The impact of renewable energy policy on **economic growth** and **employment** in the European Union



Summary of the results of the Employ-RES research project conducted on behalf of the European Commission DG Energy and Transport

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This summary gives a brief overview over the study and its results. Many more details on results, approach and assumptions can be found in the full report, which is available at http://ec.europa.eu/energy/renewables/studies/index_en.htm

abbreviations

GDP	=	Gross Domestic Product
RES	=	Energy from Renewable Sources
BAU	=	Business as usual (Projection)
ADP	=	Accelerated Deployment Policy (Projection)
PE	=	Pessimistic Export (Projection)
ME	=	Moderate Export (Projection)
OE	=	Optimistic Export (Projection)
EU-27	=	European Union comprising 27 Member States
O&M	=	Operation and Maintenance

Key results

Policies that support renewable energy sources (RES) give a significant boost to the economy and the number of jobs in the EU. Improving current policies so that the target of 20% RES in final energy consumption in 2020 can be achieved will provide a net effect of about 410,000 additional jobs and 0.24% additional gross domestic product (GDP). This Employ-RES study, which was conducted on behalf of the European Commission's Directorate-General Energy and Transport, is the first study to assess the economic effects of supporting RES in this detail, looking not only at jobs in the RES sector itself, but taking into account its impact on all sectors of the economy.

A scientifically sound approach

The study is based on a sound analysis of the historic situation, based on an input-output model (MULTIREG) that was used to assess the effect of developments in the RES sector on other economic sectors. With regard to future developments the analysis employs a RES-sector bottom-up model (GREEN-X) that was designed to simulate the effect of RES support policies to 2030. In order to calculate future economic effects, two well-established, independent macro-economic models (NEMESIS and ASTRA) were used in parallel and their results were compared for maximum reliability – a unique approach. Both the approach and the results have been peer-reviewed.

All relevant economic mechanisms included

Increased use of RES has various effects on the economy, some of which are positive in terms of employment and economic growth, while others are negative. This study presents both gross and net effects. Broadly speaking, gross effects include only the positive effects in RES and RES-related industries, while net effects are the sum of positive and negative effects. For the net effects, all relevant economic mechanisms are considered:

- Increased investments, operation and maintenance costs and biomass fuel supply for RES
- Reduced investments, operation and maintenance costs in the conventional energy sector
- Fossil fuel imports and use avoided
- Increasing energy costs and their effects on the economy due to reduced competitiveness (industry) or reduced budgets for consumption (consumers and governments)
- Trade in RES technology and fuels among EU countries and with the rest of the world

In 2005 the RES sector employs 1.4 million people and generates € 58 billion value added

The *total gross* value added generated by the RES industry reaches €58 billion in 2005, equal to 0.58% of EU Gross Domestic Product (GDP). The RES sector employs roughly 1.4 million people, equal to 0.65% of the total EU workforce. About 55% of value added and employment occurs directly in the RES sector and 45% in other sectors due to the purchase of goods and services.

Two scenarios for the future: current RES policies and stronger RES policies

The impact on GDP and future employment is shown below for two key scenarios:

- Current RES support policies (Business as Usual (BAU) scenario) lead to a share of RES in final energy consumption of 14% by 2020 and 17% by 2030.
- Stronger RES support policies (Accelerated Deployment Policies (ADP) scenario) lead to a share of RES in final energy consumption of 20% by 2020 and 30% by 2030.
  This shows that, to meet the EU's 2020 target for RES, stronger support policies than those currently implemented are needed.

Both scenarios assume an oil price increasing to $100 per barrel by 2020 ($109 per barrel by 2030) and a price for CO_2 in the sectors covered by the EU Emission Trading System increasing to €34 per ton in 2020 (€44 per ton in 2030), which is in line with the high-price scenario of the European Commission. All prices refer to the base year 2005.

The two scenarios of European RES deployment are combined with three scenarios that represent a possible range of future world market shares taken by European economies in the field of RES technologies: a pessimistic, a moderate (ME) and an optimistic (OE) export scenario.

Net results are calculated by taking into account all the economic effects mentioned above and by comparing the two RES scenarios with a hypothetical scenario where all RES support policies are abandoned as of 2006 (no-policy scenario). Net results are thus additional to the economic effect of RES plants that would have been built without support.

