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2020 RES scenarios for Europe

- are Member States well on track
for achieving 2020 RES targets?

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Executive Summary



Model-based assessment of 2020 RES deployment

By use of a specialised energy system model (Green-X) a quantitative analysis was conducted to assess feasible RES developments up to 2020 according to selected policy pathways (i.e. a Business-As-Usual and a Policy Recommendations case), indicating RES deployment at Member State and at EU-27 level that can be expected in the near future, as well as related impacts on costs and benefits. Subsequently we present background information and key outcomes in a brief manner.

Methodology and key assumptions

The Green-X model was applied to perform a detailed quantitative assessment of the future deployment of renewable energy on country- and sector level. The core strength of this tool lies on the detailed RES resource and technology representation accompanied by a thorough energy policy description, which allows assessing various policy options with respect to resulting costs and benefits. For a detailed description we refer to www.green-x.at.

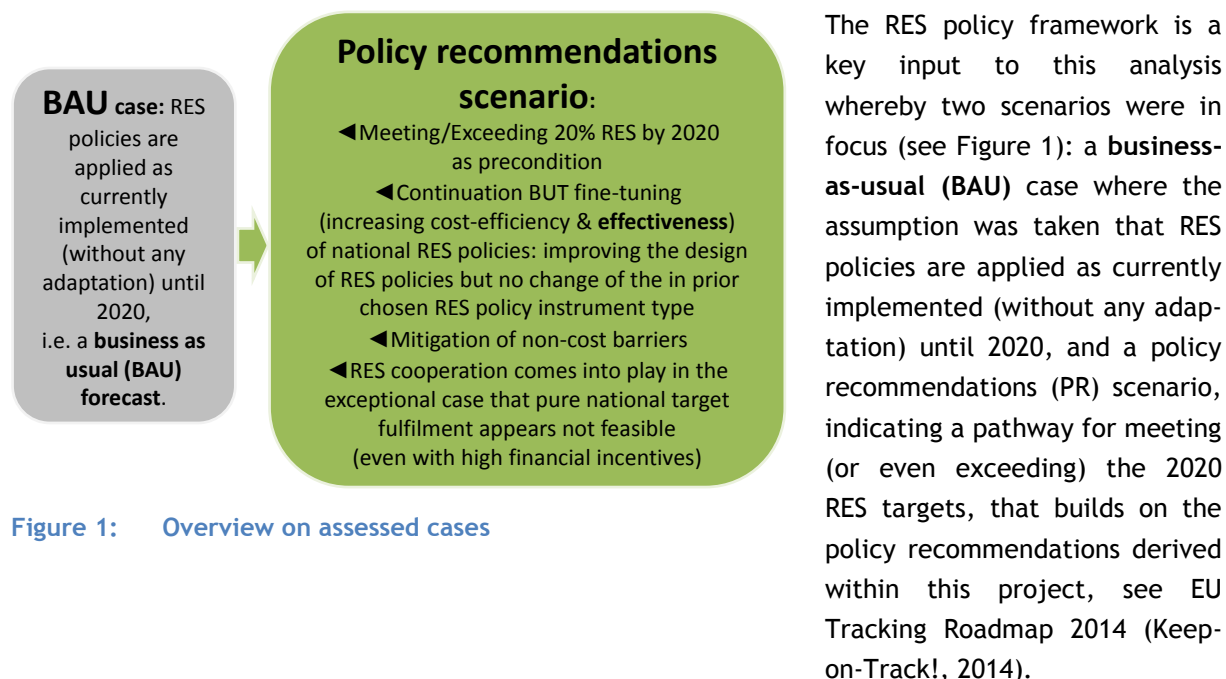


Figure 1: Overview on assessed cases

In order to ensure consistency with existing EU scenarios and projections data on future developments of demand and of energy/carbon prices are taken from PRIMES modelling - i.e. the PRIMES scenarios used is the most recent *reference scenario* as of 2013 (EC, 2013). With respect to the potentials and cost of RES technologies we refer to the Green-X database, respectively. Table 1 shows which parameters are based on PRIMES and which have been defined for this study.

Table 1: Main input sources for scenario parameters

Based on PRIMES	Defined for this study
Energy demand by sector	RES policy framework
Primary energy prices	Reference electricity prices
Conventional supply portfolio and conversion efficiencies	RES cost (<i>Green-X</i> database, incl. biomass)
CO ₂ intensity of sectors	RES potential (<i>Green-X</i> database)
	Biomass trade specification
	Technology diffusion
	Learning rates

Results on 2020 RES deployment and target achievement

Next, a closer look is taken on key outcomes on expected future RES deployment and related costs, expenditures and benefits at the aggregated (EU-27) level.

First, Figure 2 shows the contribution of RES to meeting gross final and sector-specific energy demands in 2020 for both assessed cases. It turns out that under current RES support and related framework conditions (BAU case) at EU27 level only a RES share of 17.9% appears feasible. Thus, improving national RES policies, for example according to the recommendations as provided within this project, appears essential for several Member States to bring them back on track. This is demonstrated by the results on the alternative policy pathway (Policy Recommendations case), where a RES share of 21.0% can be achieved by 2020. For doing so, RES in all energy sectors have to contribute more but possibly the most impressive changes can be identified for RES in the electricity sector, where 37.2% (PR case) instead of 30.9% (BAU case) are reached in 2020, and for biofuels in transport (i.e., 7.9% (PR case) instead of 5.5% (BAU case)).

Indicators on the costs and benefits of an accelerated RES deployment in the European Union offer central information for decision makers. In this context, Figure 3 summarises the assessed costs and benefits arising from the future RES deployment in the focal period 2011 to 2020. More precisely, this graph provides for the researched cases throughout the period 2011 to 2020 the on average per year arising investment needs and the resulting costs - i.e. additional generation cost and support expenditures. Moreover, they offer an indication of the accompanying benefits in terms of supply security (avoided fossil fuels expressed in monetary terms - with impact upon a country's trade balance) and climate protection (avoided CO₂ emissions - monetarily expressed as avoided expenses for emission allowances). Other benefits - even of possibly significant magnitude - such as job creation or industrial development were not included in this assessment. Apparently, with improved policy design and mitigated non-cost barriers RES deployment and consequently also related investments increase strongly, by about 35% with respect to the latter. Moreover, a significantly improved balance between costs and benefits can be observed.

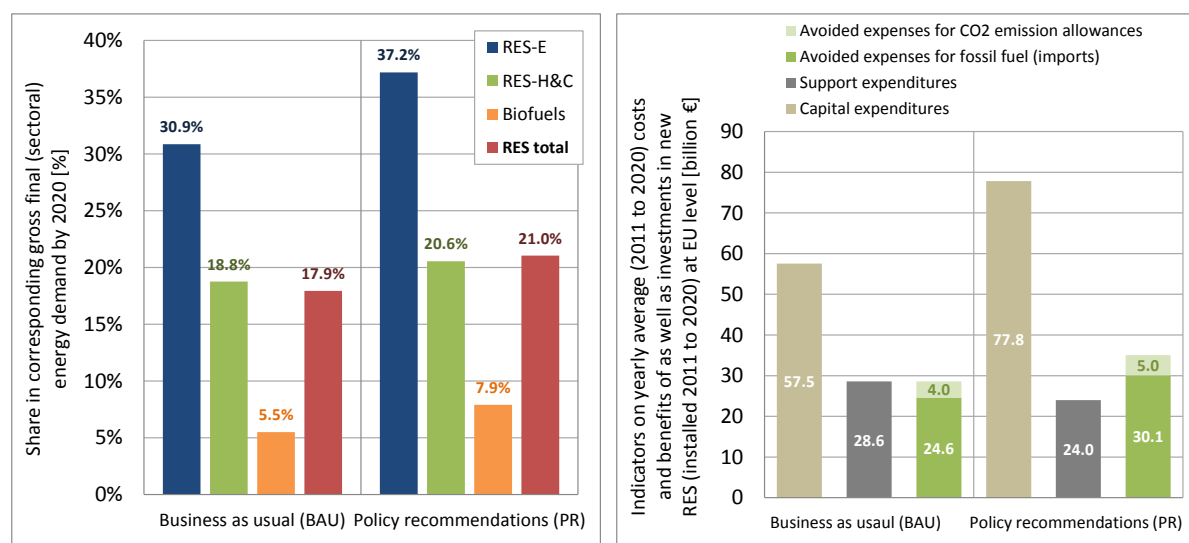


Figure 2: Sector-specific RES shares by 2020 at EU-27 level according to the assessed cases (BAU vs. PR)

Figure 3: Investments, selected costs & benefits at EU-27 level according to the assessed cases (BAU vs. PR)

RES deployment and RES target achievement at the national level is discussed next. Thereby, Figure 4 provides a graphical illustration of the outcomes of our model-based assessment of 2020 RES target achievement by Member State, indicating the likeliness by Member State following a “traffic light approach”¹. Complementary to that, Figure 5 offers further insights on the expected national RES deployment under BAU conditions. This graph also shows the additional deployment at sector level that would occur according to the Policy Recommendations case. Thus, under BAU conditions nine out of the assessed 27 Member States, e.g. Austria, Denmark or Italy, appear well on track. In another four Member States (i.e. Finland, Germany, Ireland and Slovakia) there are doubts whether 2020 targets can be reached with already implemented measures, while the remainder of fourteen Member States can be classified as “not well on track.” In contrast to that, if recommended policy measures are implemented well in time, all Member States still have the possibility to achieve their 2020 RES targets. The majority of countries would even exceed its obligation, and there are good reasons for doing so since, as discussed above, additional RES deployment contributes well to increase supply security and local employment, to name only some additional benefits. Finally, by 2020 five Member States (i.e. France, Luxembourg, Malta, the Netherlands and the UK) make use of RES cooperation mechanisms as a buyer while all others act as (possible) seller.

¹ Following the traffic light approach a green colour is used to show that a MS is expected to achieve its 2020 target while an orange colour indicates that there are doubts whether this MS may achieve its given RES target. Finally, red highlights that a MS is not well on track with respect to target achievement. In this context, in order to reflect uncertainty appropriately a threshold of -2% / +3% (of the required 2020 RES deployment) is used to distinguish between achievement, doubt or shortfall.

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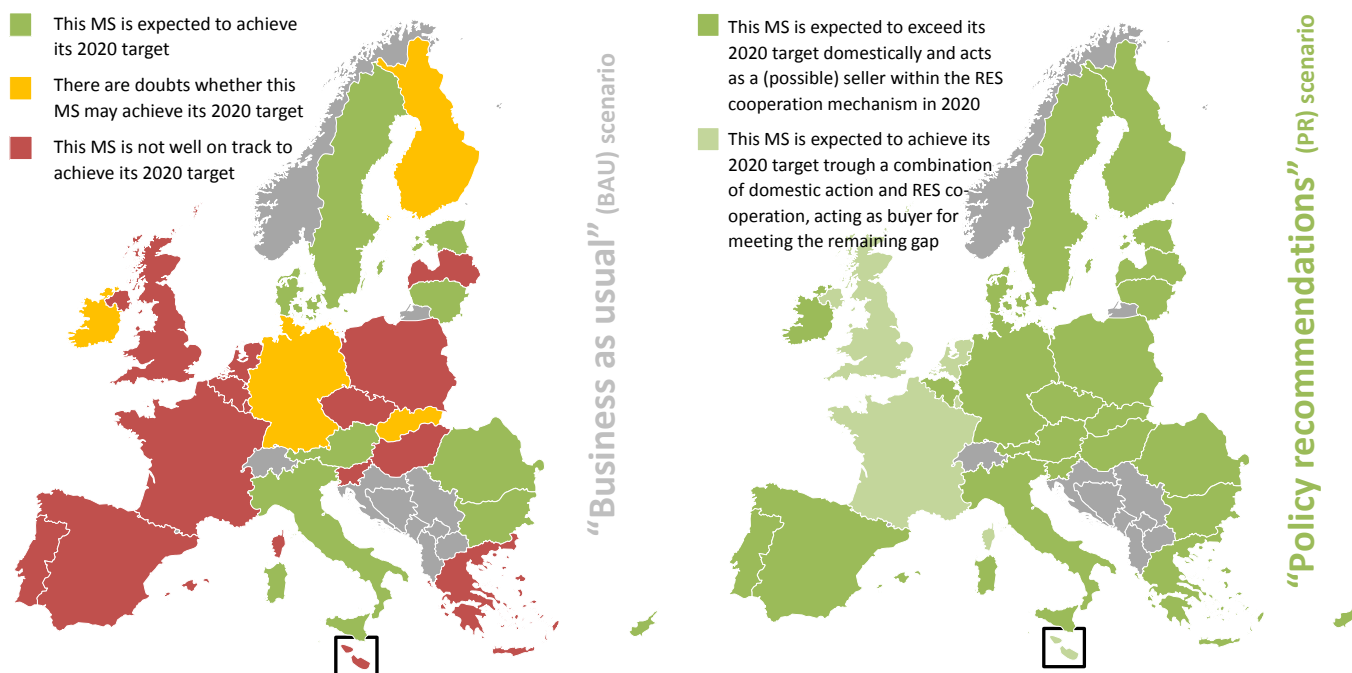


Figure 4: Assessment of 2020 RES target achievement according to the assessed cases (BAU(left) vs. PR (right))

Note: The traffic light colours of the figure on the left hand-side show an achievement or shortfall of 2020 RES targets by MS after possible adjustments through RES cooperation. In this context, in order to reflect uncertainty appropriately a threshold of -2% / +3% (of the required 2020 RES deployment) is used to distinguish between achievement, doubt or shortfall.

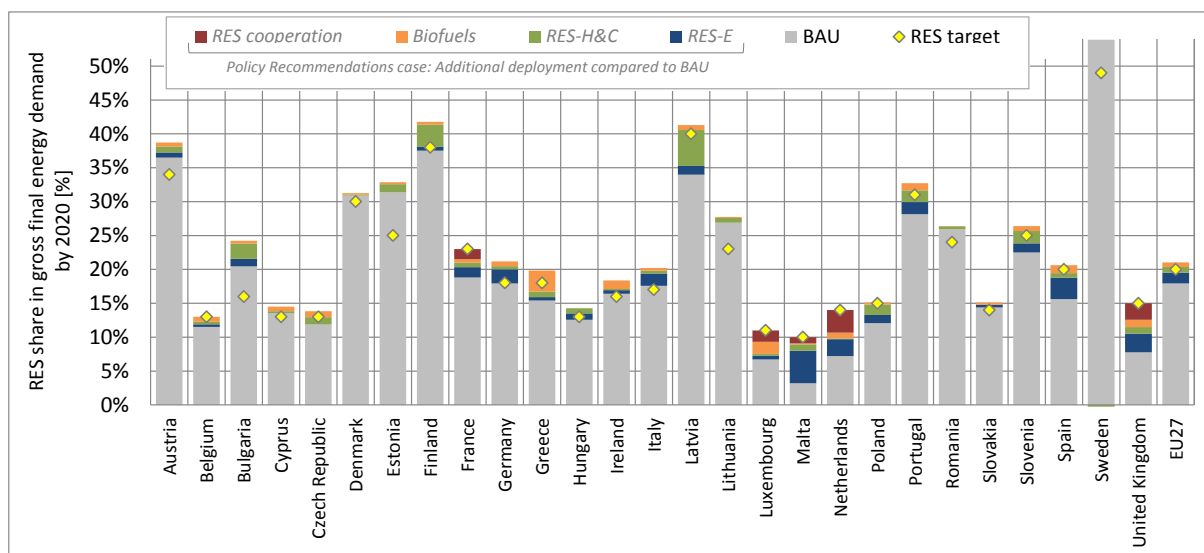


Figure 5: Comparison of 2020 RES targets and RES deployment according to a Business-as-usual (BAU) scenario by Member State, and additional (sector-specific) RES deployment in the Policy recommendations case

Introduction



The policy context

- past progress and future perspectives for RES in the EU

As outlined in detail in the Re-Shaping study (see Ragwitz et al., 2012), the first decade of the new millennium was characterized by the successful deployment of RES across EU Member States - total RES deployment increased by more than 40%. More precisely:

- RES electricity generation grew by approximately 40%, RES heating and cooling supply by 30% and biofuels by a factor of 27 during the period 2001 to 2010,
- New renewables in the electricity sector (all technologies except hydropower) increased fivefold during the same period,
- Total investments in RES technologies increased to about € 40 billion annually in 2009, and more than 80% of all RES investments in 2009 were in wind and PV.
- With respect to PV an ongoing trend of achieving impressive cost reductions from year to year has started in the final period close to 2010.

These impressive structural changes in Europe's energy supply are the result of a combination of strong national policies and the general focus on RES created by the EU Renewable Energy Directives in the electricity and transport sectors towards 2010 (2001/77/EC and 2003/30/EC).

Despite the challenges posed by the financial and economic crisis, RES investments were generally less affected than other energy technologies and partly increased even further over the last couple of years. The European Energy and Climate Package is one of the key factors that contributed to this development. The EU ETS Directive has introduced full auctioning post 2012, thus exposing fossil power generation to the full cost of carbon allowances, at least in theory. In practice, an over-supply of allowances has however led to a deterioration of prices on the carbon market.

The pathway for renewables towards 2020 was set and accepted by all the European Council, the European Commission and the European Parliament in April 2009. The related policy package, in particular the EU Directive on the support of energy from renewable sources (2009/28/EC), subsequently named as RES Directive, comprises the establishment of binding RES targets for each Member State, based on an equal RES share increase modulated by Member State GDP. This provides a clear framework and vision for renewable technologies in the short to mid-term.

Implementing the 2020 RES Directive has taken another step forward with the formulation of the National Renewable Energy Action Plans (NREAPs), which outline the national strategies concerning support schemes, cooperation mechanisms and (non-cost) barrier mitigation, in particular with respect to grid-related and administrative issues. In addition, a detailed reporting framework for the European Commission and Member States has been drawn up to ensure that these strategies are well established and coordinated.

Despite the successful development of the RES sector over the last decade, substantial challenges still lie ahead. For the renewable energy electricity and heating & cooling sectors (RES-E and RES-

H&C), the growth rate of total generation has to continue in line with the trend observed during the last five years. For meeting 2020 RES targets, compared to the period 2001 to 2010, yearly growth in RES-E needs to almost double from 3.4% (2001 to 2010) to 6.7% in the years up to 2020. There also needs to be a substantial increase in growth in the RES-H&C sector from the 2.7% per year achieved over the past decade to 3.9% per year until 2020. Therefore, the EU as a whole should continue to uphold the past level of achievement and the most successful countries could even over-achieve the 2020 targets by continuing to follow their present trend.

Objective and structure of this report

This report presents the outcomes of a detailed model-based assessment of how well Member States are on track for achieving 2020 RES target. By use of a specialised energy system model (Green-X) a quantitative analysis was conducted to assess feasible RES developments up to 2020 according to selected policy pathways, indicating RES deployment at Member State and at EU-27 level that can be expected in the near future, as well as related impacts on costs and benefits.

As a starting point, section 0 provides a short description of the methodology and key assumptions of this analysis, introducing the model applied and the scenarios assessed. Note that details on background parameter and the overall approach taken are provided in Annex I to this report.

Key outcomes of the analysis of 2020 RES target achievement are subject of section 0. While the first part presents and discusses results on expected future RES deployment and related costs, expenditures and benefits at the aggregated (EU-27) level the subsequent subsections offers a cross-country comparison and an assessment of the need for RES cooperation.

Details on country-specific RES developments in the 2020 context are then discussed in section 0, where for each Member State a closer look is taken on domestic RES deployment at the aggregated and at sector and technology level.

This report concludes with a summary of key findings and recommendations on the way forward, see section 0.

Short description of methodology and key assumptions



3.0 Model-based assessment of possible RES developments for meeting binding 2020 RES targets

By use of a specialised energy system model (Green-X) a quantitative analysis was conducted to assess feasible RES developments up to 2020 according to selected policy pathways, indicating RES deployment at Member State and at EU-27 level that can be expected in the near future, as well as related impacts on costs and benefits. Subsequently we present background information and key outcomes in a brief manner.

Note that the Annex to this report provides a detailed description of the methodology and the assumptions taken for this analysis of possible RES developments in the near future (up to 2020). In contrast to that, below only a concise summary of relevant background information is provided.

3.0.1 Constraints of the model-based policy analysis

- ▶ Time horizon: 2010 to 2020 - Results are derived on an annual base
- ▶ Geographical coverage: all Member States of the European Union as of 2012 (EU27; without Croatia)
- ▶ Technology coverage: covering all RES technologies for power and heating and cooling generation as well biofuel production. The (conventional) reference energy system is based on EC modelling (PRIMES)
- ▶ Energy demand: demand forecasts are taken from “EU energy, transport and GHG emissions trends to 2050: Reference Scenario 2013” (EC, 2013)
- ▶ RES imports to the EU: generally limited to biofuels and forestry biomass meeting the sustainability criteria

3.0.2 The policy assessment tool: the Green-X model

The Green-X model was applied to perform a detailed quantitative assessment of the future deployment of renewable energy on country- and sector level. The core strength of this tool lies on the detailed RES resource and technology representation accompanied by a thorough energy policy description, which allows assessing various policy options with respect to resulting costs and benefits. A short characterization of the model is given in the Annex to this main report, whilst for a detailed description we refer to www.green-x.at.

3.0.3 Overview on assessed cases

The RES policy framework is a key input to this analysis whereby two scenarios were in focus (see Figure 6): a business-as-usual (BAU) case where the assumption was taken that RES policies are applied as currently implemented (without any adaptation) until 2020, and a policy recommendations (PR) scenario, indicating a pathway for meeting (or even exceeding) the 2020 RES targets, that builds on the policy recommendations derived within this project, see EU Tracking Roadmap 2014 (Keep-on-Track!, 2014). Note that in the PR case RES cooperation is an important element for over-

all RES target achievement for certain Member States. It comes however only into play in exceptional cases when national target achievement appears not feasible even with high financial incentives.²

Generally, data on currently implemented RES policies in the assessed Member States as considered in the BAU case has been collected until end of March 2014. Thus, any policy changes that have been taken afterwards could not be considered in this model-based assessment.

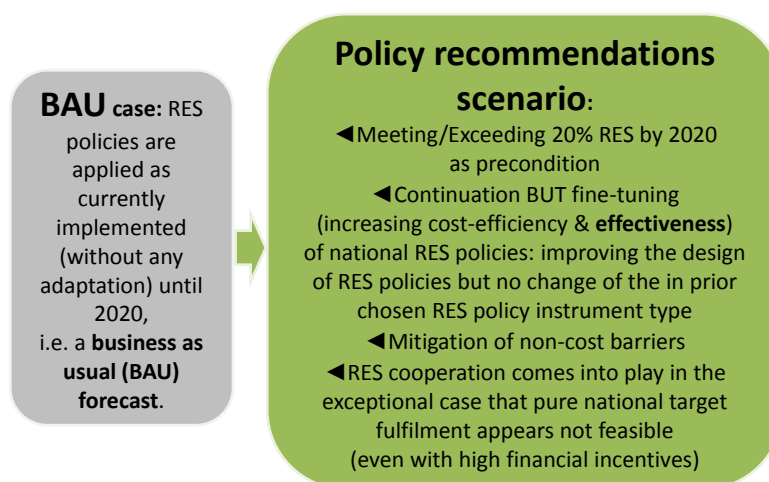


Figure 6: Overview on assessed cases

3.0.4 Overview on key parameters

Table 2: Main input sources for scenario parameters

Based on PRIMES	Defined for this study
Energy demand by sector	RES policy framework
Primary energy prices	Reference electricity prices
Conventional supply portfolio and conversion efficiencies	RES cost (Green-X database, incl. biomass)
CO ₂ intensity of sectors	RES potential (Green-X database)
	Biomass trade specification
	Technology diffusion
	Learning rates

² As threshold with respect to financial RES support across Member States a high value is used - i.e. differences in country-specific support per MWh RES are limited to a maximum of 30 €/MWhRES. Consequently, if support in a country with temporarily limited RES potentials and / or an ambitious RES target exceeds the upper boundary, the remaining gap to its RES target would be covered in line with the flexibility regime as defined in the RES Directive through (virtual) imports from other countries that achieve a surplus in RES deployment. The needed support costs for the (virtual) exports are taken over by the importing country. No additional transaction costs are considered.

In order to ensure maximum consistency with existing EU scenarios and projections the key input parameters of the scenarios presented in this report are derived from PRIMES modelling. With respect to the potentials and cost of RES technologies we refer to Resch et al. (2014) and/or the Green-X database, respectively. Table 2 shows which parameters are based on PRIMES and which have been defined for this study. More precisely, the PRIMES scenario used is the PRIMES *reference scenario* as of 2013 (EC, 2013).

Key results on 2020 RES target achievement



This section is dedicated to take a closer look on key outcomes of the model-based assessment of 2020 RES target achievement. While the first subsections present and discuss results on expected future RES deployment and related costs, expenditures and benefits at the aggregated (EU-27) level the subsequent part offers a cross-country comparison.

RES deployment at EU-27 level

First, Figure 7 illustrates RES developments up to 2020 at EU-27 level in relative terms (i.e. RES share in gross final energy demand) according to the assessed cases (BAU and Policy Recommendations (PR)). It turns out that under current RES support and related framework conditions (BAU case) at EU-27 level only a RES share of 17.9% appears feasible. Thus, improving national RES policies, for example according to the recommendations as provided within this project, appears essential for several Member States to bring them back on track. This is demonstrated by the results on the alternative policy pathway (Policy Recommendations case), where a RES share of 21.0% can be achieved by 2020.

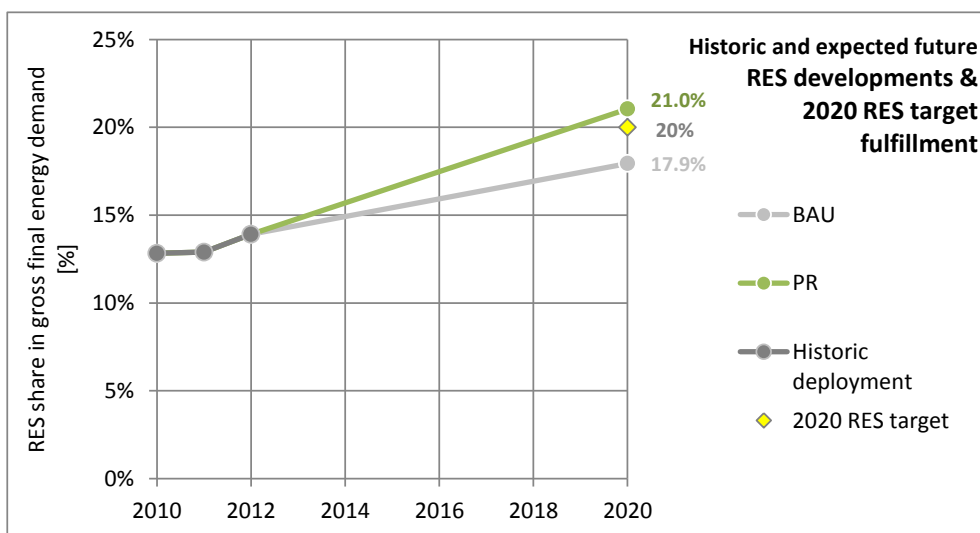


Figure 7: RES developments up to 2020 at EU-27 level in relative terms (i.e. RES share in gross final energy demand) according to assessed cases (BAU and PR)

Complementary to above, Figure 8 and Figure 9 provide details on RES deployment at sector level, indicating current (2012) and future (2020) RES generation by sector at EU-27 level in absolute terms (i.e. TWh electricity, heat or transport fuels produced) (Figure 8) as well as sector-specific RES deployment in relative terms (i.e. RES share in corresponding sector-specific and in aggregated gross final energy demand) (Figure 9). As applicable from these graphs, RES in all energy sectors have to contribute more to achieve or even over-succeed the given 2020 RES target as illustrated by

the PR case. Possibly the most impressive changes can be identified for RES in the electricity sector, where 37.2% (PR case) instead of 30.9% (BAU case) are reached in 2020, and for biofuels in transport (i.e., 7.9% (PR case) instead of 5.5% (BAU case)).

