Fraunhofer Institute Systems and Innovation Research

Energy Economics Group

KEMA

ECOFYS

THE REGIONAL ENVIRONMENTAL CENTER for Central and Eastern Europe

Abstract of First Results

FORRES 2020:
Analysis of renewable energy's evolution up to 2020[1]

Mario Ragwitz, Joachim Schleich, Fraunhofer ISI
Claus Huber, Gustav Resch, Thomas Faber, EEG
Monique Voogt, ECOFYS
Walter Ruijgrok, KEMA
Peter Bodo, REC

Karlsruhe (Germany)
January 2004

Study supported by:

Directorate-General Energy and Transport

Altener

[1] Project supported under Tender No. TREN/D2/10-2002. Project ends in December 2004.

Foreword

This summary provides a digest of the interim results of the project FORRES 2020: "Analysis of renewable energy's evolution up to 2020". The objectives of this project are to produce an independent analysis and assessment of the implementation of renewable energy sources in the Member States of the European Union and the Candidate Countries since the publication of the White Paper on renewable energy sources in 1997 and to propose a perspective for the period up to 2020. The results of the project will:

(1) provide input for monitoring the progress of the targets set in the White Paper, the Directive on the promotion of electricity from renewable energy sources, and the Directive on biofuels; and
(2) provide insights into the possible future implementation of renewable energy sources under different policy developments up to 2020.

A main report on the project is available, which provides an overview of the progress made on the European market for renewable energy sources for the current EU-15 Member States and the 10 Accession States (indicated as EU-10+). A separate volume contains more detailed country reports for each of these 25 countries as well as for the two future Accession States Bulgaria and Romania.

The FORRES 2020 study was initiated and financed by the European Commission, Directorate-General for Energy and Transport. An international consortium of research and consultancy partners is conducting the study. The core project team consists of Mario Ragwitz, Joachim Schleich (Fraunhofer-ISI, Germany), Claus Huber, Gustav Resch, Thomas Faber (EEG, Vienna University of Technology, Austria), Monique Voogt (ECOFYS, Netherlands), Walter Ruijgrok (KEMA, Netherlands) and Peter Bodo (Regional Environmental Centre, Hungary).

Support from the European Commission, DG TREN is gratefully acknowledged. The authors would like to thank their colleagues for their support in various parts of the study. The responsibility for the contents of the study and the views expressed remains with the core project team.

For further information, questions and comments, please contact the project manager at the following address:

Dr. Mario Ragwitz
Fraunhofer-ISI
Breslauer Str. 48
D-76139 Karlsruhe
Germany
Tel: + 49 721 6809-157
E-mail: Mario.Ragwitz@isi.fhg.de

Summary

An important aspect of the EU policy to increase the share of renewable energy sources (RES) is the monitoring and evaluation of the progress made towards the 2010 targets and the determination of realistic targets for the period up to 2020. The monitoring process concentrates on two main issues. Firstly, it monitors the national adoption of EU legislation and its translation into national action plans and policy instruments in each of the 25 EU States. Secondly, it provides a framework to analyse the impacts of these national policies and measures and the extent to which each of the EU-25 states is realising the targeted deployment of renewable energy. Based on different assumptions with regard to the implemented policies, scenarios for the future implementation of renewables until 2020 can be calculated.

Analysing current policies

The European renewable energy market and its set of supporting measures is very dynamic. Countries are continuously monitoring their sets of policies and measures, which often results in the fine-tuning of instruments and sometimes the introduction of a completely new set of instruments. For electricity, the formulation of the Renewable Electricity Directive has clearly had a strong influence on the amount and level of supporting policies. For biofuels changes in the policy environment can be observed as a result of the Biofuels Directive. For the heat sector the recently formulated Directive on the Energy Performance of Buildings represents a starting point for policy setting on the European level. More significant policy changes are expected in the near future.

Calculation methodology

The calculations and projections conducted in this study are based on two different methods:

1. Forecasts of RES penetration based on econometric analyses.
2. Forecasts of RES penetration with the model ***Green-X***.

The ***Green-X*** model allows for a comparative, quantitative analysis of interactions between electricity from renewable sources (RES-E), conventional electricity and CHP generation, demand-side activities and GHG-reduction in the electricity sector in all EU-27 countries. The model calculates the impact of various renewable energy promotion strategies, taking into account boundary conditions on the markets. Technologies are specified by means of dynamic cost-resource curves. The econometric analysis uses correlations between historically observed policy implementations and corresponding RES penetration. The econometric analysis is used to set a benchmark for the results of the ***Green-X*** model.