Achieving the 2020 RES target leads to *total gross* value added in the RES sector of about 1.1% of GDP[1]

Assuming business as usual polices and moderate export expectations (BAU-ME scenario), the *total gross* value added of the RES sector in the EU-27 in 2020 would amount to €99 billion (0.8% of total GDP). Based on the Accelerated Deployment Policy scenario (ADP-ME) the value would amount to €129 billion (1.1% of total GDP).

Compared to a situation with no RES policies implemented after 2006, the *additional gross* value added due to RES policies amounts to €22 billion or 0.19% of total GDP for the BAU-ME scenario and €52 billion or 0.44% of total GDP for the ADP-ME scenario.

The *total gross* value added of the RES sector may increase up to €197 billion by 2030 in case of the Accelerated Deployment Policy scenario combined with optimistic export expectations (ADP-OE).

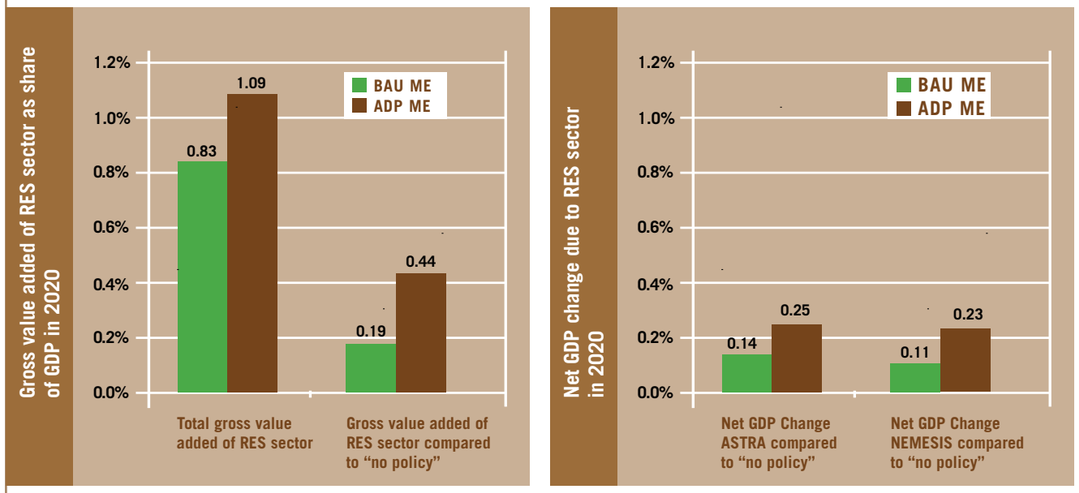
Achieving the 2020 RES target leads to a *net* increase in GDP of about 0.24%

The *net* GDP change due to RES policies in 2020 is expected to amount to 0.11% - 0.14% under the BAU-ME scenario and to 0.23% - 0.25% under the ADP-ME scenario for the EU-27 (ranges according to results of the two models used). Again this is in comparison with a hypothetical scenario in which all RES support policies are abandoned.

1. There are clear policy objectives for 2020, based on the targets agreed in the Renewable Energy Directive for that year. This is why the uncertainty in the future policy scenarios is lower for 2020 than for 2030. The emphasis in this key result section is therefore on the year 2020. Corresponding figures for the year 2030 can be found in Table 1 and in sections 6 to 8 of this summary.

Assuming an accelerated deployment policy combined with optimistic export expectations (ADP-OE) *net additional* GDP compared to the no-policy scenario would amount to 0.44% of GDP in 2030.

Figure 1: Economic growth effects by 2020 in the EU-27 showing the gross value added of the RES sector (left) and the net GDP impact of RES policies (right), both as a ratio of GDP



Achieving the 2020 RES target will deliver 2.8 million jobs in the RES sector in total

Total gross employment in the RES sector in the EU-27 in 2020 will amount to 2.3 million people under the BAU-ME scenario and 2.8 million under the ADP-ME scenario.

Compared to the hypothetical scenario in which all RES support policies are abandoned, the *additional gross* employment due to RES policies amounts to 0.6 million people for the BAU-ME scenario and 1.1 million people for the ADP-ME scenario.