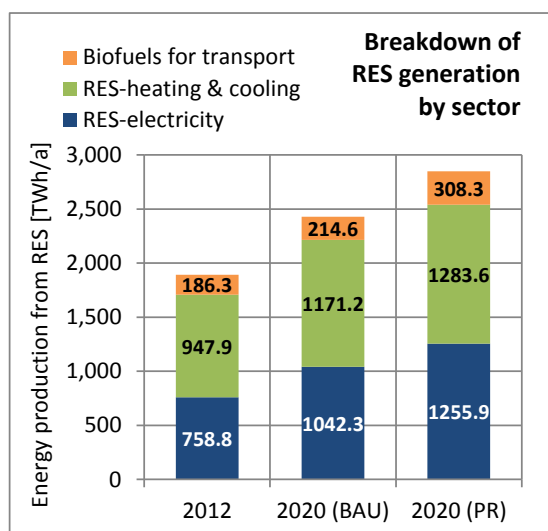


Figure 8: Breakdown of RES generation by sector at EU-27 level in 2012 and 2020 according to assessed cases (BAU and PR)

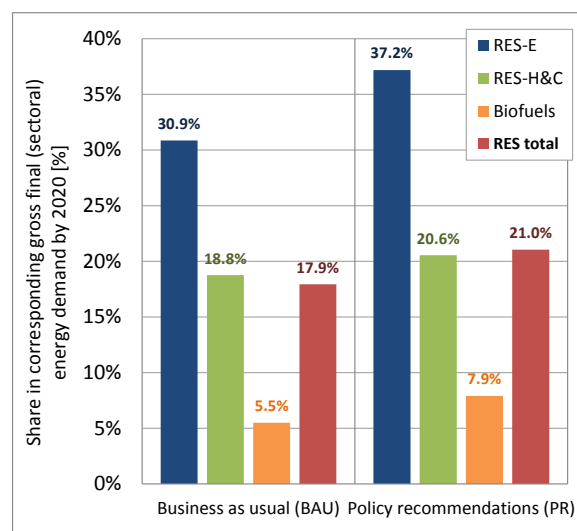


Figure 9: Sector-specific RES shares by 2020 at EU-27 level according to the assessed cases (BAU vs. PR)

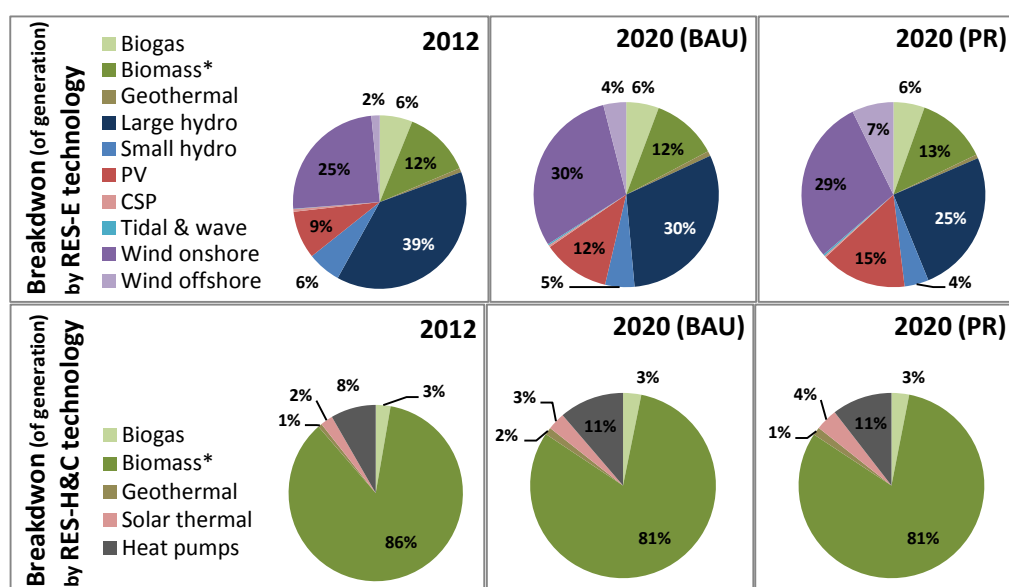


Figure 10: Breakdown of RES generation by technology and by sector (electricity (up) and heating & cooling (down) at EU-27 level in 2012 and 2020 according to assessed cases (BAU and PR)

Technology details are shown in Figure 10, providing a breakdown of RES generation by technology for the electricity sector (upper graphs) and for heating and cooling (lower graphs) according to both assessed cases. A broad portfolio of RES technologies has to contribute to assure RES target achievement, in particular for RES-E the deployment of different technology options appears well

balanced in the 2020 context. In the sector of heating and cooling the dominance of biomass (incl. biowaste) will remain although its relative share in overall sector-specific RES generation is expected to decline in forthcoming years.

Investments and selected costs & benefits at EU-27 level

Indicators on the costs and benefits of an accelerated RES deployment in the European Union offer central information for decision makers. In this context, Figure 11 summarises the assessed costs and benefits arising from the future RES deployment in the focal period 2011 to 2020. More precisely, this graph provides for the researched cases throughout the period 2011 to 2020 the on average per year arising investment needs and the resulting costs - i.e. additional generation cost and support expenditures. Moreover, they offer an indication of the accompanying benefits in terms of supply security (avoided fossil fuels expressed in monetary terms - with impact upon a country's trade balance) and climate protection (avoided CO₂ emissions - monetarily expressed as avoided expenses for emission allowances). Other benefits - even of possibly significant magnitude - such as job creation or industrial development were not included in this assessment. Apparently, with improved policy design and mitigated non-cost barriers RES deployment and consequently also related investments increase strongly, by about 35% with respect to the latter. Moreover, a significantly improved balance between costs and benefits can be observed.

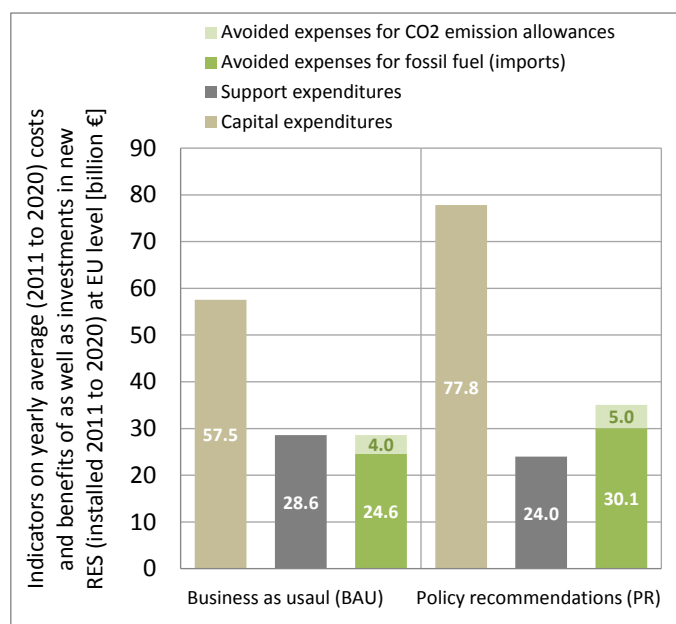


Figure 11: Investments, selected costs & benefits at EU-27 level according to the assessed cases (BAU vs. PR)

Cross-country comparison of RES deployment and 2020 RES target achievement

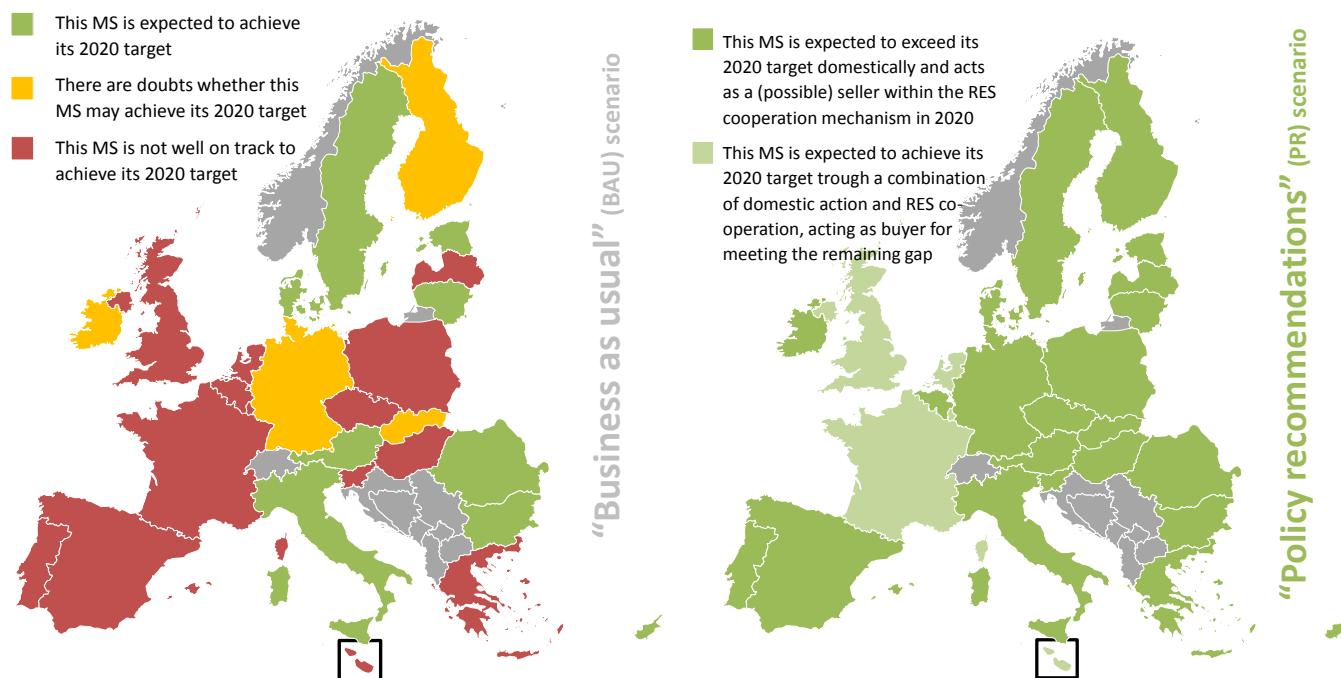


Figure 12: Assessment of 2020 RES target achievement according to the assessed cases (BAU(left) vs. PR (right))

Note: The traffic light colours of the figure on the left hand-side show an achievement or shortfall of 2020 RES targets by MS after possible adjustments through RES cooperation. In this context, in order to reflect uncertainty appropriately a threshold of -2% / +3% (of the required 2020 RES deployment) is used to distinguish between achievement, doubt or shortfall.

RES deployment and RES target achievement at the national level is discussed next. Thereby, Figure 12 provides a graphical illustration of the outcomes of our model-based assessment of 2020 RES target achievement by Member State, indicating the likeliness by Member State following an “traffic light approach”³. Complementary to that, Figure 13 offers further insights on the expected national RES deployment under BAU conditions. This graph also shows the additional deployment at sector level that would occur according to the Policy Recommendations case. Thus, under BAU conditions nine out of the assessed 27 Member States, e.g. Austria, Denmark or Italy, appear well on track. In another four Member States (i.e. Finland, Germany, Ireland and Slovakia) there are doubts whether 2020 targets can be reached with already implemented measures, while the remainder of fourteen Member States can be classified as “not well on track.” In contrast to that, if recommended policy measures are implemented well in time, all Member States still have the possibility to achieve their

³ Following the traffic light approach a green colour is used to show that a MS is expected to achieve its 2020 target while an orange colour indicates that there are doubts whether this MS may achieve its given RES target. Finally, red highlights that a MS is not well on track with respect to target achievement. In this context, in order to reflect uncertainty appropriately a threshold of -2% / +3% (of the required 2020 RES deployment) is used to distinguish between achievement, doubt or shortfall.

2020 RES targets. The majority of countries would even exceed its obligation, and there are good reasons for doing so since, as discussed above, additional RES deployment contributes well to increase supply security and local employment, to name only some additional benefits. Finally, by 2020 five Member States (i.e. France, Luxembourg, Malta, the Netherlands and the UK) make use of RES cooperation mechanisms as a buyer while all others act as (possible) seller.

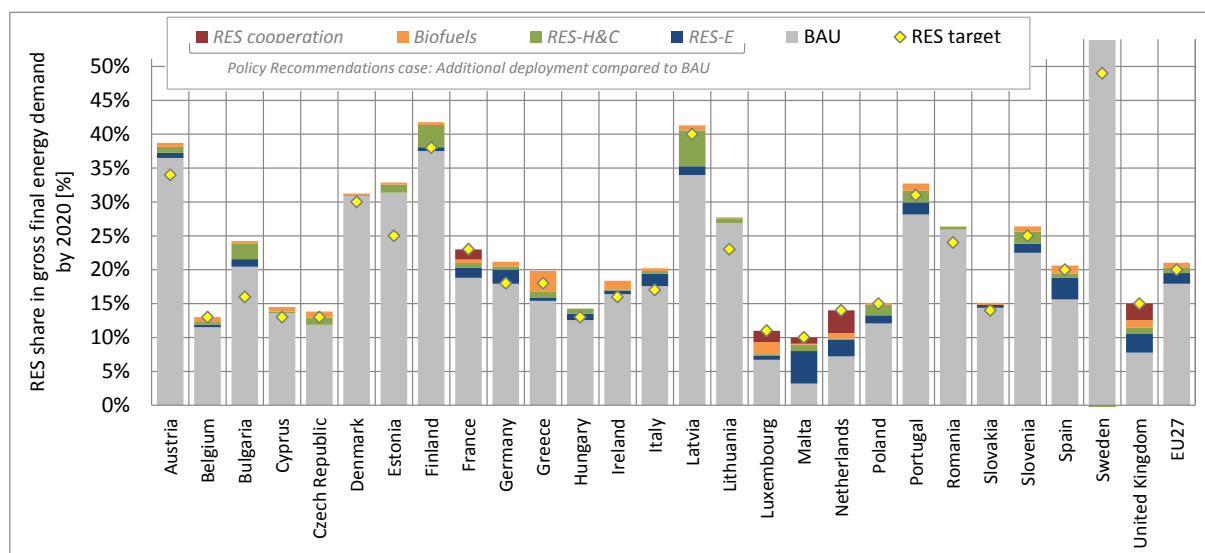


Figure 13: Comparison of 2020 RES targets and RES deployment according to a Business-as-usual (BAU) scenario by Member State, and additional (sector-specific) RES deployment in the Policy recommendations case

The need for and impact of RES cooperation

Further details on the need for and impact of RES cooperation are provided below. Generally, RES cooperation between Member States (incl. also Third countries) comes into play if a country falls short in achieving its given RES target purely domestically. In order to provide to Member States sufficient flexibility, the RES Directive has defined rules for cross-country cooperation, allowing to (virtually) import surpluses in RES generation from other Member States.

A simplified approach has been taken in this model-based assessment to incorporate the feasibility and impact of RES cooperation into the outcomes related to country-specific RES target achievement:

- If a Member State over-complies with its given target the surplus in RES generation represents a possible export volume, in other words the supply related to RES cooperation.
- If a Member State falls short in achieving its given target, the deficit in RES generation defines the required import volume, in other words the demand for RES cooperation.
- The feasibility of country-specific imports and exports is then defined at European level: Summing up country-specific import and export volumes, we can clarify on the match between supply (export volumes) and demand (import volumes) for RES cooperation:
 - If demand and supply perfectly match (i.e. import and export volumes are of similar magnitude), feasibility equals possibility or requirements, respectively, meaning

that all countries that have a surplus can sell that in full magnitude to other Member States that fall short etc.

- If demand exceeds supply, meaning that required imports are larger in magnitude than possible exports, potential sellers can sell their full surplus in RES generation while buying countries may end up with a deficit. In our assessment this characterises the situation occurring under BAU conditions.
- If possible supply exceeds required demand, buying countries can cover their whole demand for RES imports while potential sellers have the opportunity to sell only parts of their surplus in RES generation. This describes the situation that can be expected if RES deployment follows the PR case.

Below Table 3 lists the resulting country-specific RES shares by 2020 for both assessed cases (BAU vs. PR) with and without RES cooperation. Complementary to that, **Error! Reference source not found.** provides an illustration of the feasible (virtual) exchange of RES volumes between Member States by 2020, indicating for the case of a seller (exporting country) the feasible surplus in RES generation that can be sold to buying countries while in the case of a buyer (importing country) feasible import volumes can be identified.

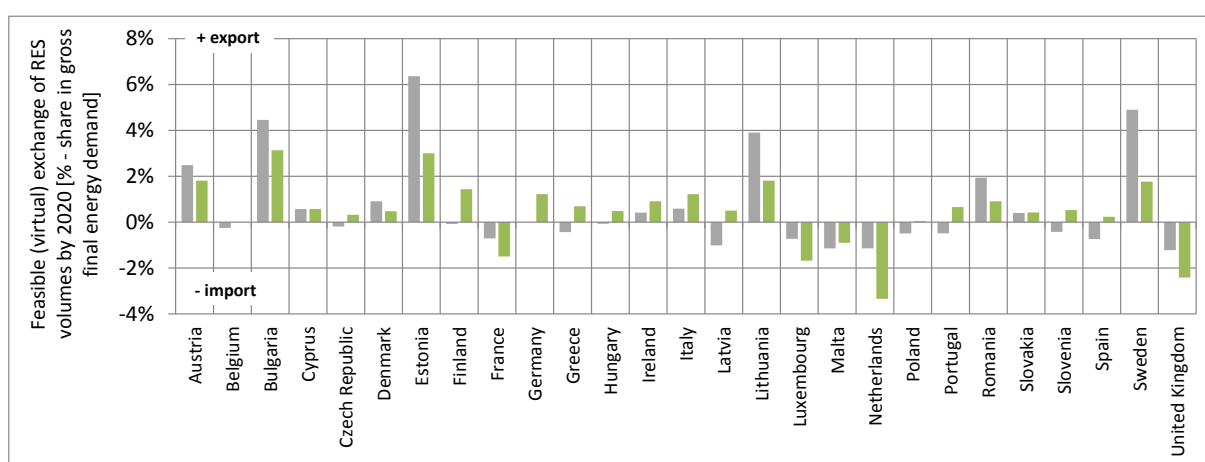


Figure 14: Feasible (virtual) exchange of RES volumes between Member States (i.e. RES cooperation) by 2020 according to the assessed cases (BAU vs. PR)

Table 3: RES share in gross final energy demand by 2020 at Member State level for both assessed cases (BAU vs. PR) with and without RES cooperation

RES share in gross final energy demand by 2020			RES share without cooperation (BAU)	RES share with cooperation (BAU)	RES share without cooperation (PR)	RES share with cooperation (PR)
		RES target				
Austria	%	34.0%	36.5%	34.0%	38.7%	36.9%
Belgium	%	13.0%	11.5%	11.8%	13.0%	13.0%
Bulgaria	%	16.0%	20.5%	16.0%	24.2%	21.1%
Cyprus	%	13.0%	13.6%	13.0%	14.5%	13.9%
Czech Republic	%	13.0%	11.9%	12.1%	13.8%	13.5%
Denmark	%	30.0%	30.9%	30.0%	31.3%	30.8%
Estonia	%	25.0%	31.4%	25.0%	32.9%	29.9%
Finland	%	38.0%	37.5%	37.6%	41.8%	40.3%
France	%	23.0%	18.8%	19.5%	21.5%	23.0%
Germany	%	18.0%	17.9%	18.0%	21.2%	20.0%
Greece	%	18.0%	15.4%	15.8%	19.8%	19.1%
Hungary	%	13.0%	12.6%	12.6%	14.3%	13.8%
Ireland	%	16.0%	16.4%	16.0%	18.4%	17.5%
Italy	%	17.0%	17.6%	17.0%	20.2%	19.0%
Latvia	%	40.0%	34.0%	35.0%	41.3%	40.8%
Lithuania	%	23.0%	26.9%	23.0%	27.8%	25.9%
Luxembourg	%	11.0%	6.7%	7.4%	9.3%	11.0%
Malta	%	10.0%	3.2%	4.4%	9.1%	10.0%
Netherlands	%	14.0%	7.2%	8.4%	10.7%	14.0%
Poland	%	15.0%	12.1%	12.6%	15.1%	15.1%
Portugal	%	31.0%	28.1%	28.6%	32.7%	32.1%
Romania	%	24.0%	25.9%	24.0%	26.4%	25.5%
Slovakia	%	14.0%	14.4%	14.0%	15.1%	14.7%
Slovenia	%	25.0%	22.5%	22.9%	26.4%	25.9%
Spain	%	20.0%	15.6%	16.4%	20.6%	20.4%
Sweden	%	49.0%	53.9%	49.0%	53.6%	51.9%
United Kingdom	%	15.0%	7.8%	9.0%	12.6%	15.0%
EU27	%	20.0%	17.9%	17.9%	21.0%	21.0%

Detailed results on domestic RES deployment by Member State



This section provides details on country-specific RES developments in the 2020 context. Thus, on the following pages for each Member State a closer look is taken on domestic RES deployment at the aggregated and at sector and technology level.

Austria

For Austria it can be expected that its 2020 RES target can be achieved under baseline conditions, i.e. if currently implemented RES policy measures are kept in place and framework conditions may not change to the worse in forthcoming years. Thus, Austria is a candidate for exporting surpluses in RES deployment that are not needed for own target fulfilment - again, even under baseline conditions this appears likely (cf. Figure 16). A closer look at the sector level indicates that significant progress can be expected in forthcoming years for RES in the electricity sector but also RES in heating & cooling and in transport show a continuous and steady growth. Thus, as demonstrated by the PR scenario the feasible progress is higher if policy recommendations like an increase of subsidy volumes for RES-H&C (see EU Tracking Roadmap 2014 (Keep-on-Track!, 2014) for details) are implemented in time. This may increase the contribution of various new RES technologies in the heating and cooling but also in the electricity sector, see for example Figure 17 and Figure 18.

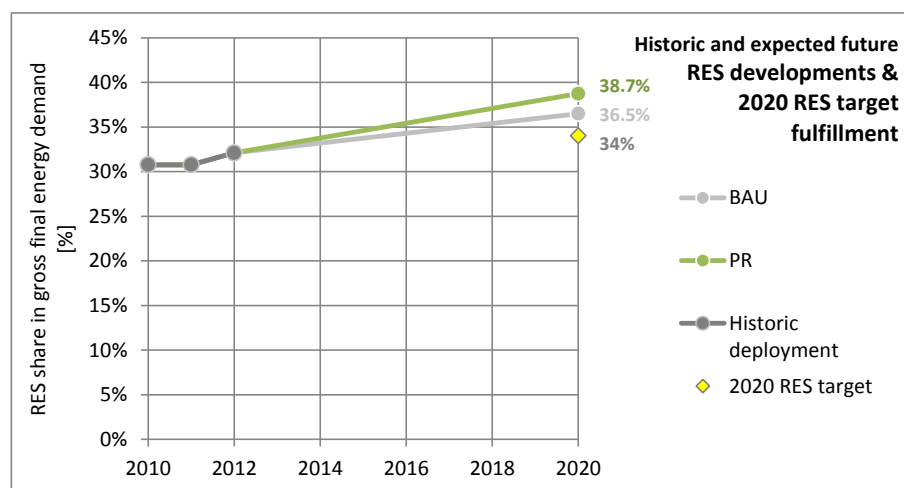


Figure 15: RES developments up to 2020 in Austria in relative terms (i.e. RES share in gross final energy demand) according to assessed cases (BAU and PR)

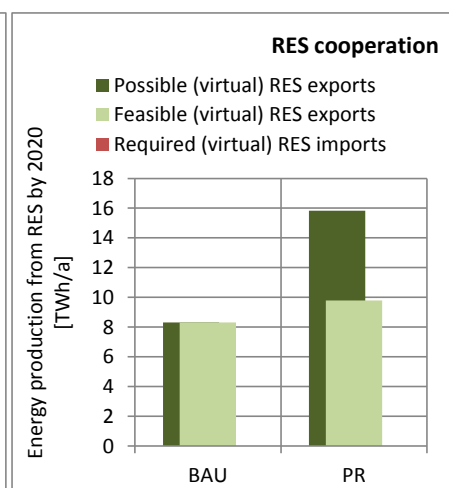


Figure 16: RES cooperation by 2020 in Austria according to assessed cases (BAU and PR)

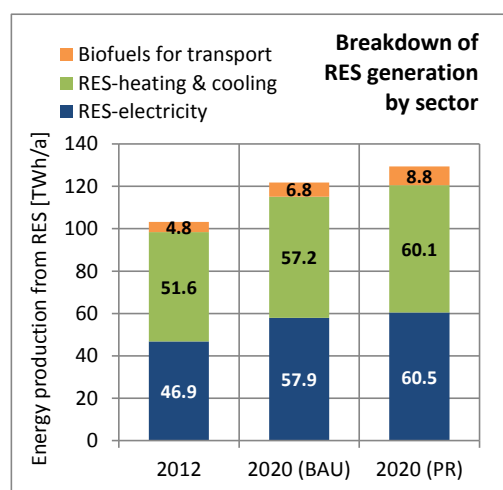


Figure 17: Breakdown of RES generation by sector in Austria in 2012 and 2020 according to assessed cases (BAU and PR)

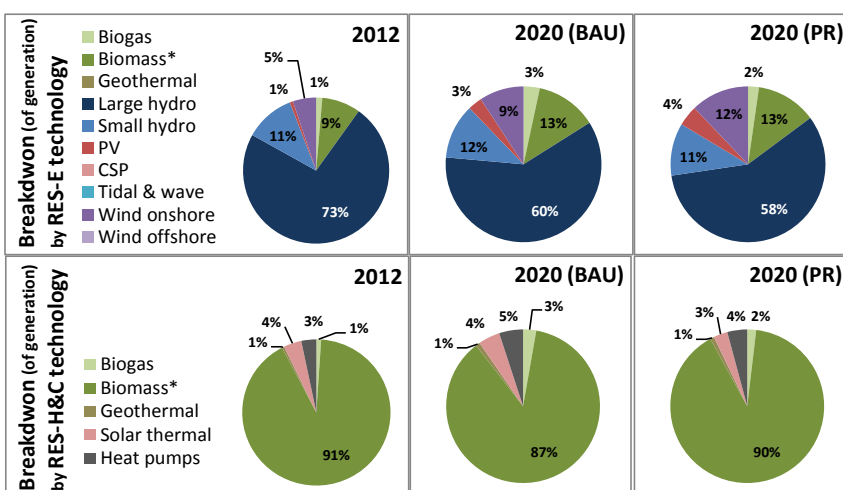


Figure 18: Breakdown of RES generation by technology and by sector (electricity (up) and heating & cooling (down) in Austria in 2012 and 2020 according to assessed cases (BAU and PR)

Belgium

Belgium is a Member State where the achievement of its 2020 RES target is not expected under baseline conditions, see Figure 19. This may however change if policy recommendations like the establishment of a legal framework for each RES technology in the electricity sector and for RES in heating and cooling (see EU Tracking Roadmap 2014 (Keep-on-Track!, 2014) for details) are implemented in time. As demonstrated by the PR scenario, Belgium may then well achieve its 2020 target, caused by an expansion of various new RES technologies for heating and cooling but also in the electricity sector, see Figure 21 and Figure 22. As also shown in the PR scenario biofuels in transport have the potential to contribute significantly more towards target fulfilment - for doing so, a clarification on sustainability criteria and/or a dedication to specific applications is of need, aiming to increase social acceptance.

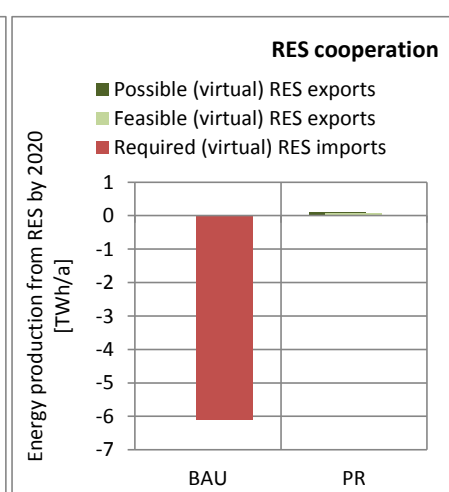
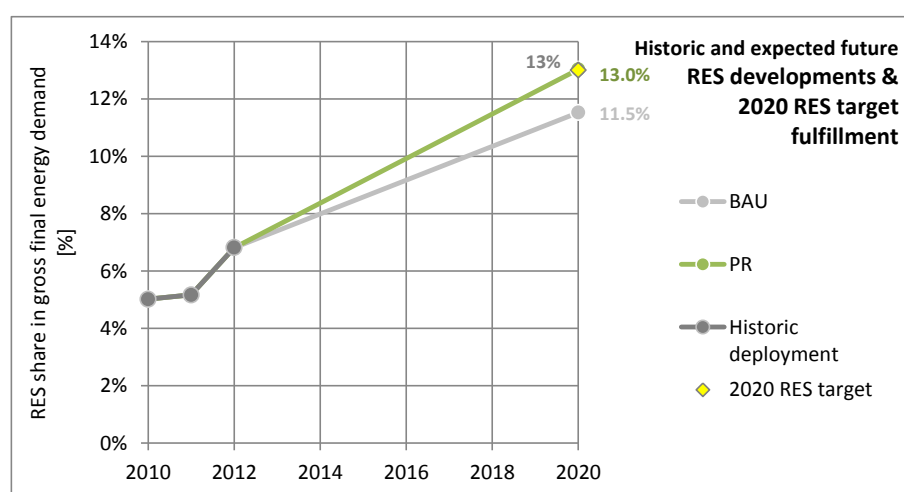


Figure 19: RES developments up to 2020 in Belgium in relative terms (i.e. RES share in gross final energy demand) according to assessed cases (BAU and PR)

Figure 20: RES cooperation by 2020 in Belgium according to assessed cases (BAU and PR)

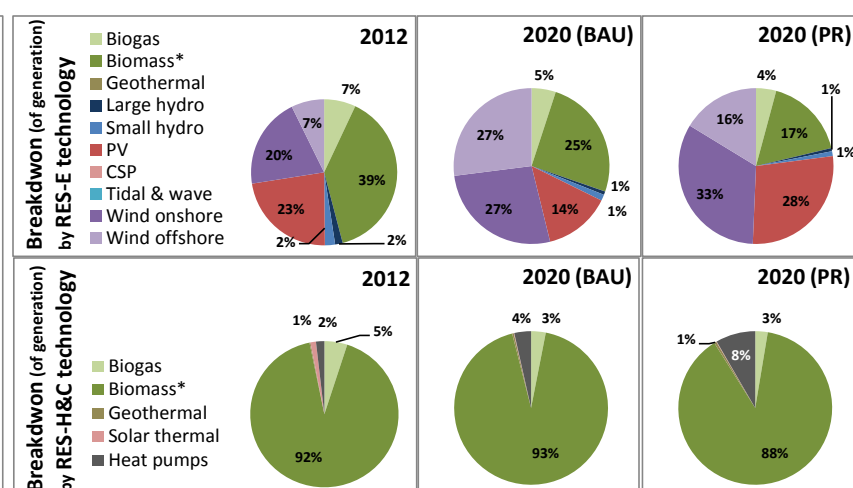
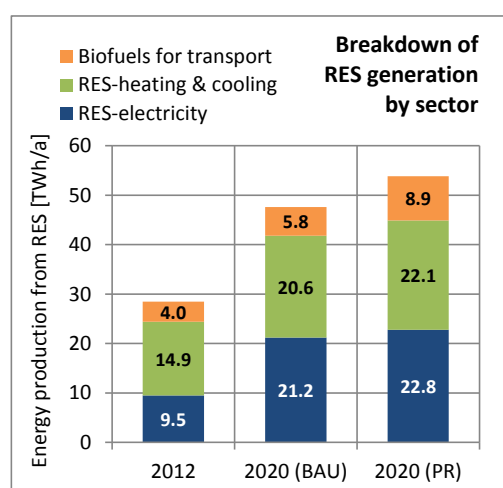


Figure 21: Breakdown of RES generation by sector in Belgium in 2012 and 2020 according to assessed cases (BAU and PR)

Figure 22: Breakdown of RES generation by technology and by sector (electricity (up) and heating & cooling (down)) in Belgium in 2012 and 2020 according to assessed cases (BAU and PR)

Bulgaria

For Bulgaria it can be expected that its 2020 RES target can be achieved under baseline conditions, i.e. if currently implemented RES policy measures are kept in place and framework conditions may not change to the worse in forthcoming years. The results of the scenario work clearly show that Bulgaria has the potential to act as seller in a European market on RES cooperation - even under baseline conditions this appears likely (see Figure 24). Important for the Bulgarian case is however that implemented RES policy measures are executed as foreseen, meaning that Government bodies and other relevant entities do not disregard previously adopted official regulations since such a lack of transparency has been a key barrier for an enhanced RES take-off in the past. Moreover, the alternative PR scenario clearly demonstrates that much more than needed appears feasible in the 2020 context. This requires that policy recommendations like the establishment of an adequate incentive scheme for RES-H&C (see EU Tracking Roadmap 2014 (Keep-on-Track!, 2014)) are implemented in time.

