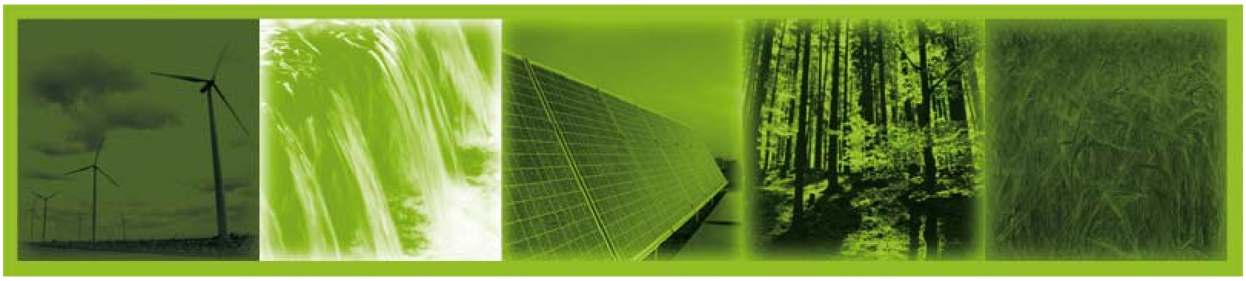
REPAP 2020

Renewable Energy Policy Action Paving the Way towards 2020



Renewable Energy Industry Roadmap for Hungary

Authors: Gustav Resch, Christian Panzer, Sebastian Busch, Mario Ragwitz°, Daniel Rosende°, Jozsef Fucsko*

Vienna University of Technology, Energy Economics Group, Vienna
in cooperation with
°Fraunhofer Institute Systems and Innovation Research, Karlsruhe
*Hungarian Environmental Economics Centre (MAKK)

Energy Economics Group

Fraunhofer ISI

June 2010

Intelligent Energy Europe

REPAP 2020

Renewable Energy Policy Action Paving the Way towards 2020

The project

REPAP2020 - Renewable Energy Policy Action Paving the way towards 2020

Year of implementation:	April 2009 – September 2011
Client:	European Commission, DG TREN; Intelligent Energy for Europe - Programme
Consortium:	
EU partners: EREC (coordinator) EUFORES **Scientific partners:** Fraunhofer ISI Energy Economics Group (EEG) Kuhbier law firm	**National Association partners:** APER, Italy APREN, Portugal BEE, Germany EDORA, Belgium PIGEO, Poland REA, UK SERO, Sweden SER, France
Web:	www.repap2020.org

Remark: This report represents the consolidated edition – i.e. including comments and feedback as received during and after the corresponding REPAP2020 workshop as held on 19th of May 2010 in Budapest, Hungary.

Contact details:

<< Project coordinator >>

European Renewable Energy Council (EREC)

Email: info@erec.org

<< Lead author of this report >>

Gustav Resch

Vienna University of Technology, Institute of Power Systems and Energy Economics, Energy Economics Group (EEG)

Address: Gusshausstrasse 25 / 373-2, A-1040 Vienna, Austria

Phone: +43(0)1/58801-37354

Fax: +43(0)1/58801-37397

Email: resch@eeg.tuwien.ac.at

Content

1 Current situation - RES market status

1.1 Current status of RES

Hungary has promising future potentials for several RES technologies within all energy sectors. However, in general terms the country can be classified as energy-poor, depending on imports for over half of its primary energy needs. Coal, oil and gas reserves are negligible at present and, until the economic contraction during the past decade reduced demand, Hungary also relied upon imports for up to 30% of its electricity demand.

With respect to RES, looking at the resources, bioenergy - especially agricultural biomass – deserves particular attention to play its central role in forming Hungary's future energy mix.

In contrast to above, current RES deployment is at a comparatively low level, focussed on very few technologies. Both in relative and in absolute terms RES in the heat sector provide the highest contribution, whereby (traditional) biomass use is of key importance. RES for power supply are the second largest contributor, referring to biomass and hydropower as dominating sources. 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.

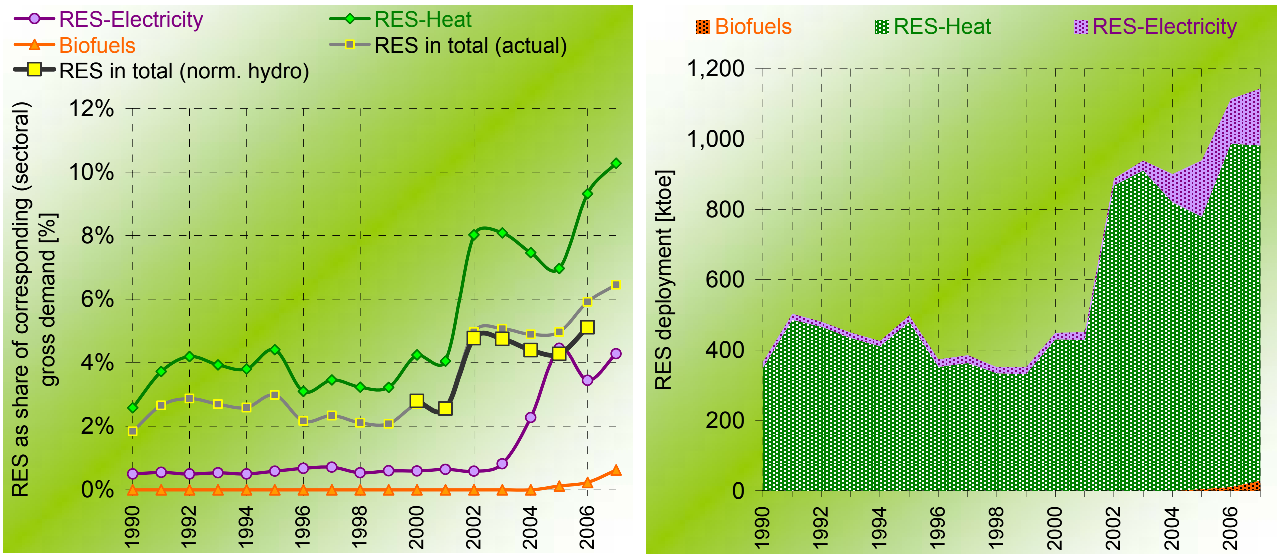


Figure 1 Historic development of RES by sector in Hungary in the period 1990 to 2007 – in relative terms (as share of corresponding demand) (left) as well as in absolute terms (i.e. generated electricity, heat and transport fuels) (right)

Source: Eurostat (2009)

1.1.1 Electricity sector

Geographical conditions in Hungary are favourable for RES development, especially biomass. Between 2003 and 2005, biomass electricity generation increased steeply, mainly through co-firing. The RES-E 2010 target was already achieved in 2005 (3.6%), with the main contribution being from solid biomass. The growth of other RES-E like biogas and wind power has been very modest.

In general, the Paks nuclear power plant delivers over 40% of domestic power generation, and due to the at present negligible RES share fossil fuel plants account for virtually all the remaining 60%. Since the mid-1990s, oil and gas have accounted for more than half of the electricity from fossil fuel plants. Annual gross electricity consumption stood at about 44 TWh in 2007, of which about 12% refers to cogeneration (CHP) plant. Total installed capacity amounted to 8.5 GW (i.e. net capacity by 2007) of which it is estimated that about 3 GW is seriously outdated and inefficient.

Figure 2 provides an illustration of the historic development of electricity generation from RES in Hungary by technology. As applicable therein, biomass co-fired in conventional power plant is currently the dominating RES for power supply. Moreover, the technical and economic potentials for biomass and also biogas still offer promising opportunities for future expansion. Historically, also hydropower has been used, but its future potential appears comparatively limited. Current installed wind capacity is very modest as compared to the available potential.

In general, due to the low ambition level, Hungary is currently well on track to reach its RES-E target of 3.6% gross electricity consumption for 2010 as it outperformed this target each year since 2005. Besides biomass, biogas and wind, geothermal and solar energy also offer significant future potentials.

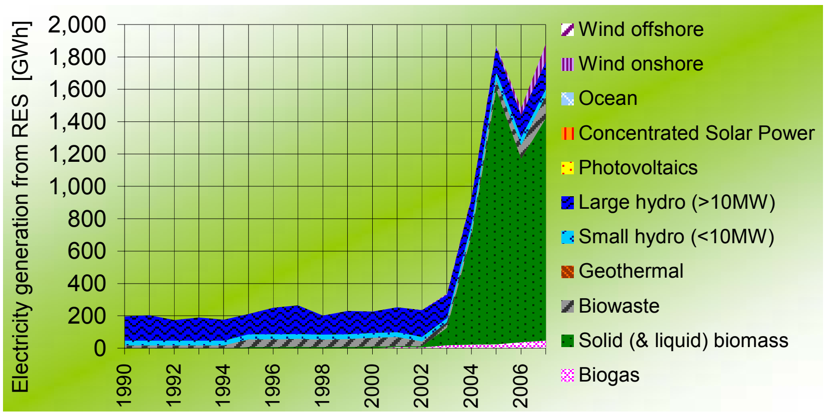


Figure 2 Electricity production from RES in Hungary in the period 1990 to 2007

Source: Eurostat (2009)

1.1.2 Heating (and cooling)

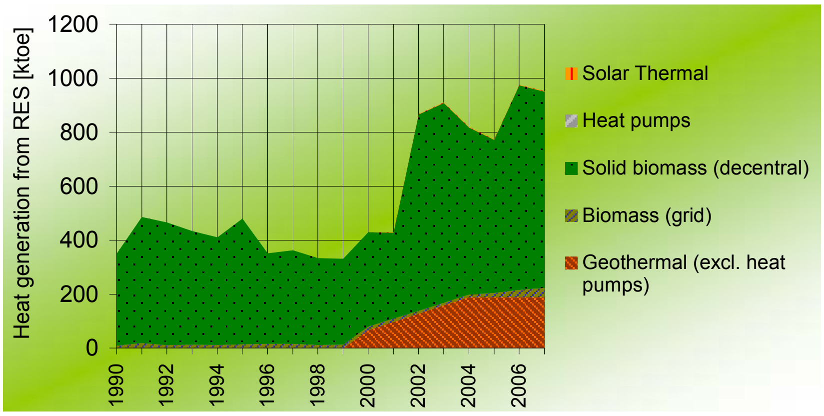


Figure 3 Heat production from RES in Hungary in the period 1990 to 2007

Source: Eurostat (2009)

As stated above, RES in the heat sector provide the highest contribution among all energy sectors to meet Hungary's energy needs. As shown in Figure 3, offering a technology breakdown of the historic development of heat production from RES in Hungary, the use of biomass for heat supply is of key importance. Forestry wastes and sawmill by-products are currently burnt in furnaces to provide heat for the forestry industry or pelletised for retail sale. In general, the supply side for biomass is however 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 realised for example for green houses and district heating.

1.1.3 Transport sector

The potential for biofuels (biodiesel and bioethanol) is far from being well exploited. An initial growth is achieved whereby emphasis was given placed on bioethanol production. In 2009 there was a boom in the use of rape-seed, which disappeared however by 2010.

1.2 Supporting policies for RES[1]

1.2.1 Electricity sector

The main support instrument at national level has been a feed-in tariff (FIT), with additional support by means of investment grants as offered via EU structural funds. Due to the immature state of the RES industry, comparatively low support levels (taking into account tariff height and guaranteed duration) for most RES-E technologies[2] as well as diverging

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

2 Some workshop participants claimed that the currently offered feed-in-tariffs for geothermal and photovoltaics are insufficient. Accordingly, only wind energy and cofiring of biomass was seen as profitable under the current regulatory environment.

interest of the fossil power sector, actual RES-E deployment lags behind expectations. There has been a differentiation in support scheme by technology and size of power plant, placing more focus on areas in line with the overall national economic strategy and competitive advantages.

As explained in detail in Rathmann et al. (2010), Hungary has introduced a non-central-budget-based feed-in-tariff scheme which is expected to remain operational at least until 2020 (Decree Nr. 389/2007, Act Nr. .LXXXVI of 2007 on electricity). According to the regulation the transmission system operator (MAVIR) is statutorily obliged to purchase RES-E and to pay a guaranteed price. For practical implementation, MAVIR established a separate (so called "green") balancing group for RES-E and CHP.

The Hungarian Energy Office (HEO) is responsible for its execution and defines the period of payment and the maximum amount of eligible electricity in compliance with the statutory provisions (§ 11 (3) Act Nr. LXXXVI of 2007).

Establishing a quota system based on tradable green certificates has been identified as a possible alternative to the present support (via feed-in tariffs). However, this does not imply any kind of prescription: The Hungarian Energy Office reports every two years to the government about its opinion in this respect. The government reviews this report and decides on further steps.

The feed-in tariff levels are set annually and are inflation corrected – i.e. tariffs are adjusted to the rate of HUF producer price index (Annex Nr. 13 Decree Nr. 389/2007). However, changes to take out this inflation indexing in order to apply a digressive scheme are currently in discussion. A further major change in the FIT decree is expected for autumn 2010 in line with the targets established by the National Renewable Energy Action Plan.

