioned by the majority of interviewed stakeholders – is the lack of a long-term strategy for the heating and cooling sector as a whole, as well as for the future role of RES-HC in this sector in particular. Besides, stakeholders regret the absence of binding targets for this sector. The stakeholder interviews carried out for this study confirm the dominance of this barrier, which has already been reported in the previous evaluation by [37]. Since non-economic barriers of RES-HC deployment have only partly been assessed in previous evaluations of the RED, an analysis of how these barriers have evolved over time cannot be provided.

It is important to note that the analysis provided here is not representative, since there were simply not enough persons answering the survey and the number of interviews was limited.

It is rather difficult to give an estimate on the quantitative effects of non-economic barriers for RES-HC. In the online survey, stakeholders were asked to rate the effect of individual, pre-defined barriers as well as the potential costs of overcoming those barriers. The rating was based on a scale from 1 to 10 with 1 being "low effect/least expensive" and 10 being "high effect/most expensive". The barriers subject to the rating included:

- *low public perception* of RES-H/C technologies
- *lack of information* (customer attention, interest and knowledge)
- *lack of reliable advice*
- *lack of skilled and knowledgeable professionals* (e.g. installers)
- *split incentives* (especially landlord-tenant dilemma)
- *complex procedures to facilitate grid access/connection* of RES-H/C technologies to DH networks,

while the lack of a long-term strategy as well as the absence of a sector specific binding target was only asked about during the stakeholder interviews.

Unfortunately, not all survey participants gave an estimate for the effect of the individual barriers and the cost of overcoming them. Therefore, Table 2-12 and Table 2-13 only list the answers provided. For Member States that are not listed, not enough information was available.

Table 2-12 provides an overview of the effect of the different barriers in nine Member States. Overall there are no major trends visible in the stakeholder ratings: most barriers are rated between low-medium to medium-high. While in some countries most barriers fall into the category medium-high (e.g. Spain, Romania or the UK), in others the barriers are mostly in the medium category (Austria, Czech Republic or Finland). Examining a particular barrier across the different Member States, some barriers fall somewhere into the categories low-medium to medium-high (*low public perception*, *lack of information* or *lack of reliable advice*), while *lack of skilled professionals* as well as *split incentives* are rated as having a slightly higher effect, falling into the categories medium to medium-high. *Complex procedures for RES access to DH networks* shows the biggest spread, ranging from low in Lithuania to medium-high in the Czech Republic and Spain.

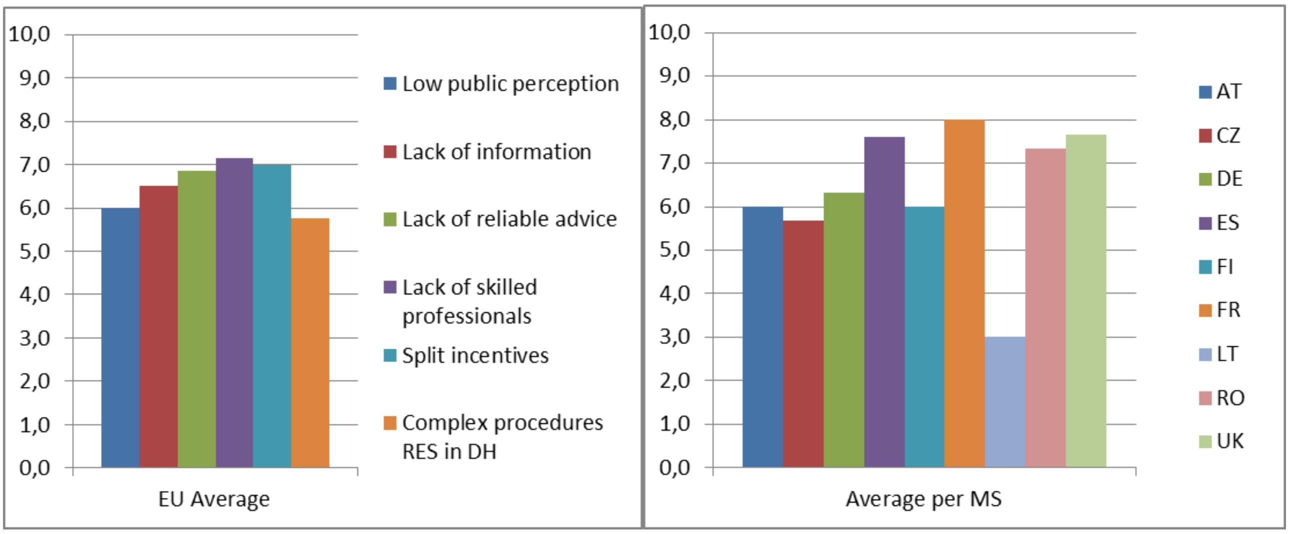
Table 2-12: Effect of individual RES-HC barriers

	AT	CZ	DE	ES	FI	FR	LT	RO	UK
Low public perception	medium	medium	low-medium	medium-high	medium	?	low-medium	medium-high	medium-high
Lack of information	low-medium	low-medium	medium-high	medium	medium	medium-high	?	medium-high	medium-high
Lack of reliable advice	medium	low-medium	medium-high	medium-high	medium	?	?	medium-high	medium-high
Lack of skilled professionals	medium	medium	medium-high	medium-high	medium	?	?	medium-high	medium-high
Split incentives	medium-high	medium	medium-high	?	medium	?	?	medium	medium-high
Complex procedures RES in DH	medium	medium-high	low-medium	medium-high	medium	?	low	medium	medium

Source: RES-HC survey results; 1,2: low; 3,4: low-medium; 5,6: medium, 7,8: medium-high, 9,10: high, ? = too few answers

Figure 2-42 shows two graphs: on the left-hand side the EU-wide effects of the individual barriers, on the right-hand side the combined barrier effects per Member State.

Figure 2-42: Effects of individual RES-HC barriers EU-wide and per Member State



Source: Authors' own illustration

The semi-quantitative analysis across the EU shows that close to all barriers asked for in the survey and the conducted interviews are considered to be of medium to medium-high importance (Figure 2-42, left-hand side). A *lack of reliable advice*, a *lack of skilled professionals* and *split incentives* are the three barriers with the highest EU average effect. As is detailed in the recommendations chapter below (Chapter 2.3.3), the two former ones could be addressed by strengthening Art. 14(3). *Split incentives* should be dealt with on a national level, since the building ownership structure across the different Member States varies substantially and it is not considered a barrier in each Member State. The combined effect of all barriers per Member State can be assessed on the right-hand side of Figure 2-42: four Member States show a combined effect of medium-high importance (Spain, France, Romania, and the UK), one Member State of only low-medium importance (Lithuania), with the remaining four showing medium importance of the combined barriers (Austria, the Czech Republic, Germany, and Finland). Three of the four Member States with the highest ranking of the combined barriers (Spain, Romania, and the UK) struggle more than others with RES-HC deployment, even though on different levels. Romania, for instance, is only at the beginning of introducing RES-HC requirements into the building code, offering qualification and training courses, or incentivising RES-HC through information campaigns etc. In the UK the situation is different: here the Renewable Heat Incentive (RHI) has proven very successful for a short period of time (mostly due to financial incentives), but only in areas that are not connected to the gas grid. Deploying more RES-HC technologies in gas grid areas is much more difficult, again, mostly due to economic reasons, but also due to a lack of knowledge and advice on these technologies. Our general recommendations below (Chapter 2.3.3) further elaborate on the barriers concerned.

It is important to note that this analysis is based on a limited set of answers from stakeholders and should therefore be treated with care.

Table 2-13 provides an overview of the costs of overcoming the different barriers in the assessed Member States. Again, the data is based on the survey results and interviews. What emerges from a cross analysis of Member States is that on average the *lack of skilled professionals* is considered more costly to overcome than the *low public perception* of RES-HC, the *lack of information* or the *lack of reliable advice*. The perceived costs of overcoming the same barrier (e.g. *lack of information*) often differ between Member States. Especially for *split incentives*, they range from “low” in Finland via “medium” in Austria to “high” in Romania. *Complex procedures for RES-HC access to DH networks*, however, shows less of a spread between Member States: here the range is from low-medium (Austria and Finland) to medium-high (Romania). While Romania seems to incur high costs of overcoming for almost all non-economic barriers, countries such as Austria, the Czech Republic, Finland, France and, to a lesser extent Germany all have low to medium costs of overcoming barriers. For the UK the perceived costs generally fall into the medium to high categories, with *split incentives* being the only exception with low-medium costs of overcoming. Spain’s costs of overcoming the different barriers are mostly in the medium category.

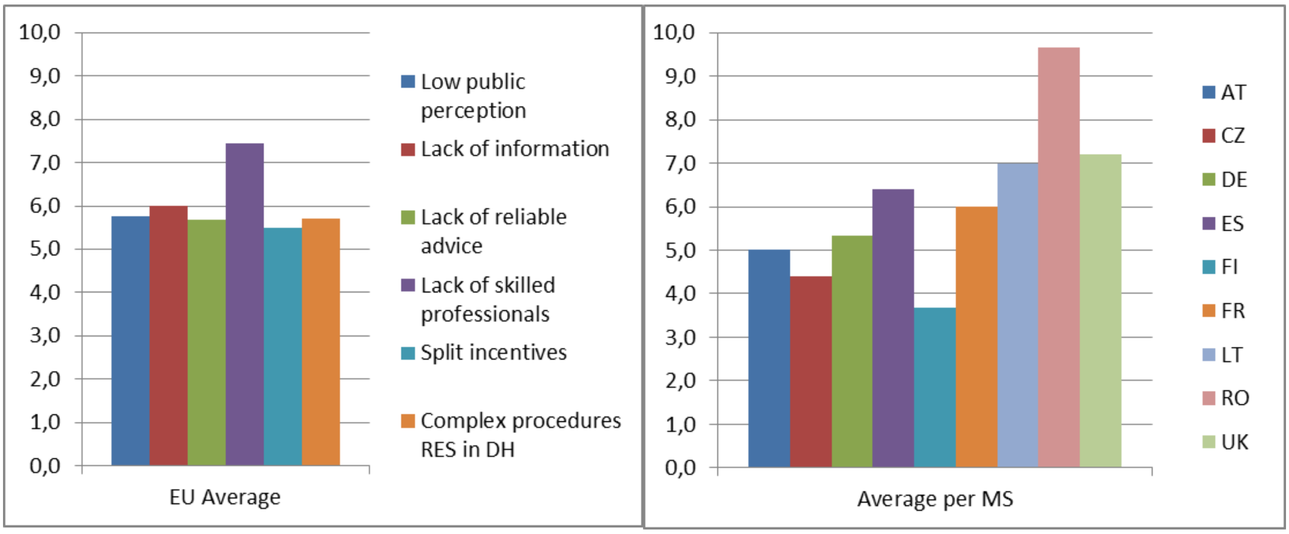
Table 2-13: Costs of overcoming barriers in RES-HC

	AT	CZ	DE	ES	FI	FR	LT	RO	UK
Low public perception	low-medium	medium	low	medium	low	?	medium-high	high	medium-high
Lack of information	low-medium	low-medium	?	medium	low-medium	medium	?	high	medium-high
Lack of reliable advice	medium	low	?	medium	low-medium	?	?	high	medium
Lack of skilled professionals	medium	low-medium	medium-high	medium-high	medium	?	?	high	high
Split incentives	medium	?	?	?	low	?	?	high	low-medium
Complex procedures RES in DH	low-medium	medium	medium	medium	low-medium	?	medium	medium-high	?

Source: RES-HC survey results; 1,2: low; 3,4: low-medium; 5,6: medium, 7,8: medium-high, 9,10: high, ? = too few answers

Figure 2-43 shows the costs of overcoming RES-HC barriers as an EU average (left-hand side) and per Member State (right-hand side).

Figure 2-43: Costs of overcoming RES-HC barriers EU-wide and per Member State



Source: Authors' own illustraion

The EU averages of the costs of overcoming the different RES-HC barriers show that the *lack of skilled professionals* is most costly to overcome (rating of medium-high in our semi-quantitative approach). All other barriers addressed lie within the medium category. This is an interesting result, that may show the difficulties in some Member States of fully implementing Art. 14(3), possibly due to a lack of sufficient financial resources. Along with strengthening the impact of Art. 14(3), financial aspects of its implementation may also need to be addressed more directly.

The right-hand side of Figure 2-43 shows the wide spread of the combined costs of overcoming the non-economic barriers analysed in this study for the different Member States. Romania is most strongly affected by high costs of overcoming, Finland is least affected. The remaining countries fall into medium to medium-high category. It is interesting to note that the four countries with the highest ranking of the combined barriers (Spain, France, Romania, and the UK, see Figure 2-42 above) also have the highest cost of overcoming their barriers (together with Lithuania, where the combined barrier effect was only low-medium). Unfortunately, as a consequence of the analysis one might say that there are no low-hanging fruit to be picked: the highest barriers are also the most costly ones to overcome.

Again, it is important to note that this analysis is based on a limited set of answers from stakeholders and should therefore be treated with care.

2.2.3. RES-T

Further deployment of biofuels/non-biological origin-fuels and the use of renewable electricity can increase the share of renewable energies in the transport sector. The implementation of the RED in the Member States has been the main driver in creating a market for biofuels; technologies using electricity as driving energy (electric road transport, rail electrification) usually have not been considered when implementing policies with regard to the RED. The ILUC Directive from 2015 increased multiple accounting factors for renewable electricity used in road transport and introduced multiplier factor for renewable electricity in rail transport. Nonetheless, the analysis of non-economic barriers focuses on the deployment of biofuels as they are targeted with most policies regarding the 10% renewable energy target of the transport sector.

The following subsections discuss the importance of non-economic barriers for the deployment of renewable energies in the transport sector based on information from the literature and stakeholder interviews. For the transport sector it was not possible to quantify the non-economic barriers in terms of lower deployment or cost impacts. Therefore, the non-economic barriers are ranked in terms of their relevance resulting in the identification of the most urgent non-economic barriers to be overcome in the future.

2.2.3.1. Unstable regulatory framework and missing long-term framework as primary non-economic barrier - investment risk

The implementation of biofuel mandates was the main driver for the market entry of biofuels in the Member States. Thus, the RED has created the market for biofuels which would not have entered the market on a purely economic basis. The ongoing discussion on potential changes of the RED and the unclear situation if and how the crop-based biofuels can be considered with regard to the 10% target have severely hampered the deployment of biofuels.[43] Several Member States reduced their biofuel targets (e.g. Spain, Austria) as a result of the unintended effects and the low public acceptance of crop-based biofuels. Germany switched from a biofuel quota to a GHG reduction system which is based on the requirements of the Fuel Quality Directive.[44] The smaller than expected share of biofuels led to excess biofuel capacities in the EU [75].

Commission Decision (EU) 2015/1513 which limits crop-based biofuels to 7% of total energy demand of transport provides more stability to the biofuel market up to 2020; but it also sets a deployment limit on the technologies which have benefitted most from the RED.

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[43] Other economic and regulatory reasons (e.g. “Blending Wall” in US market has been reached, low fossil fuel process in recent years, less fuel demand than expected due to economic crisis) are stated in [75].

[44] 2009/30/EC.

Literature [75, 76] and most interviewees of all stakeholder types identify the unstable market situation that has been observed in the past and the lack of a long-term framework for the transport sector as the main and the most relevant non-economic barrier. [75, 77] recognise the reduced investment risk up to 2020, but expect little impact on the deployment of biofuels until the framework for the period after 2020 is designed. Similar comments were stated by interviewees of all stakeholder groups.

Other non-economic barriers are secondary to this barrier since the size (and the deployment) of the biofuel and renewable energy market in transport is currently directly linked to the requirements of the RED.

2.2.3.2. Non-economic barriers for advanced biofuel and non-organic renewable fuel deployment - investment risk

The production of advanced biofuels and non-biological-origin renewable fuels (see Annex IX of RED) is generally more costly than the production of biofuels based on crops. Thus, overall biofuel or renewable fuel targets will not create a market for these fuel types as long as no additional incentives or specific targets have been established. Double-counting has been introduced by Directive 2009/28/EC and is implemented by the majority of EU Member States. The ILUC Directive added the requirement of implementation of national targets for advanced biofuels and harmonised the eligible feedstocks for these incentives.

Double-counting mechanisms for advanced biofuels created a market for biofuels based on used cooking oil and animal fats [77, 78]. A positive impact on other advanced biofuels has not been observed. Thus, double-counting beyond 2020 is expected to benefit especially the deployment of biofuels which have already been introduced to the market [77]. The difficulty of estimating the economic value of multiple counting of advanced biofuels is documented in [77]. [77] and [75] question the effectiveness of double-counting as a measure on its own in order to bring other advanced biofuels into the market. [75] considers a policy mix of funding in R&D, reliable financial incentives and a regulatory instrument as a prerequisite to achieve the market entry of other advanced biofuels.

National targets for advanced biofuels other than biofuels from used cooking oil and animal fat have not been effective yet. It is therefore not possible to evaluate the impact of the implemented national targets. [75] states that the sequence of implementation of instruments is important and too ambitious targets and mandates of advanced biofuels without complimentary instruments could impede further deployment of these fuels. Stakeholders mention similar concerns in [77].

The difficulty of establishing reasonable targets for advanced biofuels due to the immaturity of some production processes and uncertainties of production costs is stated in [77] and by interviewees (mostly stakeholders from ministries, but also biofuel producers). The various proposals of the ILUC Directive with changing values for the national targets also indicate this challenge.

However, further deployment of established advanced biofuels can be expected until 2020 with the current regulation framework (impact of double-counting). Harmonised national legislation on eligibility of feedstocks for double-counting will increase the market for advanced biofuel production plants. Nonetheless, relevant deployment of other advanced biofuels will depend on the setup of the regulatory framework after 2020 and will probably require additional instruments to create market opportunities for more advanced technologies. It can be expected that several countries with transport sector strategies other than advanced biofuel deployment will lower the national targets below 0.5%.

2.2.3.3. Non-economic barriers for biofuel deployment – standards / certification

Other non-economic barriers relate to blending standards and the sustainability certification schemes of biofuels. The lack of EU-wide fuel standards for biofuel blends above B7 and E10 are mentioned in the literature (e.g. [76]) and by interviewees from all stakeholder groups as a potential non-economic barrier with an increasing share of biofuels. Currently, only a few MS have introduced E10 and B7 and the demand for these biofuel blends is small. Thus, the current impact of the barrier on biofuel deployment is negligible.

However, E10 and B7 are the maximum blends for which most carmakers grant engine warranties. [75] states the "blending wall" of E10 as a relevant barrier for further uptake of bioethanol in the US market. Higher biofuel blends are probably required if higher RES-T / biofuel targets are set in the regulatory framework beyond 2020. Thus, a timely definition of EU-wide standards would create a stable and clear framework for fuel producers. Moreover, it would allow automobile manufacturers and regulators to adapt their vehicles and regulations to these fuel requirements and therefore enhance consumers' trust in the compatibility of biofuel blends with vehicle engines (see Section 2.2.3.4).

The differences in the certification procedures in terms of sustainability criteria created a market distortion especially in the introduction phase of the biofuel market. The establishment of the EU-wide voluntary schemes diminished this barrier and has increased the liquidity of the market. Progress reports (e.g. France, Germany) and few interviewees (especially biofuel producers from Western European MS) pointed out that national verification schemes are less strict and prone to fraud. Other stakeholders (e. g. from Slovakia) state the flexibility of national verification schemes as a reason for implementation. Small-scale industry could be certified with adapted procedures and instruments. Generally, the impact of different certification schemes in the EU was considered in most interviews a relevant barrier in the past. Currently, the sustainability compliance verification process is perceived as a minor non-economic barrier by the majority of the interviewed stakeholders.

2.2.3.4. Non-economic barriers for biofuel deployment – public and consumer acceptance

Low public acceptance of crop-based biofuels is considered a very relevant barrier in some of the EU countries. Stakeholders from Germany, Austria and the UK gave the negative image of crop-based biofuels as a very crucial reason for non-deployment of biofuels. Policymakers decided to change the transport sector strategies away from crop-based biofuels. The perception of crop-based biofuels is different in other countries. Especially Eastern European countries appear to consider crop-based biofuel as an economic opportunity for their farming sector.

The ILUC Directive introduced the 7% limit for these biofuels and set stricter GHG targets for biofuels as a reaction to the unintended effects of crop-based biofuels and their negative image. Nevertheless, the stakeholders from countries with a low public acceptance expressed their doubts about the possibility of changing the public perception of these biofuels in the short term through the ILUC Directive and other initiatives. Additionally, literature [77, 79] and few stakeholders pointed out the possibility of limited GHG mitigation and other adverse effects of fuels eligible as advanced biofuels. They recommend to specify more in detail the eligible feedstocks of advanced biofuels.

Concerns regarding the compatibility of higher biofuel blends and the cars' engines are observed in most EU countries since most carmakers do not grant a warranty for high biofuel blends. The example of the US shows that automobile manufacturers also grant warranties for higher biofuel blends. An EU-wide definition of higher biofuel blends standards is the prerequisite for all further action (Section 2.2.3.3).

