PUBLIZIERBARER Endbericht Studien

A) Projektdaten

Titel:	ASSESSING FLEXIBILITY MECHANISMS FOR ACHIEVING THE AUSTRIAN 2020 RENEWABLE ENERGY TARGET (ReFlex)
Programm:	ACRP 1
Koordinator/ Projekteinreicher:	JOANNEUM RESEARCH Forschungsgesellschaft mbH
Kontaktperson - Name:	Mag. Andreas Türk, MBA
Kontaktperson – Adresse:	Elisabethstrasse 18, 8010 Graz
Kontaktperson – Telefon:	0316-876-1337
Kontaktperson E-Mail:	andreas.tuerk@joanneum.at
Projekt- und Kooperationspartner (inkl. Bundesland):	Technische Universität Wien, Energy Economics Group (Wien); Karl-Franzens-Universität Graz, Wegener Center (Steiermark)
Projektwebsite:	http://www.joanneum.at/resources/reflex/
Schlagwörter:	Cooperation mechanisms, renewables, flexible
Projektgesamtkosten:	172.200,- Euro
Fördersumme:	172.200,- Euro
Klimafonds-Nr:	K09AC0K00080
Projektstart & Ende	02.2010-08.2011

B) Project Overview

1 Executive Summary

The EU directive on the promotion of the use of energy from renewable sources (“RES directive”; 2009/28/EC) includes the European target of a 20% renewable energy share (RES) in gross final energy demand. It sets binding targets for all EU member states. The national targets under the RES directive however have not been directly based on physical potentials but on existing renewable energy production and GDP. This has led to an unequal gap between national targets and (cost-efficient) potentials. The RES directive therefore allows countries the use of “cooperation mechanisms” for reaching the national 2020 targets for renewable energy in a cost efficient manner. Countries with relatively expensive RES potentials can thereby meet their targets by purchasing RES shares from countries with relatively cheap RES potentials. The cooperation mechanisms provided in the RES directive are statistical transfer, joint projects, and joint support schemes. Statistical transfer is the (virtual) transfer of RES shares from a country, which has an excess of RES shares, to the receiving country. Within joint projects between member states (or with third countries) RES shares are transferred from projects established in the selling country with financial support from the receiving country. Finally, joint support schemes allow Member States to agree on a joint policy framework to offer support for the expansion of renewable energy production.

While the European Commission as recently as in June 2012 encouraged an increased use of the cooperation mechanisms so far there has been limited research on how to include them in a portfolio of measures to meet national 2020 RES targets. This project aims to contribute to that debate: It offers a first assessment of the use and impacts of the cooperation mechanisms for achieving the Austrian 34% RES-target by 2020. A comprehensive model-supported analysis has been conducted that assesses the impacts of increasing domestic energy efficiency and renewable energy measures and the potential for cooperation with other (EU) countries through the use of the cooperation mechanisms. In addition to direct impacts related to RES deployment and energy efficiency measures, macroeconomic and external effects were incorporated into the analysis. By combining two levels of assumed final energy demand in 2020 with different levels of assumed capacity extension of RES technologies in Austria, six key cases were defined that lead to different shares of RES in relation to the gross final energy demand.

For all scenarios, the techno-economic simulation model Green-X provided a cost-efficient track of RES capacity extension per technology, the related costs and expenditures (i.e. capital, support) as well as selected benefits (e.g. fossil-fuel and CO_2 emission avoidance). The outcomes of Green-X as well as costs for energy efficiency measures served as input to the macroeconomic modelling. In addition external effects of different scenarios, such as reduced air pollution, were quantified and incorporated into the overall assessment. Impacts were considered both in the short- (up to 2020) and long-term (up to 2050). Complementary to the quantitative analysis, a qualitative assessment of the different types of RES cooperation mechanisms was conducted. This included an assessment of design options and implementation barriers as well as a comparison of the RES cooperation mechanism to the use of the flexible Kyoto mechanisms for reaching greenhouse gas emission reduction targets. Experiences with the flexible Kyoto mechanisms, to which the RES cooperation mechanisms have parallels, have shown that the high number of factors impacting the success of a mechanism makes it extremely difficult to predict the mechanisms’ actual use. Anticipated supply-demand balances may provide an indicator of future market dynamics but other factors, such as institutional or administrative barriers, may significantly influence these in practice.

Based on the results, the report concludes that a domestic underachievement of Austria’s 2020 RES target and, consequently, a purchase of required RES volumes via cooperation mechanisms, cannot be recommended from an economic viewpoint. To achieve the Austrian 34% RES-target by 2020 the results suggest a mix of a strong domestic energy efficiency policy package, that reduces final energy demand by 150 PJ by 2020 and a few additional incentives to increase RES deployment above targeted levels, such as increasing budgetary caps for RES electricity or enhanced stipulation of RES in the heat sector. An overachievement of Austria’s RES target (up to 36%) represents the most beneficial option, among all assessed scenarios from an economic point of view if long-term domestic macroeconomic and external effects are considered. It is assumed thereby that it is realized with a moderate increase of current RES support (beyond just increasing current budgetary caps, providing additional support for rather cost-efficient RES technology options in Austria) and a strong energy efficiency policy package. Such an overachievement of the RES target may also be an appropriate strategy for Austria to hedge against unforeseeable changes in the economic framework (e.g. a higher economic and energy demand growth than projected may reduce the share of RES) or implementation risks of planned RES or energy efficiency

measures. At the same time, an overachievement of the RES target would give Austria the opportunity to sell RES volumes to other EU Member States by 2020 via statistical transfer. This could also potentially be done in the years before 2020 whenever surpluses occur. In addition to generating income from statistical transfer, Austria might also allow for renewable energy investments by other countries in the framework of joint projects. This may improve the point of departure for post-2020 targets by increasing Austria's total renewable energy production well in time. However in contrast to statistical transfers, joint projects represent a long-term commitment to (virtually) export RES which should only be followed if Austria remains to be well on track to fulfill its domestic target. At the same time, given that Austria does not depend on the cooperation mechanisms in order to meet its target, joint support schemes may not have sufficient benefits which would justify their potentially high transaction costs, in particular for the short timeframe till 2020.

Apart from the focus on Austria, this project also considered the European perspective: intensified cooperation between Member States in achieving their 2020 RES targets would allow to reduce the cost burden on the EU level significantly: Annual European support expenditures for RES-electricity for example can be decreased by several billion € in 2020. For Austria such a European cost-minimization would imply an overachievement of its target. The report therefore concludes that an overachievement of Austria's RES target economically makes sense from both an Austrian and a European perspective. Moreover, such a strategy may serve as a safeguard against unpredictable changes and could lay the foundation for future RES target achievements. Thus, a strategy aiming an overachievement of Austria's RES target would contribute to an economically attractive and future-oriented pathway for Austria's RES policy while facilitating RES cooperation across the European Union.

2 Background and project aims

In June 2009 the EU directive on the promotion of the use of energy from renewable sources (RES) subsequently named as "RES directive" (2009/28/EC) came into force establishing a common framework for the use of energy from renewable sources. Each Member State has a target calculated according to the share of energy from renewable sources in its gross final consumption for 2020. This target is in line with the overall '20-20-20' goal for the Community. Austria has accepted a national RES target of 34%. This target can be reached through the use of RES in electricity generation, heating and cooling and transportation.

The overall RES share in gross final energy consumptions is calculated using the following equation:

$$RES_{SHARE} = \frac{RES_{electricity} + RES_{heating-cooling} + RES_{transportation}}{GrossFinalEnergyConsumption}$$

The RES directive allows EU countries the use of so-called "cooperation mechanisms" to reach the national targets for renewable energy in a cost efficient manner. With these mechanisms, the directive 2009/28/EC offers the possibility for EU Member States to transfer the RES production exceeding their own targets to other Member States, so that the receiving state can also reach its goal.

Cooperation mechanisms include:

1. "Statistical transfer", the (virtual) transfer of RES shares above those needed by the selling country
2. "Joint Projects" between member states as well as with third countries: the transfer of RES from projects in the selling country with financial support from the receiving country; and
3. "Joint support schemes" where Member States can agree on a joint policy framework to offer support for RES.

The framework for these mechanisms can only be a corner-stone. To implement these mechanisms there is the need of concrete concepts as well as additional investigations that display the potential and the real cost-effectiveness of the mechanisms in comparison to pure national efforts to reach the given targets.

The objective of this project was to provide a model-supported analysis of the extent to which Austria should achieve its renewable energy goal though increasing domestic energy efficiency and renewable energy or through buying or selling virtual RES volumes that may become available through the use of RES-cooperation mechanisms. The modelling exercise took into consideration not only direct costs but also macroeconomic impacts and indirect costs of the trading options. This enabled a comprehensive evaluation of the political choices. In addition, the design and necessary conditions for implementation of the cooperation mechanisms was examined, thereby contributing to on-going European research in this field.

3 Project contents and results

Aim of the model-based assessment was to analyse options for Austria to meet the 34% RES-target for 2020 by national expansion of renewable energies, increased energy efficiency, or possible use of the cooperation mechanisms established by the RES directive. These mechanisms allow buying or selling RES shares to fulfil the target or to make profit from exceeding the targets respectively. Assessed scenarios include different assumptions on the energy policy framework for RES as well as on complementary energy efficiency measures, resulting in different levels of RES deployment in absolute terms (i.e. generated electricity, heat and biofuels) as well as in relative terms (i.e. RES share in gross final energy demand) in Austria and at the European level. The EU-wide analysis is needed specifically to assess the possibilities for cooperation on RES target fulfilment between Austria and other EU Member States.

For all scenarios the techno-economic simulation model Green-X provided a cost-efficient track of RES capacity extension per technology, the related costs and expenditures (i.e. capital, support) as well as selected benefits (e.g. fossil-fuel and CO_2 emission avoidance). The outcomes of Green-X as well as costs for energy efficiency measures served as input to the macroeconomic modelling. In addition external effects of different scenarios, such as reduced air pollution, were quantified and incorporated into the overall assessment. Impacts were considered both in the short- (up to 2020) and long-term (up to 2050). Complementary to the quantitative analysis, a qualitative assessment of the different types of RES cooperation mechanisms was conducted.

Scenario definition

Six key cases were assessed by application of the Green-X model. The results of the six cases were input for the subsequent macroeconomic modelling. A “Reference case” served as basis for the assessments. It assumed a continuation of currently implemented RES support measures. In addition, in this Reference case no complementary additional energy efficiency measures were assumed to be implemented in forthcoming years. With respect to RES technologies no removal of current non-cost barriers1 was assumed.

The database of Green-X was adjusted according to the new insights for Austria derived in this project. This includes particularly technology-specific RES potentials for Austria and the related costs as well as assumptions related to the future energy demand. The six cases of different RES technology extension differ by the overall achievable RES share in the gross final energy consumption by 2020 (i.e. variants 1, 2 and 3) and by the underlying trend with respect to the overall future energy demand growth (i.e. demand trends A with no additional energy efficiency measures and B with additional energy efficiency measures).