All applicable RES-E technologies are eligible – with a separate scheme defined for new wind energy projects, awarded through calls for applications (§ 1 (5) Decree Nr. 389/2007). Former permits were already granted for 330 MW wind energy on the basis of the former FIT decree. In 2009 a two-step tender process was announced for 410 MW new wind development. The details of the wind tender were defined in Act Nr. LXXXVI of 2007 and Decree Nr. 33/2009 of Ministry of Transport, Telecommunication and Energy. Submissions were closed in February 2010, and the actual auction phase will take place for those who pass the first round. Results on that were expected initially to be announced in summer 2010. Unfortunately, this process was delayed by the new government. Speculation on the possible cancellation of the tender has created considerable stir in the RES industry and has made investors cautious about investing in Hungary. Clarity on this issue is required promptly if wind is to deliver its share of the RES target.

In principle, the amount of payment under the FIT scheme varies by technology, by plant size, and by day period (solar and wind energy are subject to a single standard tariff). The intraday periods depend on the area concerned and differ for weekdays and weekends/holidays. The most characteristic feature of the system is that both the guaranteed duration of support and the quantity of electricity qualified to receive remuneration through the FIT are defined by HEO, which performs calculation on their expectation of the perceived return on investment on a project by project basis.

Structural grant funding and feed-in tariff can be cumulated (despite former structural funding schemes before 2008 did not allow for this combination) but in this case the guaranteed duration and amount of electricity remunerated by the FIT are reduced in order to avoid excessive support. In 2008 a system of guarantees of origin (GoO) was set up to allow a transparent observation of market development, whereby HEO is responsible for issuing and reviewing GoOs.

1.2.2 Heating (and cooling)

Different investment support instruments are available for renewable heating and cooling. Among them are of highlight:

- Revolving soft loan – Energy Saving Credit Fund
- NEP (National Energy Saving Plan), offering non-refundable grants to private individuals, blocks of flats and building societies to increase the use of RES
- Subsidy – The Panel Programme for Prefabricated Houses (national fund) has been operational in the past, which promoted the modernization and renovation of pre-fabricated buildings to reduce energy demand and increase RES supply. In 2009 this programme was replaced by the Green Investment Scheme (GIS). Besides, the new scheme has been also extended to non-prefabricated buildings. The scheme is funded from sales of government owned Kyoto Protocol based CO_2 rights (AAUs), whereby funds are distributed on an application basis.
- EEOP (Energy and Environmental Operative Program) – the structural funds scheme EEOP provides capital grants for enterprises, public administration bodies and institutions as well as NGOs.
- RES use in agriculture – a subsidy scheme of the Ministry of Agriculture and Rural Development aiming to increase the wide-spread use of RES in agriculture via investment incentives.

In recent years natural gas achieved a strong growth and holds a significant share in the heat market, which will be hard to break considering the decreasing gas prices throughout 2009.

1.2.3 Transport sector

Biofuel production is mostly aimed at export markets. Due to the capital intensive nature of production and a lack of financing, a number of planned biofuel projects have never reached the completion stage.

1.3 Deployment barriers

Three general obstacles can be identified:

- For several RES-E technologies the offered support is seen as insufficient to trigger the required investments. The present feed-in tariff system does not offer sufficiently differentiated support for the various RES-E options and, additionally, the maximum support level is prescribed by the corresponding legislative act which limits political flexibility to reshape support according to the given needs.
- Several administrative barriers for an enhanced RES deployment exist at present which will be discussed in further detail in subsequent sections.
- From the investor's viewpoint the RES policy is classified as unpredictable, whereby specifically a long-term commitment to an enhanced RES exploitation is lacking. The corresponding governmental decision-making process is comparatively complex as several ministries and agencies are responsible for specific aspects relevant for RES. It can be expected that this will remain also in the pronounced new system in the future.

Other barriers involve:

- Natural gas, being in competition to RES-E production, has received support by the administration in the past. Fortunately, corresponding incentives have been phased out.[3] In contrast, the run-time of the nuclear power plant in Paks will be extended. Even an add-on with two new blocks in the near future is under discussion (Remann, 2008c).
- The Hungarian administration recently decided to impose a so called "Robin Hood tax" of 8% on the profits of energy suppliers. The new law also affects power plant suppliers producing RES-E of more than 50 MW (Remann, 2008b).
- Wind energy suffers from several constraints in Hungary, as the capacity of wind produced energy is limited to 330 MW until 2010 due to supposed system stabilityissues This capacity is already fully assigned. Furthermore, according to (Remann, 2008a) the inflexible grid is not laid out for a large amount of additional power from prospective plants. Although the feed-in tariff is granted for the plants,' the regulations are perceived as untransparent and consequentially fail to generate investor confidence. There is also a lack of adequate regional wind maps.
- Solid biomass for electricity generation achieved a substantial deployment in the past. However, this comprised only Co-firing in existing (coal-based) power plants, which represented a low-cost option. However, Hungary ran out of these possibilities, and from now on it should do greenfield investments in this respect, which represents a very expensive option characterised by uncertain revenues. Additionally, the offered support appears insufficient given also the associated regulatory obstacles involved.

---

3 Except some gas bill support for low income households on an application basis.

2 Targets & trajectories

In this section the feasible future deployment of RES in Hungary 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[4] 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:[5]

- 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 the RES exploitation 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 effective RES support also accompanying energy efficiency measures are conditioned which limit the future growth of energy demand.[6] 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

---

4 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.

5 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.

6 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 Hungary

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	%	4.30%	6.04%	6.91%	8.22%	9.96%	**13.00%**

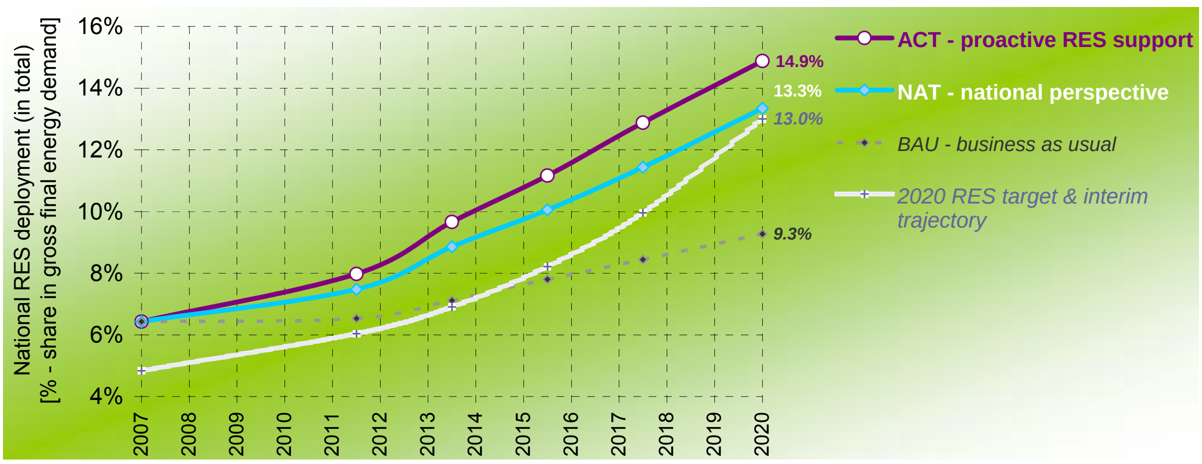
Source: *based on Directive 2009/28/EC*

In 2005 renewable energy sources account for a share of 4.3% of gross final energy consumption in Hungary, which is comparatively low compared to the EU wide average. Until the year 2020, Hungary is due to increase this share to 13%. Compared to the EU wide target of 20% this target can be classified as moderate.

2.2 Sector targets and trajectories[7] [8]

According to both scenarios Hungary will meet and exceed its RES target of 13% in 2020.

As illustrated in Figure 4 this can be expected with assumed policy changes not only for 2020, especially 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 latter years close to 2020. According to the NAT case Hungary would achieve a RES share in gross final energy demand by 2020 of 13.3%, whilst with proactive RES support all over Europe a RES share of 14.9% can be expected for 2020.



7 When comparing the outcomes of this scenario calculation and the official Hungarian forecast document, for a few technologies significant differences can be observed..

8 According to the opinion of some participants of the REPAP workshop, specifically the possibilities for RES in the cooling market are seen as promising, which appears to be insufficiently reflected in the current scenario elaboration.

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 Hungary & 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. Noteworthy, the contribution of RES to Hungary's electricity supply will increase significantly, achieving an about four to almost six times higher RES generation with respect to 2005. The RES-E share in gross electricity demand would rise from 4.4% in 2005 to a level of 19.5% (NAT) to 23.2% (ACT) by 2020. RES for heating and cooling, being the highest contributor today, would also increase substantially to level of about 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 Hungary – 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	18,922	21,111	21,543	21,960	22,296	22,727
Gross final consumption of RES	ktoe	938	1,578	1,909	2,208	2,550	3,032
Share of RES in gross final energy consumption	%	5.0%	7.5%	8.9%	10.1%	11.4%	13.3%
Gross final Consumption of electricity from RES	ktoe	159	327	452	570	706	831
Share of RES electricity in gross final electricity consumption	%	4.4%	8.6%	11.5%	14.1%	17.1%	19.5%
Gross final energy consumption from RES in heating and cooling	ktoe	774	1,056	1,184	1,324	1,473	1,704
Share of RES heating and cooling in gross final heating and cooling consumption	%	7.0%	8.4%	9.3%	10.3%	11.4%	13.0%
Final energy from RES consumed in transport	ktoe	5	195	272	315	371	498
Share of RES in transport	%	0.1%	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 Hungary*

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	18,922	21,111	21,543	21,960	22,296	22,727
Gross final consumption of RES	ktoe	938	1,683	2,081	2,451	2,872	3,382
Share of RES in gross final energy consumption	%	5.0%	8.0%	9.7%	11.2%	12.9%	14.9%
Gross final Consumption of electricity from RES	ktoe	159	339	488	641	798	988
Share of RES electricity in gross final electricity consumption	%	4.4%	8.9%	12.4%	15.9%	19.3%	23.2%
Gross final energy consumption from RES in heating and cooling	ktoe	774	1,150	1,320	1,495	1,702	1,897
Share of RES heating and cooling in gross final heating and cooling consumption	%	7.0%	9.1%	10.4%	11.6%	13.1%	14.5%
Final energy from RES consumed in transport	ktoe	5	195	272	315	371	498
Share of RES in transport	%	0.1%	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[9]

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, Hungary offers the possibilities for a comparatively strong production of biomass. For biomass in total, assuming substantial improvements in the corresponding support framework, according to both cases more than a tripling of present generation levels can be expected up to 2020, whereby all subcategories – i.e. solid biomass[10], biogas and biowaste – would achieve a significant growth.

Table 4 Future contribution of RES to electricity consumption in Hungary – 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	407	1,658	514	2,500	628	3,172	761	3,958	934	4,951	1,135	6,018
Biogas	6	25	39	243	75	465	138	856	234	1,402	316	1,859
Solid (& liquid)	390	1,574	415	1,868	473	2,185	532	2,516	604	2,923	713	3,465
Biodegradable fraction of MSW	11	59	60	388	80	523	90	586	96	625	107	695
Concentrated Solar Power	0	0	0	0	0	0	0	0	0	0	0	0
Geothermal	0	0	11	78	23	157	45	298	83	558	119	811
Hydro, total (excl. pumping)	62	179	130	528	171	703	214	883	248	1,011	248	1,011
Small hydro (<10MW)	12	40	20	68	22	74	22	74	22	74	22	74
Large hydro (>10MW)	50	139	110	460	149	628	192	808	226	937	226	937
Photovoltaic	0	0	12	13	28	29	49	50	84	86	162	167
Ocean	0	0	0	0	0	0	0	0	0	0	0	0
Wind	17	13	310	686	560	1,195	682	1,437	771	1,606	796	1,653
onshore	17	13	310	686	560	1,195	682	1,437	771	1,606	796	1,653
offshore	0	0	0	0	0	0	0	0	0	0	0	0
RES electricity in total	438	1,850	977	3,804	1,410	5,255	1,751	6,626	2,120	8,212	2,460	9,661
Gross electricity consumption		*41,982*		*44,376*		*45,638*		*46,882*		*47,993*		*49,418*
Share of RES electricity in gross final electricity consumption		4.4%		8.6%		11.5%		14.1%		17.1%		19.5%

Source: Green-X model – REPAP2020 scenarios (2009), historic data based on Eurostat (2009)

---

9 According to information received during and after the REPAP workshop the historic data for 2005 (as taken from Eurostat) for large-scale hydropower and PV was classified as wrong. According to MAVIR the installed capacity of large hydro in 2005 amounted to 37 MW, and according to alternative sources PV achieved by 2005 an installed capacity of 100 kW (which when rounded equals however to the expressed value of 0 MW).