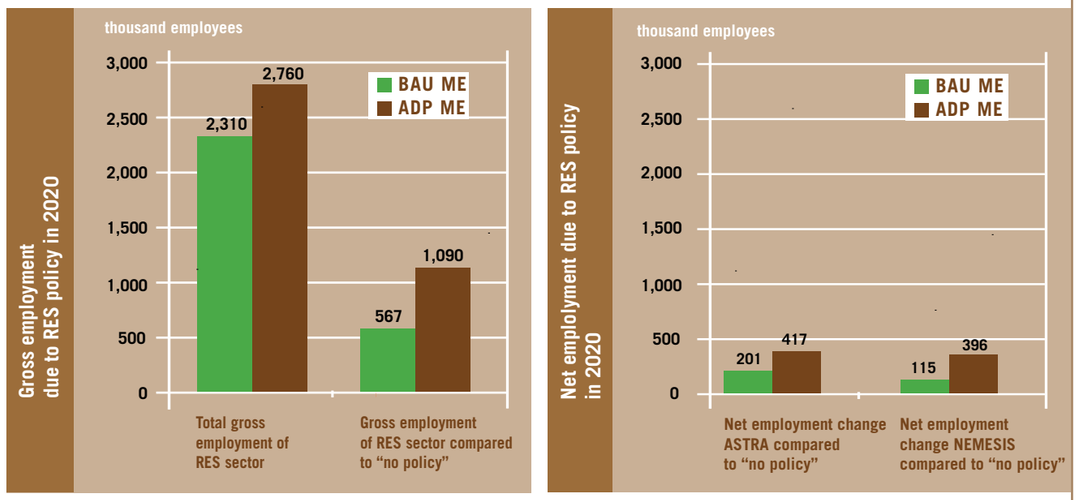
Total gross employment in the RES sector may increase by up to 3.4 million people by 2030 if there is an accelerated deployment policy combined with optimistic export expectations (ADP-OE).

Achieving the 2020 RES target generates about 410,000 net additional jobs

The *total net* increase in employment in the RES sector in the EU-27 in 2020 compared to the hypothetical scenario in which all RES support policies are abandoned will amount to about 115,000 – 201,000 people under the BAU-ME scenario and to 396,000 – 417,000 people under the ADP-ME scenario (ranges according to results of the two models used).

Net additional employment, compared to the no-policy scenario, would amount to 128,000 – 656,000 jobs in 2030 (ranges according to results of the two models used), assuming an accelerated deployment policy combined with optimistic export expectations (ADP-OE). The relatively large difference of this particular result of the two models is mainly due to differences in the way the impact of the energy cost increase on the overall economy is modelled, in particular the modelling of related sectoral shift. More detailed explanations of this aspect can be found in Chapter 8 of this report and in the main report of the study.

Figure 2: Employment effects by 2020 in the EU-27, showing the gross increase in jobs in the RES sector (left) and the net increase in jobs in the whole economy as a result of RES policies (right)



Stronger policies needed to reap maximum economic benefits from RES

Recent strong growth in comparably low-cost biomass and onshore wind projects needs to be sustained, as these technologies are expected to generate most of the near-term future RES production, employment and economic growth.

More innovative technologies such as photovoltaic, offshore wind, solar thermal electricity and second-generation biofuels require more financial support in the short-term, but it is precisely these technologies that are key to achieving the EU's 2020 RES target and higher shares in the future, to maintain the EU's current competitive position in the global market for RES technologies and to increase employment and GDP in the mid term.

Policies promoting technological innovation in RES are therefore essential to strengthen the first-mover advantage of Europe's RES industries. If successful, these technologies can help the EU maintain a higher world market share of RES and the net GDP advantage is expected to be about 10% higher than the figures for 2020 presented above.

