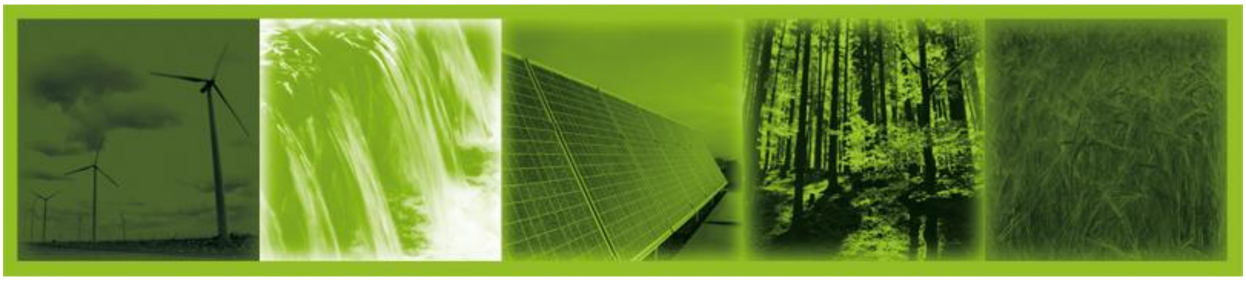
REPAP 2020

Renewable Energy Policy Action Paving the Way towards 2020



Renewable Energy Industry Roadmap for Slovakia

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Content

1 Current situation - RES market status

1.1 Current status of RES

Slovakia offers significant future potentials for several kinds of RES options which are waiting to be exploited in the forthcoming years. In contrast to above, current RES deployment is at a comparatively low level, focussed on very few technologies. While in absolute terms currently RES in the heat sector provide the highest contribution, whereby (traditional) biomass use is of key importance in relative terms the electricity sector is strongest penetrated by RES. Therefore in absolute terms RES for power supply are the second largest contributor, referring to hydropower as dominating source. Figure 1 offers a depiction in relative terms (left) – i.e. indicating the contribution of RES to gross energy consumption by sector and at the aggregated level (i.e. to gross final energy demand) – as well as in absolute terms (right), expressing the generated electricity, heat and transport fuels from renewable sources.

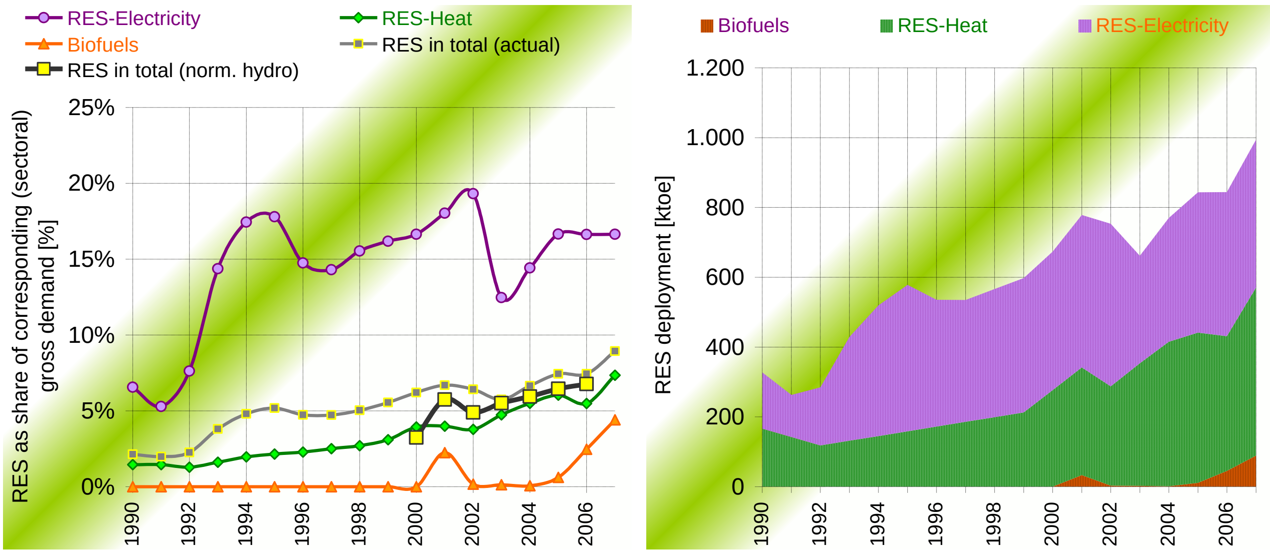

Figure 1 Historic development of RES by sector in Slovakia in the period 1990 to 2007 – in relative terms (as share of corresponding demand) (left) as well as in absolute terms (i.e. generated electricity, heat and transport fuels) (right)

Source: Eurostat (2009)

1.1.1 Electricity sector

The installed electricity generation capacity in Slovakia relies on fossil, nuclear and hydroelectric sources. Since the early nineties electricity consumption in Slovakia has been fairly steady whereas the total generating capacity in 2006 was 8.2 GW, 32% of this nuclear. Slovakia has gone from being a net exporter of electricity to being a net importer following shut-down of the Bohunice V1 reactors.

Figure 2 provides an illustration of the historic development of electricity generation from RES in Slovakia by technology. As applicable therein, hydro power, especially large scale, is currently the dominating RES for power supply, and its technical and economic potential is comparatively well exploited. Good opportunities exist for biomass. Current installed wind capacity is very modest as compared to the available potential and only amounts to 3.14MW. Slovakia is currently not on track with reaching its RES-E target of 31% gross electricity consumption for 2010. Besides biomass, hydro and wind, also geothermal and solar energy offer significant future potentials.

The Slovakian RES-E market has gained strong attention from local and international investors and project developers. Additionally, a smaller number of players are active in developing medium and large scale hydropower schemes.

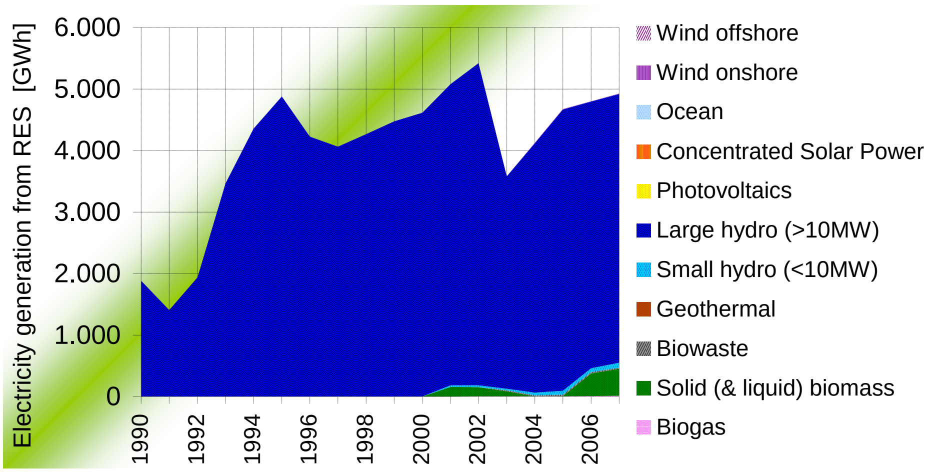

Figure 2 Electricity production from RES in Slovakia in the period 1990 to 2007

Source: Eurostat (2009)

1.1.2 Heating (and cooling)

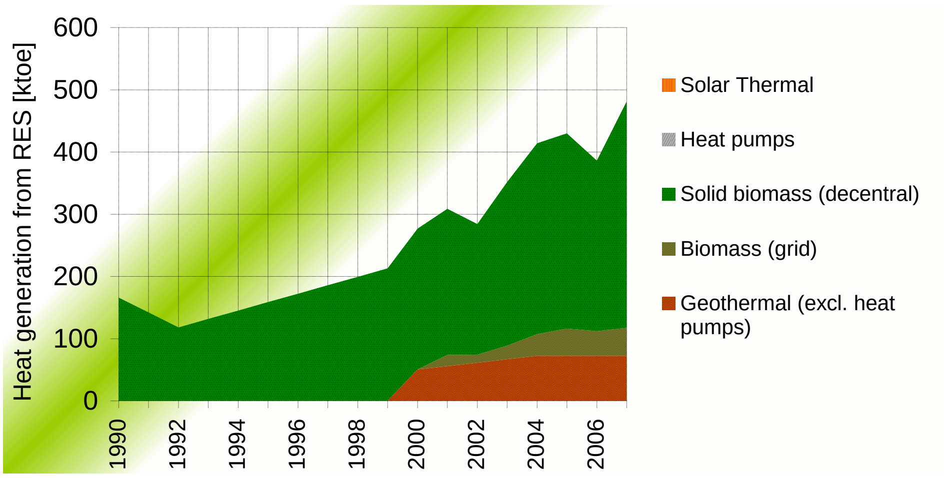

Figure 3 Heat production from RES in Slovakia in the period 1990 to 2007

Source: Eurostat (2009)

As stated above, RES in the heat sector provide the highest contribution among all energy sectors to meet Slovakia's energy needs. As shown in Figure 3, offering a technology breakdown of the historic development of heat production from RES in Slovakia, the use of biomass for heat supply is of key importance. This comprises however mainly traditional biomass use at non-commercial level. In recent years some developments in the District Heating / CHP sector based on solid biomass have been observed. Moreover, the supply side for biomass is far from being well developed. Besides, geothermal energy use for heating purposes is underdeveloped given the promising future potentials for this energy source. So far, only some small-scale projects have been realized.

1.1.3 Transport sector

The potential for biofuels (biodiesel and bioethanol) is far from being well exploited. Hence, some 77 ktoe of biodiesel have been generated in Slovakia in the year 2007. Additionally, hardly any generation has been noticed for bioethanol – only 12 ktoe in 2007.

1.2 Supporting policies for RES[1]

1.2.1 Electricity sector

Currently, the key support instrument of RES-E in Slovakia is a feed-in tariff. The Regulatory Office for Network Industries sets feed-in tariff rates annually, taking into account the index of national core inflation. The revision of feed-in tariffs every year brings some uncertainty into the RES-E market. On 19 June 2009, Slovakia adopted a new Law on the Promotion of RES and High-Efficiency Cogeneration in order to foster the attractiveness of investments in RES technologies and to meet the country's EU targets. New RES-E support schemes entered into effect on 1 January 2010. Under this new support scheme, a feed-in premium will be available for RES-E producers. Some secondary legislation for full implementation of this new law has not yet been adopted. Additionally, Slovakia promotes the RES-E through a fiscal measure: exemption from consumption tax.

The fixed tariff is determined for different types of RES technologies on the basis of installed capacity and the date of commissioning the plant (before or after 1 January 2005). The feed-in tariff has been determined in such way that the pay-back period is 12 years. Regional energy utilities purchase RES-E for a fixed feed-in tariff based on the guaranties of origin under the Government regulation that determines the rules for the operation of the market in electricity No. 317/2007.

New RES-E support schemes is in effect from 1 January 2010. The new support scheme is available for the following RES technologies: hydropower, solar, wind, geothermal, biomass (including all products derived from biomass processing), biogas, sewage gas and biomethane.

Under this new support scheme, a feed-in premium will be available for RES-E producers. The feed-in premium scheme will be based on a premium payment on top of the basic electricity price. The feed-in premium will be set by the Regulatory Office for Network

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1 The information represented in this section is taken from the forthcoming „Renewable Energy Policy Country Profiles" as derived within the European research project Re-Shaping (see Rathmann et al., 2010).

Industries for a certain type of RES. A producer of RES-E will be entitled to a premium for 15 years after the initial operation, reconstruction or modernization of a power plant. The premium will be determined taking into account the type of RES, technology used, the date of the installation and the size of the installation.

RES-E producers have the right to a premium if the total installed capacity is up to 10 MW. If the installed capacity exceeds 10 MW, the right to the premium applies to a proportional part of produced electricity calculated as a ratio of 10 MW to the total installed capacity. In the case of wind energy, producers have right to a premium if the total installed capacity is up to 15 MW.

In Slovakia, electricity is subject to a consumption tax [5]. Renewable energy is promoted through the exemption of the consumption of RES-E from tax. All technologies used in the RES-E generation are eligible for this exemption. From 01/01/2010 onwards, the amount of tax will amount to 0.13 €ct/kWh.

1.2.2 Heating (and cooling)

The generation of RES-H is supported by subsidies. In 2007, the Government of the Slovak Republic adopted the Programme for Promotion of Biomass and Solar Energy Use in Households, which is financed by state budget Based on this programme, households that install a biomass boiler or solar panels are eligible for a subsidy under specified criteria. Only new installation of biomass boilers and solar collectors can claim a subsidy.

Additionally, an obligation to evaluate the possibility of RES utilization in new large buildings is adopted by the Act on Energy Performance of Buildings No 555/2005. According to this Act it is necessary for new large buildings to perform the technical, economical and environmental evaluation of utilization of alternative energy systems.

Finally, Slovakia supports electricity generated in high efficiency CHP depending on the capacity of the CHP plant and on the used technology.

1.2.3 Transport sector

Since May 2004, pure biofuels used for transport purposes have been fully exempt from excise tax. In July 2007, a scheme for offering reduced excise tax on biofuel blends has been introduced. Diesel blends with esters and petrol blends with a bioethanol derivate, ETBE, receive excise tax exemptions proportional to the content of biofuel in the blend. The exemptions are limited to 7.2% for petrol blend with ETBE and to 5 % for diesel blend with esters.

1.3 Deployment barriers

Slovakia applies the deep connection charges approach in case of necessary grid reinforcement. The cost for grid connection (according to the capacity) has to be covered by the applicant for connection (RES-E generator) in the form of the fee for connection. The connection fees are calculated according to transparent rules presented in the business conditions of individual TSO or DSOs. The size of fees for the connection corresponds to the size of costs required for essential technical modifications and a fee for reserve capacity. Hence, a significant barrier for the deployment of RES is the higher overall generation costs of all technologies, which is especially faced for wind power generators. Additionally, the corresponding, insufficient grid capacity in many sites with favourable wind conditions sets another barrier for a fast wind energy development. In the field of hydropower the technical and economic potential which can be realised without large constraints seems to be far already exploited at present. Mainly wind energy and small hydropower are facing environment protection constrains as protected landscape areas and national parks cover more than 9/10 of Slovakia's surface.

However, main barrier for RES-E represents the national electricity grid and corresponding regulation which in actual state cannot sufficiently regulate the variable electricity production especially from wind and photovoltaics. There is also a need to think about additional back-up power supply.

RES heating and cooling support is not systematic. RES utilisation in district heating systems is supported only by direct subsidies, mainly from structural funds. There is more a conceptual approach for households where each personal entity can get subsidy for installation of solar-thermal and biomass boilers but heat pumps are excluded.

Although monitoring and evaluation is extremely important to measure the success of a policy or support programme and to readjust their priorities if necessary, little has been done in this field. The dispersion of resources and lack of staff have largely contributed to this situation. If a medium and long-term energy efficiency and renewable energy strategy is to be implemented, it needs to include a strong and consistent methodology for assessing the results of the initiatives undertaken and for reshaping future policy accordingly.

2 Targets & trajectories

In this section the feasible future deployment of RES in Slovakia up to 2020 is illustrated based on a model-based scenario assessment as derived within the REPAP2020 project. This scenario elaboration is conducted by application of a well known software tool with respect to forecasting the deployment of RES in a real-world policy context, namely the ***Green-X*** model[2] and its corresponding database on RES potential and cost in Europe. The derived scenarios are meant to form a basis for establishing the 27 national renewable energy industry roadmaps. The subsequently discussed results refer to two diverging policy pathways as briefly characterised below:[3]

- NAT case – National target fulfilment: In the NAT scenario each Member States tries to fulfil its national RES target by its own. For the exceptional case that a member state would not posses sufficient RES potentials or their would cause significantly higher cost compared to the EU average, cooperation mechanisms would serve as a complementary option. This implies that countries with a 2020 RES target which can be achieved at comparatively low cost would go beyond their target level to export their excess in RES deployment – in order to assure a balance of deficit and excess at the EU level.

- ACT case – Proactive support / realisable deployment: The ACT scenario depicts an optimistic future with respect to the RES exploitation. The assumption is taken that all EU member states apply proactive RES support whereby EU-wide equal incentives are preconditioned for individual RES technologies (e.g. by applying a harmonised but technology-specific premium feed-in system to support RES-E). With EU-wide effective and efficient RES support this scenario ends up with a higher RES exploitation as foreseen in the RES directive.

Please note that in both cases besides efficient and effective RES support also accompanying energy efficiency measures are conditioned which limit the future growth of energy demand.[4] Additionally, in all cases a stepwise removal of current non-economic barriers (i.e. administrative deficiencies, grid access, etc.) is presumed for the future. This process which

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2 The model ***Green-X*** has been initially developed by the Energy Economics Group (EEG) at Vienna University of Technology in the research project "Green-X – Deriving optimal promotion strategies for increasing the share of RES-E in a dynamic European electricity market", a joint European research project funded within the 5th framework program of the European Commission, DG Research - Contract No. ENG2-CT-2002-00607.

For details on model or project please visit the project web-site www.green-x.at. Note that a detailed model description is also given in Appendix C to this report.

3 For a detailed definition of these cases we refer to Appendix B to this report which includes also an overview on the applied methodology and related key assumptions.

4 In order to ensure maximum consistency with existing EU scenarios energy demand projections are taken from PRIMES modelling as used for the European Commission's climate and energy policy analysis. More precisely the underlying scenario of this RES policy assessment is the PRIMES case on meeting both EU targets by 2020 – i.e. on climate change (20% GHG reduction) and renewable energies (20% RES by 2020) / 2008 (PRIMES target case) (NTUA, 2008).

is assumed to be launched immediately would allow an accelerated RES technology diffusion in the forthcoming years.