2.2.3.5. Non-economic barriers for alternative drive technology deployment

Several market entry barriers for vehicles with alternative drive trains can be found. The main barrier for electric drive trains is the high costs. Still, financial incentives for car buyers' and R&D activities on its own will not be sufficient to overcome the market entry barrier of electric vehicles [80]. [80] suggests a mix of regulatory elements (e.g. strict targets in energy efficiency and/or CO_2-standard schemes, zero emission vehicle mandates for vehicle manufacturers), financial incentives for consumers and charging infrastructure development and new technology awareness campaigns in order to create a market for electric vehicles. All of these measures will not be part of the RED.

However, the ILUC Directive increased the multiplier factor for accounting of renewable electricity in road transport (from 2.5 to 5 times) and introduced a multiplier factor of 2.5 for renewable electricity used in rail transport. It added as well as the possibility of reducing the national target level of advanced biofuels on the basis of incentives for renewable electricity use in transport to the regulatory framework. It is expected that several Western and Middle European countries with high numbers of new car registrations will push for increased market entry electric vehicles as their future transport sector strategy.

Italy is the only EU Member State with a relevant share of methane-based vehicles. The market entry of methane-based vehicles has not been established despite financial support schemes. Thus, for these vehicles a policy framework also has to be created with several elements that do not constitute part of the RED.

2.3. EU-level recommendations

2.3.1. General role of non-economic barriers

Across Member States and sectors, economic barriers dominate, but non-economic barriers are also present and have an impact on costs and deployment. Non-economic barriers typically become more visible once economic conditions improve.

Also, binding long-term targets and regulatory stability are perceived as highly important. This has been mentioned across Member States and sectors as a key issue, with regard to the development of renewables in general and as far as the reduction of non-economic barriers is concerned.

In many cases it is expected that non-economic barriers will be addressed only or at least more effectively if Member States pursue such targets, which will then "trickle down" to improving the various processes that can be behind non-economic barriers. Furthermore, another overarching issue in overcoming non-economic barriers is learning curves. Often, non-economic barriers are not just due to political strategies or economic interests, but "simply" a result of a lack of knowledge and experience. Learning-by-doing can best be facilitated by increasing the share of renewables and making experiences and best practices transparent.

Notwithstanding these overarching issues, there is a need and there are ways to address non-economic barriers directly. In some cases non-economic barriers are even more important than economic barriers; in many cases they are becoming more relevant, also in economic terms, for example as more and more issues and conflicts have to be taken into account in RES-E planning and permitting.

Measures on a European level can be effective in two dimensions. They can:

1) reduce barriers in individual Member States and
2) make different Member State markets more accessible for international companies, so that they do not have to adapt to different conditions in different Member States (which is sometimes even a barrier between different regions within one Member State).

This section presents and discusses the recommendations per sector, based on the analysis presented in the previous sections.

2.3.2. Detailed recommendations for RES-E

There is a range of non-economic barriers for RES-E and various measures that can be used to tackle these barriers.

2.3.2.1. Spatial planning

Spatial planning and the way and extent to which sites are made available for RES development are a key issue in many Member States. +This becomes all the more important with an increasing RES-E deployment that leads to a reduction of sites that are easily available and an increase of conflicts with other utilisation interests. Spatial planning for RES-E should also be coordinated with network-related spatial planning.

Spatial planning can be influenced by (binding) targets, as the development and assessment of spatial planning rules need to take into account whether sufficient sites are made available to meet targets. However, even if there are such targets on a Member State level, these are not necessarily broken down into regional targets and there can, therefore, still be a mismatch between the level of target setting and governance level that is responsible for spatial planning.

In terms of EU level recommendations, it is generally difficult to address spatial planning on the EU level, as there is no specific competence for regulating the spatial planning law of the Member States. For example, on the Member State level one way to promote RES-E deployment is to develop priority areas, e.g. for wind power, including an early consultation of municipal planning, aviation or military authorities etc. This can help to identify conflicts at an early stage and guide local planning. However, as far as the EU is concerned, there is no possibility of requiring the Member States to introduce such priority areas for renewable energy.

An alternative, more indirect approach with an effect on Member States' spatial planning can be found in the context of the Habitats Directive, where a coherent European ecological network of special areas of conservation has been successfully put in place. The question is whether such an approach could be transferred to RES-E planning.

One potential approach could also be found in the context of the European Spatial Development Perspective (ESDP), which aims to ensure the consistency and complementarity of regional planning in the various Member States to guarantee the economic cohesion. While the ESDP does not carry legal force, its output – due to the financial support of the objectives of the EU – can potentially promote, for example, the development of priority areas.

2.3.2.2. Permitting: Introducing new requirements on RES permit granting process with one designated authority (one-stop-shop)

Permitting is considered an important issue across Member States, even though the permitting regimes can differ significantly. Even in Member States like Germany, where a functioning permitting regime was established even before the Renewable Energy Directive came into force, the permitting for RES plants is a highly relevant issue.

When assessing permitting regimes and providing recommendations, it is important to differentiate between the following two drivers that can turn permitting into a barrier, assuming that delays in the process are not due to the project developer itself. The planning itself, providing the required documents, the issue of cost-effectiveness, the experience of the project developer and the approach it selects are also factors that may delay the planning and permitting but are beyond the responsibility of the permitting authority.

- Firstly, the permitting process can reduce or slow down RES deployment because the permitting process as such is organised in an inefficient and/or ineffective way.
- Secondly, even if the permitting process is organised as efficiently and effectively as possible, the process can slow down or increase the costs of project development. In this case it is not due to the way in which the permitting process is organised internally, but because permitting has to address many and often highly controversial external factors.

In practice, these two aspects often coexist and clearly distinguishing between them is not always straightforward. Importantly, the following recommendations for improving the permitting process can help to address the first bullet point above. However, it will not be effective in terms of the second point, or may even be counterproductive, especially in the case of time limits. This can be the case if the permitting process is streamlined at the expense of properly taking into account the various external factors and concerns that can complicate the permitting process, but are still legitimate and need to be addressed, also to ensure legal security for project developers and public acceptance. The second point can mainly be addressed by improving the resources available to the authorities, including guidelines and data exchange proposed in Section 2.3.2.4, and by comprehensive public participation that should be launched as early as possible.

One-stop-shop: Status quo and experiences

One approach to streamlining the permitting process is to introduce a so-called one-stop-shop. This means that the entire permitting procedure is carried out by one appropriate authority, serving as a contact point for the project developers and organising the internal consultation of all necessary authorities. The result of the process is one single permit covering all required authorisations.

Designated single administrative authorities that are responsible for providing information and the permit granting process have been a long-standing and well-established element of general recommendations to streamline administrative procedures, not just in the area of permit granting for renewables [81–83].

The OECD stated already back in 2003, that *“the one-stop-shop concept has been implemented in a vast number of permutations and combinations. There is evidence that many of the variations of this basic idea have been successful in reducing administrative burdens on businesses and the general public. These gains have been experienced as reductions in the time and cost invested in seeking information, especially on licence and permit requirements.”* [83: 30].

Example: EU Service Directive

In the European Union Member States, many one-stop-shops have been created for example following the Services Directive 2006/123 EC [84].

Since the introduction of the EU Service Directive [84] many Member States were able to introduce Single Points of Contact (SPC) or one-stop-shops. [85, 86] analyse the performance of these and make suggestions for improvements of SPCs.

In the document "Service Directive: Explanations and practical examples" [87] the European Commission points out different benefits that result from the introduction of single points of contact in Member States and problems that were stated by stakeholders and addressed by the Directive.

Cost reductions were realised on the side of administrative authorities and businesses. *"According to research conducted by the Netherlands, the use of Points of Single Contact could bring savings of some 60 million euros a year in that country"* and *"according to a study conducted by the United Kingdom, the systematic use of Points of Single Contact should allow cost savings between 3.8 and 13.7 euros per transaction, representing potential short-term gains of around 20 million euros in that country."* [87]

One-stop-shops can thus be regarded as administrative best practice that has proven effective in many areas. There is no evident reason why this should not be applied in the case of permits for renewables.

Introducing a one-stop-shop can affect the economics of a project in the following ways:

1) There are reduced administrative costs for developers. The level of savings depends on the efficiency gains that result from the situation before the one-stop was introduced and the new processes.

2) Provided that the one-stop-shop approach also leads to a faster process, as in the French example, there will be lower costs of regulatory delays.

3) Delays in permitting not only increase costs; they can also lead to reduced revenues (see section "The impact on revenues" in Section 2.2.1.1). This is the case if the remuneration is reduced over time. This is especially critical in Member States with an automatic reduction mechanism for remuneration levels, whereby payments for new installations are adjusted on a regular basis, either through predetermined or responsive tariff degressions. Examples include Germany, Italy and France, or in Member States with high regulatory uncertainty and frequent changes.

Member States that have implemented a one-stop-shop include France (for wind power, biogas and PV only), Lithuania and Italy (for part of the process) and Germany. The lack of a one-stop-shop is perceived as a barrier in many Member States. The barrier is more acutely felt when there are different administrative levels to consult, as in Spain or in Italy, since different municipalities or regions often do not have the same requirements. The multiplicity of counters to go through is then increased for national project developers since they have to study the whole process again when dealing with a region or community with which they are not familiar.

The barrier is also much more important when there are no time limits imposed to deliver an answer or when time limits are not respected by the authorities (see Section 2.3.2.3 below). This is the case in, for example, Portugal, Spain, Italy, Slovakia and Romania. Conversely, the lack of a one-stop-shop is not perceived as a main barrier to RES development when the permitting process is carried out within the legal deadlines and when the requirements are transparent, as in Austria.

Precisely because the permitting procedure can involve many different authorities at local, regional and national levels and from different administrations, the lack of a one-stop-shop is perceived as a difficult barrier to lift. In the UK, there is a specific waiver regarding visual amenity that can be applied in projects by local authorities. They use this if a project is not popular. The implementation of one-stop-shops, which may give more power to central administrations, could be perceived by local authorities as a loss of competence. At the same time, increasing issues with lacking public acceptance may increase the need for local knowledge of the permitting authorities.

However, existing regulations may already offer an approach that could allow integration of these differences between Member States: Regulation (EU) No 347/2013, the so-called TEN-E guidelines [88] on trans-European energy infrastructure, includes a provision which concerns the organisation of permit granting processes. The permit process contains three types of organisation schemes: An integrated, a coordinated and a collaborative scheme. According to Article 8(3) TEN-E guidelines,

- The integrated scheme nominates one sole competent authority to issue a legally binding decision – according to national law, while other concerned authorities may give their opinion in the course of the procedure, which is taken into account by the competent authority.
- Within the coordinated scheme, the comprehensive decision comprises multiple individual legally binding decisions issued by several authorities concerned and coordinated by the competent authority. Competences of the coordinating authority comprise, for example, the right to disregard a decision issued by one of the contributing authorities if not delivered in time.
- According to the collaborative scheme, the comprehensive decision shall be coordinated by the competent authority. Its task is to monitor compliance with the time limits by the authorities concerned.

This approach allows different national levels of administration and administrative competences to be taken into account. It might dissipate objections to the streamlining process by allowing different national schemes while establishing an overall one-stop-shop approach.

In Lithuania, stakeholders expect that a functioning and comprehensive one-stop-shop approach could reduce administrative barriers. However, some stakeholders have also raised doubts about whether a requirement in the European RED to set up a one-stop-shop regime will actually be effective in developing a functioning scheme in practice.

In those Member States in which a one-stop-shop has already been introduced, it is often perceived as a positive development that makes the permitting process more efficient (e.g. Germany). In Member States where the concept has not been implemented yet, the large majority of stakeholders support the introduction of such a system as well as a provision in the Renewable Energy Directive that makes a one-stop-shop mandatory for Member States. In both groups of Member States, it is important to note that the one-stop-shop approach is supported by different types of stakeholders, including both project developers and authorities.

However, the implementation is not always a simple process, may be less effective than envisaged, and can lead to some unexpected drawbacks. The practical effects of one-stop-shops depend on the detailed implementation and the specific situation. The one-stop-shop has to be carefully thought through according to the national context and must not be inflexible to differing national requirements. Adopting, as described above, the organisation scheme options offered by the TEN-E guidelines, might leave enough flexibility to ensure the Member States’ compliance and implementation.

A one-stop-shop can be very effective at reducing permitting time and costs, but does not necessarily do so. For example, the recent one-stop-shop experimentation for renewable permitting in France, despite a reduction of permitting times a preliminary assessment reveals that this can be seen as a relative success with room for further improvement: *“Developers welcome the fact that the collaboration of various State services makes it easier to find a compromise”* and *“the one-stop-shop experimentation is perceived as a concrete action to facilitate the procedures. However they have not achieved a high level of simplification yet”.*[45] RES associations said that the one-stop-shop just created a single gate for the developers, with the administrative requirements remaining the same. They still have to provide 2 or 3 times the same information for several institutions. Another effect of the implementation in France is that developers lose the possibility of interaction with the people that are actually examining the project in the different administrations.

In Italy, the government has implemented a single authorisation approach, which works as a one-stop-shop on the regional level. The project developer presents a request to the region that then collects the opinion of all interested parties. It can also organise an environmental impact assessment. The government presents this as a one-stop-shop. Nevertheless, producers and associations have the feeling that this does not reflect reality. They have to go to multiple gates to find documents prior to submitting a project file to the regional authorities. A similar situation can be found in Lithuania. Denmark has also officially implemented a one-stop-shop for permitting of offshore wind. However, there are still complaints that the administrative process is slow when the potential investors have to apply for approval at different administrative offices and levels.

One-stop-shop: Recommendation

Overall, it can be concluded that a one-stop-shop approach is a useful measure to reduce non-economic barriers. The inclusion of such a provision at EU level is also supported by the large majority of interviewed stakeholders. The actual implementation should be left to the Member States, if only because administrative structures and permitting regimes can differ significantly between Member States and also indeed between technologies.

Putting in place a one-stop-shop can be recommended especially if certain conditions apply:

- The implementation of the one-stop-shop should simplify the administrative burden and reduce process times. There should be deadlines for all consulted authorities to respond to the request and these should be respected, so as to avoid the black box phenomenon (a project developer will not know where the problem lies and which procedure is taking so long). A good practice would be to put in place a system of electronic tracking so that the project developer can see the progress made in assessing his project.
- The one-stop-shop should be as comprehensive as possible, covering all steps of the permitting process.
- The one-stop-shop should ensure that no duplication of documents is needed.

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[45] See "Le Journal de l'Éolien - n°19 May 2016" and the report "Evaluation des expérimentations de simplification en faveur des entreprises dans le domaine environnemental - décembre 2015".

- The project developer's rights to appeal to the decision of the authority should not be diminished by the fact that only one authority organises all consultations. In particular, deadlines for appeals have to be well-considered.
- Explanations as to the outcome of the procedure in the case of rejection have to be supplied in a clear and transparent manner.
- The one-stop-shop should not only refer to issuing permits, but also to providing information, i.e. there has to be a contact point from which developers can obtain answers and clarifications. A good practice could include the provision of a Geographic Information System which includes all constraints that can exist at a local level (military, radar, protected areas, projected grid development, local planning…) and that developers can use to select appropriate sites. In countries in which the regional authorities have a lot of administrative power and different requirements are in place, there should also be a one-stop-shop that acts as a central information point on all these differences between regions.
- For larger installations, the one-stop-shop could be implemented in different phases, starting with some technologies which are already mature. For example, marine energy may not yet be included.

2.3.2.3. Permitting: Time limits

Like the one-stop-shop, time limits for permit granting procedures have been a long-standing and well-established element of general recommendations to streamline administrative procedures, not just in the area permit granting for renewables [81–83].

According to OECD [83: 11], *"the extent of an administrative burden is determined only partially by the direct input involved in marshalling required information and engaging in filling out forms and dealings with administrators. In addition, costs are also imposed on the business or the citizen by time delays and uncertainty, either in the provision of information, or in providing answers to requests. Setting time limits on public servants' and regulators' case-handling time often leads to reduced administrative costs for businesses and citizens".*

Permitting time limits can thus be regarded as administrative best practice, and there is no evident reason why this should not be applied in the case permits for renewables. A key question has always been to what extent and how such time limits can be enforced [83: 52], and what kind of complementary mechanisms are thus required.

Delays in the administrative permitting process represent a barrier across Member States (see also Section 2.2.1 on quantitative effects of barriers). In the analysis, no arguments have been raised as to why permitting time limits should not be introduced and they can be seen as a must-have in any efficient permitting process. The large majority of interviewees expect that a time limit provision will be introduced in the new RED. Against this background, a difference between stakeholder types should be noted: While project developers emphasise the necessity of time limits, "regulators" do not disagree but more often point to the limitations of such a provision.

Overall, while time delays are a relevant barrier and time limits a relevant solution, it is also important to understand what role they can play and when one should not expect too much from time limits. While the one-stop-shop approach can be expected to directly make the permitting process more efficient, the way in which a time limit can be implemented and enforced and how effective it can be is less obvious. This can be for the following reasons:

- Time limits are already in place in many Member States, but are often not kept (e.g. Germany, Spain), often because a thorough process simply takes longer than the time limit allows.
- There can be a trade-off between shortening permitting periods and properly addressing an increasing number of conflicts.
- Defining the period that is covered by a time limit and implementing this definition is not straightforward in practice.
- Delays in project development are often not due to the permitting phase as such, but also result from the planning phase, which would not be covered by the time limit.
- More binding time limits, potentially including penalties for authorities, are problematic and potentially even counterproductive, maybe even for the project developer.

These limitations and the ambivalence of time limits should be kept in mind. However, it is reasonable to have an indicative time limit that is imposed on the permitting authorities. Even with an indicative time limit, project developers could be protected from revenue losses that may result from delays (see "**Suspending the tariff degression**" below).

At EU level, a requirement for Member States to introduce time limits can be recommended. However, it is rather difficult to define harmonised time limits and this should therefore be left to the Member States.

Trade-off between shortening permitting periods and properly addressing an increasing number of conflicts

In general terms, there is a trade-off between putting pressure on the permitting process through time limits on the one hand and properly addressing all the relevant issues, not the least in order to ensure legal security for and acceptance of RES projects on the other hand. Generally speaking, time limits do not help to deal with complex permitting issues.

More specifically, any attempts to shorten planning and permitting procedures – through deadlines that apply to the project developer or the permitting authority or through reducing the formal requirements for the permitting documents – can potentially contradict other relevant provisions of European law. In particular, the Aarhus Convention has led to improved compliance with environmental aspects with its far-reaching provisions for the participation process and to the right of action for NGOs. In several Member States, the Convention has led to far-reaching changes in the participation and action rules. This development is primarily understood as a positive step for an improved integration of the public and NGOs in environmental planning and compliance with the essential requirements for transparency and participation. This should not – regardless of whether lowering the legal level is even possible – be reversed by a regulation to its opposite, in particular, if conflicts increase and public acceptance becomes more relevant, as in the case of many RES-E projects across Member States. Conflicting use and the question of the feasibility of investments are significantly influenced by EU law; the habitat and species protection of the Habitats Directive, the Water Framework Directive and the Environmental Impact Assessment Directive are particularly relevant.

From the project developers' point of view, tedious planning and permitting processes can also increase costs, reduce revenues and potentially put projects at risk. Nevertheless, from their perspective there are also two sides to the coin. If permitting requirements are reduced and permitting procedures are streamlined, it can have the negative side-effect of potentially a lower acceptance and especially a higher legal insecurity, which can backfire on the project development. While project developers emphasise that time limits are important and highlight the costs of delays, they also confirm the significant risk that can result from court cases. This can be especially relevant in the context of auction schemes where projects that come online with delays are subject to penalty payments.

In any case, a concentration and simplification of the approval of projects should not imply that other rights are affected. In particular, the requirements of the Aarhus Convention and its implementation in the EU on access to information, public participation in decision-making and access to justice in environmental issues in the EU may not be affected. These rights should not be called into question. ECJ ruling (C-137/14, 2015-10-15) also has far-reaching consequences in this respect. Based on this, private and environmental organisations cannot be precluded from litigation on the grounds that they have not raised their argument in the permitting process. This makes comprehensive public participation even more important. Otherwise, the legal certainty for project developers could be seriously put at risk.

It is often seen as a barrier if there are extensive legal appeals, which is sometimes even seen as a misuse of appeal rights. However, this should not result in reducing such appeal rights. Rather, if legal appeals cannot be avoided despite comprehensive public participation and proper planning, the question is how appeal procedures can be made more efficient, for example by strengthening the capacities of administrative courts.

How to define time limits in practice?

Against this general background, the following aspects need to be taken into account when setting time limits. First of all, time limits will typically only be indicative, rather than binding. They provide authorities and project developers with an indicative timeframe. If a time limit exists, it will be easier for developers to indicate when permitting is taking too long, and the time limit will provide a benchmark on the basis of which the administrative structures can be set up that are capable of meeting the time limit.