Scenarios for developments until 2020

Model calculations and analyses are based on two different scenarios; each with a different mix of promotion schemes and assumptions. The first scenario is the business-as-usual scenario (BAU). This scenario models the future development based on present policies under currently existing barriers and restrictions, e.g. administrative and regulative barriers. Future policies, which have already been decided on, but have not yet been implemented, will also be considered. The second scenario is the policy scenario (PS). This scenario models the future evolution based on the currently available best practice strategies of individual EU Member States. Strategies that have proven to be most effective in the past for implementing a maximum share of RES have been assumed for all countries. Furthermore, the policy scenario assumes a stable planning horizon and that currently existing barriers will be overcome. Both scenarios include the effects of technology learning and economies of scale, which have a higher impact in the policy scenario.

Projections until 2020

Electricity

The major outcomes of the projections for the electricity sector for the EU-25 until 2020 are shown in Table 1. For calculating the overall share, the BAU scenario is related to the baseline demand scenario, whereas the policy scenario is set in relation to the efficiency demand scenario. As can be observed, wind energy shows the strongest increase under both scenario assumptions. The major difference between the two scenarios with respect to wind energy is that, in the policy scenario, offshore wind generation is about twice as high as in the BAU scenario. Only limited growth is projected for hydropower due to the limited remaining potentials especially for large hydropower. Photovoltaic electricity is projected to grow moderately due to the fact that the cost decline of the technology will not keep track with the annual decline of feed-in tariffs currently implemented and used in the model. Both solar thermal electricity as well as wave & tide energy will experience significant growth in the next two decades. Electricity generation from biomass, biogas and biowaste is expected to reach more than three times the current penetration under BAU assumptions and about eight times the present value in the policy scenario. Geothermal energy grows only moderately in both scenarios because, at the current stage of the project, only conventional geothermal electricity generation potentials are considered, e.g. not hot-dry-rock technologies.

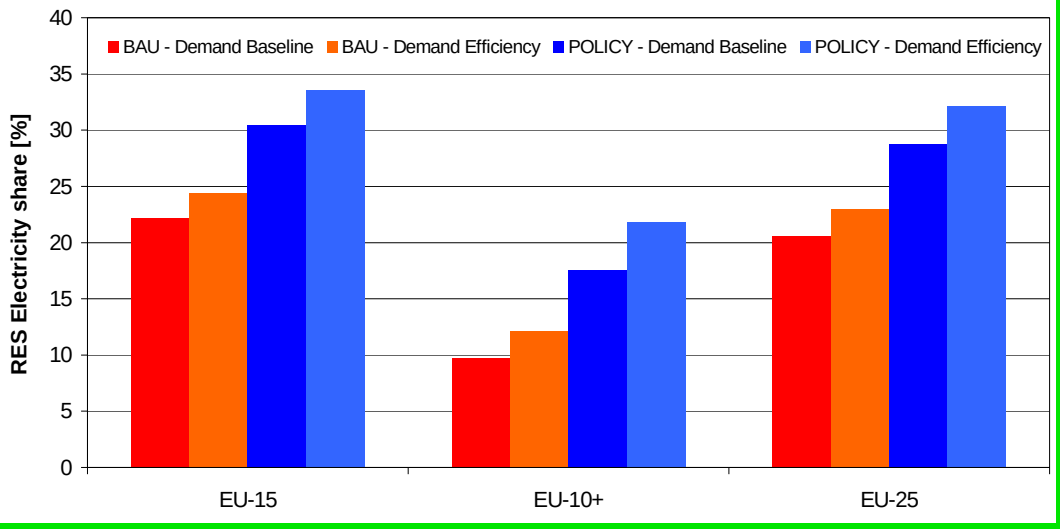
Table 1: Projected RES electricity generation in 2020 in EU-25 under BAU and policy scenario

Electricity [TWh]	2001	2020 BAU	2020 Policy
Wind energy	34	335	438
Hydro power	326	342	349
large-scale	288	298	302
small-scale	38	44	47
Photovoltaic	0.2	0.8	4.0
Solar thermal	0.0	4.2	15.2
Wave & tide	0.0	6.9	36.1
Biomass, biogas, biowaste	37	128	302
Geothermal	6.3	7.7	8.2
TOTAL RES-Electricity	**403**	**824**	**1153**
TOTAL Demand *	2960	4000	3580
Share of Demand	13.6%	20.6%	32.2%

* EU energy outlook 2003

The projected share of renewable energy sources in the electricity sector (RES-E) for the EU-15 Member States and for the Candidate Countries for the year 2020 is shown in Figure 1. Projected RES-E production figures under BAU and policy scenario assumptions are related to two different demand forecasts from the EU energy outlook 2003 (baseline and efficiency). Large differences between individual countries exist with regard to the achievable generation due to differences in current penetration and future potentials for the different renewables. For some countries, like Denmark and Ireland, significant differences between BAU and policy scenario indicate that major improvements of the existing policies are feasible. For other countries, such as Austria, the control of electricity demand deserves high relevance in order to increase the share of RES-E. Generally Figure 1 indicates the need for additional support in most EU-25 countries in order to utilise higher shares of the existing RES-E potentials.