2.1 Overall renewable energy target and trajectory

Table 1 Overall renewable energy targets and trajectories for Slovakia

RES target for 2020 and indicative trajectory	Unit	2005	Average 2011-2012	Average 2013-2014	Average 2015-2016	Average 2017-2018	2020
Share of RES in gross final energy consumption	%	6,70%	8,16%	8,89%	9,99%	11,45%	**14,00%**

Source: based on Directive 2009/28/EC

In 2005 renewable energy sources account for a share of 6.7% of gross final energy consumption in Slovakia, which is below the EU wide average which equalled about 8.5%. Until the year 2020, Slovakia is due to increase this share to 14%, compared to the EU wide target of 20% this target can be classified as moderate.

2.2 Sector targets and trajectories

According to both scenarios Slovakia will meet and significantly exceed its RES target of 14% in 2020. As illustrated in Figure 4 this can be expected with assumed policy changes not only for 2020, also in the near future proactive RES support would boost RES deployment well above the given indicative interim trajectory. Differences between both cases are however remarkable for the early years, whereas close to 2020 the gap between the scenarios stabilizes. According to the NAT case Slovakia would achieve a RES share in gross final energy demand by 2020 of 15.2%, whilst with proactive RES support all over Europe a RES share of 18.5% can be expected for 2020.

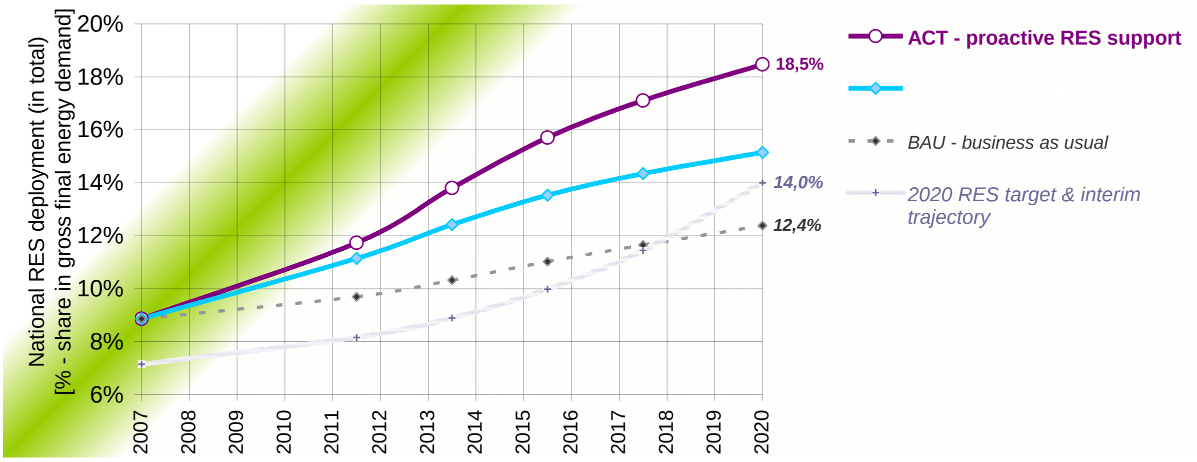

Figure 4 Comparison of the RES share in gross final energy demand according to the NAT & the ACT scenarios with the 2020 RES target for Slovakia & the corresponding indicative interim trajectory

Source: Green-X model – REPAP2020 scenarios (2009)

Further details on the RES deployment by sector as well as in absolute terms (produced electricity, heat or biofuels) are depicted in Table 2 for the NAT case, while the corresponding data for the ACT case is represented in Table 3. Of highlight, the contribution of RES to Slovakia's heat supply will increase significantly, achieving an about two to more than three times higher RES generation as of 2005. The RES share in gross heat demand would then rise from 6.0% in 2005 to a level of 13.1% (NAT) to 16.8% (ACT) by 2020. RES for electricity, being the highest contributor today, would also increase substantially to level of (more than) twice their 2005 generation according to the NAT (ACT) scenario. Biofuels for transport purposes achieve the fastest increase which results from the fact that their use at present (2005) is (almost) zero.

Table 2 Sectoral targets and trajectories for Slovakia – NAT scenario

Indicators on expected contribution from RES by sector	Unit	2005	NAT (National target fulfillment) Average 2011-2012	Average 2013-2014	Average 2015-2016	Average 2017-2018	2020
Gross final energy consumption	ktoe	11.324	12.485	12.854	13.226	13.569	14.022
Gross final consumption of RES	ktoe	790	1.392	1.597	1.790	1.947	2.125
Share of RES in gross final energy consumption	%	7,0%	11,1%	12,4%	13,5%	14,3%	15,2%
Gross final Consumption of electricity from RES	ktoe	349	617	676	739	777	802
Share of RES electricity in gross final electricity consumption	%	14,5%	22,8%	23,8%	24,7%	24,8%	24,2%
Gross final energy consumption from RES in heating and cooling	ktoe	430	683	793	904	997	1.092
Share of RES heating and cooling in gross final heating and cooling consumption	%	6,0%	8,9%	10,2%	11,4%	12,3%	13,1%
Final energy from RES consumed in transport	ktoe	11	92	128	147	173	231
Share of RES in transport	%	0,6%	4,4%	6,0%	6,7%	7,7%	10,0%

Source: Green-X model – REPAP2020 scenarios (2009)

Table 3 Sectoral targets and trajectories – ACT scenario Slovakia

Indicators on expected contribution from RES by sector	Unit	2005	ACT (proactive support - realisable deployment) Average 2011-2012	Average 2013-2014	Average 2015-2016	Average 2017-2018	2020
Gross final energy consumption	ktoe	11.324	12.485	12.854	13.226	13.569	14.022
Gross final consumption of RES	ktoe	790	1.465	1.774	2.077	2.321	2.591
Share of RES in gross final energy consumption	%	7,0%	11,7%	13,8%	15,7%	17,1%	18,5%
Gross final Consumption of electricity from RES	ktoe	349	657	772	875	930	963
Share of RES electricity in gross final electricity consumption	%	14,5%	24,3%	27,1%	29,3%	29,7%	29,0%
Gross final energy consumption from RES in heating and cooling	ktoe	430	716	875	1.055	1.218	1.397
Share of RES heating and cooling in gross final heating and cooling consumption	%	6,0%	9,4%	11,2%	13,3%	15,0%	16,8%
Final energy from RES consumed in transport	ktoe	11	92	128	147	173	231
Share of RES in transport	%	0,6%	4,4%	6,0%	6,7%	7,7%	10,0%

Source: Green-X model – REPAP2020 scenarios (2009)

2.3 Contribution of RES to electricity consumption

Table 4 (NAT) and Table 5 (ACT) illustrate further details on the technology-specific contribution to the above discussed strong increase of RES in the electricity sector. As observable therein, Slovakia has a vast production of hydroelectricity, especially through large scale facilities, which however still offers potential for further exploitation.

Table 4 Future contribution of RES to electricity consumption in Slovakia – NAT scenario

Expected contribution from RES to electricity consumption	2005		NAT (National target fulfillment) Average 2011-2012		Average 2013-2014		Average 2015-2016		Average 2017-2018		2020	
Unit	MW	GWh	MW	GWh	MW	GWh	MW	GWh	MW	GWh	MW	GWh
Biomass	49	31	226	1.322	313	1.822	415	2.440	463	2.715	505	2.940
Biogas	2	4	60	364	67	401	88	535	104	622	126	742
Solid (& liquid)	44	4	148	839	223	1.276	305	1.758	337	1.944	356	2.050
Biodegradable fraction of MSW	3	23	18	119	22	145	23	148	23	148	23	148
Concentrated Solar Power	0	0	0	0	0	0	0	0	0	0	0	0
Geothermal	0	0	0	0	0	0	0	0	0	0	0	0
Hydro, total (excl. pumping)	1.690	4.023	1.927	5.768	1.958	5.908	1.958	5.908	1.958	5.908	1.958	5.908
Small hydro (<10MW)	62	176	260	1.137	291	1.277	291	1.277	291	1.277	291	1.277
Large hydro (>10MW)	1.628	3.848	1.667	4.631	1.667	4.631	1.667	4.631	1.667	4.631	1.667	4.631
Photovoltaic	0	0	0	0	5	5	27	24	43	39	43	39
Ocean	0	0	0	0	0	0	0	0	0	0	0	0
Wind	5	7	34	80	53	125	93	216	163	370	195	439
onshore	5	7	34	80	53	125	93	216	163	370	195	439
offshore	0	0	0	0	0	0	0	0	0	0	0	0
RES electricity in total	1.760	4.061	2.187	7.171	2.329	7.861	2.493	8.589	2.628	9.032	2.700	9.327
Gross electricity consumption		*28.087*		*31.443*		*33.088*		*34.776*		*36.418*		*38.577*
Share of RES electricity in gross final electricity consumption		14,5%		22,8%		23,8%		24,7%		24,8%		24,2%

Source: Green-X model – REPAP2020 scenarios (2009)

Table 5 Future contribution of RES to electricity consumption in Slovakia – ACT scenario

Expected contribution from RES to electricity consumption	2005		ACT (proactive support - realisable deployment) Average 2011-2012		Average 2013-2014		Average 2015-2016		Average 2017-2018		2020	
Unit	MW	GWh	MW	GWh	MW	GWh	MW	GWh	MW	GWh	MW	GWh
Biomass	49	31	272	1.609	434	2.550	585	3.368	639	3.673	674	3.839
Biogas	2	4	86	528	149	865	201	1.103	209	1.135	222	1.182
Solid (& liquid)	44	4	167	962	263	1.540	361	2.117	408	2.390	429	2.509
Biodegradable fraction of MSW	3	23	18	119	22	145	23	148	23	148	23	148
Concentrated Solar Power	0	0	0	0	0	0	0	0	0	0	0	0
Geothermal	0	0	0	0	0	0	1	4	3	20	8	48
Hydro, total (excl. pumping)	1.690	4.023	1.953	5.837	1.984	5.977	1.984	5.977	1.984	5.977	1.984	5.977
Small hydro (<10MW)	62	176	260	1.137	291	1.277	291	1.277	291	1.277	291	1.277
Large hydro (>10MW)	1.628	3.848	1.693	4.700	1.693	4.700	1.693	4.700	1.693	4.700	1.693	4.700
Photovoltaic	0	0	16	15	37	34	67	61	118	108	238	217
Ocean	0	0	0	0	0	0	0	0	0	0	0	0
Wind	5	7	76	174	187	412	367	765	514	1.034	565	1.125
onshore	5	7	76	174	187	412	367	765	514	1.034	565	1.125
offshore	0	0	0	0	0	0	0	0	0	0	0	0
RES electricity in total	1.760	4.061	2.317	7.636	2.643	8.974	3.003	10.175	3.259	10.811	3.469	11.205
Gross electricity consumption		*28.087*		*31.443*		*33.088*		*34.776*		*36.418*		*38.577*
Share of RES electricity in gross final electricity consumption		14,5%		24,3%		27,1%		29,3%		29,7%		29,0%

Source: Green-X model – REPAP2020 scenarios (2009)

The strongest contributor to the boost of RES-E is biomass energy according to both assessed policy paths. Differences between the cases are however substantial: According to the NAT scenario total biomass energy, solid biomass and biogas, will increase from 49 MW in 2005 to above 2.94 GW by 2020, whereby solely solid biomass would contribute to 2.05 GW. When the ACT scenario is assumed, the penetration of total biomass energy would be above 3.8 GW. Thereby, also solid biomass only would be developed to 2.51 GW.

In absolute terms, the largest exploitation in forthcoming years would be expected for hydropower as discussed above. Additionally, a high growth share is expected from wind energy, which would achieve between 439 and 1,125 GWh generated electricity (compared to hardly anything as of today), whereby apparently only wind onshore energy would contribute. A comparatively lower expansion is projected for geothermal electricity with no contribution in the NAT scenario and only 8 MW in the ACT. With respect to PV, in the latter stage significant differences occur among the policy paths, achieving 39 GWh, respectively

217 GWh in the NAT and ACT scenario. The development of concentrated solar electricity is expected to be unaffected by the policy pathway and does not show any contribution.

According experts and associations these scenarios seem underestimated. For example, in NAT case is expected contribution from photovoltaic on zero for years 2011 – 2012, what is already today not a valid number. Even with conservative approach Slovakia will probably reach 40-50 MW minimum in 2011 – 2012.

The most conservative scenario of European Photovoltaic Industry Association – EPIA (baseline scenario) is predicting the share of PV on final energy demand 2.7% in 2020 what represents 1 GWp of total installed capacity. In case of more optimistic proactive scenario (Accelerated Scenario a Paradigm Shift Scenario) it could be till 2 GWp and after net modernization the share could reach 10% of final energy demand in 2020.

Values for wind and geothermal energy are very low, too.

According to the European Wind Energy Association's low scenario would be 800 MW, and a high scenario would be 1.000 MW amounting between 1.8 to 2.3 TWh.

In the field of geothermal energy there is a potential for low-medium temperature electricity production in order to have 25 MWe installed by 2020. Slovakia has also the possibility to develop Enhanced Geothermal Systems (EGS) with about 75 MWe by 2020. The targets for geothermal energy should be then 100 MW and 780 GWh. (Data were provided by European Geothermal Energy Council (EGEC)).

2.4 Contribution of RES to heating & cooling consumption

In context to the above discussed electricity sector, both scenarios with respect to aggregated level for RES in the sector of heating and cooling show as well big deviations only for some technologies. As applicable from Table 6 (NAT) and Table 7 (ACT) this is observed for solid biomass, geothermal and solar thermal panels. These technologies are dependent on the underlying policy assumptions. Under the strong proactive support of RES a substantial deployment of new plants can be expected. The main driver for the increase in the RES-H&C sector is biomass, whereby again solid biomass represents the largest contributor. Other RES options as solar thermal, heat pumps of geothermal grid-connected heat supply achieve an increase in deployment, but compared to biomass this appears of less significance.

Table 6 Future contribution of RES to heating and cooling consumption in Slovakia – NAT scenario

Expected contribution from RES to heating and cooling	2005		NAT (National target fulfillment) Average 2011-2012		Average 2013-2014		Average 2015-2016		Average 2017-2018		2020	
Unit	MW	ktoe	MW	ktoe	MW	ktoe	MW	ktoe	MW	ktoe	MW	ktoe
Biomass	n.a.	358	3.686	601	4.242	711	4.821	820	5.293	904	5.768	986
Biogas	n.a.	1	50	8	57	8	59	8	59	8	75	10
Solid (& liquid)	n.a.	357	3.548	575	4.079	681	4.654	790	5.126	874	5.585	954
Biodegradable fraction of MSW	n.a.	0	89	18	106	22	108	22	108	22	108	22
Geothermal (excl. heat pumps)	n.a.	72	212	80	212	80	212	80	212	80	212	80
Solar Thermal	n.a.	0	50	2	49	2	46	2	167	7	368	15
Heat pumps	n.a.	0	2	0	1	0	9	1	41	5	81	11
RES heating and cooling in total	n.a.	430	3.950	683	4.505	793	5.088	904	5.713	997	6.429	1.092
Gross final heating and cooling demand		*7.120*		*7.633*		*7.785*		*7.942*		*8.099*		*8.307*
Share of RES heating and cooling in gross final heating and cooling consumption		6,0%		8,9%		10,2%		11,4%		12,3%		13,1%

Note: n.a. … not applicable

Source: Green-X model – REPAP2020 scenarios (2009)

Table 7 Future contribution of RES to heating and cooling consumption in Slovakia – ACT scenario[5]

Expected contribution from RES to heating and cooling	2005		ACT (proactive support - realisable deployment) Average 2011-2012		Average 2013-2014		Average 2015-2016		Average 2017-2018		2020	
Unit	MW	ktoe	MW	ktoe	MW	ktoe	MW	ktoe	MW	ktoe	MW	ktoe
Biomass	n.a.	358	3.715	606	4.395	742	5.148	902	5.841	1.053	6.599	1.211
Biogas	n.a.	1	54	8	84	10	101	11	102	11	129	13
Solid (& liquid)	n.a.	357	3.572	580	4.205	710	4.940	869	5.632	1.020	6.362	1.176
Biodegradable fraction of MSW	n.a.	0	89	18	106	22	108	22	108	22	108	22
Geothermal (excl. heat pumps)	n.a.	72	316	100	365	111	407	120	407	120	407	120
Solar Thermal	n.a.	0	175	7	340	14	506	21	693	29	1.005	42
Heat pumps	n.a.	0	26	3	58	8	90	12	124	16	180	24
RES heating and cooling in total	n.a.	430	4.232	716	5.159	875	6.151	1.055	7.065	1.218	8.190	1.397
Gross final heating and cooling demand		*7.120*		*7.633*		*7.785*		*7.942*		*8.099*		*8.307*
Share of RES heating and cooling in gross final heating and cooling consumption		6,0%		9,4%		11,2%		13,3%		15,0%		16,8%

Note: n.a. … not applicable; Source: Green-X model – REPAP2020 scenarios (2009)

2.5 Contribution of RES to transport fuel consumption

The utilisation of biofuels in the Slovakian transport sector will increase noticeably under all the scenarios until 2020 as Table 8 shows. Due to similar assumptions on the underlying policy framework for biofuels – i.e. in both cases an EU-wide trading regime based on physical trade is conditioned to achieve the sector target of 10% - similar deployment patterns occur for biofuels under both policy tracks. In the European context, Slovakia is expected to act as importer (i.e. about 4% of national biofuel generation).

Bioethanol will make up around 47% of the domestic biofuel generation, while for biodiesel a comparatively low deployment is projected, only 14%. Besides, it is expected that second generation biofuels will also provide only a marginal contribution by 2020. Consequently the rest needs to be covered by physical biofuel imports from other EU Member States.

5 Table was commented by European Geothermal Energy Council (EGEC): For Heating & Cooling, today geothermal energy is mainly used for spas and heating of greenhouses. But there exists a huge potential to develop much more this technology, notably with District Heating, and reach 460 Ktoe by 2020. GHP will develop as it presents the advantage to provide both heating and cooling. By simplifying the administrative procedures, promoting the GHP technology and training & certifying GHP installers, Slovakia could install more than 25 000 systems with 275 MW and produce 52 Ktoe by 2020.