The Austrian dimension

With respect to the future development of the overall energy demand, two different energy demand paths serve as a basis for the assessments. On the one hand, a business-as-usual path assuming a continuation of past trends regarding energy demand was assumed. (i.e. “path A”, applied in the reference case, case 1A, 2A and 3A). On the other hand, additional energy efficiency measures were assumed in “path B” (i.e. applied in case 1B, 2B and 3B), whereby the resulting demand development, the REFLEX efficiency case (leading to a reduction of 150PJ by 2020) is in the same magnitude as the "efficiency case" of the Austrian NREAP.

The following cases have been assessed with the Green-X model:

[1] Currently the diffusion of various RES technologies is limited by several deficiencies of non-cost nature. Such deficiencies may include complex, time-consuming administrative procedures or problems associated with grid access etc.

- Two cases (1A, 1B) where Austria achieves less than its target of 34% by 2020 31.8% in the 1A case and 32.9% in the 1B case. Consequently, for fulfilling the RES obligation of 34% (virtual) imports through the use of cooperation mechanisms is a necessity.
- Two cases (2A, 2B) where Austria exactly fulfils its RES target of 34% by 2020.
- Two cases (3A, 3B) of exceeding the RES target. With the share of 36% in both cases Austria would then possess a potential for (virtual) exports of RES shares through cooperation mechanisms.

Consequently, for achieving the above sketched RES shares in dependence of the underlying energy demand trend a different necessity for strengthening the RES support can be expected. Besides, at least for all variants aiming for a RES share of 34% or more by 2020 a mitigation of non-cost RES barriers was assumed. See Table 1 for the complete overview of the assessed cases and further explanations of the applied policy instruments.

The bandwidth of RES shares by 2020 in the different cases (i.e. ranging from about 32 to 36%) may be considered as narrow since a few proponents of the Austrian RES sector have called for stronger RES exploitation by 2020 and beyond. Policy realism and experiences from the achievement of Austrian climate targets on the other hand may ask for a lower RES share by then. Thus, the pathways assessed within this study represent a pragmatic compromise between both extremes, indicating expected (BAU cases) and required RES deployment for 2020 as well as more ambitious cases of doing more than required or targeted, considering the anticipated indicative RES target of 34.2% by 2020 laid down in the Austrian National Renewable Energy Action Plan (BMWFJ, 2010b).

Table 1: Overview of the assessed cases

Overview of assessed cases	Additional energy efficiency measures	Strengthening of current RES support[2]	Mitigation of non-cost barriers for RE[3]	RES share by 2020	Deployment of new RES (2011 to 2020) [TWh]
Reference case	No	No	No	30.2%	36,7
Case 1A - RE import	No	No[4]	Yes	31.8%	42,1
Case 2A - target compliance	No	Yes (moderate)	Yes	34.0%	50,2
Case 3A - RE export	No	Yes (strong)	Yes	36.0%	57,2
Case 1B - RE import	Yes[1]	No	No	32.9%	33,2
Case 2B - target compliance	Yes[1]	No (fine-tuning)[5]	Yes	34.0%	36,8
Case 3B - RE export	Yes[1]	Yes (moderate)	Yes	36.0%	42,9

Notes:

1 The future energy demand development in the efficiency cases is assumed to be consistent with the "efficiency case" of the Austrian NREAP.

2 As default a continuation of current RES support is a precondition. A strengthening of RES support shall consequently mean an adaptation of current practice (year 2010), which generally coincidences with a fine-tuning of technology-specific incentives and the implementation of additional support measures. Incentives for a moderate strengthening of RES support include additional support for rather cost efficient RES technology options, whereas in case of a stronger RES support strengthening the whole RES technology portfolio (to some extent also marginal RES technology options such as PV) would receive additional incentives for investments.

3 As default the diffusion of various RES technologies is limited by several deficiencies of non-cost nature. Such deficiencies may include complex, time-consuming administrative procedures or problems associated with grid access.

4 The case to achieve a RES share in gross final energy demand of about 32% by 2020 under the assumptions that no additional energy efficiency measures are taken but that current non-cost RES barriers are mitigated requires no increase of the height of current RES support levels (e.g. in terms of Euro per MWh for RES electricity). However, achieving the conditioned RES target calls for an enlargement of the budgetary caps that limit yearly RES deployment in the electricity sector.

5 The specific case to achieve a RES share in gross final energy demand of 34% by 2020 in case 2B assumes, on the one hand, that additional energy efficiency measures limit overall demand growth and, on the other hand, that current non-cost RES barriers are mitigated. It requires a fine-tuning of current technology-specific RES support measures. This means no increase of currently offered support levels but a partial removal of budgetary constraints for RES in the electricity sector. Thus, if only support levels are kept constant while all budgetary caps are removed it can be expected that an over fulfilment of the 34% RES target by 2020 will occur.

The EU dimension

The RES development in other EU Member States follows two storylines: the national perspective of accomplishing the EU goals with less cooperation, and the European perspective of intensified cooperation, which are as well combined with two different scenarios of final energy demand for all EU Member States. See Figure 1 for an overview of the EU scenarios and Table 2 for the exact definition of the assessed cases for the EU in line with the Austrian scenario definition. The table shows the parameter definition for the EU 27 Member States for the corresponding Austrian scenario, with the exception that the reference case with mitigation of non-cost barriers (second case in Table 2) is not a case explicitly modelled for Austria. This case will only be discussed in the European dimension results.

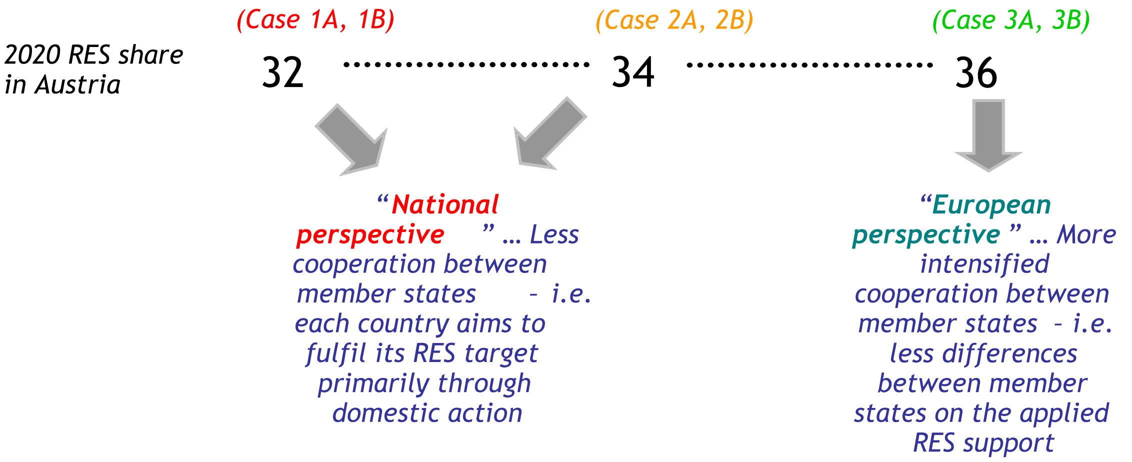

Figure 1: ***Description of the European dimension of the computed scenarios***

Table 2: Overview of the defined parameters for the European dimension

Overview of assessed cases	Additional energy efficiency measures	Strengthening of RES support	Mitigation of non-cost barriers for RES	National or European perspective	RES share by 2020
Reference case	No	No	No	-	14,1%
Reference case with mitigation of non-cost barriers	No	No / Partly[1]	Yes	-	15,7%
Case 1A, 2A	No	Yes	Yes	national	19,8%
Case 3A	No	Yes	Yes	European	19,8%
Case 1B, 2B	Yes	Yes	Yes	national	19,8%
Case 3B	Yes	Yes	Yes	European	19,8%

Notes:

For countries like Austria which currently apply yearly budgetary caps to limit deployment of (certain) RES-E technologies the assumption is taken that the height of current financial support remains constant while caps are removed.

Green-X model

Based on the previous defined scenarios a comprehensive calculation was conducted by application of the simulation model Green-X. The calculation included a variation of the energy-political framework for RES and a variation of the development of other key input parameters (e.g. energy demand). A short characterisation of the model is given in the following paragraphs, while for a detailed description we refer to www.green-x.at. The Green-X model covers geographically the EU-27 Member States. It allows to investigate the future deployment of RES as well as accompanying costs, comprising capital expenditures, additional generation costs (of RES compared to conventional options), consumer expenditures due to supporting policies, etc. – and benefits – i.e. contribution to supply security (avoidance of fossil fuels) and corresponding carbon emission avoidance. Thereby, results are derived at country- and technology-level on a yearly basis. The time-horizon allows for in-depth assessments up to 2030. Within the model, the most important RES-Electricity (i.e. biogas, biomass, bio waste, wind on- & offshore, hydropower large- & small-scale, solar thermal electricity, photovoltaics, tidal stream & wave power, geothermal electricity), RES-Heat technologies (i.e. biomass – subdivided into log wood, wood chips, pellets, grid-connected heat, geothermal (grid-connected) heat, heat pumps and solar thermal heat) and RES-Transport options (e.g. first generation biofuels (biodiesel and bioethanol), second generation biofuels (lignocellulosic bioethanol, BtL) as well as the impact of biofuel imports are described for each investigated country by means of dynamic cost-resource curves. This allows, besides the formal description of potentials and costs a detailed representation of dynamic aspects such as technological learning and technology diffusion.

Besides the detailed RES technology representation the core strength of the model is the in-depth inclusion of energy policies. Green-X is fully suitable to investigate the impact of applying (combinations of) different energy policy instruments (e.g. 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 country- or at European level in a dynamic framework.

Criteria for the assessment of RES support schemes

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 costs for consumer (society), subsequently named consumer expenditures – over time. The criteria used for evaluating the various policy instruments are based on two conditions:

- Minimise generation costs
- 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 consumers/society[2]. This means that feed-in tariffs, investment incentives or RES trading systems should be designed in a way that public transfer payments are also minimised. This implies lowering generation costs as well as producer surplus (PS)[3].

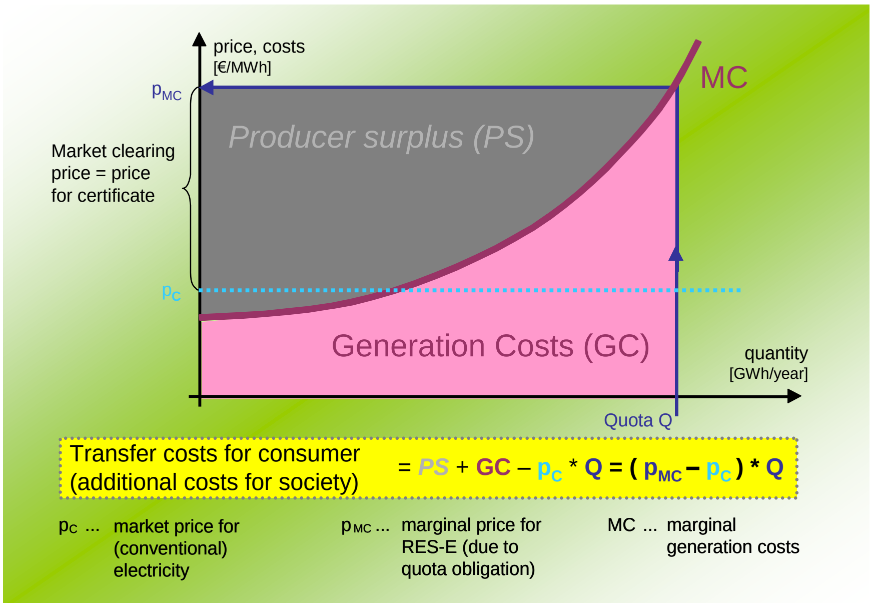

Figure 2: Basic definitions of the cost elements (illustrated for a RES trading system)

In some cases it may not be possible to reach both objectives simultaneously – minimize 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 2.