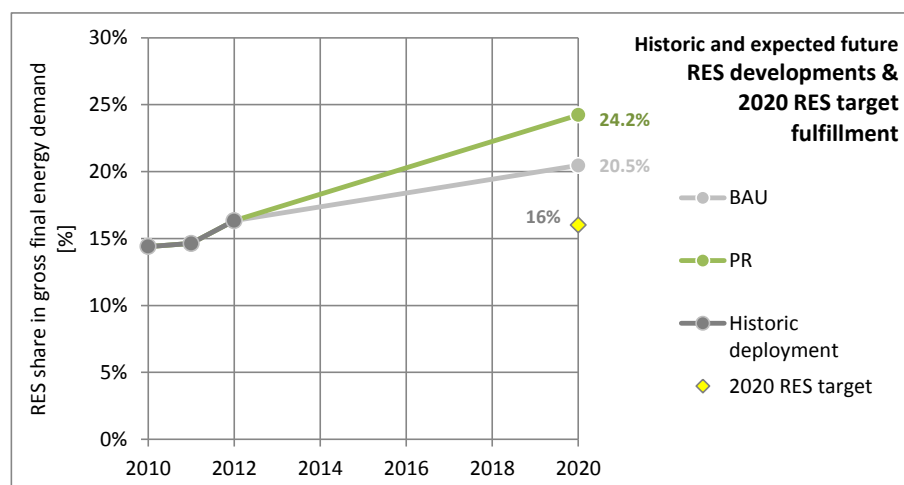


Figure 23: RES developments up to 2020 in Bulgaria in relative terms (i.e. RES share in gross final energy demand) according to assessed cases (BAU and PR)

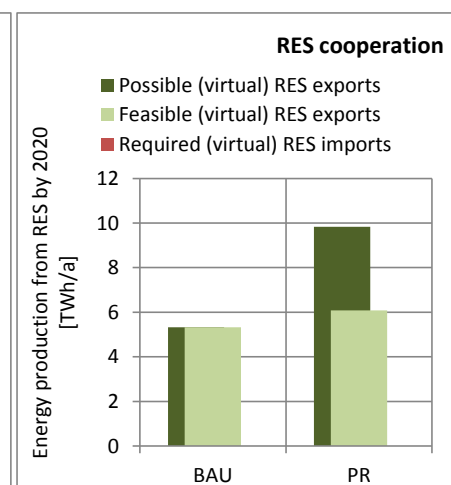


Figure 24: RES cooperation by 2020 in Bulgaria according to assessed cases (BAU and PR)

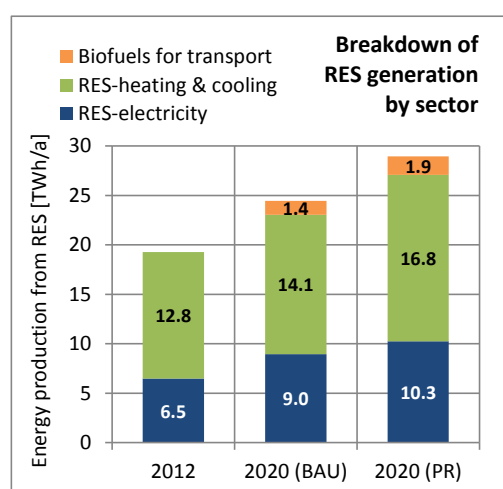


Figure 25: Breakdown of RES generation by sector in Bulgaria in 2012 and 2020 according to assessed cases (BAU and PR)

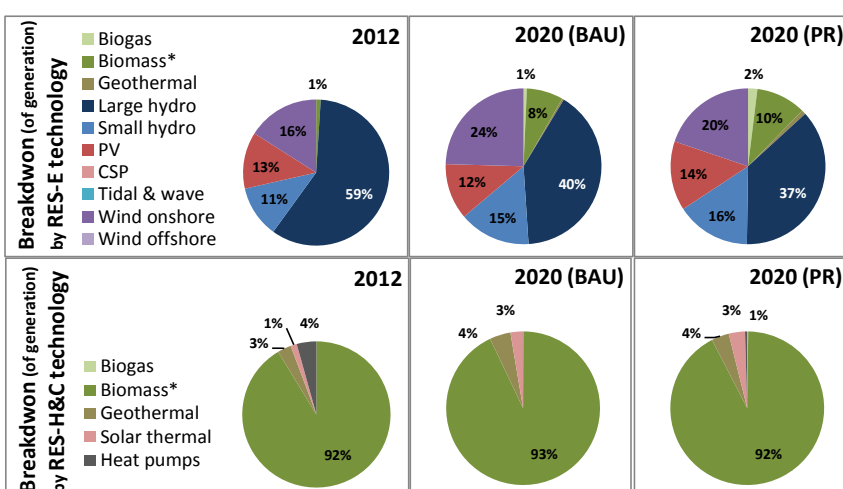


Figure 26: Breakdown of RES generation by technology and by sector (electricity (up) and heating & cooling (down) in Bulgaria in 2012 and 2020 according to assessed cases (BAU and PR)

Cyprus

Modelling outcomes show that Cyprus will already achieve its 2020 RES target under baseline conditions. By doing so Cyprus will become a candidate for exporting RES surpluses that are not needed for own target fulfilment - again, even under baseline conditions this appears likely (cf. Figure 28). Uncertainty however remains in this respect since the overall surplus is comparatively small, i.e. a surplus of 0.6% percentage points is expected by 2020 in the BAU case, and because compared to the status quo there is still a strong RES expansion necessary in forthcoming years. Reliability and complexity of the existing legal framework for RES-E is a major concern today as indicated in the policy recommendations derived for Cyprus (see EU Tracking Roadmap 2014 (Keep-on-Track!, 2014)), and the negative impact of these issues is possibly underestimated in the BAU case. An even more optimistic picture is drawn by the PR scenario where an extension of the support for biofuels in transport and improvements related to incentives for RES in heating & cooling are assumed, see Figure 29.

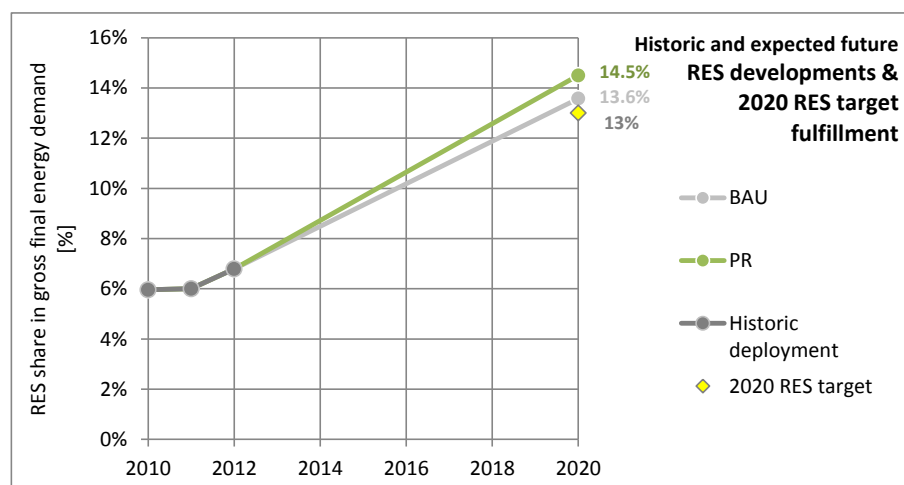


Figure 27: RES developments up to 2020 in Cyprus in relative terms (i.e. RES share in gross final energy demand) according to assessed cases (BAU and PR)

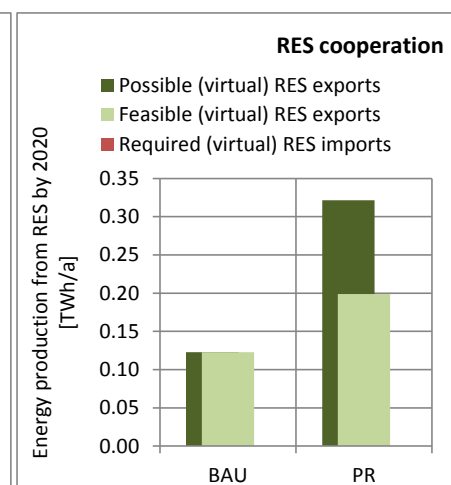


Figure 28: RES cooperation by 2020 in Cyprus according to assessed cases (BAU and PR)

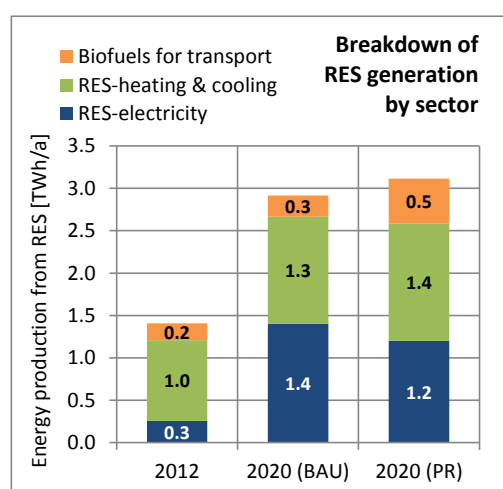


Figure 29: Breakdown of RES generation by sector in Cyprus in 2012 and 2020 according to assessed cases (BAU and PR)

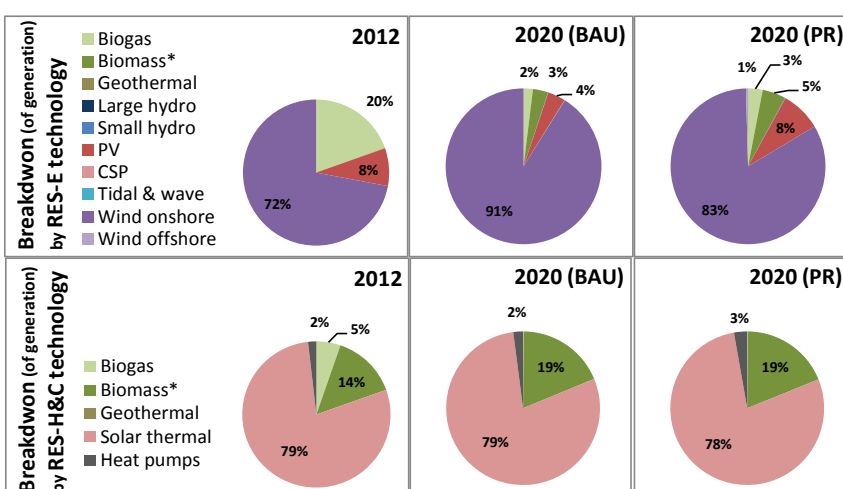


Figure 30: Breakdown of RES generation by technology and by sector (electricity (up) and heating & cooling (down) in Cyprus in 2012 and 2020 according to assessed cases (BAU and PR)

Czech Republic

Despite a strong uptake of RES deployment in previous years the Czech Republic is expected to fail in achieving its 2020 RES target under baseline conditions. The main reason for that is the unpredictable and unstable support for renewables in the various sectors. Thanks to past initiatives for RES-E there is however progress in deployment expected in the near future, specifically some wind or biogas projects are expected to remain in their pipeline of realisation. If policy recommendations like to sharpen and to extend support for RES-H&C and for biofuels in transport (see EU Tracking Roadmap 2014 (Keep-on-Track!, 2014) for details) are implemented, a sufficiently strong uptake of RES appears feasible. Thus, in the PR scenario the Czech Republic turns from an importer (BAU case) to an exporter country related to European RES cooperation (cf. Figure 32) and major contributor for doing so are biofuels in transport and RES-H&C (see Figure 33).

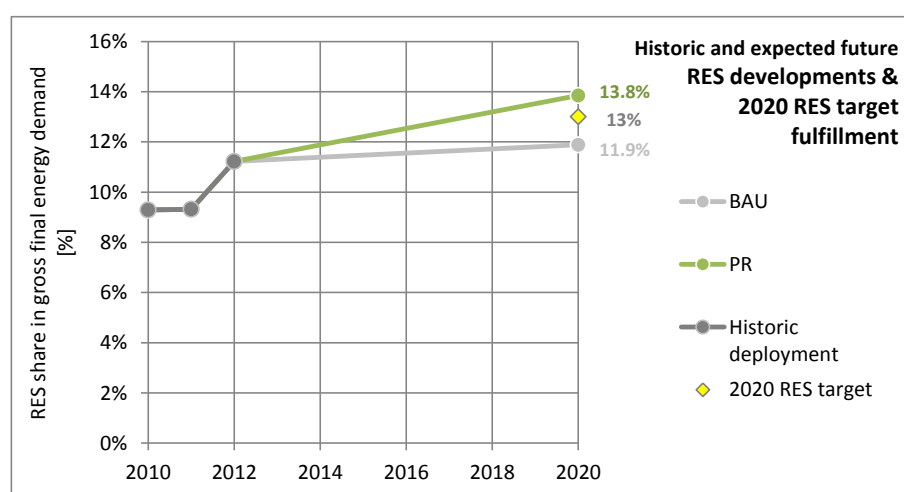


Figure 31: RES developments up to 2020 in the Czech Republic in relative terms (i.e. RES share in gross final energy demand) according to assessed cases (BAU and PR)

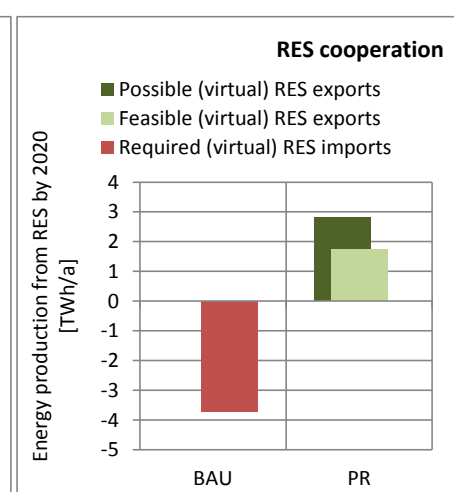


Figure 32: RES cooperation by 2020 in the Czech Republic according to assessed cases (BAU and PR)

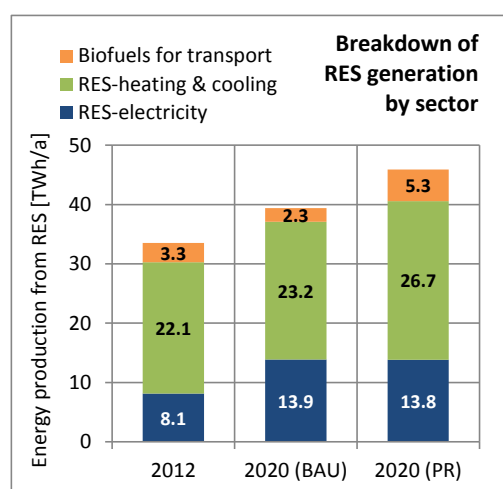


Figure 33: Breakdown of RES generation by sector in the Czech Republic in 2012 and 2020 according to assessed cases (BAU and PR)

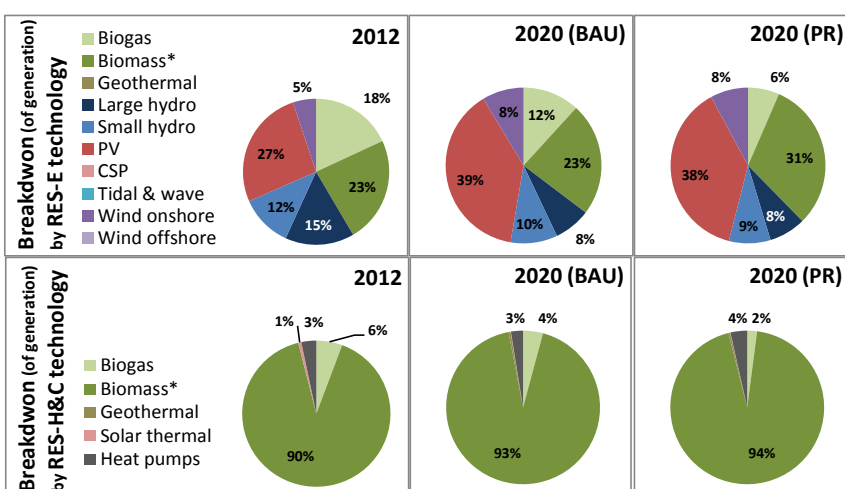


Figure 34: Breakdown of RES generation by technology and by sector (electricity (up) and heating & cooling (down)) in the Czech Republic in 2012 and 2020 according to assessed cases (BAU and PR)

Denmark

Denmark is on track to achieve its 2020 RES target. RES deployment by 2020 in the BAU case is 0.9 percentage points above the given target (30%). According to the PR case a further increase to 31.3% is feasible thanks to an increase of RES deployment in heating & cooling and in transport - despite reduced efforts for RES-E (compared to BAU). This indicates that overall RES target achievement is beyond question if currently implemented RES policy measures are kept in place and framework conditions may not change to the worse in forthcoming years. Generally, Denmark may act as exporter of surpluses in RES deployment in a European market related to RES cooperation. As shown in Figure 36 the possible export volumes increase from BAU to PR while feasibility for doing so decreases since several MSs with shortages under baseline conditions are expected to achieve their given targets domestically if policy recommendations are implemented (PR case).

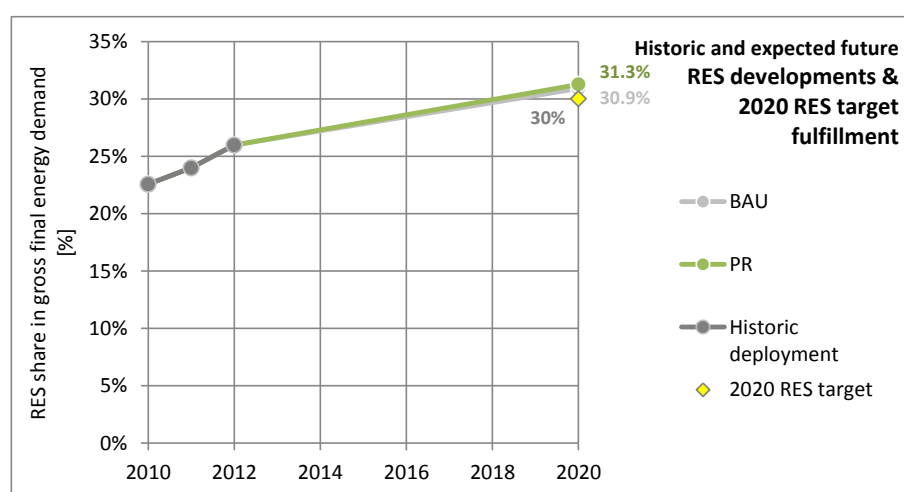


Figure 35: RES developments up to 2020 in Denmark in relative terms (i.e. RES share in gross final energy demand) according to assessed cases (BAU and PR)

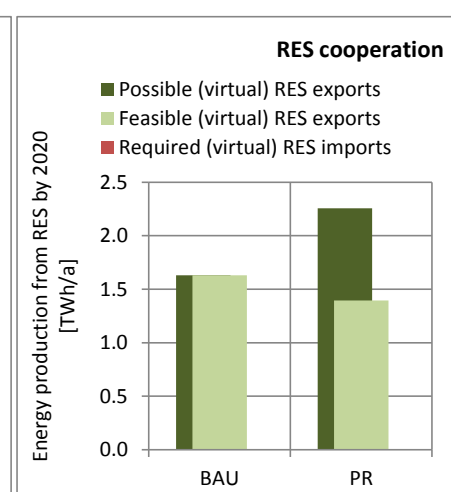


Figure 36: RES cooperation by 2020 in Denmark according to assessed cases (BAU and PR)

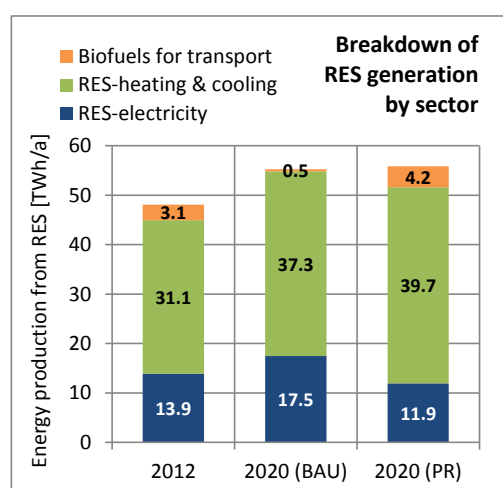


Figure 37: Breakdown of RES generation by sector in Denmark in 2012 and 2020 according to assessed cases (BAU and PR)

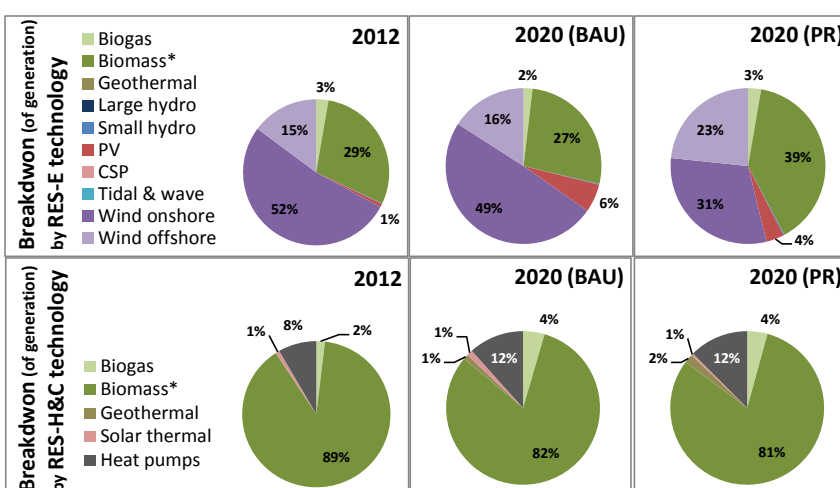


Figure 38: Breakdown of RES generation by technology and by sector (electricity (up) and heating & cooling (down) in Denmark in 2012 and 2020 according to assessed cases (BAU and PR)

Estonia

As applicable from Figure 39 Estonia is well on track to achieve its 2020 RES target of 25%. If currently implemented RES policy measures are kept in place and framework conditions may not change to the worse in forthcoming years (BAU case) a significant surplus appears feasible: a RES share of 31.4% can be expected under baseline conditions. RES deployment may increase further to 32.9% if policy recommendations like the introduction of RES-H building obligations (see EU Tracking Roadmap 2014 (Keep-on-Track!, 2014) for details) are reflected in future policy making. Under both assessed cases Estonia is a candidate for exporting surpluses in RES deployment that are not needed for own target fulfilment, see Figure 40. Despite an increase of the surplus in RES deployment as indicated by the possible exports, feasible (virtual) RES export volumes are higher under baseline conditions due to a shortage in RES deployment at EU level (and, in turn, an increased demand).

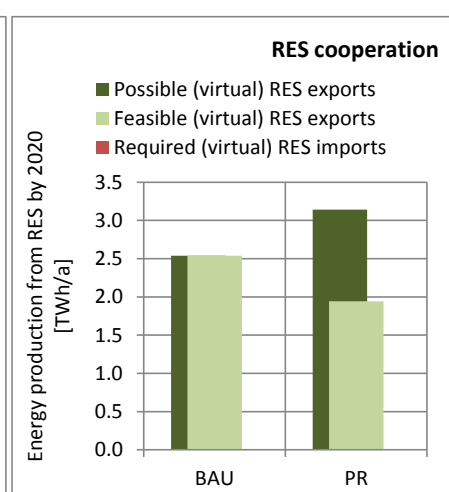
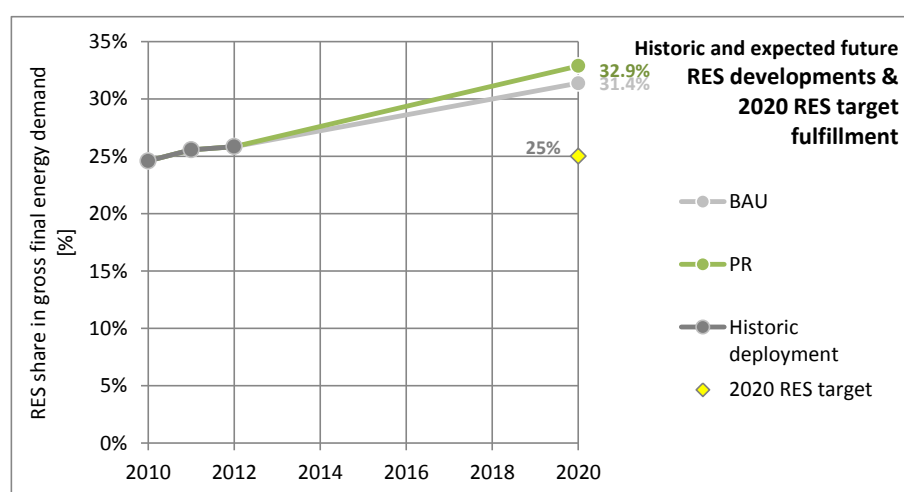


Figure 39: RES developments up to 2020 in Estonia in relative terms (i.e. RES share in gross final energy demand) according to assessed cases (BAU and PR)

Figure 40: RES cooperation by 2020 in Estonia according to assessed cases (BAU and PR)

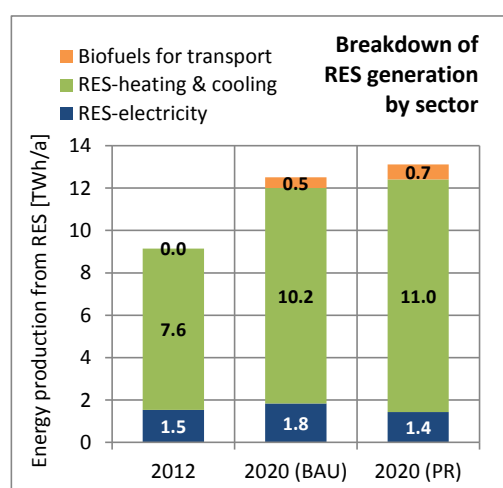


Figure 41: Breakdown of RES generation by sector in Estonia in 2012 and 2020 according to assessed cases (BAU and PR)

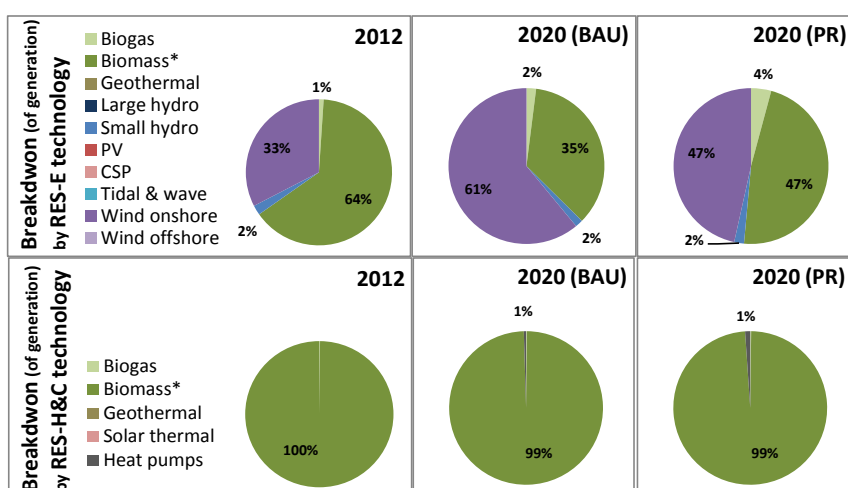


Figure 42: Breakdown of RES generation by technology and by sector (electricity (up) and heating & cooling (down) in Estonia in 2012 and 2020 according to assessed cases (BAU and PR)

Finland

The results on RES deployment in Finland as shown in Figure 43 indicate a small gap (37.5% instead of 38%) by 2020 under baseline conditions. This falls within the typical uncertainty corridor but can be understood as a warning signal to improve the RES policy framework in Finland in the near future. The policy recommendations derived within this project like the improvement of the attractiveness for small-scale RES-H&C (see EU Tracking Roadmap 2014 (Keep-on-Track!, 2014) for details) may guide this reform process. Moreover, the PR scenario aims to reflect the impacts of implementing the recommendations derived. Apparently, Finland may get well back on track and may even achieve a significant surplus (about 12 TWh or 3.8 percentage points) by 2020, cf. Figure 43 and Figure 44. This is the consequence of an accelerated take-off of RES within all energy sectors as demonstrated by the PR case.