Table 8 Future contribution of RES to transport fuel consumption in Slovakia – both NAT & ACT scenario

Expected contribution from RES to transport fuel consumption	2005		NAT (National target fulfillment) … ACT (proactive support - realisable deployment) Average 2011-2012		Average 2013-2014		Average 2015-2016		Average 2017-2018		2020	
Unit	MW	ktoe	MW	ktoe	MW	ktoe	MW	ktoe	MW	ktoe	MW	ktoe
Bioethanol	n.a.	0	19	13	44	30	76	52	121	83	157	108
Biodiesel	n.a.	11	64	36	63	35	61	17	59	33	57	32
2nd generation biofuels	n.a.	n.a.	0	0	0	0	0	0	0	0	5	4
Net biofuel imports	n.a.	n.a.	n.a.	43	n.a.	63	n.a.	78	n.a.	57	n.a.	87
Renewable electricity	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Hydrogen from RES	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
RES in transport (total)	n.a.	11	83	92	106	128	137	147	180	173	220	231
Transport demand (diesel and gasoline)		*1.736*		*2.077*		*2.146*		*2.210*		*2.252*		*2.306*
Share of RES in transport		0,6%		4,4%		6,0%		6,7%		7,7%		10,0%

Note: n.a. … not applicable; Source: Green-X model – REPAP2020 scenarios (2009)

3 Measures for achieving the targets

3.1 Policy measures

The key criterion besides continuity and long-term stability of any implemented policy for achieving an accelerated future RES deployment in an effective & efficient manner is the technology specification of the necessary support. This is reflected in Slovakia's current support for renewable electricity. When reconsidering the implemented RES support scheme, a fine tuning of several technology-specific incentives is however recommended. In general, an increase of incentives in line with other European Member States appears adequate, especially for biomass and biogas. Specifically for the Slovakian situation under the FIT regime as implemented today it appears necessary to increase investor's confidence. This can be simply achieved by guaranteeing not only the duration of being qualified to receive support but also the level of remuneration.[6] Additionally, in order to allow RES heating and cooling playing its central role for RES target achievement the corresponding policy framework deserves similar attention as RES electricity.

Besides improving financial support for RES, it appears worth mentioning that a removal of previously identified[7] and also subsequently discussed non-economic deployment barriers is of crucial relevance for Slovakia to assure a successful RES deployment in the mid- to long-run.

Remark: A closer look at the European level – Summary of key outcomes of a comprehensive policy assessment to meet Europe's commitment on 20% RES by 2020. Source: *futures-e* project (see Resch et al., 2009)

An independent in-depth model based assessment of various policy options for renewable energies in general, and RES electricity in particular, to meet Europe's commitment on 20% RES by 2020 was undertaken within the scope of the *futures-e* project. A broad set of policy scenarios conducted with the ***Green*-X** model were thoroughly analysed, illustrating the consequences of policy choices for the future RES evolution and the corresponding cost within the European Union as well as at country level. Feasible policy pathways were identified and targeted recommendations provided in order to pave the way for a successful and in the long-term stable deployment of RES in Europe.

Therein it was concluded that besides proactive RES support, an accompanying (strong and) effective energy efficiency policy to reduce demand growth and a removal of non-economic RES barriers are necessary to meet the 2020 RES commitment. In this context, efforts are needed in all Member States and a broad set of RES technologies has to be supported.

Subsequently we illustrate the impact of individual key measures to move from a business-as-usual (BAU) to an enhanced RES deployment in line with 20% RES by 2020.

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6 In almost all EU member states applying a FIT system to support RES-E deployment the guaranteed duration of support includes also the regulation that a certain RES project receives the level of remuneration as valid at the start of operation throughout the whole supporting period. This simple measure contributes substantially to minimise investor's risk and allows keeping the required societal support expenditures at an acceptable level.

7 See section 1.3 for a brief summary of non-economic deployment barriers.

Results on national RES support options – from BAU to strengthened national support

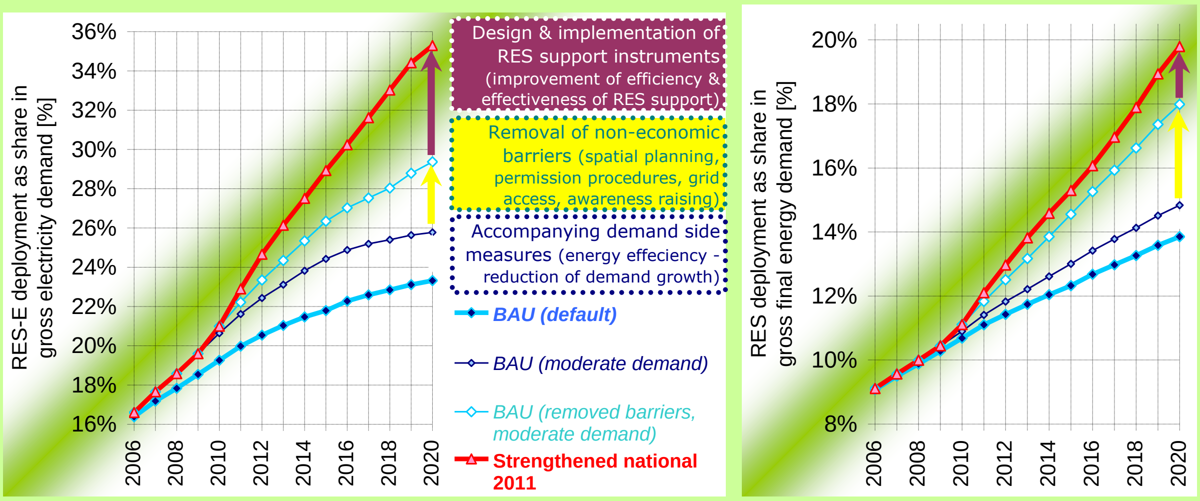

Figure 5 *RES-E (left) and RES (right) deployment (expressed as share in gross electricity demand (left) / gross final energy demand (right)) in the period 2006 to 2020 in the EU-27 according to the BAU (incl. selected sensitivity variants) and the case of "strengthened national support"*

Figure 45 (above) illustrates the future deployment in relative terms for both RES-E (left) and RES (right) in the EU-27 up to 2020 for the business-as-usual (BAU) case (incl. selected sensitivity cases – all assuming a retaining of currently implemented RES support) and the case of "strengthened national support" (in line with 20% RES by 2020). More precisely this graph illustrates the RES-E share in gross electricity demand (left) and the share of RES (in total) in gross final energy demand (right).

A rather constant expansion of RES-E as well as RES in total can be expected with effective and efficient RES support in place while under BAU conditions a slow down of deployment is projected for the later years close to 2020. Analysing the above illustrated sensitivity variants of the BAU case indicates the impact of the individual key measures to move from a BAU to an enhanced RES deployment in line with 20% RES by 2020:

- *Accompanying demand side measures:* Retaining current financial RES support but supplemented by energy efficiency measures to reduce demand growth would allow for a 2020 RES-E share of 25.8% (compared to 23.8% as default). The corresponding figure for RES in total is 14.8% (instead of 13.9% as default).
- *Removal of non-economic barriers:* If in addition to the above non-economic deficits would also be removed the RES-E deployment could be further increased to 29.4%. For RES in total the impact of non-economic barriers is even more dramatic – i.e. an accelerated RES diffusion due to removal of deficits would allow for a RES share of 18% of gross final demand.
- *Design and implementation of RES support instruments:* The detailed policy design has a significant impact on the RES deployment, especially at the electricity sector. This can be seen from the comparison of the "strengthened national support" case with the BAU variant where similar framework conditions are applied (i.e. removed (non-economic) barriers and a moderate demand growth). 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 29.4% (BAU with removed barriers and moderate demand) to 35.3% ("strengthened national support"). For RES in total the impact is comparatively smaller – i.e. an increase of the RES share of gross final energy demand from 18% to 19.8% is observable.

3.1.1 Measures on administrative procedures, regulations and codes

A comprehensive assessment of administrative barriers with respect to the realisation of RES projects was conducted in the European research project OPTRES – for details see Ragwitz et al. (2007). In Figure 6 we present the perception of administrative barriers per renewable energy source, as identified by a stakeholder consultation.

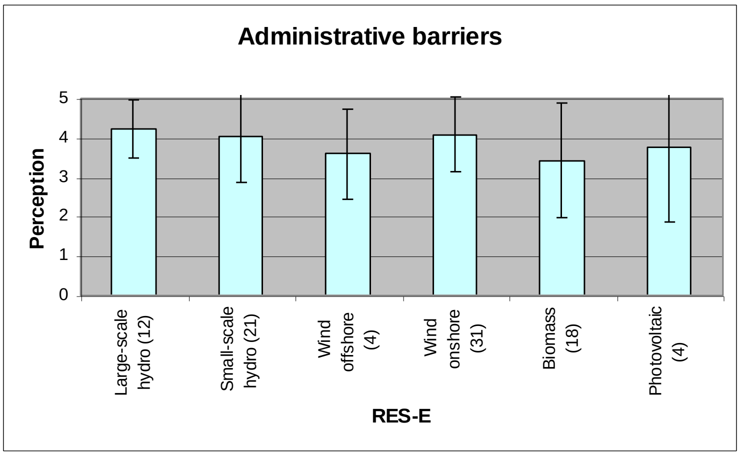

Figure 6 Perception of administrative barriers

Notes: Perception from 0 (no perceived barrier) to 5 (high perceived barrier). Number of received answers per source is provided in brackets, while standard deviation is marked by bars. Only those RES-E types with at least 4 answers have been depicted.

Source: OPTRES project – for details see Ragwitz et al. (2007)

Figure 6 (above) shows that the respondents of the stakeholder consultation perceived the administrative problems to be highest for hydropower projects and on-shore wind. However, also for the other renewable energy sources the administrative barriers are perceived an important obstacle in the development of renewable energy projects.

► *Should authorisation procedure take into account the specificities of different renewable energy technologies? If yes, how?*

Certainly the specifics of different RES sources should be considered for the design of authorization procedures. Procedures should also take into account the installed capacity / output. For small installations it should be simplified. Additionally, an Environmental Impact Assessment (EIA) is at present required for all wind energy generators, even for small-scale applications in the kW class. Hence, for such small-scale installations an EIA should not be obligatory.

► *Should the renewable energy potential be taken into account in spatial planning?*

Generally RES, and their respective potential, are insufficiently taken into account in spatial planning. In many countries and regions future development of RES projects is not taken into account at the moment of drawing up spatial planning programs. This means that spatial planning programs have to be adopted in order to allow for the implementation of a RES project in a specific area, especially when there is a high RES potential involved in that particular area. This process can take a very long time. Often the acquirement of permits related to spatial planning is the longest trajectory of the overall period needed for development of the project. This is especially the case for projects in the field of wind and biomass. Responsible authorities should be stimulated to anticipate the development of future RES projects in their region, by allocating suitable areas. Besides, having designated areas for RES would avoid getting in conflicts of interest (e.g. with environmental constraints) at a later stage.

Surveys show that spatial planning, construction permits and EIA (environmental impact assessment) procedures are key problems for regulators. In the RES-E sector to obtain the necessary permits can take years in countries where the authorities take into account the opinion of many stakeholders that are hard to harmonize. Since RES-E development is not taken into consideration in the special planning, every project and project variants have to be evaluated on an individual basis.

The number of the often long lasting appeal procedures could be effectively decreased by including RES-E development plans in local and regional spatial planning. In Germany for example these problems have been solved to a large extent. In the case of onshore wind projects the administrative barriers regarding spatial planning are low thanks to the Building Code (1996), which made states designate areas for onshore wind parks. Thanks to this, a wind farm can be established within 1 year. A similar approach is being followed for offshore wind parks. The federal states and the Bundesamt für Seeschifffahrt und Hydrographie (Federal Maritime and Hydrographic Agency) are responsible for designating areas and issuing permits for offshore wind installations.

In Slovakia, although there was the intent to consider RES for heating on municipal level, RES are generally insufficiently taken into account in spatial planning.

District heating concepts have been prepared for most municipalities and regions of the Slovak Republic, but the majority of the plans have not been implemented. This has a number of reasons, varying from the lack of finance, the lack of political commitment to energy issues up to the lack of information of decision-makers. Inclusion of RES technologies into spatial planning depends on the willingness of authorities at the municipal level, and is not performed in practice.

In spatial planning there is a need to consider potential areas and technologies both for RES heating and electricity production. It would be very useful to identify special zones suitable for different types of renewables. Municipalities should be motivated or even obliged by law to prepare energy concepts and consequently align spatial planning.

► *Should timetables for processing applications be communicated in advance?*

Usually long lead times are needed to obtain necessary permits. Time needed to obtain all necessary permits for the construction of a RES plant can take many years (e.g. RES-E). Also it can be unclear what the exact length of a procedure will be. Clear guidelines for authorization procedures are highly recommended, and there were not included yet obligatory response periods for authorities involved need to be incorporated in such procedures.

In Finland it was reported that the administration works only well in relation of forest biomass projects. Recently renewable energy project developers in Finland are facing with long lasting permitting processes for hydro power and long, complicated procedures for offshore wind, solar and non-forest biomass investments.

In the Slovakian case, mainly RES-E projects are now suffering from uncertainty in timetables and rules for application due to the fact that the law establishing support for RES-E has been adopted recently. Each responsible authority in the application processing should give the consideration within 30 days of obtaining the application. Usually this deadline was not hold, particularly in case of distributors who are overloaded by a lot of applications at present.

Timetables have to be communicated in advance and have to be mandatory when stipulated. The rules for connection to the grid and for application processing should not be changed during the process. Also simplified processes for small investments would help.

In contrast to RES-E, for RES district heating the timetable of application processing does not represent a barrier.

► *How many steps should be needed to obtain the final authorization? Should there be a one-stop shop for coordinating all the steps?*

Generally, a high number of authorities are involved to obtain the final authorization. Often many authorities are involved in both permitting as well as support related procedures for renewable energy projects. Responsible authorities usually comprise several administrative bodies at national, regional and local level. An important improvement would be to reduce the number of local, regional and national administrations involved in the authorization processes for permits and financial support. Project developers are much more positive in situations where a single administrative body has been made responsible for co-ordination of several administrative procedures, such as the Bundesamt for off-shore wind in Germany.

Furthermore, there is a lack of co-ordination between different authorities. In many cases project developers need to submit similar information multiple times to different authorities. A suggestion to reduce the administrative burden for RES development would be to standardize procedures, such as standardized administrative requirements and application forms between different authorities.

It is urgently required to reduce the number of necessary steps. Accordingly, the licensing process can be simplified and become more transparent, especially for small scale projects. There is at present no one-stop-shop for obtaining authorisations for RES-E projects which represents a weak point in the existing system. For heating decision is made mainly on local level.

3.1.2 Measures concerning buildings:

► *What measures should be introduced into the building codes to ensure the share of renewable energy used in the building sector will increase?*

Policy instruments should be introduced that provide incentives for integrating a RES-H/C device into the heating/cooling system. But since RES-H/C applications operate only effectively if they are fitted to the overall system design, the chosen policy instrument should create incentives for a good overall system performance. Hence, it should also support the reduction of a building's energy consumption (e.g. by improving its insulation) and motivate for an efficient use of the RES-H/C equipment.

As far a possible the policy instrument should motivate the utilization of high efficiency equipment, e.g. through linking the financial incentives to quality standards of a determined minimum rate of efficiency.

At the present time, there is no legal obligation to utilize RES in buildings. Only in Act 555/2005 on Energy Performance of buildings there is an obligation for new large buildings (over 1,000m^2) to take RES as a energy supply option into account. The outcome of such an energy assessment has to be mentioned in technical description of the project documentation. However, the majority of investors are in practice not taking this assessment into account.

A very helpful measure could be either to change current civil code or to prepare a new law (e.g. a Renewable Energy Heating Act) where RES utilization will be required and set obligatory in some reasonable scale in all new buildings and also for refurbishment. But in addition to imposing regulations, it is just as essential to create reliable, state budget independent incentives.

► *How should an obligation for minimum levels of renewable energy in new and newly refurbished buildings be drafted to best ensure renewable energy integration in buildings? At what levels should it be set?*

The obligation should take the different target groups and their different needs into account and might be different for each of these groups. The target groups are private homeowners living in their own home, homeowners renting to others as well as private, municipal and social housing organizations. As such companies often own and manage a large number of buildings they can become a key driver (but also key barrier) for switching buildings to RES-H/C.

Whereas housing companies often have sufficient technical skills to handle even innovative RES-H/C technologies they generally base their economic calculation on shorter pay back times e.g. private building owners in the domestic sector. In addition, the level of willingness to pay might generally be lower than with small scale investors. These circumstances should be considered in the setting of minimum levels for RES and in the corresponding support schemes.

From the perspective of the building owner (investor) apart from the level of support one of the main indicators is the share of the investment costs he can and/or legally is allowed to allocate to the tenants (by increasing the rent). From the perspective of tenants the crucial question concerns the relationship between the financial burden that might derive from an allocation of the investment costs on the rent and potentially reduced costs for heating/cooling due to the reduced use of conventional fuel.

The chosen obligation should ensure that investment is still effectively motivated. Costs for building owners and tenants shall not be too high to discourage investments (e.g. by postponing the reconstruction of heating systems as long as possible).

3.1.3 Measures on information:

► *How should specific information be targeted at different groups, as end consumers, builders, property managers, property agents, installers, architects, farmers, suppliers of equipment using renewable energy sources, public administration?*

The question is basically about information sharing to all stakeholders. General information for example about subsidies for renewable technologies needs to be broadcasted to all stakeholders. As the internet offers 24 hours access to information and can be updated easily, a base for general information would be a web page. A best practice examples is given in Luxembourg, where subsidies for heat in households are communicated with the information paper "Förderprogramm zur Energieeinsparung und Nutzung erneuerbarer Energien im Wohnbereich" of the Ministère de l'Environnement of Luxembourg in an easy manner. Thereby, the paper targets not only public administration, but also especially end consumers, property managers and agents, installers and architects and is kept in an understandable and clear style.

End users can be informed by customer information brochures about the possibility to make use of support for renewables. The information brochures can be shared among installers, property managers and suppliers of equipment to hand them over to the end consumers.