Beyond such an indicative function, binding time limits will be much more difficult to implement. One main reason for this is that there will always be some flexibility needed to address new issues that emerge only during the permitting process. Moreover, binding time limits would require defining and implementing a clear-cut starting point. Authorities could, for example, confirm that all documents are available. However, they are typically not willing to do so, again because new issues may emerge during the permitting process. There would also need to be clearly defined harmonised requirements on project developers as to what needs to be submitted to kick-off that period. This would also reduce flexibility for developers.

While such requirements are generally difficult to put in place even on a Member State level, they would be even more difficult to define in a European Directive – across all the different permitting regimes in Member States.

Differentiating between planning and permitting process

Furthermore, delays often do not occur in the permitting process itself (see also Chapter 2.2.1.1). There needs to be a distinction between situations in which

1. the permitting process itself is not too lengthy, once all permitting documents have been submitted. In these cases, it is often the process before the actual permitting process in

order to obtain all required documents, which delays the process. In such a situation, it is difficult to speed up the process with a permitting time limit.

2. the permitting process itself takes a long time, a permitting time limit can be more effective. For the planning process, spatial planning (see Section 2.3.2.1) and improving the resources available to the authorities, including guidelines and data exchange (see Section 2.3.2.4.) as well as comprehensive public participation that is launched as early as possible.

Automatic approval

Automatic approvals are part of the MS reporting requirements under the RED, but one has to be careful to make it compulsory.

Automatic approvals after a permitting time limit has expired are a double-edged instrument. Time limits should be indicative, but automatic permits would turn them into binding limits. While their objective is to enforce time limits, in practice their effect may be weak or even counter-productive. It may lead to a situation where authorities keep postponing the starting point of the permitting period.

As opposed to general time limits, which are standard best practice, automatic approvals can be regarded as more critical. According to the OECD [83: 51] *“silence is consent rules are not widely, or universally, used in any country. This reflects the fact that the effect of an unwarranted approval of an application can be extremely serious and costly in some cases. The operation of silence is consent has the potential to give rise to dangers in certain areas, whether of a safety-related or financial nature. The limited field of operation of silence is consent thus seems to reflect judgements by governments that the potential harms associated with such unwarranted approvals can, in many cases, outweigh the benefits of reduced administrative burdens and increased certainty.”* The limited practical implementation of the “silence is consent” rule is also confirmed by OECD [89]. There are some examples in European Member States, but there are also significant legal concerns.

In the case of RES permitting, such potential side-effects do not only include legal aspects that need to be assessed in the permitting approvals, but also extend to the general acceptability of projects by the societal stakeholders. If a project is contested, but gets automatic approval, this could discredit the permitting process and RES deployment beyond the project at hand.

And a more general point on time limits, which is however also particularly relevant for introducing binding time limits through automatic permits: “*Legislated time limits are difficult to apply ‘across the board’. This is due to the fact that because of different degrees of complexity and consequences of making incorrect judgements, there can legitimately be wide variations in the time needed to exercise various kinds of administrative judgements*“ [83].

Against this background, it is generally problematic to make automatic approvals compulsory for all Member States. This is even more so the case for RES permitting where there are many emerging conflicts and critical issues of acceptability that can require time to resolve, partly because the legal situation is not entirely clear yet. In any case, it needs to be ensured that all required assessments, including those under EU law, e.g. the required Environmental Impact Assessment,[46] are carried out and are not "overruled" by an automatic approval.

If all requirements such as the ones mentioned in the previous paragraph are still to be met, this significantly reduces the effectiveness of the instrument.

This option should only apply to small-scale plants and definitely exclude projects requiring an environmental impact assessment.

Penalties to enforce time limits

A long permitting duration and exceeding the permitting limits can affect both costs and revenues. Revenues are affected especially in those cases with a time-dependent support level reduction (see Chapter 2.2.1.1).

One way of making time limits more binding could be to impose penalties for the permitting authorities if deadlines are not met. This has been proposed by several stakeholders in different Member States (e.g. Germany and France). A recent report by [47] also includes the following recommendation:

"Increase accountability for decision making processes at the regulatory/governmental level. Currently, in many cases, if a government or regulatory agency does not make a decision after a pre-determined period on a project, it is likely assessed unfavourably. It will be prudent for decision making authorities to be held accountable for delays in decisions within their control. The accountability can come in the form of pre-determined fines associated with not achieving set milestones."

The function of such a penalty could be two-fold. On the one hand, it could be used to enforce time limits and put pressure on permitting authorities to process permit applications quickly and effectively. On the other hand, there could also be a payment to project developers that compensates for costs and lost revenues caused by delays in the permitting process.

However, such penalties would be coupled with numerous negative implications. It would therefore be very difficult to implement and is not advisable, both in general and as an EU provision in particular for the following reasons:

- Such a time limit could only then begin when all paperwork is submitted. The threat of a penalty would be likely to prompt the responsible agencies to carefully and thoroughly examine whether all required paperwork had actually been received and, if not, to demand further documents. This could cause further delays in practice.

- Furthermore, if applied as a European provision, it would infringe upon the agency structure, so that Member States would be required to employ additional staff to avert delays due to personnel shortages (sick leave and other types of leave). This could also be deemed an unreasonable and inadmissible encroachment upon the sovereignty of the Member States.

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[46] Directive 2011/92/EU of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment (OJ L 26 28.1.2012 p. 1). See also the requirements defined by Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (OJ L 206, 22.7.1992, p. 7) or Directive 2009/147/EC of 30 November 2009 on the conservation of wild birds (OJ L 20, 26.1.2010, p. 7).

- Moreover, most Member States already allow for restitution for breaches of official duties. This would also include a delayed decision on an application from developers. However, proving such a breach of official duties is difficult and rarely successful in reality. Restitution surpassing current measures would have to be integrated into existing systems of liability of public authorities. A justification would further be required for why RES projects warrant extra liability, beyond that of other projects subject to approval. Such discrimination appears to be legally unsubstantiated and violates the principle of equality.
- It would entail an extended investor protection, which assigns the responsibility for the length of the process solely to the public authority. However, as described above, the length of the process can be influenced by numerous other factors: matters of public interest such as nature conservation, health protection or spatial planning as well as possible legal objections and opposition from citizens or organisations.
- The possibility of obtaining compensation could also be seen as a hidden subsidy, if this resulted in a simplified burden of proof for investors.
- Lastly, the threat of restitution could, in practice, also increasingly lead to a failure to completely assess individual issues in the administrative process due to a lack of time. This could create a burden for all parties and potentially reduce the legal certainty of the decisions, setting the stage for long legal battles to resolve the matters in question.

Suspending the tariff degression

An alternative proposal would be to suspend the tariff degression once the application has been submitted or once the time limit has been exceeded. Again, such an approach would require a clear definition of a time limit and a clear starting point, which is not a trivial task.

However, an important difference to the compensations or penalties discussed above lies in the following: A suspension of the tariff degression would have neither a penalising character nor an assumption of blame, also among the public. The responsibility of distributing subsidies would also generally not be in the hands of the permitting agency. This prevents such an “extended investor protection” from being carried over into other sectors and their proceedings. Moreover, the interests of investors would have no priority over the public interest.

2.3.2.4. Planning and permitting: best practice guidelines

A lack of knowledge by permitting authorities is perceived as a barrier in many Member States. This has two dimensions: Firstly, permitting authorities can generally have a low level of know-how in processing RES permits in general or for certain technologies. Secondly, even if authorities are experienced, they are increasingly faced with new issues and conflicts that emerge and that need to be addressed during the permitting process. This can be due to a generally low level of acceptance for RES development. But it can also be due to the fact that once RES development is no longer a niche development, the number of conflicts increases and new types of issues enter the permitting arena, like military constraints, aviation security or the conflict with weather radar systems. Also, environmental impacts and their assessment become more relevant.

In this process, it is important to support permitting authorities with guidelines on how to deal with various issues and provide best practice. This is not to say that individual permitting processes can be replaced by general guidelines. Even with such guidelines in place, permitting authorities still need to look at each case and its individual characteristics. Guidelines can nevertheless help to support permitting authorities in this process. This can include comprehensive information on existing studies carried out elsewhere and relevant court cases, e.g. combined in one single database provided to permitting authorities.

Such guidelines have partly already been developed within Member States and various experiences are being gained. As issues and conflicts are often very similar across Member States, this process could be further facilitated through the exchange and development of best practice on a European level.

2.3.2.5. Planning and permitting: build-up of the necessary infrastructure

A key requirement for efficient planning and permitting processes is not just an efficient process provided by public authorities. Rather, it also requires that project developers have access to the necessary infrastructure, for example in terms of service providers or in terms of information on site availability, constraints, etc. This infrastructure is usually to some extent an indirect result of a growing RES market and to some extent it can explicitly be built up. It could be further explored whether and how a cross-border infrastructure, e.g. in terms of service providers, could be facilitated.

2.3.2.6. Grid access

Grid access is perceived more or less as a barrier in all the Member States that have been analysed in detail. Progress has been made in reducing this barrier in many cases in terms of the connection process as such. Further harmonisation of grid access procedures within Member States is still an issue, including the development of such harmonised rules with the participation of the renewables industry. Moreover, in some cases the existing network capacity cannot be fully utilised because network operators and especially DSOs would need to improve their knowledge of the maximum capacity that can be connected. Known capacities should be made as transparent as possible to plant developers. In some cases the problem of virtual saturation also persists, whereby plants that are not being built block network access for other plants. However, overall it can be stated that progress has been made in reducing the grid access barrier in many cases in terms of the connection process as such.

However, the reason for why this barrier is still relevant or becomes even more relevant is that with an increasing share of RES-E the network constraints increase. The focus of this barrier is thus shifting from grid connection for individual plants to overall grid development, including both the distribution and the transmission level. Member States therefore have to take measures to expand their grid. This should be undertaken as early as possible considering future RES development plans, and not only when network constraints have already become visible in the network.

Key action areas are regulation of network tariffs that should include appropriate investment and innovation incentives and a binding network planning process, which should at least be carried out on the transmission level but could also extend to the distribution level. In addition, involving the public in the planning process is crucial. This should also include opening the black-box of the planning process from scenario assumptions, to network modelling as well as interpreting modelling results.

In terms of the Renewable Energy Directive, there are no recommended measures that could be addressed in this framework.

2.3.2.7. Small-scale issues

This section summarises key issues in the area of small-scale generation that can be observed in Member States (Öko-Institut own research). It is necessary to distinguish between general barriers for small-scale generators and actors, mainly related to complicated administrative procedures, specific barriers for self-consumption and barriers for energy cooperatives.

Complicated administrative procedures

In several Member States like the Czech Republic, Finland, Slovakia, Romania and Poland, administrative requirements have been reported as a key barrier for small-scale plants and actors. Especially small actors with a small portfolio and private actors can be blocked by the design of administrative procedures.

A key question is whether this merely strengthens the case for generally streamlining administrative procedures for all actors, or whether there should be specific rules and exemptions put in place for small-scale actors. Complicated procedures increase the costs for all developers. However, while large actors are often able to deal with these requirements, albeit at higher costs, administrative requirements are more likely to act as a real deployment barrier for small-scale actors.

There are some areas in which specific rules for small-scale players are highly reasonable. Lifting operational licensing requirements that are in place in, for example, the Czech Republic, even for small-scale private investors and act as a key barrier, is a case in point. In Portugal there is a simplified licensing regime in place for micro-producers. For small-actors it is also important to provide transparent information about all the processes beyond what may be needed for larger investors (see the example of Finland).

While licensing exemptions should be granted for small-scale/private generators, other permitting exemptions should be linked to the impact of small-scale plants, rather than the actors behind the small-scale plants. Examples can be found in Spain and Germany. In Germany there have been proposals to exempt energy cooperatives from certain permitting requirements. However, this can hardly be justified if the plants developed by cooperatives are similar to plants developed by other actors and are likely to have similar environmental impacts. At the same time, if there are exemptions for smaller plants, like automatic permits or notification procedures, they should apply to all actors and should also depend on the plants. Automatic permits should be used to facilitate procedures for such small-scale plants rather than to generally enforce permitting time limits (see Section 2.3.2.3).

Self-consumption and net-metering

As for self-consumption and net-metering, it is important to distinguish between specific barriers on the one hand and a regulatory regime that distributes benefits and costs without providing specific economic incentives to these options on the other hand.

Net-metering in particular is not so much about barriers, but is rather a support scheme that can be introduced and designed in different ways. In some Member States, for example in Lithuania, this scheme is important as it makes up for the lack of other support schemes for PV. In this example it is restricted to small-scale plants below a capacity threshold and the question is rather whether it should be extended to larger installations.

In the Czech Republic, there have been plans to switch to a kW-based grid tariff system. There are certainly good arguments for this, especially with an increasing share of self-consumption. Yet again it is important to keep in mind that self-consumption in this example replaces a proper support scheme. Therefore, changing the grid tariff design is not just about putting in place a well-thought-out financing scheme for the grid, but is also about changing the support scheme for PV.

Another issue that was discussed is the need to establish a clear regulatory framework for how excess production that is not self-consumed is treated and to allow this production to be sold to third parties. In Spain, there is a difference between a self-consumption only regime in which excess electricity is not remunerated on the one hand and a self-consumption and selling regime on the other hand.

Energy cooperatives

In terms of energy cooperatives, the analysis shows that there are generally two broad groups of Member States.

On the one hand, there are some Member States like Germany and the UK in which citizens' energy cooperatives are popular, both in a cultural sense and in terms of the funding that can be made available by citizens. In these cases, it can be decisive to remove specific barriers so that projects can get started.

In these cases, a key issue is auction schemes and the risks they introduce, especially the volume risk that can be crucial for energy cooperatives that only have a small portfolio of projects. In Germany's central and North-Eastern federal states for example, the share of projects that are developed by energy cooperatives with a portfolio of no more than one project per year accounts for between 20 and 40% of all wind projects, according to a survey conducted by [90]. Both in France and Germany there is a discussion about exemptions from auctions, and in France there are also concerns about the length of time that auction procedures take. Another problem is financial regulation, which threatened to block energy cooperatives in Germany before it was adapted and which remains an issue in France. In the UK, the strong emphasis on locational signals, for example through grid charges, that requires project developers to choose certain regions defined by power system requirements, is at odds with the regional approach put forward by energy cooperatives, namely to develop projects in "their region", while moving it to another region would often undermine the very idea of the project. This problem involves both the regional variation of costs and uncertainty about the costs. Energy cooperatives also face the general problem of citizens' projects – that administrative processes can act as a barrier. As discussed above a key question is again whether this requires a general streamlining of procedures or calls for specific rules for cooperatives. In some countries like Portugal or Italy, energy cooperatives could also benefit from a more explicit definition which could also be the basis for a transparent certification of cooperatives.

At the same time, there are Member States like the Czech Republic or Lithuania in which the problem is not so much removing barriers to get cooperatives going, but rather the fact that there is generally a low interest in such activities. In these cases, it is more doubtful whether removing specific non-economic barriers can lead to a growth of energy cooperatives.

2.3.2.8. Further recommendations

Further to the recommendations above, the following issues and recommendations were mentioned in the interviews with stakeholders:

- Improving general public acceptance, by providing more information and showing RES-E benefits to society.
- As not all conflicts and issues can normally be resolved ex-ante and court cases can be costly and lengthy, alternative conflict resolution mechanisms can be established. The Clearingstelle EEG in Germany is a case in point. It applies mediation, joint dispute resolution and arbitration, especially with regard to disputes about grid access.
- Introducing a time limit for auctions, so that this process does not lead to delays.
- Certification of RES-E plants: A more harmonised certification of RES-E plants can simplify the deployment of different plant types across Member States and can also facilitate access to financing for these plants in different Member States. See also RED Art. 13(6) subpara 3 and 4 for heat pumps and solar thermal energy, as well as the “European Quality Label for Heat Pumps” and “Solar Keymark”.
- Better qualifications: This includes academic qualifications, but also qualifications for installers are an issue in some Member States and could benefit from more harmonised requirements.

2.3.3. Detailed recommendations for RES-HC

In many of the analysed Member States, stakeholders report about the dominance of economic barriers for a faster deployment of RES-HC technologies. However, there are still several non-economic barriers that could, at least to a certain degree, be addressed by the forthcoming RED.

Recommendation	Comment
Introduce binding targets for RES-HC	Considered in many Member States as a very important element to justify policy measures and increase investment security.
Development of long-term strategies for the heating and cooling sector	Considered in many Member States as an important element to enhance investment security (already mentioned in previous evaluations).
Strengthen impact of Art 13(4): Integration of RES-HC use obligation in national building codes	Not all Member States have a RES-HC use obligation in their building code for new and/or existing buildings that are subject to major renovation, although the impact in the existing building stock could be increased by implementing a broader “trigger”.
Obligation of technology retailers/installers to include at least one RES-HC technology option in their offers	Addresses the barrier that cross technology installers often prefer to offer less complex technology solutions and provide recommendations accordingly. Thus consumers are not fully informed about other technology options.
Combined with this option: Obligation to technology retailers/installers to provide lifetime based cost information on the offered technology alternatives	Would provide a better picture about the life-cycle costs of different technology options rather than considering simple investment costs only.
Strengthen impact of Art. 14(3): Qualification and certification of building sector professionals	Not all Member States have fully implemented Art. 14(3) yet; furthermore, extending the qualification/certification requirement to all professionals in the building sector should be considered.
Strengthen requirements for renewable cooling	Includes the agreement on a widely accepted definition of RES-C and the development of a methodology for including RES-C in energy statistics.
Streamline permitting procedures for large scale RES-HC plants	Similar recommendations apply as for permitting procedures in the RES-E sector.
Mandatory heat (and cold) planning for newly developed areas as well as areas with an existing building stock	Already in place in some Member States, this addresses the lack of a mid- to long-term planning horizon which is needed for efficient RES-HC investments at the municipal level.
Improved reporting on RES-HC barriers	Art. 22(1e) needs to be adapted to specifically ask for barriers on RES-HC technologies, since Member States tend to report on RES-E only.

2.3.3.1. Introducing binding targets for RES-HC shares for 2030 in each Member State

This recommendation has been the single most favoured recommendation across stakeholders from most Member States in which interviews have been conducted. Binding sector-specific targets for RES-HC for 2030 would force Member States’ governments and public authorities to pay greater attention to the regulatory and support framework in the RES-HC sector, especially to increase their efforts in designing effective RES-HC policies. Moreover, binding targets for RES-HC would provide a long-term planning horizon for potential investors in RES-HC technologies and create a stable investment environment. Many stakeholders perceive binding targets for RES-HC as more relevant than measures directly addressing non-economic barriers.

2.3.3.2. Developing long-term strategies for the heating and cooling sector

Several stakeholders are concerned about a lack of long-term strategies and visions for the heating and cooling sector as a whole, as well as the future role of RES in the sector. Member States should be obliged to develop such long-term strategies. Long-term strategies for the heating and cooling sector would have to be aligned to Member States' assessment of the potential for the application of high-efficiency cogeneration and efficient district heating and cooling following Art. 14 EED as well as the long-term building renovation strategies following Art. 4 EED. The different elements could be merged to a long-term vision on how the heating and cooling sector could be transformed in view of the climate targets which require a sector decarbonisation in the long run. One of the blind spots not yet fully covered is process heating and cooling in the industry and services sectors. Stakeholders mention that process heat and RES-C have not been sufficiently addressed in the existing RED.

2.3.3.3. Strengthening impact of Art 13(4): integration of RES-HC use obligation in national building codes

With Art 13(4) the RED has already implemented a RES-HC use obligation in the building sector. However, only a few countries have implemented such obligations (e.g. [91]). This might be for several reasons, e.g.:

- many Member States focus their overall RES policy on RES-E, paying less attention to the requirements applying to RES-HC;
- although RES-HC is mainly within the scope of the RED there is a strong link of this policy field to the building sector as well as energy efficiency in general. For that reason RES-HC is also affected by the EPBD and the EED;
- the somewhat unclear legal interpretation of the insertion *"[…] or by other means with equivalent effect, where appropriate […]"* in Art 13(4).

While the first two points could be addressed by the two recommendations above, one option to strengthen the requirement in Art. 13(4) would be to delete the insertion *"or by other means with equivalent effect, where appropriate"* in the wording, making the requirement more straightforward.

A further option for strengthening the impact of Art. 13(4) would be to extend the obligation regarding the specific requirements in the existing building stock. Currently the obligation applies to buildings that are subject to a major renovation. Even if all Member States had fully implemented this requirement, the impact would have been limited since many renovations are step-by-step renovations which do not fall under the definition of "major renovation" as provided by Art. 2 of the EPBD. The impact of the obligation could be intensified by broadening the occasions on which the obligation needs to be fulfilled. The definition of this trigger is one of the key design elements of a use obligation which has a very significant impact on the effectiveness of the measure (see e.g. [92]). A more effective trigger would be to:

- expand the requirement to the replacement of a boiler (similar to the regional renewable heat law in Baden-Wuerttemberg – EWärmeG BW[47]) and/or

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[47] https://um.baden-wuerttemberg.de/fileadmin/redaktion/m-um/intern/Dateien/Dokumente/5_Energie/Energieeffizienz/EWaermeG_BW/150317_Novelle_Erneuerbare_Waerme-Gesetz.pdf.