Green-X scenario results

Subsequently we present the results of the model-based assessment of future RES deployment in Austria and in other EU Member States. Thereby, a first analysis is made related to following questions:

- How high is the potential RES deployment until 2020 in Austria and its corresponding support expenditures?
- How significant are possible benefits such as GHG reduction and supply security linked to RES deployment?
- What policy action is required for achieving the RES targets conditioned within this assessment from an Austrian and European perspective?

---

[2] Consumer 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 consumer 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.

[3] The producer surplus is defined as the profit of RES-based energy production. If, for example, a RES 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 RES producers equals the producer surplus.

RES deployment by 2020 – the Austrian dimension

The modelled scenarios for Austria vary in their RES deployment in different sectors of gross final energy demand, as can be seen in Figure 3. Thereby, biofuels in the transport sector generally achieve a comparatively constant deployment, ranging from 9.4% to 9.6% in all cases. This is in line with the mandatory 10% RES share by 2020 in the transport sector as required by the EU RES-Directive since also electricity from RES used in the transport sector (besides biofuels) has to be taken into consideration for target calculation. Thus, the sectors electricity and heat are responsible for the differences in the total RES shares between the cases. The reference case projects a 65.8% RES share for the electricity sector and a 28.5% RES share for the heat sector in 2020. In the different A-cases, which follow the reference energy demand projections to 2020, the RES share in the electricity sector (RES-E share) varies between 69.2% and 79.2% by 2020. The B-cases, which include additional energy efficiency measures, project a RES-E share from 66.6% to 72.6% by 2020. The RES share in the heat sector (RES-H share) of the A-cases ranges from 30.2% to 34.7%. With additional energy efficiency measures in place (B-cases) the RES-H share varies between 31.7% and 35.3%.

As seen in Figure 3 it becomes apparent, on the one hand, that RES-H achieves a higher share if energy efficiency plays a key role, and, on the other hand, that RES-E needs to be increased less to achieve the overall targeted RES deployment. Moreover, the comparatively strong difference in the RES-E share between case 3A and case 3B is caused by the strong strengthening of the national RES support in 3A needed to reach a 36% RES target if overall energy demand grows strong versus the moderate strengthening necessary in 3B where a package of energy efficiency measures is implemented.

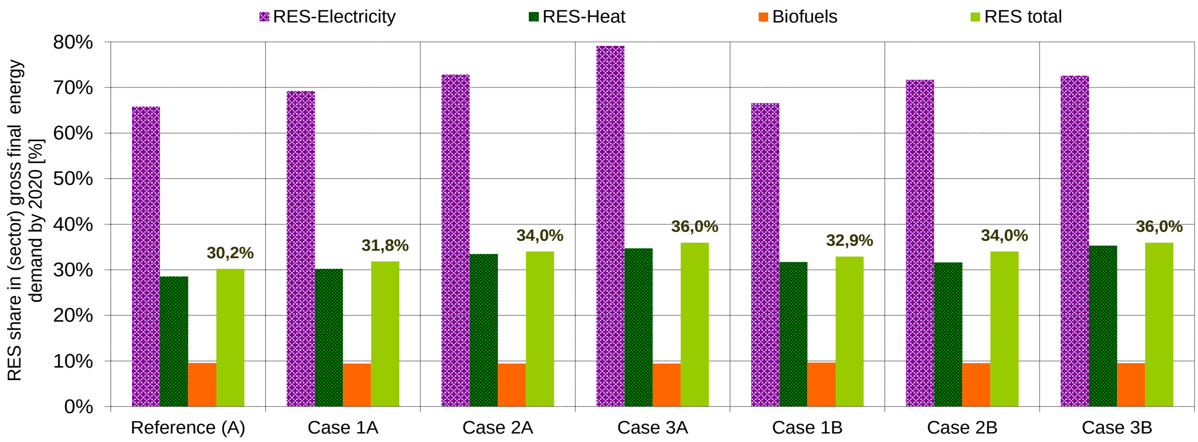

Figure 3: Comparison of the resulting RES share in (sector) gross final energy demand by 2020 in Austria for all assessed cases

The deployment of new RES systems installed in the period 2011 to 2020 is shown in Figure 4 for all six cases. It can be observed that additional energy efficiency measures anticipated in the B-cases have a considerable impact. If additional energy efficiency measures are implemented as conditioned in the B cases, a RES growth as anticipated in the reference case appears sufficient to fulfil the Austrian 34% RES goal (as modelled in the 2B scenario). This scenario implies a mitigation of non-cost barriers and only a partly strengthening of financial RES support.[4] If in addition the national support for RES technologies is strengthened moderately a 36% RES share (case 3B) can be achieved. The amount of biofuels as it is fixed as it is limited at the European level. Given the current discussion on biofuels in the EU a higher amount as we assumed is unrealistic.

[4] As discussed previously this means that no increase of currently offered support levels is required. However, a partly removal of budgetary constraints for certain RES technologies in the electricity sector represents a necessity.

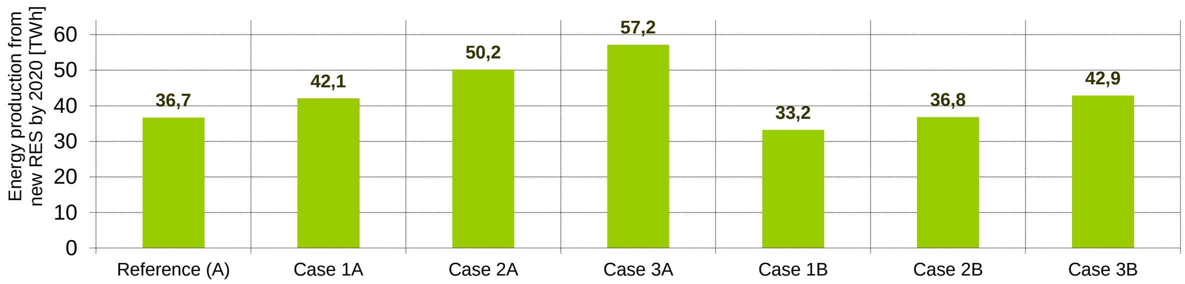

Figure 4: **Comparison of the resulting total deployment of new (2011 to 2020) RES installations in Austria for all assessed cases**

The resulting RES deployment in the year 2020 is a result of new installations mainly in the RES-E and RES-H sectors, as can be seen in detail in Figure 5. These sectors bear the biggest potentials for substituting conventional energy sources by RES in Austria.

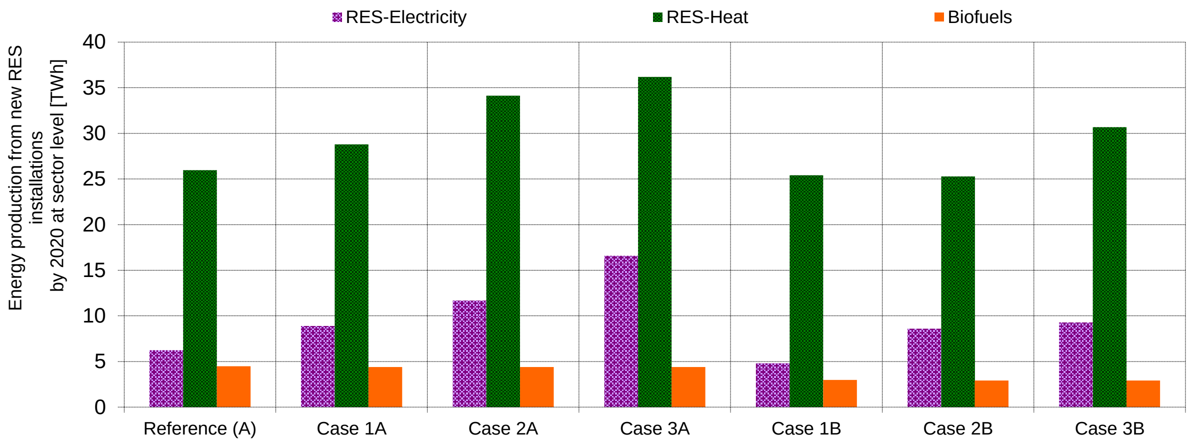

Figure 5: **per sector comparison of the resulting deployment of new (2011 to 2020) RES installations in Austria for all assessed cases**

The technology breakdown of the new RES installations in Figure 5 visualises the potential for new RES installations in Austria in more detail. Solid biomass, specifically in the heat sector, is the key contributor among all RES options in the year 2020 in all of the modelled scenarios. In the electricity sector biomass is again of key relevance followed by large and small-scale hydropower, wind onshore, and biogas and bio-waste. Electricity generation from photovoltaics is an important technology in scenario 3A and can be classified as marginal option. Heat pumps, heat from bio-waste and biogas as well as solar thermal heat are the other RES technologies beside solid biomass to realize the targeted RES volumes for 2020 in the heat sector.

Indicators on costs and benefits for Austria

Cumulative capital expenditures

A comparison of the required cumulative capital expenditures for new RES installations in the period of 2011 to 2020 is shown in Figure 6. The impact of additional energy efficiency measures is apparent:[5] To meet the 34% target with scenario 2B requires far less expenditures than with 2A. For case 3A the need for a substantially higher deployment of (currently) more costly technology options as photovoltaics or solar thermal heat collectors lead to the highest expenditures. In case 3A capital expenditures are 50% higher than in case 3B in order to achieve a similar (36%) RES share by 2020.

[5] Note that a business-as-usual path (i.e. the reference path) for demand growth is conditioned in all A cases, while all B variants reflect a stabilisation of energy demand, implying additional energy efficiency measures to be taken.

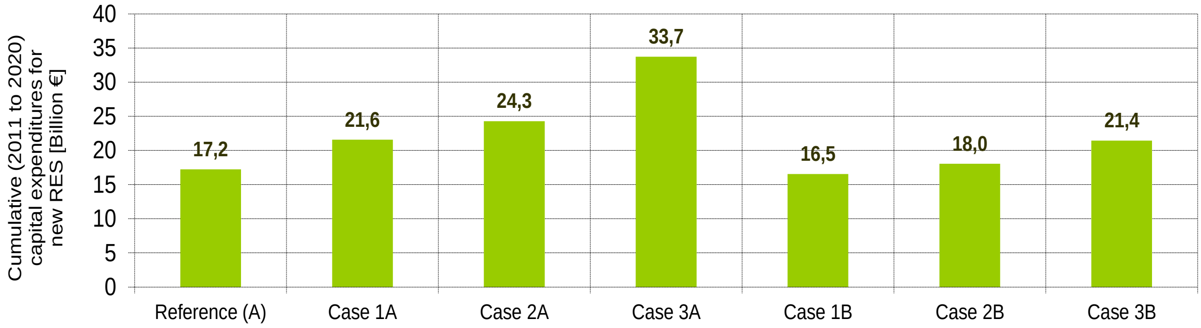

Figure 6: Comparison of the total required capital expenditures for new (2011 to 2020) RES installations in Austria for all assessed cases

Heat from biomass can be classified as cost-efficient option and as key contributor in all assessed cases. Capital expenditures for small-scale biomass heat installations range from 7 to 9 billion € among all assessed cases. This represents the majority of investments in the RES-H sector and about half of all required capital expenditures in the reference case (see Figure 6). On the other hand, certain RES-E technologies can be classified from a cost perspective as marginal options where upfront investments are comparatively high.6

As can be seen in Figure 7 the cumulative capital expenditures for new RES-E installations are lower in the reference case as well as in case 1A and 1B compared to RES-H. If higher targets are to be achieved, more expensive RES-E technologies have to be deployed leading to a significant increase of capital expenditures.