Furthermore, there could be a subsidy for consultancy on renewable energy and energy efficiency related tops for end consumers. This would give the advantage, that consumers would choose the most appropriate efficiency and renewable energy option according to an energy expert.

Renewable energy and energy efficiency exhibitions are a great possibility to get to know information physically and are therefore for energy experts as well as for technology end consumers adequate. With expositions, it is possible to share specific information as well. For instance, the SOLTEC exhibition in Germany is mainly focusing in solar technologies and through this focus, information can be shared in more detail.[8]

Workshops and speeches provide the possibility to share specific information only of major interest for a small target group. Workshops and speeches can be integrated to exhibitions as well.

Experts and public administration members need the most up to date information having a higher degree of details than the ones for example for end users. Regularly reports published by the responsible administrative bodies keep the legal framework up-to-date. A best practice example is the German "Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit", which published a brochure of the environment policy from 2005 to 2009 in July 2009 being detailed and giving an overview of the topic as well.[9] With published articles in RES journals, the dynamics of the market can be analyzed in detail.

Specific information for a smaller target group can be shared via internet as well. It would be possible to establish a work group in a small field of work being responsible for specific field publishing news on their own internet platform.

Highly recommended are targeted information campaigns for professionals, general public, public authorities, etc… Additionally, the establishment of pilot and demonstration projects, training of building administrators, guidelines for the integration of RES in new buildings appear beneficial.

► *How should guidance for planners and architects be provided to help them consider the optimal combination of renewable energy sources, high efficiency technologies and district heating and cooling when planning, designing, building and renovating industrial or residential areas?*

Planners and architects should be provided with an internet platform that holds information on possible options of including renewable energy, high efficiency technologies and districts heating and cooling into new or existing buildings. It should not only contain up-to-date information on technology, how it can be installed and how profitable such investments are on the long run. It should also include detailed information on successfully completed exemplary projects, legislation and events related to the topic. Local information on the applicability of solar technology and the availability of district heating and cooling is desirable. Furthermore it should be possible to order printed copies of the contained information as well as publications explaining the various concerns in greater detail. Contact information to all relevant professional associations and their local members would complete the web page's content.

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8 Information about the exhibition is given on the web page: http://www.soltec.de/s

9 Document available on http://www.bmu.de/ministerium/aufgaben/aufgaben/doc/44214.php

The information should be gathered in consultation with experts in energy, technology, construction and installation and be updated continuously to secure a high level of relevance and actuality. The web page should be supervised with the help of the chambers of architects as well as planners associations respectively consumers advice centers to secure that the target groups are addressed properly. These organizations could also contact their members and customers to raise the web page's awareness level within the target groups.

3.1.4 Measures on electricity infrastructure development:

► *Should there be priority connection rights or reserved connection capacities provided for new installations producing electricity from renewable energy sources?*

According to stakeholder consultation, the legally guaranteed access to the grid for RES-E sources and priority transmission and distribution is not considered as a key barrier in countries where this guarantee is currently not applied.

Introduction of positive discrimination of RES-E as regards the guarantee of grid access or transmission and distribution of RES-E, however, may become an additional motivating factor for reasons of investment security, low transaction costs and the acknowledgement of RES-E system benefits.

3.1.5 Priority/Guaranteed Access to the grid:

► *Should priority or guaranteed access be ensured?*

Priority access to the grid has to be ensured and is currently provided for in Act 309/2009 on RES-E support. However, this priority is associated to several conditions such as taking into account the security of supply and grid stability. As mentioned in chapter 1.3 on deployment barriers, one of the main obstacles for an enhanced deployment of RES-E technologies is the negative attitude of the national electricity grid operator towards RES. The key is to anticipate the creation of well-dimensioned access capacity and storage capacities so that it will be available for RES-E.

► *How should it be ensured that transmission system operators, when dispatching electricity generating installations give priority to those using renewable energy sources?*

It is already ensured by Act 309/2009 on RES-E support.

► *How should the transmission and distribution of electricity from renewable energy sources be guaranteed by the transmission and distribution system operators?*

It is already ensured by Act 309/2009 on RES-E support.

3.2 Financial support

Table 9 gives an indication on the necessary financial support by illustrating the weighted average (2011 to 2020) levelised (to a period of 15 years) total remuneration per MWh of RES generation for new installations in the investigated cases (NAT and ACT). This shows the gross support requirements as besides the financial premium offered by a RES support scheme also default revenues from the selling of the produced energy on the related energy market are included.[10] Gross figures were selected here as net expenditures largely depend on the future development of energy and carbon prices at European as well as at global scale.[11]

A comparison of the technology- or sector-specific figures by scenario shows significant differences between both cases. This illustrates the need to increase support levels if an ambitious and accelerated RES deployment is targeted. However, the figures of the ACT case represent the upper limit of such support requirements, where a fine tuning of the EU-wide equally conditioned technology-specific support levels to the Slovakian circumstances offers a significant potential for cost reduction.[12]

Consequently, if Slovakia follows the NAT policy track the support requirements would decrease significantly. An important precondition for that is however that the implemented RES policy needs to be classified as stable and the investor's risk is reduced to a low level (e.g. by offering a guaranteed duration of support (incl. support levels)).

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10 For the case of small-scale RES heating systems this shall mean the price of heat supply based on a typical conventional reference technology.

11 Obviously, also gross figures are not independent from the future development of energy prices. As the price development for energy related equipment in the years before the financial crisis (2008) has shown, prices (and largely also cost) for most types of power plants coincided to a large extent with rising energy and raw material prices.

The overall impact of energy prices on support cost is however seen larger on net compared to gross figures.

12 Compare e.g. total remuneration for RES in the heat sector: Although support is significantly higher in the ACT case differences in terms of resulting RES deployment are comparatively small.

Table 9 Weighted average (2011 to 2020) total remuneration for yearly new RES installation in Slovakia – NAT and ACT scenario

RES policy indicator (i.e. required total remuneration)	Unit	Weighted average (2011 to 2020) total remuneration for yearly new RES installations: NAT (National target fulfillment)	ACT (proactive support)
Biogas	€/MWh$_{RES}$	77,3	145,6
(Solid & liquid) Biomass	€/MWh$_{RES}$	78,1	129,7
Biowaste	€/MWh$_{RES}$	73,9	111,2
Geothermal electricity	€/MWh$_{RES}$	0,0	151,6
Hydro large-scale	€/MWh$_{RES}$	73,8	122,8
Hydro small-scale	€/MWh$_{RES}$	74,0	126,7
Photovoltaics	€/MWh$_{RES}$	247,7	369,6
Solar thermal electricity	€/MWh$_{RES}$	0,0	0,0
Tide & Wave	€/MWh$_{RES}$	0,0	0,0
Wind onshore	€/MWh$_{RES}$	74,3	106,2
Wind offshore	€/MWh$_{RES}$	0,0	0,0
RES electricity (average)	€/MWh$_{RES}$	78,9	137,6
RES heating and cooling (district heat)	€/MWh$_{RES}$	49,2	82,8
RES heating and cooling (decentral)	€/MWh$_{RES}$	74,5	117,2
Biofuels (average)	€/MWh$_{RES}$	98,9	98,9

Source: Green-X model – REPAP2020 scenarios (2009)

3.3 Increasing biomass availability

As depicted in Table 10, the use of biomass for energy purposes would increase substantially up to 2020 in both cases (NAT and ACT), while differences between the two policy tracks are remarkable. According to the scenario calculation biomass use in terms of primary energy is expected to rise to a level of 1.5 to 1.8 Mtoe until 2015, and this increase is then prolonged to a range of 2.0 to 2.5 Mtoe in 2020. Slovakia’s significant biomass potentials in the forestry and also in the agricultural sector decrease the need for biomass imports.

In order to reach these goals there was a recommendation to create legal and administrative conditions for production of energy crops.

Table 10 Expected availability of biomass in Slovakia – NAT and ACT scenario

Expected availability of biomass for energy purposes	Unit	NAT (National target fulfillment) 2015 Domestic	NAT 2015 Import	NAT 2020 Domestic	NAT 2020 Import	ACT (proactive support) 2015 Domestic	ACT 2015 Import	ACT 2020 Domestic	ACT 2020 Import
Agricultural products	ktoe	150	14	296	26	185	14	585	26
Agricultural residues	ktoe	400	0	515	0	544	0	627	0
Forestry products	ktoe	457	0	604	0	503	0	621	0
Forestry residues	ktoe	361	16	417	37	400	24	417	37
Biowaste	ktoe	146	0	147	0	159	0	159	0
Biomass in total	ktoe	1.543		2.042		1.829		2.472	

Source: Green-X model – REPAP2020 scenarios (2009)

3.4 Flexibility/Joint projects/European perspective

Table 11 Excess and deficit production of RES compared to the indicative trajectory in Slovakia – NAT scenario

Comparison of expected domestic RES consumption with indicative trajectory	Unit	NAT (National target fulfillment)				
		Average 2011-2012	Average 2013-2014	Average 2015-2016	Average 2017-2018	2020
Excess	ktoe	373	454	469	394	161
Deficit	ktoe	0	0	0	0	0

Source: Green-X model – REPAP2020 scenarios (2009)

Table 12 Excess and deficit production of RES compared to the indicative trajectory in Slovakia – ACT scenario

Comparison of expected domestic RES consumption with indicative trajectory	Unit	ACT (proactive support - realisable deployment)				
		Average 2011-2012	Average 2013-2014	Average 2015-2016	Average 2017-2018	2020
Excess	ktoe	446	631	757	768	628
Deficit	ktoe	0	0	0	0	0

Source: Green-X model – REPAP2020 scenarios (2009)

Table 11 (NAT) and Table 12 (ACT) depict that Slovakia will have an excess in RES production every year under both discussed policy cases considering the indicative trajectory of the national 2020 RES target. Given the implemented cooperation mechanisms in the RES directive this represents an opportunity for additional incomes to compensate Slovakia's policy expenditures. The excess generation can be virtually exported by means of e.g. statistical transfers to other EU member states possessing a deficit in RES deployment compared to their given RES targets. If other countries follow the policy approaches as suggested in the NAT case, a significant share of Slovakia's excess would then be required at the European level and the expected income in 2020 would be of similar magnitude as Slovakia's yearly support expenditures for all new RES (installed 2006 to 2020).

3.5 Estimated costs & benefits of RES policy support measures

Obviously an accelerated RES deployment in Slovakia does have a price, but this is also accompanied by increased benefits. The assessed costs and benefits arising from the future RES deployment in the forthcoming years up to 2020 are summarized concisely in Figure 7. More precisely, this graph illustrates for both main cases – i.e. the NAT (left) and the ACT scenario (right) – the on average per year throughout the period 2006 to 2020 resulting costs – i.e. capital expenditures[13], additional generation cost, and consumer expenditures due to RES support – as well as an indication of the accompanying benefits in terms of supply security (avoided fossil fuels expressed in monetary terms – with impact on a

13 Capital expenditures are included in this comparison of costs and benefits as neutral indicator to simply illustrate the amount of investments necessary to achieve the projected RES deployment. From a macroeconomic viewpoint investments are often classified as beneficial given the multiplying effects of such expenses for a country's economy.

country's trade balance) and climate protection (avoided CO_2 emissions – monetary expressed as avoided expenses for emission allowances). Other benefits – even of possibly significant magnitude - such as job creation or industrial development were neglected in this assessment.[14]

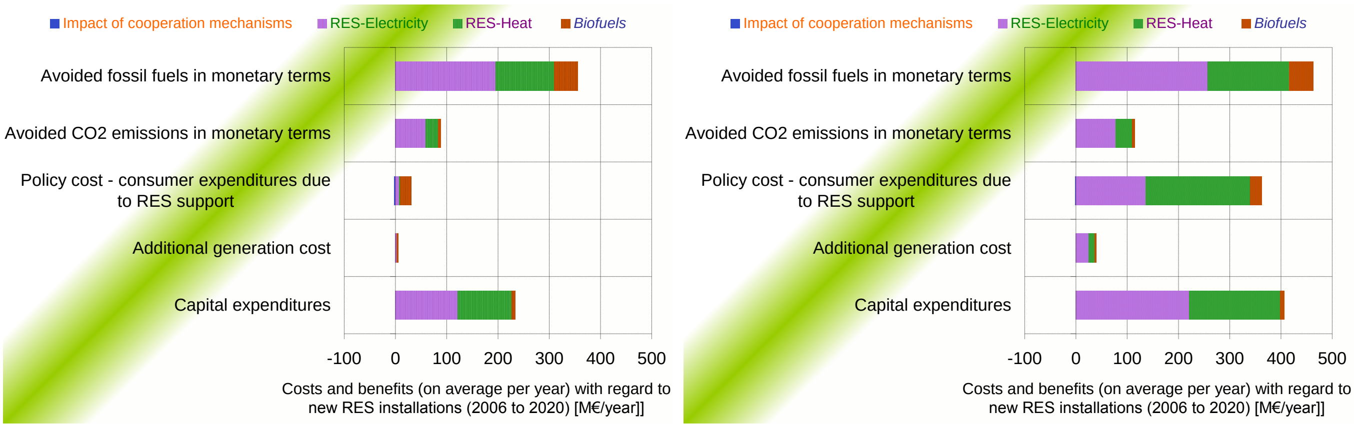

Figure 7 Overview on costs and benefits (on average (2006 to 2020) per year) with regard to new RES (installed 2006 to 2020) in Slovakia according to the NAT (left) and the ACT case (right)

Source: Green-X model – REPAP2020 scenarios (2009)

3.5.1 Expected renewable energy use

Until 2020, RES use in Slovakia will rise by 269% compared to 2005 and will reach 2,125 ktoe according to the NAT scenario. The corresponding figure for the ACT case is an increase by 328% and a deployment of 2,591 ktoe.

Under each scenario, RES for heating and cooling will be the main contributor to the renewable energy production – with a share of 51% (54%) of all RES consumed in Slovakia in 2020 according to the NAT (ACT) case. Renewable electricity will follow as second largest contributor and would then account for 37% of all RES in 2020 according to both scenarios. In absolute terms the transport sector will remain of lower importance, with about 11% (9%) of all RES consumed by 2020 in the NAT (ACT) case.

3.5.2 Expected GHG reduction

RES will contribute substantially to reduce GHG emissions in Slovakia's energy sector. Under the NAT case new RES installations (in the period 2006 to 2020) will account for a cumulative avoidance of about 48.3 Mt CO_2 by 2020. The corresponding figure for the ACT case is 61.8 Mt CO_2.

A significant amount of this CO_2 reduction (i.e. at least two thirds of total) will take place in the electricity sector caused by the carbon intensity of Slovakia's fossil power supply (where the substitution can be expected). Obviously, the remaining part – i.e. 26 (NAT) to 27%

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14 For a comprehensive macroeconomic assessment (incl. employment and economic growth impacts) of an accelerated RES deployment we refer to the comprehensive assessment as recently conducted within the EC study Employ-RES led by Fraunhofer ISI (see Ragwitz et al., 2009).

(ACT) of total - refers to RES in the heat and transport sector. This will contribute significantly to achieve Slovakia carbon reduction target for the Non-ETS sector.

3.5.3 Avoided fossil fuel imports

Avoidance of carbon emission goes hand in hand with reduction of fossil fuel use for energy supply. Given the fact that Slovakia is largely dependent on imports of fossil fuels an accelerated RES deployment will contribute significantly to increase domestic supply security. When the ACT scenario is assumed, cumulated avoided fossil fuels due to new RES installations (2006 to 2020) are in magnitude of 21.17 Mtoe in 2020. Monetary expressed this amounts to a lump sum of 6.96 billion €.[15] According to the NAT scenario fossil fuel savings are in size of 16.44 Mtoe or 5.34 billion € by 2020.

In energy terms, about 63% of all savings by 2020 will take place in the electricity sector according to both policy pathways. Corresponding avoidance of fossil fuels in the heat sector will be in size of 28.6% (ACT) to 31.1% (NAT) of the total, and obviously the remaining part (8.4 to 5.9% of total) refers to biofuels in the transport sector.

3.5.4 Expected capital expenditures

Capital expenditures, i.e. the required investments in RES technologies, will cumulate to 3.51 billion € until 2020 according to the NAT scenario. In the ACT case this will sum up to 6.09 billion €. In the NAT case as well as in the ACT scenario, the electricity sector will be responsible for the largest part of these expenditures, amounting to more than half of the total required investments. However, investments in RES-H are only marginally below, accounting for the about 45% of total required investments of RES in Slovakia up to 2020. Capital expenditures for biofuel refineries amount to less than 4% of the total within both cases.

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15 The monetary expression of fossil fuel avoidance is based on an assumed international energy price development as taken from the EU energy outlook (as of 2007). More precisely, a so called "high price case" is used as reference for all calculations. According to this, the oil price for instance goes up to 100 $$_{2005}$ per barrel, which is still significantly below past energy prices as observed throughout 2008.

For further details on the applied approach and related assumptions we refer to Appendix B of this report.