Scenarios on the future RES-E deployment as presented in this document were generally classified as appropriate, however the short-term trend (in the years 2011 to 2014) was seen as too optimistic for some technologies (i.e. hydropower, biowaste).

Some technology-specific notes include:

- Specifically with respect to geothermal the overall trend was seen as fairly good, whereby local estimates for the potential of traditional technologies are in size of 60 MW for 2020, while for enhanced geothermal system the European Geothermal Energy Council proposes a maximum feasible potential in size of 300 MW for the similar time frame.
- In contrast to that, for hydropower most participants classified the expressed deployment as too optimistic, which could only be achieved if societal and possibly also environmental constraints with respect to the erection of large-scale dams could be overcome in time.
- An alternative scenario (according to Mr. Pálffy, a representative of Solar System Hungary Kft) for the deployment of PV up to 2020 amounts to 250 MW, which is however according to other participants classified as comparatively optimistic.

10 Please note that expressed capacity figures for solid biomass include both cofiring and dedicated power plants, where solely biomass is used as fuel.

Table 5 Future contribution of RES to electricity consumption in Hungary – 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	407	1,658	535	2,635	683	3,530	850	4,540	1,065	5,784	1,350	7,284
Biogas	6	25	39	244	75	469	139	861	240	1,430	384	2,139
Solid (& liquid)	390	1,574	436	2,003	527	2,538	621	3,093	728	3,728	860	4,450
Biodegradable fraction of MSW	11	59	60	388	80	523	90	586	96	625	107	695
Concentrated Solar Power	0	0	0	0	0	0	0	0	0	0	0	0
Geothermal	0	0	11	78	23	157	45	298	83	558	147	979
Hydro, total (excl. pumping)	62	179	130	528	174	711	219	897	261	1,065	299	1,231
Small hydro (<10MW)	12	40	20	68	24	82	26	88	26	88	26	88
Large hydro (>10MW)	50	139	110	460	149	628	192	808	235	977	272	1,142
Photovoltaic	0	0	12	13	28	29	49	50	84	86	162	167
Ocean	0	0	0	0	0	0	0	0	0	0	0	0
Wind	17	13	310	686	593	1,255	813	1,668	878	1,790	896	1,825
onshore	17	13	310	686	593	1,255	813	1,668	878	1,790	896	1,825
offshore	0	0	0	0	0	0	0	0	0	0	0	0
RES electricity in total	438	1,850	998	3,939	1,501	5,681	1,976	7,453	2,370	9,284	2,854	11,486
Gross electricity consumption		*41,982*		*44,376*		*45,638*		*46,882*		*47,993*		*49,418*
Share of RES electricity in gross final electricity consumption		4.4%		8.9%		12.4%		15.9%		19.3%		23.2%

Source: Green-X model – REPAP2020 scenarios (2009), historic data based on Eurostat (2009)

Another strong contributor to the boost of RES-E is wind energy according to both assessed policy paths. Differences between the cases are comparatively small: According to the NAT scenario wind energy, obviously solely wind onshore, will increase from 17 MW in 2005 to above 796 MW by 2020. When the ACT scenario is assumed, the deployment of wind energy would be slightly higher (896 MW) compared to the NAT case. According to the European Wind Energy Association, the figures indicated by the ACT scenario are too pessimistic: EWEA's low scenario forecasts for 2020 an installed capacity of 900 MW by 2020 and 1.200 MW in a high scenario.

A strong exploitation in forthcoming years would be also expected for hydropower[11], whereby total generation in 2020 would achieve 1 to 1.2 TWh. Only marginally below that geothermal electricity would follow with 0.81 to 0.98 TWh generated electricity (compared to zero as of today). A comparatively lower expansion is projected for photovoltaics.

2.4 Contribution of RES to heating & cooling consumption[12]

In contrast to the above discussed electricity sector, both scenarios show comparatively similar deployment paths at the aggregated level for RES in the sector of heating and cooling. As applicable from Table 6 (NAT) and Table 7 (ACT) this is also valid for the

---

11 As stated in prior, most participants classified the expressed deployment of hydropower as too optimistic, which could only be achieved if societal and possibly also environmental constraints with respect to the erection of large-scale dams could be overcome in time.

12 The following technology-specific comments on the scenarios of the future RES-H deployment were received during and after the REPAP workshop:

- A significant difference to the official Hungarian forecast document is applicable for biogas with respect to the heat use (i.e. as classified in the modelling work as by-product to electricity production), while the electricity production is in a similar range. According to the view of some participants the direct feed-in of biogas into the natural gas grid was seen as alternative promising future option in comparison to the use in (small-scale) CHP plants. This option was however neglected in the model-based assessment.
- According to the some participants heat pumps would offer a significant future potential.

individual RES technologies – with one exception: Geothermal energy for grid connected heat supply is dependent on the underlying policy assumptions. Only with strong proactive support 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 Hungary – 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.	583	6,252	807	6,860	919	7,562	1,041	8,300	1,171	9,094	1,326
Biogas	n.a.	1	17	2	27	3	47	4	79	7	139	11
Solid (& liquid)	n.a.	582	5,984	750	6,496	842	7,139	954	7,822	1,076	8,517	1,218
Biodegradable fraction of MSW	n.a.	0	252	56	337	74	375	83	398	88	437	98
Geothermal (excl. heat pumps)	n.a.	189	869	234	869	234	869	234	869	234	1,162	278
Solar Thermal	n.a.	2	193	9	391	18	593	27	823	37	1,217	55
Heat pumps	n.a.	0	54	7	117	14	180	22	247	31	359	44
RES heating and cooling in total	n.a.	774	7,368	1,056	8,237	1,184	9,204	1,324	10,238	1,473	11,832	1,704
Gross final heating and cooling demand		*11,116*		*12,576*		*12,712*		*12,844*		*12,951*		*13,089*
Share of RES heating and cooling in gross final heating and cooling consumption		7.0%		8.4%		9.3%		10.3%		11.4%		13.0%

Note: *n.a. … not applicable*

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

Table 7 Future contribution of RES to heating and cooling consumption in Hungary – ACT scenario

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.	583	6,254	808	6,871	921	7,607	1,048	8,358	1,179	9,217	1,341
Biogas	n.a.	1	17	2	29	3	49	4	83	7	144	11
Solid (& liquid)	n.a.	582	5,985	750	6,505	844	7,182	960	7,877	1,084	8,636	1,233
Biodegradable fraction of MSW	n.a.	0	252	56	337	74	375	83	398	88	437	98
Geothermal (excl. heat pumps)	n.a.	189	1,399	327	1,593	367	1,747	399	2,023	456	2,023	456
Solar Thermal	n.a.	2	194	9	394	18	593	27	823	37	1,217	55
Heat pumps	n.a.	0	54	7	117	14	180	22	247	31	359	44
RES heating and cooling in total	n.a.	774	7,900	1,150	8,974	1,320	10,127	1,495	11,451	1,702	12,816	1,897
Gross final heating and cooling demand		*11,116*		*12,576*		*12,712*		*12,844*		*12,951*		*13,089*
Share of RES heating and cooling in gross final heating and cooling consumption		7.0%		9.1%		10.4%		11.6%		13.1%		14.5%

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 Hungarian 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, Hungary is expected to act as exporter but only with comparatively small volumes.

Bioethanol will make up around 55% of the domestic biofuel generation, and biodiesel[13] complement the majority of the remaining gap. Besides, it is expected that second generation biofuels will provide only a marginal contribution by 2020.

Table 8 Future contribution of RES to transport fuel consumption in Hungary – 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.	5	260	177	381	261	412	282	412	282	410	280
Biodiesel	n.a.	0	35	24	80	55	139	95	220	151	311	214
2nd generation biofuels	n.a.	n.a.	0	0	0	0	0	0	0	0	16	11
Net biofuel imports	n.a.	n.a.	n.a.	-6	n.a.	-44	n.a.	-62	n.a.	-61	n.a.	-7
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.	5	295	195	462	272	551	315	632	371	737	498
Transport demand (diesel and gasoline)		*3,916*		*4,399*		*4,566*		*4,723*		*4,835*		*4,979*
Share of RES in transport		0.1%		4.4%		6.0%		6.7%		7.7%		10.0%

Note: n.a. … not applicable

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

13 According to the expert view of some participants of the REPAP workshop the Hungarian climate appears not suitable for rape seed production. Consequently, the expressed figures for biodiesel were classified as unrealistic.

3 Measures for achieving the targets

3.1 Policy measures[14]

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 Hungary'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 Hungarian situation under the FIT regime as implemented today it appears necessary to increase investor's confidence. In this context, the following measures appear of relevance:

- In general, a long-term commitment to an enhanced RES exploitation should be provided by policy makers. This might involve a clear long-term energy strategy involving RES as an important element. Besides, a restructuring of competences and an increase of transparency with respect to the support conditions for the available RES technology options are recommended.
- More specifically with respect to the FIT regime it appears beneficial to offer clear structured tariffs for all available RES-E technologies which should no longer be calculated on a project by project basis. In this context, for several RES-E technologies the currently offered support can be classified as insufficient to trigger the required investments. Consequently, a further differentiation of support by technology including an increase of tariff height and / or guaranteed duration where adequate would be recommended.

14 With respect to future policy measures for supporting RES deployment in Hungary the World Wildlife Fund (WWF) gave the following statements as feedback to this present study:

"The National Renewable Energy Action Plan should take the available European Union funds into consideration. For the time being we are familiar with the available funds until 2013 since that is the end of the present EU budget period. We know how much money can be obtained and what activities are being supported. It is strongly advisable to fit the planned renewable technologies (in the future) and investments to the funds that we can use until 2013. For instance biomass production and processing as well as biogas technologies are supported by the Agricultural Ministry (FVM). It is very difficult to change or convert the supporting system because in case of a completely new decision the present financial supports can be lost."

"The proposed financial system: Environmental and nature conservation principles and targets should be involved in the financial support methods in a more effective and visible way since renewable energy production is not equivalent to nature conservation and environmental protection. There is a need for a new separate energy operative programme (i.e. currently there is a so called Environmental and Energy Operative Programme in the New Hungary Development Plan to distribute EU and domestic funds via investment subsidies) but it is also indispensable to launch a new environmental and energy targeted financial support which implies real environmental indicators. It is crucial to support projects which have synergic impacts including environmental protection and nature conservation. The introduction of a green heat support scheme is also recommended as there is not enough available financial support for renewable based heat production."

Moreover, 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 to mention that a removal of previously identified[15] and also subsequently discussed non-economic deployment barriers is of crucial relevance for Hungary to assure a successful RES deployment in the mid- to long-run.

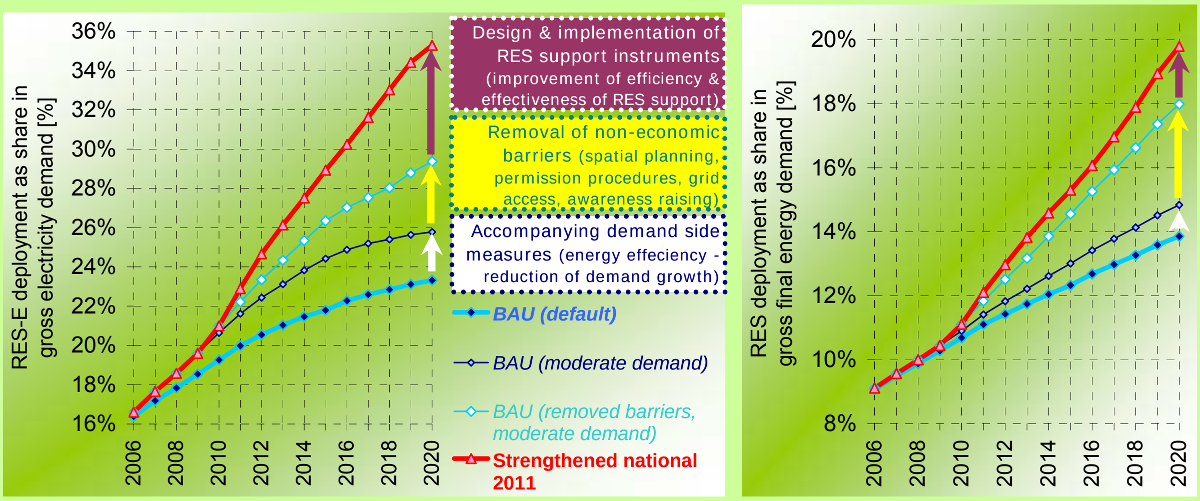
Remark: A closer look at the European level – Summary of key outcomes of a comprehensive policy assessment to meet Europe's commitment on 20% RES by 2020. Source: *futures-e* project (see Resch et al., 2009)

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.

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



---

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

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 4 (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.