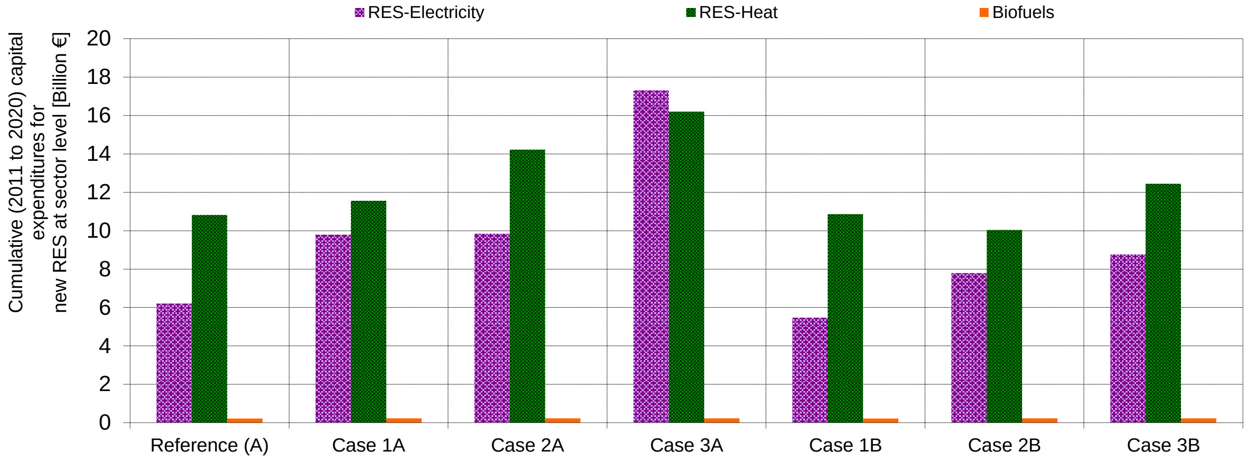

Figure 7: Comparison of the required capital expenditures per sector for new (2011 to 2020) RES installations in Austria for all assessed cases

Scenario results – the European dimension

All researched policy cases are tailored to achieve the target of 20% RES by 2020 at the EU level. Moreover, for all cases (except the reference case) a removal of non-economic barriers (i.e. administrative deficiencies, grid access, etc.) is assumed for the future[7]. More precisely, a gradual removal of these deployment constraints, which allows an accelerated RES technology diffusion, is conditioned on the assumption that this process will begin in 2011.

The policy framework for biofuels in the transport sector is set equal under all assessed policy variants: an EU-wide trading regime based on physical trade of refined biofuels is assumed to assure an effective and efficient fulfilment of the country's requirement to achieve (at least) 10% RES in the transport sector by 2020. Thereby, second

---

[6] Note that in contrast to high capital cost these RES-E technologies have typically low operational expenses, and, furthermore, no fuel expenses are associated with their use.

[7] It can be concluded that a removal of non-economic RES barriers represents a necessity for meeting the 2020 RES commitment. Moreover, a mitigation of these constraints would also significantly increase the cost efficiency of RES support.

generation biofuels receive a sort of prioritization (i.e. a higher support given via higher weighting factors within the biofuel quota regime) in line with the rules defined in the RES directive. Other novel options in this respect such as e-mobility or hydrogen have not been assessed within this analysis as also no direct impact on the overall RES target fulfilment can be expected.

The characteristics of each assessed policy pathway are discussed subsequently:

- **Reference case:** RES policies are applied as currently implemented (without any adaptation) – until 2020, i.e. a business as usual (BAU) forecast. Under this scenario a modest RES deployment can be expected for the future up to 2020.
- **Reference case with mitigated non-economic barriers:** RES policies are in place as currently implemented including mitigation of non-economic barriers.
- **Strengthened national RES policies** (Case 1A, 2A, 3A, 1B, 2B, 3B): a continuation of national RES policies until 2020 is conditioned for this policy pathway, whereby the assumption is made that national RES support schemes will be further optimized in the future with regard to their effectiveness and efficiency in order to meet the 2020 RES commitments. In particular, the further fine-tuning of national support schemes involves in case of both (premium) feed-in tariff and quota systems a technology-specification of RES support. No change of the in prior chosen policy track is assumed – i.e. all countries which currently apply a feed-in tariff or quota system are assumed to use this type of support instrument also in the future.

  However in case of fixed feed-in tariffs a switch towards a premium system is conditioned to assure market compatibility as relevant with increasing shares of RES-E in the electricity market.[8]

The following sub-variants have been assessed:

- **"National perspective"** – national target fulfilment (Case 1A, 2A, 1B, 2B): Within this scenario each Member States tries to fulfil its national RES target by its own. The use of cooperation mechanisms as agreed in the RES Directive is reduced to a necessary minimum: For the exceptional case that a Member State would not possess sufficient RES potentials, cooperation mechanisms would serve as a complementary option. Additionally, if a Member State possesses barely sufficient RES potentials, but their exploitation would cause significantly higher consumer expenditures compared to the EU average, cooperation would serve as complementary tool to ensure target achievement. As a consequence of above, the required RES support will differ comparatively strongly among the EU countries.
- **"European perspective"** (3A, 3B): In contrast to the "national perspective" case as described above, within this scenario the use of cooperation mechanisms does not represent the exceptional case: If a Member State would not possess sufficient potentials that can be economically[9] exploited, cooperation mechanisms would serve as a complementary option. Consequently, the main aim of the "EU perspective" scenario is to fulfil the 20% RES target at the EU level, rather than fulfilling each national RES target purely domestically. Generally, it reflects a 'least cost' strategy in terms of consumer expenditures due to RES

[8] In general, the process of strengthening of national RES policies for increasing their efficiency and effectiveness involves the following aspects: the provision of a stable planning horizon; a continuous RES policy/long-term RES targets; a clear and well defined tariff structure; yearly targets for RES-E deployment; a guaranteed but strictly limited duration of financial support; a fine-tuning of incentives to country-specific needs for the individual RES technologies; a dynamic adaptation/decrease of incentives in line with general market conditions (i.e. to incorporate the impact of changing energy and raw material prices) and specifically to stimulate technological progress and innovation.

[9] In the "European perspective" case economic restrictions are applied to limit differences in applied financial RES support among countries to an adequately low level – i.e. differences in country-specific support per MWh RES are limited to a maximum of 8 €/MWh RES while in the "national perspective" variant this feasible bandwidth is set to 20 €/MWh RES. Consequently, if support in a country with low 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 via (virtual) imports from other countries. Moreover, in both variants a stronger alignment of support conditions between countries is presumed for wind energy and PV as for these technologies in the case of premium support a stepped tariff design is generally implemented, offering on the contrary a graduate differentiated support in dependence of the efficiency at the plant site (i.e. the site-specific full load hours). Such a system is currently implemented for example in Germany or France for wind onshore in order to trigger investments not only at best sites and to limit over support simultaneously.

support. In contrast to simple short-term least cost policy approaches, the applied technology-specification of RES support does however still allow an EU-wide well balanced RES portfolio.

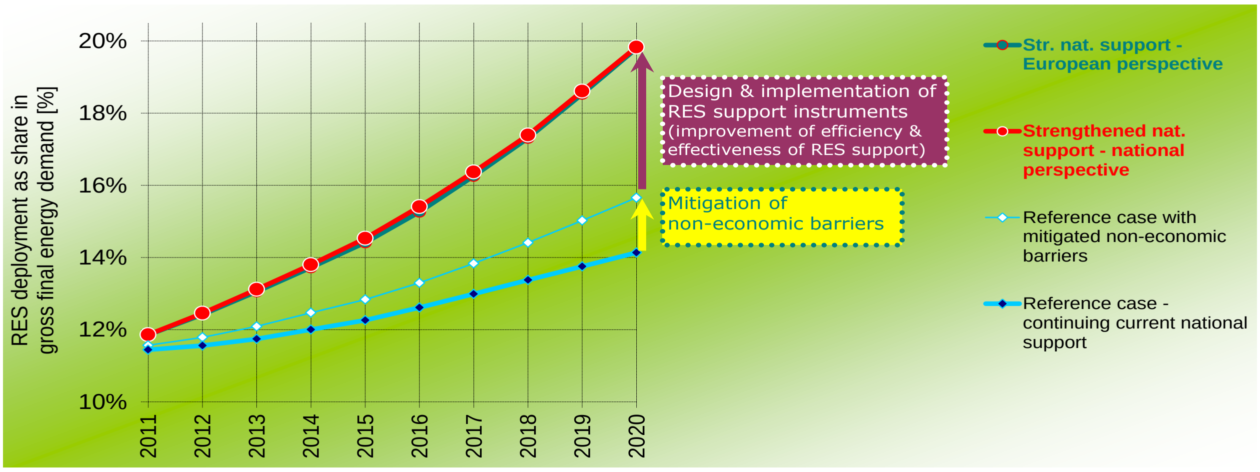

Figure 8: Comparison of RES deployment up to 2020 at the European level according to different RES-policy scenarios.

Source: Green-X, 2011 (RE-Shaping project)

Analysing Figure 8, two variants of the reference case and the "strengthened national policies" case indicate the impact of the individual key measures to move from a BAU to an enhanced RES deployment in line with 20% RES by 2020:

- **Mitigation of non-economic RES barriers:** Retaining current financial RES support but supplemented by a mitigation of non-economic deficits would allow a 2020 RES-E share of 29.2% (compared to 25.9% as default). The corresponding figure for RES in total is 15.7% (instead of 14.1% as default). A significant impact can be also observed for the corresponding yearly support expenditures due to RES-E support. Required expenditures by 2020 would increase substantially under the assumed retaining of current support conditions (without any further adaptation) – i.e. rising from about 50 to 72 billion € in 2020 for RES-E solely, while expenditures for RES in total increase from 74 to 98 billion € (see Table 3). This indicates the need to align support conditions to the expected/observed market development, as otherwise specifically novel RES technologies would achieve significant over support in case of future mass deployment.