Figure 1: Share of RES electricity production in EU-15, EU-10+ and EU-25 in 2020



Heat

Far fewer policy measures have been implemented in the heat sector than in the electricity sector in the EU-25 countries. This applies especially to bioenergy, where significantly more effective policy instruments would be feasible than are currently implemented in any of the countries. Since the policy scenario presented here is based on the currently available best practice policies in one of the EU countries, this implies that stronger growth could be achieved by applying new and more effective policy measures. Furthermore, it has to be emphasised that no efficiency demand scenario from the EU energy outlook (2003) was available, therefore the baseline demand had to be used as a reference value for both the BAU and the policy scenario. A fairly large increase can be observed in the policy scenario for geothermal heat generation as well as for active solar thermal applications. This is mainly the result of assumed strong regulations for geothermal heat pumps, similar to the Swedish case, and of assumed effective investment support instruments for solar thermal heat as are currently being applied in Austria and Germany. However, despite the success of these individual examples, it is clear that strong policies, clear target setting, and/or a commonly adopted approach is strongly lacking on the European renewable heat market.

Table 2: Projected RES heat generation in 2020 in EU-25 under BAU and policy scenario

Heat [Mtoe]	2001	2020 BAU	2020 Policy ***
Biomass	47	53	75
Geothermal	1.0	5	18
Solar Thermal	0.5	3	7
TOTAL RES-Heat	**49**	**60**	**100**
TOTAL Demand * **	419	478	478
Share of Demand	11.7%	12.6%	20.8%

* EU energy outlook 2003
** No efficiency scenario available
*** More effective policies feasible

Biofuels

The projected biofuel consumption in 2020 for the EU-25 is shown in Table 3 for both scenarios. Since a number of EU countries have since implemented tax exemptions for liquid biofuels, a major share is already projected in the BAU scenario. In the policy scenario, the increase in biofuel production is significantly stronger because all countries are assumed to implement such tax exemptions for liquid biofuels. The high share of biofuels in the transport sector is due to the assumption that a rapid take-off of biofuel production and consumption can also be achieved in the EU-10+ countries and that the production of biofuels from solid biomass (lignocellulose) is technically and economically feasible after 2010.

Table 3: Projected biofuel production in 2020 in EU-25 under BAU and policy scenario

Transport [Mtoe]	2001	2020 BAU	2020 Policy
TOTAL Biofuels	**1**	**19**	**52**
TOTAL Demand *	279	351	323
Share of Demand	0.41%	5.5%	16.1%

* EU energy outlook 2003

2 We would like to mention that the future project work also includes a more in-depth analysis of the competing use of bioenergy in the electricity, heat and transport sectors.

Total primary energy

The projected RES primary energy production for the EU-25 in 2020 is shown in Table 4 for both scenarios. Primary energy production was calculated using the EUROSTAT convention and not the substitution principle. In the policy scenario, primary energy production from RES is projected to more than triple compared to 2001 levels, whereas it less than doubles under the BAU scenario. The major difference between the BAU and policy scenario corresponds to a more significant contribution of bioenergy in the sectors of electricity, heat and transport. [2]

Table 4: Projected RES primary energy production in EU-25 in 2020 under BAU and policy scenario

Total primary energy [Mtoe]	2001	2020 BAU	2020 Policy
TOTAL Renewables	**101**	**179**	**316**
TOTAL Demand *	**1680**	**1900**	**1700**
Share of Demand	6.0%	9.4%	18.6%

according to EUROSTAT convention

* EU energy outlook 2003

The projected share of primary energy production from RES in total demand for the individual EU-15 Member States and for the Candidate Countries for the year 2020 is shown in Figure 2 and Figure 3, respectively. Projected RES production figures under BAU and policy scenario assumptions are again related to two different demand forecasts from the EU energy outlook 2003 (baseline and efficiency). For most countries, differences in primary energy use from total RES between the policy and the BAU scenario are substantially larger than the differences in the electricity sector between both scenarios. The reason is, in partial, the large difference between biomass electricity generation in the BAU and the policy scenario, which has a strong impact on the primary energy balance. However, this also suggests that, for many countries, there is especially a need for more effective policies in the heat and transport sectors. Figure 2 and Figure 3 display those countries, which could contribute most significantly in closing the gap between the two scenarios by implementing stronger policies for the promotion of RES and by controlling electricity demand.