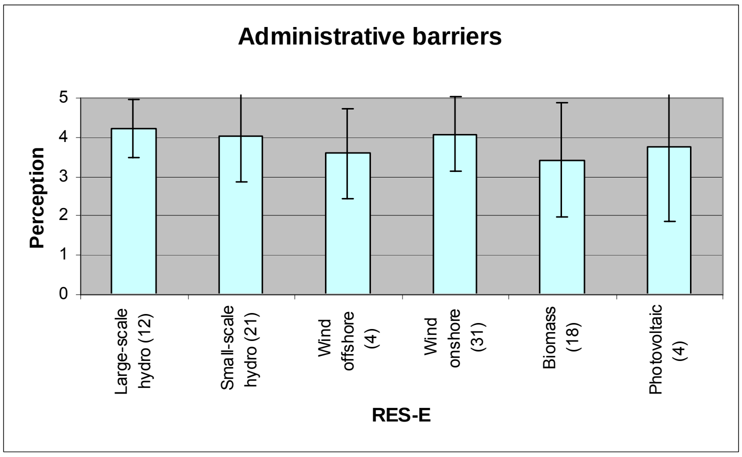


Figure 6 Perception of administrative barriers

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.

The current authorisation process in Hungary may last for several years, a large number of different authorities (i.e. 30 to 40) have to be involved, and it is classified as very expensive. According to some experiences the technical knowledge on the specifics of most RES-E technologies and appropriate human capacities are missing in the involved authorities. Besides, also the decision making process is developed in a too weak and often unclear manner.

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

Certainly the specifics of different RES technologies should be considered for the design of authorization procedures.

► *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.

The following comments on the current situation with respect to spatial planning in Hungary were provided at the REPAP workshop:

- There is no national regulation on installation of RES power plants, only the installation of wind power plants is regulated but in an inappropriate manner.
- Hungary has a "National Spatial Plan". All correspondingly relevant RES options (i.e. wind, geothermal, photovoltaics) should be integrated in this document.
- At present regulations exist partly at the local level, but there is a clear need to have them in a consistent manner at the national level.

► *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 authorisation procedures are highly recommended, and there included are currently no obligatory response periods for the authorities involved. These need to be incorporated in such procedures.

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

Generally, a high number of authorities are involved to obtain the final authorisation. 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.

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.

► *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 for housing companies 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).

The following comments on the current situation with respect to measures concerning buildings for the case of Hungary were provided at the REPAP workshop:

- In Hungarian buildings the energy demand for heating is comparatively high (i.e. 250 kW/m2/year, corresponding to 170% of the EU's average). Even most of the new buildings belong only to the "C" category. Consequently, emphasis has to be put on decreasing the energy demand of buildings. According to some participants this is seen as important precondition for an enhanced and economically efficient exploitation of RES for heating purposes.
- Moreover, according to some participants it was seen as simpler to regulate and control the size and quality of insulation than to control the rate of RES use for heating purposes.
- One promising technology option was however identified: cooling/air-conditioning with solar energy.

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 of end users on renewable energy and energy efficiency measures. 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.[16]

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 contribute to identify strengths and weaknesses and allow to 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.[17] 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.

The following comments on how specific information should be targeted to different groups for the case of Hungary were provided at the REPAP workshop:

- There should exist a transparent and comprehensive website that collects and displays all support possibilities. The current support possibilities are displayed as fragmented as the system is implemented.
- On the website of the Hungarian Energy Centre, i.e. a state-owned agency, some information about support and tender possibilities as well as articles for professionals and consumers is applicable.
- The website of the National Development Agency also provides information on investment subsidies for RES support (in the Environment and Energy Operative Programme).
- Information brochures exist, but they are only suitable for a start-up.

► *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?*

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

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

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.

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.

The following comments referring to the Hungarian situation on the addressed topic were provided at the REPAP workshop:

- At present a lack of reliable information can be identified.
- It was seen as important to provide targeted information to relevant stakeholders (e.g. ministries, profession chambers and even energy agencies).
- Demonstrations projects were seen as appropriate dissemination and information tool as they appear more tangible than website info or brochures.

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?*

Directive 2009/28/EC, specifically article 16, defines already the corresponding regulation (at the EU level), but this needs to be implemented in national law.

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

According to the view of some workshop participants the Directive 2009/28/EC, specifically article 16, provides already the corresponding regulation (at the EU level).

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

The following comments referring to the Hungarian situation on the addressed topic were provided at the REPAP workshop:

- The access should be guaranteed, but the distribution operator may not offer the simplest solution, or does not allow access to the closest point. As explanation for that e.g. technical and economic problems or safety concern were named, which has to be accepted by the project developer. This underpins the lack of transparency in this respect. Besides, the distribution operator may also take an advantage because of its natural monopoly position. Additionally, the information gap was seen as hindrance – i.e. a digital map of the distribution networks is hardly available and, besides, the existing database appears incomplete, especially on middle and low voltage level.
- With respect to system stability the inefficient regulation of the power system was seen as a key problem – including also an inefficient reserve market. The power system can be classified as inflexible to absorb intermittent power. Besides, the high share of base load power provided by the inflexible nuclear power plant was seen as hindrance. However, the differentiation of FIT levels, where lower support is provided during night hours proved to be an effective incentive[18].
- In the new tendering system for wind energy it is classified as advantage if the wind power plant would be capable to be down-regulated. This does however not represent an advantage for an investor as it definitely increases uncertainty and reduces possibly earnings. Besides, also from a societal viewpoint an artificial reduction of the possible contribution of wind energy to target fulfilment cannot be classified as beneficial.

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

18 Time differentiation of FIT has been mainly effective for natural gas fuelled CHP.

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.[19] 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.[20]

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 Hungarian circumstances offers a significant potential for cost reduction.[21]

Consequently, if Hungary 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)).

Table 9 Weighted average (2011 to 2020) total remuneration for yearly new RES installation in Hungary – 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$_{RES}$	94.2	128.4
(Solid & liquid) Biomass	€/MWh$_{RES}$	101.3	135.5
Biowaste	€/MWh$_{RES}$	85.3	108.9
Geothermal electricity	€/MWh$_{RES}$	84.4	152.2
Hydro large-scale	€/MWh$_{RES}$	74.1	121.1
Hydro small-scale	€/MWh$_{RES}$	82.6	126.0
Photovoltaics	€/MWh$_{RES}$	264.5	371.1
Solar thermal electricity	€/MWh$_{RES}$	0.0	0.0
Tide & Wave	€/MWh$_{RES}$	0.0	0.0
Wind onshore	€/MWh$_{RES}$	87.8	107.0
Wind offshore	€/MWh$_{RES}$	0.0	0.0
RES electricity (average)	€/MWh$_{RES}$	95.7	132.7
RES heating and cooling (district heat)	€/MWh$_{RES}$	63.4	88.4
RES heating and cooling (decentral)	€/MWh$_{RES}$	90.9	119.1
Biofuels (average)	€/MWh$_{RES}$	105.1	105.1

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

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

20 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.

21 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.

3.3 Increasing biomass availability[22]

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 comparatively small. According to the scenario calculation biomass availability and consequently also use in terms of primary energy is expected to rise to a level of 2.7 to 2.9 Mtoe until 2015, and this increase is then prolonged to a range of 3.9 to 4.3 Mtoe in 2020.[23] Hungary's significant biomass potentials in the forestry and even more important in the agricultural sector decrease the need for biomass imports to a negligible level under all scenarios.

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

Expected availability of biomass for energy purposes	Unit	NAT (National target fulfillment)				ACT (proactive support)			
		2015		2020		2015		2020	
		Domestic	Import	Domestic	Import	Domestic	Import	Domestic	Import
Agricultural products	ktoe	574	33	792	70	574	33	832	70
Agricultural residues	ktoe	515	0	1,163	0	643	0	1,493	0
Forestry products	ktoe	649	0	724	0	647	0	724	0
Forestry residues	ktoe	559	13	571	20	559	13	571	20
Biowaste	ktoe	398	0	573	0	399	0	581	0
Biomass in total	ktoe	2,741		3,912		2,868		4,291	

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

22 The following comments were provided at the REPAP workshop on the addressed topic:

- According to some participants the growth potential cannot be neglected, but production and use of biomass should be optimized and rationalized
- In general, decentralization – i.e. smaller scale biomass projects – wre classified as more sustainable.
- The range of feasible biofuel options should be extended (for example by considering agricultural by-products) – but for combustion of agricultural residues the technology is seen as non-mature. Accordingly, innovation would be important (but the offered support can be classified as insufficient).
- A clear spatial planning would be important with respect to the enhanced use of biomass.

Additionally, the World Wildlife Fund (WWF) provided the following statement on sustainability standards for biomass projects: "No doubt that biomass potential is fairly visible in Hungary and it has the quickest and direct effects on the share of RES but also biomass can have the most harmful impacts on nature. Since 2002 there have been introduced several biomass based renewable energy projects in Hungary. These power plants are focusing on electricity production from forestry biomass which should be constantly converted into a more green and mixed approach. It is absolutely necessary to support the present system in a temporary period while building up new biomass projects. The existing and inefficient power plants shouldn't be closed down immediately but switched from forestry biomass to other sources such as agricultural by-products or energy plantations. There is a strong need for more efficient and small-scale power plants which are able to generate electricity and heat (CHP). It is highly recommended to support the different technologies and different sourced biomass projects with different support prices depending on their real impacts on the environment, economy or job creation. It is also substantial to work out and implement new sustainability standards regarding biomass utilization as for this moment these conditions are hidden and a cheating in this respect appears easy. We cannot see who is responsible for compiling biomass sustainable standards and how these will be implemented in reality. These criteria should clarify and include the origin, quantity and sustainability conditions of the future biomass production."

23 According to the opinion of a few participants of the REPAP workshop these figures were seen as high, specifically when compared to the official figures of the Hungarian RES forecast document.

3.4 Flexibility/Joint projects/European perspective

Table 11 Excess and deficit production of RES compared to the indicative trajectory in Hungary – 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	303	420	404	331	78
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 Hungary – 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	408	592	647	653	427
Deficit	ktoe	0	0	0	0	0

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

Table 11 (NAT) and Table 12 (ACT) depict that Hungary 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 Hungary'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 Hungary's excess would then be required at the European level and the expected income in 2020 would compensate a part of Hungary's yearly support expenditures for all new RES (installed 2006 to 2020).

A few comments with respect to the possible use of flexibility measures from the Hungarian perspective as received during the workshop include:

- Joint projects were seen as feasible, if Hungary would have identified its RES potentials and possibilities in a detailed manner (i.e. location by location) However, potentials have not been assessed on regional/local level, and also the cost of RES technologies have not been assessed well. Accordingly, this assessment needs to be done in order to assure the fulfilment of Hungary's own RES target.
- A possibility for cross-border projects, for example, with respect to geothermal energy has been acknowledged.
- With respect to statistical transfers the uncertainty on future prices and the overall demand for them was seen as major obstacle.
- In general, it was concluded that a careful monitoring of the future evolution of co-operation mechanisms and their use would appear beneficial.

3.5 Estimated costs & benefits of RES policy support measures

The accelerated RES deployment in Hungary 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 summarised 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 resulting costs per year throughout the period 2006 to 2020– i.e. capital expenditures[24], 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 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, regional or industrial development were neglected in this assessment.[25]

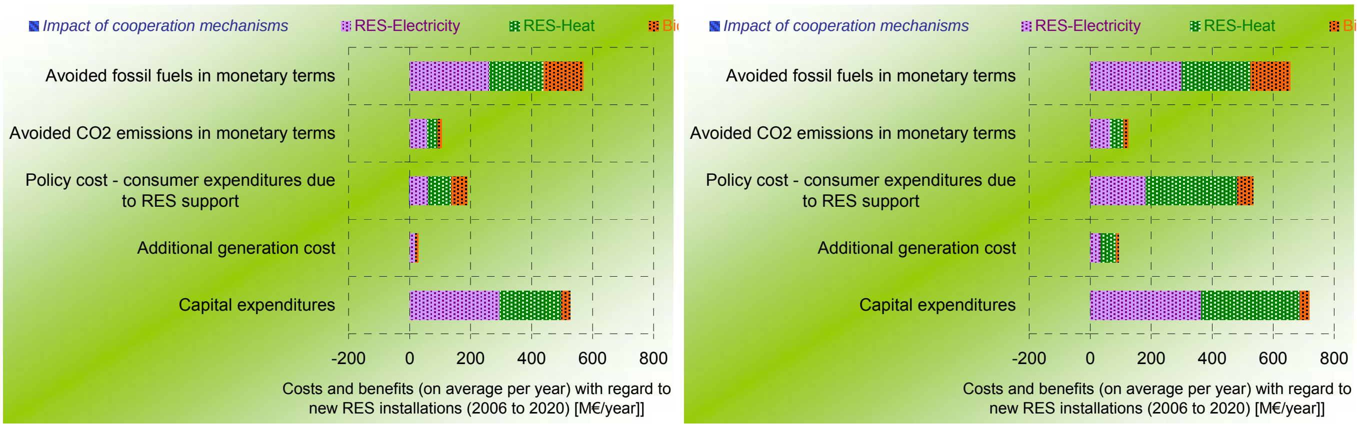


Figure 7 *Overview on costs and benefits (on average (2006 to 2020) per year) with regard to new RES (installed 2006 to 2020) in Hungary according to the NAT (left) and the ACT case (right)*

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

3.5.1 Expected renewable energy use

Until 2020, RES use in Hungary will rise by 223% compared to 2005 and will reach 3,032 ktoe according to the NAT scenario. The corresponding figure for the ACT case is an increase by 261% and a deployment of 3,382 ktoe.