This summary gives a brief overview over the study and its results. Many more details on results, approach and assumptions can be found in the full report, which is available at http://ec.europa.eu/energy/renewables/studies/index_en.htm

Overview table: Assumptions and results

Table 1: Key inputs and results of the scenarios analysed in the study

	Key figures at European level (EU27)		Start of modelling	Business as usual (BAU)			Accelerated deployment policies (ADP)		
		Unit	2006	2010	2020	2030	2010	2020	2030
	Energy system characteristics (inputs)								
	Gross final energy demand	Mtoe / a	1,240	1,299	1,416	1,477	1,293	1,174	1,154
	Oil price	US$2005 / barrel	59	76	100	109	76	100	109
	Reference (wholesale) electricity price	€2005 / MWh	61.9	66.8	81.9	82.4	66.0	75.1	70.7
	Reference heat price (grid)	€2005 / MWh	33.0	38.0	53.6	60.5	38.0	53.6	60.6
	Reference heat price (non-grid)	€2005 / MWh	58.0	65.3	85.3	90.7	65.3	85.5	90.9
	Reference transport fuel price	€2005 / MWh	46.1	53.0	75.2	83.6	53.0	75.2	83.6
	CO2 price	€2005 / ton	20.0	20.0	34.2	44.2	20.0	34.2	44.2
	RES deployment. turnover and cost (GREEN-X)								
	Total RES deployment	Mtoe / a	112.5	138.8	196.3	245.9	141.5	239.4	347.5
	RES share in gross final energy demand	%	9%	11%	14%	17%	11%	20%	30%
	RES share in gross electricity demand	%	16%	19%	23%	28%	20%	32%	49%
	RES share in gross heat demand	%	10%	12%	14%	17%	12%	22%	30%
	RES share in transport fuel demand	%	1%	2%	6%	6%	2%	8%	12%
	Average specific generation costs for new RES (in relation to 2006)	%	100%	117%	144%	147%	119%	144%	156%
	Additional generation costs for RES	bln. €2005 / a	5.0	4.7	3.8	5.0	4.8	9.4	18.4
	Avoided CO2 emissions due to RES	mln t / a	674	710	935	1.120	723	1.334	1.792
	Yearly capital expenditures for new RES	bln. €2005 / a	25.5	27.2	40.7	47.4	38.8	63.2	86.4
	O&M expenditures for RES	bln. €2005 / a	11.5	14.5	20.3	25.8	14.8	25.3	39.6
	Expenditures for biomass fuels	bln. €2005 / a	16.0	24.0	47.8	60.7	24.6	57.6	78.4
	Trade relations for RES (transformation module)								
	Avoided fossil fuel imports due to RES	bln. €2005 / a	43.1	62.8	109.5	145.0	64.0	157.6	232.4
	Net exports of global cost components of RES technologies with rest of the world								
	scenario moderate exports	bln. €2005 / a	3.6	5.1	6.6	6.1	5.4	9.0	8.0
	scenario optimistic exports	bln. €2005 / a	3.7	5.6	8.7	12.2	6.0	11.4	17.6
	Macroeconomic impacts of RES								
MULTIREG	Gross value added	bln. €2000 / a *	58						
MULTIREG	scenario moderate exports (gross effect module)	bln. €2005 / a		65	99	122	70	129	188
MULTIREG	scenario optimistic exports (gross effect module)	bln. €2005 / a		65	101	128	70	131	197
MULTIREG	Gross employment	mln. jobs *	1.38						
MULTIREG	scenario moderate exports (gross effect module)	mln. jobs		1.47	2.31	2.34	1.58	2.76	3.36
MULTIREG	scenario optimistic exports (gross effect module)	mln. jobs		1.48	2.34	2.40	1.59	2.80	3.48
ASTRA	Net GDP effect								
ASTRA	scenario moderate exports	% of GDP2020		0.08	0.14	0.30	0.09	0.25	0.40
ASTRA	scenario optimistic exports	% of GDP2020		0.08	0.14	0.31	0.09	0.26	0.44
ASTRA	Net employment effect								
ASTRA	scenario moderate exports	thousand jobs		326	201	300	371	417	59
ASTRA	scenario optimistic exports	thousand jobs		331	213	339	375	432	128
NEMESIS	Net GDP effect								
NEMESIS	scenario moderate exports	% of GDP2020		0.11	0.11	0.15	0.21	0.23	0.36
NEMESIS	scenario optimistic exports	% of GDP2020		0.12	0.13	0.20	0.22	0.25	0.44
NEMESIS	Net employment effect								
NEMESIS	scenario moderate exports	thousand jobs		198	115	188	315	396	545
NEMESIS	scenario optimistic exports	thousand jobs		211	145	262	327	428	656

* past values from 2005

1. Background and objectives

Background

The Commission Communication "An energy policy for Europe"[2] clearly states the points of departure for a European energy policy as: "combating climate change, limiting the EU's external vulnerability to imported hydrocarbons, and promoting growth and jobs". The promotional effect of increased diffusion of renewables on the first two objectives is largely undisputed. Renewables have clearly shown to be an indispensable contribution to greenhouse gas reductions and increased security of supply in Europe.