3.5.5 Expected costs of achieving the 2020 target

► *Policy cost – consumer expenditures due to RES support[16]:*

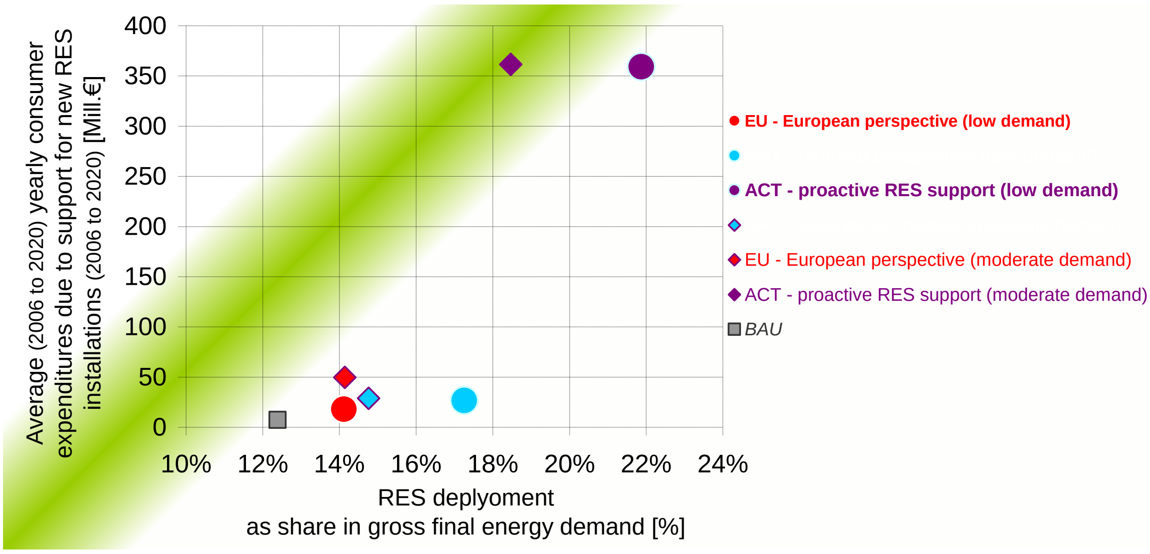

Figure 8 Comparison of the resulting 2020 RES deployment and the corresponding (yearly average) consumer expenditures due to RES support for new RES (installed 2006 to 2020) in Slovakia for the NAT and ACT case (incl. sensitivity variants on low energy demand)

Source: Green-X model – REPAP2020 scenarios (2009)

Policy costs, i.e. consumer expenditures due to the assumed RES support related to new RES installations (2006 to 2020) amount to 29 M€ on average per year in the period 2006 to 2020 according to the NAT case. This figure includes revenues in size of 2.5 M€ (on average per year) from the sell of excess RES deployment not needed for domestic RES target fulfilment throughout the use of cooperation mechanisms as established in the RES directive. Of highlight, these revenues will increase significantly in the final years close to 2020 as exchanged volumes and prices are expected to increase.[17] According to the NAT case the income from selling this surplus in the year 2020 is of similar magnitude as yearly consumer expenditures for all new RES plants installed in the period 2006 to 2020.

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16 Consumer expenditures (or transfer costs for consumers/society) are defined as the direct premium financial transfer costs from the consumer to the producer due to the RES policy compared to the case of consumers purchasing conventional electricity / heat or transport fuels – i.e. for RES-E the underlying reference price equals to the wholesale price at the (regional) power market. Consequently, expressed consumer costs do not consider any indirect costs or externalities (environmental benefits, impacts on employment, etc.).

The calculation of above discussed reference prices (for conventional energy supply) is done by sector (whereby heat is further distinct into grid-connected and decentral heat) and by country. Obviously, these reference prices and consequently also the resulting net support cost for RES are dependent on the future development of fossil fuel prices. In this assessment the assumed international energy price development is taken from the EU energy outlook (as of 2007). More precisely, a so called "high price case" is used as reference for all calculations. According to this, the oil price for instance goes up to 100 $$_{2005}$ per barrel in 2020, which is still significantly below past energy prices as observed throughout 2008.

17 The assumed price for the sell / buy of excess / deficit RES volumes is set equal to the average support premium for new RES-E installations at EU level and calculated on a yearly basis.

As EU wide harmonised RES support assumptions are not tailored to the Slovakian circumstances a significant increase of policy cost occurs in the ACT scenario (compared to NAT). Average yearly consumer expenditures for new RES plants (installed 2006 to 2020) would then amount to 362 M€.

Figure 8 (above) offers an illustrative comparison of the average yearly (direct) policy cost and the resulting RES deployment in 2020. As exchange via the use of cooperation mechanisms is considered in the cost calculation also the RES deployment is corrected accordingly – i.e. the resulting RES share (in gross final demand) as relevant for domestic target fulfilment is expressed. Please note that further insights on the resulting policy cost per sector and on the above discussed impact of cooperation mechanisms can be gained from Figure 7. This graph offers an illustrative sectoral breakdown of costs and benefits (on average (2006 to 2020) per year) with regard to new RES (installed 2006 to 2020) in Slovakia for both assessed policy paths (NAT and ACT).

► *Additional generation costs:*

Additional generation costs, i.e. the generation cost of new RES installations minus reference market prices (for conventional energy supply), are of comparatively small magnitude. On average per year throughout the period 2006 to 2020 additional generation cost for new RES installations of that period amount to 5.3 M€ in the NAT case. Obviously, the accelerated deployment of at present more costly novel RES technologies as assessed in the ACT case leads to an increase of such cost to 40 M€ on average per year.

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Appendix A – Key results on the future deployment of RES up to 2020 in Slovakia (*Green*-X scenarios)

The following pages depict key results of the scenario calculations (i.e. NAT, EU and ACT scenario in case of moderate energy demand growth) with respect to the future RES deployment up to 2020 in Slovakia, indicating details on RES exploitation as well as on the associated costs and benefits.

For a brief description of the method of approach and the scenario definition we refer to Appendix B of this report.

Country: Country: Slovakia

Proposed RES target for 2020: 14%

Conversion: ktoe --> GWh: 11,63
Conversion: GWh --> TWh: 1000

Scenarios on the future RES deployment up to 2020

Key assumptions

Gross final energy demand		[Unit]	2005	2007°	2011-2012	2013-2014	2015-2016	2017-2018	2020
Electricity sector	RES-E	ktoe	2.415	2.547	2.704	2.845	2.990	3.131	3.317
Heat sector	RES-H	ktoe	7.120	6.551	7.633	7.785	7.942	8.099	8.307
Transport sector	RES-T	ktoe	1.789	2.021	2.149	2.224	2.294	2.339	2.397
Total		ktoe	11.324	11.119	12.485	12.854	13.226	13.569	14.022
Diesel and gasoline	*RES-T*	*ktoe*	*1.736*	*1.961*	*2.077*	*2.146*	*2.210*	*2.252*	*2.306*

° Data for diesel and gasoline consumption in 2007 is approximated based on both projected and actual demand data

Results on RES deployment and related costs & benefits

Key results on national RES deployment (at aggregated level - incl. biofuel trade)

Total RES deployment		[Unit]	2005	2007	NAT (National target fulfillment) 2011-2012	2013-2014	2015-2016	2017-2018	2020	EU (European perspective) 2011-2012	2013-2014	2015-2016	2017-2018	2020	ACT (proactive support - realisable deployment) 2011-2012	2013-2014	2015-2016	2017-2018	2020
RES-Electricity	RES-E	ktoe	349	415	617	676	739	777	802	643	740	796	821	843	657	772	875	930	963
RES-Heat	RES-H	ktoe	430	481	683	793	904	997	1.092	687	812	921	1.016	1.126	716	875	1.055	1.218	1.397
Biofuels	RES-T	ktoe	11	89	92	128	147	173	231	92	128	147	173	231	92	128	147	173	231
RES TOTAL		ktoe	790	986	1.392	1.597	1.790	1.947	2.125	1.423	1.680	1.864	2.010	2.199	1.465	1.774	2.077	2.321	2.591
RES share on gross final energy demand		%	7,0%	8,9%	11,1%	12,4%	13,5%	14,3%	**15,2%**	11,4%	13,1%	14,1%	14,8%	**15,7%**	11,7%	13,8%	15,7%	17,1%	**18,5%**

New* RES deployment (installed after end of 2005)		[Unit]		2007°	NAT (National target fulfillment) 2011-2012	2013-2014	2015-2016	2017-2018	2020	EU (European perspective) 2011-2012	2013-2014	2015-2016	2017-2018	2020	ACT (proactive support - realisable deployment) 2011-2012	2013-2014	2015-2016	2017-2018	2020
RES-Electricity	RES-E	ktoe		72	228	288	350	389	414	255	352	408	433	455	268	383	487	541	575
RES-Heat	RES-H	ktoe		46	257	405	553	681	819	261	424	570	700	853	291	486	704	903	1.124
Biofuels	RES-T	ktoe		78	56	93	130	140	199	56	93	130	140	199	56	93	130	140	199
RES TOTAL		ktoe		196	542	786	1.033	1.210	1.432	573	869	1.108	1.273	1.506	615	963	1.321	1.584	1.898
RES (new) share on gross final energy demand		%		1,8%	4,3%	6,1%	7,8%	8,9%	10,2%	4,6%	6,8%	8,4%	9,4%	10,7%	4,9%	7,5%	10,0%	11,7%	13,5%

* new refers to all RES plants installed from 2006 to 2020

° approximated based on both model-based scenario calculations and actual RES deployment

Impact of Intra-European biofuel trade & flexibility measures - key results on RES deployment & policy cost

Impact on total RES deployment & policy cost	[Unit]	NAT (National target fulfillment) 2011-2012	2013-2014	2015-2016	2017-2018	2020	EU (European perspective) 2011-2012	2013-2014	2015-2016	2017-2018	2020	ACT (proactive support - realisable deployment) 2011-2012	2013-2014	2015-2016	2017-2018	2020
Default (purely domestic) RES deployment	*ktoe*	*1.353*	*1.544*	*1.719*	*1.908*	*2.064*	*1.384*	*1.627*	*1.794*	*1.972*	*2.139*	*1.426*	*1.721*	*2.006*	*2.282*	*2.530*
Default RES share on gross final energy demand	*%*	*10,8%*	*12,0%*	*13,0%*	*14,1%*	***14,7%***	*11,1%*	*12,7%*	*13,6%*	*14,5%*	***15,3%***	*11,4%*	*13,4%*	*15,2%*	*16,8%*	***18,0%***
Default policy cost - consumer expenditures	*M€*	*29*	*34*	*22*	*26*	*43*	*57*	*86*	*85*	*98*	*133*	*430*	*558*	*647*	*742*	*863*
Impact of Intra-European biofuel trade (incorporated in results named as "national RES deployment")																
Adapted RES deployment	ktoe	1.392	1.597	1.790	1.947	2.125	1.423	1.680	1.864	2.010	2.199	1.465	1.774	2.077	2.321	2.591
Adapted RES share on gross final energy demand	%	11,1%	12,4%	13,5%	14,3%	**15,2%**	11,4%	13,1%	14,1%	14,8%	**15,7%**	11,7%	13,8%	15,7%	17,1%	**18,5%**
Adapted policy cost - consumer expenditures	M€	49	55	31	30	53	76	107	93	102	143	449	579	655	746	873
Impact of Intra-European biofuel trade & cooperation mechanisms																
Adapted RES deployment	ktoe	1.386	1.596	1.788	1.945	2.069	1.411	1.672	1.843	1.923	1.982	1.460	1.773	2.076	2.320	2.589
Adapted RES share on gross final energy demand	%	11,1%	12,4%	13,5%	14,3%	**14,8%**	11,3%	13,0%	13,9%	14,2%	**14,1%**	11,7%	13,8%	15,7%	17,1%	**18,5%**
Adapted policy cost - consumer expenditures	M€	45	54	30	29	34	71	103	82	52	41	445	578	654	745	872

Electricity sector **(results referring to national RES deployment)**

Breakdown by RES-electricity category		[Unit]	2005	2007	Electricity production: NAT (National target fulfillment) 2011-2012	2013-2014	2015-2016	2017-2018	2020	EU (European perspective) 2011-2012	2013-2014	2015-2016	2017-2018	2020	ACT (proactive support - realisable deployment) 2011-2012	2013-2014	2015-2016	2017-2018	2020
Biogas	BG	TWh	0,00	0,01	0,36	0,40	0,53	0,62	0,74	0,50	0,72	0,78	0,79	0,79	0,53	0,86	1,10	1,14	1,18
(Solid) Biomass	BM	TWh	0,00	0,44	0,84	1,28	1,76	1,94	2,05	0,92	1,46	1,89	2,02	2,12	0,96	1,54	2,12	2,39	2,51
Biowaste	BW	TWh	0,02	0,02	0,12	0,14	0,15	0,15	0,15	0,12	0,14	0,15	0,15	0,15	0,12	0,14	0,15	0,15	0,15
Geothermal electricity	GE	TWh	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,02	0,05
Hydro large-scale	HY-LS	TWh	3,85	4,22	4,63	4,63	4,63	4,63	4,63	4,63	4,63	4,63	4,63	4,63	4,70	4,70	4,70	4,70	4,70
Hydro small-scale	HY-SS	TWh	0,18	0,13	1,14	1,28	1,28	1,28	1,28	1,14	1,28	1,28	1,28	1,28	1,14	1,28	1,28	1,28	1,28
Photovoltaics	SO-PV	TWh	0,00	0,00	0,00	0,00	0,02	0,04	0,04	0,01	0,03	0,06	0,11	0,22	0,01	0,03	0,06	0,11	0,22
Solar thermal electricity	SO-ST	TWh	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Tide & Wave	TW	TWh	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Wind onshore	WI-ON	TWh	0,01	0,00	0,08	0,13	0,22	0,37	0,44	0,16	0,34	0,46	0,58	0,62	0,17	0,41	0,77	1,03	1,12
Wind offshore	WI-OFF	TWh	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
RES-E TOTAL	RES-E	TWh	4,06	4,83	7,17	7,86	8,59	9,03	9,33	7,48	8,61	9,26	9,55	9,80	7,64	8,97	10,18	10,81	11,21
RES-E share on gross electricity demand		%	14,5%	16,3%	22,8%	23,8%	24,7%	24,8%	24,2%	23,8%	26,0%	26,6%	26,2%	25,4%	24,3%	27,1%	29,3%	29,7%	29,0%

Deployment in terms of capacities

Breakdown by RES-electricity category		[Unit]	2005°	2007°	Installed capacities (cumulative): NAT (National target fulfillment) 2011-2012	2013-2014	2015-2016	2017-2018	2020	EU (European perspective) 2011-2012	2013-2014	2015-2016	2017-2018	2020	ACT (proactive support - realisable deployment) 2011-2012	2013-2014	2015-2016	2017-2018	2020
Biogas	BG	MW	2,0	3,0	60,0	67,2	88,0	103,6	125,9	81,8	123,4	136,7	137,5	137,5	86,4	148,5	201,2	208,9	222,3
(Solid) Biomass	BM	MW	44,0	134,0	148,1	223,1	304,8	337,1	356,2	160,2	251,2	325,5	347,9	367,0	167,1	263,5	360,9	407,8	429,4
Biowaste	BW	MW	2,8	2,2	18,3	22,3	22,7	22,7	22,7	18,3	22,3	22,7	22,7	22,7	18,3	22,3	22,7	22,7	22,7
Geothermal electricity	GE	MW	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,7	3,3	8,0
Hydro large-scale	HY-LS	MW	1.627,7	1.627,7	1.666,9	1.666,9	1.666,9	1.666,9	1.666,9	1.666,9	1.666,9	1.666,9	1.666,9	1.666,9	1.693,0	1.693,0	1.693,0	1.693,0	1.693,0
Hydro small-scale	HY-SS	MW	62,0	57,0	260,0	291,0	291,0	291,0	291,0	260,0	291,0	291,0	291,0	291,0	260,0	291,0	291,0	291,0	291,0
Photovoltaics	SO-PV	MW	0,0	0,0	0,0	5,4	26,8	42,9	42,9	16,1	37,5	66,8	118,4	237,7	16,1	37,5	66,8	118,4	237,7
Solar thermal electricity	SO-ST	MW	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Tide & Wave	TW	MW	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Wind onshore	WI-ON	MW	5,0	0,0	34,0	53,3	93,2	163,4	194,7	71,6	152,2	210,3	267,9	284,0	76,5	187,3	366,6	514,1	564,6
Wind offshore	WI-OFF	MW	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
RES-E TOTAL	RES-E	MW	1.760,1	1.760,1	2.187,3	2.329,1	2.493,4	2.627,6	2.700,3	2.274,8	2.544,4	2.719,9	2.852,4	3.006,8	2.317,3	2.643,1	3.002,9	3.259,3	3.468,7

° historic data on biomass capacities exclude possibly cofiring in conventional power plant

Capital expenditures

Breakdown by RES-electricity category		[Unit]			Capital expenditures (new plants): NAT (National target fulfillment) 2010	2015	2020	Cumulative (06-20)	Yearly average	EU (European perspective) 2010	2015	2020	Cumulative (06-20)	Yearly average	ACT (proactive support - realisable deployment) 2010	2015	2020	Cumulative (06-20)	Yearly average
Biogas	BG	M€			27,5	53,1	8,5	345,7	23,0	27,5	23,7	0,0	398,5	26,6	27,5	106,6	22,9	717,3	47,8
(Solid) Biomass	BM	M€			40,9	72,3	4,1	475,6	31,7	40,9	64,2	4,1	493,8	32,9	40,9	66,9	4,2	622,4	41,5
Biowaste	BW	M€			22,4	0,0	0,0	124,6	8,3	22,4	0,0	0,0	124,6	8,3	22,4	0,0	0,0	124,6	8,3
Geothermal electricity	GE	M€			0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	8,2	28,3	1,9
Hydro large-scale	HY-LS	M€			0,0	0,0	0,0	161,1	10,7	0,0	0,0	0,0	161,1	10,7	0,0	0,0	0,0	209,0	13,9
Hydro small-scale	HY-SS	M€			70,2	0,0	0,0	360,1	24,0	70,2	0,0	0,0	360,1	24,0	70,2	0,0	0,0	360,1	24,0
Photovoltaics	SO-PV	M€			0,0	25,0	0,0	98,0	6,5	0,0	34,3	111,0	520,5	34,7	0,0	33,1	100,4	489,8	32,7
Solar thermal electricity	SO-ST	M€			0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Tide & Wave	TW	M€			0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Wind onshore	WI-ON	M€			0,0	42,3	8,4	261,9	17,5	0,0	22,7	4,3	392,7	26,2	0,0	127,6	13,1	766,9	51,1
Wind offshore	WI-OFF	M€			0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
RES-E TOTAL	RES-E	M€			161,0	192,7	21,1	1.827,0	121,8	161,0	144,9	119,4	2.451,3	163,4	161,0	334,3	148,8	3.318,5	221,2