---

24 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.

25 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).

Under each scenario, RES for heating and cooling will be the main contributor to the renewable energy production – with a share of 56% of all RES consumed in Hungary in 2020 according to both the NAT and the ACT case. Renewable electricity will follow as second largest contributor, especially in the ACT case the expansion in the period 2006 to 2020 is of remarkable magnitude. RES-E would then account for 29% of all RES in 2020. In absolute terms the transport sector will remain of lower importance, with about 16% (14%) 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 Hungary's energy sector. Under the NAT case new RES installations (in the period 2006 to 2020) will account for an avoidance of about 7.7 Mt CO_2 by 2020. The corresponding figure for the ACT case is 9.2 Mt CO_2.[26]

A significant amount of this CO_2 reduction (i.e. almost half of total) will take place in the electricity sector caused by the carbon intensity of Hungary's fossil power supply (where the substitution can be expected). Obviously, the remaining part – i.e. 51 (ACT) to 52% (NAT) of total - refers to RES in the heat and transport sector. This will contribute significantly to achieve Hungary 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 Hungary 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, avoided fossil fuels due to new RES installations (2006 to 2020) are in magnitude of 3.6 Mtoe in 2020. Monetary expressed this amounts to a lump sum of 1.6 billion €.[27] According to the NAT scenario fossil fuel savings are in size of 3.1 Mtoe or 1.4 billion € by 2020.

In energy terms, 47 (NAT) to 49% (ACT) of all savings by 2020 will take place in the electricity sector. Corresponding avoidance of fossil fuels in the heat sector will be in size of 36% of the total according to both cases, and obviously the remaining part (14 to 17% of total) refers to biofuels in the transport sector.

---

26 For details on the applied methodology with respect to the calculation of expressed figures we refer to Annex B of this report

27 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.

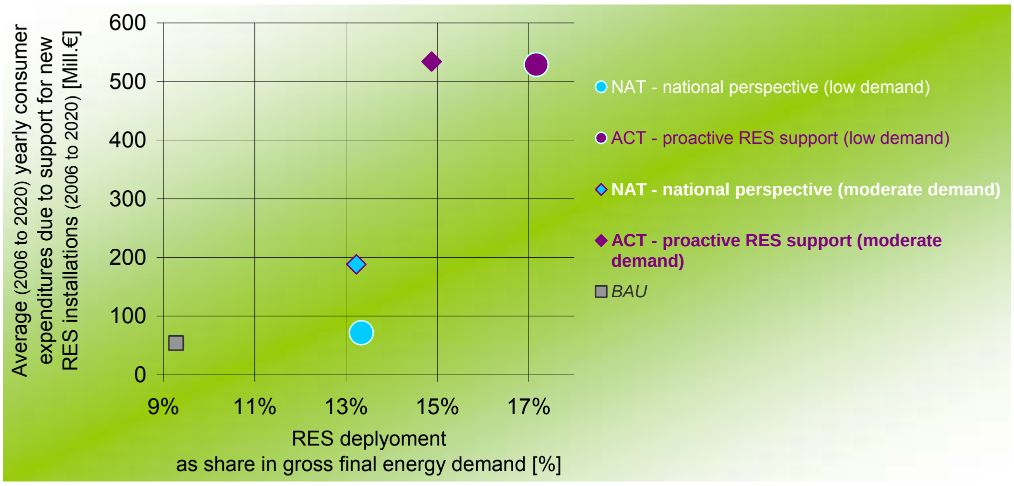
3.5.4 Expected capital expenditures

Capital expenditures, i.e. the required investments in RES technologies, will cumulate to 7.9 billion € until 2020 according to the NAT scenario. In the ACT case this will sum up to 10.8 billion €. In both cases the electricity sector will be responsible for the largest part of these expenditures, but investments in RES-H are only marginally below. Capital expenditures for biofuel refineries amount to 4 to 6% of the total within both cases.[28]

Financing of RES projects is associated with several problems at present according to the viewpoint of various participants. Commercial loans are available, but achieving the required equity share (as also required to receive investment support) represents a major hindrance. One of the reasons is that only the state owned Hungarian Development Bank is authorised to give loans that can be accounted in the equity part of the financing of such investments, but its conditions are difficult to meet.

3.5.5 Expected costs of achieving the 2020 target

► *Policy cost – consumer expenditures due to RES support[29]:*



28 Alternative figures for the required CAPEX according to the scenarios of the Energy Office (RES research project) range from 4.9 (lowest cost solution) to 10.5 billion € (climate aware solution).

29 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.

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 Hungary 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 188 M€ on average per year in the period 2006 to 2020 according to the NAT case. This figure includes revenues in size of 1.4 M€ (on average per year) from selling 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.[30]

As EU wide harmonised RES support assumptions are not tailored to the Hungarian 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 535 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 Hungary 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 27.5 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 94 M€ on average per year.

30 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.

4 References

European Commission (2008): PROGRESS - Promotion and Growth of Renewable Energy Sources and Systems. Final Report.

European Parliament and Council (2009): Directive of the European Parliament and the Council on the promotion of the use of energy from renewable sources. Directive 2009/28/EC. Brussels, 23 April 2009.

European Bank for Reconstruction and Development (2008): Hungary country fact sheet. www.ebrd.com/pubs/factsh/country/Hungary.pdf (accessed 08.12.2008)

Eurostat. (2009). Eurostat. Retrieved 2009, from http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home

Fraunhofer ISI; EEG; Rütter + Partner; LEI; SEURECO. (2009). EmployRES - The impact of renewable energy policy on economic growth and employment in the European Union. Retrieved July 2009, 17, from http://ec.europa.eu/energy/renewables/studies/renewables_en.htm

NTUA (2007a): PRIMES Baseline scenario (for the EU27) – conducted by National Technical University of Athens, 31 July 2007.

NTUA (2007b): PRIMES Efficiency case (for the EU27) – conducted by National Technical University of Athens, 9 August 2007.

NTUA (2008): PRIMES scenario on meeting both EU targets by 2020 – i.e. on climate change (20% GHG reduction) and renewable energies (20% RES by 2020) ('NRVCVnsat') – conducted by National Technical University of Athens, 25 January 2008.

Ragwitz, Mario; J. Schleich, C. Huber, T. Faber, M. Voogt, W. Ruijgrok, P. Bodo (2005): FORRES 2020 – Analysis of the renewable energy's evolution up to 2020, Final report of the research project FORRES 2020 of the European Commission, DGTREN (Tender Nr. TREN/D2/10-2002).

Ragwitz, Mario; A. Held, G. Resch, T. Faber, R. Haas, C. Huber, P.E. Morthorst, S.G. Jensen, R. Coenraads, M. Voogt, G. Reece, I. Konstantinaviciute, B. Heyder (2007): OPTRES – Assessment and optimisation of renewable energy support measures in the European electricity market; Final report of the research project OPTRES, with support from the European Commission, DGTREN under the Intelligent Energy for Europe - Programme (Contract No. EIE/04/073/S07.38567), Karlsruhe, Germany, 2007.

Ragwitz, Mario; W. Schade, B. Breitschopf, R. Walz, N. Helfrich, M. Rathmann, G. Resch, T. Faber, C. Panzer, R. Haas, C. Nathani, M. Holzhey, P. Zagame, A. Fougeyrollas, I. Konstantinaviciute (2009): Employ-RES - The impact of renewable energy policy on economic growth and employment in the European Union. Final report of the research project Employ-RES of the European Commission, DGTREN (Tender Nr. TREN/D1/474/2006).

Rathmann, Max; T. Winkel, E. Stricker, M. Ragwitz, A. Held, B. Pflueger, G. Resch (2010): Pre-up version of the forthcoming report "Renewable Energy Policy Country Profiles". A report compiled within the European research project Re-Shaping, with support from the European Commission, DGTREN under the Intelligent Energy for Europe – Programme (Contract no.: IEE-08-517). Uetrecht, Netherlands, 2010 (forthcoming).

Remann, C. (2008a): Ungarn bereitet Ausbau von Kernkraftwerk vor. Report from BFAI, Germany (in German). https://www.bfai.de/fdb-SE,MKT200810088005,Google.html (accessed 10.12.2008).

Remann, C. (2008b): Ungarn belegt Energieversorger mit "Robin-Hood-Steuer". Report from BFAI, Germany (in German). https://www.bfai.de/ext/Einzelsicht-Export/DE/Content/__SharedDocs/Links-Einzeldokumente-Datenbanken/fachdokument,templateId=renderPrint/MKT200811128013.pdf (accessed 10.12.2008)

Remann, C. (2008c): Erneuerbare Energien stecken in Ungarn noch in den Kinderschuhen. Report from BFAI, Germany (in German). https://www.bfai.de/fdb-SE,MKT200805168001,Google.html (accessed 10.12.2008).

Resch Gustav; C. Panzer, M. Ragwitz, T. Faber, C. Huber, M. Rathmann, G. Reece, A. Held, R. Haas, P.E. Morthorst, S. Grenna Jensen, L. Jaworski, I. Konstantinaviciute, R. Pasinetti, K. Vertin (2009a): futures-e – Action plan on deriving a future European Policy for Renewable Electricity; Concise final report of the research project futures-e, with support from the European Commission, DG TREN, EACI under the Intelligent Energy for Europe – Programme (Contract No. EIE/06/143/SI2.444285). Vienna, Austria, 2009.

Appendix A – Key results on the future deployment of RES up to 2020 in Hungary (*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 Hungary, 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: Hungary**

Proposed RES target for 2020:	13%

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	3,610	3,779	3,816	3,924	4,031	4,127	4,249
Heat sector	RES-H	ktoe	11,116	9,273	12,576	12,712	12,844	12,951	13,089
Transport sector	RES-T	ktoe	4,196	4,673	4,719	4,907	5,085	5,218	5,389
Total		ktoe	18,922	17,725	21,111	21,543	21,960	22,296	22,727
Diesel and gasoline	*RES-T*	*ktoe*	*3,916*	*4,361*	*4,399*	*4,566*	*4,723*	*4,835*	*4,979*

° 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	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
RES-Electricity	RES-E	ktoe	159	158	327	452	570	706	831	327	439	560	692	832	339	488	641	798	988
RES-Heat	RES-H	ktoe	774	953	1,056	1,184	1,324	1,473	1,704	1,040	1,171	1,312	1,460	1,644	1,150	1,320	1,495	1,702	1,897
Biofuels	RES-T	ktoe	5	29	195	272	315	371	498	195	272	315	371	498	195	272	315	371	498
RES TOTAL		ktoe	938	1,140	1,578	1,909	2,208	2,550	3,032	1,562	1,882	2,187	2,524	2,974	1,683	2,081	2,451	2,872	3,382
RES share on gross final energy demand		%	5.0%	6.4%	7.5%	8.9%	10.1%	11.4%	**13.3%**	7.4%	8.7%	10.0%	11.3%	**13.1%**	8.0%	9.7%	11.2%	12.9%	**14.9%**

New* RES deployment (installed after end of 2005)		[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
RES-Electricity	RES-E	ktoe		53	205	330	448	584	709	205	317	438	570	710	217	367	519	677	866
RES-Heat	RES-H	ktoe		217	336	528	730	938	1,242	320	515	718	926	1,183	430	664	901	1,168	1,435
Biofuels	RES-T	ktoe		24	187	264	307	363	491	187	264	307	363	491	187	264	307	363	491
RES TOTAL		ktoe		293	728	1,122	1,484	1,886	2,442	712	1,096	1,463	1,860	2,384	834	1,295	1,727	2,208	2,792
RES (new) share on gross final energy demand		%		1.7%	3.4%	5.2%	6.8%	8.5%	10.7%	3.4%	5.1%	6.7%	8.3%	10.5%	3.9%	6.0%	7.9%	9.9%	12.3%