- define a fixed deadline by which the obligation must be met (e.g. when an existing boiler reaches 25 or 30 years).

In order to ensure compliance, it is also important that appropriate control mechanisms are in place. At present some Member States have an obligation to include RES in new buildings, but compliance (including the verification that a RES-HC device has been properly installed as to ensure its full functionality) is not sufficiently checked by public authorities leading to a certain delivery gap. This has been reported as a challenge in, for instance, Portugal and Spain.

Use obligations also need to go hand in hand with qualification measures for installers such as certification schemes facilitating professionals to install RES-HC devices properly and quality measures aiming at the provision of high quality technologies.

2.3.3.4. Obligation of technology retailers/installers to include at least one RES-HC technology alternative in their offers

Own research by Öko-Institut shows that cross-technology installers tend to recommend traditional HC technologies or less complex technology solutions. This could partly be due to a lack of knowledge about 1) RES-HC installation technologies, 2) RES-HC installation know-how, 3) possible support schemes, or 4) the benefits of RES-HC technologies. Since the advice given at the installer-consumer interface has a significant influence on the final technology choice, biased recommendations constitute a major barrier for RES-HC technologies.

Requiring technology retailers and installers who offer heating and cooling technologies to customers to include a minimum of one RES-HC alternative in their offers could help in tackling this barrier. The requirement would have the beneficial effect that consumers are aware of RES options for their heating system. However, there is the danger that installers will simply put in a very costly RES option, e.g. ground source HP, which would make the installers preferred technology option look much better. For this reason additional guidance on the alternative RES option(s) might be required.

Moreover, mandatory leaflets for installers could be introduced to be handed out to households; these leaflets could explain the environmental benefits of choosing RES-HC technologies and provide examples of installation/equipment prices for a selected range of reference cases (e.g. single family house / multi-family house). The costs associated with this recommendation should be reasonable. Adding an extra RES-HC option to installers' offers to customers should be possible without much extra effort. If the installer has no knowledge of how to install the given RES-HC technology, however, extra costs for training (plus losses due to lost time on the job) will be incurred. A positive side effect may be that installers actually consider participating in training courses and may therefore be able to install a broader range of RES-HC technologies.

2.3.3.5. Combined with the previous option: obligation of technology retailers/installers to provide lifetime-based cost information on the offered technology alternatives

In addition to the above requirement, technology retailers and installers could further be obliged to provide lifetime-based cost information on the offered technology alternatives. More specifically, this would mean that, apart from the investment costs, offers would have to provide estimates on the energy and maintenance costs for the average use phase of the technology. This additional information would help to move away from the simple investment cost considerations and enable consumers to make more informed decisions.

Since the cost balance heavily depends on the energy price scenario to be used, this option would require some additional guidance about the basic economic framework data that should be used for calculating the lifetime costs (mainly concerning the energy price scenario(s) to be used). Since such requirements could pose a significant burden for small installers, an alternative would be to oblige installers to provide information material (e.g. in the form of leaflets) in which examples for a selected range of reference cases are illustrated (e.g. single family house / multi-family houses).

2.3.3.6. Strengthening impact of Art. 14(3): Qualification and certification of building sector professionals

Following Art. 14(3), certification schemes for installers should have been introduced by all Member States by the end of 2012. The analysis of the mid-term evaluation of the RED [93, 93] as well as information given by stakeholders suggests that this is not the case in every Member State. In addition, lacking control mechanisms to verify that RES-HC installations function properly (see above) may disincentivise installers to obtain certification.

Apart from installers, stakeholders also suggested extending qualification and certification measures to the upstream part of the value chain in the building sector, e.g. including architects, building equipment engineers, construction engineers, etc. All professional groups that are involved in planning new or refurbishing existing buildings should have sufficient know-how related to RES-HC technologies and their specific installation requirements. This would ensure that RES-HC technology options are taken into account from the very start of the planning and conception process. In France for instance, this issue was addressed by the implementation of a qualification procedure for installers (Qualit'EnR) and engineering firms (OPQIBI) and a specific program for solar thermal (called Socol initiative) providing technical and financial assistance to stakeholders who want to develop a solar thermal project.

2.3.3.7. Strengthening requirements for renewable cooling

RES-C technologies do not play a major role in climate protection discussions in the EU today. At the same time the cooling demand is expected to increase significantly in the decades ahead. RES-C technologies could contribute to the EU renewable energy target if an appropriate political framework for a further spread of the technologies was created. Moreover, from interviewing stakeholders and examining the progress reports, it is evident that many Member States' regulations do not sufficiently address RES-C, although a large variety of RES-C technologies are ready for the market.

So far there is no generally accepted definition for renewable cooling. Furthermore, statistics on cooling need to be improved, since actual numbers on cooling are often hidden in the statistics for electricity consumption. Options for improving the framework conditions for RES-C include (see [94]):

- Strengthening renewable cooling as a technology for the RED
- Setting up a definition for RES-C
- Developing a methodology for including renewable cooling in energy statistics
- Developing and introducing routines to monitor RES-C generation from different technologies.

2.3.3.8. Streamlining permitting procedures for large scale RES-HC plants

Stakeholders from some Member States reported lengthy permitting procedures for RES-HC installations, which mainly applied to large biomass (incl. biogas) and geothermal plants. The problem can occur due to, for example, complex and partly unclear regulation, diverging regulations at the sub-national level, or insufficient expertise by public authorities dealing with the applications. In order to streamline the permitting procedure similar recommendations apply as for RES-E (see Chapters 2.3.2.2 and 2.3.2.3). This includes, for instance, the implementation of one-stop-shops, the introduction of time limits, supporting permitting authorities with best practice guidelines, etc.

2.3.3.9. Mandatory heat (and cold) planning for both newly developed areas and areas with an existing building stock

Mandatory heat (and cold) planning would make sure that heat/cold is being used more efficiently within the concerned area. In their planning or building regulations and codes Member States shall introduce measures ensuring that municipal heat and cold plans are developed for areas that are to be developed as well as – where appropriate – areas with an existing building stock. The plans shall assess the total heating and cooling demand of the concerned area, taking into account possible changes in demand over time due to, for instance, increased cooling demand in the summer months or reduced heating demand due to more building renovations in the future. Heat and cold plans shall include a district heating/cooling option as well as a strategy for a nearly zero-energy system by 2050. In accordance with Directive 2010/31/EU, the nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby. The plans should be developed by the municipality concerned, but with the participation of urban planners, DH/C grid operator(s) and supplier(s) as well as consumers.

2.3.3.10. Improved reporting on RES-HC barriers

The recommendation is to adapt Art. 22(1e) so that Member States are explicitly asked to report on barriers to RES-HC deployment. Currently, hardly any of the progress reports feature any information on RES-HC deployment barriers, especially non-economic ones. The reporting obligation in Art. 22(1e) is predominantly used by the Member States for reporting about barriers to RES-E deployment, even though no particular RES sector is mentioned. As our study shows, non-economic barriers to RES-HC technology deployment do play a role, which is contrary to what might be assumed after reading many of the progress reports.

2.3.4. Detailed recommendations for RES-T

The main barriers for the non-deployment of renewable energies in transport are economic and related to the costs for renewable technologies. Thus, the policy framework is the main means of creating a market for renewable fuels in transport. The main non-economic barriers for additional deployment of renewable energy sources in transport are therefore past changes to the regulatory framework as well as the lack of a long-term policy framework beyond 2020. Therefore, the focus for increasing renewable deployment in transport should be on establishing a consistent and stable framework for future development. Other non-economic barriers have been addressed in the ILUC Directive, which has to be implemented in national legislation by September 2017.

2.3.4.1. Establishing a stable long-term framework for transport beyond 2020

Generally, the interviewed stakeholders consider the RED and a potential subsequent regulation as one part of a broader transport and also biomass strategy of the EU. Thus, any subsequent regulation beyond 2020 should be a part of a consistent set of directives and regulations with regard to the transport sector which should address options other than a fuel switch as well (e.g. modal shift, energy efficiency in transport).

Establishing a target specific to the transport sector

GHG abatement costs are higher in transport than in other sectors. Thus, a cross-sectoral target of GHG reduction or renewable share beyond 2020 would have little impact on additional deployment of renewable energy technologies in the transport sector. A target specific to the transport sector therefore needs to be established for 2030 in order to create a larger market for low carbon and renewable energy technologies in transport (e.g. electric vehicles, low GHG fuels). An intermediate target for 2025 would incentivise early action and prepone investment in new technologies.

Renewable share target vs. GHG intensity target

Currently, two directives are related to the content of the fuel mix in the transport sector. The FQD requires fuel suppliers to reduce the GHG intensity of the fuel; the RED is directed at the Member States and has a renewable fuel share target. Theoretically, the RED could switch to a GHG intensity based system.

A GHG intensity target is theoretically more suitable than a renewable energy share target for the transport sector to ensure an absolute GHG emission reduction. Compared to an overall renewable share target, a GHG intensity target incentivises the use of feedstock and technologies with lower GHG emissions. However, the complexity and uncertainty of the GHG and sustainability impact of different fuel options (e.g. ILUC effect of crop-based biofuels and emissions of additional electricity demand from electric vehicles[48], changes in life-cycle emissions of fossil fuels) complicate the reporting, verification and monitoring of a GHG target in the transport sector.

Thus, a renewable energy share target might be the more suitable option for creating a stable framework for investors in renewable energy technologies in transport. On the other hand, certain renewable technologies (e.g. crop-based biofuels) have a poor life-cycle emission balance and should not be considered sustainable when taking all effects (e.g. ILUC) into account. This approach would promote renewable technologies, regardless of their contribution to reducing GHG intensity and other sustainability criteria. Therefore, the fuel types of questionable sustainability impact should be limited or not be counted towards the renewable share target (see the current limitation of 7% for food-based biofuels).

A clear picture of stakeholder opinions could not be drawn. There were different views as to whether a GHG intensity based system or a renewable share based system is more appropriate for a future system.

Integration of sub-targets and incentives for advanced technologies

An overall renewable share/GHG intensity target in transport without technology-specific sub-targets would favour technologies which have low costs in the short-term perspective (e.g. crop-

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[48] There are different options for calculating GHG emissions (marginal vs. average approach) and for defining the balancing scope.

based biofuels, established advanced biofuels). These technologies are often close to market entry or already in the market, which contributes to an additional cost advantage compared to technologies for which further investments are needed to enter the market. However, these technologies have been either limited through the ILUC Directive and will not be sufficient for achieving the transport system required for overall EU mid-term targets (2030) and the long-term targets (2050) [95][49]. Other low GHG technologies and changes, e.g. in the modal shift are required.

A national sub-target for advanced biofuels is requested through the ILUC Directive; multiplier factors for the use of renewable electricity in road transport electric vehicles have been increased and new multiplier factors for the use of renewable electricity in rail transport have been added to the RED in September 2015. This approach is directed at promoting technologies with currently higher costs (e.g. electric vehicles, advanced biofuels) in order to facilitate their market uptake, as these technologies will be crucial for achieving future cross-sectoral GHG targets. This implies production on a larger scale and might result in further technological developments, both of which would contribute to decreasing production costs.

The stakeholders' opinion was split between the two options. Stakeholders from countries with a strategy on crop-based biofuels (e.g. Slovakia, Lithuania) often tended to reject sub-targets for new technologies; understandably, the opinion has been reversed with stakeholders from countries with a different strategy (e.g. the UK, Germany).

A transport-specific overall GHG intensity target / renewable share target in combination with binding sub-targets for advanced biofuels seems appropriate to foster the deployment of these technologies.

Adding flexibility to the targets

The analysis shows that there seem to be different strategies towards achieving the 10% renewable target and different preconditions (e.g. vehicle stock age, share of new registrations of vehicles, economic and feedstock resources) in EU Member States. The differences between the Member State strategies will probably increase with higher renewable targets.

The ILUC Directive added flexibility with a reference value for the national sub-targets of advanced biofuels which can be lowered due to adverse preconditions or due to national strategies with a focus on other low GHG solutions. This flexibility seems to be appropriate for the differences between EU Member States and should be continued. Additional flexibility towards the overall national targets for transport (e. g. one EU-wide target which is supplemented with differing and mutually agreed on national targets) could reflect the differences between the Member States.

2.3.4.2. Fuel standards for higher biofuel blends at EU-level

EU-wide standards for high biofuel blends seem necessary if higher renewable share targets are to be set beyond 2020. Early implementation would create investment security for car manufacturers and biofuel producers/suppliers. It could help to overcome the blending wall barriers which have been reported from the US market. Additionally, consumer acceptance for high biofuel blends could be increased with early implementation of high biofuel blend specifications and warranties for high biofuel usage from car industry.

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[49] E.g. 80% of passenger road transport activities are electric driven.

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97. EPIA (2016) Global Market Outlook For Solar Power 2016-2020, Brussels
98. Oehsen et al. (2014) PV-Eigenstrom für Wärmepumpen- und Haushaltsstrombedarf in Wohngebäuden (100 % Wärme aus erneuerbaren Energien? Auf dem Weg zum Niedrigstenergiehaus im Gebäudebestand)

3. Annex

3.1. EU-28 deployment of renewable energy per sector / technology

Table 3-1: EU-28 renewable energy deployment 2015 vs. planned NREAP trajectory 2015

	Approximated deployment 2015	**Aggregated, anticipated NREAP trajectory 2015**	**Aggregated, anticipated NREAP 2020 trajectory**
Technology	**Mtoe**	**Mtoe**	**Mtoe**
RES electricity	79.2	76.9	103.2
Biomass (solid)	7.7	9.8	13.4
Biomass (liquid)	0.5	0.9	1.1
Biogas	5.1	3.8	5.5
Geothermal	0.5	0.6	0.9
Hydro small scale (<= 10 MW)	4.1	4.2	4.6
Hydro large scale (> 10 MW)	25.8	25.8	26.6
Solar photovoltaics	8.7	4.4	7.1
Concentrated solar power	0.5	0.8	1.6
Wind onshore	20.8	22.0	30.2
Wind offshore	3.8	4.3	11.7
Marine / Ocean	0.0	0.1	0.6
All other renewables	1.8	*0.1*	*-0.1*
RES heating & cooling	91.8	85.1	111.8
Biomass (solid)	72.5	66.4	80.9
Biomass (liquid)	0.3	4.1	4.4
Biogas	3.2	2.8	4.5
Geothermal	0.7	1.4	2.6
Heat pumps	9.7	7.3	12.3
Solar thermal	2.0	3.0	6.5
All other renewables	3.4	*0.2*	*0.6*
RES transport	14.8	21.3	31.8
Bioethanol / bio ETBE	2.6	5.0	7.3
Biodiesel	10.9	14.4	21.0
Compliant biofuels	13.1	0.1	N/A
Hydrogen and synthetic fuels	0.0	0.0	0.0
Renewable electricity	1.7	2.0	3.2
Others (incl. biogas)	0.1	0.5	1.3

RES total	184.1	183.4	246.8

Source: 2015 values approximated by EEA (date: 04/10/2016). Aggregation from Table 4a, 10, 11, 12 of Member States NREAPs based on [8] and [4].

Note: The values reported correspond to the gross final energy consumption of the given technology in the given sector as reported in the detailed SHARES 2014 data set (Eurostat 2016d) per Member, but approximated for 2015 by EEA (date 04/10/2016).
The values reported do not include the specific accounting rules of Articles 3(4) and 21(2) in the transport sector which are applied when calculating RES-T shares according to the RES Directive. The values thus inform on actual deployment. Compliant biofuels are a subset of Bioethanol /bio ETBE and biodiesel. The sum reported for RES electricity includes electricity provided to the transport sector. The sum for RES transport in 2015 only considers compliant biofuels. The aggregated, planned NREAP trajectory category “all other renewables” captures the difference between the aggregated planned NREAP trajectory calculated via Table 4a (which informs on anticipated sector deployment) versus a bottom-up aggregation of the given technology detail taken from Table 10-12. Therefor the estimated 2015 deployment should not be compared to this value. The aggregated, planned NREAP trajectory for “Others (incl. biogas)” includes what Member States report in Table 11 of their NREAPs plus the above mentioned difference (0.19 ktoe in 2015; 0.52 ktoe in 2020).

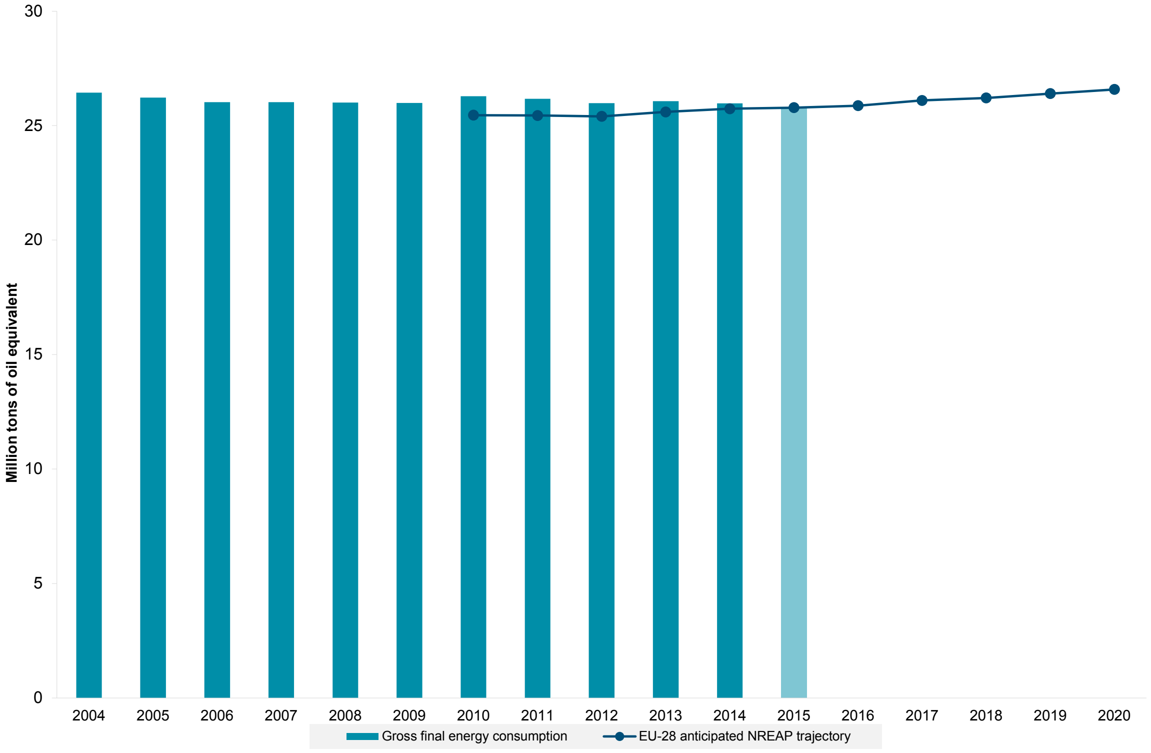
Table 3-2: EU-28 renewable energy deployment by source 2004-2015 (Mtoe)