- **Design and implementation of RES support instruments:** The detailed policy design has a significant impact on the RES deployment and corresponding expenditures, specifically for the electricity sector. This can be seen from the comparison of the "strengthened national policy" case with the BAU variant where similar framework conditions are applied (i.e. removed (non-economic) barriers and a moderate demand development). For RES-E the direct improvement of the efficiency and effectiveness of the underlying support instruments causes an increase of the RES-E share from 29.2% (BAU with removed barriers) to 36.4% ("strengthened national support – national perspective"). For RES in total the impact on deployment is of similar magnitude – i.e. an increase of the RES share of gross final energy consumption from 15.7% to 19.8% is observable. With respect to support expenditures the consequences are more significant for the electricity sector as then the required burden can be decreased substantially (while the deployment follows an opposite trend). More precisely, yearly expenditures in 2020 would decline from 72 to 63 billion € for RES-E, while for RES in total an insignificant increase is observable (i.e. from 98 to 105 billion € in 2020) (see Table 3).

- **More intensified cooperation between Member States** ("strengthened national support – European perspective") in achieving their 2020 RES targets would finally allow to reduce the cost burden while under the conditioned fulfillment of the 2020 RES target aggregated (at EU level) RES deployment would remain unaffected at the EU level – i.e. obviously, national RES deployment would differ10. Yearly support expenditures can be decreased by about 5% for RES-E, i.e. from 63 to 60 billion € in 2020 (see Table 3). For RES in total the impact is in magnitude of 4% for this specific policy path.

The key figures of the assessed and above explained cases are presented in Table 3. The reference case reaches 14.1% RES share in gross final energy consumption by 2020. Including mitigation of non-economic barriers results in a 15.7% RES deployment. Strengthened national support is needed to reach the EU 2020 target of a 20% RES in the gross final energy demand. The strengthened national support - national perspective case projects total support expenditures of € 105 billion by 2020. In the European perspective case with intensified cooperation to reach the 2020 RES target the total support expenditures by 2020 are reduced to € 101 billion by € 4 billion.

Table 3: Key Figures on RES-E deployment by 2020 and corresponding support expenditures for researched cases (from BAU to strengthened national support, from a national/European perspective) Source: Green-X, 2011 (RE-Shaping project)

Key Figures for researched cases - from BAU to strengthened national support			**Resulting deployment by 2020**		**Yearly support expenditures by 2020**	
Scenario		*Corresponding measures*	RES-E share in gross electricity demand [%]	RES share in gross final energy demand [%]	RES-E support [Bill.€]	Support for RES in total [Bill.€]
1	Reference case - continuing current national support		24.7%	14.1%	50	74
2	Reference case (moderate final energy demand & mitigated barriers)	*(1 --> 2) Mitigation of non-economic RES barriers*	29.2%	15.7%	72	98
3	Strengthened national support - national perspective	*(2 --> 3) Improvement of design and implementation of RES support instruments*	36.6%	19.8%	63	105
4	Strengthened national support - European perspective	*(3 --> 4) Intensified cooperation*	36.4%	19.8%	60	101

A closer look at the relevant performance indicators shows that improved energy policies could EU wide lead to:

- **Additional investments** of **462 billion Euros** in the overall period **2011 to 2020**.
- Above indicated investments would trigger about **3,014 PJ additional RES generation in** the year **2020.**
- An avoidance of **4,773 PJ** of **fossil primary energy use in 2020**.
- In last consequence about **341 million tonnes CO_2** can be avoided **in 2020** by an enhanced RES generation based on improved energy policies.

The average yearly consumer expenditures (2011-2020) due to RES support for new RES installations serves as a key indicator for the assessed European cases. The question is how the cost burden for the consumer of the

[10] Although RES deployment would remain unaffected at the EU level, national RES deployment would differ between both cases of strengthened national RES support (with more or less intensified cooperation between Member States).

strengthened national support compares in the national and European perspective. Figure 9 shows that average yearly consumer expenditures decrease in the European perspective case compared to the national perspective case of strengthened national support. This would speak for more cooperation between EU Member States to fulfill their RES targets compared to national fulfillment only.

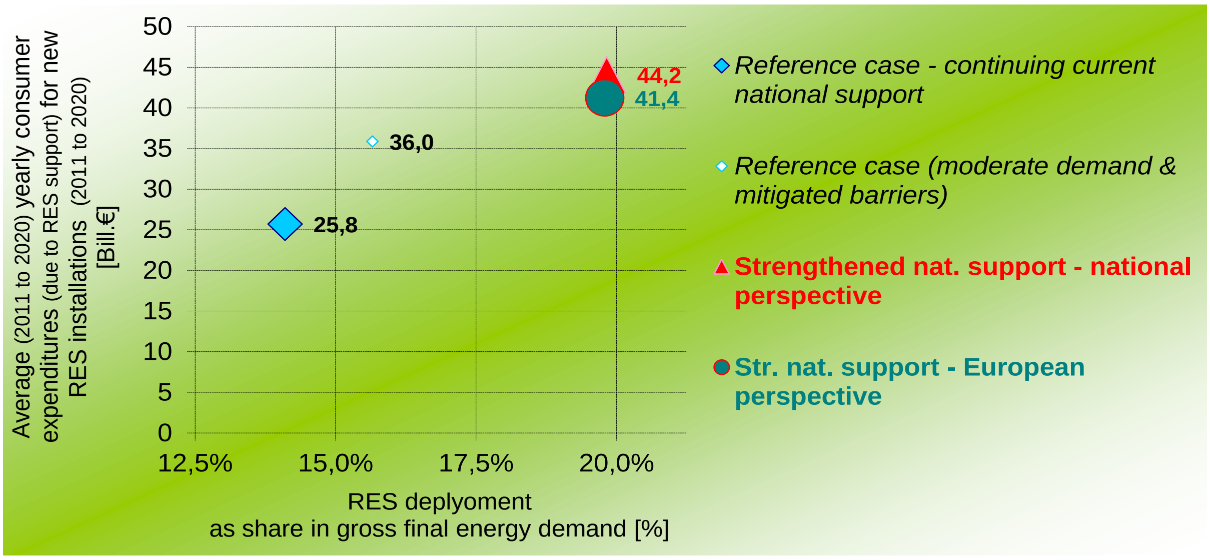

Figure 9: Comparison of the resulting 2020 RES deployment and the corresponding (yearly average) consumer expenditures due to RES support for new RES (installed 2011 to 2020) in the EU-27 for selected cases[11]

Figure 10 depicts the two assessed European cases for strengthened national support on the national level. The (virtual) exchanges of RES volumes by 2020 due to cooperation mechanism are plotted for all EU Member States for both cases. The Green-X model calculates 2.7 TWh of (virtually) exported RES volumes by 2020 in the national perspective case for Austria, whereas 6.7 TWh are (virtually) exported in the European perspective case. In other words, this indicates that for achieving the RES target of 20% RES by 2020 from a European perspective it appears beneficial from an economic viewpoint (i.e. considering support expenditures as decisive indicator) that Austria does more than required. Consequently, Austria could then virtually sell the surplus in RES deployment to other countries facing a deficit.

[11] i.e. BAU and strengthened national support without (national perspective) or with intensified cooperation (European perspective) between member states

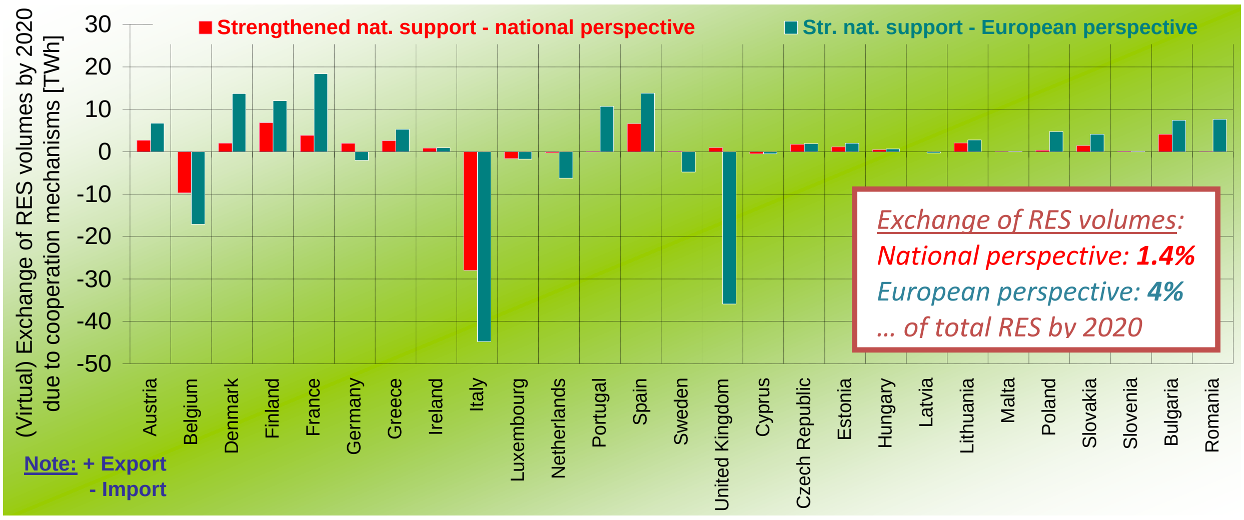

Figure 10: The need for cooperation – (virtual) exchange of RES volumes by 2020 for selected cases – i.e. strengthened national support without (national perspective) or with intensified cooperation (European perspective) between member states

Uncertainties regarding prices to which virtual RES volumes will be sold in the future may be a reason for too little incentives for over fulfillment for some EU Member States at present. From an EU perspective Austria however would be a country with relatively cheap options for over fulfilling its RES target and therefore should be encouraged by the RES cooperation mechanisms to do so.

This section describes the two components of economic well-being that are affected by measures for achieving the Austrian RES-target. These two components are economic effects displayed on markets (macroeconomic effects) and effects not displayed on markets ("external effects"). After discussing those two economic components separately in detail, the combination of both will be considered.

Macroeconomic Modelling- Results for the short term perspective until 2020

According to the scenario definitions all capital investments in RES and EEM are made in the time period until 2020, thereby achieving the respective RES-share levels of each scenario. The production of energy is based on RES increases according to the results from Green-X. This increase in the RES-shares for energy generation causes economic effects due to structural changes of the energy supply structure as well as respective prices, as renewable energy generation partly demands other inputs (technology specific input structure) than fossil-based energy production. A stimulus for exports by energy efficiency increases is included in the CGE model. Decreasing production costs (due to less costs for energy due to the efficiency measures) and consequently a more cost effective production lead to decreasing commodity prices (compared to foreign countries).

The results include three main components:

- **Consumption.** Consumption represents the welfare of the society.
- **Trade balance.** The trade balance expresses the difference between the values of imported and exported commodities. It is crucial to understand that the level of consumption is connected to the trade balance as it affects the import of commodities. If increasing consumption is requiring increasing imports, and this is not accompanied by a rise in exports, it results in a trade balance deficit which is financed by foreign depts.
- **Gross fixed capital investments.** The investments lead to changes in the economy's capital stock over time.

Table 4 summarizes the effects on central macroeconomic parameters as monetary deviations from the reference case and accumulated over the 10-year period 2011-2020.