* 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	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
Default (purely domestic) RES deployment		*ktoe*			*1,594*	*1,975*	*2,307*	*2,661*	*3,110*	*1,578*	*1,949*	*2,285*	*2,635*	*3,052*	*1,699*	*2,148*	*2,550*	*2,983*	*3,460*
Default RES share on gross final energy demand		*%*			*7.6%*	*9.2%*	*10.5%*	*11.9%*	***13.7%***	*7.5%*	*9.0%*	*10.4%*	*11.8%*	***13.4%***	*8.1%*	*10.0%*	*11.6%*	*13.4%*	***15.2%***
Default policy cost - consumer expenditures		*M€*			*292*	*339*	*309*	*342*	*456*	*171*	*221*	*177*	*200*	*302*	*829*	*784*	*1,016*	*1,113*	*1,323*
Impact of Intra-European biofuel trade (incorporated in results named as "national RES deployment")																			
Adapted RES deployment		ktoe			1,578	1,909	2,208	2,550	3,032	1,562	1,882	2,187	2,524	2,974	1,683	2,081	2,451	2,872	3,382
Adapted RES share on gross final energy demand		%			7.5%	8.9%	10.1%	11.4%	**13.3%**	7.4%	8.7%	10.0%	11.3%	**13.1%**	8.0%	9.7%	11.2%	12.9%	**14.9%**
Adapted policy cost - consumer expenditures		M€			283	315	296	331	443	163	197	164	190	289	820	760	1,003	1,102	1,310
Impact of Intra-European biofuel trade & cooperation mechanisms																			
Adapted RES deployment		ktoe			1,575	1,908	2,207	2,549	3,006	1,557	1,877	2,175	2,484	2,956	1,680	2,080	2,450	2,872	3,381
Adapted RES share on gross final energy demand		%			7.5%	8.9%	10.1%	11.4%	**13.2%**	7.4%	8.7%	9.9%	11.1%	**13.0%**	8.0%	9.7%	11.2%	12.9%	**14.9%**
Adapted policy cost - consumer expenditures		M€			281	314	296	331	434	160	195	158	167	281	818	759	1,003	1,102	1,309

REPAP 2020

Electricity sector (results referring to national RES deployment)

Electricity production

Breakdown by RES-electricity category		[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
Biogas	BG	TWh	0.03	0.05	0.24	0.46	0.86	1.40	1.86	0.24	0.46	0.85	1.40	1.86	0.24	0.47	0.86	1.43	2.14
(Solid) Biomass	BM	TWh	1.57	1.37	1.87	2.18	2.52	2.92	3.46	1.87	2.19	2.54	2.96	3.58	2.00	2.54	3.09	3.73	4.45
Biowaste	BW	TWh	0.06	0.14	0.39	0.52	0.59	0.63	0.69	0.39	0.52	0.59	0.63	0.69	0.39	0.52	0.59	0.63	0.69
Geothermal electricity	GE	TWh	0.00	0.00	0.08	0.16	0.30	0.56	0.81	0.08	0.16	0.30	0.56	0.81	0.08	0.16	0.30	0.56	0.98
Hydro large-scale	HY-LS	TWh	0.14	0.14	0.46	0.63	0.81	0.94	0.94	0.46	0.63	0.81	0.94	0.94	0.46	0.63	0.81	0.98	1.14
Hydro small-scale	HY-SS	TWh	0.04	0.04	0.07	0.07	0.07	0.07	0.07	0.06	0.07	0.07	0.07	0.07	0.07	0.08	0.09	0.09	0.09
Photovoltaics	SO-PV	TWh	0.00	0.00	0.01	0.03	0.05	0.09	0.17	0.01	0.03	0.05	0.09	0.17	0.01	0.03	0.05	0.09	0.17
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	0.09	0.69	1.19	1.44	1.61	1.65	0.69	1.05	1.31	1.42	1.55	0.69	1.25	1.67	1.79	1.82
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	1.85	1.84	3.80	5.26	6.63	8.21	9.66	3.80	5.10	6.51	8.05	9.67	3.94	5.68	7.45	9.28	11.49
RES-E share on gross electricity demand		%	4.4%	4.2%	8.6%	11.5%	14.1%	17.1%	19.5%	8.6%	11.2%	13.9%	16.8%	19.6%	8.9%	12.4%	15.9%	19.3%	23.2%

Deployment in terms of capacities

Installed capacities (cumulative)

Breakdown by RES-electricity category		[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
Biogas	BG	MW	6.0	19.0	38.9	74.8	138.4	233.6	315.7	38.9	74.4	138.0	233.6	315.7	39.0	75.5	139.3	240.1	383.6
(Solid) Biomass	BM	MW	390.0	306.0	415.4	472.5	532.0	604.4	712.8	415.6	473.6	535.0	609.9	731.1	436.1	526.8	620.8	728.3	859.8
Biowaste	BW	MW	11.3	21.9	59.7	80.4	90.2	96.2	106.9	59.7	80.4	90.2	96.2	106.9	59.7	80.4	90.2	96.2	106.9
Geothermal electricity	GE	MW	0.0	0.0	11.1	23.4	45.3	82.5	118.7	11.1	23.4	45.3	82.5	118.7	11.1	23.4	45.3	82.5	146.6
Hydro large-scale	HY-LS	MW	50.0	50.0	109.6	149.2	192.3	226.1	226.1	109.6	149.2	192.3	226.1	226.1	109.6	149.2	192.3	234.8	272.3
Hydro small-scale	HY-SS	MW	12.0	12.0	20.1	21.9	21.9	21.9	21.9	19.3	19.7	19.7	19.7	19.7	20.1	24.4	26.4	26.4	26.4
Photovoltaics	SO-PV	MW	0.0	0.0	12.2	28.2	48.9	83.8	162.3	12.2	28.2	48.9	83.8	162.3	12.2	28.2	48.9	83.8	162.3
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	17.0	61.0	310.0	559.7	682.2	771.3	796.0	310.0	482.2	616.7	667.2	739.7	310.0	593.0	812.9	878.2	896.4
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	438.3	438.3	977.0	1,410.1	1,751.1	2,119.9	2,460.4	976.4	1,331.2	1,686.0	2,019.0	2,420.2	997.8	1,500.9	1,976.0	2,370.3	2,854.2

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

Capital expenditures

Capital expenditures (new plants)

Breakdown by RES-electricity category		[Unit]			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€			15.8	82.8	70.7	815.0	54.3	15.8	83.0	70.7	815.9	54.4	15.8	82.1	138.0	1,015.8	67.7
(Solid) Biomass	BM	M€			13.2	56.6	85.3	820.7	54.7	13.2	59.1	115.7	906.1	60.4	13.2	98.7	110.4	1,246.5	83.1
Biowaste	BW	M€			75.3	19.7	22.7	552.5	36.8	75.3	19.7	22.7	552.5	36.8	75.3	19.7	22.7	552.5	36.8
Geothermal electricity	GE	M€			5.9	31.1	1.0	401.2	26.7	5.9	31.1	1.0	401.1	26.7	5.9	31.1	99.7	499.5	33.3
Hydro large-scale	HY-LS	M€			21.4	51.3	0.0	363.2	24.2	21.4	51.3	0.0	363.2	24.2	21.4	51.3	58.4	556.8	37.1
Hydro small-scale	HY-SS	M€			3.6	0.0	0.0	17.7	1.2	3.6	0.0	0.0	12.1	0.8	3.6	2.3	0.0	28.7	1.9
Photovoltaics	SO-PV	M€			0.0	23.4	73.9	354.5	23.6	0.0	24.0	72.5	357.7	23.8	0.0	23.2	65.6	337.2	22.5
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€			2.9	57.9	7.4	1,095.4	73.0	2.9	125.4	4.5	1,013.6	67.6	2.9	158.7	5.4	1,222.9	81.5
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€			138.3	322.8	260.9	4,420.1	294.7	138.3	393.6	287.1	4,422.3	294.8	138.3	466.9	500.2	5,460.0	364.0

Policy cost - consumer expenditures due to RES support

Consumer expenditures (new plants)

Breakdown by RES-electricity category		[Unit]			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€			0.5	12.8	34.6	172.5	11.5	0.5	12.4	34.7	169.4	11.3	0.5	33.0	108.4	476.8	31.8
(Solid) Biomass	BM	M€			3.3	24.2	52.3	305.1	20.3	3.3	29.6	68.0	373.5	24.9	3.3	84.1	179.0	985.6	65.7
Biowaste	BW	M€			0.0	4.1	5.1	40.6	2.7	0.0	3.3	4.1	33.6	2.2	0.0	11.6	15.9	113.5	7.6
Geothermal electricity	GE	M€			0.4	2.6	7.6	38.5	2.6	0.4	2.1	6.0	31.2	2.1	0.4	16.4	73.0	281.4	18.8
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	19.8	37.1	212.1	14.1
Hydro small-scale	HY-SS	M€			0.1	0.2	0.2	1.9	0.1	0.1	0.1	0.1	1.0	0.1	0.1	1.7	1.7	14.6	1.0
Photovoltaics	SO-PV	M€			0.0	10.8	31.8	141.5	9.4	0.0	10.8	31.9	141.9	9.5	0.0	14.9	49.6	207.8	13.9
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€			6.0	17.3	19.9	197.7	13.2	6.0	13.7	15.3	160.3	10.7	6.0	44.7	50.3	421.4	28.1
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€			10.3	71.8	151.5	897.8	59.9	10.3	71.9	160.1	910.9	60.7	10.3	226.3	514.9	2,713.2	180.9

Heat sector (results referring to national RES deployment)

Deployment in terms of generation

Breakdown by RES-heat category					Heat production														
					NAT (National target fulfillment)					EU (European perspective)					ACT (proactive support - realisable deployment)				
		[Unit]	2005	2007	2011-2012	2013-2014	2015-2016	2017-2018	2020	2011-2012	2013-2014	2015-2016	2017-2018	2020	2011-2012	2013-2014	2015-2016	2017-2018	2020
Biogas (grid)	BG	ktoe	1.0	5.0	1.5	2.6	4.3	6.7	10.7	1.5	2.5	4.2	6.7	10.7	1.5	2.7	4.4	6.8	11.0
Solid biomass (grid)	BM	ktoe	15.0	29.0	115.1	167.9	233.1	313.1	425.7	116.3	170.8	237.1	310.4	417.5	116.3	170.8	237.0	318.2	438.2
Biowaste (grid)	BW	ktoe	0.0	0.0	55.5	74.2	83.1	88.2	97.8	55.5	74.2	83.1	88.2	97.8	55.5	74.2	83.1	88.2	97.8
Geothermal heat (grid)	GE	ktoe	189.1	189.6	233.5	233.5	233.5	233.5	277.9	233.5	233.5	233.5	233.5	233.5	326.8	366.7	398.6	455.6	455.6
Solid biomass (non-grid)	BM-NG	ktoe	567.0	727.0	634.9	674.0	720.6	763.2	791.9	617.4	657.5	705.2	754.1	786.0	634.1	673.2	723.1	765.7	794.4
Solar thermal heating and hot water	SO-TH	ktoe	2.0	2.0	8.8	17.7	26.9	37.3	55.1	8.8	17.7	26.7	36.9	54.3	8.8	17.8	26.9	37.3	55.1
Heat pumps	HP	ktoe	0.0	0.0	6.7	14.5	22.3	30.6	44.5	6.7	14.5	22.2	30.6	44.5	6.7	14.5	22.3	30.6	44.5
RES-H TOTAL	RES-H	ktoe	774.1	952.6	1,056.0	1,184.5	1,323.7	1,472.6	1,703.7	1,039.7	1,170.8	1,312.1	1,460.3	1,644.4	1,149.8	1,320.1	1,495.3	1,702.4	1,896.6
RES-H share on gross heat* demand		%	7.0%	10.3%	8.4%	9.3%	10.3%	11.4%	13.0%	8.3%	9.2%	10.2%	11.3%	12.6%	9.1%	10.4%	11.6%	13.1%	14.5%

* excl. electricity inputs

Deployment in terms of capacity

Breakdown by RES-heat category					Installed capacity (cumulative)														
					NAT (National target fulfillment)					EU (European perspective)					ACT (proactive support - realisable deployment)				
		[Unit]		2007°	2011-2012	2013-2014	2015-2016	2017-2018	2020	2011-2012	2013-2014	2015-2016	2017-2018	2020	2011-2012	2013-2014	2015-2016	2017-2018	2020
Biogas (grid)	BG	MW		67.9	16.6	27.2	47.5	79.1	139.1	16.6	26.6	46.7	79.1	139.1	16.7	28.8	49.4	82.7	144.3
Solid biomass (grid)	BM	MW		461.6	855.8	1,051.8	1,319.6	1,658.2	2,121.7	860.8	1,063.7	1,338.2	1,661.5	2,127.0	863.9	1,068.1	1,341.9	1,692.7	2,219.7
Biowaste (grid)	BW	MW		0.0	251.6	336.7	375.4	398.5	437.1	251.6	336.7	375.4	398.5	437.1	251.6	336.7	375.4	398.5	437.1
Geothermal heat (grid)	GE	MW		716.9	868.7	868.7	868.7	868.7	1,162.2	868.7	868.7	868.7	868.7	868.7	1,399.0	1,592.6	1,746.9	2,023.0	2,023.0
Solid biomass (non-grid)	BM-NG	MW		n.a.	5,127.9	5,443.8	5,819.7	6,163.8	6,395.7	4,986.5	5,310.0	5,695.6	6,090.7	6,348.4	5,121.5	5,437.2	5,839.9	6,184.3	6,416.2
Solar thermal heating and hot water	SO-TH	MW		44.1	193.2	391.4	593.2	822.6	1,216.8	193.2	391.4	588.9	814.0	1,199.3	193.9	393.6	593.2	822.6	1,216.8
Heat pumps	HP	MW		0.0	53.8	117.0	180.1	247.3	359.2	53.8	116.7	179.6	247.2	359.0	53.8	117.0	180.1	247.3	359.2
RES-H TOTAL	RES-H	MW		1,290.6	7,367.7	8,236.7	9,204.2	10,238.2	11,831.8	7,231.2	8,113.9	9,093.2	10,159.6	11,478.8	7,900.5	8,974.0	10,126.8	11,451.1	12,816.3