Policy cost - consumer expenditures due to RES support

Breakdown by RES-electricity category		[Unit]			Consumer expenditures (new plants): NAT (National target fulfillment) 2010	2015	2020	Cumulative (06-20)	Yearly average	EU (European perspective) 2010	2015	2020	Cumulative (06-20)	Yearly average	ACT (proactive support - realisable deployment) 2010	2015	2020	Cumulative (06-20)	Yearly average
Biogas	BG	M€			0,0	0,9	1,4	12,6	0,8	0,0	13,7	13,9	121,6	8,1	0,0	56,7	64,4	481,3	32,1
(Solid) Biomass	BM	M€			1,5	5,2	6,1	55,1	3,7	1,5	25,1	27,1	216,9	14,5	1,5	78,1	107,6	758,8	50,6
Biowaste	BW	M€			0,2	0,0	0,0	1,1	0,1	0,2	0,3	0,3	4,3	0,3	0,2	2,4	2,4	23,0	1,5
Geothermal electricity	GE	M€			0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	3,7	10,0	0,7
Hydro large-scale	HY-LS	M€			0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	6,9	6,9	69,3	4,6
Hydro small-scale	HY-SS	M€			0,0	0,0	0,0	0,5	0,0	0,0	0,2	0,2	2,8	0,2	0,0	25,0	25,0	235,6	15,7
Photovoltaics	SO-PV	M€			0,0	3,6	6,8	37,9	2,5	0,0	12,6	39,9	171,8	11,5	0,0	17,9	64,1	259,4	17,3
Solar thermal electricity	SO-ST	M€			0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Tide & Wave	TW	M€			0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Wind onshore	WI-ON	M€			0,0	0,0	0,0	1,3	0,1	0,0	2,1	3,0	22,6	1,5	0,0	19,7	34,7	209,4	14,0
Wind offshore	WI-OFF	M€			0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
RES-E TOTAL	RES-E	M€			1,8	9,8	14,2	108,6	7,2	1,8	54,1	84,5	540,0	36,0	1,8	206,9	308,8	2.046,8	136,5

Heat sector (results referring to national RES deployment)

Deployment in terms of generation

Breakdown by RES-heat category		[Unit]	2005	2007	Heat production: NAT (National target fulfillment) 2011-2012	2013-2014	2015-2016	2017-2018	2020	EU (European perspective) 2011-2012	2013-2014	2015-2016	2017-2018	2020	ACT (proactive support - realisable deployment) 2011-2012	2013-2014	2015-2016	2017-2018	2020
Biogas (grid)	BG	ktoe	1,0	2,0	7,8	8,2	8,4	8,4	9,9	7,9	10,0	11,0	11,0	11,0	8,1	10,3	11,2	11,3	12,7
Solid biomass (grid)	BM	ktoe	43,0	43,0	196,1	260,9	322,1	358,1	388,6	197,0	265,0	313,1	342,8	371,3	199,8	288,9	400,4	504,3	612,3
Biowaste (grid)	BW	ktoe	0,0	0,0	18,2	22,1	22,5	22,5	22,5	18,2	22,1	22,5	22,5	22,5	18,2	22,1	22,5	22,5	22,5
Geothermal heat (grid)	GE	ktoe	72,2	72,2	80,2	80,2	80,2	80,2	80,2	80,2	80,2	80,2	80,2	80,2	99,9	110,8	120,0	120,0	120,0
Solid biomass (non-grid)	BM-NG	ktoe	314,0	364,0	378,4	419,6	467,5	515,5	564,9	379,7	420,8	469,3	523,5	588,2	379,7	420,8	468,1	515,3	563,8
Solar thermal heating and hot water	SO-TH	ktoe	0,0	0,0	2,1	2,0	1,9	6,9	15,3	3,8	10,6	17,4	24,3	35,3	7,3	14,1	21,0	28,8	41,7
Heat pumps	HP	ktoe	0,0	0,0	0,2	0,2	1,2	5,4	10,7	0,2	3,4	7,6	11,8	17,5	3,4	7,6	11,8	16,3	23,6
RES-H TOTAL	RES-H	ktoe	430,2	481,2	683,0	793,2	903,8	997,0	1.092,0	687,1	812,0	920,9	1.016,0	1.125,9	716,4	874,7	1.055,0	1.218,3	1.396,5
RES-H share on gross heat* demand		%	6,0%	7,3%	8,9%	10,2%	11,4%	12,3%	13,1%	9,0%	10,4%	11,6%	12,5%	13,6%	9,4%	11,2%	13,3%	15,0%	16,8%

* excl. electricity inputs

Deployment in terms of capacity

Breakdown by RES-heat category		[Unit]		2007°	Installed capacity (cumulative): NAT (National target fulfillment) 2011-2012	2013-2014	2015-2016	2017-2018	2020	EU (European perspective) 2011-2012	2013-2014	2015-2016	2017-2018	2020	ACT (proactive support - realisable deployment) 2011-2012	2013-2014	2015-2016	2017-2018	2020
Biogas (grid)	BG	MW		7,1	49,9	56,8	58,8	59,0	75,4	51,8	80,4	96,5	97,5	97,6	54,2	84,1	100,5	101,7	128,5
Solid biomass (grid)	BM	MW		159,8	671,0	889,8	1.100,5	1.208,0	1.290,7	674,0	907,2	1.071,3	1.157,1	1.234,1	686,1	1.005,9	1.381,4	1.715,1	2.076,9
Biowaste (grid)	BW	MW		0,0	88,9	106,4	107,7	107,7	107,7	88,9	106,4	107,7	107,7	107,7	88,9	106,4	107,7	107,7	107,7
Geothermal heat (grid)	GE	MW		186,3	212,3	212,3	212,3	212,3	212,3	212,3	212,3	212,3	212,3	212,3	315,6	365,3	407,2	407,2	407,2
Solid biomass (non-grid)	BM-NG	MW		2.766,9	2.876,6	3.189,3	3.553,7	3.918,5	4.293,8	2.886,1	3.198,8	3.567,1	3.979,1	4.471,3	2.886,1	3.198,8	3.558,1	3.916,8	4.285,6
Solar thermal heating and hot water	SO-TH	MW		0,0	50,4	48,6	46,1	166,7	367,9	91,7	255,3	418,1	584,5	848,8	175,2	340,5	505,8	693,1	1.004,5
Heat pumps	HP	MW		0,0	1,6	1,5	9,4	41,4	81,3	1,6	25,6	57,5	89,5	132,8	25,7	57,7	89,8	123,6	179,6
RES-H TOTAL	RES-H	MW		3.120,0	3.950,5	4.504,6	5.088,4	5.713,4	6.429,1	4.006,3	4.785,9	5.530,5	6.227,7	7.104,5	4.231,7	5.158,7	6.150,6	7.065,1	8.189,9

° approximated based on both model-based scenario calculations and actual RES deployment

Capital expenditures

Breakdown by RES-heat category		[Unit]			Capital expenditures (new plants): NAT (National target fulfillment) 2010	2015	2020	Cumulative (06-20)	Yearly average	EU (European perspective) 2010	2015	2020	Cumulative (06-20)	Yearly average	ACT (proactive support - realisable deployment) 2010	2015	2020	Cumulative (06-20)	Yearly average
Biogas (grid)	BG	M€			0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Solid biomass (grid)	BM	M€			28,2	20,6	9,5	270,8	18,1	28,2	12,3	8,7	269,1	17,9	28,2	48,8	48,6	576,7	38,4
Biowaste (grid)	BW	M€			0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Geothermal heat (grid)	GE	M€			0,0	0,0	0,0	22,3	1,5	0,0	0,0	0,0	22,3	1,5	0,0	24,4	0,0	340,1	22,7
Solid biomass (non-grid)	BM-NG	M€			39,9	113,8	120,4	1.122,2	74,8	39,9	115,2	122,5	1.238,9	82,6	39,9	138,2	116,3	1.297,0	86,5
Solar thermal heating and hot water	SO-TH	M€			0,0	0,0	28,0	113,7	7,6	0,0	29,7	40,5	288,0	19,2	0,0	30,2	50,1	348,1	23,2
Heat pumps	HP	M€			0,0	0,0	8,6	44,5	3,0	0,0	9,4	10,6	75,4	5,0	0,0	9,3	15,4	103,8	6,9
RES-H TOTAL	RES-H	M€			68,2	134,4	166,5	1.573,5	104,9	68,2	166,6	182,2	1.893,6	126,2	68,2	250,9	230,4	2.665,6	177,7

Policy cost - consumer expenditures due to RES support

Breakdown by RES-heat category		[Unit]			Consumer expenditures (new plants): NAT (National target fulfillment) 2010	2015	2020	Cumulative (06-20)	Yearly average	EU (European perspective) 2010	2015	2020	Cumulative (06-20)	Yearly average	ACT (proactive support - realisable deployment) 2010	2015	2020	Cumulative (06-20)	Yearly average
Biogas (grid)	BG	M€			0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Solid biomass (grid)	BM	M€			9,9	0,0	0,0	30,5	2,0	9,9	0,6	0,4	39,6	2,6	9,9	86,9	143,5	974,0	64,9
Biowaste (grid)	BW	M€			0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Geothermal heat (grid)	GE	M€			0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	24,3	13,3	260,1	17,3
Solid biomass (non-grid)	BM-NG	M€			0,0	0,0	0,0	0,0	0,0	0,0	9,9	11,6	104,3	7,0	0,0	140,8	223,0	1.437,0	95,8
Solar thermal heating and hot water	SO-TH	M€			0,0	0,0	0,0	0,0	0,0	0,0	4,5	6,1	43,2	2,9	0,0	24,6	45,0	283,8	18,9
Heat pumps	HP	M€			0,0	0,0	0,0	0,0	0,0	0,0	1,4	1,6	11,3	0,8	0,0	9,5	18,0	107,0	7,1
RES-H TOTAL	RES-H	M€			9,9	0,0	0,0	30,5	2,0	9,9	16,4	19,7	198,3	13,2	9,9	286,0	442,8	3.061,9	204,1

Transport sector

Deployment in terms of consumption

Energy consumption in transport

Breakdown by RES-transport category		[Unit]	2005	2007	NAT (National target fulfillment) 2011-2012	NAT 2013-2014	NAT 2015-2016	NAT 2017-2018	NAT 2020	EU (European perspective) 2011-2012	EU 2013-2014	EU 2015-2016	EU 2017-2018	EU 2020	ACT (proactive support - realisable deployment) 2011-2012	ACT 2013-2014	ACT 2015-2016	ACT 2017-2018	ACT 2020
Bioethanol**	BE	ktoe	0,0	12,0	12,9	30,2	52,4	83,0	108,3	12,9	30,2	52,4	83,0	108,3	12,9	30,2	52,4	83,0	108,3
Biodiesel**	BD	ktoe	11,0	77,0	35,9	34,9	17,1	33,1	32,0	35,9	34,9	17,1	33,1	32,0	35,9	34,9	17,1	33,1	32,0
2nd generation biofuels**°	2BF	ktoe	n.a.	n.a.	0,0	0,0	0,0	0,0	3,7	0,0	0,0	0,0	0,0	3,7	0,0	0,0	0,0	0,0	3,7
Net biofuel import*		ktoe	n.a.	n.a.	43,3	62,8	77,8	56,8	86,6	43,3	62,8	77,8	56,8	86,6	43,3	62,8	77,8	56,8	86,6
Biofuel TOTAL	RES-T	ktoe	11,0	89,0	92,0	127,9	147,3	173,0	230,6	92,0	127,9	147,3	173,0	230,6	92,0	127,9	147,3	173,0	230,6
Biofuel share on diesel and gasoline demand		%	0,6%	4,5%	4,4%	6,0%	6,7%	7,7%	10,0%	4,4%	6,0%	6,7%	7,7%	10,0%	4,4%	6,0%	6,7%	7,7%	10,0%

° 2nd generation biofuels shall mean biofuel from wastes, residues, non-food cellulosic and ligno-cellulosic material

* a negative figure means an export to other (EU) countries

** generation based on national bioenergy feedstocks

Deployment in terms of capacity *(referring to generation based on national feedstocks)*

Installed capacity (cumulative)

Breakdown by RES-transport category		[Unit]		2007°	NAT (National target fulfillment) 2011-2012	NAT 2013-2014	NAT 2015-2016	NAT 2017-2018	NAT 2020	EU (European perspective) 2011-2012	EU 2013-2014	EU 2015-2016	EU 2017-2018	EU 2020	ACT (proactive support - realisable deployment) 2011-2012	ACT 2013-2014	ACT 2015-2016	ACT 2017-2018	ACT 2020
Bioethanol	BE	MW		17,4	18,8	43,9	76,1	120,7	157,5	18,8	43,9	76,1	120,7	157,5	18,8	43,9	76,1	120,7	157,5
Biodiesel	BD	MW		137,8	64,2	62,5	60,9	59,2	57,2	64,2	62,5	60,9	59,2	57,2	64,2	62,5	60,9	59,2	57,2
2nd generation biofuels	2BF	MW		n.a.	0,0	0,0	0,0	0,0	5,4	0,0	0,0	0,0	0,0	5,4	0,0	0,0	0,0	0,0	5,4
Biofuel TOTAL	RES-T	MW		155,2	82,9	106,4	137,0	180,0	220,0	82,9	106,4	137,0	180,0	220,0	82,9	106,4	137,0	180,0	220,0

° approximated based on both model-based scenario calculations and actual RES deployment

Capital expenditures

Capital expenditures (new plants)

Breakdown by RES-transport category		[Unit]			NAT (National target fulfillment) 2010	NAT 2015	NAT 2020	NAT Cumulative (06-20)	NAT Yearly average	EU (European perspective) 2010	EU 2015	EU 2020	EU Cumulative (06-20)	EU Yearly average	ACT (proactive support - realisable deployment) 2010	ACT 2015	ACT 2020	ACT Cumulative (06-20)	ACT Yearly average
Bioethanol	BE	M€			0,0	10,4	0,0	101,9	6,8	0,0	10,4	0,0	101,9	6,8	0,0	10,4	0,0	101,9	6,8
Biodiesel	BD	M€			0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
2nd generation biofuels	2BF	M€			0,0	0,0	7,7	7,7	0,5	0,0	0,0	7,7	7,7	0,5	0,0	0,0	7,7	7,7	0,5
Biofuel TOTAL	RES-T	M€			0,0	10,4	7,7	109,6	7,3	0,0	10,4	7,7	109,6	7,3	0,0	10,4	7,7	109,6	7,3

Policy cost - consumer expenditures due to RES support

Consumer expenditures (new plants)

Breakdown by RES-transport category		[Unit]			NAT (National target fulfillment) 2010	NAT 2015	NAT 2020	NAT Cumulative (06-20)	NAT Yearly average	EU (European perspective) 2010	EU 2015	EU 2020	EU Cumulative (06-20)	EU Yearly average	ACT (proactive support - realisable deployment) 2010	ACT 2015	ACT 2020	ACT Cumulative (06-20)	ACT Yearly average
Bioethanol	BE	M€			0,0	8,9	18,3	97,8	6,5	0,0	8,9	18,3	97,8	6,5	0,0	8,9	18,3	97,8	6,5
Biodiesel	BD	M€			0,0	6,7	5,4	86,7	5,8	0,0	6,7	5,4	86,7	5,8	0,0	6,7	5,4	86,7	5,8
2nd generation biofuels	2BF	M€			0,0	0,0	0,6	0,6	0,0	0,0	0,0	0,6	0,6	0,0	0,0	0,0	0,6	0,6	0,0
Net biofuel import*		M€			0,0	12,3	14,6	146,4	9,8	0,0	12,3	14,6	146,4	9,8	0,0	12,3	14,6	146,4	9,8
Biofuel TOTAL	RES-T	M€			0,0	27,9	38,9	331,5	22,1	0,0	27,9	38,9	331,5	22,1	0,0	27,9	38,9	331,5	22,1

* a negative figure means savings due to exports to other (EU) countries

Summary - Results on selected costs and benefits

Capital expenditures

Capital expenditures (new plants)

Breakdown by RES sector		[Unit]		2007°	NAT (National target fulfillment) 2010	NAT 2015	NAT 2020	NAT Cumulative (06-20)	NAT Yearly average	EU (European perspective) 2010	EU 2015	EU 2020	EU Cumulative (06-20)	EU Yearly average	ACT (proactive support - realisable deployment) 2010	ACT 2015	ACT 2020	ACT Cumulative (06-20)	ACT Yearly average
Electricity sector	RES-E	M€		90,1	161,0	192,7	21,1	1.827,0	121,8	161,0	144,9	119,4	2.451,3	163,4	161,0	334,3	148,8	3.318,5	221,2
Heat sector	RES-H	M€		20,0	68,2	134,4	166,5	1.573,5	104,9	68,2	166,6	182,2	1.893,6	126,2	68,2	250,9	230,4	2.665,6	177,7
Transport sector	RES-T	M€		0,0	0,0	10,4	7,7	109,6	7,3	0,0	10,4	7,7	109,6	7,3	0,0	10,4	7,7	109,6	7,3
Total (national RES deployment)	RES	M€		110,1	229,2	337,5	195,2	3.510,1	234,0	229,2	321,9	309,3	4.454,5	297,0	229,2	595,6	386,9	6.093,7	406,2

° approximated based on both model-based scenario calculations and actual RES deployment

Policy cost - consumer expenditures due to RES support

Consumer expenditures (new plants)