Table 4: Accumulated results of macroeconomic effects until 2020 (2.5% discount rate)

	Consumption cum. 2011 - 2020	Gross fixed capital investments cum. 2011-2020	Foreign Trade Balance cum. 2011-2020
	Mio € compared to Reference Scenario – discounted		
1 A	-975	-740	-1.038
2 A	754	-31	-2.988
3 A	431	2.993	-5.585
1 B	-36.640	38.680	1.131
2 B	-37.473	37.364	1.571
3 B	-36.075	38.383	-381

The effects on consumption in the A-scenarios differ in prefix but considering that they represent accumulated numbers for a 10-year period they are relatively small. Even though the consumption in 2A and 3A is positive it can be seen that consumption effects are overcompensated by increased net imports financed by foreign creditors. The reasons for this are twofold. First, some RES-technologies (especially PV) need commodities (such as technical components) with high import shares. Therefore an increase in RES-production in these technologies leads to a higher demand for imports. Second, the installation of noncompetitive RES-technologies[12] leads to increased energy prices. Since energy is an input in all sectors of the economy the domestic price level rises compared to other regions. This in turn leads to a reduced demand for domestic exports while increasing the demand for – relative – cheaper imports from abroad. An opposite effect arises from decreased demand for the increasingly expensive fossil fuels, but it can't outweigh the tendencies for negative trade balance effects in the A-scenarios.

The B-scenarios show a quite different picture. Adjusted data[13] from the EnergyTransition (WIFO 2011) project show, that the needed expenses on EEM are about €46 billion over the considered 10-year period. The investments in EEM are additional investments to the yearly economic gross fixed capital formation[14]. Since funds generally available in the economy are either used for consumption or investments these additional investments (€46 billion) consequently lead to a reduction in consumption during the investment period. Taking this into account it is obvious that EEM have a major influence on the overall consumption (and welfare) in the short term. As displayed in Table 4 by highly negative consumption in the B-scenarios within the period 2011-2020, a transfer of funds from consumption towards capital investment takes place. This of course leads to a higher capital stock (see gross fixed capital investments in Table 4). These investments in energy efficiency pay off in form of energy savings. The payoff of the investments (in form of saved energy expenses) occurs over a long term period along the lifetimes of the technologies/investments. Until 2020 these payoffs do not prevail, i.e. do not compensate the investment costs.

Unlike in the A-Scenarios, the trade balance is almost balanced or even positive for the B-Scenarios. This has two reasons. First, due to only moderate RES-capacity expansion in all B-scenarios only a small impact on imports occurs. The second reason is that EEMs mainly demand commodities that have a low import rate (e.g. construction services).

---

[12] The generation of RES-energy is more expensive relative to the reference generation costs of the respective energy form (Heat, Electricity or transport fuel). These additional generation costs were calculated by the Green-X model.

[13] The data from the Energy Transition contains packages of energy efficiency projects in Austria. The data was adjusted to meet a reduction in final energy consumption of 150 PJ by 2020.

[14] The macroeconomic expression for the total capital investments of an economy within one year

Development of consumption over time

For a better understanding of the results it is useful to have a look at the development of consumption over time.

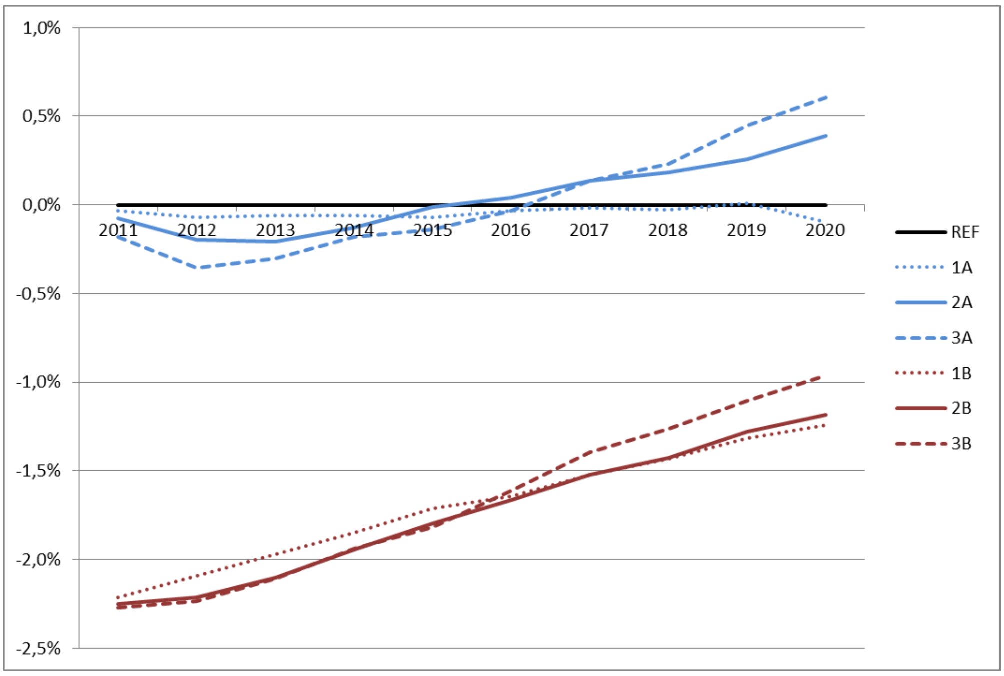

Figure 11: Deviation of consumption relative to the reference case

The results of the A-scenarios in Figure 11 show a (compared to the reference case) relatively lower consumption level within the first years and an increase towards 2020 in case 2A and 3A. The reasons for this deviation compared to the reference case are twofold: on the one hand the negative effects are caused by accelerating the expansion of non-competitive and therefore relatively expensive RES-technologies and by the deadweight loss due to the necessary subsidies granted for RES-technologies[15]. On the other hand the positive effects are caused by increased domestic employment, a higher capital stock of RES-facilities and therefore higher amounts of return on investment for consumption uses as well as the reduction of the increasingly expensive imports of fossil fuels.

Along the B-scenarios it is easy to see that the effects of the reduction in consumption due to investments in EEM dominate up to 2020. Figure 11 shows that the consumption in the B-scenarios is clearly below the reference consumption. Nevertheless, the consumption growth in the B-Scenarios is stronger than in the A-scenarios. The reason for that is that funds, formerly used for energy consumption, due to increased energy efficiency gradually becomes available to a bigger extent for other consumption purposes. This increases in the long run the consumption possibilities as beside higher consumption the same energy service (e.g. warm houses) can still be consumed – but just at smaller costs. This long-term increase in consumption possibilities increases also the welfare. However, before getting this benefits energy efficiency investments have to be financed. For that the government and the private households would need to reduce their total consumption at an average of 1.7% per year in the time period until 2020 to reach the level of energy savings according to the ReFlex Efficiency Scenario.

To conclude the view until 2020: The B-scenarios lead to a high reduction in consumption (in the short run), a higher capital stock and have small negative or positive effects on the trade balance. In the A-scenarios consumption remains relatively constant while imports increase in all A-scenario cases.

[15] Deadweight loss or „excess burden“ is the loss of economic efficiency in allocation of goods on a market by taxes or subsidies.

Scenario results for the time until 2050

The view until 2020 is insufficient to compare the outcomes of the scenarios since the pay-off of the EEM occurs over a long period of time[16]. Therefore the period under investigation has been expanded up to 2050. The view until 2050 includes all the long-term payoffs of the investments that have taken place until 2020. These payoffs are energy savings, less import of expensive fossil fuels, higher employment and the capital rent from the RES installations. This view – including the whole lifetime of most of the installed technologies – allows evaluating the total long-term effects on welfare of investments, of the production of renewable energy and of energy savings.

Table 5: Accumulated results of macroeconomic effects until 2050 (2.5% discount rate)

	Consumption cum. 2011 - 2050	Gross fixed capital investments cum. 2011-2050	Foreign Trade Balance cum. 2011-2050
	M€ compared to Reference Scenario - discounted		
1 A	3.053	530	-4.433
2 A	12.434	3.656	-8.612
3 A	18.762	8.776	-15.990
1 B	-1.710	39.400	806
2 B	-2.611	38.064	1.485
3 B	8.185	42.031	-5.212

The outcome of all A-Scenarios – as shown Table 5 – is a strong increase in welfare; however there are strong negative effects on the trade balance. In particular in 2A and 3A there are strong positive welfare effects compared to the short term view (compare with Table 4).

In contrast, the reduction in consumption in the B-scenarios– due to the EEM investments until 2020 – is far lower than in the short term view. However, the highly negative consumption in the short-term view is compensated by positive effects (energy cost savings, return on capital) only in 3B that has positive welfare effects up to 2050 as positive effects and feedback effects[17] prevail. Case 1B and 2B show a negative total deviation in consumption when applying a discount rate of 2.5% up to 2050. The foreign trade balance in the B-scenarios shows a similar picture as the results until 2020: a small but positive effect on foreign trade balance in the cases 1B and 2B, while the moderate expansion of RES-support in 3B leads to a negative effect.

The results regarding gross fixed capital investments among all scenarios differ from the results until 2020. The capital investments – and thereby the capital stock – increases noticeable in the cases of moderate and strong expansion of RES capacities (i.e. 2A, 3A and 3B) as well as in cases of increased energy efficiency (B-scenarios). This sketches the complex effect of the expansion of RES capacities. The higher domestic energy production increases the domestic value added. That is partly compensated by imports, but still leads to higher demand for labor, which leads consequently to more revenues available for consumption, savings and investments and thereby to an increasing capital stock and – once again – factor (labor, capital) incomes.

Development of consumption over time

The view on the development of consumption over time in Figure 12 gives a better understanding of the effects of the different scenarios.

[16] Up to 40 years in case of passive houses or thermal rehabilitation

[17] i.e. a higher disposable income, a higher demand for labor and thereby a higher employment rate leading to higher economic growth and capital investments what again leads to more factor income, more demand for goods and labor.

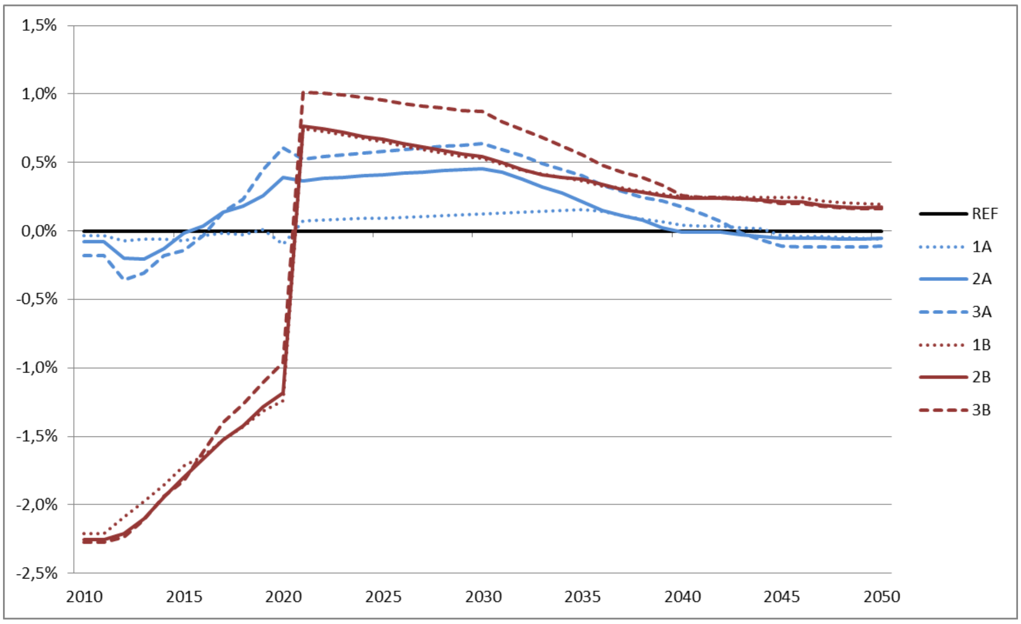

Figure 12: Deviation of consumption relative to the reference case (2010-2050)

The A-scenarios show a continuation of the positive development of welfare until 2020. The positive effects go along with the lifetimes of the RES-installations and decrease towards 2050. In case of 3A it can be seen that this case – with the strongest RES-expansion – leads initially to the strongest decrease in consumption (due to high investment needs, dead weight loss due to subsidies, utilization of relatively costly technologies compared to 1A and 2A) but has the most positive long lasting deviations after 2020.