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

Capital expenditures

Breakdown by RES-heat category					Capital expenditures (new plants)														
					NAT (National target fulfillment)					EU (European perspective)					ACT (proactive support - realisable deployment)				
		[Unit]			2010	2015	2020	Cumulative (06-20)	Yearly average	2010	2015	2020	Cumulative (06-20)	Yearly average	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€			15.2	40.4	52.9	455.2	30.3	15.2	42.1	53.3	434.4	29.0	15.2	40.9	58.8	474.5	31.6
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€			131.8	0.0	0.0	371.0	24.7	131.8	0.0	0.0	131.8	8.8	131.8	0.0	0.0	1,986.9	132.5
Solid biomass (non-grid)	BM-NG	M€			77.2	162.3	104.8	1,561.2	104.1	77.2	159.7	104.9	1,516.9	101.1	77.2	176.9	135.8	1,748.3	116.6
Solar thermal heating and hot water	SO-TH	M€			0.0	37.8	60.5	423.6	28.2	0.0	35.9	58.9	416.2	27.7	0.0	36.2	59.9	421.4	28.1
Heat pumps	HP	M€			0.0	18.4	31.3	207.7	13.8	0.0	18.4	31.7	209.1	13.9	0.0	18.3	31.0	206.2	13.7
RES-H TOTAL	RES-H	M€			224.2	259.0	249.5	3,018.8	201.3	224.2	256.1	248.8	2,708.3	180.6	224.2	272.3	285.7	4,837.3	322.5

Policy cost - consumer expenditures due to RES support

Breakdown by RES-heat category					Consumer expenditures (new plants)														
					NAT (National target fulfillment)					EU (European perspective)					ACT (proactive support - realisable deployment)				
		[Unit]			2010	2015	2020	Cumulative (06-20)	Yearly average	2010	2015	2020	Cumulative (06-20)	Yearly average	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€			0.0	21.4	38.1	233.7	15.6	0.0	8.4	10.7	74.4	5.0	0.0	61.1	114.7	682.2	45.5
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	3.9	7.7	94.3	6.3	0.0	0.0	0.0	0.0	0.0	0.0	49.6	74.4	1,425.3	95.0
Solid biomass (non-grid)	BM-NG	M€			0.0	57.4	75.7	574.1	38.3	0.0	17.8	11.3	148.3	9.9	0.0	166.1	281.3	1,847.4	123.2
Solar thermal heating and hot water	SO-TH	M€			0.0	14.0	24.4	158.0	10.5	0.0	9.0	14.7	104.1	6.9	0.0	30.2	55.9	351.9	23.5
Heat pumps	HP	M€			0.0	7.8	14.5	88.3	5.9	0.0	4.6	7.9	52.3	3.5	0.0	18.2	34.9	206.9	13.8
RES-H TOTAL	RES-H	M€			0.0	104.5	160.4	1,148.4	76.6	0.0	39.8	44.6	379.1	25.3	0.0	325.2	561.3	4,513.7	300.9

Transport sector

Deployment in terms of consumption

Breakdown by RES-transport category		Energy consumption in transport			NAT (National target fulfillment)					EU (European perspective)					ACT (proactive support - realisable deployment)				
		[Unit]	2005	2007	2011-2012	2013-2014	2015-2016	2017-2018	2020	2011-2012	2013-2014	2015-2016	2017-2018	2020	2011-2012	2013-2014	2015-2016	2017-2018	2020
Bioethanol**	BE	ktoe	5.0	27.0	177.1	260.7	281.7	281.7	280.4	177.1	260.7	281.7	281.7	280.4	177.1	260.7	281.7	281.7	280.4
Biodiesel**	BD	ktoe	0.0	2.0	23.9	55.2	95.2	151.1	213.7	23.9	55.2	95.2	151.1	213.7	23.9	55.2	95.2	151.1	213.7
2nd generation biofuels**°	2BF	ktoe	n.a.	n.a.	0.0	0.0	0.0	0.0	11.2	0.0	0.0	0.0	0.0	11.2	0.0	0.0	0.0	0.0	11.2
Net biofuel import*		ktoe	n.a.	n.a.	-6.1	-43.6	-62.1	-61.5	-7.3	-6.1	-43.6	-62.1	-61.5	-7.3	-6.1	-43.6	-62.1	-61.5	-7.3
Biofuel TOTAL	RES-T	ktoe	5.0	29.0	195.0	272.2	314.8	371.4	497.9	195.0	272.2	314.8	371.4	497.9	195.0	272.2	314.8	371.4	497.9
Biofuel share on diesel and gasoline demand		%	0.1%	0.7%	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)*

Breakdown by RES-transport category		Installed capacity (cumulative)			NAT (National target fulfillment)					EU (European perspective)					ACT (proactive support - realisable deployment)				
		[Unit]		2007°	2011-2012	2013-2014	2015-2016	2017-2018	2020	2011-2012	2013-2014	2015-2016	2017-2018	2020	2011-2012	2013-2014	2015-2016	2017-2018	2020
Bioethanol	BE	MW		40.6	260.0	381.5	412.1	412.1	409.6	260.0	381.5	412.1	412.1	409.6	260.0	381.5	412.1	412.1	409.6
Biodiesel	BD	MW		2.9	35.0	80.5	139.1	219.9	310.8	35.0	80.5	139.1	219.9	310.8	35.0	80.5	139.1	219.9	310.8
2nd generation biofuels	2BF	MW		n.a.	0.0	0.0	0.0	0.0	16.2	0.0	0.0	0.0	0.0	16.2	0.0	0.0	0.0	0.0	16.2
Biofuel TOTAL	RES-T	MW		43.5	295.1	461.9	551.2	632.1	736.7	295.1	461.9	551.2	632.1	736.7	295.1	461.9	551.2	632.1	736.7

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

Capital expenditures

Breakdown by RES-transport category		Capital expenditures (new plants)			NAT (National target fulfillment)					EU (European perspective)					ACT (proactive support - realisable deployment)				
		[Unit]			2010	2015	2020	Cumulative (06-20)	Yearly average	2010	2015	2020	Cumulative (06-20)	Yearly average	2010	2015	2020	Cumulative (06-20)	Yearly average
Bioethanol	BE	M€			28.8	0.0	0.0	264.8	17.7	28.8	0.0	0.0	264.8	17.7	28.8	0.0	0.0	264.8	17.7
Biodiesel	BD	M€			0.0	26.5	21.4	167.8	11.2	0.0	26.5	21.4	167.8	11.2	0.0	26.5	21.4	167.8	11.2
2nd generation biofuels	2BF	M€			0.0	0.0	23.1	23.1	1.5	0.0	0.0	23.1	23.1	1.5	0.0	0.0	23.1	23.1	1.5
Biofuel TOTAL	RES-T	M€			28.8	26.5	44.5	455.6	30.4	28.8	26.5	44.5	455.6	30.4	28.8	26.5	44.5	455.6	30.4

Policy cost - consumer expenditures due to RES support

Breakdown by RES-transport category		Consumer expenditures (new plants)			NAT (National target fulfillment)					EU (European perspective)					ACT (proactive support - realisable deployment)				
		[Unit]			2010	2015	2020	Cumulative (06-20)	Yearly average	2010	2015	2020	Cumulative (06-20)	Yearly average	2010	2015	2020	Cumulative (06-20)	Yearly average
Bioethanol	BE	M€			28.5	54.8	47.2	684.4	45.6	28.5	54.8	47.2	684.4	45.6	28.5	54.8	47.2	684.4	45.6
Biodiesel	BD	M€			0.0	16.2	36.0	181.4	12.1	0.0	16.2	36.0	181.4	12.1	0.0	16.2	36.0	181.4	12.1
2nd generation biofuels	2BF	M€			0.0	0.0	1.9	1.9	0.1	0.0	0.0	1.9	1.9	0.1	0.0	0.0	1.9	1.9	0.1
Net biofuel import*		M€			0.0	-11.5	-1.2	-70.9	-4.7	0.0	-11.5	-1.2	-70.9	-4.7	0.0	-11.5	-1.2	-70.9	-4.7
Biofuel TOTAL	RES-T	M€			28.5	59.5	83.9	796.8	53.1	28.5	59.5	83.9	796.8	53.1	28.5	59.5	83.9	796.8	53.1

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

Summary - Results on selected costs and benefits

Capital expenditures

Breakdown by RES sector		Capital expenditures (new plants)			NAT (National target fulfillment)					EU (European perspective)					ACT (proactive support - realisable deployment)				
		[Unit]		2007°	2010	2015	2020	Cumulative (06-20)	Yearly average	2010	2015	2020	Cumulative (06-20)	Yearly average	2010	2015	2020	Cumulative (06-20)	Yearly average
Electricity sector	RES-E	M€		142.6	138.3	322.8	260.9	4,420.1	294.7	138.3	393.6	287.1	4,422.3	294.8	138.3	466.9	500.2	5,460.0	364.0
Heat sector	RES-H	M€		91.9	224.2	259.0	249.5	3,018.8	201.3	224.2	256.1	248.8	2,708.3	180.6	224.2	272.3	285.7	4,837.3	322.5
Transport sector	RES-T	M€		11.5	28.8	26.5	44.5	455.6	30.4	28.8	26.5	44.5	455.6	30.4	28.8	26.5	44.5	455.6	30.4
Total (national RES deployment)	RES	M€		246.0	391.3	608.3	555.0	7,894.5	526.3	391.3	676.2	580.4	7,586.2	505.7	391.3	765.7	830.4	10,752.9	716.9

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

Policy cost - consumer expenditures due to RES support

Breakdown by RES sector		Consumer expenditures (new plants)			NAT (National target fulfillment)					EU (European perspective)					ACT (proactive support - realisable deployment)				
		[Unit]		2007°	2010	2015	2020	Cumulative (06-20)	Yearly average	2010	2015	2020	Cumulative (06-20)	Yearly average	2010	2015	2020	Cumulative (06-20)	Yearly average
Electricity sector	RES-E	M€		15.2	10.3	71.8	151.5	897.8	59.9	10.3	71.9	160.1	910.9	60.7	10.3	226.3	514.9	2,713.2	180.9
Heat sector	RES-H	M€		0.0	0.0	104.5	160.4	1,148.4	76.6	0.0	39.8	44.6	379.1	25.3	0.0	325.2	561.3	4,513.7	300.9
Transport sector	RES-T	M€		6.2	28.5	59.5	83.9	796.8	53.1	28.5	59.5	83.9	796.8	53.1	28.5	59.5	83.9	796.8	53.1
Total (national RES deployment)	RES	M€		21.4	38.8	235.8	395.8	2,842.9	189.5	38.8	171.3	288.6	2,086.7	139.1	38.8	611.0	1,160.1	8,023.7	534.9
Impact of cooperation mechanisms		M€		0.0	0.0	-0.6	-9.2	-20.8	-1.4	0.0	-3.6	-8.3	-98.7	-6.6	0.0	-0.8	-0.8	-11.0	-0.7
Total (corrected)	RES	M€		21.4	38.8	235.3	386.6	2,822.2	188.1	38.8	167.7	280.3	1,988.0	132.5	38.8	610.2	1,159.3	8,012.6	534.2

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

Additional generation costs

Breakdown by RES sector		[Unit]		2007°	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
				Additional generation costs (new plants)															
Electricity sector	RES-E	M€		3.4	0.4	21.1	56.0	266.1	17.7	0.4	20.4	58.3	262.0	17.5	0.4	43.5	109.0	510.6	34.0
Heat sector	RES-H	M€		0.0	0.0	0.0	0.0	2.5	0.2	0.0	0.0	0.1	0.4	0.0	0.0	51.0	97.6	754.3	50.3
Transport sector	RES-T	M€		2.7	6.2	12.8	12.0	144.2	9.6	6.2	12.6	12.0	144.2	9.6	6.2	12.8	12.0	144.2	9.6
Total (national RES deployment)	RES	M€		6.1	6.7	33.9	68.0	412.8	27.5	6.7	33.0	70.4	406.6	27.1	6.7	107.3	218.7	1,409.1	93.9