Technology	**Unit**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
RES electricity	Mtoe	**40.2**	**42.3**	**44.2**	**46.6**	**49.4**	**52.4**	**56.5**	**61.2**	**66.5**	**71.0**	**75.0**	**79.2**
Biomass (solid)	Mtoe	3.1	3.7	4.1	4.3	4.8	5.2	6.0	6.3	6.8	6.9	7.3	7.7
Biomass (liquid)	Mtoe	0.0	0.2	0.3	0.1	0.2	0.3	0.4	0.3	0.3	0.3	0.4	0.5
Biogas	Mtoe	1.0	1.1	1.3	1.8	2.1	2.4	2.7	3.3	4.0	4.6	5.0	5.1
Geothermal	Mtoe	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Hydro small scale (<= 10 MW)	Mtoe	3.2	3.5	3.5	3.6	3.6	3.8	3.8	3.8	3.9	4.0	4.0	4.1
Hydro large scale (> 10 MW)	Mtoe	26.4	26.2	26.0	26.0	26.0	26.0	26.3	26.2	26.0	26.1	26.0	25.8
Solar photovoltaics	Mtoe	0.1	0.1	0.2	0.3	0.6	1.2	1.9	3.9	5.8	7.0	7.9	8.7
Concentrated solar power	Mtoe	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.3	0.4	0.5	0.5
Wind onshore	Mtoe	4.9	5.9	7.1	8.6	10.1	11.4	12.8	14.5	16.2	18.1	19.8	20.8
Wind offshore	Mtoe	0.0	0.0	0.0	0.0	0.0	0.4	0.5	0.7	1.1	1.5	1.9	3.8
Marine / Ocean	Mtoe	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
All other renewables (renewable waste)	Mtoe	0.9	1.0	1.1	1.3	1.3	1.3	1.5	1.6	1.6	1.6	1.7	1.8
RES heating & cooling	Mtoe	**61.0**	**64.5**	**66.8**	**71.4**	**74.9**	**77.9**	**84.4**	**80.2**	**86.0**	**89.2**	**87.5**	**91.8**
Biomass (solid)	Mtoe	55.4	58.0	59.4	62.4	65.2	66.8	72.2	66.7	71.6	73.5	70.3	72.5
Biomass (liquid)	Mtoe	0.1	0.2	0.3	0.4	0.5	0.6	0.6	0.2	0.3	0.2	0.3	0.3
Biogas	Mtoe	0.7	0.7	0.8	1.0	1.0	1.2	1.5	2.1	2.2	2.6	2.9	3.2
Geothermal	Mtoe	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7
Heat pumps	Mtoe	1.8	2.3	2.9	3.5	4.2	5.0	5.5	6.3	6.9	7.4	8.2	9.7
Solar thermal	Mtoe	0.6	0.7	0.8	1.0	1.1	1.3	1.5	1.6	1.7	1.8	1.9	2.0
All other renewables (renewable waste)	Mtoe	2.0	2.0	2.1	2.5	2.2	2.3	2.4	2.6	2.8	3.1	3.2	3.4
RES transport	Mtoe	**2.3**	**3.2**	**4.2**	**6.4**	**9.6**	**12.2**	**13.7**	**9.9**	**12.9**	**13.5**	**14.7**	**14.8**
Bioethanol / bio ETBE	Mtoe	0.3	0.5	0.8	1.2	1.8	2.3	2.8	2.8	2.8	2.7	2.6	2.6
Biodiesel	Mtoe	0.9	1.6	2.3	4.2	6.7	8.8	9.7	10.3	11.2	10.1	11.1	10.9
Compliant biofuels	Mtoe	1.2	2.1	3.1	5.3	8.5	11.1	12.5	8.5	11.6	12.0	13.1	13.1
Hydrogen and synthetic fuels	Mtoe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Renewable electricity	Mtoe	1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.3	1.3	1.49	1.55	1.73
Others (incl. biogas)	Mtoe	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1
RES total	**Mtoe**	**102.4**	**108.9**	**114.2**	**123.3**	**132.7**	**141.4**	**153.4**	**149.9**	**164.2**	**172.2**	**175.6**	**184.1**

Source: Aggregated from [2]; EEA RES proxy (2015). Wind on- and offshore distinction 2009-2014 based on Member States Progress Reports. Wind onshore 2015 = wind total (SHARES 2014) - wind offshore. Please note: the data reported here reflects a bottom-up aggregation of detailed SHARES 2014 data. It does not consider the use of multipliers in the transport sector. The distinction of hydro into large- and small scale has been accomplished based on the detailed SHARES 2014 datasets from individual Member States. The RES total sum is calculated without double counting renewable electricity and does thus not correspond to adding up the sectoral sums. In period 2004-2010 all consumed biofuels are included in this category; as of 2011 only those compliant with Articles 17 and 18 of Directive 2009/28/EC.

3.1.1. Renewable energy deployment per technology in electricity

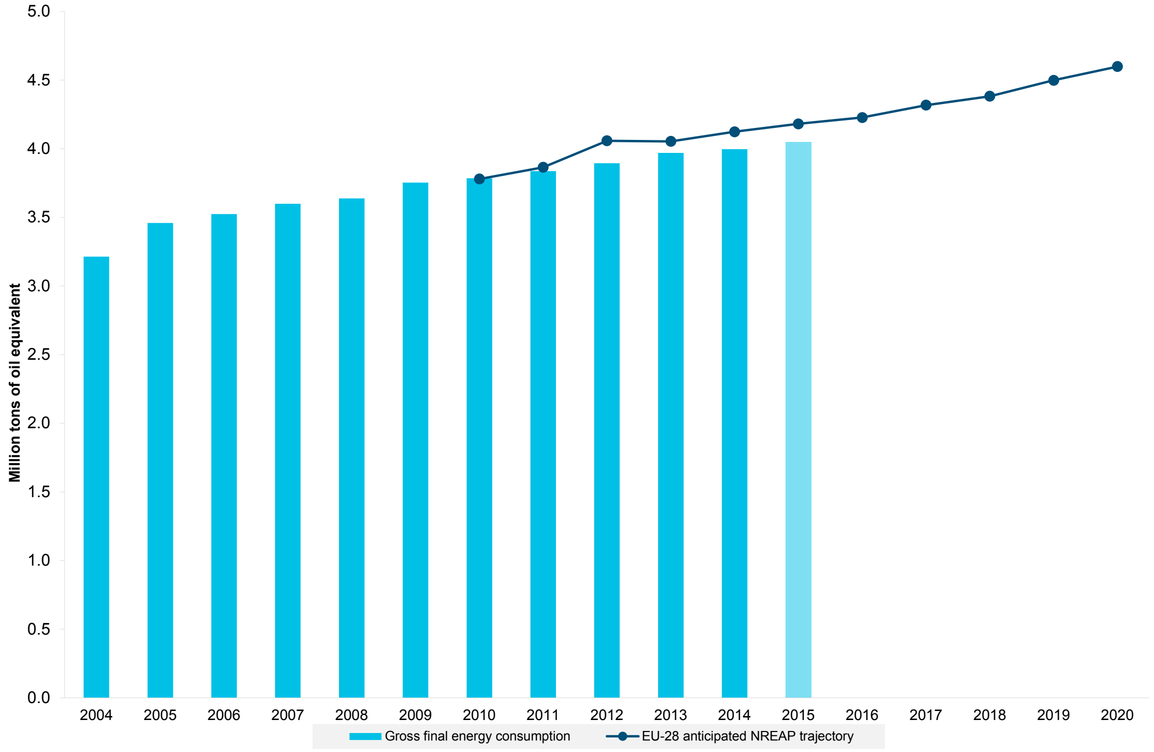
Figure 3-1: EU-28 gross final energy consumption from hydro (> 10 MW) vs. planned NREAP trajectory in electricity



Source: [2, 9]; aggregation of Table 10 from Member States NREAPs based on [8] and [4].

Note: 2015 values approximated by EEA (date: 04/10/2016)

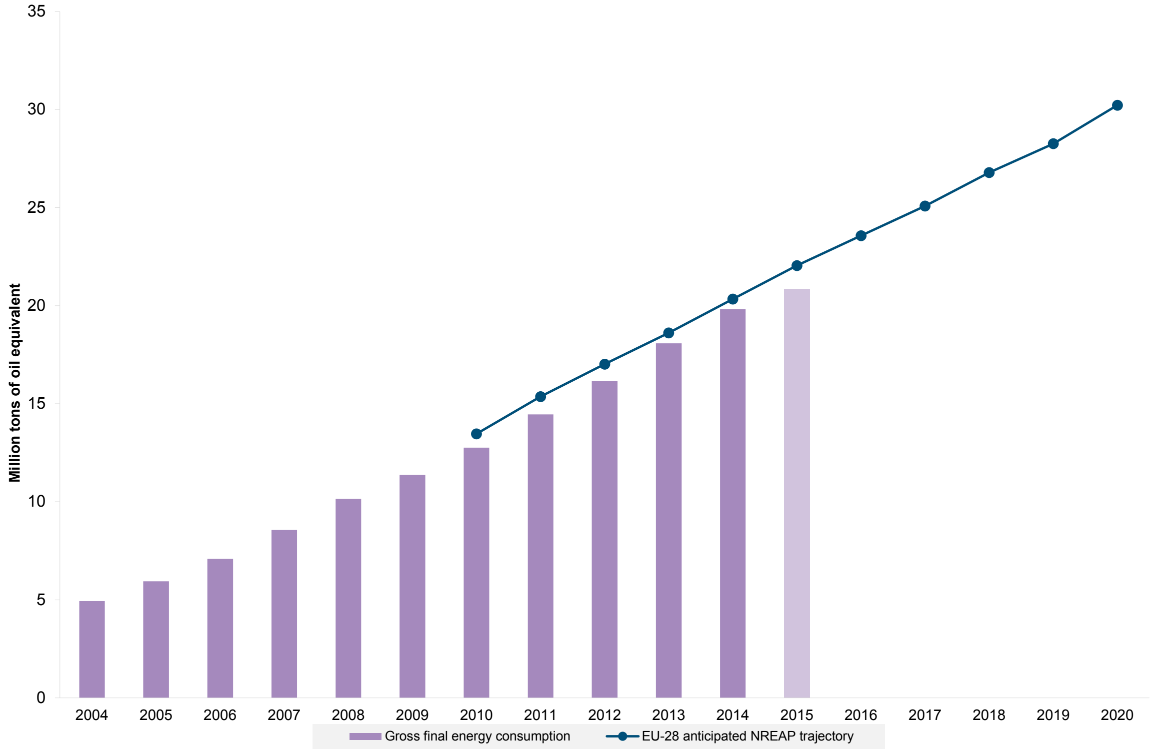
Figure 3-2: EU-28 gross final energy consumption from hydro (1- 10 MW) vs. planned NREAP trajectory in electricity



Source: [2, 9]; aggregation of Table 10 from Member States NREAPs based on [8] and [4]

Note: 2015 values approximated by EEA (date: 04/10/2016)

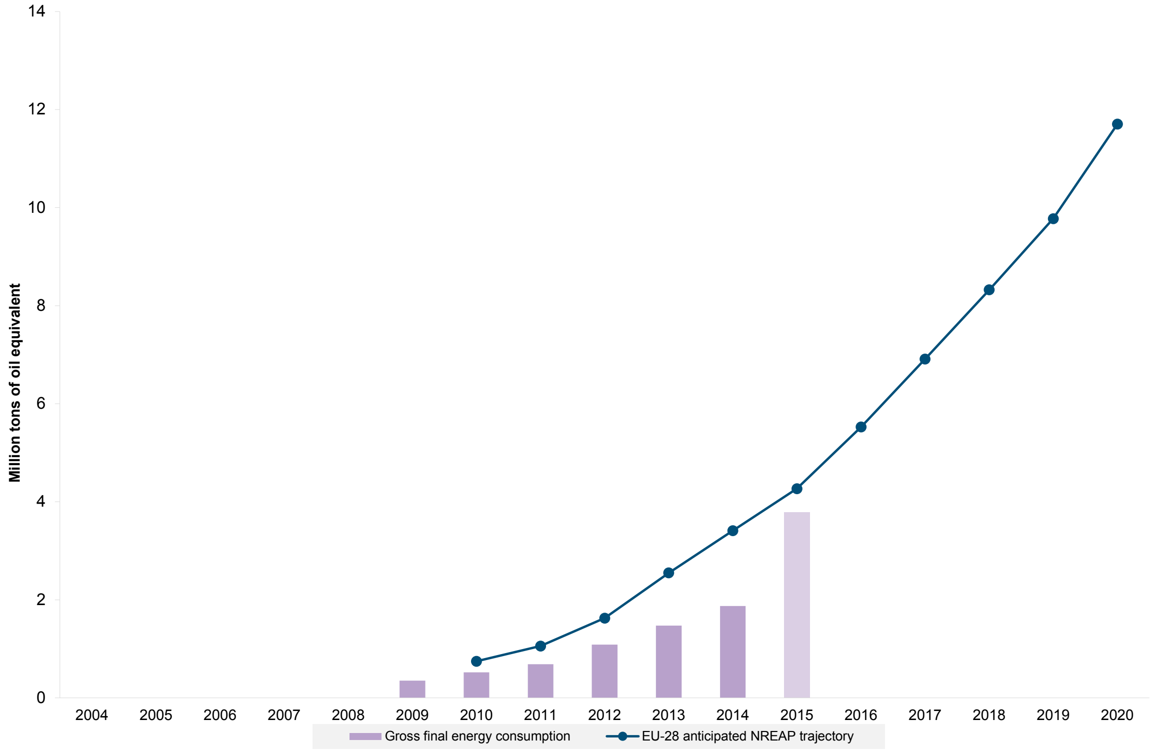
Figure 3-3: EU-28 gross final energy consumption from onshore wind vs. planned NREAP trajectory in electricity



Source: [2, 9]; aggregation of Table 10 from Member States based on [8] and [4]

Note: 2015 values derived from approximations by EEA (date: 04/10/2016)

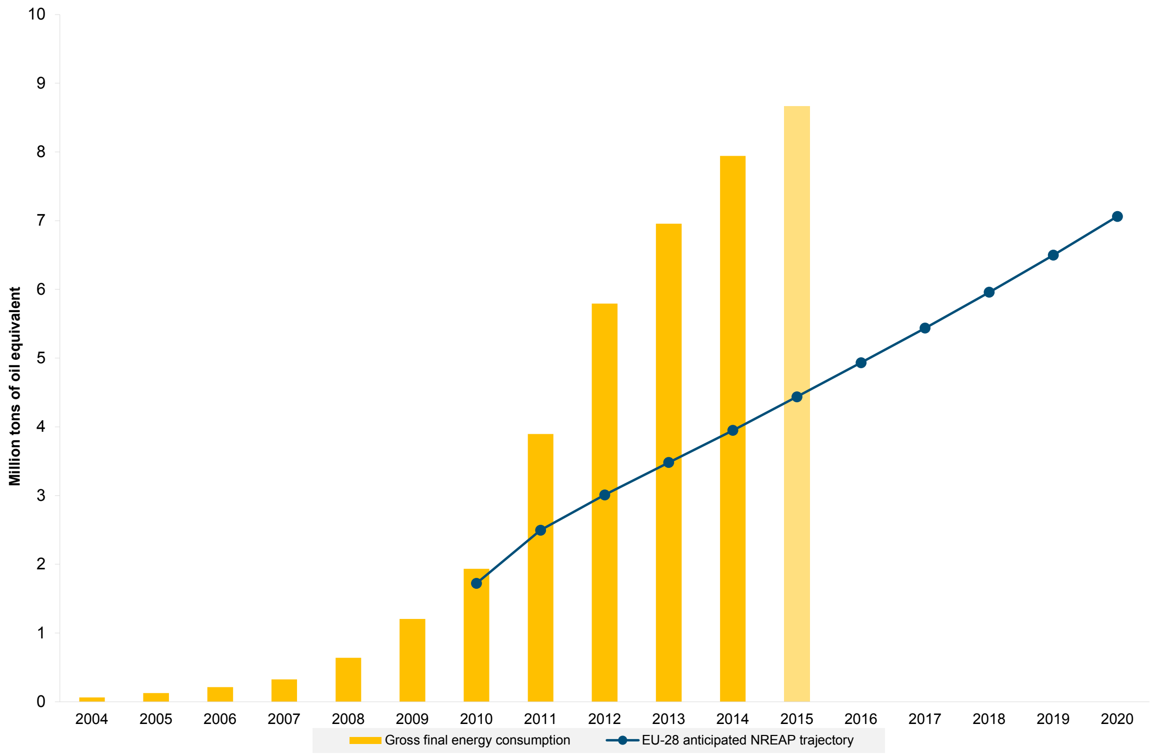
Figure 3-4: EU-28 renewable gross final energy consumption from offshore wind vs. planned NREAP trajectory in electricity



Source: [2, 9]; aggregation of Table 10 from Member States NREAPs based on [8] and [4]

Note: 2015 values derived from approximations by EEA (date: 04/10/2016)

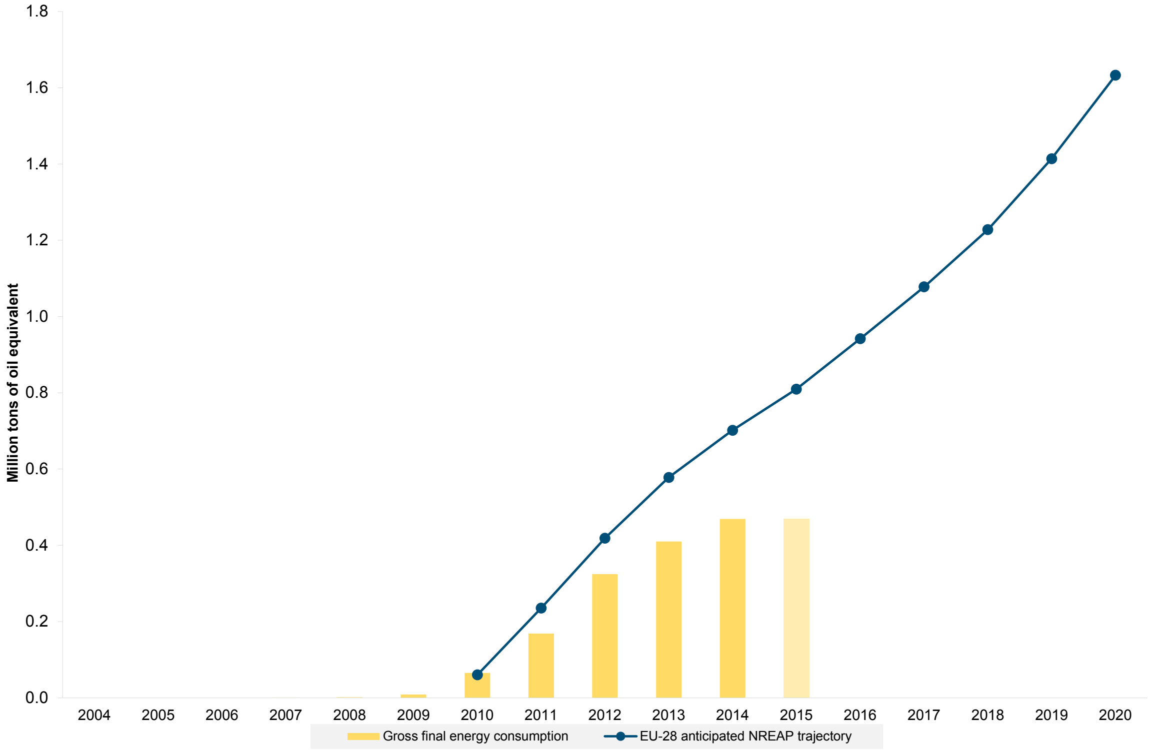
Figure 3-5: **EU-28 renewable gross final energy consumption from solar PV vs. planned NREAP trajectory in electricity**



Source: [2, 9]; aggregation of Table 10 from Member States NREAPs based on [8] and [4]

Note: 2015 values approximated by EEA (date: 04/10/2016)

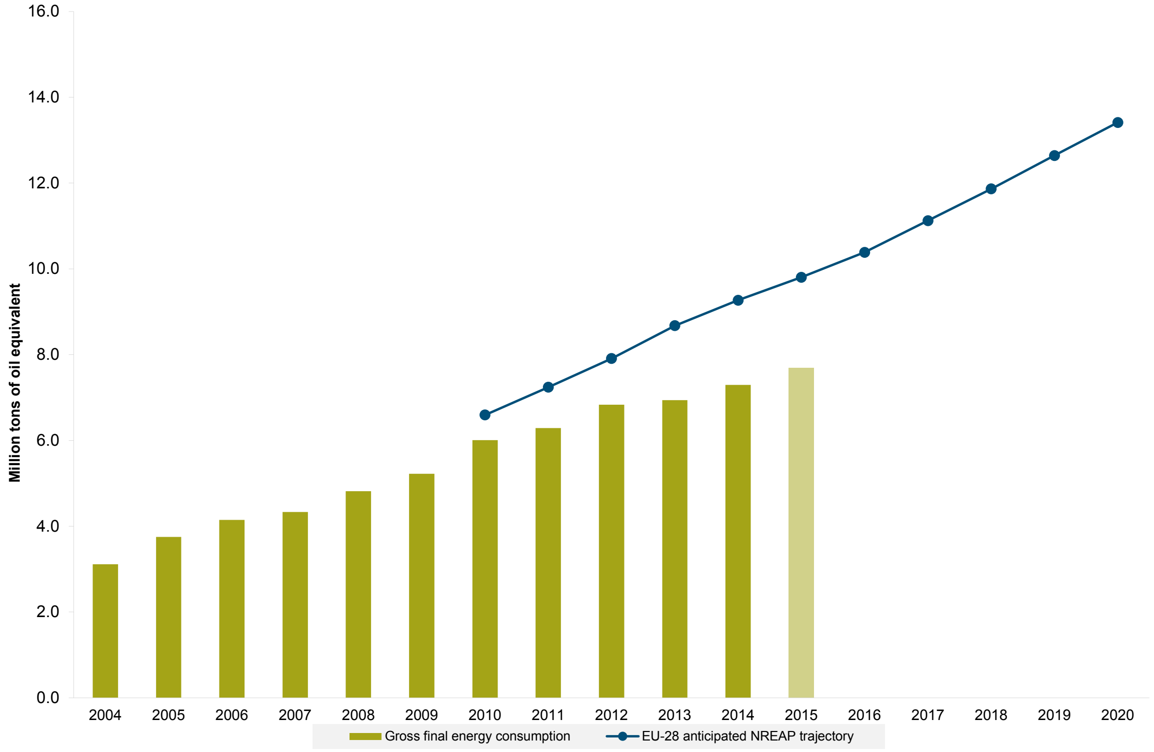
Figure 3-6: **EU-28 renewable gross final energy consumption from solar CSP vs. planned NREAP trajectory in electricity**