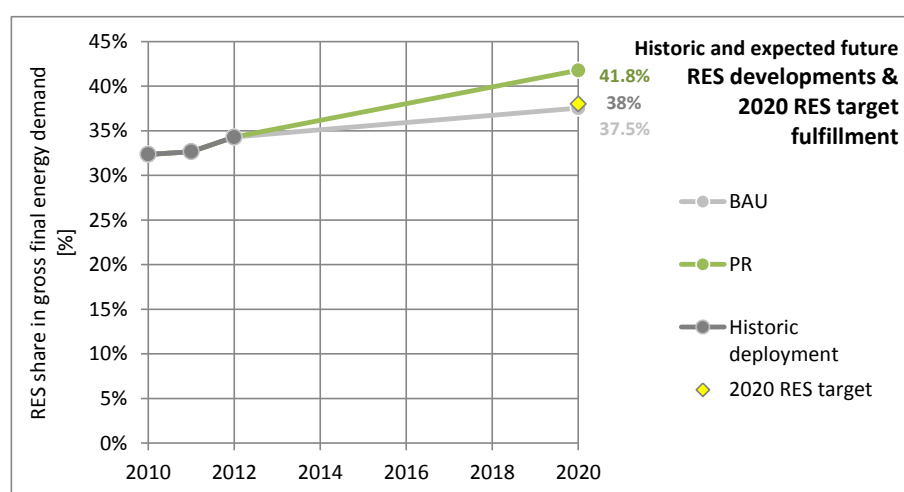


Figure 43: RES developments up to 2020 in Finland in relative terms (i.e. RES share in gross final energy demand) according to assessed cases (BAU and PR)

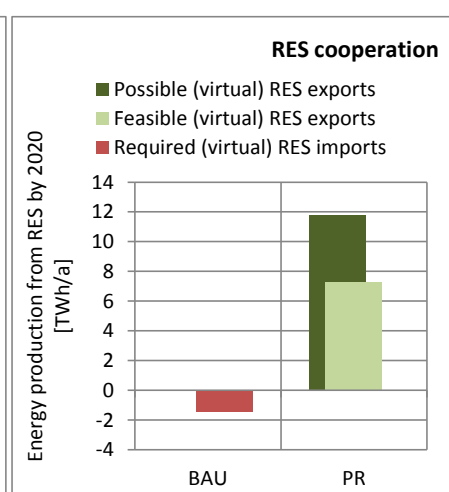


Figure 44: RES cooperation by 2020 in Finland according to assessed cases (BAU and PR)

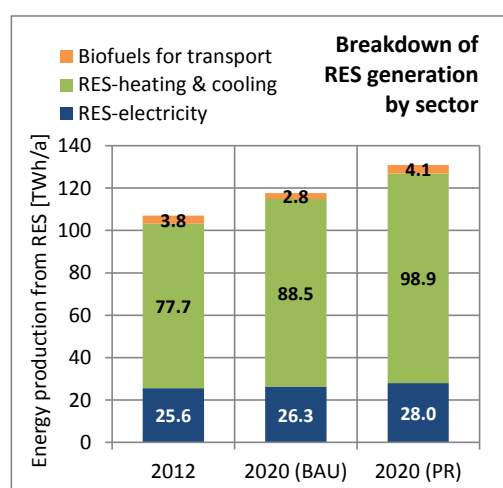


Figure 45: Breakdown of RES generation by sector in Finland in 2012 and 2020 according to assessed cases (BAU and PR)

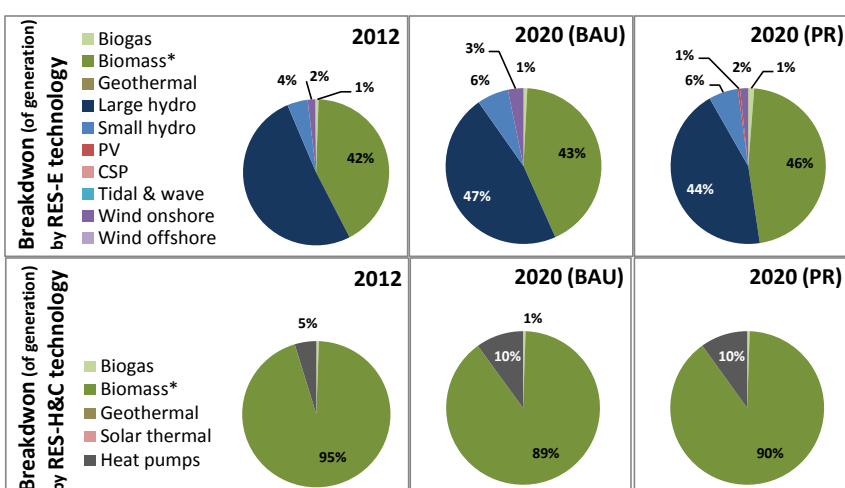


Figure 46: Breakdown of RES generation by technology and by sector (electricity (up) and heating & cooling (down) in Finland in 2012 and 2020 according to assessed cases (BAU and PR)

France

France is not well on track with respect to its 2020 RES target. Under both assessed cases (BAU and PR) a deficit can be expected by 2020, see Figure 47. The gap in domestic RES deployment that needs to be filled through proactive use of RES cooperation mechanisms is comparatively large under baseline conditions - i.e. a deficit of 4.2 percentage points, corresponding to about 76 TWh can be expected for 2020 in the BAU case. The assessment of barriers and the derivation of policy recommendations as derived within this project (see EU Tracking Roadmap 2014 (Keep-on-Track!, 2014)) signpost our view of the necessary reforms while the PR case aims to indicate general consequences of doing so: An accelerated deployment of RES within all energy sectors as illustrated in Figure 49 may bring domestic RES use in France close to the given target (21.5% instead of 23% by 2020) and, in turn, reduces the need for (virtual) RES imports to ca. 27 TWh, cf. Figure 48.

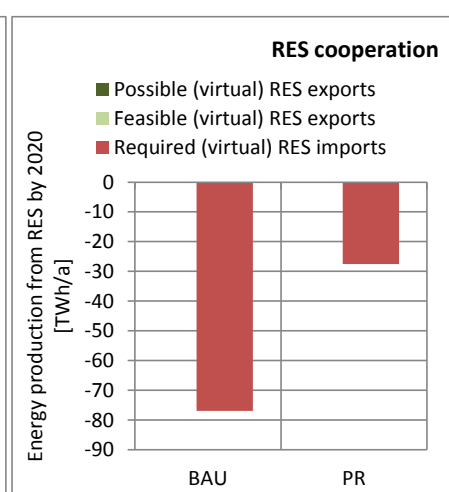
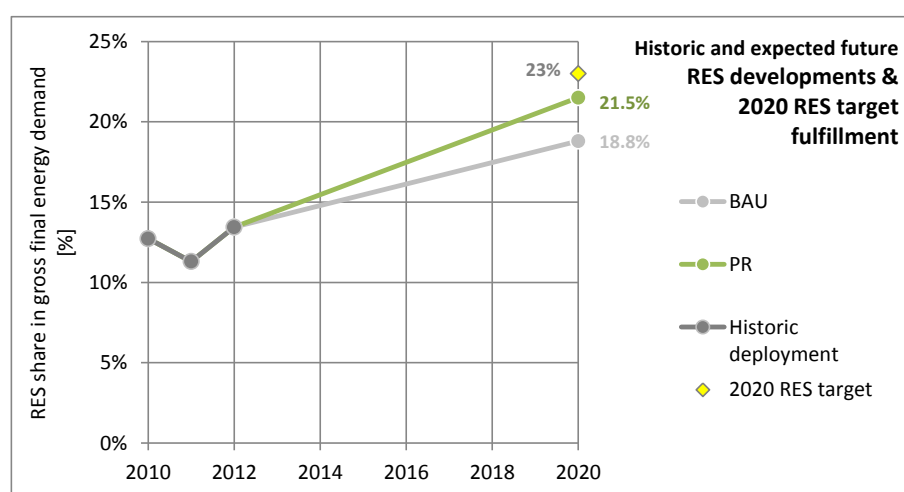


Figure 47: RES developments up to 2020 in France in relative terms (i.e. RES share in gross final energy demand) according to assessed cases (BAU and PR)

Figure 48: RES cooperation by 2020 in France according to assessed cases (BAU and PR)

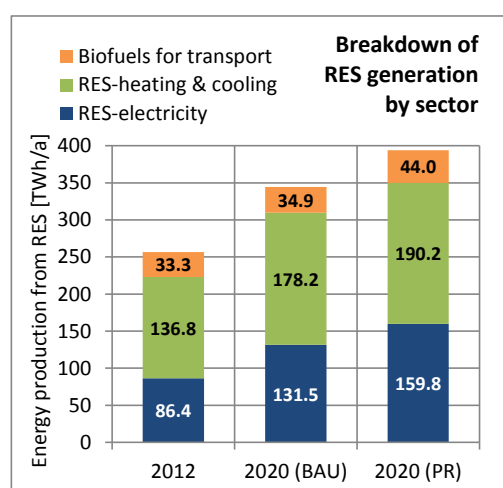


Figure 49: Breakdown of RES generation by sector in France in 2012 and 2020 according to assessed cases (BAU and PR)

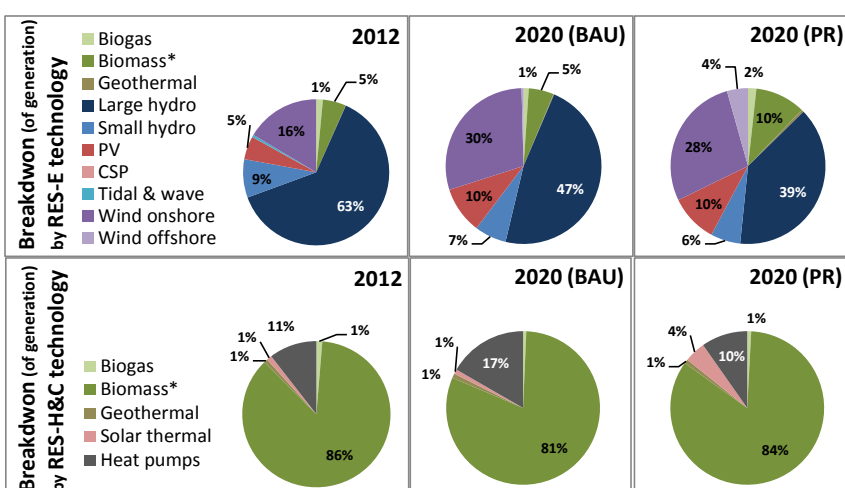


Figure 50: Breakdown of RES generation by technology and by sector (electricity (up) and heating & cooling (down)) in France in 2012 and 2020 according to assessed cases (BAU and PR)

Germany

For Germany it can be expected that the given 2020 RES target (18%) can be achieved under baseline conditions, i.e. if currently implemented RES policy measures are kept in place and framework conditions may not change to the worse in forthcoming years⁴. A negligible deficit of 0.1 percentage points, corresponding to 1.4 TWh in absolute terms, occurs in the BAU case in 2020, cf. Figure 51 and Figure 52. Through dedicated action as demonstrated by the PR case the uncertainty related to RES target achievement can however be significantly reduced. Policy recommendations like an improvement of the functionality of the RES-H&C market or an increase of the reliability of the general RES-E strategy (see EU Tracking Roadmap 2014 (Keep-on-Track!, 2014)) would boost RES deployment within all three energy sectors to 21.2%. In that case a significant surplus of about 78 TWh would occur and Germany would face the opportunity to act as seller in the EU market for RES cooperation, cf. Figure 52.

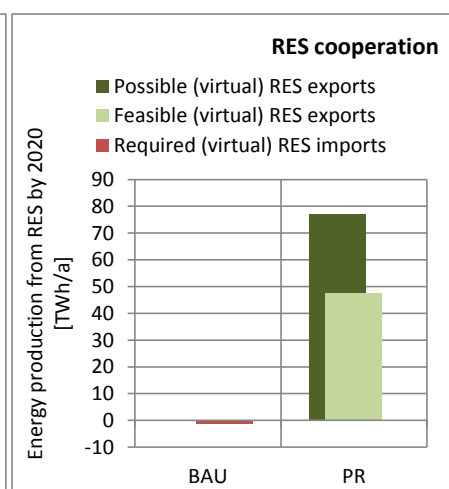
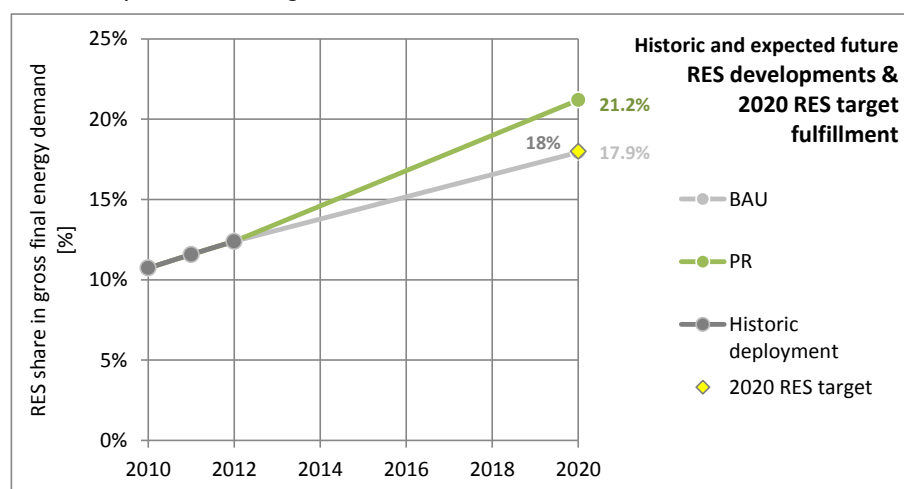


Figure 51: RES developments up to 2020 in Germany in relative terms (i.e. RES share in gross final energy demand) according to assessed cases (BAU and PR)

Figure 52: RES cooperation by 2020 in Germany according to assessed cases (BAU and PR)

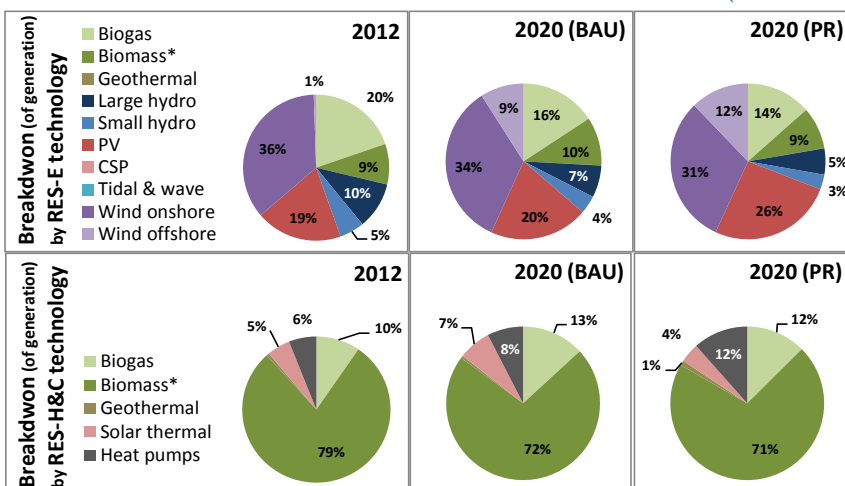
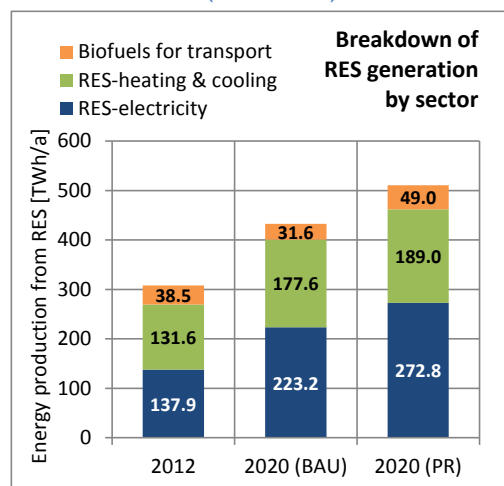


Figure 53: Breakdown of RES generation by sector in Germany in 2012 and 2020 according to assessed cases

Figure 54: Breakdown of RES generation by technology and by sector (electricity (up) and heating & cooling (down) in Germany in 2012 and 2020 according to assessed cases (BAU and PR)

⁴ Any RES policy changes made in regards to the new Erneuerbare Energien Gesetz (EEG) in 2014 are not considered in the BAU or PR cases.

Greece

Despite a strong uptake of RES deployment in previous years Greece is expected to fail in achieving its 2020 RES target under baseline conditions. As a consequence of currently unpredictable and unstable support for renewables in the various sectors, partly triggered by retroactive measures that have been taken for RES-E, and a generally limited access to finance, RES target achievement is getting out of reach in the BAU case (i.e. 15.4% compared to 18%). Thanks to past initiatives for RES-E there is however progress in deployment expected in the near future, specifically some PV projects have recently (throughout 2013 and 2014) started operation or remain in their pipeline of realisation. If policy recommendations like the implementation of a suitable strategy for RES-H&C and for biofuels in transport (see EU Tracking Roadmap 2014 (Keep-on-Track!, 2014)) are implemented well in time, a sufficiently strong uptake of RES appears however feasible. Thus, as shown in Figure 56 in the PR scenario Greece would then turn from an importer (BAU case) to an exporter country concerning RES cooperation. Key options for doing so are biofuels in transport and RES in the electricity sector (see Figure 57).

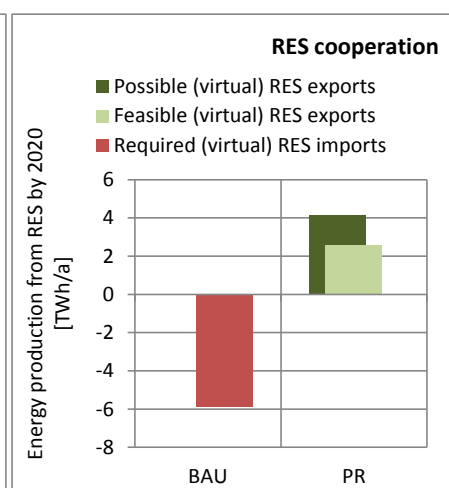
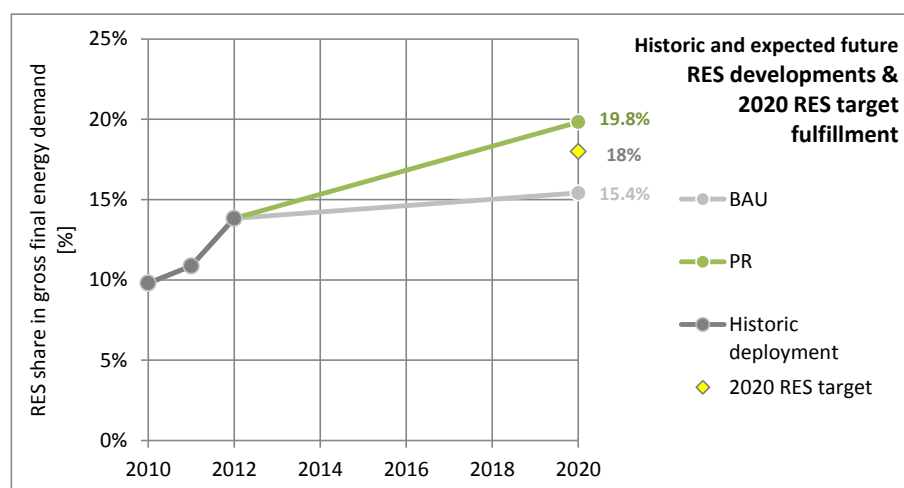


Figure 55: RES developments up to 2020 in Greece in relative terms (i.e. RES share in gross final energy demand) according to assessed cases (BAU and PR)

Figure 56: RES cooperation by 2020 in Greece according to assessed cases (BAU and PR)

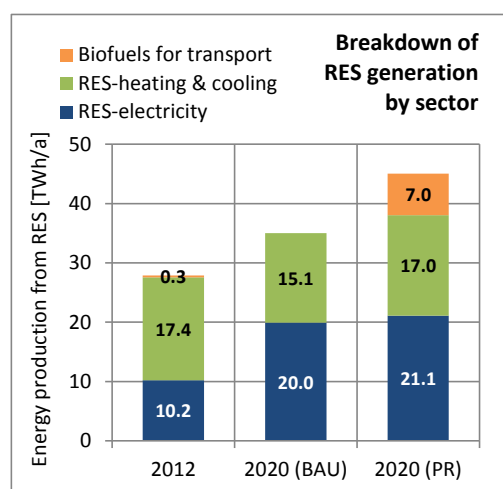


Figure 57: Breakdown of RES generation by sector in Greece in 2012 and 2020 according to assessed cases (BAU and PR)

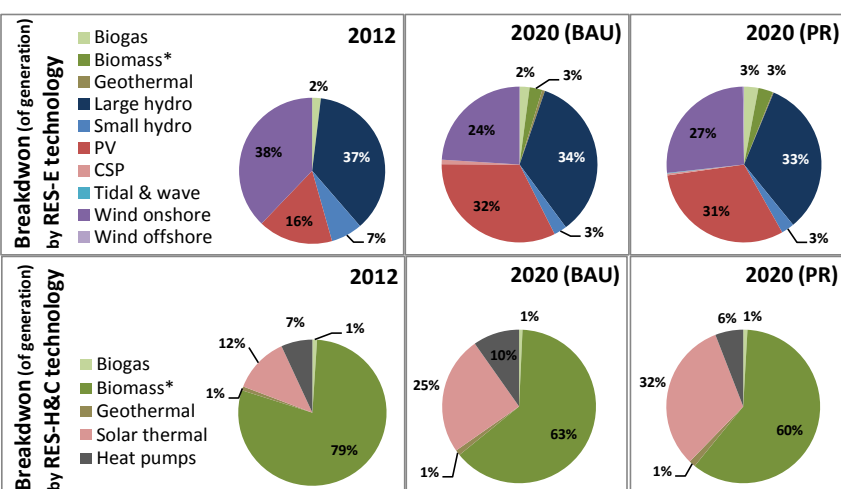


Figure 58: Breakdown of RES generation by technology and by sector (electricity (up) and heating & cooling (down) in Greece in 2012 and 2020 according to assessed cases (BAU and PR)

Hungary

Figure 59 indicates a small gap (12.6% instead of 13%) in RES deployment by 2020 for Hungary under baseline conditions, falling within the general uncertainty corridor related to this model-based analysis. However, it should but understood as a warning signal to improve the RES policy framework in Hungary in forthcoming years. The policy recommendations derived within this project like the simplification of the application procedures for RES-E support or the implementation of clearly defined rules for grid access (see EU Tracking Roadmap 2014 (Keep-on-Track!, 2014) for details) signpost the way forward in this respect. Thus, the PR scenario, reflecting the expected consequences of doing so, clearly shows that Hungary has the opportunity to get back on track and may even achieve a comparatively high surplus (about 2.5 TWh or 1.3 percentage points) by 2020, cf. Figure 59 and Figure 60. Thus, the PR case indicates an accelerated uptake of RES within all energy sectors whereby the expansion of RES-E and RES-H&C appears most impressive, cf. Figure 61.

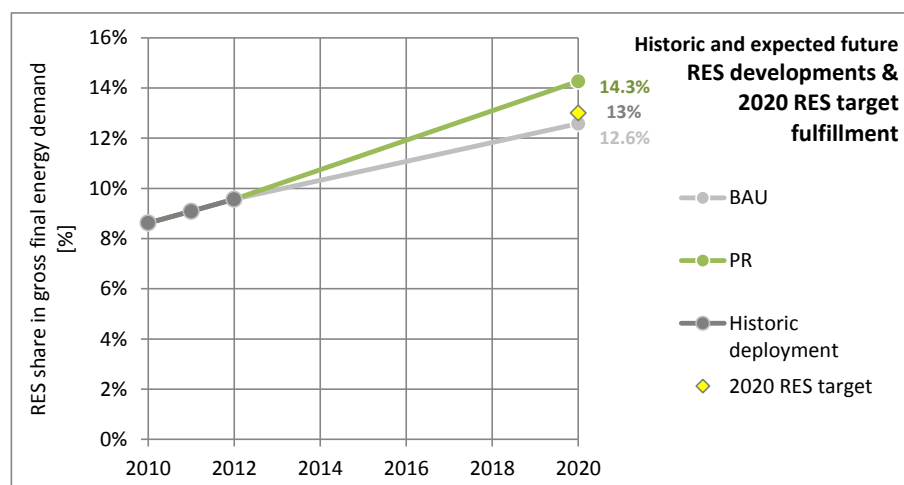


Figure 59: RES developments up to 2020 in Hungary in relative terms (i.e. RES share in gross final energy demand) according to assessed cases (BAU and PR)

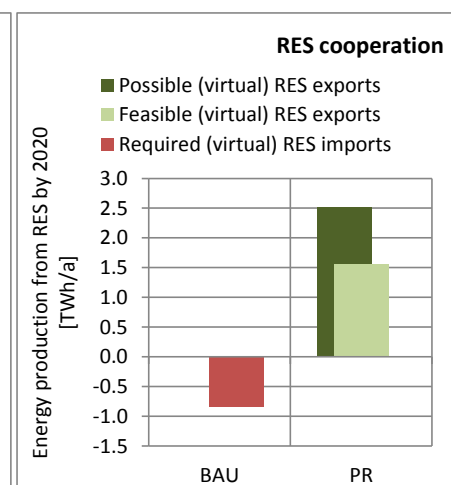


Figure 60: RES cooperation by 2020 in Hungary according to assessed cases (BAU and PR)

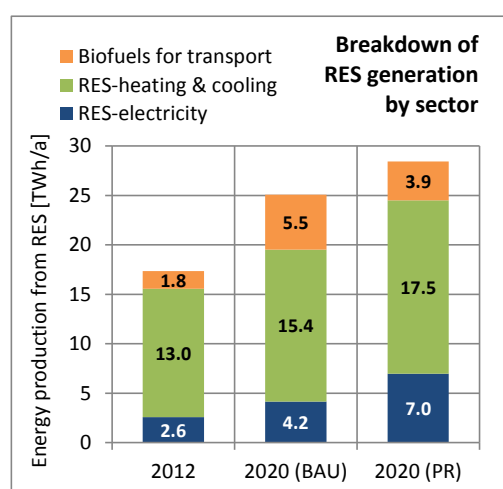


Figure 61: Breakdown of RES generation by sector in Hungary in 2012 and 2020 according to assessed cases (BAU and PR)

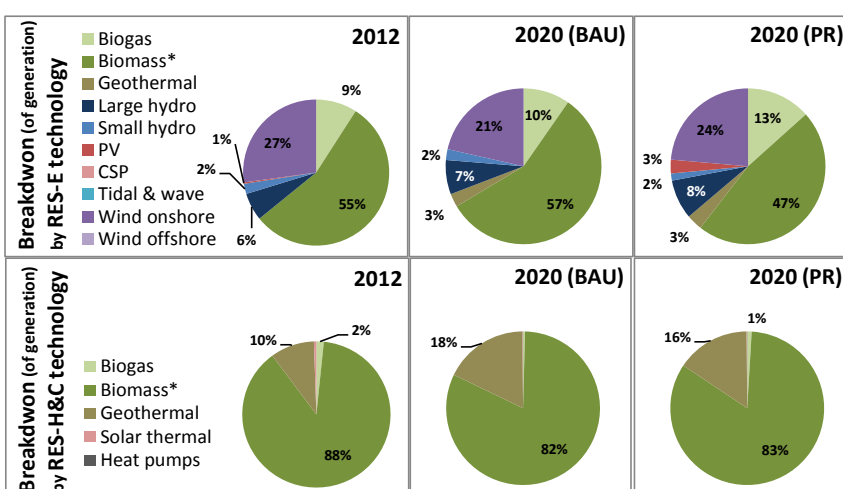


Figure 62: Breakdown of RES generation by technology and by sector (electricity (up) and heating & cooling (down) in Hungary in 2012 and 2020 according to assessed cases (BAU and PR)

Ireland

As shown in Figure 63 Ireland is expected to achieve its 2020 RES target if currently implemented RES policy measures are kept in place and framework conditions may not change to the worse in forthcoming years. Thus, even under baseline conditions Ireland may act as exporter of surpluses in RES deployment that are not needed for own target fulfilment. However, uncertainty remains in this respect since the overall surplus is comparatively small, i.e. a surplus of 0.4 percentage points is indicated according to the BAU case by 2020 and because compared to the status quo there is still a strong RES deployment necessary in forthcoming years. A simplification of planning and permitting procedures, especially for wind parks, or the establishment of a reliable RES-H&C strategy are two examples for policy recommendations as derived within this project (see EU Tracking Roadmap 2014 (Keep-on-Track!, 2014)) that aim to speed up RES deployment and, consequently, safeguard RES target achievement. By doing so, the potential for possible and also for feasible exports in a European market for RES cooperation would increase significantly, cf. Figure 64.