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

Total avoided CO_2 emissions

Breakdown by RES sector		[Unit]		2007°	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
				Total avoided CO_2 emissions (new plants)															
Electricity sector	RES-E	Mt[CO2] / a		0.5	1.1	2.6	3.7	30.9	2.1	1.1	2.6	3.7	30.5	2.0	1.1	3.1	4.5	35.1	2.3
Heat sector	RES-H	Mt[CO2] / a		0.4	0.5	1.4	2.9	17.5	1.2	0.5	1.4	2.7	16.7	1.1	0.5	1.9	3.5	22.7	1.5
Transport sector	RES-T	Mt[CO2] / a		0.0	0.2	0.6	1.1	7.4	0.5	0.2	0.6	1.1	7.4	0.5	0.2	0.6	1.1	7.4	0.5
Total (national RES deployment)	RES	Mt[CO2] / a		1.0	1.8	4.7	7.7	55.9	3.7	1.8	4.6	7.5	54.6	3.6	1.8	5.5	9.2	65.2	4.3

° 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 (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
				Avoided CO_2 emissions (monetary expression - new plants)															
Electricity sector	RES-E	M€		10.3	21.7	71.2	125.0	858.6	57.2	21.7	69.9	125.2	845.5	56.4	21.7	82.9	152.7	983.0	65.5
Heat sector	RES-H	M€		8.2	9.4	39.1	99.9	508.0	33.9	9.4	38.1	91.6	482.6	32.2	9.4	50.5	121.2	657.3	43.8
Transport sector	RES-T	M€		0.8	3.9	16.9	39.1	212.1	14.1	3.9	16.9	39.1	212.1	14.1	3.9	16.9	39.1	212.1	14.1
Total (national RES deployment)	RES	M€		19.3	35.0	127.2	264.0	1,578.8	105.3	35.0	124.9	255.9	1,540.2	102.7	35.0	150.3	313.1	1,852.4	123.5

° 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 (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
				Avoided fossil fuels (energy terms - new plants)															
Electricity sector	RES-E	ktoe		170	359	961	1,448	11,376	758	359	944	1,450	11,201	747	359	1,119	1,768	12,943	863
Heat sector	RES-H	ktoe		151	171	559	1,092	6,662	444	171	544	1,010	6,361	424	171	708	1,300	8,454	564
Transport sector	RES-T	ktoe		25	121	316	518	3,680	245	121	316	518	3,680	245	121	316	518	3,680	245
Total (national RES deployment)	RES	ktoe		346	651	1,836	3,058	21,718	1,448	651	1,803	2,978	21,241	1,416	651	2,143	3,586	25,077	1,672

° 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 (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
				Avoided fossil fuels (monetary terms - new plants)															
Electricity sector	RES-E	M€		33.0	92.8	323.1	604.9	3,902.1	260.1	92.8	317.2	605.7	3,842.2	256.1	92.8	376.2	738.8	4,481.2	298.7
Heat sector	RES-H	M€		36.3	58.7	218.5	486.4	2,693.9	179.6	58.7	212.5	450.0	2,569.2	171.3	58.7	276.7	578.3	3,418.7	227.9
Transport sector	RES-T	M€		9.2	54.1	163.1	303.8	1,935.9	129.1	54.1	163.1	303.8	1,935.9	129.1	54.1	163.1	303.8	1,935.9	129.1
Total (national RES deployment)	RES	M€		78.5	205.6	704.7	1,395.1	8,531.9	568.8	205.6	692.8	1,359.5	8,347.3	556.5	205.6	816.1	1,620.8	9,835.8	655.7

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

Biomass use

Breakdown by feedstock category		[Unit]			NAT (National target fulfillment) Total 2015	Imports* 2015	Total 2020	Imports* 2020		EU (European perspective) Total 2015	Imports* 2015	Total 2020	Imports* 2020		ACT (proactive support - realisable deployment) Total 2015	Imports* 2015	Total 2020	Imports* 2020	
				Biomass use (in terms of primary energy)															
Agricultural products	AP	ktoe			574	33	792	70		574	33	767	70		574	33	832	70	
Agricultural residues	AR	ktoe			515		1,163			521		1,191			643		1,493		
Forestry products	FP	ktoe			649		724			636		724			647		724		
Forestry residues	FR	ktoe			559	13.0	571	20.2		559	13.0	571	20.2		559	13.0	571	20.2	
Biowaste	BW	ktoe			398		573			397		573			399		581		
Total Biomass availability		ktoe			2,740.7		3,912.4			2,732.8		3,915.7			2,868.4		4,291.2		

*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 Hungary 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 a moderate increase in energy efficiency (compared to baseline) is preconditioned.

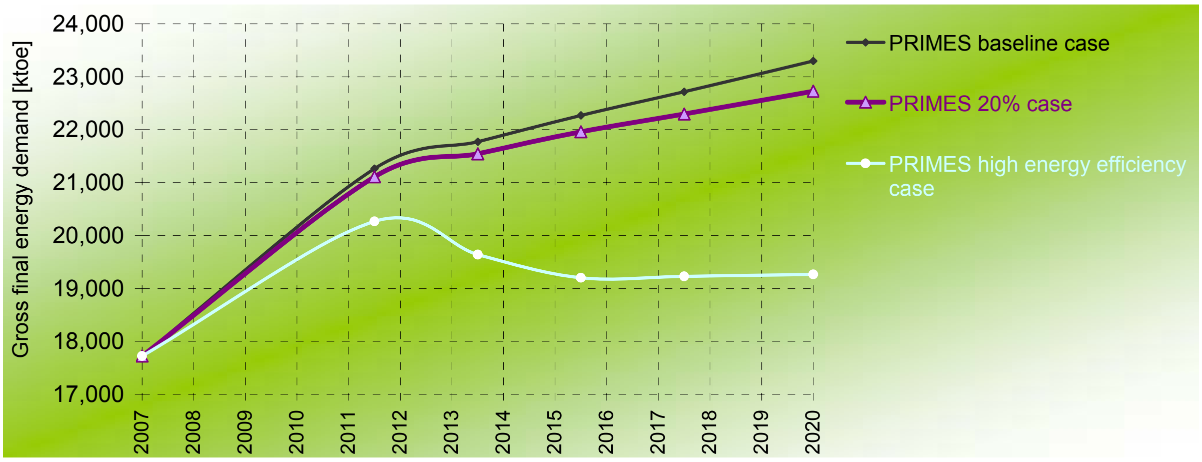


Figure B-1 Comparison of projected gross final energy demand development up to 2020 in Hungary.

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%.

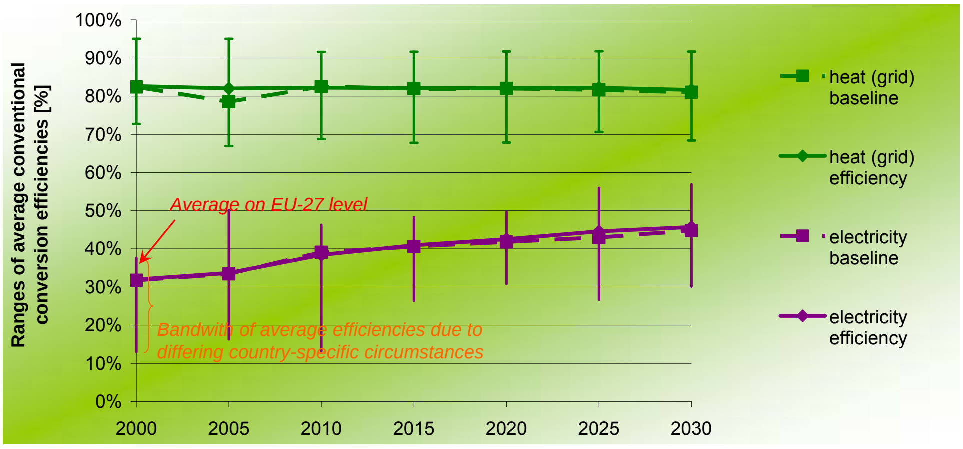


Figure B-2 Country-specific average conversion efficiencies of conventional (fossil-based) electricity and grid-connected heat production in the EU27.

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.

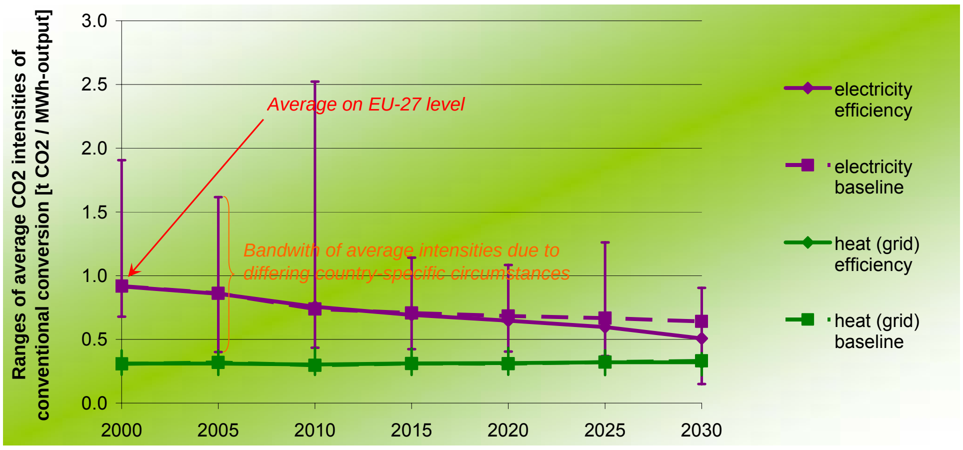


Figure B-3 Country-specific average sectoral CO_2 intensities of the conventional (fossil-based) energy system in the EU27.

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[31] 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:

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

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 B-4 (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%.

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

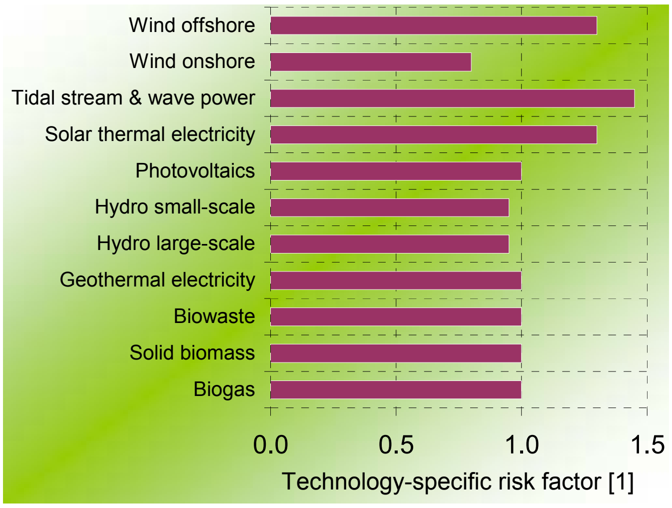


Figure B-4 Technology-specific risk factors

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,[32]
- the guaranteed duration of financial support is limited. [33]

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.*

32 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.

33 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)*[34]

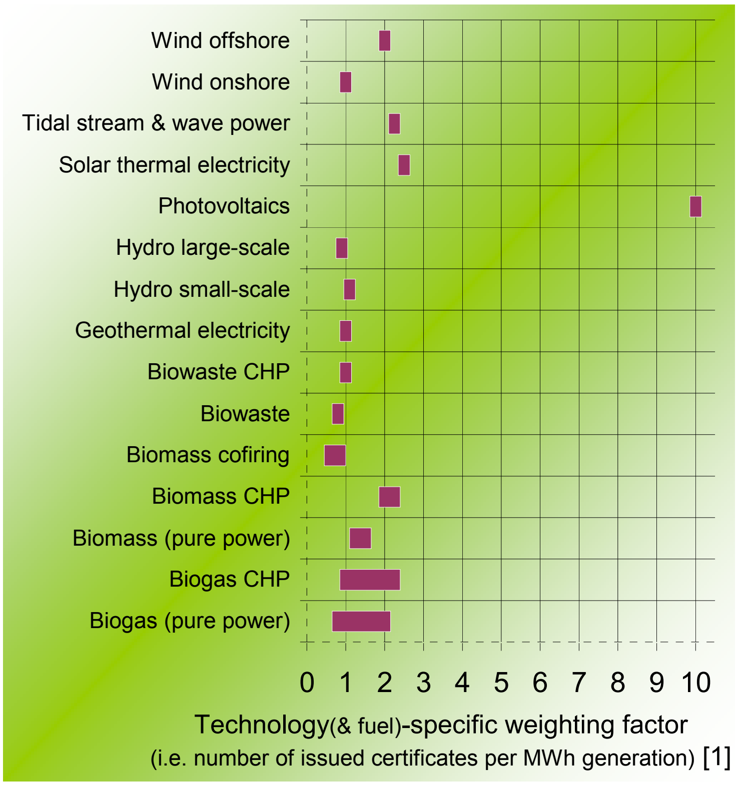


Figure B-5 Technology-specific weighting factors (as assumed for the NAT and EU case in countries which currently already use a trading system to support RES-E)

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

34 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[35] 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.

---

35 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.