The end of the (in the model assumed) investment period of the B-scenarios in 2020 can clearly be seen as a sharp increase in consumption as the investments in EEM end in our analysis.[18] After 2020 the consumption is in all B-scenarios higher than in the reference case. There are several reasons for this effect. First, the reduced import of increasingly expensive fossil fuels benefits the local economy. The second reason comes from the higher employment rate and hence higher level of income in all scenarios. This higher income level – and the additional disposable income due to energy savings – leads not only to higher consumption but also to economic growth. Since investments are linked to economic growth, this leads to more investments, which is the third reason for increased welfare. These additional investments lead to a higher capital stock and hence to a higher factor income (i.e. rents). Also, the B-scenarios have a higher consumption level than the A-scenarios in 2050. This is because some EEMs, like thermal refurbishment and passive house standards, have an assumed economic lifetime of 40 years and generate energy savings until 2050. This emphasizes the need for long-term consideration of EEMs as they pay-off only in the long term. Nevertheless, due to the applied discount rate of 2.5% this higher level of consumption in the long-term in the B-scenarios is reduced significantly as Table 5 shows. The accumulated deviation of consumption from the Reference case along the B-scenarios is only positive for Scenario 3B. That means that the discounted payoff to cover the investment costs is only sufficient in the case where the EEMs are implemented in combination with a moderate expansion of RES support.

To conclude, the results shows that – according to the underlying model – the expansion of RES capacities and the implementation of EEM have a noticeable effect on welfare and the economic activities in Austria. However, the results merely display the macroeconomic view of the scenarios. Other factors like external effects as well as RES and greenhouse gas certificates trade have to be taken into consideration as discussed in the following sections.

External effects of different scenarios – overall comparison

In the following, external effects are shown for each scenario. Figure 13 shows for each scenario the sum of discounted annual external benefits and external costs from RES expansion and energy efficiency measures

[18] As only the effects from investments until 2020 are intended to be modeled. Of course, in reality investments in renewable energies and energy efficiency will go also beyond 2020.

implemented within the time period 2011-2020. Certainly, external benefits and costs of the implemented measures go beyond this period, until the end of the expected service life of investments made. On the one side, the use of RES technologies causes external costs due to emissions of local air pollutants (e.g. biomass). In the analysed scenarios heating with renewable energies (RES-H) causes – in absolute terms – the highest external costs, whereby the highest share of external costs from heating is caused by non-grid heating. Comparatively low are external costs caused by electricity generation from renewables (RES-E) and transport using renewable fuels (RES-T). However, on the other side, reducing emissions from the reference energy mix by an intensified RES expansion in the sectors grid-heat (Avoided-Reference-H-grid) and non-grid heat (Avoided-Reference-H-non-grid) as well as electricity (Avoided-Reference-E) and transport (Avoided-Reference-T) leads to a compensation of external costs from using RES

Once again, an intensified use of RES in the sector heating achieves the highest external benefits, whereby especially transforming non-grid heating systems leads to the highest external benefits. It turned out (illustrated by Figure 13) that external benefits from RES expansion by far exceed external costs due to emissions of local air pollutants from RES use (e.g. form biomass). Beside RES expansion also energy efficiency measures leads to external benefits. In this respect one major advantage of energy efficiency measures is that they do not only lead to a substitution of energy sources but to a real reduction of energy demand. For the analysed scenarios, most external benefits can be achieved by energy efficient buildings (EFF-Buildings). However, also external benefits caused by energy efficiency in the production sector (EFF-Production) and transport service (EFF-T) are not negligible.

As shown in Figure 13 external benefits as well as external costs of RES expansion steadily rise from the reference scenario to scenario 3A. In the B-scenarios both external benefits as well as external costs of RES expansion are comparatively low, as the general demand for energy decreases and therefore less RES expansion is required. Nevertheless, in the B-scenarios external benefits are further increased by energy efficiency measures.

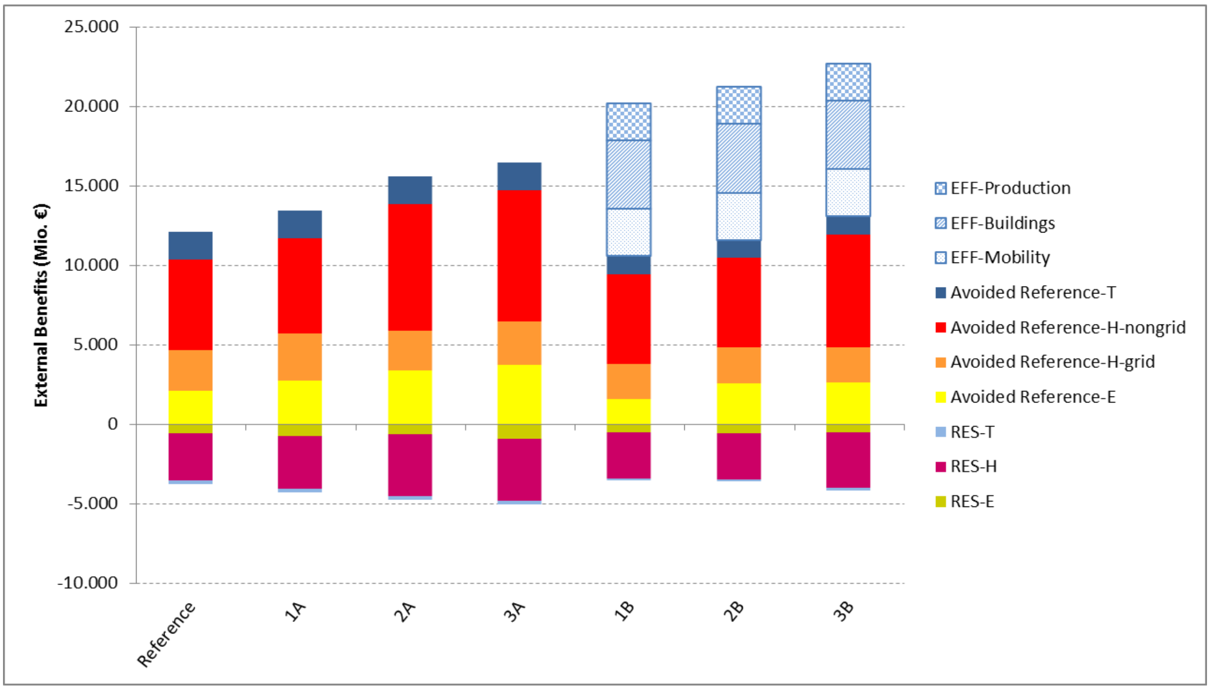

Figure 13: External Benefits and Costs of measures implemented between 2011 and 2020

To ensure the comparability of the scenarios, balancing external benefits with external costs is necessary. These net external effects of each scenario are shown in Figure 13. It can be seen that those scenarios, which include energy efficiency measures (B-scenarios) gain much more net external benefits than scenarios without energy efficiency.

Moreover, net external benefits of the scenarios become much more significant when comparing different strategies leading to the same share of RES compared to the gross final energy consumption. For instance: a RES share of 34% could be achieved either by scenario 2A or 2B – or nearly already by scenario 1B. Comparing net external benefits of these scenarios reveal that achieving the target of 34% by including energy efficiency measures (1B or 2B) leads to a rise in external benefits of approximately € 6.7 billion (difference 2B-2A). This pattern can be seen too, when scenarios resulting in a RES-share of 36% (3A, 3B) are compared: choosing scenario 3B leads to € 7 billion higher external benefits than achieving a 36% RES share with scenario 3A.

The potential use of cooperation mechanisms by Austria

Austria can be expected to reach or even exceed its 2020 renewable target with a moderate increase of RES support and/or additional energy efficiency measures. From that perspective Austria does not depend on using the cooperation mechanisms. However, due to the potential for overachieving the 2020 target and particular interim targets, statistical transfer should be considered. Statistical transfer may offer a revenue stream from selling excess renewable shares without requiring additional investments. Because the future market for renewable shares is highly uncertain, this potential should be assessed early in discussions with potential trading partners, which may lead to early agreements. Investments in renewable energy and energy efficiency aiming an overachievement of the 2020 goal may thereby indirectly be co-financed through revenues from statistical transfer. An overachievement of RES targets can also help building a basis for potential post-2020 targets.

Austria might allow renewable energy investments by other countries in the framework of joint projects. This may equally lead to improving the point of departure for post-2020 targets in case no post-2020 transfers of RES share take place. In particular, costs for achieving post-2020 targets may increase when the most cost-efficient renewable potentials are dedicated to joint projects that may include (statistical) transfers of renewable energy beyond 2020. This could be avoided through exclusion of the most cost-efficient renewable energy potentials from joint projects or through limitation of post-2020-transfers of renewable energy shares. Generally, the use of joint projects for investments in Austria would lead to substitution of domestic expenditures with foreign investments while maintaining a similar RES share (e.g. overachievement). At the same time macroeconomic benefits from foreign RES investments in Austria may be lower than those from pure domestic investment due to e.g. a potentially higher import of construction material and labor. The potential benefit of joint projects for Austria therefore is less obvious than the benefit from statistical transfer of existing surpluses. Whether Austria will have a net benefit from joint projects will consequently depend on the degree to which national co-benefits from RES investments are “priced in” in negotiations with investors. For Austria, which is on good track to reach its 2020 renewable target, joint support schemes may not have sufficient benefits which would justify their potentially high transaction costs, in particular for the short timeframe till 2020.

4 Conclusions and recommendations

While Austria has already agreed on a comprehensive set of measures to meet its 2020 RES target, the assessment of the different scenarios conducted within this project reveals that there may still exist additional opportunities for Austria's energy policy.

The integrated assessment of the project results demonstrates that the different scenarios for meeting or over-achieving Austria's RES target have different economic advantages and drawbacks that also depend on the discount rate applied and therefore on societal preferences regarding future costs and revenues. Moderately increasing the current support for RES (i.e. providing additional support for rather cost-efficient RES technologies) would yield high macroeconomic benefits in the short and medium term. A strong increase of the current RES support (providing additional support also to less cost-efficient RES technologies) would lead to a strong welfare increase, however accompanied by a significant negative impact on the activity balance. Energy efficiency measures, on the other hand, would lead to strong cumulated external benefits in the long-term through the reduction of energy use that leads to a reduction of air pollutants.