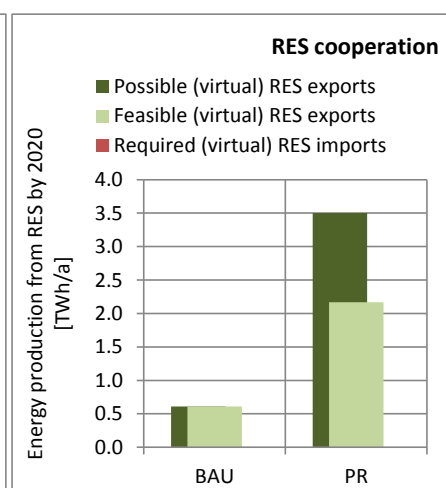
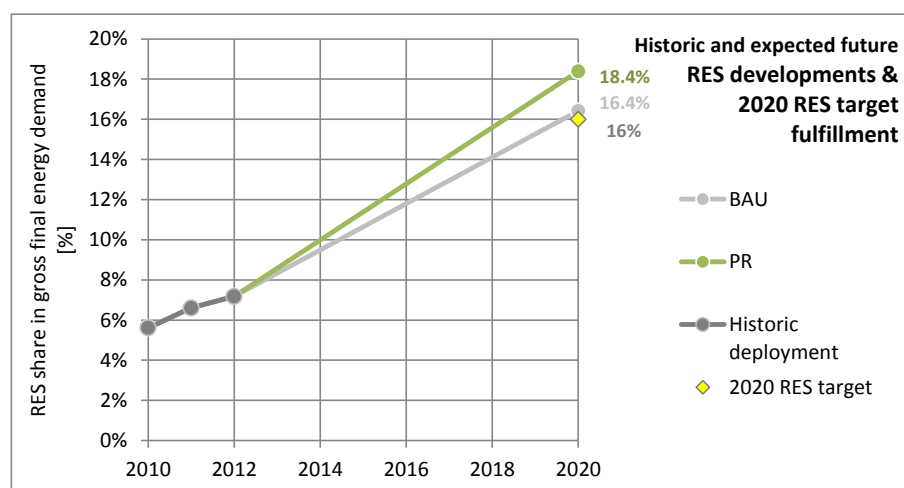


Figure 63: RES developments up to 2020 in Ireland in relative terms (i.e. RES share in gross final energy demand) according to assessed cases (BAU and PR)

Figure 64: RES cooperation by 2020 in Ireland according to assessed cases (BAU and PR)

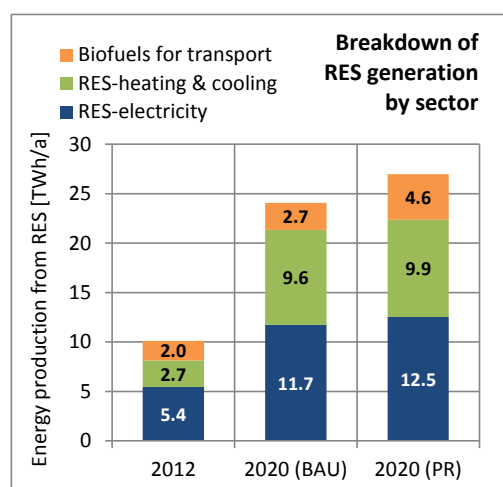


Figure 65: Breakdown of RES generation by sector in Ireland in 2012 and 2020 according to assessed cases (BAU and PR)

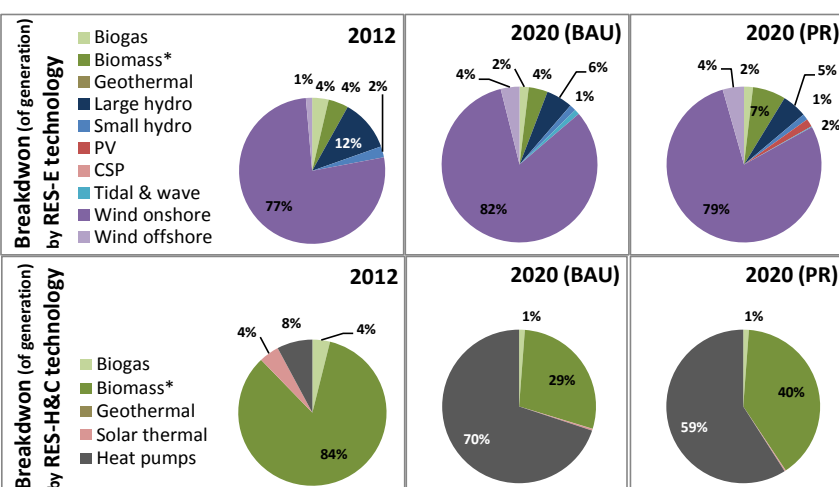


Figure 66: Breakdown of RES generation by technology and by sector (electricity (up) and heating & cooling (down) in Ireland in 2012 and 2020 according to assessed cases (BAU and PR)

Italy

Thanks to an impressive progress in RES deployment throughout previous years Italy is expected to achieve its 2020 RES target even under baseline conditions, i.e. if currently implemented RES policy measures are kept in place and framework conditions may not change to the worse in forthcoming years. Thus, a surplus of 0.6 percentage points corresponding to 8 TWh can be expected in the BAU case. Consequently, Italy is a candidate for exporting surpluses in RES deployment that are not needed for own target fulfilment to other Member States being short in domestic RES deployment. A closer look at the sector level indicates significant progress in forthcoming years for RES in the electricity sector but also RES in heating & cooling and in transport show a continuous and steady growth. Apparently, this progress is more impressive in the PR case, aiming to reflect the consequences of implementing targeted RES policy recommendations as derived within this project.

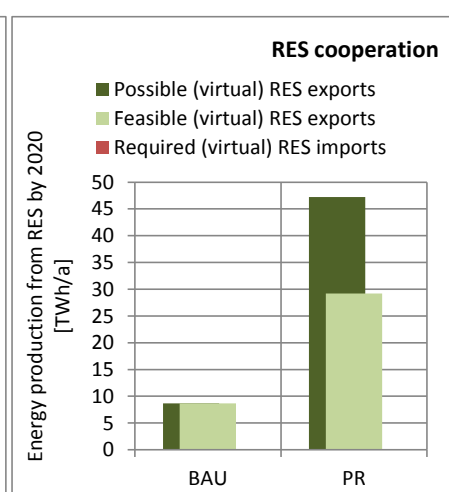
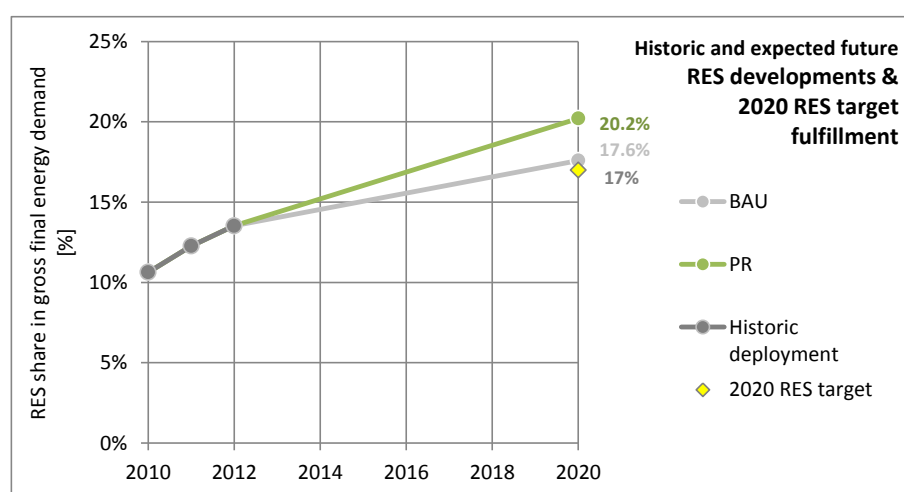


Figure 67: RES developments up to 2020 in Italy in relative terms (i.e. RES share in gross final energy demand) according to assessed cases (BAU and PR)

Figure 68: RES cooperation by 2020 in Italy according to assessed cases (BAU and PR)

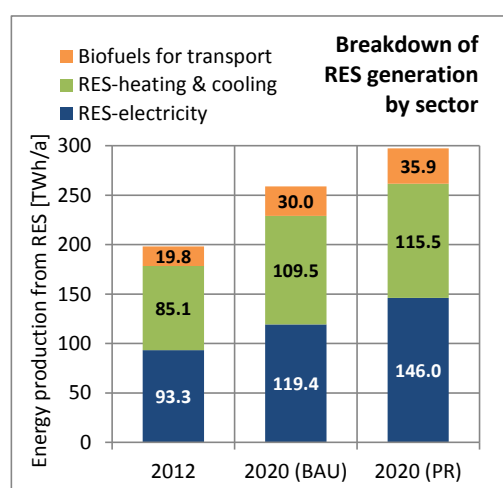


Figure 69: Breakdown of RES generation by sector in Italy in 2012 and 2020 according to assessed cases (BAU and PR)

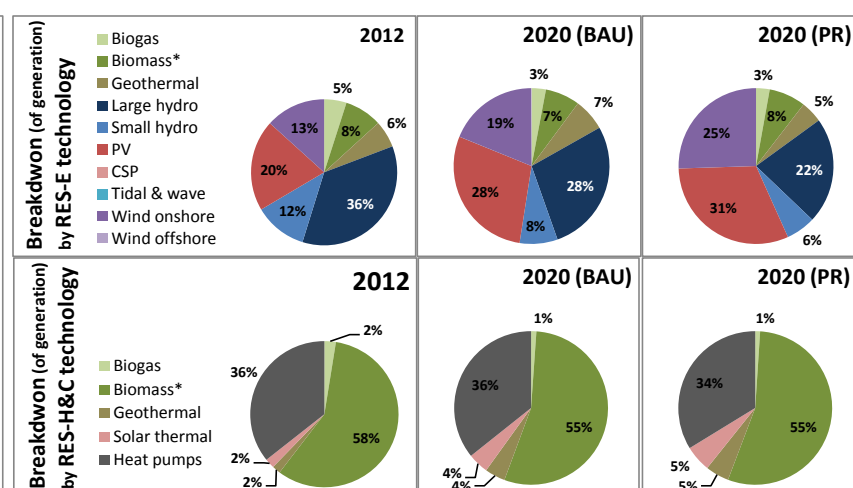


Figure 70: Breakdown of RES generation by technology and by sector (electricity (up) and heating & cooling (down) in Italy in 2012 and 2020 according to assessed cases (BAU and PR)

Latvia

Figure 71 shows a strong increase of the RES share (in gross final energy demand) in previous years in Latvia. The main reason for this positive trend is however a strong decline of energy consumption - but not a significant uptake of RES generation in absolute terms. Since the demand forecast used in this model-based assessment, i.e. the latest PRIMES reference scenario (EC, 2013), assumes a demand increase in forthcoming years up to 2020 the BAU scenario of future RES progress draws a pessimistic view on 2020 RES target achievement. Thus, a 2020 RES share of 34.0% can be expected under baseline conditions, leading to a significant gap compared to the given target (40%) (cf. Figure 72). As indicated by the PR scenario it appears feasible for Latvia to achieve and even over-succeed the 2020 RES target. If policy recommendations like a reliable and transparent RES policy design and implementation (see EU Tracking Roadmap 2014 (Keep-on-Track!, 2014)) are implemented in time, a sufficiently strong uptake of RES in all energy sectors appears feasible (cf. Figure 73). Thus, in the PR case Latvia turns from an importer (BAU case) to an exporter country related to European RES cooperation.

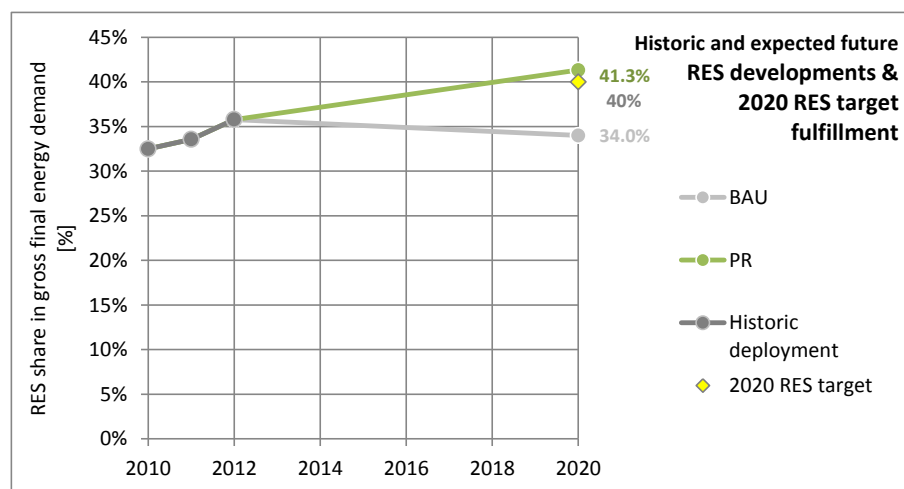


Figure 71: RES developments up to 2020 in Latvia in relative terms (i.e. RES share in gross final energy demand) according to assessed cases (BAU and PR)

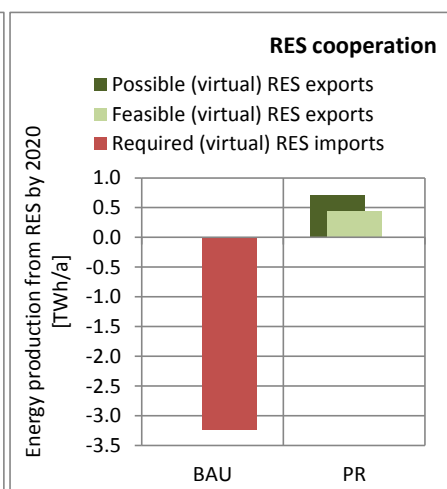


Figure 72: RES cooperation by 2020 in Latvia according to assessed cases (BAU and PR)

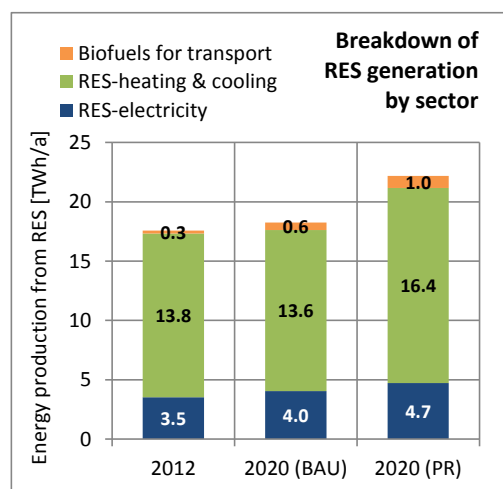


Figure 73: Breakdown of RES generation by sector in Latvia in 2012 and

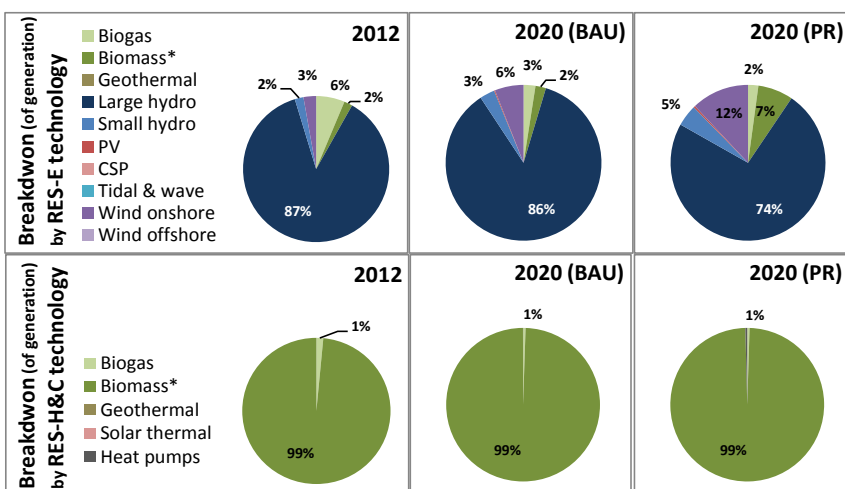


Figure 74: Breakdown of RES generation by technology and by sector (electricity (up) and heating & cooling (down) in Latvia in

2020 RES scenarios for Europe

-are Member States well on track for achieving 2020 RES targets?



2020 according to assessed cases
(BAU and PR)

2012 and 2020 according to assessed cases (BAU and PR)

Lithuania

It can be expected that Lithuania achieves its 2020 RES target under baseline conditions, i.e. if currently implemented RES policy measures are kept in place and framework conditions may not change to the worse in forthcoming years. Generally, Lithuania may act as exporter of surpluses in RES deployment in a European market related to RES cooperation. As shown in Figure 76 the possible export volumes increase from BAU to PR while feasibility for doing so decreases since several MSs with shortages under baseline conditions will achieve their given targets domestically if policy recommendations are implemented (PR case). A closer look at the sector level indicates significant progress in forthcoming years for RES in the electricity sector and in heating & cooling. In contrast to above, for biofuels in transport a decline is expected under both cases in the period up to 2020 (see Figure 77).

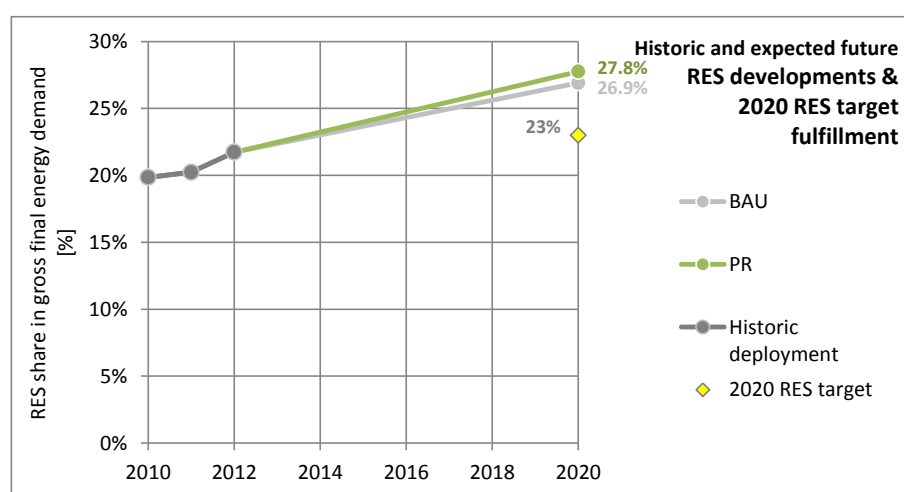


Figure 75: RES developments up to 2020 in Lithuania in relative terms (i.e. RES share in gross final energy demand) according to assessed cases (BAU and PR)

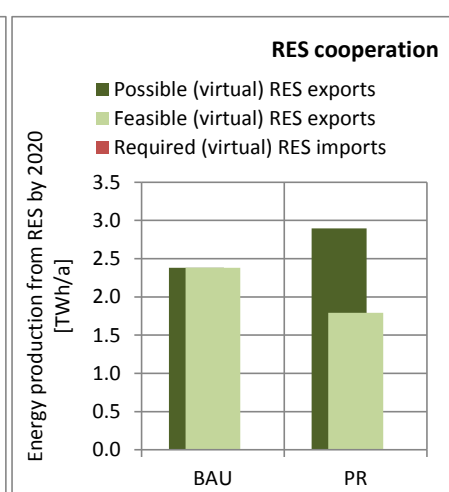


Figure 76: RES cooperation by 2020 in Lithuania according to assessed cases (BAU and PR)

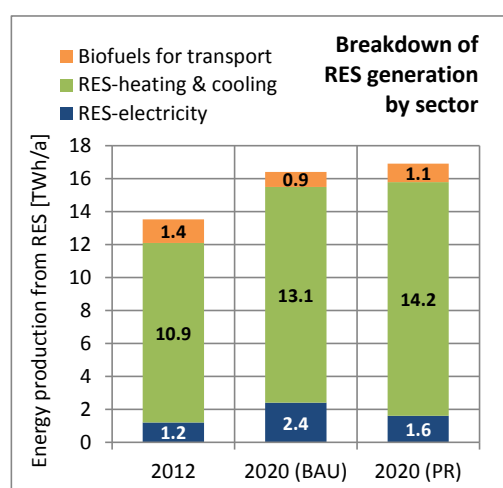


Figure 77: Breakdown of RES generation by sector in Lithuania in 2012 and 2020 according to assessed cases (BAU and PR)

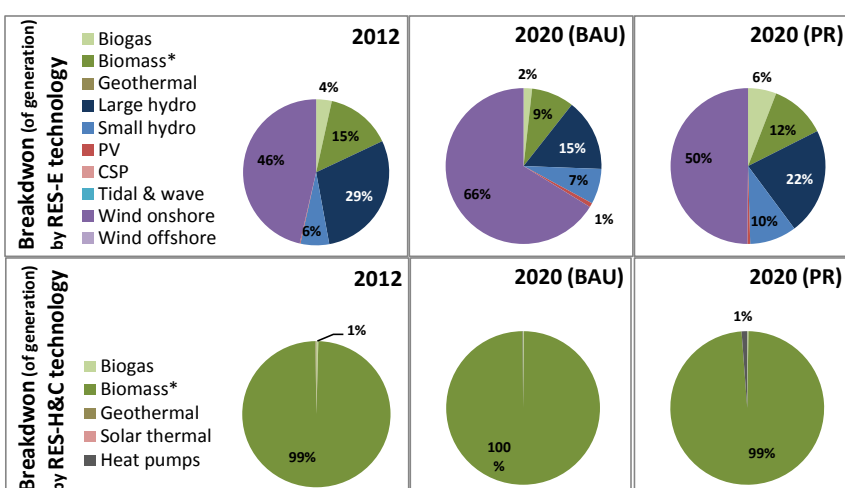


Figure 78: Breakdown of RES generation by technology and by sector (electricity (up) and heating & cooling (down) in Lithuania in 2012 and 2020 according to assessed cases (BAU and PR)

Luxembourg

Considering domestic RES deployment, Luxembourg is not well on track with respect to its 2020 RES target. Under both assessed cases (BAU and PR) a deficit can be expected by 2020, cf. Figure 79. The gap in domestic RES deployment that has to be filled through proactive use of RES cooperation mechanisms is of significant magnitude under baseline conditions - i.e. a deficit of 4.3 percentage points, corresponding to about 2.1 TWh can be expected for 2020 in the BAU case. The assessment of barriers and the derivation of policy recommendations as derived within this project (see EU Tracking Roadmap 2014 (Keep-on-Track!, 2014)) signpost our view of the necessary reforms while the PR case aims to indicate general consequences of doing so: An accelerated deployment of RES within all energy sectors (cf. Figure 81), and in particular of biofuels in transport, may bring domestic RES use in Luxembourg closer to the given target (9.3% compared to 11% by 2020) and, in turn, reduces the need for (virtual) RES imports to approx. 0.8 TWh, cf. Figure 80.

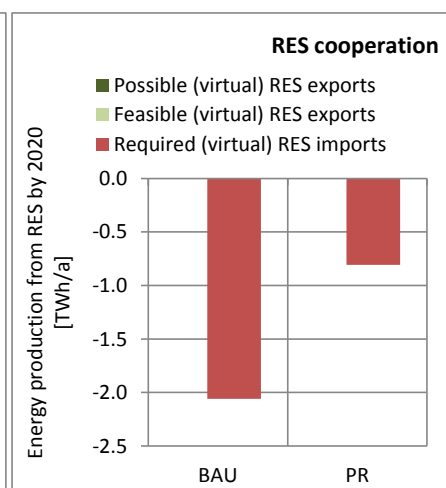
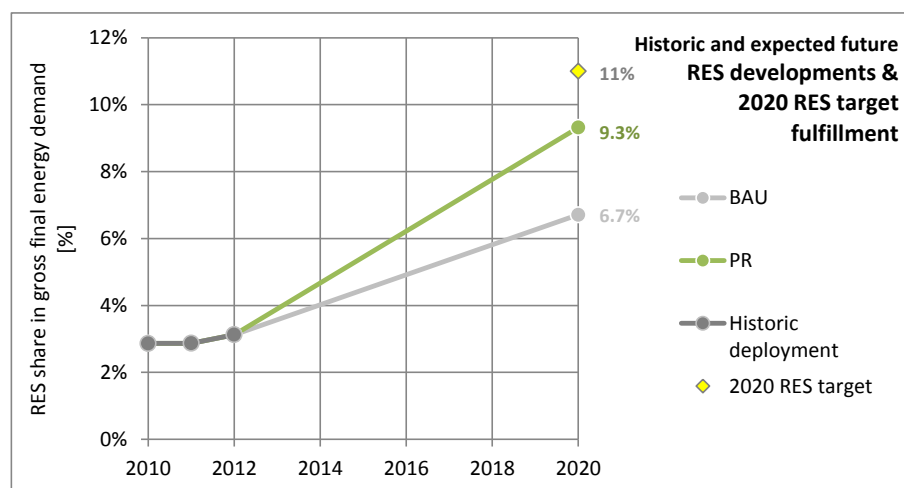


Figure 79: RES developments up to 2020 in Luxembourg in relative terms (i.e. RES share in gross final energy demand) according to assessed cases (BAU and PR)

Figure 80: RES cooperation by 2020 in Luxembourg according to assessed cases (BAU and PR)

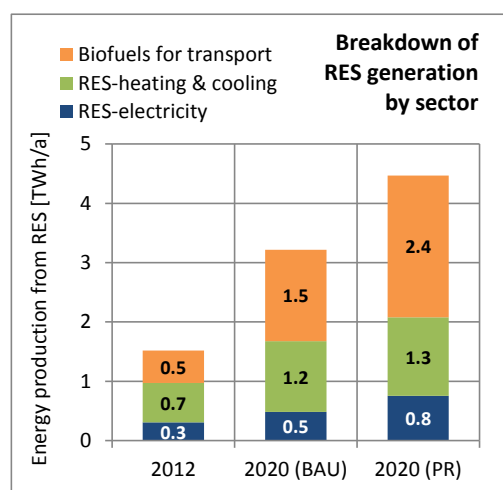


Figure 81: Breakdown of RES generation by sector in Luxembourg in 2012 and 2020 according to assessed cases (BAU and PR)

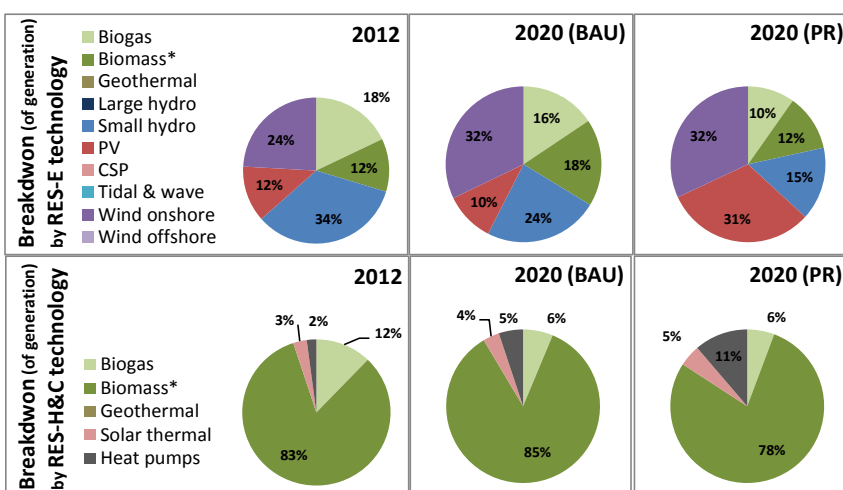


Figure 82: Breakdown of RES generation by technology and by sector (electricity (up) and heating & cooling (down) in Luxembourg in 2012 and 2020 according to assessed cases (BAU and PR)

Malta

Malta is expected to fail in achieving its 2020 RES target under baseline conditions - i.e. as shown in Figure 83 a RES share of 3.2% by 2020 can be expected for 2020 according to the BAU case. This may however change if policy recommendations like the establishment of financial incentives for several RES technology in the electricity sector and for RES in heating and cooling (see EU Tracking Roadmap 2014 (Keep-on-Track!, 2014)) are implemented in time. As indicated by the PR scenario, Malta may then come very close to the given 2020 RES target - i.e. a RES share of 9.1% appears feasible, reducing to gap to the binding 2020 RES of 10% significantly compared to BAU. This is the consequence of a rapid expansion of various new RES technologies in the electricity sector but also in the sector of heating and cooling, see Figure 85 and Figure 86.