Breakdown by RES sector		[Unit]		2007°	NAT (National target fulfillment) 2010	NAT 2015	NAT 2020	NAT Cumulative (06-20)	NAT Yearly average	EU (European perspective) 2010	EU 2015	EU 2020	EU Cumulative (06-20)	EU Yearly average	ACT (proactive support - realisable deployment) 2010	ACT 2015	ACT 2020	ACT Cumulative (06-20)	ACT Yearly average
Electricity sector	RES-E	M€		4,7	1,8	9,8	14,2	108,6	7,2	1,8	54,1	84,5	540,0	36,0	1,8	206,9	308,8	2.046,8	136,5
Heat sector	RES-H	M€		4,1	9,9	0,0	0,0	30,5	2,0	9,9	16,4	19,7	198,3	13,2	9,9	286,0	442,8	3.061,9	204,1
Transport sector	RES-T	M€		0,0	0,0	27,9	38,9	331,5	22,1	0,0	27,9	38,9	331,5	22,1	0,0	27,9	38,9	331,5	22,1
Total (national RES deployment)	RES	M€		8,8	11,7	37,6	53,1	470,7	31,4	11,7	98,3	143,1	1.069,8	71,3	11,7	520,8	790,5	5.440,3	362,7
Impact of cooperation mechanisms		M€		0,0	0,0	-0,7	-19,1	-37,9	-2,5	0,0	-5,9	-102,1	-323,7	-21,6	0,0	-1,1	-1,2	-15,7	-1,0
Total (corrected)	RES	M€		8,8	11,7	36,9	33,9	432,8	28,9	11,7	92,4	41,0	746,1	49,7	11,7	519,7	789,3	5.424,6	361,6

° approximated based on both model-based scenario calculations and actual RES deployment

Additional generation costs

Breakdown by RES sector		[Unit]		2007°	NAT 2010	NAT 2015	NAT 2020	NAT Cumulative (06-20)	NAT Yearly average	EU 2010	EU 2015	EU 2020	EU Cumulative (06-20)	EU Yearly average	ACT 2010	ACT 2015	ACT 2020	ACT Cumulative (06-20)	ACT Yearly average
				Additional generation costs (new plants)															
					NAT (National target fulfillment)					EU (European perspective)					ACT (proactive support - realisable deployment)				
Electricity sector	RES-E	M€		0,4	0,0	3,6	6,8	38,4	2,6	0,0	13,2	38,7	168,2	11,2	0,0	29,6	79,9	369,8	24,7
Heat sector	RES-H	M€		0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,7	0,0	0,0	22,0	23,9	185,4	12,4
Transport sector	RES-T	M€		0,0	0,0	7,5	2,5	40,8	2,7	0,0	6,9	2,5	40,8	2,7	0,0	7,5	2,5	40,8	2,7
Total (national RES deployment)	RES	M€		0,4	0,0	11,1	9,3	79,1	5,3	0,0	20,1	41,2	209,7	14,0	0,0	59,1	106,3	596,0	39,7

° approximated based on both model-based scenario calculations and actual RES deployment

Total avoided CO_2 emissions

Breakdown by RES sector		[Unit]		2007°	NAT 2010	NAT 2015	NAT 2020	NAT Cumulative (06-20)	NAT Yearly average	EU 2010	EU 2015	EU 2020	EU Cumulative (06-20)	EU Yearly average	ACT 2010	ACT 2015	ACT 2020	ACT Cumulative (06-20)	ACT Yearly average
				Total avoided CO_2 emissions (new plants)															
					NAT (National target fulfillment)					EU (European perspective)					ACT (proactive support - realisable deployment)				
Electricity sector	RES-E	Mt[CO2] / a		1,0	1,6	2,8	3,1	33,2	2,2	1,6	3,3	3,4	37,1	2,5	1,6	3,9	4,3	42,7	2,8
Heat sector	RES-H	Mt[CO2] / a		0,1	0,3	1,1	1,9	12,8	0,9	0,3	1,2	2,0	13,4	0,9	0,3	1,5	2,6	16,8	1,1
Transport sector	RES-T	Mt[CO2] / a		0,0	0,0	0,2	0,4	2,3	0,2	0,0	0,2	0,4	2,3	0,2	0,0	0,2	0,4	2,3	0,2
Total (national RES deployment)	RES	Mt[CO2] / a		1,1	1,9	4,2	5,3	48,3	3,2	1,9	4,7	5,8	52,8	3,5	1,9	5,6	7,3	61,8	4,1

° approximated based on both model-based scenario calculations and actual RES deployment

Total avoided CO_2 emissions in monetary terms

Breakdown by RES sector		[Unit]		2007°	NAT 2010	NAT 2015	NAT 2020	NAT Cumulative (06-20)	NAT Yearly average	EU 2010	EU 2015	EU 2020	EU Cumulative (06-20)	EU Yearly average	ACT 2010	ACT 2015	ACT 2020	ACT Cumulative (06-20)	ACT Yearly average
				Avoided CO_2 emissions (monetary expression - new plants)															
					NAT (National target fulfillment)					EU (European perspective)					ACT (proactive support - realisable deployment)				
Electricity sector	RES-E	M€		19,4	31,3	76,9	105,7	889,2	59,3	31,3	90,6	116,1	996,2	66,4	31,3	104,9	147,0	1.163,9	77,6
Heat sector	RES-H	M€		1,8	7,0	30,8	63,7	365,2	24,3	7,0	32,1	68,0	383,9	25,6	7,0	40,4	90,1	486,8	32,5
Transport sector	RES-T	M€		0,0	0,0	5,8	13,5	68,4	4,6	0,0	5,8	13,5	68,4	4,6	0,0	5,8	13,5	68,4	4,6
Total (national RES deployment)	RES	M€		21,2	38,3	113,4	182,9	1.322,8	88,2	38,3	128,5	197,6	1.448,4	96,6	38,3	151,1	250,6	1.719,0	114,6

° approximated based on both model-based scenario calculations and actual RES deployment

Avoided fossil fuels in energy terms

Breakdown by RES sector		[Unit]		2007°	NAT 2010	NAT 2015	NAT 2020	NAT Cumulative (06-20)	NAT Yearly average	EU 2010	EU 2015	EU 2020	EU Cumulative (06-20)	EU Yearly average	ACT 2010	ACT 2015	ACT 2020	ACT Cumulative (06-20)	ACT Yearly average
				Avoided fossil fuels (energy terms - new plants)															
					NAT (National target fulfillment)					EU (European perspective)					ACT (proactive support - realisable deployment)				
Electricity sector	RES-E	ktoe		283	464	893	1.051	10.470	698	464	1.052	1.154	11.706	780	464	1.218	1.461	13.529	902
Heat sector	RES-H	ktoe		35	128	413	688	4.695	313	128	433	732	4.928	329	128	556	1.015	6.364	424
Transport sector	RES-T	ktoe		0	0	96	197	1.274	85	0	96	197	1.274	85	0	96	197	1.274	85
Total (national RES deployment)	RES	ktoe		318	592	1.402	1.935	16.439	1.096	592	1.581	2.084	17.907	1.194	592	1.871	2.673	21.167	1.411

° approximated based on both model-based scenario calculations and actual RES deployment

Avoided fossil fuels in monetary terms

Breakdown by RES sector		[Unit]		2007°	NAT 2010	NAT 2015	NAT 2020	NAT Cumulative (06-20)	NAT Yearly average	EU 2010	EU 2015	EU 2020	EU Cumulative (06-20)	EU Yearly average	ACT 2010	ACT 2015	ACT 2020	ACT Cumulative (06-20)	ACT Yearly average
				Avoided fossil fuels (monetary terms - new plants)															
					NAT (National target fulfillment)					EU (European perspective)					ACT (proactive support - realisable deployment)				
Electricity sector	RES-E	M€		46,6	101,7	257,9	367,6	2.930,3	195,4	101,7	303,8	403,8	3.289,3	219,3	101,7	351,8	511,1	3.858,6	257,2
Heat sector	RES-H	M€		7,8	44,4	149,2	275,1	1.715,8	114,4	44,4	155,8	291,4	1.795,6	119,7	44,4	204,7	419,1	2.390,6	159,4
Transport sector	RES-T	M€		0,0	0,0	49,5	115,4	695,9	46,4	0,0	49,5	115,4	695,9	46,4	0,0	49,5	115,4	695,9	46,4
Total (national RES deployment)	RES	M€		54,5	146,1	456,6	758,1	5.342,0	356,1	146,1	509,0	810,6	5.780,8	385,4	146,1	606,0	1.045,6	6.945,2	463,0

° approximated based on both model-based scenario calculations and actual RES deployment

Biomass use

Breakdown by feedstock category		[Unit]			NAT Total 2015	NAT Imports* 2015	NAT Total 2020	NAT Imports* 2020		EU Total 2015	EU Imports* 2015	EU Total 2020	EU Imports* 2020		ACT Total 2015	ACT Imports* 2015	ACT Total 2020	ACT Imports* 2020	
				Biomass use (in terms of primary energy)															
					NAT (National target fulfillment)					EU (European perspective)					ACT (proactive support - realisable deployment)				
Agricultural products	AP	ktoe			150	14	296	26		157	14	313	26		185	14	585	26	
Agricultural residues	AR	ktoe			400		515			472		529			544		627		
Forestry products	FP	ktoe			457		604			473		619			503		621		
Forestry residues	FR	ktoe			361	16,2	417	36,7		400	24,1	417	36,7		400	24,1	417	36,7	
Biowaste	BW	ktoe			146		147			146		147			159		159		
Total Biomass availability		ktoe			1.542,6		2.042,1			1.685,2		2.088,4			1.829,1		2.472,4		

*only additional future imports from outside the EU - incl. also refined biofuels

Appendix B – Method of approach / Key assumptions

The method of approach and related key assumptions for the scenario elaboration undertaken within the REPAP2020 project will be discussed subsequently, describing the approach and parameters used for the model-based policy assessment undertaken as conducted by means of policy scenarios. Finally, an overview on assessed cases concludes this appendix.

B.1 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 again perform a detailed quantitative assessment of the future deployment of renewable energies on country-, sectoral- 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 characterisation of the model is given in Appendix C, whilst for a detailed description we refer to www.green-x.at.

B.2 Overview of 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 an updated edition of the ***Green-X*** database on RES potentials and cost as initially assessed within the 'FORRES 2020' study (see Ragwitz et al., 2005). Table B-1 shows which parameters are based on PRIMES and which have been defined for this study. More precisely the PRIMES scenarios used are:

- The PRIMES scenario on meeting both EU targets by 2020 – i.e. on climate change (20% GHG reduction) and renewable energies (20% RES by 2020) / 2008 (PRIMES target case) (NTUA, 2008)
- The European Energy and Transport Trends by 2030 / 2007 / Efficiency Case (NTUA, 2007b)
- The European Energy and Transport Trends by 2030 / 2007 / Baseline Case (NTUA, 2007a)

Table B-1 Main input sources for scenario parameters

Based on PRIMES	Sectoral energy demand by country
	Primary energy prices (international)
	Conventional supply portfolio by energy sector by country and corresponding conversion efficiencies and CO_2 intensities
Defined for this study	National 2020 RES targets (based on proposed RES Directive)
	Sectoral reference energy prices by country
	RES potentials and cost by country (Green-X database)
	Biomass import restrictions
	Technology diffusion (and corresponding national non-economic RES barriers)
	Technological learning (mainly based on a 'global learning system')

B.2.1 Energy demand

Figure B-1 depicts the projected gross final energy demand development for Slovakia according to the different PRIMES scenarios.

For the conducted policy assessment the following assumptions are taken: With respect to an ambitious RES exploitation (i.e. 20% RES by 2020 at EU-27 level) the PRIMES target case appears suitable as (default) reference for the policy assessment, whereby an increase in energy efficiency (compared to baseline) is preconditioned.

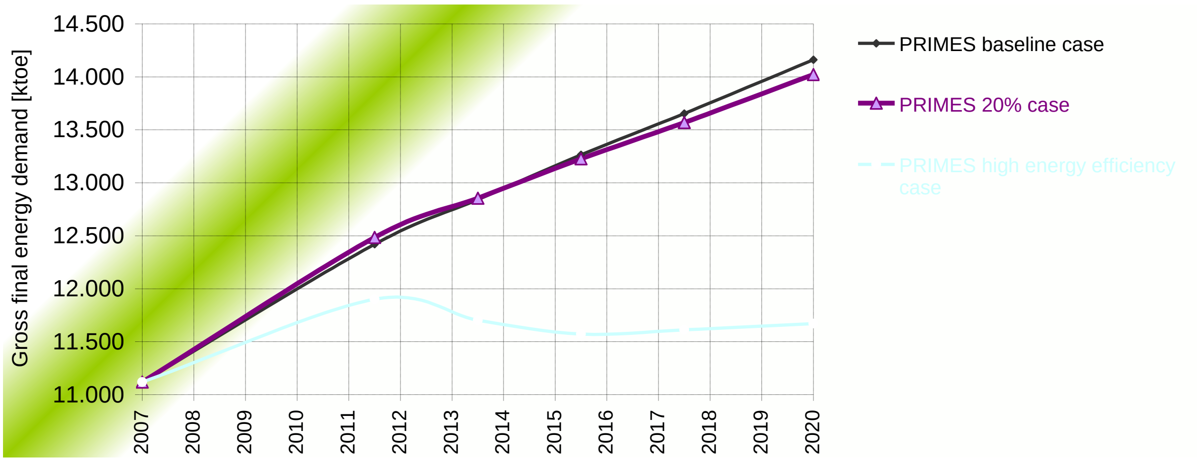

Figure B-1 Comparison of projected gross final energy demand development up to 2020 in Slovakia.

Source: *PRIMES scenarios*

B.2.2 Conventional supply portfolio

The conventional supply portfolio, i.e. the share of the different conversion technologies in each sector, has been based on the PRIMES forecasts on a country specific basis. These projections on the portfolio of conventional technologies have an impact in particular on the calculations done within this study on the avoidance of fossil fuels and CO_2 emissions. As it is at least out of the scope of this study to analyse in detail which conventional power plants would actually be replaced by for instance a wind farm installed in the year 2014 in a certain country (i.e. either a less efficient existing coal-fired plant or a possibly new high-efficient combined cycle gas turbine), the following assumptions are made:

- Keeping in mind that, besides renewable energies, fossil energy represents the marginal generation option that determines the prices on energy markets, it was decided to stick on country level to the sector-specific conventional supply portfolio projections as provided by PRIMES. Sector- as well as country-specific conversion efficiencies, as derived on a yearly basis, are used to derive the amount of avoided primary energy based on the renewable generation figures obtained. Assuming that the fuel mix stays unaffected, avoidance can be expressed in units of coal or gas replaced.
- A similar approach is chosen with regard to the avoidance of CO_2 emissions, where yearly changing average country- as well as sector-specific CO_2 intensities of the fossil-based conventional supply portfolio forms the basis.

In the following the derived data on aggregate conventional conversion efficiencies and the CO_2 intensities characterising the conventional reference system is presented.

Figure B-2 shows the dynamic development of average conversion efficiencies as projected by PRIMES for conventional electricity generation as well as for grid-connected heat production. Thereby, conversion efficiencies are shown for both the PRIMES baseline and PRIMES efficiency case. Error bars indicate the range in country-specific average efficiencies between EU member states. For the transport sector, where efficiencies are not explicitly expressed in PRIMES results, the average efficiency of the refinery process to derive fossil diesel and gasoline was assumed to be 95%.

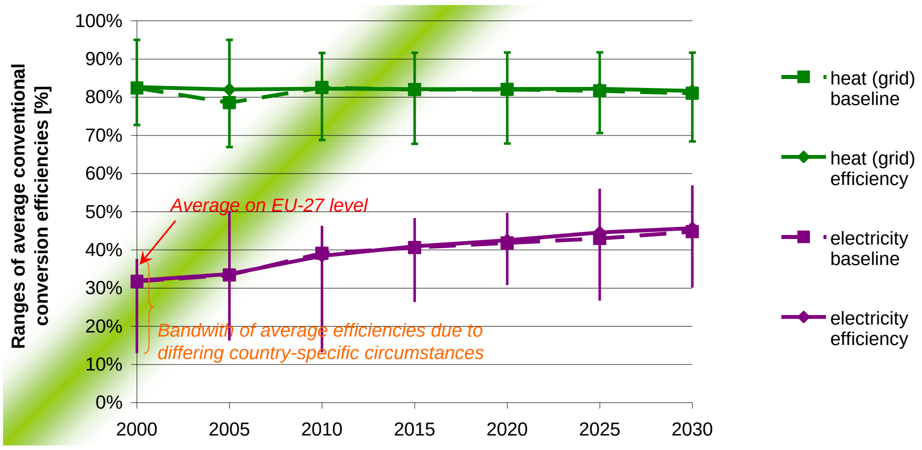

Figure B-2 Country-specific average conversion efficiencies of conventional (fossil-based) electricity and grid-connected heat production in the EU27.

Source: PRIMES scenarios

The corresponding data on country- as well as sector-specific CO_2 intensities of the conventional energy conversion system are shown in Figure B-3. Error bars again illustrate the variation over countries.

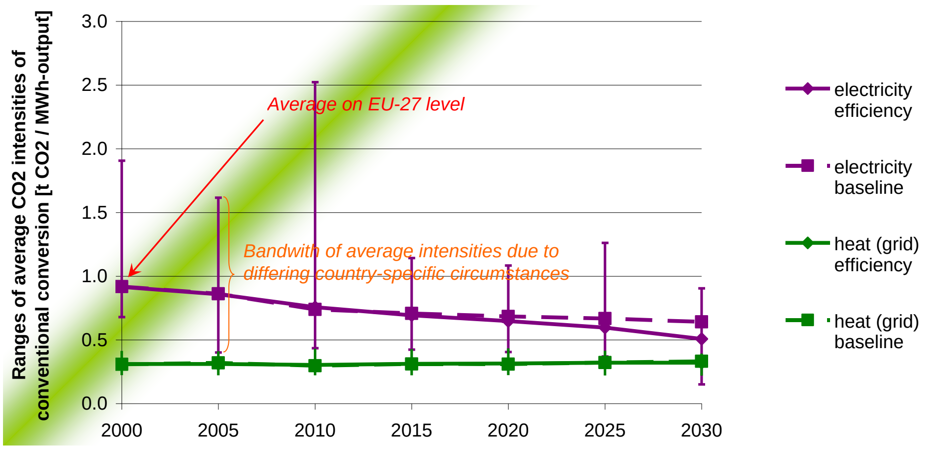

Figure B-3 Country-specific average sectoral CO_2 intensities of the conventional (fossil-based) energy system in the EU27.