Based on the results of this project it can be concluded that a domestic underachievement of Austria's 2020 RES target and, consequently, a purchase of required RES volumes via cooperation mechanisms cannot be recommended from an economic viewpoint. For achieving the committed 34% RES-target by 2020 in Austria the results suggest a mix of a strong domestic energy efficiency policy package reducing final energy demand by 150 PJ by 2020 and a few additional incentives to increase RES deployment above targeted levels, such as increasing of budgetary caps for RES electricity or enhanced stipulation of RES in the heat sector. An overachievement of Austria's RES target (up to 36%) represents the most beneficial option among all assessed scenarios from an economic point of view if it is realized with a moderate increase of current RES support (beyond just increasing current budgetary caps, providing additional support for rather cost-efficient RES technology options in Austria) and a strong energy efficiency policy package long-term domestic macroeconomic and external effects are considered. For achieving and maintaining social acceptance for such a strong policy intervention that requires significant public funding, awareness raising related to long-term external benefits appears essential.

Such an overachievement of the RES target may also be an appropriate strategy for Austria to hedge against unforeseeable changes in the economic framework (e.g. a higher economic and energy demand growth than projected (reducing the share of RES) or implementation risks of planned RES or energy efficiency measures. At the same time, an overachievement of the RES target would give Austria the opportunity to sell RES volumes to other EU Member States by 2020 and potentially also in the years before 2020 whenever surpluses occur via statistical transfer. In addition to generating income from Statistical Transfer, Austria might also allow for renewable energy investments by other countries in the framework of Joint Projects. This may improve the point of departure for post-2020 targets by increasing Austria's total renewable energy production well in time. However in contrast to Statistical Transfers, Joint Projects represent a long-term commitment to (virtually) export RES which should only be followed if Austria is well on track for domestic target fulfillment. For Austria, which is on good track to reach its 2020 renewable target, joint support schemes may not have sufficient benefits which would justify their potentially high transaction costs, in particular for the short timeframe till 2020. Overall, the market for virtual RES trade generally still faces significant uncertainties and is difficult to predict. Experiences with the flexible Kyoto mechanisms to which the cooperation mechanisms have parallels have shown that the high number of factors impacting the success of a mechanism makes it extremely difficult to predict the mechanisms' actual use. Anticipated as supply-demand balances may provide an indicator of future market dynamics but other factors, such as institutional or administrative barriers, may significantly influence these in practice.

Apart from the focus on Austria this project also considered the European perspective: Intensified cooperation between Member States in achieving their 2020 RES targets would allow to reduce the cost burden on the EU level significantly: Annual European support expenditures for RES-electricity for example can be decreased by several billion € in 2020. The report therefore concludes that an overachievement of Austria's RES target economically makes sense from both an Austrian and a European perspective. Austria could use this opportunity to gain additional revenues by using the cooperation mechanisms. Moreover, aiming for an overachievement may serve as a safeguard against unpredictable changes and could lay the foundation for future RES target achievements. Thus, a strategy aiming an overachievement of Austria's RES target would contribute to an economically attractive and future-oriented pathway for Austria's RES policy while facilitating RES cooperation across the European Union.

C) Project details

5 Method

The framework for the cooperation mechanisms as set in the RES directive are only a corner-stone. To implement these mechanisms there is the need of concrete concepts as well as additional investigations that display the potential and the real cost-effectiveness of the mechanisms in comparison to pure national efforts to reach the given targets. The objective of this project was to provide a model-supported analysis of the extent to which Austria should achieve its renewable energy goal through increasing domestic energy efficiency and renewable energy or through buying or selling virtual RES volumes that may become available through the RES-cooperation mechanisms. The modelling exercise took into consideration not only direct costs but also macroeconomic impacts and indirect costs of the trading options. This enabled a comprehensive evaluation of the political choices. In addition, the design of the cooperation mechanisms was examined, thereby contributing to on-going European research in this field.

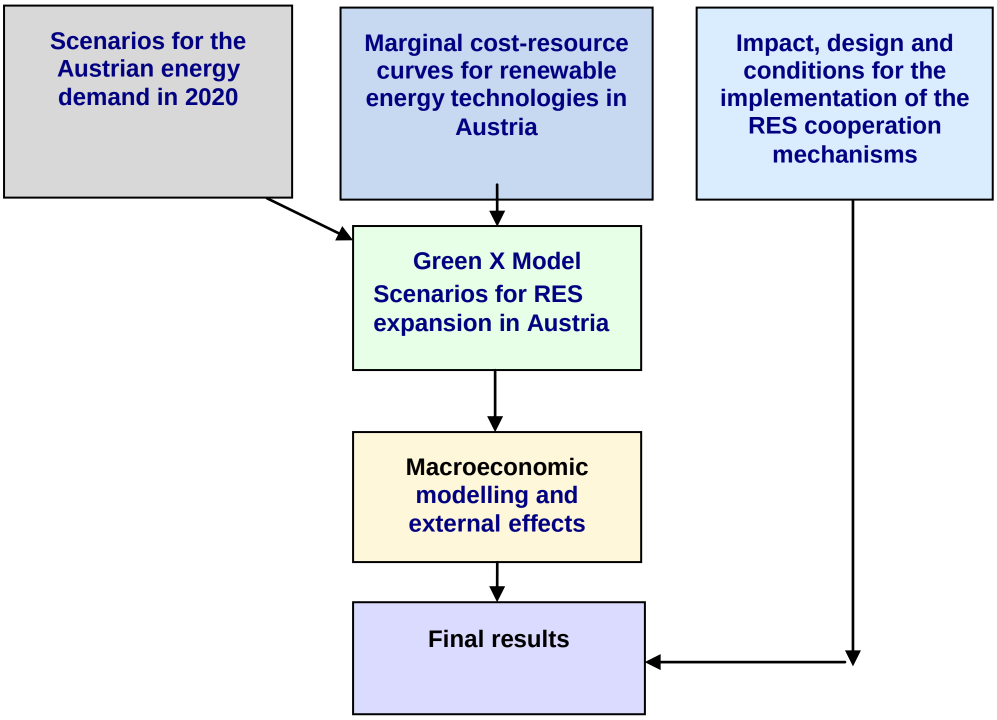

Figure 14: Flow chart of the modeling steps

The project included the following steps:

Scenarios for the final energy demand in 2020: First, the project derived two scenarios for the Austrian (gross) final energy demand in 2020. In the so-called “reference-scenario” it was assumed that no additional energy efficiency measures are introduced, whereas in the “efficiency-scenario” additional energy efficiency measures in the same magnitude as foreseen in the Austrian National Renewables Action Plan (NREAP) are implemented.

Costs for renewable energy technologies: In the next step dynamic cost-potential-curves for Renewable Energy Technologies in Austria were derived and this data was used to update the database of the Green-X-model. The resulting data was prepared to be sufficiently detailed for the subsequent macroeconomic modelling.

Green-X modelling: Both outcomes described above were included in the Green-X model. By combining two levels of assumed gross final energy demand with different levels of assumed capacity expansion of RES-technologies, six key scenarios with respect to Austria’s RES target fulfilment were developed. A reference case assuming no additional policy measures served as reference for the calculations. For all six scenarios Green-X provided a cost-efficient track of RES capacity expansion per technology, its costs as well as avoided fossil based energy and avoided carbon dioxide (CO2) emissions. Beside the different implementation intensities of energy efficiency measures and RES deployment, the six scenarios differ with respect to the resulting RES share in gross final energy demand by 2020 – for each demand path a case of (exact) RES target compliance was modelled as well as one case for over- and one for under-fulfilment.

Macroeconomic modelling and external effects: The costs for meeting the six scenarios, the CO2 emissions saved as well as the cost structure for RES technologies and energy efficiency measures in Austria served as input for a Computed General Equilibrium (CGE) model. The CGE model provided information about impacts of the different scenarios on economic indicators, including welfare and employment. Furthermore, data of the Green-X model regarding the extent and structure of RES-capacity extension and substituted fossil based energy was used to calculate external effects (e.g. emissions of increased/decreased harmful air pollutants). The amount of each type of harmful substances was multiplied by external damage costs. Finally, the macroeconomic and external effects were part of an integrated assessment of the scenarios.

RES cooperation mechanisms: In parallel to the modelling work the RES cooperation mechanisms were assessed regarding their possible design, advantages, disadvantages, potentials, and barriers and were compared to the flexible mechanisms of the Kyoto Protocol.

Final results: Based on this assessment and the modelling results, conclusions on a potential use of the RES cooperation mechanisms by Austria were drawn. The qualitative results were included in the final policy recommendations.

6 Workplan and time schedule

The workplan and time schedule was the following:

	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8
WP1: Scenarios for the Austrian energy demand 2020																			
1.1 Analysis of energy scenarios																			
1.2 Development of demand scenarios for 2020																			
WP2: Marginal cost curves in Austria for Renewable Energy Technologies																			
2.1 Assessment of the potential for renewable energy in Austria using static marginal cost curves																			
2.2 Analysis of input factors for renewable energy production																			
2.3 Rendering the cost curves dynamic																			
WP3: Impact, design and conditions for implementation of the RES Mechanisms																			
3.1 Comparison of impacts, incentive structures and transaction costs of the three mechanisms																			
3.2 Barriers to use of flexible RES mechanisms																			
3.3 Necessary institutional conditions for implementation of the flexible RES mechanisms																			
WP4: Scenarios for the expansion of renewable energy sources in the EU with the focus on Austria																			
4.1 Data adjustment and scenario definition																			
4.2 Computation of scenarios																			
4.3 Analysis of scenarios and preliminary policy conclusions																	**D7**		
WP5: Macroeconomic Modeling																			
5.1 Macroeconomic general equilibrium evaluation																			
5.2 Explicit economic cost differentials																			
5.3 Comprehensive macroeconomic evaluation																			
WP6: Expert- and Stakeholder dialogue																			
6.1 Initiations of a stakeholder process																			
6.2 International workshop																			
6.3 Formulation of the final conclusions																			
WP7: Project management																			
7.1 Project management																			

7 Publications and Dissemination

The publication strategy is as follows:

Dissemination in Austria:

- *Publications in an Austrian energy related magazine eg the journal issued by Österreichs Energie (The Austrian association of energy producers).*
- *Distribution of the German summary for policymakers among stakeholders*
- *The results were presentation at the Austrian "Klima Tag" 2012 14. and 15. July*
- *The results were submitted to the World Sustainable Energy Days 27.02-1.3. 2013, Wels Austria*

Working Paper:
A Working Paper with the title: Assessing the Role of Cooperation Mechanisms for Achieving the Austrian 2020 Renewable Energy Target was published and uploaded on SSRN.
http://ssrn.com/abstract=2185965

Academic Publication
The results will be published either in the Energy Policy journal or the International Journal of Energy Research http://onlinelibrary.wiley.com/journal/10.1002/(ISSN)1099-114X

Stakeholder Workshop
In February 2012 a Workshop is planned to present the results to researchers and stakeholders.

Diese Projektbeschreibung wurde von der Fördernehmerin/dem Fördernehmer erstellt. Für die Richtigkeit, Vollständigkeit und Aktualität der Inhalte übernimmt der Klima- und Energiefonds keine Haftung.