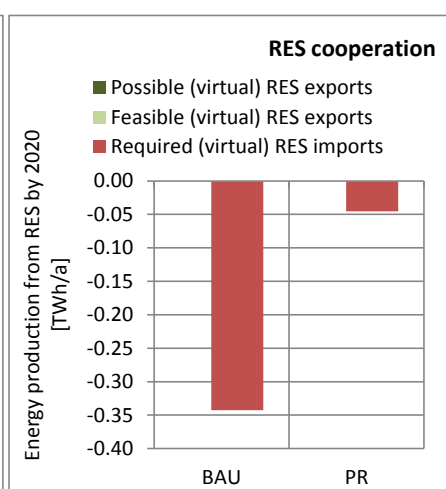
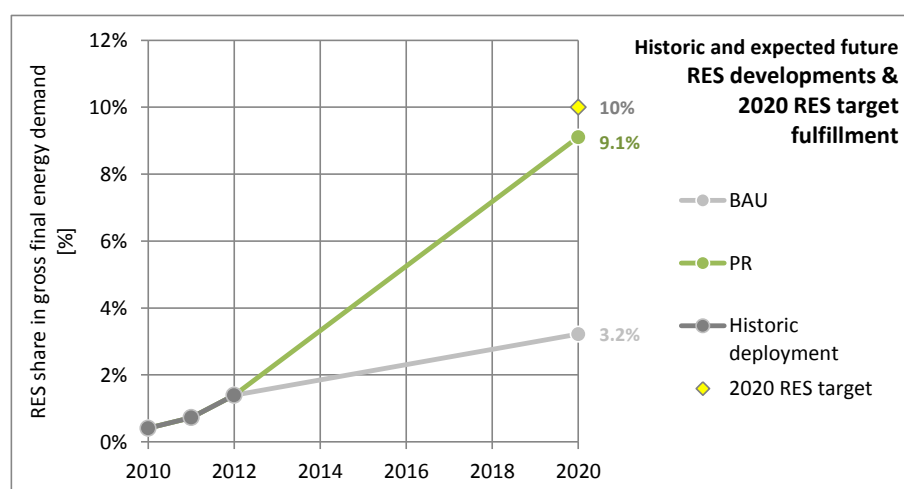


Figure 83: RES developments up to 2020 in Malta in relative terms (i.e. RES share in gross final energy demand) according to assessed cases (BAU and PR)

Figure 84: RES cooperation by 2020 in Malta according to assessed cases (BAU and PR)

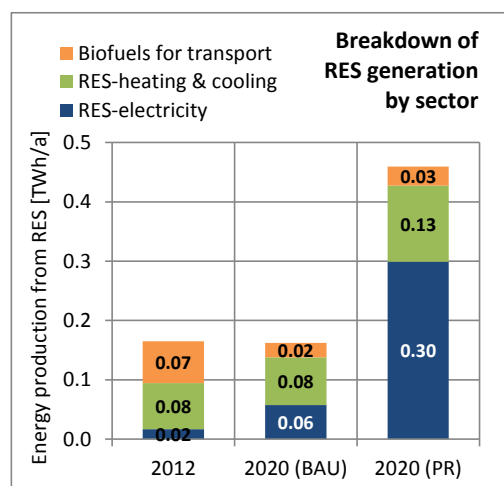


Figure 85: Breakdown of RES generation by sector in Malta in 2012 and 2020 according to assessed cases (BAU and PR)

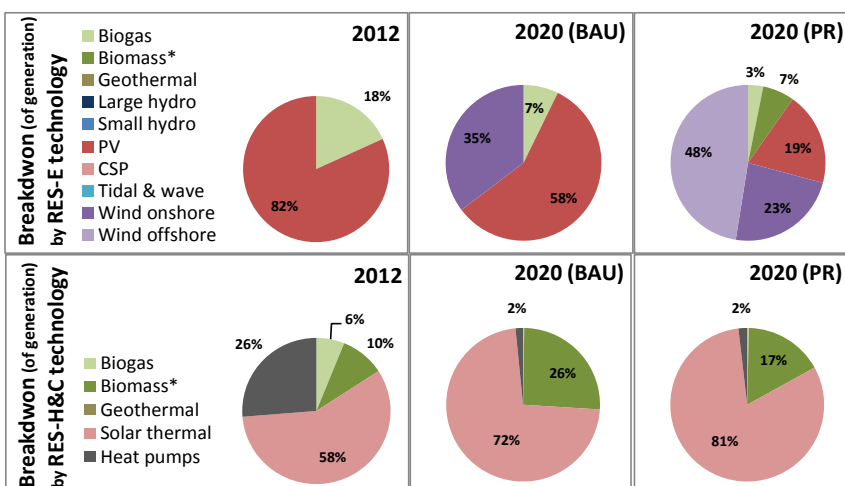


Figure 86: Breakdown of RES generation by technology and by sector (electricity (up) and heating & cooling (down) in Malta in 2012 and 2020 according to assessed cases (BAU and PR)

The Netherlands

The Netherlands is not well on track to achieve its 2020 RES target. Considering domestic RES deployment under both assessed cases (BAU and PR) a significant deficit can be expected in 2020, see Figure 87. The gap in domestic RES deployment that needs to be filled through (virtual) RES imports from other Member States or Third countries is comparatively large under baseline conditions - i.e. a deficit of 6.8 percentage points, corresponding to about 40 TWh RES generation, can be expected for 2020 in the BAU case. The barriers assessed and the related policy recommendations derived within this project (see EU Tracking Roadmap 2014 (Keep-on-Track!, 2014)) signpost our view on the necessary reforms while the PR case aims to indicate general consequences of doing so: A strong uptake of RES use within all energy sectors as anticipated in the PR case (see Figure 89) reduces the gap to target fulfilment significantly and, in turn, cuts the need for (virtual) RES imports to the half compared to BAU (20 TWh (PR) instead of 40 TWh (BAU)), cf. Figure 88.

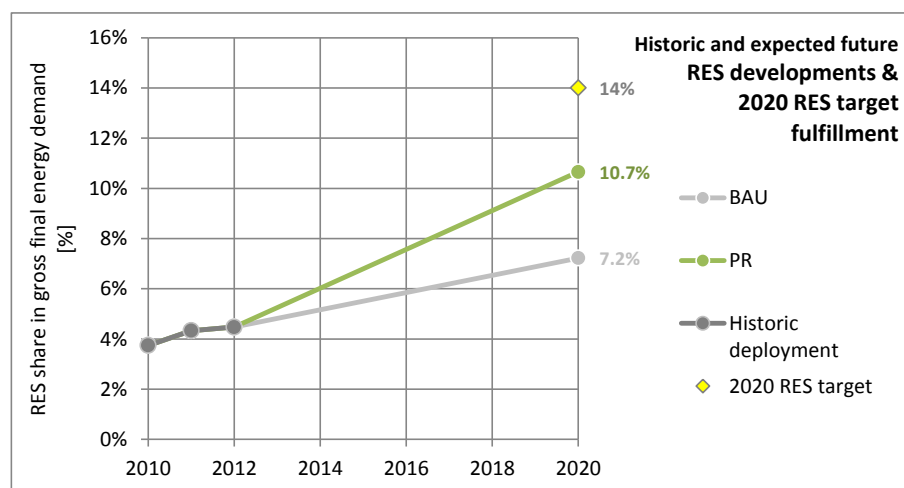


Figure 87: RES developments up to 2020 in the Netherlands in relative terms (i.e. RES share in gross final energy demand) according to assessed cases (BAU and PR)

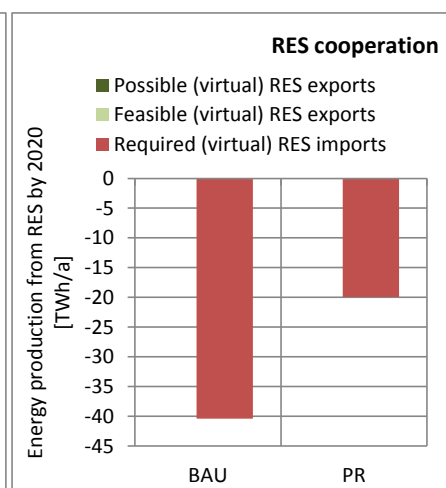


Figure 88: RES cooperation by 2020 in the Netherlands according to assessed cases (BAU and PR)

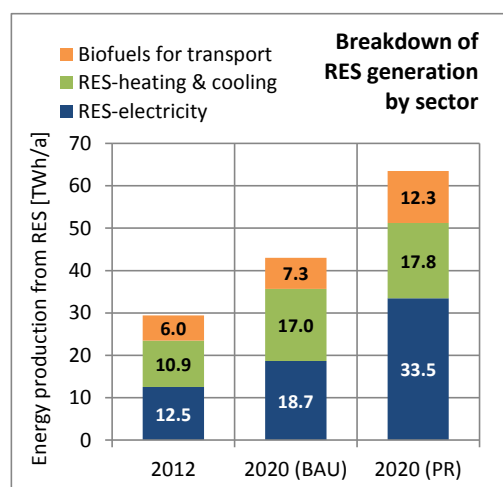


Figure 89: Breakdown of RES generation by sector in the Netherlands in 2012 and 2020 according to assessed cases (BAU and PR)

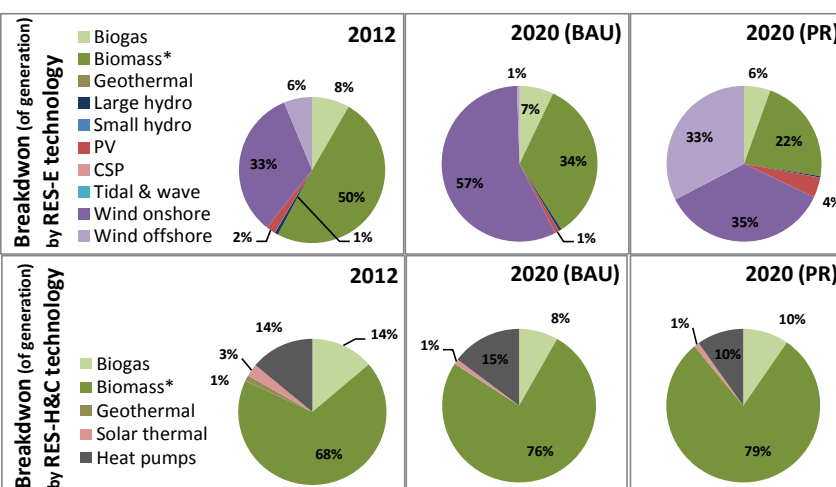


Figure 90: Breakdown of RES generation by technology and by sector (electricity (up) and heating & cooling (down)) in the Netherlands in 2012 and 2020 according to assessed cases (BAU and PR)

Poland

Poland is a Member State where the achievement of its 2020 RES target cannot be expected under baseline conditions, see Figure 91. Since the demand forecast used in this model-based assessment, i.e. the latest PRIMES reference scenario (EC, 2013), assumes for Poland a demand increase in forthcoming years up to 2020 the BAU scenario of future RES progress draws a pessimistic view on 2020 RES target achievement, leading to a gap of 2.9 percentage points (or 27 TWh) compared to the given RES target in 2020. This may however change if policy recommendations like the introduction of a new RES act to fully implement the RES Directive 2009/28/EC (see EU Tracking Roadmap 2014 (Keep-on-Track!, 2014) for details) are considered in actual RES policy making which has been far from being coherent or predictable in previous years. As demonstrated by the PR scenario, Poland may then well achieve its 2020 target, caused by a strong development of various new RES technologies for heating and cooling but also in the electricity sector, cf. Figure 93 and Figure 94.

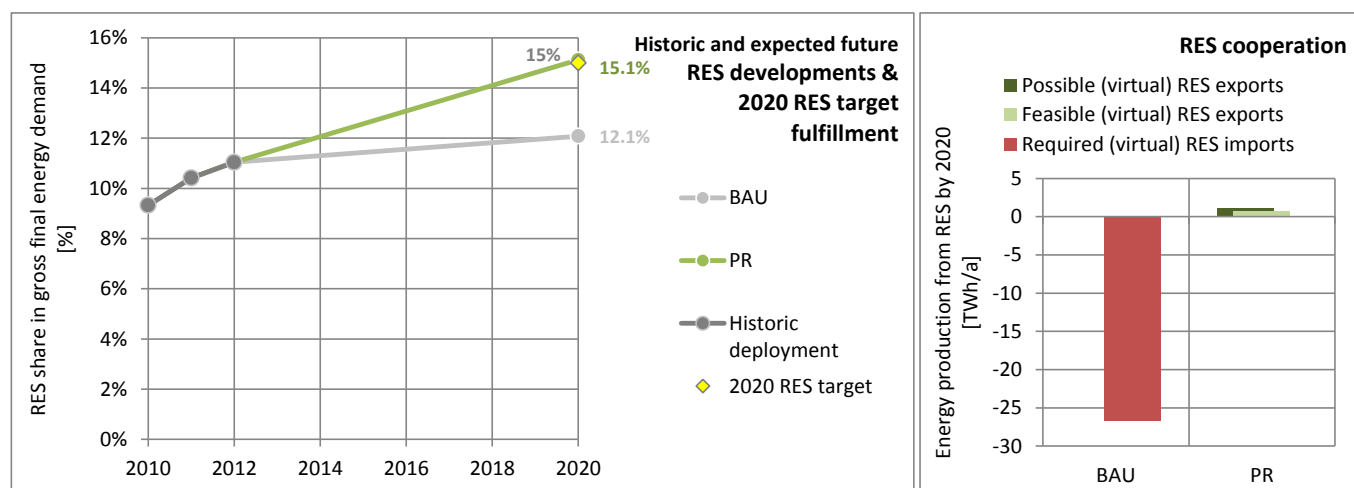


Figure 91: RES developments up to 2020 in Poland in relative terms (i.e. RES share in gross final energy demand) according to assessed cases (BAU and PR)

Figure 92: RES cooperation by 2020 in Poland according to assessed cases (BAU and PR)

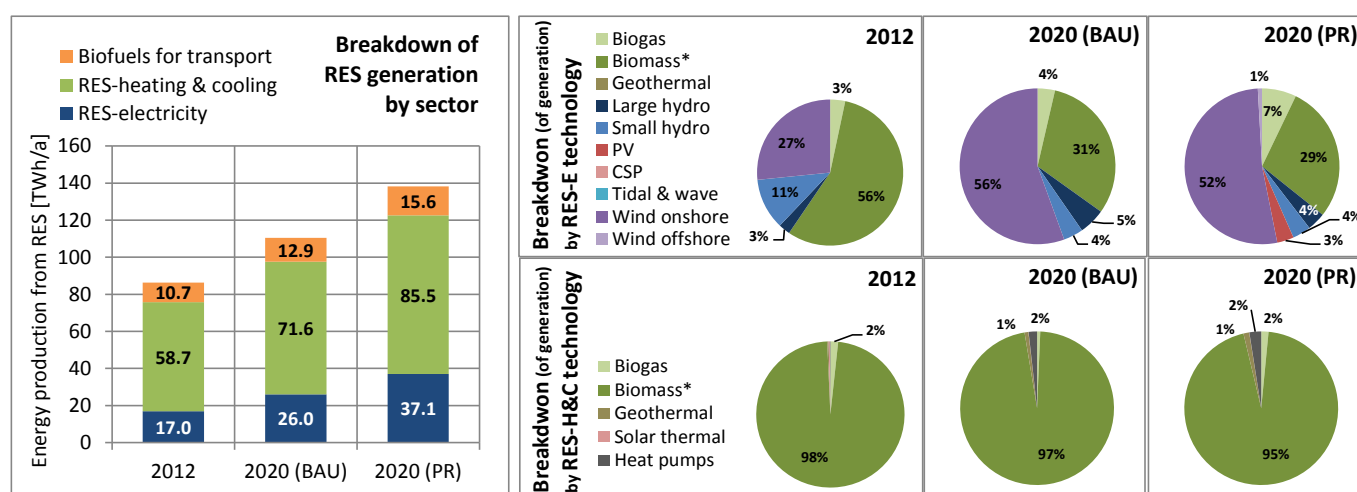


Figure 93: Breakdown of RES generation by sector in Poland in 2012 and 2020 according to assessed cases (BAU and PR)

Figure 94: Breakdown of RES generation by technology and by sector (electricity (up) and heating & cooling (down)) in Poland in 2012 and 2020 according to assessed cases (BAU and PR)

Portugal

Portugal is expected to fail in achieving its 2020 RES target under baseline conditions - i.e. if no new RES policy measures are established in addition to the existing ones and if framework conditions may not change in forthcoming years. As a consequence of regulatory instability due to the revision of the RES-E support scheme and the non-existence of a RES-H&C strategy, RES target achievement is getting out reach in the BAU case (i.e. 28.1% compared to 31%, cf. Figure 95). Thus, according to the BAU scenario only a moderate RES expansion is expected within all energy sectors in forthcoming years. If policy recommendations like the implementation of a suitable strategy for RES-H&C and for biofuels in transport (see EU Tracking Roadmap 2014 (Keep-on-Track!, 2014)) are implemented well in time, a sufficiently strong uptake of RES appears however feasible. As shown in Figure 96 in the PR scenario Portugal would then turn from an importer (BAU case) to an exporter country concerning RES cooperation. Key RES technologies for doing can be found within all energy sectors (see Figure 97 and Figure 98).

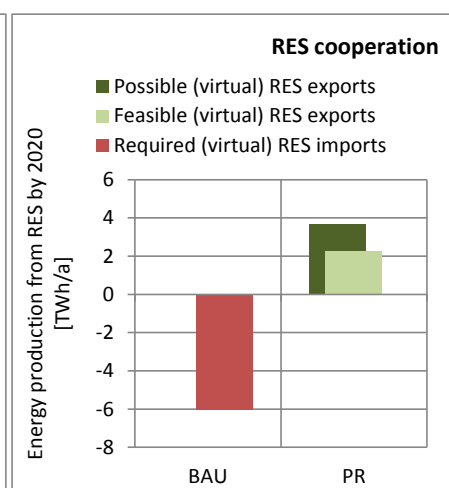
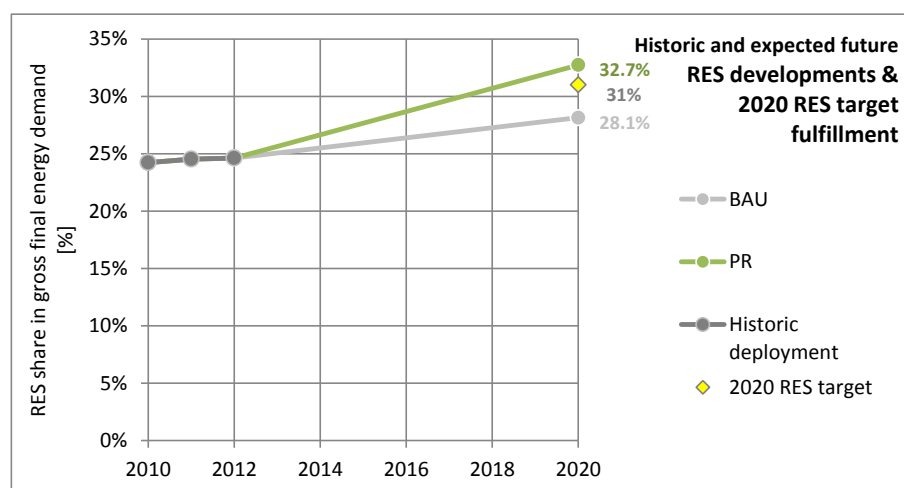


Figure 95: RES developments up to 2020 in Portugal in relative terms (i.e. RES share in gross final energy demand) according to assessed cases (BAU and PR)

Figure 96: RES cooperation by 2020 in Portugal according to assessed cases (BAU and PR)

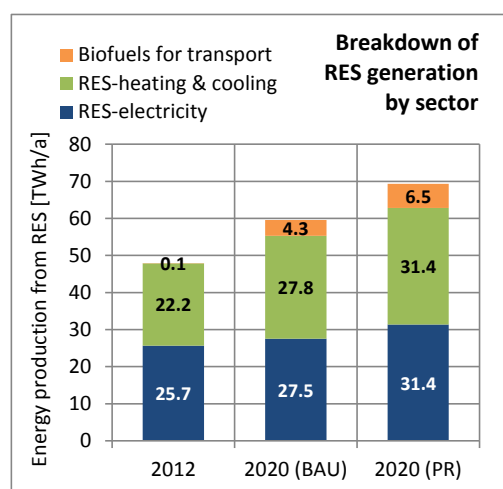


Figure 97: Breakdown of RES generation by sector in Portugal in 2012 and 2020 according to assessed cases (BAU and PR)

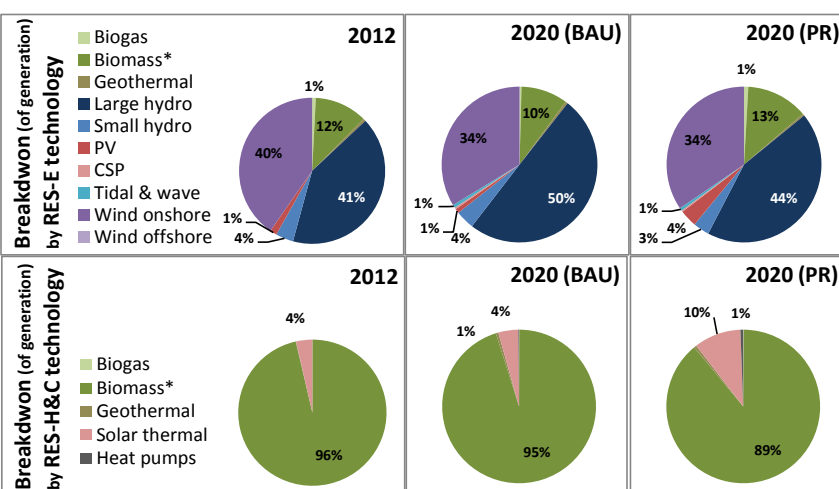


Figure 98: Breakdown of RES generation by technology and by sector (electricity (up) and heating & cooling (down) in Portugal in 2012 and 2020 according to assessed cases (BAU and PR)

Romania

Romania is on track to achieve its 2020 RES target. RES deployment by 2020 in the BAU case is 1.9 percentage points above the given target (24%). According to the PR case a further increase to 26.4% is feasible thanks to an increase of RES deployment in heating & cooling - despite reduced efforts for RES-E (compared to BAU). This indicates that overall RES target achievement is beyond question if currently implemented RES policy measures are kept in place and framework conditions may not change to the worse in forthcoming years. Generally, Romania may act as exporter of surpluses in RES deployment in a European market related to RES cooperation. As shown in Figure 100 the possible export volumes increase from BAU to PR while feasibility for doing so decreases since several MSs with shortages under baseline conditions are expected to achieve their given targets domestically if policy recommendations are implemented (PR case).

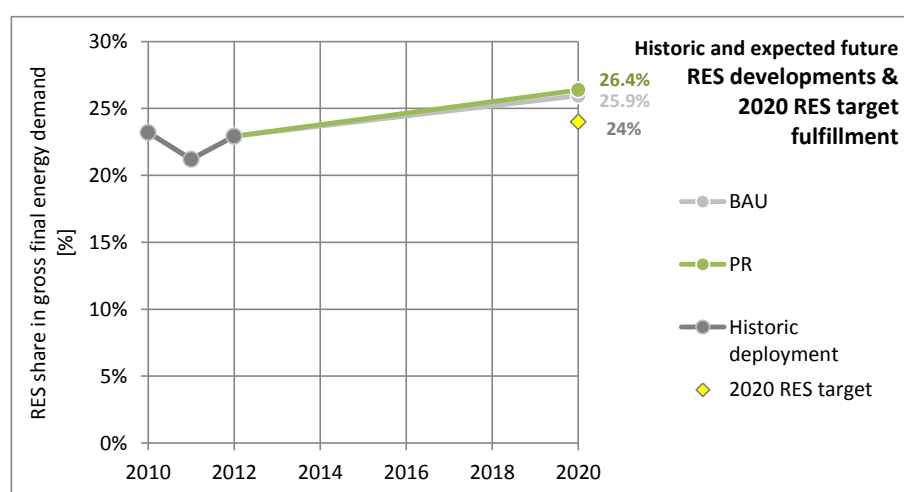


Figure 99: RES developments up to 2020 in Romania in relative terms (i.e. RES share in gross final energy demand) according to assessed cases (BAU and PR)

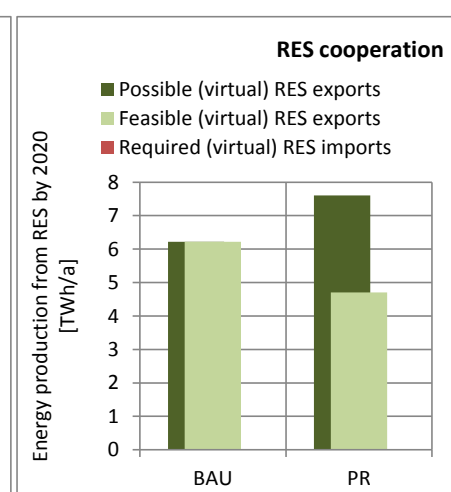


Figure 100: RES cooperation by 2020 in Romania according to assessed cases (BAU and PR)

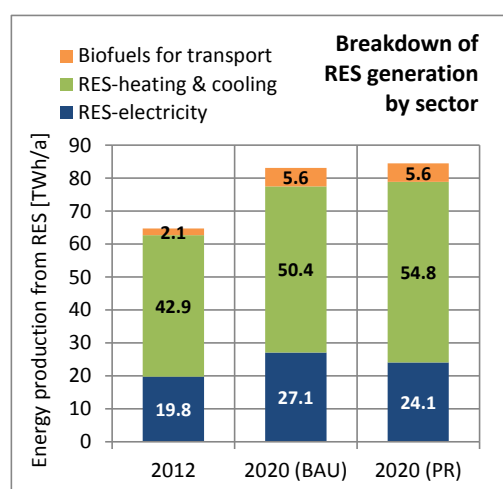


Figure 101: Breakdown of RES generation by sector in Romania in 2012 and 2020 according to assessed cases (BAU and PR)

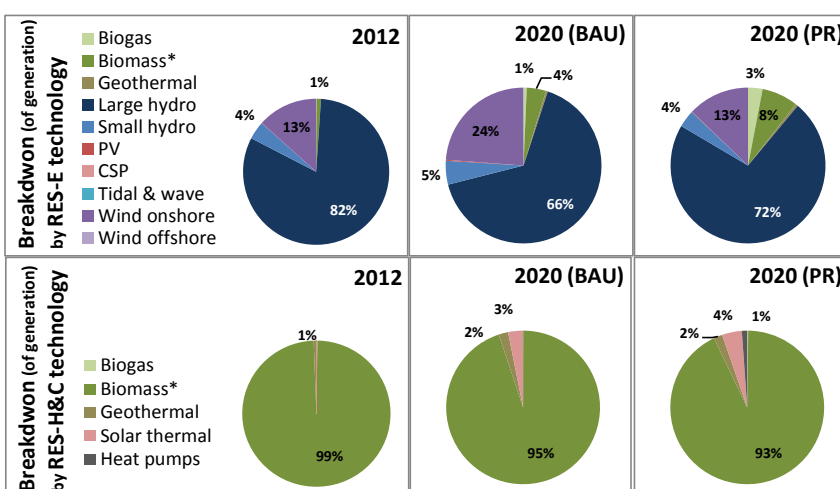


Figure 102: Breakdown of RES generation by technology and by sector (electricity (up) and heating & cooling (down) in Romania in 2012 and 2020 according to assessed cases (BAU and PR)

Slovakia

As applicable from Figure 103 Slovakia is well on track to achieve its 2020 RES target of 14%. If currently implemented RES policy measures are kept in place and framework conditions may not change to the worse in forthcoming years (BAU case) a small surplus appears feasible: a RES share of 14.4% can be expected under baseline conditions. RES deployment may increase further to 15.1% if policy recommendations like the implementation of a reliable RES-T strategy and support scheme (see EU Tracking Roadmap 2014 (Keep-on-Track!, 2014) for details) are realized well in time. Under both assessed cases Slovakia is a candidate for exporting small surpluses in RES deployment that are not needed for own target fulfilment, see Figure 40. Despite an increase of the surplus in RES deployment as indicated by the possible exports, feasible (virtual) RES export volumes are higher under baseline conditions due to a shortage in RES deployment at EU level (and, in turn, an increased demand).