Note: The differences between the PRIMES efficiency and baseline case for non-grid heat and transport are very small and therefore not shown

Source: PRIMES scenarios

B.2.3 Fossil fuel and reference energy prices

National reference energy prices used in this analysis are based on the primary energy price assumptions as used in the EU energy outlook (as of 2007). The PRIMES data provide two different scenarios on future fossil energy prices: the so called default case and the high price case (as shown in Table B-2). The latter case was used as (default) reference for all calculations. Compared to energy prices as observed in 2007 and the first three quarters of 2008 the price assumptions are for both PRIMES scenarios low for the later years up to 2020. In the high price case the oil price for instance goes up to 100 $ per barrel, which is still significantly below past energy prices as observed throughout 2008.

The CO_2-price in the scenarios presented in this report is exogenously set as shown in Table B-3, again similar to corresponding EU scenarios (as for example in the impact assessment of the Energy and Climate package of the EU). Actual market prices (for 2006 EU

Allowances) have fluctuated between 7 and 30 €/t, with averages fluctuating roughly between 15 and 20 €/t. In the model, it is assumed that CO_2-prices are directly passed through to electricity prices. This is done fuel-specific based on the PRIMES CO_2-emission factors.

Increased RES-deployment can have a CO_2-price reducing effect as it reduces the demand for CO_2-reductions. As RES-deployment should be anticipated in the EU Emission Trading System and the CO_2-price in the ***Green-X*** scenarios is exogenously set, this effect is not included, which represents a rather conservative approach.

Table B-2 International primary energy price assumptions in US$2005/boe, high price case (as used as default reference)

International (fossil) reference energy prices					
(default reference price development for imports to the EU - based on PRIMES high energy prices)					
(exchange rate: 1€ = 1.25US$)	[Unit]	2005	2010	2015	2020
Oil	[US$2005/boe]	54.5	76.4	88.1	100.0
	[€/MWh]	*27.4*	*38.4*	*44.2*	*50.2*
Gas	[US$2005/boe]	34.6	59.1	67.4	77.0
	[€/MWh]	*17.4*	*29.7*	*33.8*	*38.7*
Coal	[US$2005/boe]	14.8	19.2	21.7	24.0
	[€/MWh]	*7.4*	*9.6*	*10.9*	*12.1*

Source: PRIMES scenarios

Table B-3 CO_2 price assumptions in €2005/ton (source: PRIMES scenarios)

CO_2 price assumptions for the European ETS					
	[Unit]	2005	2010	2015	2020
CO_2 price	[€/t CO_2]	20.0	20.0	26.3	34.5

Source: PRIMES scenarios

Table B-4 Reference prices for electricity, heat and transport fuels on average at EU-27 level

Sectoral reference energy prices - on average at EU-27 level						
(default reference price development - based on PRIMES high energy prices & PRIMES target case (demand))						**average (06-20)**
(expressed per MWh output)	[Unit]	2006	2010	2015	2020	
Electricity price (wholesale)	[€/MWh electricity]	59.9	71.7	74.9	75.2	71.9
Heat price (grid-connected)	[€/MWh heat, grid]	33.0	43.4	49.4	56.5	46.2
Heat price (decentral)	[€/MWh heat, decentral]	58.0	73.1	80.5	88.4	76.0
Transport fuel price	[€/MWh transport fuel]	46.1	60.4	69.6	79.0	64.7

Reference prices for the electricity sector are taken from the ***Green-X*** model. Based on the primary energy prices, the CO_2-price and the country-specific power sector, the ***Green-X*** model determines country-specific reference electricity prices for each year in the period 2006 to 2020. Reference prices for the heat and transport sector are based on primary energy prices and the typical country-specific conventional conversion portfolio. Default sectoral reference energy prices for the ambitious policy pathways are illustrated in Table B-4. More precisely, these prices represent the average at European level (EU-27) and refer to an energy demand development according to the PRIMES target case and the PRIMES high energy prices. Note that heat prices in case of grid-connected heat supply from district heating and CHP-plant do not include the cost of distribution – i.e. they represent the price directly at defined hand over point.

B.2.4 Interest rate / weighted average cost of capital - the role of (investor's) risk

Table B-5 Example of value setting for WACC calculation

WACC methodology	Abbreviation / Calculation	Default risk assessment		High risk assessment	
		Debt (d)	Equity (e)	Debt (d)	Equity (e)
Share equity / debt	g	70.0%	30.0%	70.0%	30.0%
Nominal risk free rate	r_n	4.0%	4.0%	4.0%	4.0%
Inflation rate	i	2.0%	2.0%	2.0%	2.0%
Real risk free rate	$r_f = r_n - i$	2.0%	2.0%	2.0%	2.0%
Expected market rate of return	r_m	4.0%	6.5%	4.5%	9.5%
Risk premium	$r_p = r_m - r_f$	2.0%	4.5%	2.5%	7.5%
Equity beta	b		1.6		1.6
Tax rate (corporation tax)	r_t		25.0%		25.0%
Post-tax cost	r_{pt}	3.0%	9.2%	3.4%	14.0%
Pre-tax cost	$r = r_{pt} / (1-r_t)$	4.0%	12.3%	4.5%	18.7%
Weighted average cost of capital (pre-tax)	***WACC***	**6.5%**		**8.8%**	

Determining the necessary rate of return is based on the weighted average cost of capital (WACC) methodology. WACC is often used as an estimate of the internal discount rate of a project or the overall rate of return desired by all investors (equity and debt providers). This means that the WACC formula[18] determines the required rate of return on a company's total asset base and is determined by the Capital Asset Pricing Model (CAPM) and the return on debt. Formally, the pre-tax cost of capital is given by:

$$WACC^{\text{pre-tax}} = g_d \bullet r_d + g_e \bullet r_e = g_d \bullet [r_{fd} + r_{pd}] + g_e \bullet [r_{fe} + \beta \bullet r_{pe}] / (1 - r_t)$$

Table B-5 illustrates the determination of the WACC exemplarily for two differing cases – a default and a high risk assessment. Within the model-based analysis a range of settings is applied to reflect investor's risk appropriate. Thereby, risk refers to two different issues:

- A *'policy risk'* related to uncertainty on future earnings caused by the support scheme itself – e.g. referring to the uncertain development of certificate prices within a RES trading system. As shown in Table B-5, with respect to policy risk two different settings are used in the analysis, ranging from 6.5 % up to 8.8 %. The different values are based on a different risk assessment, a standard risk level and a set of risk levels characterised by a higher expected market rate of return. 6.5 % is used as the default value for stable planning conditions as given, e.g. under advanced fixed feed-in tariffs. The higher value is applied in scenarios with lower stable planning conditions, i.e. in the cases where support schemes cause a higher risk for investors as associated e.g. with RES trading (and related uncertainty on future earnings on the certificate market).
- A *'technology risk'* referring to uncertainty on future energy production due to unexpected production breaks, technical problems etc.. Such deficits may cause (unexpected) additional operational and maintenance cost or require substantial reinvestments which (after a phase out of operational guarantees) typically have to be born by the investors themselves. In this context, Figure (below) illustrates the default assumptions applied to consider investor's technology risk.

As default both policy and technology risk are considered in the assessment, leading to a higher WACC than the default level of 6.5%.

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18 The WACC represents the necessary rate a prospective investor requires for investment in a new plant.

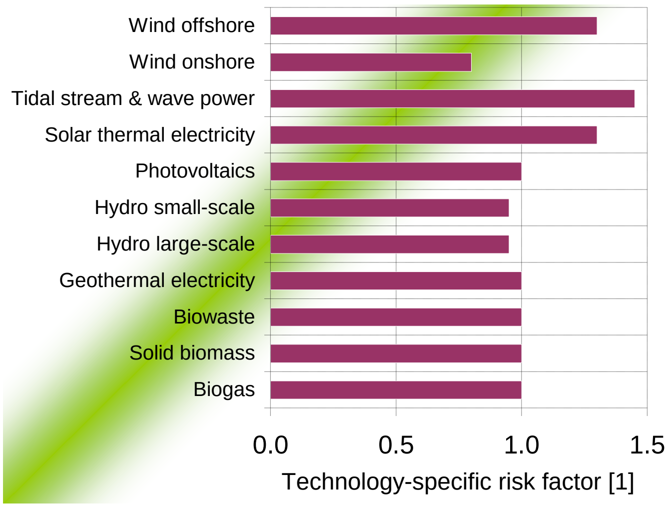

Figure B-4 Technology-specific risk factors

B.2.5 Assumptions for simulated support schemes

A number of key input parameters were defined for each of the model runs referring to the specific design of the support instruments as described below.

► *General scenario conditions*

Consumer expenditure is heavily dependent on the design of policy instruments. In the policy variants investigated, it is obvious that the design options of the various instruments were chosen in such a way that expenditure is low. Accordingly, it is assumed that the investigated schemes are characterised by:

- a stable planning horizon
- a continuous RES-E policy / long-term RES-E targets and
- a clear and well defined tariff structure / yearly targets for RES(-E) deployment.

In addition, for all investigated scenarios the following design options are assumed:

- financial support is restricted to new capacity only,[19]
- the guaranteed duration of financial support is limited. [20]

With respect to model parameters reflecting *dynamic aspects such as technology diffusion or technological change,* the following settings are applied:

- *Removal of non-financial barriers and high public acceptance in the long term.*

  In the scenario runs it is assumed that the existing social, market and technical barriers (e.g. grid integration) can be overcome in time. Nevertheless, their impact is still relevant as is reflected in the BAU-settings (referring to a BAU scenario based on current RES support) compared to, e.g. the more optimistic view assumed for reaching an accelerated RES deployment as preconditioned in the policy assessment referring to the ambitious target of 20% RES by 2020.

- *A stimulation of 'technological learning' is considered – leading to reduced investment and O&M costs for RES-E and increased energy efficiency over time.*

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19 This means that only plants constructed in the period 2005 to 2020 are eligible to receive support from the new schemes. Existing plants (constructed before 2005) remain in their old scheme.

20 In the model runs, it is assumed that the time frame in which investors can receive (additional) financial support is restricted to 15 years for all instruments providing generation-based support.

Thereby, moderate technological learning is preconditioned as default for all policy cases.

In the following, the model settings and assumptions are described for each type of support instrument separately. These assumptions refer to advanced support schemes as applied in the discussion of strengthened national and harmonised European wide policy instruments.

► *Feed-in tariffs*

Premium feed-in tariffs are defined as technology-specific; settings are applied so as to achieve an overall low burden for consumers. Tariffs decrease over time reflecting the achieved cost reductions on a technology level, but this annual adjustment in the level of support applies only to new installations. More precisely, whenever a new plant is installed, the level of support is fixed for the guaranteed duration (of 15 years as commonly applied in the case of generation-based support). A low risk premium (leading to a WACC of 6.5 %) is applied to reflect the small degree of uncertainty associated with the well defined design of this instrument.

► *Quota obligations with tradable green certificates (TGC) / guarantees of origin (GO)*[21]

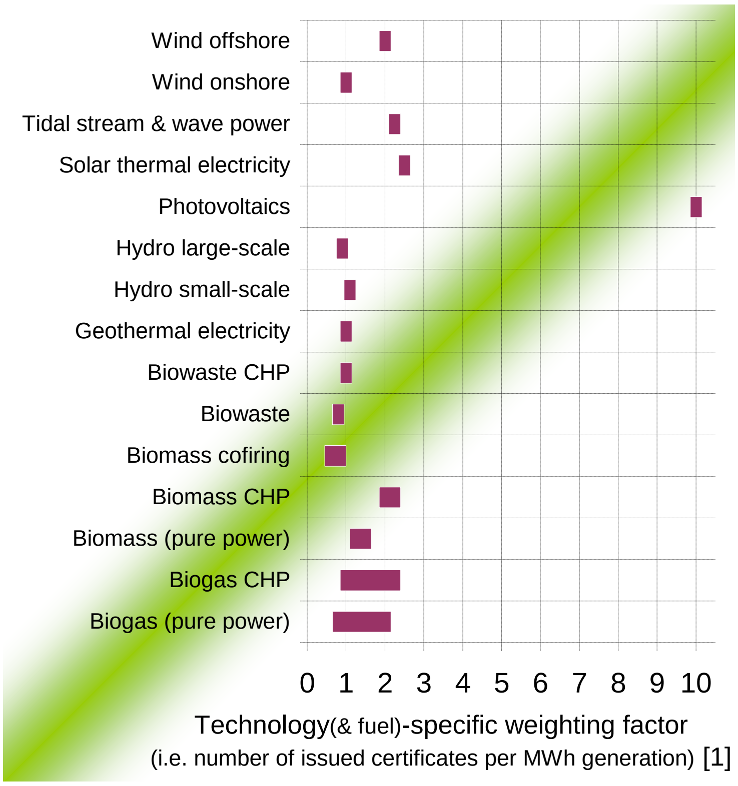

Figure B-5 Technology-specific weighting factors (as assumed for the NAT and EU case in countries which currently already use a trading system to support RES-E)

In general, the assumption is taken that an advanced RES trading system where technology-specification of support is introduced via a banding approach will be

21 Note that in both the NAT and the EU case, the assumption is taken that a technology-specific weighting is introduced in order to achieve the required deployment of novel RES-E options without over-subsidizing mature low-cost RES-E technologies.

applied in the future (from 2011 on). Advanced RES trading systems are used in both the NAT and the EU case in those countries which have already implemented a RES trading system to support RES-E, namely Belgium, Italy, Poland, Romania, Sweden and the UK.

Thereby, different weighting is given to different RES technologies in terms of the number of green certificates / guarantees of origin granted per MWh generation, e.g. wind offshore obtains twice the weighting as wind onshore – aiming to reflect the differing cost level or stages of market maturity, respectively, among the involved RES technology options. This approach would be inline with the proposed adaptation of UK's ROC's scheme. The applied assumptions with respect to technology-specific weighting factors are illustrated in Figure B-5. Thereby, ranges indicate a further graduation of weighting factors by fuel (biomass) or technology (biomass (cofiring), biogas). Please note further that as default a penalty payment of 33 €/TGC is preconditioned.

Generally, in case of RES trading schemes 'policy risk' is assumed to be at a higher level (leading to a WACC of 8.8 %). Thereby, risk refers to the uncertainty about future earnings (on the power as well as on the TGC / GO market).

B.3 Overview on investigated cases

Within the REPAP2020 project three policy scenarios of the future renewable energy deployment in the European Union up to 2020 have been conducted with the ***Green-X*** model. These scenarios are meant to form a basis for establishing the 27 national renewable energy industry roadmaps. The following paragraphs give an overview of the conceptual definition of the scenarios. We start with general remarks followed by a brief definition of the characteristics of each policy case.

B.3.1 General remarks

- The assessed cases follow the concept of *strengthened national support*: We assume a continuation of national RES policies until 2020 which will be further optimised in the future with regard to their effectiveness and efficiency. In particular the further fine-tuning of national support schemes will require in case of both (premium) feed-in tariff and quota systems a technology-specification of RES support. Thereby, in both the NAT and the EU case 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.
- All cases build on a continuation of current RES support (BAU case) for the near future. More precisely, it is assumed that assumed policy changes will become effective by 2011.
- The fulfilment of the target of 20% RES by 2020 is preconditioned both at the EU level as well as at the national level for all cases. Moreover, the ACT case goes beyond that level of ambition and illustrates the impact of an EU-wide proactive RES support.
- The NAT and the EU case, both characterised by a strict target fulfilment, differ by the use / need of / for cooperation mechanisms. In the NAT case these flexibility options represent the exceptional case, while in the EU case they are more commonly used to achieve an EU-wide economically efficient RES exploitation. As a consequence of this, the required RES support will differ among the countries.
- 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 countries

requirement to achieve (at least) 10% RES in the transport sector by 2020. 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.

- For all cases a removal of non-economic barriers (i.e. administrative deficiencies, grid access, etc.) is presumed for the future. More precisely, a stepwise removal of these deployment constraints, which allows an accelerated RES technology diffusion, is conditioned on the assumption that this process will be launched in 2010.
- Results of the scenario calculations comprise details on RES deployment as well as on the associated costs and benefits.

B.3.2 Brief characterisation of each policy track

► *NAT – National target fulfilment:*

Within the NAT 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 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 assure target achievement. As a consequence of above, the required RES support will differ comparatively large among the countries.

► *EU – European perspective:*

In contrast to the NAT case, within the EU 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[22] exploited, cooperation mechanisms as defined in the RES directive would serve as a complementary option. Consequently, the prior aim of the EU scenario is to fulfil the 20% RES target on 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 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.

► *ACT – proactive support – realizable deployment:*

Finally, the ACT scenario depicts an optimistic future with respect to RES exploitation. The assumption is taken that all EU member states apply proactive RES support whereby EU-wide equal incentives are preconditioned for individual RES technologies (e.g. by applying a harmonised but technology-specific premium feed-in system to support RES-E). With EU-wide effective and efficient RES support this scenario ends up with a higher RES exploitation as foreseen in the RES directive.

22 In the EU case economic restrictions are applied to limit differences in applied financial RES support among countries to an adequately low level. 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.

Appendix C – Short characterisation of the *Green*-X model

As in previous projects such as FORRES 2020, OPTRES or PROGRESS the ***Green*-X** model was applied to again perform a detailed quantitative assessment of the future deployment of renewable energies on country-, sectoral- 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 characterisation 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 Vienna University of Technology in the research project "Green-X – Deriving optimal promotion strategies for increasing the share of RES-E in a dynamic European electricity market", a joint European research project funded within the 5th framework program of the European Commission, DG Research (Contract No. ENG2-CT-2002-00607). Initially focussed on the electricity sector, this tool and its database on RES potentials and costs have been extended within follow-up activities to incorporate renewable energy technologies within all energy sectors.*

Green-X *covers geographically the EU-27, and can easily be extended to other countries such as Turkey, Croatia or Norway. It allows to investigate the future deployment of RES as well as accompanying cost – comprising capital expenditures, additional generation cost (of RES compared to conventional options), consumer expenditures due to applied 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 2020, accompanied by concise out-looks for the period beyond 2020 (up to 2030).*

Within the model, the most important RES-Electricity (i.e. biogas, biomass, biowaste, 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 (lignocellulotic 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 energy policy representation. 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. 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.