Source: [2, 9]; aggregation of Table 10 from Member States NREAPs based on [8] and [4]

Note: 2015 values approximated by EEA (date: 04/10/2016)

Figure 3-7: EU-28 renewable gross final energy consumption from solid biomass vs. planned NREAP trajectory in electricity

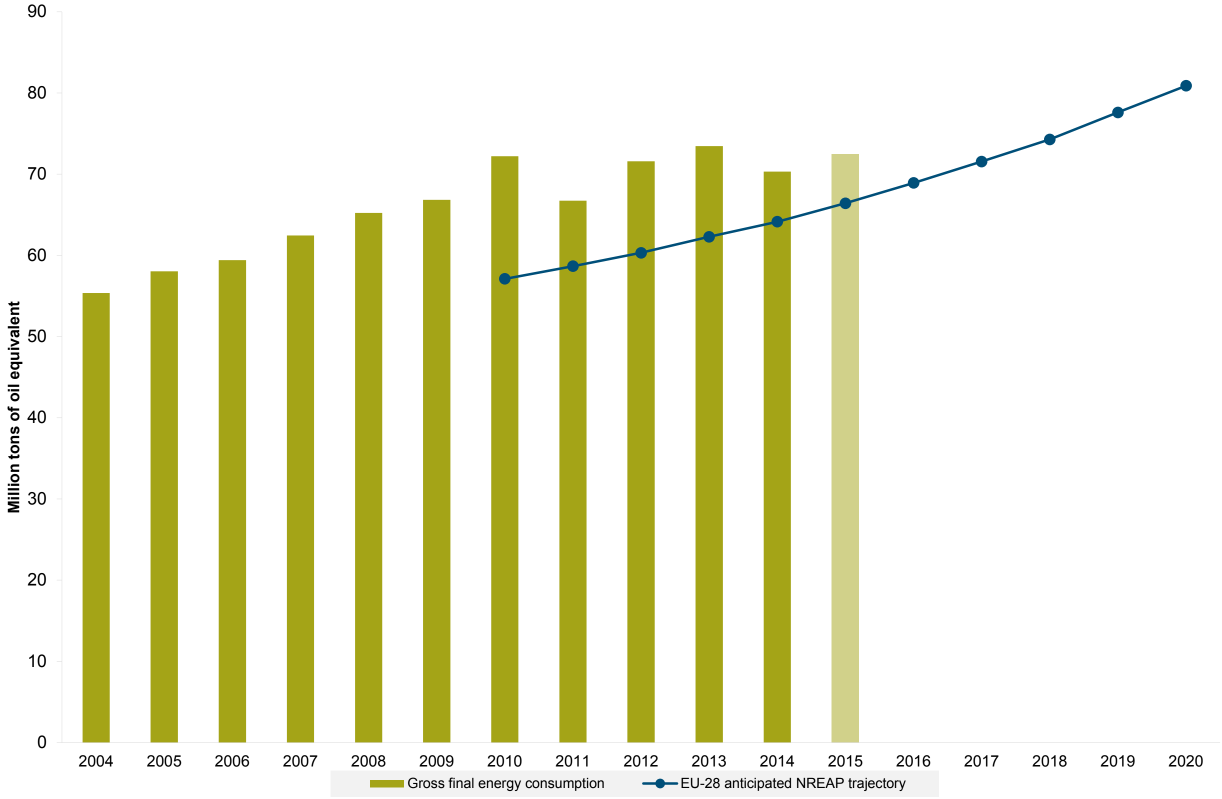


Source: [2, 9]; aggregation of Table 10 from Member States NREAPs based on [8] and [4]

Note: 2015 values approximated by EEA (date: 04/10/2016)

3.1.2. Renewable energy deployment per technology in heating & cooling

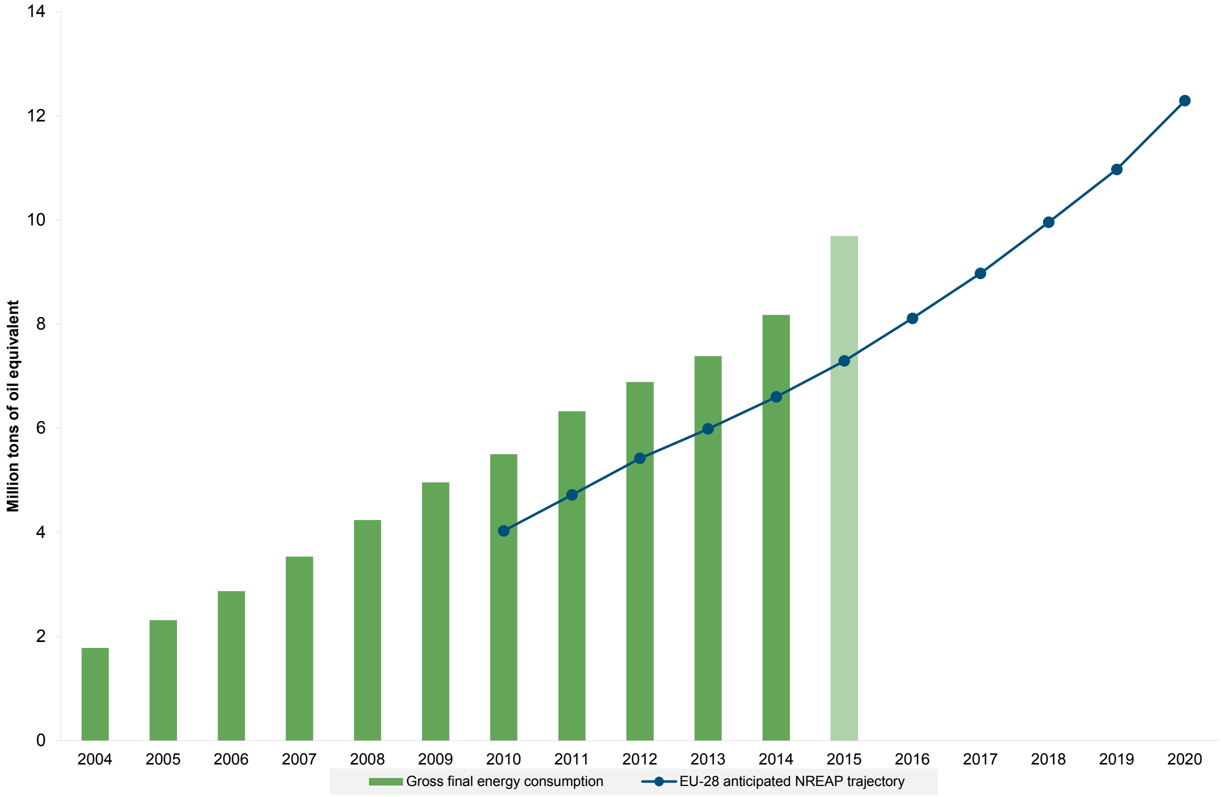
Figure 3-8: EU-28 renewable gross final energy consumption from solid biomass vs. planned NREAP trajectory in heating & cooling



Source: [2, 9]; aggregation of Table 11 from Member States NREAPs based on [8] and [4]

Note: 2015 values approximated by EEA (date: 04/10/2016)

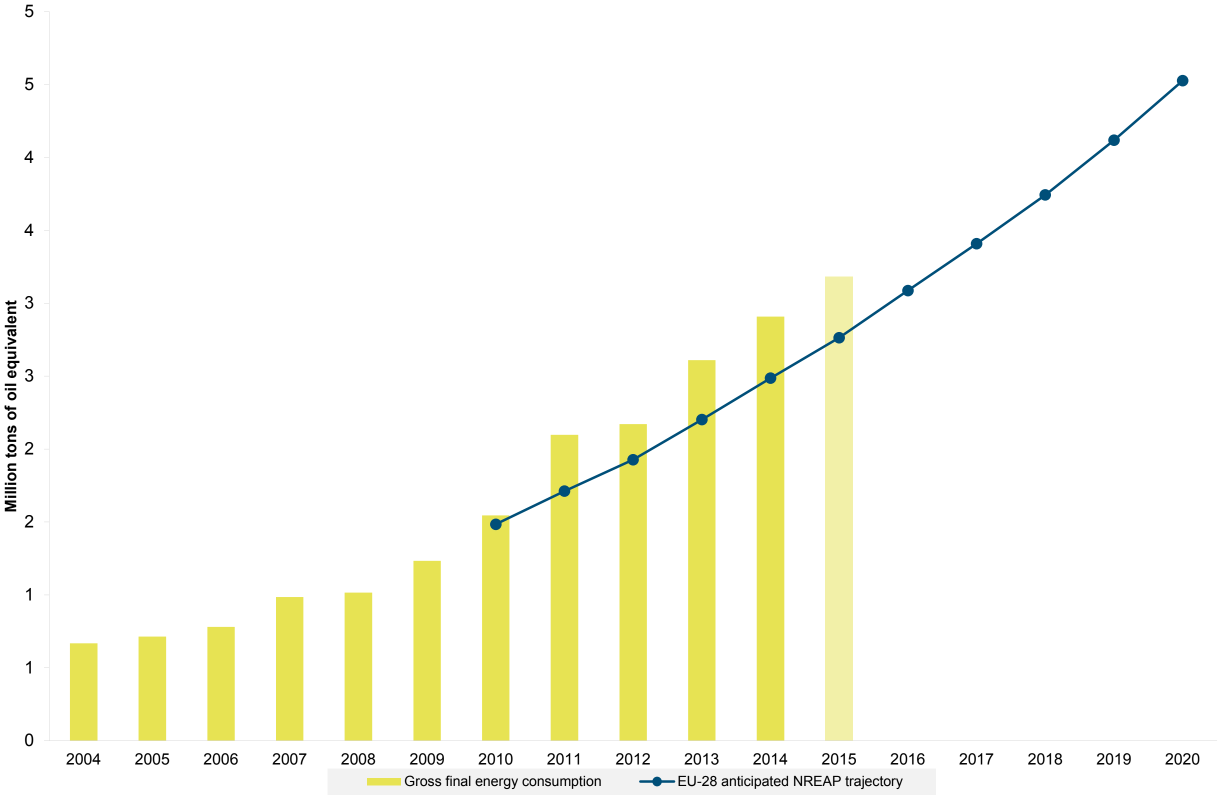
Figure 3-9: **EU-28 renewable gross final energy consumption from heat pumps vs. planned NREAP trajectory in heating & cooling**



Source: [2, 9]; aggregation of Table 11 from Member States NREAPs based on [8] and [4]

Note: 2015 values approximated by EEA (date: 04/10/2016)

Figure 3-10: **EU-28 renewable gross final energy consumption from biogas vs. planned NREAP trajectory in heating & cooling**

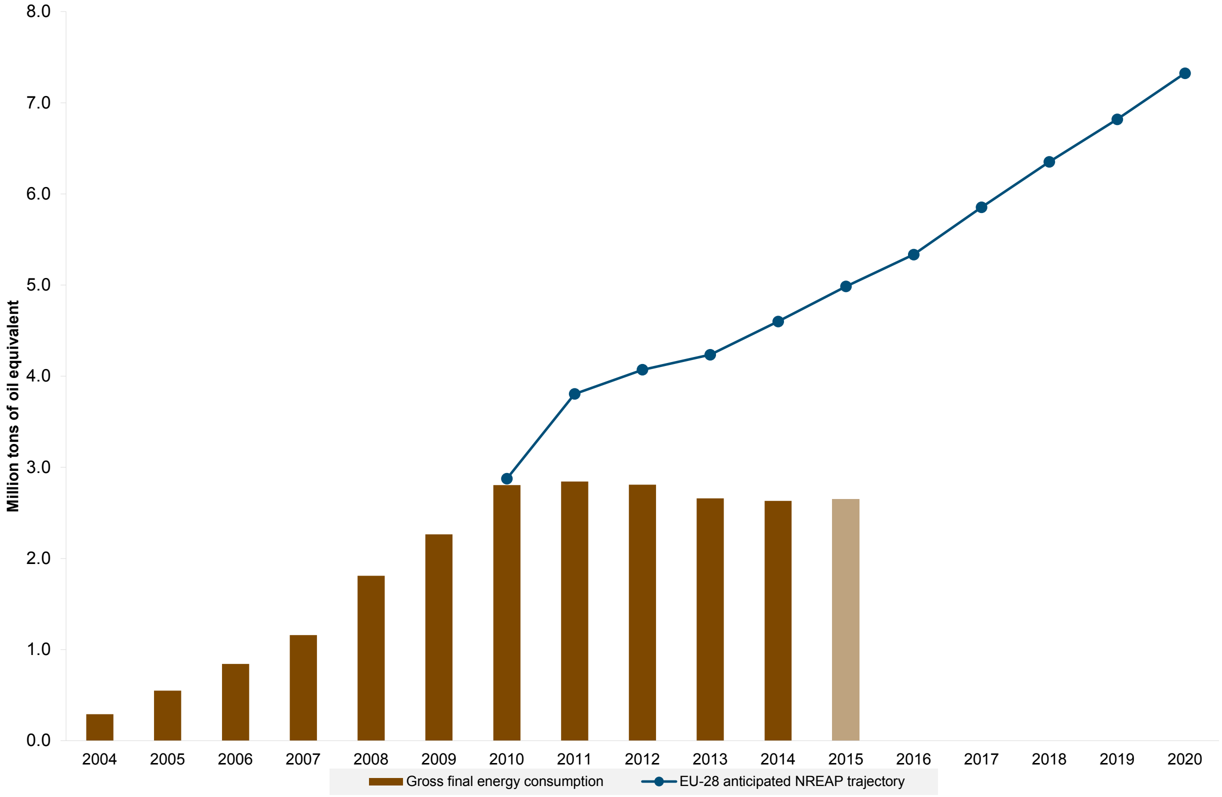


Source: [2, 9]; aggregation of Table 11 from Member States NREAPs based on [8] and [4]

Note: 2015 values approximated by EEA (date: 04/10/2016)

3.1.3. Renewable energy deployment per technology in transport

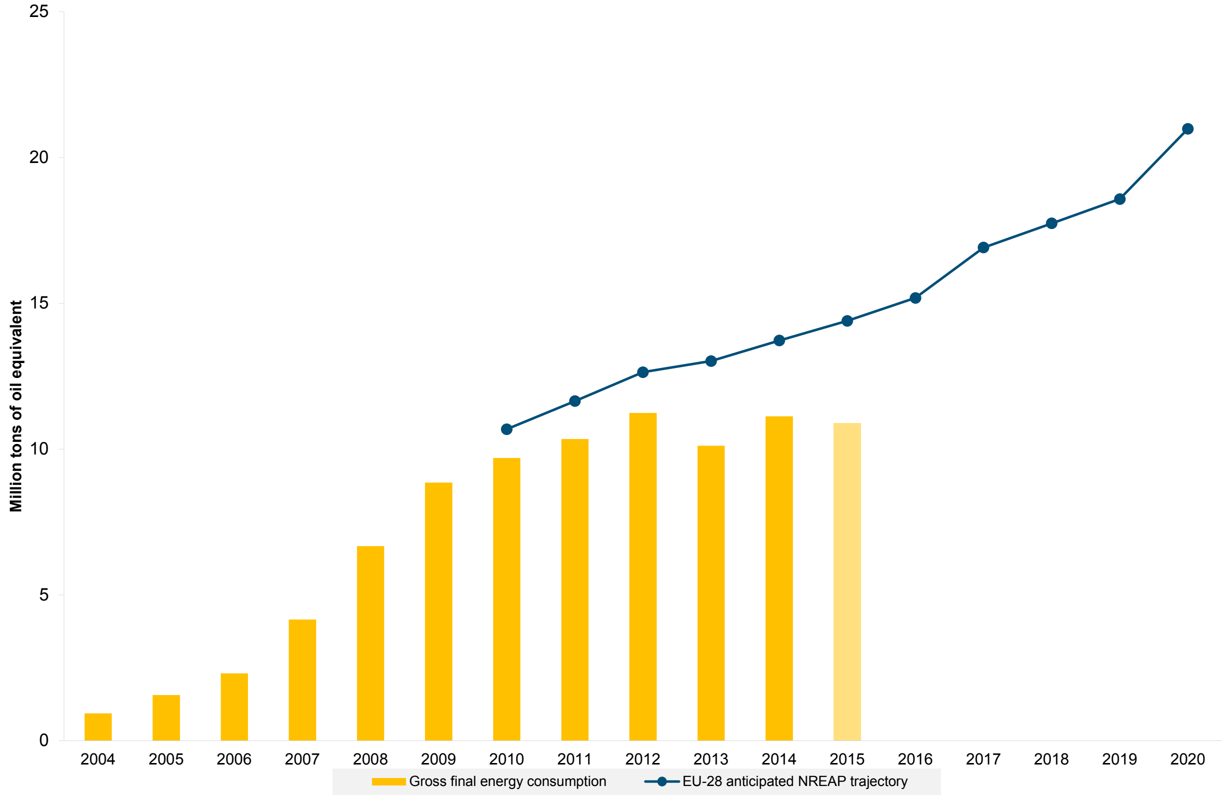
Figure 3-11: **EU-28 renewable gross final energy consumption from bioethanol / ETBE vs. planned NREAP trajectory in transport**



Source: [2, 9]; aggregation of Table 12 from Member States NREAPs based on [8] and [4]

Note: 2015 values approximated by EEA (date: 04/10/2016). Data displayed here do not include the multipliers as laid out in Article 21(2) of the RED: *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.*

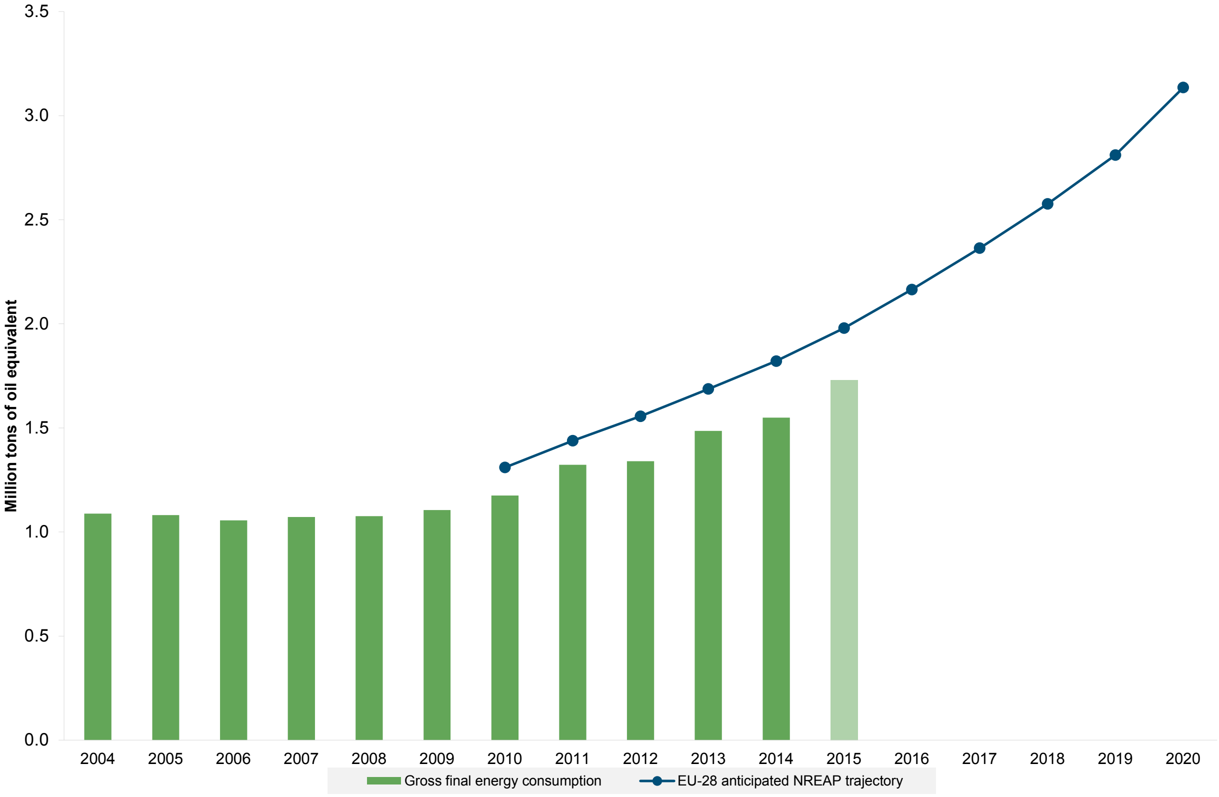
Figure 3-12: EU-28 renewable gross final energy consumption from biodiesel vs. planned NREAP trajectory in transport



Source: [2, 9]; aggregation of Table 12 from Member States NREAPs based on [8] and [4]

Note: 2015 values approximated by EEA (date: 04/10/2016). Data displayed here do not include the multipliers as laid out in Article 21(2) of the RED: *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.*

Figure 3-13: EU-28 renewable gross final energy consumption from renewable electricity vs. planned NREAP trajectory in transport



Source: [2, 9]; aggregation of Table 12 from Member States NREAPs based on [8] and [4]

Note: 2015 values approximated by EEA (date: 04/10/2016)

3.2. Value of displaced fossil fuels and imports vs 2005

Table 3-3: Annually avoided fossil fuel imports and consumption in the EU-28 through the growth of RES between 2005 and 2014/2015/2020/

Avoided imports (vs. 2005)	**Unit**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015***	***2020***
solid	Mtoe	5	7	10	15	20	23	26	*44*
liquid	Mtoe	11	15	9	15	16	18	19	*33*
gaseous	Mtoe	10	16	15	20	24	23	26	*59*
solid	bn. EUR	0.6	1.1	1.8	2.3	2.4	2.4	2.7	*5.8*
liquid	bn. EUR	3.5	6.2	5.1	9.3	9.6	9.5	6.4	*17.3*
gaseous	bn. EUR	2.6	4.1	5.0	6.5	7.4	6.3	6.7	*18.6*

Displaced fossil fuels (vs. 2005)	**Unit**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015***	***2020***
solid	Mtoe	11	15	20	29	35	40	46	*76*
liquid	Mtoe	13	17	11	17	19	21	22	*38*
gaseous	Mtoe	14	21	20	26	30	30	34	*81*
solid	bn. EUR	1.4	2.2	3.6	4.6	4.3	4.4	4.9	*10.1*
liquid	bn. EUR	4.1	7.1	6.2	10.8	11.0	10.9	7.3	*19.8*
gaseous	bn. EUR	3.6	5.4	6.6	8.3	9.2	8.1	8.9	*25.6*

Source: Authors' own calculations based on [2, 5, 13–16]

* Numbers for 2015 based on approximated RES consumption; no official data available.