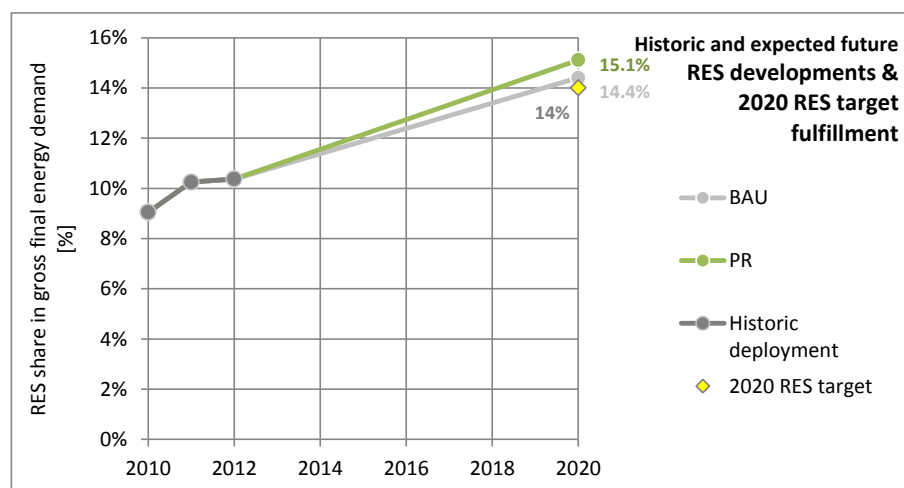


Figure 103: RES developments up to 2020 in Slovakia in relative terms (i.e. RES share in gross final energy demand) according to assessed cases (BAU and PR)

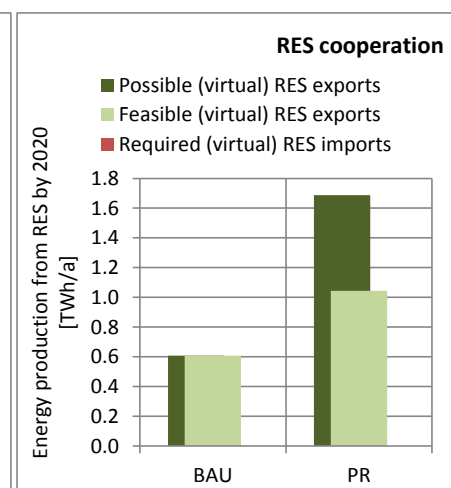


Figure 104: RES cooperation by 2020 in Slovakia according to assessed cases (BAU and PR)

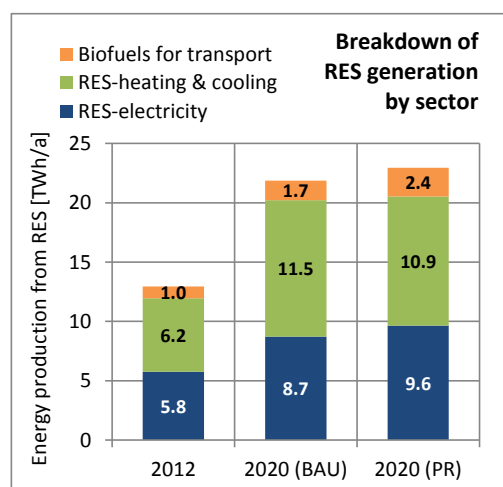


Figure 105: Breakdown of RES generation by sector in Slovakia in 2012 and 2020 according to assessed cases (BAU and PR)

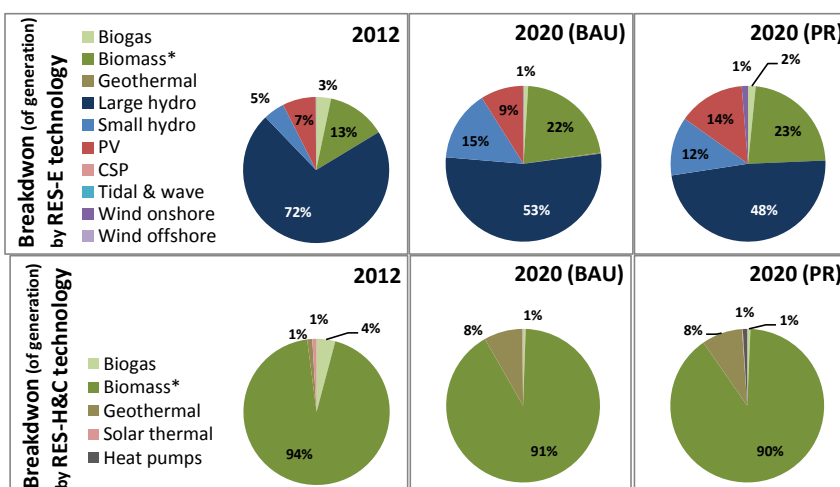


Figure 106: Breakdown of RES generation by technology and by sector (electricity (up) and heating & cooling (down) in Slovakia in 2012 and 2020 according to assessed cases (BAU and PR)

Slovenia

The unclear funding situation due to annual degression rates for some technologies (e.g. PV) has led to major reduction of installed power and number of installation in Slovenia. As a consequence of unpredictable and unstable support for renewables in the various sectors RES target achievement is getting out reach in the BAU case (i.e. 22.5% compared to 25%, see Figure 107). If policy recommendations like the mitigation of barriers in the administrative processes from the integration of RES-E technologies and a RES-H&C strategy and support scheme (see EU Tracking Roadmap 2014 (Keep-on-Track!, 2014)) are implemented well in time, a sufficiently strong uptake of RES appears however feasible. Thus, as shown in Figure 108 in the PR scenario Slovenia would then turn from an importer (BAU case) to an exporter country concerning RES cooperation. Key options for doing so are RES in the electricity sector and heating & cooling sector (see Figure 109).

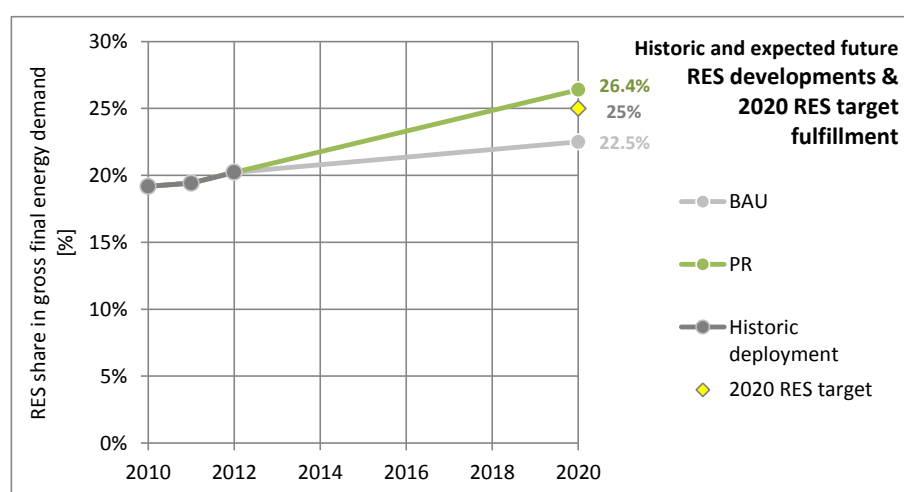


Figure 107: RES developments up to 2020 in Slovenia in relative terms (i.e. RES share in gross final energy demand) according to assessed cases (BAU and PR)

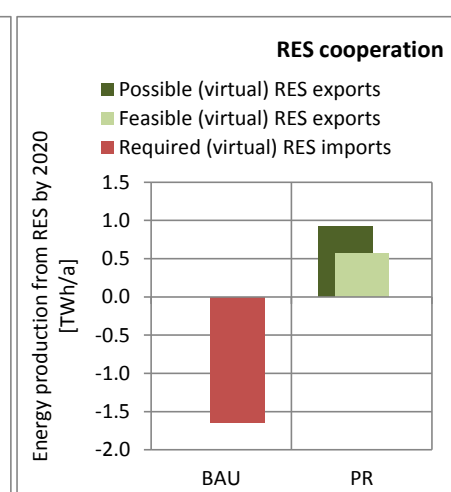


Figure 108: RES cooperation by 2020 in Slovenia according to assessed cases (BAU and PR)

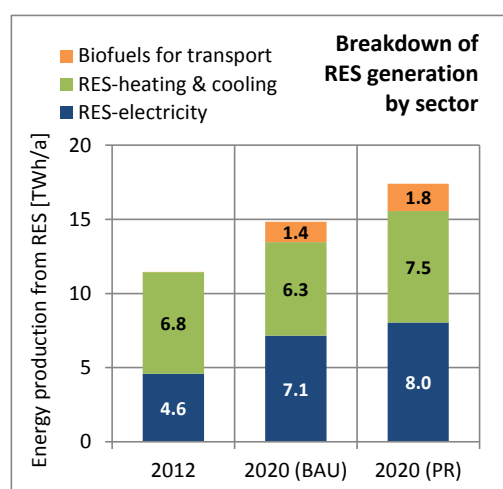


Figure 109: Breakdown of RES generation by sector in Slovenia in 2012 and 2020 according to assessed cases (BAU and PR)

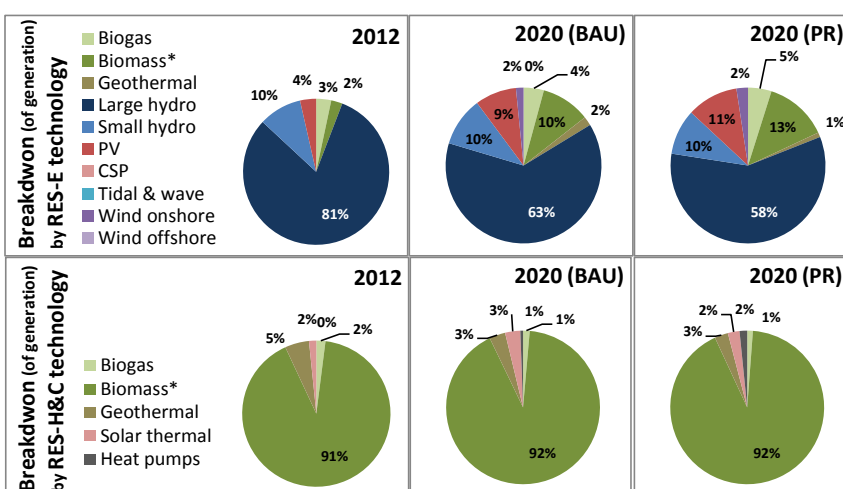


Figure 110: Breakdown of RES generation by technology and by sector (electricity (up) and heating & cooling (down) in Slovenia in 2012 and 2020 according to assessed cases (BAU and PR)

Spain

In terms of stagnating RES deployment in previous years Spain is expected to fail in achieving its 2020 RES target under baseline conditions. As a consequence of currently unpredictable and unstable support for renewables in the various sectors, partly triggered by retroactive measures that have been taken for RES-E, and a generally limited access to finance, RES target achievement is getting out reach in the BAU case (i.e. 15.6% compared to 20%). Thanks to past initiatives for RES-E there is however progress in deployment expected in the near future. If policy recommendations like the skipping of the discriminatory new grid access fee for RES-E self-consumption (see EU Tracking Roadmap 2014 (Keep-on-Track!, 2014)) are implemented well in time, a sufficiently strong uptake of RES appears however feasible. Thus, as shown in Figure 112 in the PR scenario Spain would then turn from an importer (BAU case) to an exporter country concerning RES cooperation. Key options for doing so are RES in the electricity sector and biofuels in transport sector (see Figure 113).

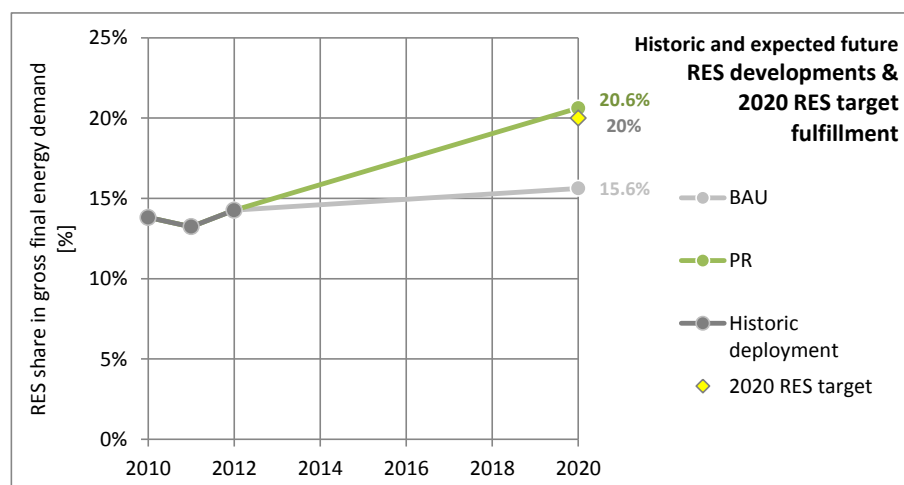


Figure 111: RES developments up to 2020 in Spain in relative terms (i.e. RES share in gross final energy demand) according to assessed cases (BAU and PR)

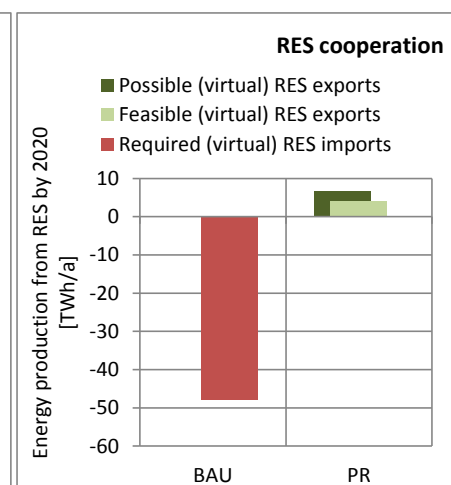


Figure 112: RES cooperation by 2020 in Spain according to assessed cases (BAU and PR)

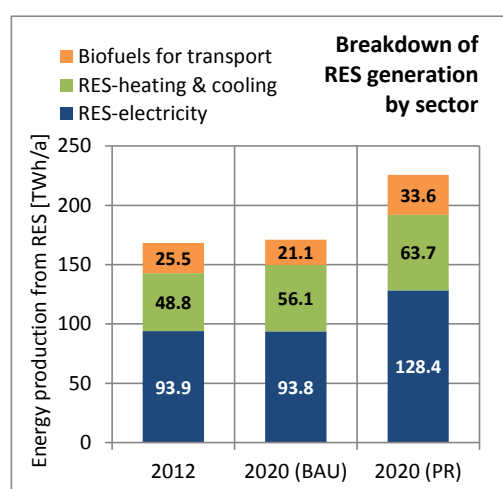


Figure 113: Breakdown of RES generation by sector in Spain in 2012 and 2020 according to assessed cases (BAU and PR)

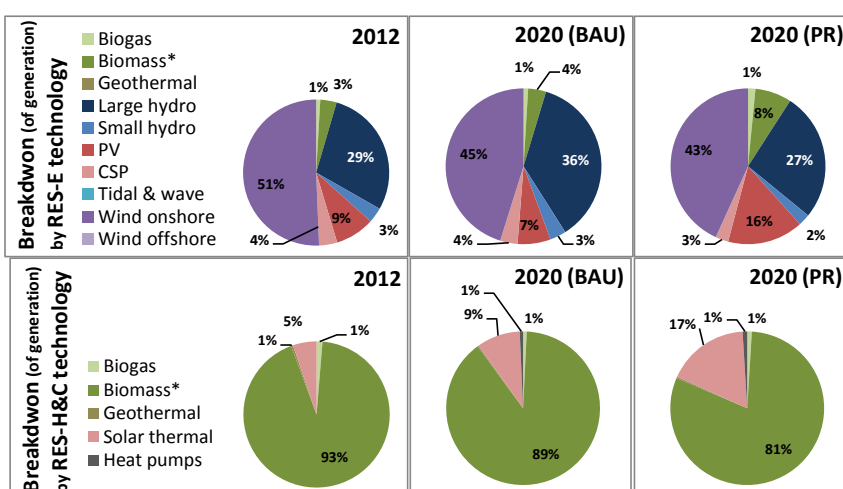


Figure 114: Breakdown of RES generation by technology and by sector (electricity (up) and heating & cooling (down) in Spain in 2012 and 2020 according to assessed cases (BAU and PR)

Sweden

As applicable from Figure 115 Sweden is already achieve its 2020 RES target of 49% by a tremendous growth from 2010 on. If currently implemented RES policy measures are kept in place and framework conditions may not change to the worse in forthcoming years (BAU case) a significant surplus appears feasible: : a RES share of about 54% can be expected under baseline and policy recommendation conditions. The small differences between both cases show, that the early success may also be the biggest barrier for further RES developments in all sectors (see EU Tracking Roadmap 2014 (Keep-on-Track!, 2014) for details). Under both assessed cases Sweden is a candidate for exporting surpluses in RES deployment that are not needed for own target fulfilment, see Figure 116. Despite an increase of the surplus in RES deployment as indicated by the possible exports, feasible (virtual) RES export volumes are higher under baseline conditions due to a shortage in RES deployment at EU level (and, in turn, an increased demand).

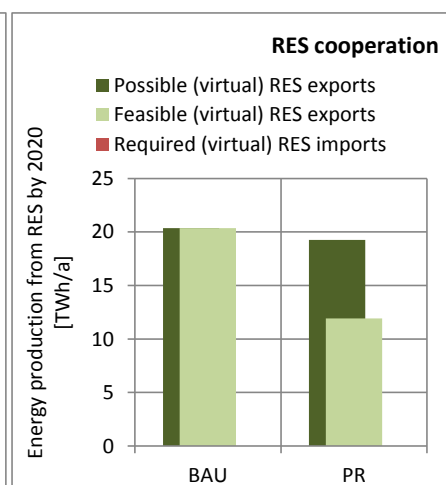
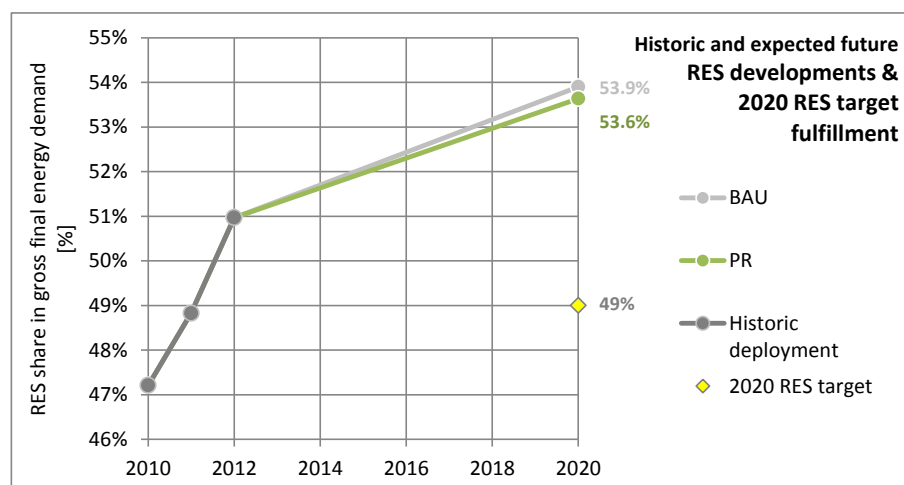


Figure 115: RES developments up to 2020 in Sweden in relative terms (i.e. RES share in gross final energy demand) according to assessed cases (BAU and PR)

Figure 116: RES cooperation by 2020 in Sweden according to assessed cases (BAU and PR)

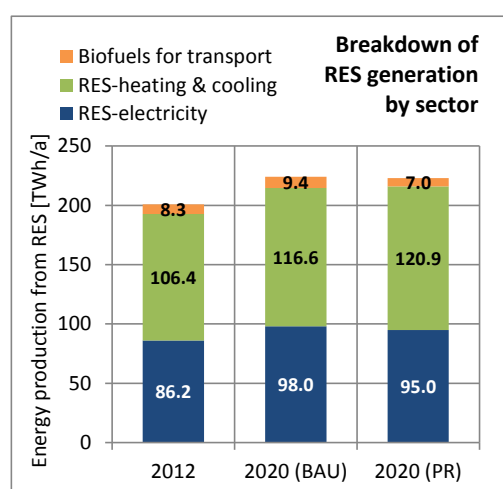


Figure 117: Breakdown of RES generation by sector in Sweden in 2012 and 2020 according to assessed cases (BAU and PR)

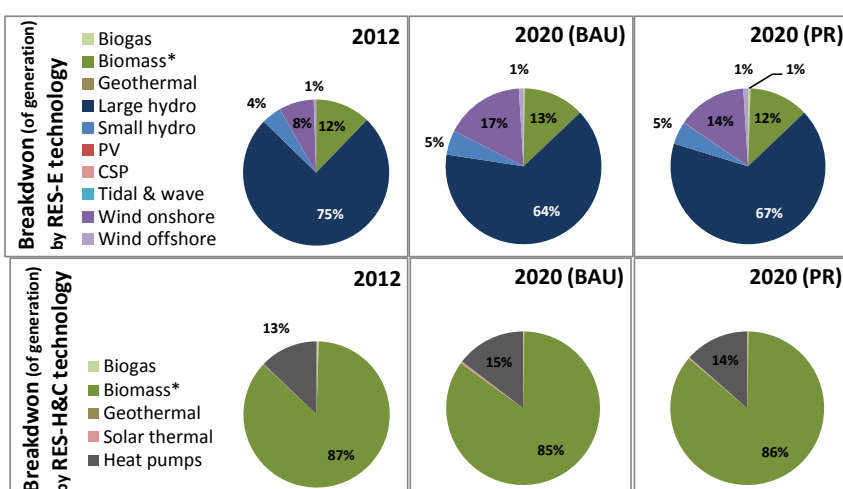


Figure 118: Breakdown of RES generation by technology and by sector (electricity (up) and heating & cooling (down) in Sweden in 2012 and 2020 according to assessed cases (BAU and PR)

United Kingdom⁵

For the UK it is not expected that its 2020 RES target can be achieved under baseline conditions. Likewise, the targets may not be fulfilled in the policy recommendation case but the target is missed by drastically lesser margin. Thus, the UK is a candidate for importing surplus RES deployment of other MS that are not needed for own target fulfilment (Figure 119). The energy produced from RES has to nearly double in 2020 to fulfil the UK target when compared to the baseline case.

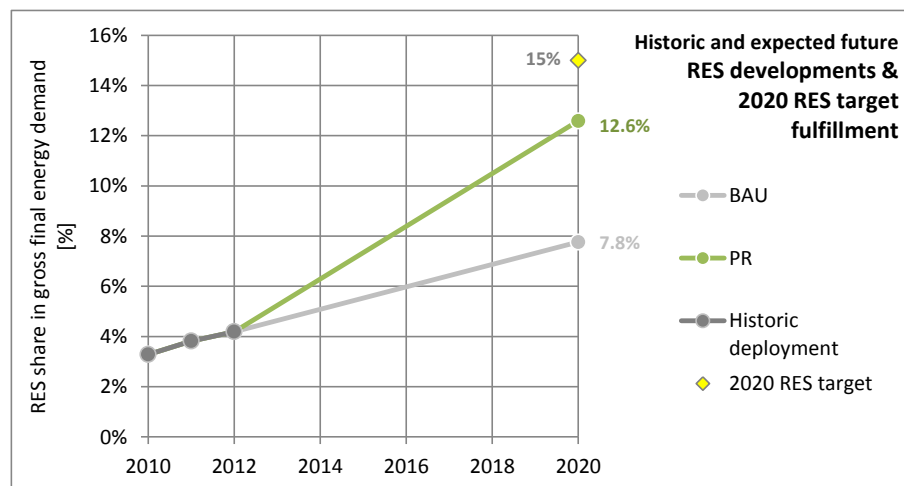


Figure 119: RES developments up to 2020 in the UK in relative terms (i.e. RES share in gross final energy demand) according to assessed cases (BAU and PR)

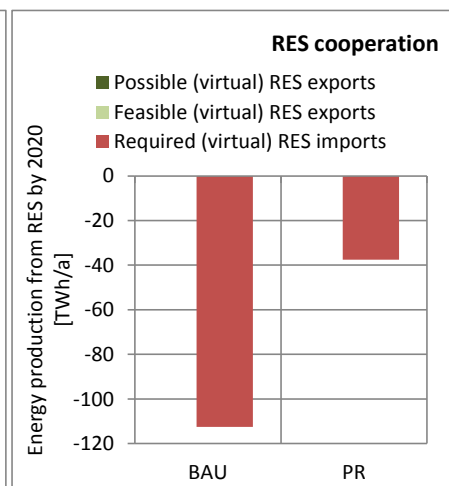


Figure 120: RES cooperation by 2020 in the UK according to assessed cases (BAU and PR)

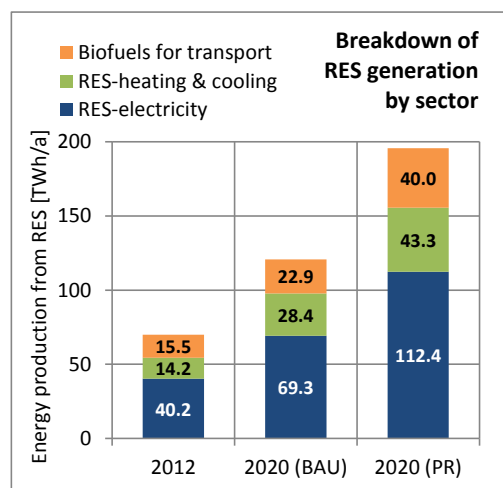


Figure 121: Breakdown of RES generation by sector in the UK in 2012 and 2020 according to assessed cases

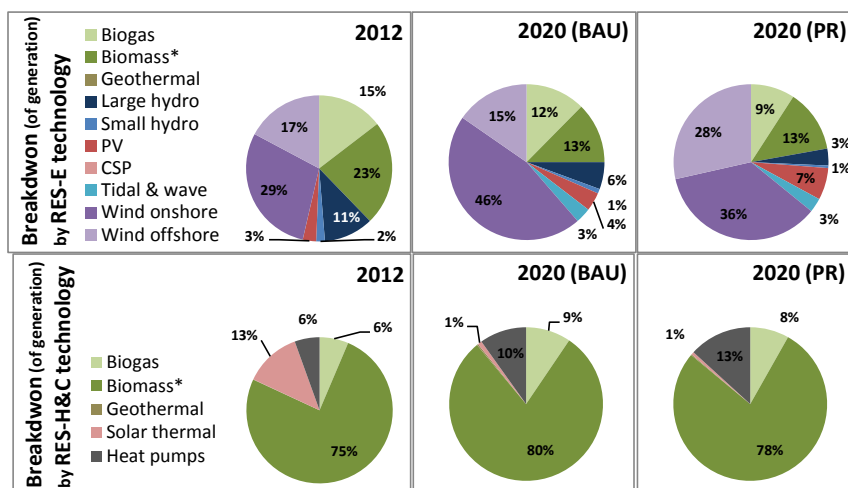


Figure 122: Breakdown of RES generation by technology and by sector (electricity (up) and heating & cooling (down) in the UK in 2012 and 2020 according to assessed cases (BAU and PR)

⁵ The results of the model-based RES policy assessment provide a very pessimistic view on UK's ability to achieve 2020 RES targets domestically, in particular if the BAU case is considered. Two issues appear of relevance in this respect: Firstly, the detailed design of the proposed new CfD scheme has not been applicable when conducting this analysis (and partly there is still unclearness nowadays). Thus, in the BAU case, reflecting only currently implemented (and not planned or intended possible future schemes) the assumption had to be taken that no dedicated support would be applicable for new RES-E installations in the UK beyond 2020. Secondly, the recent uptake of offshore wind power has been underestimated in both scenarios since last year's statistics drew a less optimistic picture than latest data as published after completion of the modelling work.



A closer look to Figure 121 indicates that energy produced from RES has to increase in each sector. This requires that policy recommendations like a clear strategy for the RES-E sector are implemented in time. Issues with the Contracts for Difference (CfD) policy and a transition from Renewable Obligations have to be resolved (see EU Tracking Roadmap 2014 (Keep-on-Track!, 2014)).

Conclusions and Recommendations



Key conclusions from the model-based assessment of 2020 RES target achievement are:

- The Green-X model was used to assess the feasibility of the achievement of the 2020 RES targets for selected policy pathways (Business-As-Usual (BAU case) vs. Policy Recommendations (PR case))
- Under current RES support frameworks and related parameters (BAU case), only a RES share of 17.9% appears feasible at EU-27 level. Nine out of the assessed 27 Member States, e.g. Austria, Denmark or Italy, appear well on track. In another four Member States (i.e. Germany, Finland, Ireland and Slovakia) there are doubts whether 2020 targets can be reached with already implemented measures, while the remainder of fourteen Member States can be classified as “not well on track.”
- Improving national RES policies, e.g. according to the recommendations provided within this project, appears essential for several Member States to bring them back on track. If corrective measures are taken and implemented well in time, all Member States still have the possibility to achieve their 2020 RES targets. The majority of countries would even exceed its obligation, and there are good reasons for doing so since, as discussed above, additional RES deployment contributes well to increase supply security and local employment, to name only some additional benefits. Finally, by 2020 five Member States (i.e. France, Luxembourg, Malta, the Netherlands and the UK) make use of RES cooperation mechanisms as a buyer while all others act as (possible) seller. Thus, this could increase RES deployment to up to 21.0% at EU-27 level.