Figure 2: Share of RES primary energy in EU-15 Member States in 2020

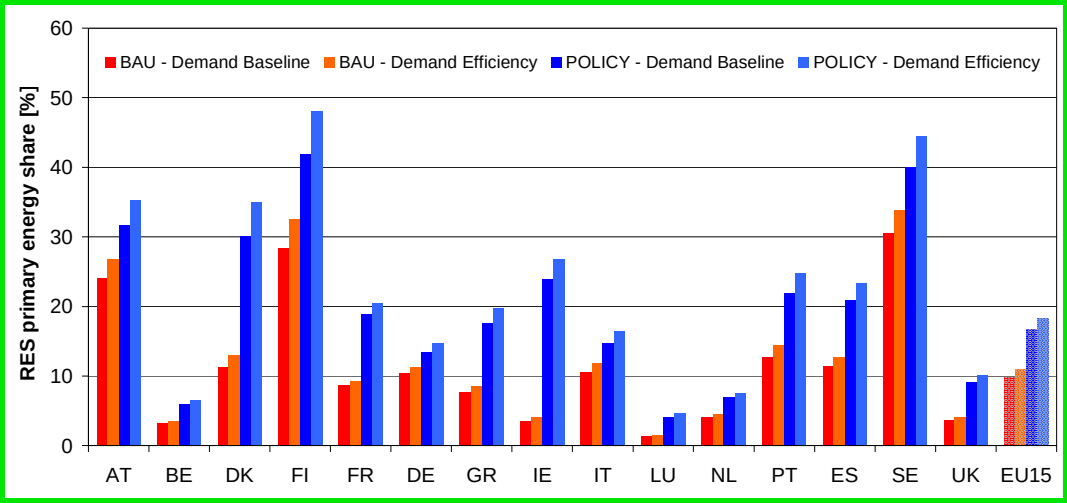
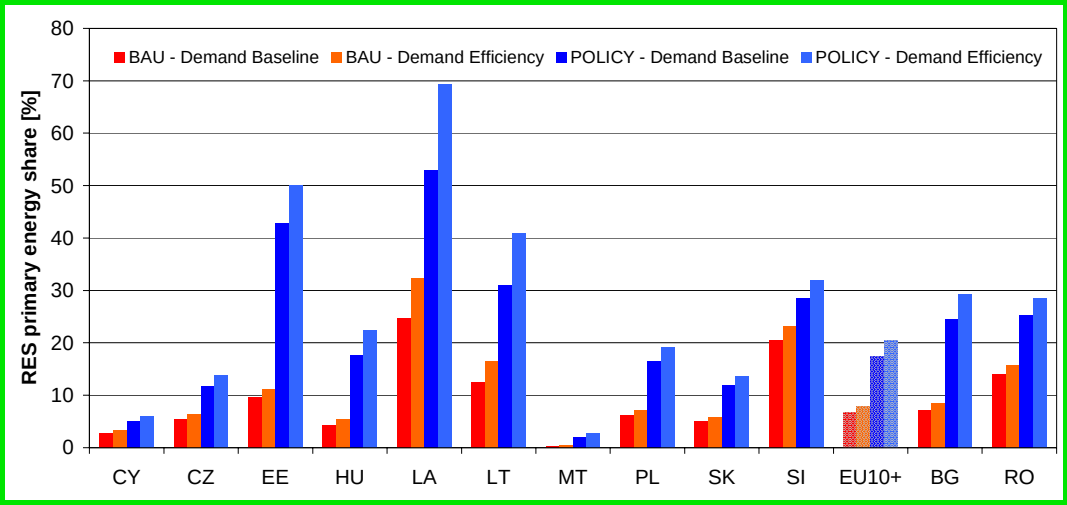


Figure 3: Share of RES primary energy in Candidate Countries in 2020



Main conclusions and implications

Under the policy scenario, a RES share of 32 % in the electricity sector and of 19 % in terms of primary energy (according to EUROSTAT convention) is feasible in 2020, but only if additional policies are implemented quickly in most Member States. For the heat sector, a share of about 21 % is projected under this scenario. However, since the policy scenario is based on a collection of the currently available best practice policies, a higher share could be achieved assuming even more effective policies in the future, especially for heat applications. For the biofuel sector, considerable growth is projected, provided that tax exemptions for biofuels are applied on a large scale. Under the BAU scenario, the RES market share reaches 21 % in the electricity sector and 9 % in terms of primary energy in 2020. This indicates that significant additional efforts are needed to reach a RES primary energy share of about 20 % in 2020.

The growth of primary energy production by RES in the BAU scenario until 2020 leads to reductions in CO_2 emissions of about 260 Mt compared to 2001. Additional emission reductions of 225 Mt can be achieved under the policy scenario by 2020, which corresponds to more than half of the EU-25 reduction commitment under the Kyoto protocol.