3.3. Contribution of the building sector in exporting renewable energy generated on buildings (as defined in article 13.4. of the Renewables Directive) to the energy sector (EU-28)

Table 3-4: EU 28 renewable energy generation on/in buildings.

Renewable energy production on/in buildings	**Unit**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2020**
Renewable energy production – heating/cooling: Estimated generation in/on buildings (total)	**Mtoe**	36.2	38.9	40.2	43.1	47.0	49.1	52.3	48.2	53.2	54.3	51.4	53.7	72.6
Renewable energy production – heating/cooling: Estimated generation in/on buildings (self-consumption)	**Mtoe**	36.2	38.9	40.2	43.1	47.0	49.1	52.3	48.2	53.2	54.3	51.4	53.7	72.6
Renewable energy production – heating/cooling: Estimated generation in/on buildings (grid-delivery)	**Mtoe**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Renewable energy production – electricity: Estimated generation in/on buildings (total)	**Mtoe**	0.0	0.1	0.2	0.2	0.4	0.6	1.1	2.4	4.0	4.7	5.3	5.7	8.7
Renewable energy production – electricity: Estimated generation in/on buildings (self-consumption)	**Mtoe**	0.0	0.0	0.1	0.1	0.1	0.2	0.4	0.8	1.3	1.6	1.8	1.9	3.1
Renewable energy production – electricity: Estimated generation in/on buildings (grid-delivery)	**Mtoe**	0.0	0.1	0.1	0.2	0.2	0.4	0.7	1.6	2.6	3.1	3.5	3.8	5.6

Sources: Authors' own calculations based on [2], [21], [22], [23–27], [28], [29], [30], [31], [32], [33], [34]

3.4. Methodologies Task 1

3.4.1. Modelling methodology

Projected 2020 progress in the deployment of renewable energy sources stems from the EU Reference Scenario 2016. The assumptions taken in this scenario have been consulted with Member States and the scenario is documented in detail in [5].

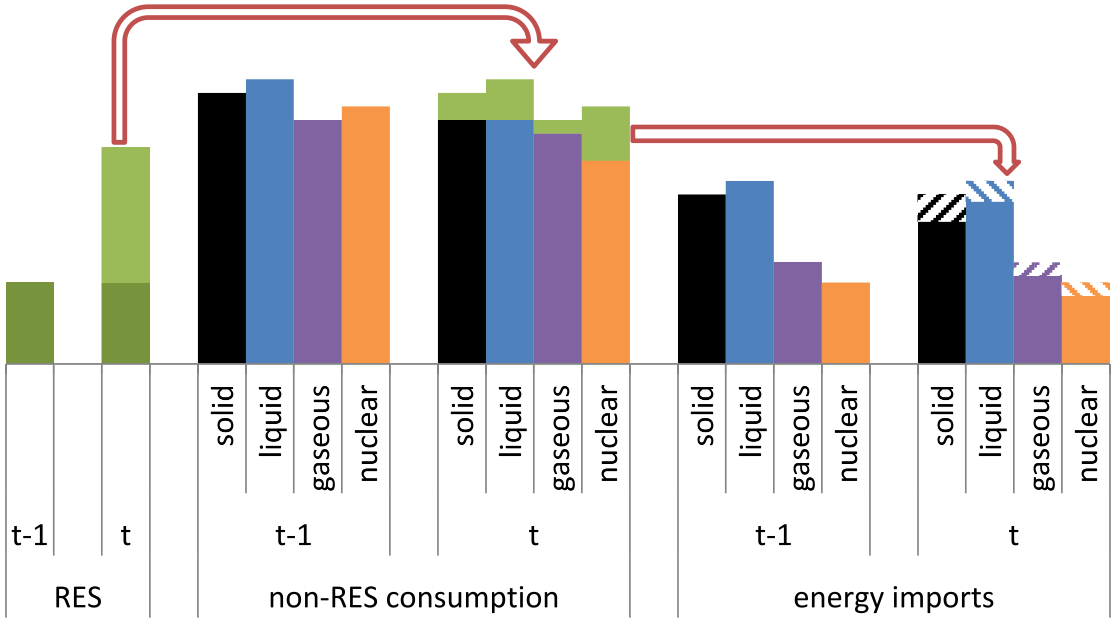
3.4.2. Estimation of avoided fossil fuel imports

According to section 2.1.5 of the study outline, the value of displaced imports of fossil fuels in each Member State is calculated in Task 1.1 for 2014 and 2015. The main assumption in this calculation is that the **growth in consumption of renewable energy (RES) between two years** (in this report, 2005 → 2014 and 2005 → 2015) **causes an equally-sized decline in consumption of fossil fuels, a part of which is imported**. Thus, Member States avoid spending a certain amount of funds on imported fossil fuels each year due to the increase in RES capacity and consumption. This figure can be used to assess the economic effects of renewable energy expansion.

To this end, the increase of a sector's gross consumption of renewable energy between two years is converted to **counterfactual amounts of fossil fuels that would have been imported in order to meet a sector's energy demand** if there had been no increase in RES consumption. This conversion is informed by analysing the specific fuel mix (solid, liquid, and gaseous fossil fuels) of the different sectors (electricity, heating and cooling, and transport) as well as fuel-specific import shares in each Member State based on the Eurostat energy balance [16]. These figures are combined with calculated effective fuel import costs from Eurostat trade statistics to arrive at an approximation of the costs which have been saved by displacing fossil fuel energy imports. A more detailed explanation of the process is illustrated below.

Figure 3-14 outlines the methodology.

Figure 3-14: Outline of estimation of avoided fossil fuel imports



Source: Authors' own representation

There are a few challenges to such a calculation, which can always only provide a rough estimate:

- energy balances do not report sector-specific consumption of renewables; rather, the mix of fuels which is displaced varies among sectors;

the ratio of final energy (FEC) to primary energy (PEC) consumption, and thus, physical imports, varies for different fuels;

nuclear energy does not count towards fossil fuels, meaning that the decrease in fossil fuel consumption can be smaller than the increase in renewable consumption;

actual energy demand, mainly in heating and cooling (H&C), can vary; heating and cooling demand is strongly linked to inter-annual temperature variations;

there are some complex linkages between energy consumption in different sectors, such as CHP plants in the electricity sector, where fossil fuels also provide some derived heat for the H&C sector; and

prices paid for fossil fuel imports vary across Member States, as does the fuel mix and the share of imported fuels in each sector.

In order to deal with these challenges, energy consumption is analysed separately for each sector and Member State in seven steps:

1. In the **electricity sector**, the growth in renewable energy is taken from Eurostat SHARES 2014 [2] for RES electricity consumption and RES derived heat consumption. A number of calculations are required to adjust for the share of nuclear power stations in the mix of electricity and heat production, and the share of combined heat and power (CHP) installations in both of them as well as the mix of different fossil fuels.

2.

    a. First, the share of nuclear in non-renewable electricity generation is determined from the energy balances [16], and RES growth is diminished accordingly to arrive at a figure for displaced consumption of fossil fuels in electricity. The same correction is applied for the share of nuclear power and heat production in CHP and heat-only plants.

    b. This figure is further split into a part from electricity-only plants and a part from combined heat and power (CHP) plants. The latter has to be further corrected for its linkage to the heating and cooling sector.

    c. From the figures resulting in a) and b), displaced primary energy (and thus, physical fossil fuel) consumption is determined by calculating the mean efficiency of electricity only, CHP, and heat only plants from the energy balances [16]. The result is the displaced amount of primary energy across the sector. Because the full efficiency is applied to heat and CHP plants, their consumption already includes the share of energy used for heat production, and must not be included in the H&C section (3.) below.

    d.

    e. The mix of different fossil fuels for each type of power station is determined from the energy balances [16], and the figures for displaced fossil fuel consumption is split accordingly to arrive at an estimate for the displaced amounts of each fuel type in the three different types of power plants, which are then summed up to provide arrive at a figure for the electricity sector.

3. In the **transport sector**, it is assumed that energy demand remained equal in both years. The growth in RES consumption as determined from Eurostat SHARES 2014 [2] is thus directly translated into displaced fossil fuel consumption according to the sector's fuel mix as determined from the energy balances [16].

4. In the heating and cooling (H/C) sector, final RES consumption is determined for thermal H/C and renewable heat pumps. The mix of fossil fuels is best estimated from the energy balances by adding up the figures for fossil fuel consumption in the industry and "other" sectors. The determined amount of displaced fossil fuels is split into figures for solid fuels, oil, and gas accordingly.

5. A correction is applied for consumption of the energy branch in order to model the energy losses (e.g. in refineries) in the transformation process from primary fossil fuels to final fossil fuels which supply the transport and heating and cooling sector. For each fossil fuel, the share of the energy branch in the Member State's total consumption is determined. The figures determined in steps 2 and 3 are summed up and augmented accordingly.

6. The total displaced primary fossil energy consumption is calculated by adding up the displaced fossil consumption in electricity, CHP and heat plants of step 1c) and the displaced fossil energy consumption in the transport and heating & cooling sectors of step 4.

7. The energy balances [16] also serve for determining the share of imports in consumption of fossil fuels. This is determined for each fuel type and the sum of the results of steps 1) and 4) diminished accordingly. The result is the final estimate of displaced primary energy

imports for solid fuels, oil, and gas through the increase of RES deployment between two consecutive years.

8. The value of displaced imports is calculated using energy prices that are specific to the Member State, and determined from Eurostat and European Commission trade statistics [13–15]50.

3.4.3. Aggregation of EU-28 anticipated NREAP trajectories on sector and technology level

Using the information submitted by Member States in their NREAPs in 2010 [4], it is possible to construct an planned NREAP trajectory of EU-28 renewable energy shares by sector. For this purpose one needs to make use of the information provided in NREAP Table 3 (RES share by sector until 2020) and Table 4a (renewable gross final energy consumption by sector). The calculation of EU-28 RES shares by sector via NREAPs has been accomplished as highlighted in Box 3-1.

The NREAP data has been drawn from [8] and supplemented by NREAP resubmissions which occurred after the finalisation of this database (Czech Republic, Bulgaria, Finland, France, Greece, Malta) and documents provided by Member State after submission of the NREAPS as which included corrections to their original submissions (these documents are called further_nreap_info.pdf)

Box 3-1 Derivation of anticipated EU-28 NREAP trajectories by sector

For each Member State the renewable energy share by sector (Table 3) was divided by the renewable gross final energy consumption by sector (Table 4a; $GFEC_{RES}$). The result is the total gross final energy consumption including non-renewable energy sources ($GFEC_{total}$) in kilotons oil equivalent (ktoe). Then $GFEC_{RES}$ and $GFEC_{total}$ were aggregated to EU-28 levels each. Finally, EU-28 $GFEC_{RES}$ was divided by EU-28 $GFEC_{total}$ to obtain an EU-28 sector share of renewable energy deployment, displayed as anticipated EU-28 NREAP trajectory in figures and tables.

To construct an anticipated EU-28 NREAP trajectory on technology level tables 10-12 of Member States NREAPs have been used. These provide information on anticipated deployment per technology organised by sector (Table 10 for electricity, Table 11 for heating and cooling, Table 12 for transport). To derive the anticipated EU-28 NREAP trajectory, the values of each technology have been totalled for all Member States.

It needs to be noted that the aggregation to EU-28 level can only serve as an approximation because information was taken into account as reported by Member States. No corrections to the data have been made (see disclaimer at beginning of this document for further information).

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[50] Gas prices: Taken directly from the EC Quarterly Market Reports 2013-2015 (https://ec.europa.eu/energy/en/statistics/market-analysis). HUB prices used where available, EBP otherwise.

Oil prices: Taken from EU Crude Oil Imports and supply cost (https://ec.europa.eu/energy/en/statistics/eu-crude-oil-imports). Sum of EU-INTRA and EU-EXTRA imports used for determination.

Coal prices: Determined from EUROSTAT database: EU trade since 1988 by SITC [DS-018995] for Bituminous Coal (32121) only; total value per Member State divided by volume.

3.4.4. Distinction of hydro power into large and small scale

To derive an EU-28 distinction of hydropower into small (<=10MW) and large scale (>10MW) from Member State level data via the detailed SHARES 2014 dataset [2], the following approach was taken per Member State. The results derived in that manner were then aggregated to EU-28 level.

- **Derivation of total normalised non-pumped hydro generation:** Normalised non-pumped / non-mixed hydro generation and normalised mixed hydro generation were totalled;
- **Derivation of capacity class shares**: The share of hydro generation per capacity class (< 1 MW; 1-10 MW; > 10 MW) was determined;
- **Derivation of normalised hydro generation for small- and large scale hydro:** Making use of the capacity class shares derived in the previous step, normalised hydro generation was attributed to small scale (<= 1 MW) and large scale (> 10 MW) capacity classes.

For mixed hydro generation no capacity class information is available; thus, implicitly, normalised mixed hydro generation is attributed to non-mixed hydro according to the capacity class shares information from above.

3.4.5. Approximated 2015 values and RES-shares

2015 RES shares and deployment were approximated by the EEA (date 04/10/2016). The methodology is documented in EEA (2015): *Renewable energy in Europe – approximated recent growth and knock-on effects [96] [96].* Methodological changes are documented in EEA (forthcoming): *Renewable energy in Europe 2017 – approximated recent growth and knock-on effects* [7].

Data sources for this approximation (on Member State level) are:

- ENTSO-E
  - Detailled monthly production (January 2014 to December 2015)
    - Production of other and renewables, of which biomass
- EurObserv'ER:
  - Biofuels barometer 2016
    - Bioethanol consumption in transport in 2014 resp. 2015
    - Biodiesel consumption in transport in 2014 resp. 2015
    - Biogas consumption in transport in 2014 resp. 2015
    - Share of certified sustainable in 2015
  - Photovoltaic barometer 2016
    - Electricity production from solar photovoltaic power in 2014 resp. 2015
  - Solar thermal barometer 2016
    - Cumulated capacity of thermal collectors installed (in MWth) in 2014 resp. 2015
  - Wind energy barometer 2016
    - Cumulative capacity at the end of 2014 resp. 2015
    - Installed offshore wind capacities at the end of 2014 resp. 2015
    - Electricity production from wind power in 2014 resp. 2015
- Eurostat
  - Supply and transformation of oil - monthly data [nrg_102m]
    - Gross Inland Deliveries Observed [indic_nrg B_105200] of Total motor gasoline (blended with bio components) [product 3234A]
    - Gross Inland Deliveries Observed [indic_nrg B_105200] of Biogasoline [product 5546O]

        - Gross Inland Deliveries Observed [indic_nrg B_105200] of Total gas/diesel oil (blended with bio components) [product 3260A]
        - Gross Inland Deliveries Observed [indic_nrg B_105200] of Biodiesels [product 5547O]
        - Gross Inland Deliveries Observed [indic_nrg B_105200] of Total kerosene type jet fuel (blended with bio components) [product 3247A]
        - Gross Inland Deliveries Observed [indic_nrg B_105200] of Bio jet kerosene [product 5549O]
    - Supply of electricity - monthly data [nrg_105m]
        - Imports [indic_nrg B_100300]
        - Exports [indic_nrg B_100500]
        - Gross inland consumption [indic_nrg B_100900]
        - Available for the internal market [indic_nrg B_107200]
        - Gross electricity generation - Total [indic_nrg 15_107000]
        - Gross electricity generation - Hydro [indic_nrg 15_107001]
        - Gross electricity generation - Hydro (of which from pumped storage) [indic_nrg 15_107301]
- Member states national data
    - Biomass for heating and cooling
        - Austria: http://www.statistik.at/web_de/statistiken/energie_umwelt_innovation_mobilitaet/energie_und_umwelt/energie/energiebilanzen/index.html
        - Germany: http://www.erneuerbare-energien.de/EE/Navigation/DE/Service/Erneuerbare_Energien_in_Zahlen/Zeitreihen/zeitreihen.html
        - Lithuania: http://osp.stat.gov.lt/en/statistiniu-rodikliu-analize?epoch=ML
        - Netherlands: http://statline.cbs.nl/StatWeb/dome/?LA=EN
        - Sweden: http://www.scb.se/Statistik/EN/EN0201/2015K04/EN0201_2015K04_SM_EN20SM1602.pdf
        - United Kingdom: https://www.gov.uk/government/statistics/renewable-sources-of-energy-chapter-6-digest-of-united-kingdom-energy-statistics-dukes
    - Biomass in electricity
        - Italy: Gestore Servici Energetici (GSE): Energia da fonti rinnovabili in Italia – Dati preliminari 2015

3.4.6. Distinction into wind on- and offshore deployment

The distinction of wind into on- and offshore deployment (not available via Eurostat SHARES) has been accomplished as follows: For the years 2004-2009 all wind deployment was attributed to wind onshore. For the years 2009-2014 data from Member States Progress Reports were taken into account. For the estimated 2015 values offshore were estimated. The normalised onshore wind value for 2015 was then calculated by deducting from the estimates of normalised total wind deployment the estimated offshore wind deployment.

3.4.7. Estimation of the contribution of the building sector in exporting renewable energy generated on buildings to the energy sector

It is important to note that all estimates carry a considerable margin of error, since the data availability is at best patchy and a considerable number of assumptions need to be made.

3.4.7.1. Estimate of share of the RES generation (per technology) installed on/in buildings

For the distinction between RES installations on/in buildings versus free-field the following assumptions will be made:

- Installations generating electricity from hydropower, wind as well as solar thermal, are assumed to operate free-field regardless of the capacity installed.
- Installations generating electricity and/or heat from geothermal are assumed to operate free-field.
- A distinction between on/in buildings vs free-field is relevant for solar PV (RES-E), solar thermal (RES-H), heat pumps (RES-H) and biomass (RES-E and RES-H/C).
    - PV (RES-E): For PV the split factor is based on data reported by the European Photovoltaic Industry Association (EPIA) in the “Global Market Outlooks for Solar Power” [23–27, 97]. The reports provide data for the period 2011-2015 and projections for the period 2016-2020. The market segmentation has been split to distinguish between utility scale systems (systems with a capacity above 1000 kW_p and built on the ground), industrial rooftop applications (systems with a capacity above 250 kW_p) and commercial (systems with a capacity between 10 and 250 kW_p) as well as residential applications (systems below or equal to 10 kW_p). It is assumed that all systems apart from the utility scale systems are installed on buildings. The EPIA reports do not provide data for each of the 28 Member States. However the missing Member States have not been very relevant in terms of market size so far and therefore have a very limited impact with regard to total values. For these Member States (CY, EE, FI, HR, HU, IE, LT, LU, LV, MT, SE) it is assumed that the whole capacity is installed on buildings.
    - Solar thermal (RES-H): For solar thermal the split factor is based on data reported by the European Solar Thermal Industry Association (ESTIF) in the reports “Solar Thermal Markets in Europe: Trends and Market Statistics” [28]. The reports provide data on cumulative collector area and heat generation for the period 2004-2015. The reported data aggregate data on both, collectors on buildings as well as large collector fields connected to DH systems. In order to receive the split factor for most Member States data on large solar thermal DH projects have been put together based on data provided by the SDH platform (European Large Scale Solar Heating Plants, http://solar-district-heating.eu/).
    - Heat pumps (RES-H): Heat pumps are mainly operating in/on buildings and only a small number of large heat-pumps are installed free-field being connected to a DH system. Based on a survey conducted by [22] who collected data in 11 Member States on large heat pump systems (thermal output > 1 MW) that are connected to DH systems the share of heat pumps operating free-field has been estimated. As [22] provides data on thermal capacity and only for few of the listed DH-connected heat pumps the respective operating hours are reported, for the conversion from capacity to heat generation an average of 5.000 operating hours is assumed. For large heat pumps for which the commissioning date is not known it is assumed that they started to operate before 2004.