The **Keep on Track!** consortium recommends to:

- Adopt an ambitious binding renewable energy target for 2030, including binding national targets, alongside energy efficiency and greenhouse gas emissions targets.
- Ensure a predictable and stable legislative framework for RES at the national level and in particular to avoid any retroactive changes to existing support schemes.
- Increase the focus on the RES-H&C and RES-T sectors, which are strongly dependent on the existence of a supportive and comprehensive framework.
- Revise the guidelines on State aid for environmental protection and energy 2014-2020 to make sure they are consistent with the RES Directive and support the achievement of its objectives.
- Re-establish a clear supportive framework for RES-T at European level in order to remove the current policy vacuum.
- Retain the focus on the removal of administrative barriers.

References



DIRECTIVE 2001/77/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market

DIRECTIVE 2003/30/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 8 May 2003 on the promotion of the use of biofuels or other renewable fuels for transport

DIRECTIVE 2009/28/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC

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Resch G., A. Ortner, C. Panzer (2014): 2030 RES targets for Europe - a brief pre-assessment of feasibility and impacts. A report compiled within the Intelligent Energy Europe project Keep-on-Track!, coordinated by Eufores and Eclareon. TU Vienna, Energy Economics Group, Vienna, Austria, 2014. Accessible at www.keepontrack.eu.

Annex 1 - Method of approach / Key assumptions



The method of approach and related key assumptions for the modelling work undertaken within this study will be discussed in detail subsequently.

Constraints of the model-based policy analysis

- ▶ Time horizon: 2010 to 2020 - Results are derived on an annual base
- ▶ Geographical coverage: all Member States of the European Union as of 2012 (EU27; without Croatia)
- ▶ Technology coverage: covering all RES technologies for power and heating and cooling generation as well biofuel production. The (conventional) reference energy system is based on EC modelling (PRIMES)
- ▶ Energy demand: demand forecasts are taken from “EU energy, transport and GHG emissions trends to 2050: Reference Scenario 2013” (EC, 2013)
- ▶ RES imports to the EU: generally limited to biofuels and forestry biomass meeting the sustainability criteria

The policy assessment tool: the Green-X model

As in previous projects such as FORRES 2020, OPTRES or PROGRESS the **Green-X** model was applied to perform a detailed quantitative assessment of the future deployment of renewable energy on country-, sector- as well as technology level. The core strength of this tool lies on the detailed RES resource and technology representation accompanied by a thorough energy policy description, which allows assessing various policy options with respect to resulting costs and benefits. A short characterization of the model is given below, whilst for a detailed description we refer to www.green-x.at.

*Short characterisation of the **Green-X** model*

The model Green-X has been developed by the Energy Economics Group (EEG) at the Vienna University of Technology under the EU research project “Green-X-Deriving optimal promotion strategies for increasing the share of RES-E in a dynamic European electricity market” (Contract No. ENG2-CT-2002-00607). Initially focussed on the electricity sector, this modelling tool, and its database on renewable energy (RES) potentials and costs, has been extended to incorporate renewable energy technologies within all energy sectors.

Green-X covers the EU-27, and can be extended to other countries, such as Turkey, Croatia and Norway. It allows the investigation of the future deployment of RES as well as the accompanying cost (including capital expenditures, additional generation cost of RES compared to conventional options, consumer expenditures due to applied supporting policies) and benefits (for instance, avoidance of fossil fuels and corresponding carbon emission savings). Results are calculated at both a country- and technology-level on a yearly basis. The time-horizon allows for in-depth assessments up to 2030. The Green-X model develops nationally specific dynamic cost-resource curves for all key RES technologies, including for renewable electricity, biogas, biomass, bio-waste, wind on- and offshore, hydropower large- and small-scale, solar thermal electricity, photovoltaic, tidal stream and wave power, geothermal electricity; for renewable heat, biomass, sub-divided into log wood, wood chips, pellets, grid-connected heat, geothermal grid-connected heat, heat pumps and solar thermal heat; and, for renewable transport fuels, first generation biofuels (biodiesel and bioethanol), second generation biofuels

(lignocellulosic bioethanol, biomass to liquid), as well as the impact of biofuel imports. Besides the formal description of RES potentials and costs, Green-X provides a detailed representation of dynamic aspects such as technological learning and technology diffusion.

Through its in-depth energy policy representation, the Green-X model allows an assessment of the impact of applying (combinations of) different energy policy instruments (for instance, quota obligations based on tradable green certificates / guarantees of origin, (premium) feed-in tariffs, tax incentives, investment incentives, impact of emission trading on reference energy prices) at both country or European level in a dynamic framework. Sensitivity investigations on key input parameters such as non-economic barriers (influencing the technology diffusion), conventional energy prices, energy demand developments or technological progress (technological learning) typically complement a policy assessment.

Within the Green-X model, the allocation of biomass feedstock to feasible technologies and sectors is fully internalised into the overall calculation procedure. For each feedstock category, technology options (and their corresponding demands) are ranked based on the feasible revenue streams as available to a possible investor under the conditioned, scenario-specific energy policy framework that may change on a yearly basis. Recently, a module for intra-European trade of biomass feedstock has been added to Green-X that operates on the same principle as outlined above but at a European rather than at a purely national level. Thus, associated transport costs and GHG emissions reflect the outcomes of a detailed logistic model. Consequently, competition on biomass supply and demand arising within a country from the conditioned support incentives for heat and electricity as well as between countries can be reflected. In other words, the supporting framework at MS level may have a significant impact on the resulting biomass allocation and use as well as associated trade.

Moreover, Green-X was recently extended to allow an endogenous modelling of sustainability regulations for the energetic use of biomass. This comprises specifically the application of GHG constraints that exclude technology/feedstock combinations not complying with conditioned thresholds. The model allows flexibility in applying such limitations, that is to say, the user can select which technology clusters and feedstock categories are affected by the regulation both at national and EU level, and, additionally, applied parameters may change over time.

Overview on assessed cases

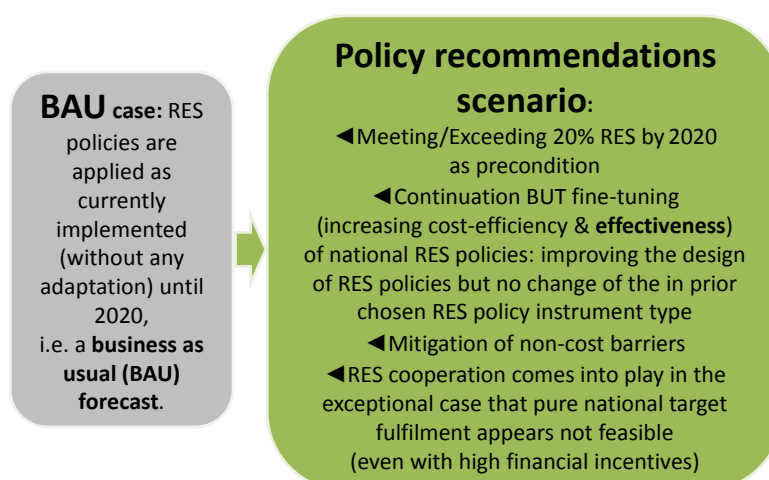


Figure 123: Overview on assessed cases

The RES policy framework is a key input to this analysis whereby two scenarios were in focus (see Figure 123): a business-as-usual (BAU) case where the assumption was taken that RES policies are applied as currently implemented (without any adaptation) until 2020, and a policy recommenda-

tions (PR) scenario, indicating a pathway for meeting (or even exceeding) the 2020 RES targets, that builds on the policy recommendations derived within this project, see EU Tracking Roadmap 2014 (Keep-on-Track!, 2014).

Note that in the PR case RES cooperation is an important element for overall RES target achievement for certain Member States. It comes however only into play in exceptional cases when national target achievement appears not feasible even with high financial incentives.⁶

Generally, data on currently implemented RES policies in the assessed Member States as considered in the BAU case has been collected until end of March 2014. Thus, any policy changes that have been taken afterwards could not be considered in this model-based assessment.

Criteria for the assessment of RES support schemes

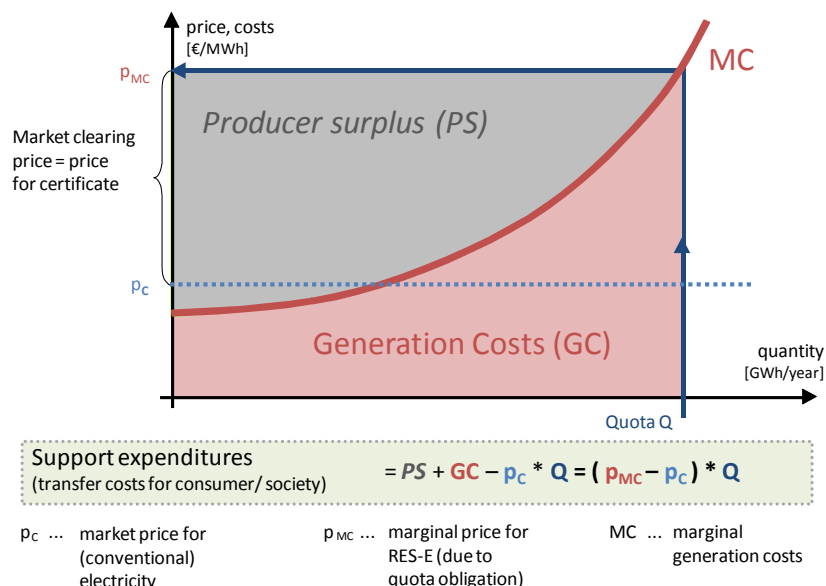


Figure 124: Basic definitions of the cost elements (illustrated for a RES trading system)

Support instruments have to be *effective* in order to increase the penetration of RES and *efficient* with respect to minimising the resulting public costs - i.e. the transfer cost for consumer (society), subsequently named **support expenditures** - over time. The criteria used for evaluating the various policy instruments are based on two conditions:

- *Minimise generation costs*

⁶ As threshold with respect to financial RES support across Member States a high value is used - i.e. differences in country-specific support per MWh RES are limited to a maximum of 30 €/MWhRES. Consequently, if support in a country with temporarily limited RES potentials and / or an ambitious RES target exceeds the upper boundary, the remaining gap to its RES target would be covered in line with the flexibility regime as defined in the RES Directive through (virtual) imports from other countries that achieve a surplus in RES deployment.

This objective is fulfilled if total RES-E generation costs (GC) are minimised. In other words, the system should provide incentives for investors to select technologies, scales and sites such that generation costs are minimised.

- *Reduce producer profits to an adequate level*

Once such cost-efficient systems have been identified, the next step is to evaluate various implementation options with the aim of minimising the transfer costs for consumer / society.⁷ This means that feed-in tariffs, investment incentives or RES trading systems should be designed in such a way that public transfer payments are also minimised.

This implies lowering generation costs as well as producer surplus (PS)⁸.

In some cases it may not be possible to reach both objectives simultaneously - minimise generation costs and producer surplus - so that compromises have to be made. For a better illustration of the cost definitions used, the various cost elements are illustrated in Figure 124.

Overview on key parameters

In order to ensure maximum consistency with existing EU scenarios and projections the key input parameters of the scenarios presented in this report are derived from PRIMES modelling and from the *Green-X* database with respect to the potentials and cost of RES technologies (see Resch et al. (2014)). Table 4 shows which parameters are based on PRIMES and which have been defined for this study. More precisely, the PRIMES scenario used is the *reference scenario* as of 2012 (EC, 2013),

Table 4: Main input sources for scenario parameters

Based on PRIMES	Defined for this study
Energy demand by sector	RES policy framework
Primary energy prices	Reference electricity prices
Conventional supply portfolio and conversion efficiencies	RES cost (<i>Green-X</i> database, incl. biomass)
CO ₂ intensity of sectors	RES potential (<i>Green-X</i> database)
	Biomass trade specification
	Technology diffusion
	Learning rates

⁷ Support expenditures - i.e. the transfer costs for consumers (society) - due to RES support are defined as the financial transfer payments from the consumer to the RES producer compared to the reference case of consumers purchasing conventional electricity on the power market. This means that these costs do not consider any indirect costs or externalities (environmental benefits, change of employment, etc.). Within this report support expenditures (due to RES support) are either expressed in absolute terms (e.g. billion €), related to the stimulated RES generation, or put in relation to the total electricity / energy consumption. In the latter case, the premium costs refer to each MWh of electricity / energy consumed.

⁸ The producer surplus is defined as the profit of green electricity generators. If, for example, a green producer receives a feed-in tariff of 60 € for each MWh of electricity sold and generation costs are 40 €/MWh, the resulting profit would be 20 € for each MWh. The sum of the profits of all green generators equals the producer surplus.

8.4.1 Energy demand

Figure 125 depicts the projected energy demand development at EU 28 level according to the PRIMES reference scenario with regard to gross final energy demand (right) as well as gross electricity demand (left).

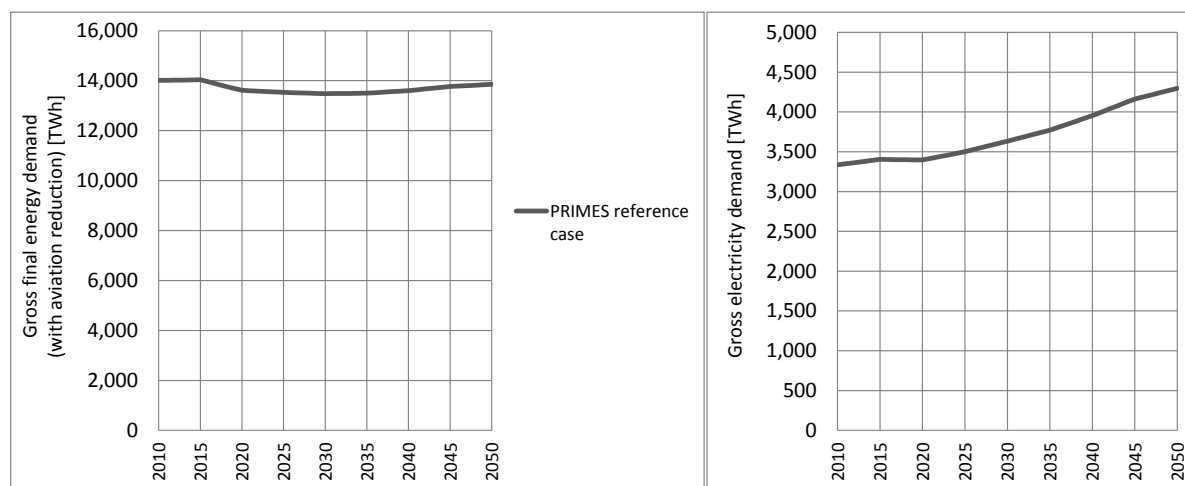


Figure 125: Comparison of projected energy demand development at European (EU-28) level - gross electricity demand (left) and gross final energy demand (right). (Source: PRIMES scenarios)

A comparison to alternative PRIMES demand projections at EU 28 levels shows the following trends: The *PRIMES reference case* as of 2013 (EC, 2013) draws a modified picture of future demand patterns compared to previous baseline and reference cases. The impacts of the global financial crisis are reflected, leading to a reduction of overall gross final energy demand in the short term, and moderate growth in later years towards 2020. Beyond 2020, according to the *PRIMES reference case* (where the achievement of climate and RES targets for 2020 is assumed) gross final energy demand is expected to stagnate and then moderately decrease.

For the electricity sector, demand growth is generally more pronounced. The distinct PRIMES cases follow a similar pattern and differences between them are moderate - i.e. all cases expect electricity consumption to rise strongly in later years because of cross-sectoral substitutions: electricity is expected to make a stronger contribution to meeting the demand for heat in the future, and similar substitution effects are assumed for the transport sector as well.

Complementary to above, a closer look at the Member State level is taken next. Thus, Figure 126 provides a comparison of actual 2012 data and projected 2020 gross final energy demand by Member State. As applicable from this graph, for several countries (e.g. France, Germany, UK, Netherlands or Spain) projected gross final energy demand by 2020 is, in accordance with the overall trend at aggregated (EU) level, below current (2012) levels. For other Member States like Cyprus, Czech Republic, Greece or Poland PRIMES scenarios show a comparatively strong increase in demand compared to today. This has important implication on country-specific RES target achievement as discussed in section 0.

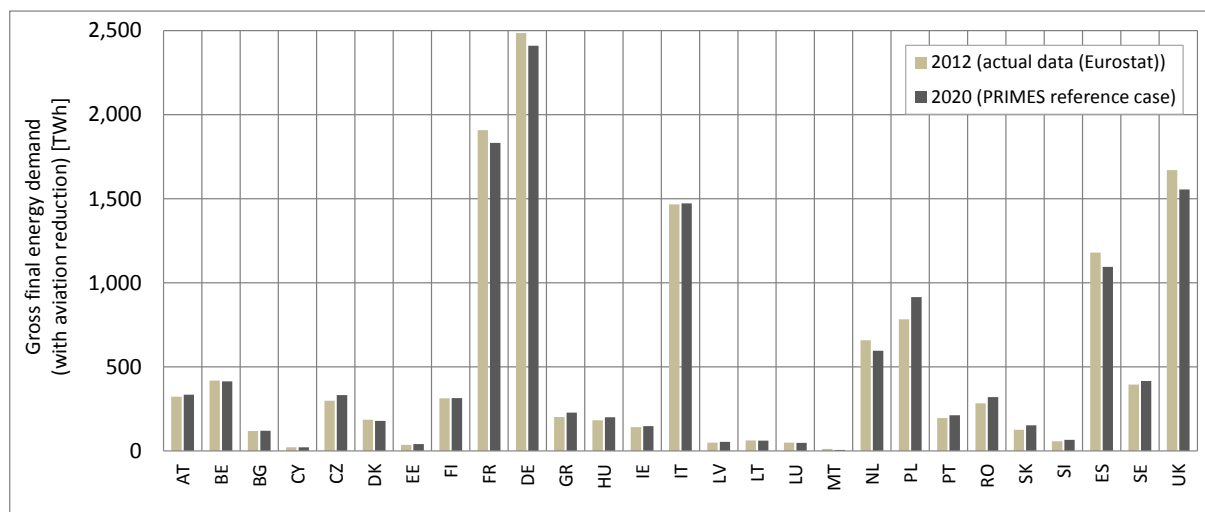


Figure 126: Comparison of actual 2012 and projected 2020 gross final energy demand by Member State. (Source: Eurostat and PRIMES scenarios)

8.4.2 Conventional supply portfolio

The conventional supply portfolio, i.e. the share of the different conventional conversion technologies in each sector, is based on PRIMES forecasts on a country-specific basis. These projections of the portfolio of conventional technologies particularly influence the calculations done within this study on the avoidance of fossil fuels and related CO₂ emissions. As it is beyond the scope of this study to analyse in detail which conventional power plants would actually be replaced, for instance, by a wind farm installed in the year 2023 in a certain country (i.e. either a less efficient existing coal-fired plant or possibly a new highly-efficient combined cycle gas turbine), the following assumptions are made:

- Bearing in mind that fossil energy represents the marginal generation option that determines the prices on energy markets, it was decided to stick to the sector-specific conventional supply portfolio projections on a country level provided by PRIMES. Sector- as well as country-specific conversion efficiencies derived on a yearly basis are used to calculate the amount of avoided primary energy based on the renewable generation figures obtained. Assuming that the fuel mix is unaffected, avoidance can be expressed in units of coal or gas replaced.
- A similar approach is chosen with regard to the avoidance of CO₂ emissions, where the basis is the fossil-based conventional supply portfolio and its average country- and sector-specific CO₂ intensities that may change over time.

In the following, the derived data on aggregated conventional conversion efficiencies and the CO₂ intensities characterising the conventional reference system (excl. nuclear energy) are presented.

Figure 127 shows the dynamic development of the average conversion efficiencies as projected by PRIMES for conventional electricity generation as well as for grid-connected heat production. Conversion efficiencies are shown for the PRIMES reference scenario (EC, 2013). Error bars indicate the range of country-specific average efficiencies among EU Member States. For the transport sector, where efficiencies are not explicitly expressed in PRIMES' results, the average efficiency of the refinery process used to derive fossil diesel and gasoline was assumed to be 95%.

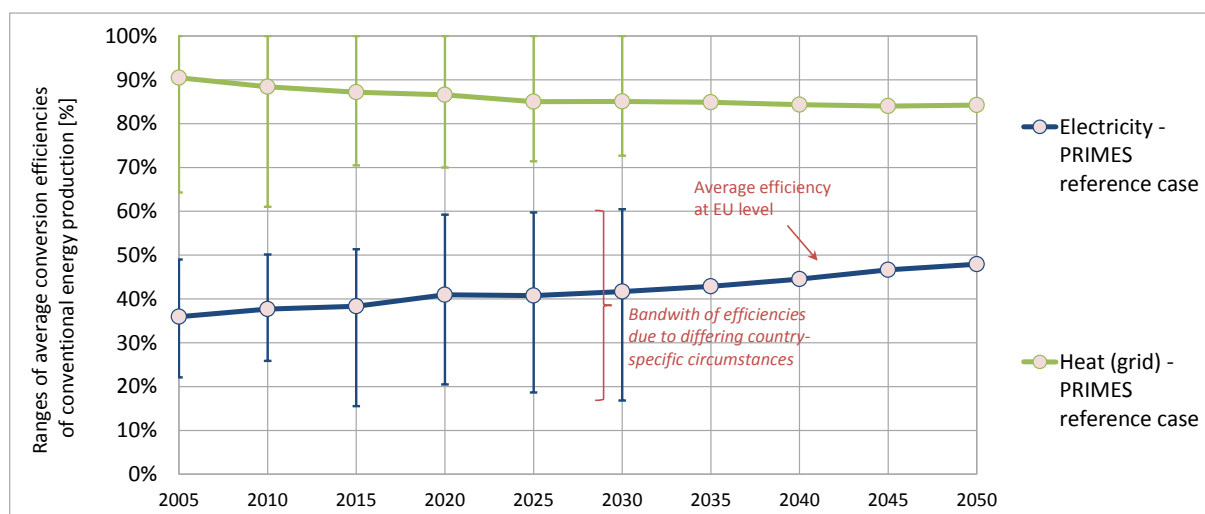


Figure 127: Country-specific average conversion efficiencies of conventional (fossil-based) electricity and grid-connected heat production in the EU28

Source: PRIMES scenarios (EC, 2013)

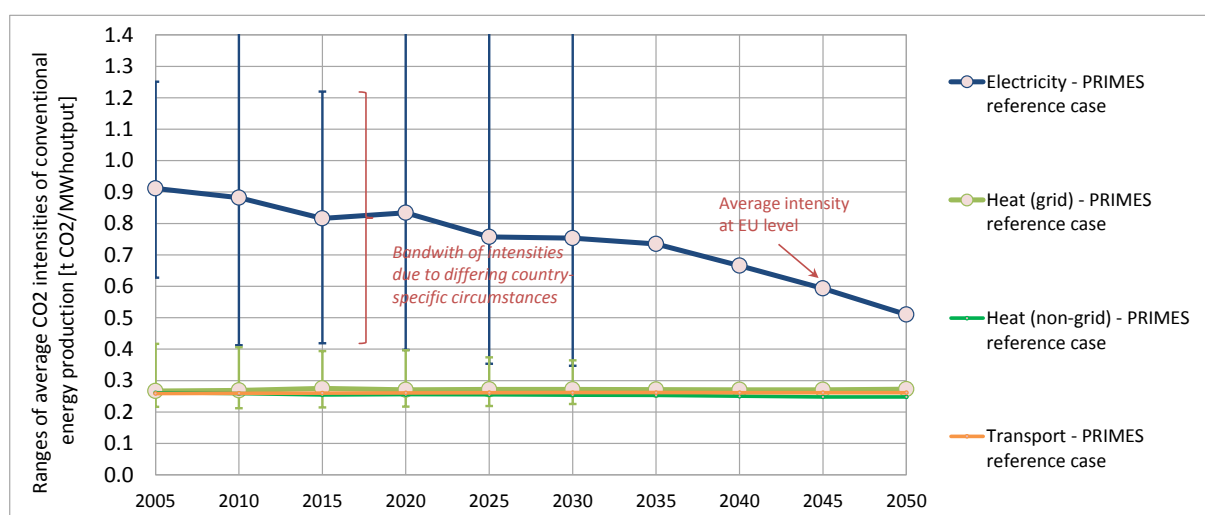


Figure 128: Country-specific average sectoral CO2 intensities of the conventional (fossil-based) energy system in the EU28.

Source: PRIMES scenarios (EC, 2013)

The corresponding data on country- and sector-specific CO₂ intensities of the conventional energy conversion system according to the PRIMES reference scenario are shown in Figure 128. Error bars again illustrate the variation across countries.

8.4.3 Fossil fuel and carbon prices

The country- and sector-specific reference energy prices used in this analysis are based on the primary energy price assumptions applied in the latest PRIMES reference scenario that has also served as basis for the Impact Assessment accompanying the Communication from the European Commission “A policy framework for climate and energy in the period from 2020 to 2030” (COM(2014) 15 final). As shown in Figure 129 generally only one price trend is considered - i.e. a default case of moderate energy prices that reflects the price trends of the *PRIMES reference case*. Compared to the energy prices as observed in 2011, all the price assumptions appear comparatively low, even for the later years up to 2050.

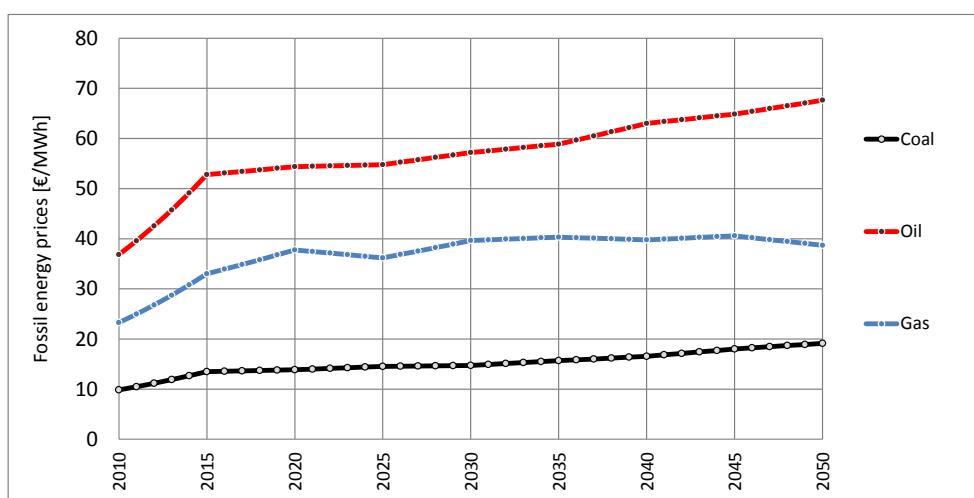


Figure 129: Primary energy price assumptions in €/MWh

Source: based on PRIMES scenarios (EC, 2013)

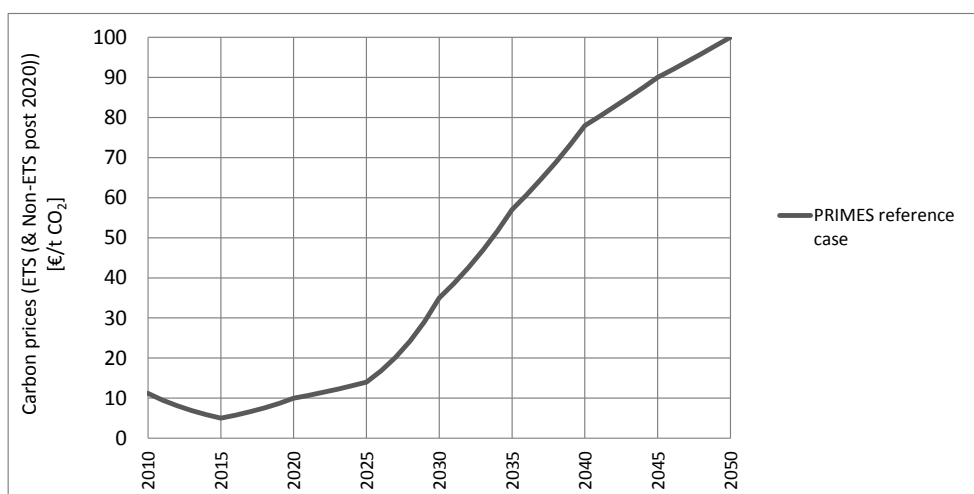


Figure 130: CO₂ price assumptions in €/t₂₀₁₀/ton

Source: PRIMES scenarios (EC, 2013)

The CO₂ price in the scenarios presented in this report is also based on recent PRIMES modelling, see Figure 130. Actual market prices for EU Allowances have fluctuated between 6 and 30 €/t since

2005 but remained on a low level with averages around 7 €/t in the first quarter of 2012. In the model, it is assumed that CO₂ prices are directly passed through to electricity prices as well as to prices for grid-connected heat supply.