- Biomass (RES-E and RES-H): For reasons of simplification and the lack of reliable data it is assumed that biogas and bioliquids are mainly used in installations (CHP, electricity or heat only plants) that operate free-field. Solid biomass is by far the largest contributor for RES-H production in the EU. Solid biomass is typically used in decentralised boilers (e.g. pellets, log wood) installed in buildings or in larger installations (e.g. electricity or heat only plants, co-firing in conventional fossil-fueled boilers etc.). Lacking data on the split factor for each of the Member States it is assumed that the use of biomass in the residential sector ("biomass in households") as well as the biomass use in the tertiary sector as reported by Eurostat SHARES represent the share of biomass that is generated in buildings. The remaining biomass is assumed to be used in conversion plants that operate free-field or is used for the production of industrial process heat.

For the 2020 projection the estimates are based on the projections provided by the PRIMES reference scenario.

Lacking assumptions on how the split factors will develop in future in the projections for 2020 the factors for solar thermal and heat pumps are kept on the 2015 level. For solar PV for 2020 the share of roof-top PV systems is estimated based on [97].

Making all these assumptions will necessarily lead to a significant error margin. For that reason the results are rough estimates only.

3.4.7.2. The share of RES generation that is consumed within the building (self-consumption)

Based on the estimated RES generation in/on buildings the share of RES generation that is consumed within the building (self-consumption) needs to be determined. Self-consumption is understood in a physical way representing the RES share that is generated on/in a building and consumed in the building immediately after generation or after temporary storage in an electrical battery or heat storage system (real-time self-consumption). In contrast to net-metering approaches, self-consumption reflects the RES share that physically "stays" within the building and therefore does not affect the infrastructure outside of the building.[51]

In the previous section for different RES technologies it has been specified whether generation occurs on/at buildings or whether the installation operates free-field. Technologies that operate on or at buildings are PV, solar thermal, heat pumps and biomass. For reasons of simplification it is assumed that all technologies installed on/at buildings and generating RES-HC are mainly producing heat that is consumed in the respective building. In other words, all RES-H/C that is generated on/at buildings will be accounted for as self-consumption (neglecting the RES-H

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[51] It must be noted that this definition of self-consumption does not reflect the way how self-consumption occasionally is understood in the context of building codes or how the nearly zero energy standard for buildings (nzeb) is defined in many Member States. In many nzeb standards onsite RES-E production is balanced against electricity consumption that occurs for the thermal conditioning of the building (e.g. electricity consumption for pumps, ventilators etc.) while balancing is done on a monthly or even annual basis. The long balancing period is blind for situations where generation and consumption occur at different hours of a day (e.g. PV peak at noon while consumption peak might be during the evening). In such situations the grid is necessary as flexibility to balance generation and consumption e.g. over a day. With regard to the definition above self-consumption would not be given in such a situation.

In contrast to the above mentioned nzeb definitions self-consumption does not only apply for electricity consumption used for the technical equipment (e.g. heat and domestic hot water generation, auxiliary electricity for the boiler, ventilation, cooling, lighting). It also covers all other consumption devices in a building. In the residential sector for instance this includes all household appliances, IT and communication devices etc.

installations on/at buildings that are connected to a DH grid). However, a distinction between self-consumption and grid-delivery has to be done for RES-E that is produced on/at buildings. This mainly applies to solar PV and biomass. However, lacking data, RES-E from biomass fueled CHP plants that are installed in buildings is not considered for self-consumption.

The self-consumption rate for solar PV depends on two factors. First, the load curve of the PV installation, and second the consumption curve within the building. While the load curve mainly depends on the orientation of the PV panels and the climatic zone, the consumption pattern is subject of several factors including

- the building type (e.g. single family house, apartment block, commercial building)
- the nature and characteristics of the different electricity consumers (e.g. fossil-fueled boiler vs. heat-pump- vs. direct-electric heating)
- the availability and capacity of internal storage devices (electric and heat/cold-related)
- the energy standard of the building (e.g. new building vs. renovated building vs. non-renovated building)
- the climatic zone
- the specific support framework which might prioritise self-consumption and thus incentivise (explicitly or implicitly) investments in storage devices.

Data on typical self-consumption rates are only available for selected building types. For instance 33 building projects were evaluated in the scope of the support scheme “Modellprojekte im Effizienzhaus-Plus-Standard” in Germany. The scheme supported the construction of new buildings that produce significantly more energy than they require. All in all 33 projects were realised until December 2014, mainly one or two-family houses, but also a handful of multi-family buildings. All buildings were realised with large PV plants, some of them including a battery to increase the self-consumption rate. For some of the buildings PV generation is exceeding the total final energy consumption. The majority of buildings have a heat-pump as the main heat source. During the first two-year monitoring phase for buildings without battery the self-consumption rate for onsite PV generation was 28% on average (however showing a rather large deviation). The rate is calculated against the whole electricity consumption of the buildings (not only the consumption used for the technical equipment). Buildings with a battery achieved a self-consumption rate of up to 60% [30]. For a new residential single-family passive house (aerothermal heat pump + solar collector) [31] metered a self-consumption rate of 22%.

In addition, in some countries model runs have been carried out for different building types in order to calculate the self-consumption rate of solar PV by varying parameters such as the storage capacity or the installed PV capacity (for Germany e.g. [29, 32, 33, 98]). For a new single-family passive house with a heat pump as main heat source [29] modelled a self-consumption rate of about 35% (provided PV production is equal to the full annual electricity consumption of the building). If PV production was one half of the annual electricity consumption the self-consumption rate would be in the range of 56%. For an unrefurbished single-family house (incl. a heat pump) the self-consumption rate was 27% (annual PV generation equals electricity consumption) respectively 42% (annual PV generation half of electricity consumption). [32] modelled for a single-family house with an oil boiler (plus solar collector) that fulfils the current German building code a self-consumption rate of about 19% (not including the electricity consumption for all household appliances other than for the technical equipment). For a new passive house with heat pump the rate of about 38% can be reached. For office buildings a higher self-consumption rate can be reached since the electricity consumption for cooling and ventilation better correlates with the generation characteristics of the PV panels. Based on a sample of 144 German households [33] modelled an average self-consumption rate of 40% for PV systems with an annual production that is one half of the overall electricity consumption. For larger PV systems for which PV output is equalling the building's electricity consumption an average self-consumption rate of 30% was reached. A summary of studies providing data on measured and simulated self-consumption rates is provided by [34].

Most of the evaluated projects or model runs aiming at calculating the self-consumption rate for solar PV apply to new residential single-family houses with a rather low energy standard. Since this building type only covers a rather limited part of the whole building sector, it is difficulty to generalise the results. The building sector is dominated by existing buildings with a much lower energy standard compared to the standard of the buildings subject to metering or modelling. It is obvious and proved by the referenced studies that buildings with a heat-pump reach higher self-consumption rates than buildings with another heating technology. Moreover, the self-consumption rate is largely depending on the PV system size: Generally self-consumption rates are decreasing the larger the ratio between annual PV production and overall electricity consumption becomes (e.g. [33]). And it seems to be comprehensible that non-residential buildings can achieve much higher self-consumption rates dues to different consumption characteristics.

Since there is a lack of data on how solar PV generation on/in buildings is distributed along the above listed factors (e.g. no data is available on the distribution among building types, e.g. residential vs. commercial or buildings with different energy standards, e.g. new vs. existing renovated vs. existing non-renovated), an aggregated average self-consumption rate needs to be determined for each Member State. Assumptions need to be made on how to adapt the exemplary metered or modelled self-consumption rates to the specific Member State context. In order to at least reflect the climatic zones different self-consumption rates are applied for Northern Europe (32%), Eastern/Western (33%) and Southern Europe (35%). The influence of the support framework on the self-consumption rate in the sense described above is assumed to be rather low until now. Only in few Member States an increasing demand for battery systems has emerged in previous years. Although studies have shown the significant impact such batteries can have, the effect on the average self-consumption rate is still limited due to the low penetration rate. This might change in the coming years and thus should be reflected in the projections. For that reason different assumptions have been made how the self-consumption rate will develop until 2030.

3.4.7.3. The share of RES generation that is exported to the energy system

The RES share of RES generation that is generated on/in buildings and is fed into the electricity grid or district heating networks is derived by subtracting the estimated self-consumed RES volumes from the estimated overall RES that has been generated on/in buildings.

3.5. Data sources Task 1

Table 3-5 Data sources

Dataset	Usage	Time
Eurostat SHARES 2014 (summary)[2]	Renewable energy shares (total and per sector) according to the RED	2004-2014
Eurostat SHARES 2014 (detailed) [2]	Renewable energy deployment (gross final energy consumption) by sector and technology	2004-2014
Member States Progress Reports [3]	Distinction of wind into on- and offshore	2009-2014
Member States National Renewable Energy Action Plans NREAPs [4], including resubmissions and further information documents provided along their NREAPs	Member States NREAP trajectory per sector and technology; aggregation of EU-28 NREAP trajectory	2010-2020
Renewable Energy Directive [9]	Determination of RED indicative trajectory per Member State and EU-28; transport target 2020	2011-2020
Energy balances [16]	Calculation of avoided imports	2014; 2015
Coal trade statistics [15]	Calculation of avoided imports	2014; 2015
Gas market reports [13]	Calculation of avoided imports	2014; 2015
EU crude oil imports and supply cost [14]	Calculation of avoided imports	2014; 2015
ECN NREAP database [8]	Member States trajectory per sector and technology; aggregation of EU-28 NREAP trajectory	2010-2020
Market data and outlook for solar PV [23–27]	Estimate of share of RES generation installed on/in buildings	2010-2020
Market data for solar thermal [28]	Estimate of share of RES generation installed on/in buildings	2013
Solar thermal DH projects (SDH platform http://solar-district-heating.eu)	Estimate of share of RES generation installed on/in buildings	
Capacity data for large heat pump systems [22]	Estimate of share of RES generation installed on/in buildings	
EU Reference Scenario 2016 [5]	Renewable energy shares and deployment	2020

Data sources for approximating 2015 RES shares and renewable energy deployment are documented in Annex 3.4.5.

3.6. Methodology Task 2 – Evaluation of non-economic barriers

Table 3-6 shows an overview of the measures that were evaluated in this study, [36] and [35]. As described above, Articles 13 and 22(3) a-c of the Renewable Energy Directive constitute the basis of this overview. Although the Ecofys studies took into account similar measures, adaptations were made in the second study in 2014, due to significance or comparability between Member States.

This study, therefore, only carried out an evaluation for barriers that were assessed in both Ecofys studies. On the right hand side of the table, the barriers are shown for which the development was evaluated.

Table 3-6: Overview of measures and corresponding barriers in administrative procedures

Measures in Ecofys et al. (2012) [28]	Measures in Ecofys et al. (2014) [29]	This study	Directive 2009/28/EC Art. 22 (3) [32]	Barriers in this overview
	Positive Self-Assessment			
“One-stop-shop”?	“One-stop-shop”?	One-stop-shop not implemented	**a**	One-stop-shop not implemented
One permit?				
Online application for permit?	Online application for permit?	Online application not possible		Missing online application
Maximum time limit procedures?	Maximum time limit procedures?	No maximum time limit for procedures		No maximum time limit for procedures
Automatic permission?	Automatic permission?	No automatic permission after dealine	**b**	No automatic permission after deadline passed
	Increased cooperation of authorities?			
Facilitated procedures for small-scale?	Facilitated procedures for small-scale?	No facilitated procedures for small scale producers		No facilitated procedures for small-scale projects
Identification/dedication of geographic sites?	Identification/dedication of geographic sites?	No identification of geographic sites	**c**	No identification of geographic sites
Automatic entry into financial support scheme?				

Source: [35, 36], authors’ own summary

Similar to the evaluation of barriers and measures in administrative procedures that is shown in Table 3-6 Table 3-7 shows an overview of barriers to grid integration that were evaluated in the preceeding studies [39], [38] and [35] and were also in this study.

In this study only barriers were evaluated that were already assessed in [38] and [35]. Additionally it was necessary for this study to merge the information on the barriers “Grid capacity” and “Divergent development of grid and renewables” of the Ecofys study from 2014 to fit the information in the RES-Integration study from 2012. To capture the overall situation of RES-E grid connection in [38] the barriers “No obligation for the grid operator to connect a new plant” as well as “No obligation for the grid operator to reinforce the grid for new plants” were merged.

Table 3-7: Relation between definitions of grid integration barriers in different study

Barriers in ECORYS et al. (2010) [31]	Barriers in Eclareon & Öko-Institut e.V. (2012) [30]	Barriers in Ecofys et al. (2014) [29]	This study
Presence of problems concerning grid connection (Main problem: Long average lead time)	Long lead times/delay	Time delay	Long lead times
	Lack of grid capacity/different pace of grid and RES-E development	Grid capacity Divergent development of grid & renewables	Lack of grid capacity/Different development of grid and renewables
		Transparency	
	Complex or inefficient procedures		
No priority grid access for electricity by RES	No obligation for the grid operator to connect a new plant No obligation for the grid operator to reinforce the grid for new plants	No obligation to connect	No obligation to connect/reinforce the grid
	Virtual saturation		
	Non-shallow cost		
Presence of problems concerning TSOs and DSOs	Lack of communication/conflicts between stakeholders	Stakeholder involvement	Lack of stakeholder communication in the grid connection process
	Speculation		

Source: [35, 38, 39], authors’ own summary

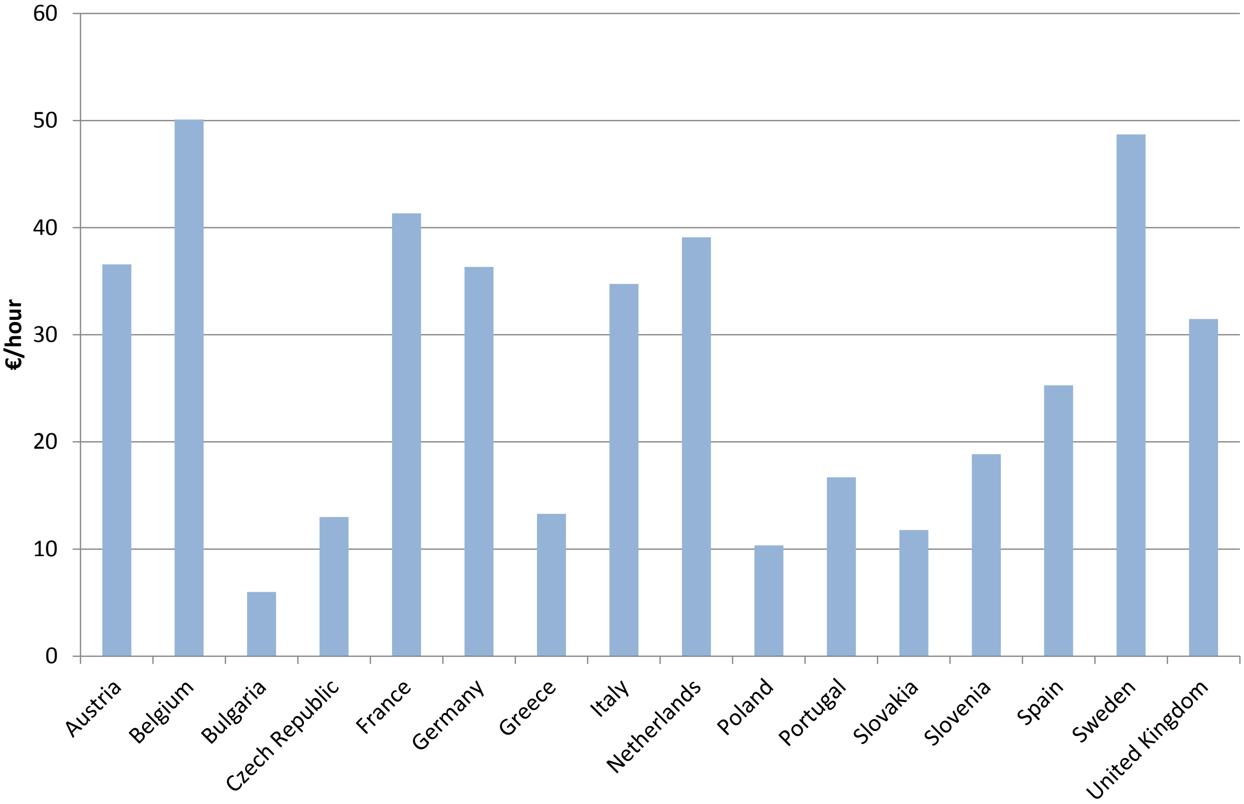
3.7. Data – Task 2

Table 3-8: Administrative and mean grid access cost of wind systems in European Member States in 2010 in EURO/kW

	Administrative cost	Mean grid access cost
Belgium	22,37	96,93
Czech Republic	67,10	55,92
Denmark	22,37	14,91
France	29,82	52,19
Germany	74,56	96,93
Greece	67,10	119,29
Ireland	29,82	108,11
Italy	22,37	37,28
Netherlands	67,10	111,84
Poland	44,74	33,55
Portugal	29,82	33,55
Spain	67,10	111,84
UK	37,28	78,29
Central & south east Europe (Austria, Bulgaria, Hungary, Romania)	37,28	141,66
Baltic and Nordic countries (Estonia, Finland, Latvia, Lithuania, Sweden)	37,28	82,01
Onshore (EU 27)	44,74	78,29
Offshore (EU)	417,15	160,44

Source: Based on [42, 44]

Figure 3-15: Labour cost of RES developers in different EU Member States in 2013



Source: Based on [51], authors' own illustration

Figure 3-15 shows the different hourly labour costs for RES developers from different EU Member States. The data is taken from the EU labour cost survey for the year 2012 category "Architectural and engineering activities; technical testing and analysis" which includes services in the consultancy of projects relative to electrical and other engineering fields. The costs of a labour hour in this field indicate the cost or benefit of an increasing or decreasing complexity of application conditions.

As a result, the cost impact of lengthier processes varies between Member States. Due to lower costs especially in Eastern European countries longer procedures do not lead to a large increase in project costs. Member States in Western Europe on the other hand have higher labour costs and therefore an increase or decrease in complexity of applications has a larger impact on the project costs.

Table 3-9: Legal administrative and legal gird connection labour requirements in EU Member States for residential PV systems in 2013 in hours

	Administrative process	Grid connection permit
Austria	0	1
Belgium	0	No data
Bulgaria	48	60
Czech Republic	10	2
France	4	4
Germany	1	2
Greece	No data	5
Italy	10	5
Poland	27	0
Portugal	3	6
Slovakia	80	5
Sweden	5	3
United Kingdom	2	1

Source: Based on [50]

Table 3-10: Legal administrative and legal gird connection labour requirements in EU Member States for commercial PV systems in 2013 in hours

	Administrative process	Grid connection permit
Austria	4	0
Belgium	0	22
Bulgaria	65	80
France	5	11
Germany	1	2
Greece	No data	10
Italy	21	7
Poland	22	22
Portugal	4	8
Sweden	5	3
United Kingdom	0	11

Source: Based on [50]

Table 3-11: Legal administrative cost and legal gird connection permit costs in EU Member States for residential PV systems in 2013

	Legal administrative cost	Legal grid connection permit cost
Austria	0,00	36,58
Bulgaria	287,97	359,96
Czech Republic	129,99	26,00
France	165,36	165,36
Germany	36,33	72,66
Greece	No data	66,41
Italy	347,54	173,77
Poland	279,52	0,00
Portugal	50,12	100,23
Slovakia	942,13	58,88
Sweden	243,56	146,14
United Kingdom	62,96	31,48

Source: Based on [50, 51]

Table 3-12: **Legal administrative cost and legal gird connection permit costs in EU Member States for commercial PV systems in 2013**

	Legal administrative cost	Legal grid connection permit cost
Austria	146,33	0,00
Bulgaria	389,96	479,95
France	206,70	454,73
Germany	36,33	72,66
Greece	No data	132,82
Italy	729,84	243,28
Poland	227,76	227,76
Portugal	66,82	133,64
Sweden	243,56	146,14
United Kingdom	0,00	346,30

Source: Based on [50, 51]