There is, however, still uncertainty about the exact contribution of renewables to the third cornerstone: promoting growth and jobs in terms of the objectives of the Lisbon Strategy. As stated in the RES roadmap:[3]

"Studies vary in their estimates of the GDP impact of increasing the use of renewables, some suggesting a small increase (of the order of 0.5%), and others a small decrease".

While most policy makers believe that increased use of RES and job creation can permanently go hand in hand, others assume that the distribution effects and the budget effects turn a large gross employment effect into a small or even negative net employment effect.

In December 2008 the Renewable Energy Directive was agreed by the European Parliament and the European Council. This Directive sets ambitious targets for each Member State with the aim of achieving a 20% share of renewable energy in Europe's final energy consumption by 2020. In order to reach this target, it is important to gain further understanding and awareness of the economic and employment benefits from renewables.
The purpose of this study is to support an objective discussion on the effects of enhanced deployment of renewable energies on growth and employment by contributing to a sound scientific basis.

Objectives

The specific aims of the project are to:

- present an analysis of the effects on employment and economic growth due to RES deployment policies
- enhance understanding of the various gross and net employment and growth impacts of (an accelerated diffusion of) renewables
- be highly transparent, using a modelling system with a sound scientific basis in order to create full trust in the quality of the analysis
- validate the methodology, assumptions and results in a scientific peer review, while incorporating stakeholder views through a consultation exercise.

2. Communication from the Commission to the European Council and the European Parliament - An energy policy for Europe {SEC(2007) 12} /* COM/2007/0001 final
3. Communication from the Commission to the European Council and the European Parliament - Renewable Energy Road Map Renewable energies in the 21st century: building a more sustainable future, COM (2006) 848 final, Brussels, 10.1.2007.

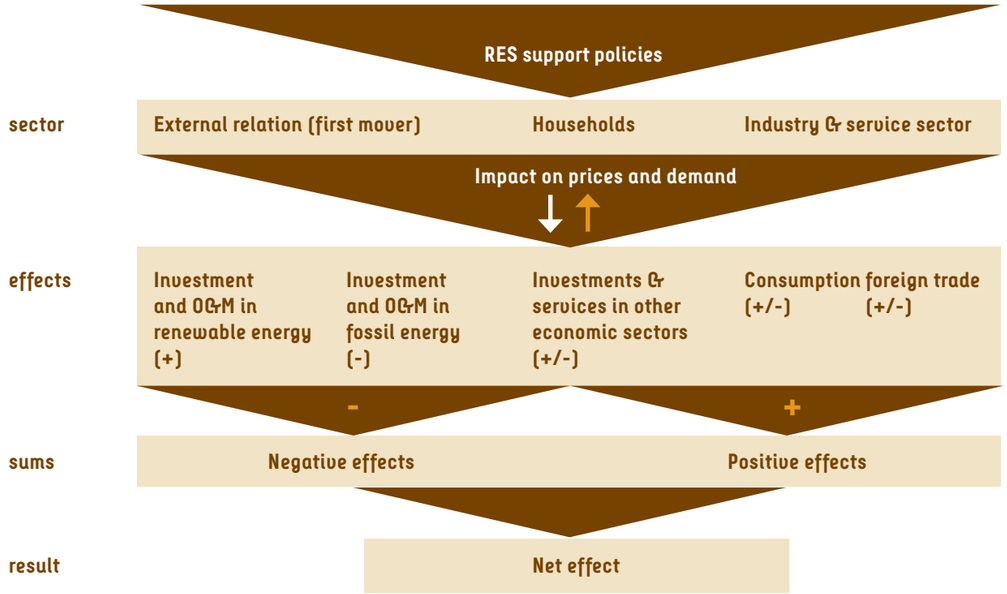
2. The economic effects modelled

Policies promoting stronger growth in RES deployment affect the economy as a whole. The impact of these policies is not restricted to the energy sector. All economic agents and sectors are directly or indirectly affected.
This means that households, industry and services as well as external relationships are influenced by promoting RES deployment. The main effects are changes in prices and demand which in turn have an impact on the output and employment of the economy. They main economic mechanisms are:

- Changes in direct demand for investment as well as operation and maintenance in the renewable and conventional energy sector. The extent of the impact on employment also depends on the productivity of the corresponding sectors.
- Changes in the price of energy for households leads to a relative change in income and consumption patterns (budget and substitution effect) and affects demand for consumption goods, thereby triggering a multiplier effect.
- Change in prices for energy in industry and services affects the delivery of intermediate inputs from the energy sector to industry and service sectors and thus end-user prices of goods and services as well as value added by the industry and service sectors.
- Changes in the export and import trade pattern for fuels and technologies: The extent of changes in export or market shares also depends on the first-mover advantage potential of the technologies and sectors involved.
- New investments normally lead to increases in productivity, reducing the need for labour for the same economic output. Furthermore, promoting new technologies should create an advantage in qualitative competitiveness.

All of these effects lead to changes in the structure of economic output and production and thus affect employment. These rather complex economic mechanisms are presented in a simplified form in Figure 3.
A positive effect (an increase in employment or GDP) is marked with a ⊕ and a negative effect (a decrease in employment or GDP) with a ⊖.The effect on gross employment or GDP includes all the positive effects from RES investments while the effect on net employment or GDP represents the difference between all positive and negative effects in the whole economy.

Figure 3: Main economic effects – a simplified illustration



Note: O&M = Operation and Maintenance

3. The modelling approach

The challenge is to capture all of the economic mechanisms and effects in a series of models. Furthermore, data and developments at a technologically disaggregated level must be connected with economic mechanisms.
The unique approach taken in this study combines technology-specific databases and models with macroeconomic modelling tools. The set of databases and models comprises:

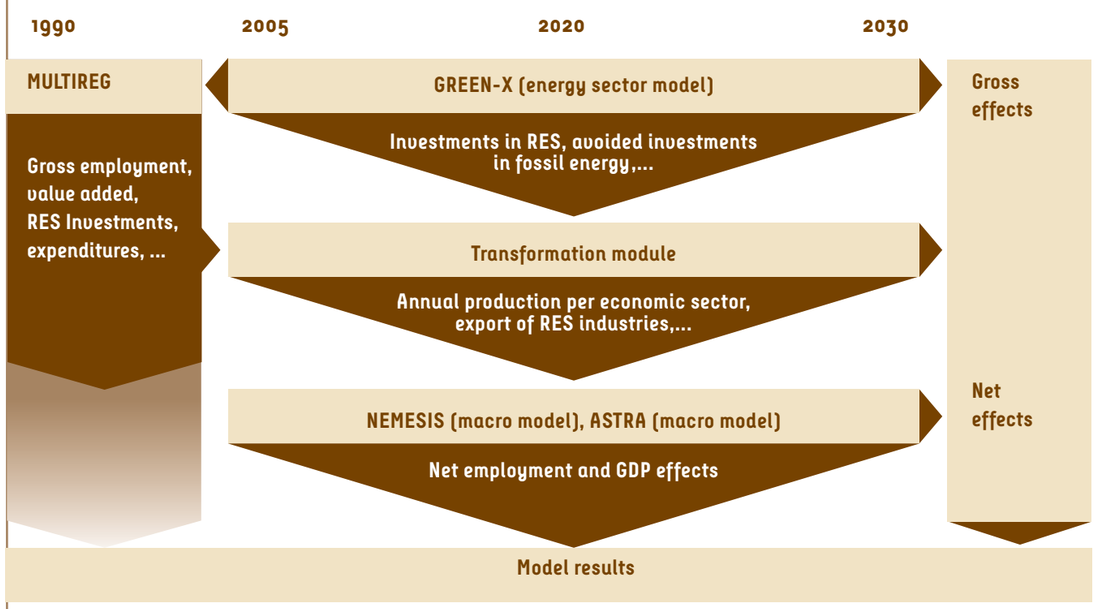
- The Green-X database provides RES deployment and cost data for the past as well as comprehensive information on the future potential and learning rates associated with RES technologies. Detailed future techno-economic simulations based on the Green-X model account for technological learning and technology diffusion under different RES support policy scenarios up to 2030. The Green-X model makes it possible to investigate the future deployment of RES, capital, operation and maintenance and fuel expenditures as well as associated costs per country and technology on an annual basis.
- The MULTIREG model provides the direct and indirect gross value added and employment impacts of historical RES deployment. It makes it possible to identify economic interdependencies between industries within a country and across countries.
- The transformation module translates technology-specific output into impulses for the macroeconomic models. These impulses comprise RES investments and avoided conventional investments, expenses for operation and maintenance, fuel demand and fuel imports avoided, plus additional costs due to RES.
- Furthermore, using a lead market database, market shares for RES technologies are developed for the macro-economic models under different scenarios. Full macro-economic modelling of future economic and employment impacts of RES employs the well-established macro-economic modelling tools NEMESIS and ASTRA. Both are real-world models and use the same data input. However, the different underlying modelling approach taken in each model makes it possible to account for the uncertainties that are inherent in the macro-economic effects:

- NEMESIS is a macro-sectoral econometric model that attaches great weight to neo-Keynesian effects. It consists of a core model that is combined with four further modules. It relies on nested CES-type production functions, applying the production factors capital, labour, energy, and intermediate consumption without energy to a single consumption function.
- ASTRA is a system dynamics-based integrated assessment model which integrates neo-classical production functions with the effects of changing structural demand. It contains nine modules of which a macro-economic module covers and connects the supply as well as the demand side. A foreign trade module covers intra-EU trade and EU trade with the rest of the world.

The modelling of net effects of policies means to feed into the economic systems the direct effects of policies such as investments in energy system, energy prices and trade of RES technologies and fuels which are derived from the Green-X model. Thereby the direct effects stimulate a number of functional chains leading to indirect effects and to changes in the economic system and the trajectories along which the economic variables such as GDP and employment are developing in future. The resulting net effects are measured in terms of GDP, value added and employment. In ASTRA additional investments become a driver of technical progress. In both models energy prices affect the consumption behaviour of private households. In NEMESIS they also enter the trade equations, while in ASTRA they affect the output relations of the energy sector in the input output table. In both models changes of trade of renewable technologies and fossil fuels are included in the trade models on a sectoral level country by country and thus become an element of the sectoral final demand affecting GDP, the input-output tables or production functions.

Figure 4 provides a simplified overview of the modelling approach. The vertical line reflects the data transformation and model output, while the horizontal line shows the time horizon. The figure omits stakeholder consultations and thorough desk research on RES data, market shares in RES technologies, lead market data and further inputs from statistics.

Figure 4: The modelling approach used



4. The characteristics of the scenarios assessed

The scenarios used in this study build on two projections for global RES deployment, three projections for RES deployment in the EU and three projections of European companies' market share in the global RES market.

The two projections for global RES deployment are based on the *reference* and *alternative* scenario in the IEA World Energy Outlook. The IEA *reference scenario* represents a conservative view of future RES deployment based on current energy policies and framework conditions that often give insufficient stimulus for accelerated RES deployment. In the IEA *alternative scenario* RES deployment increases strongly, which requires the translation of current policy targets into effective policies.

The three projections for the RES deployment in the EU are *No-policy, Business as usual (BAU)* and *Accelerated deployment policy (ADP).* These are modelled using the Green-X model. The *BAU* scenario extrapolates on current policies in all Member States, which are inadequate to achieve the agreed target of 20% RES in the EU-27 by 2020. The *ADP* scenario includes strengthened national policies and is consistent with reaching the 2020 target. The *No-policy* scenario serves as a hypothetical reference by modelling the situation in which all existing policies are abandoned.

Three projections of European companies' global market share in RES are made: *pessimistic (PE)*, *moderate (ME)* and *optimistic (OE)* export projections, derived from a database of lead markets and based on expert opinion.

In this study five scenarios, which combine the projections described above in different ways, are assessed. For the combination of projections it is assumed that development at the global and European level will be reasonably consistent: an ambitious development at the global level will make an ambitious development in the EU more likely, because Europe will profit from economies of scale, the existence of large global markets, and the intensive research and development that will take place. The IEA's *Alternative scenario* is therefore combined with the EU *Accelerated deployment policy* projection, and the IEA's *Reference scenario* with the EU *Business-as-usual* projection. These combinations are then combined with both a moderate and an optimistic export projection.

Figure 5: General design of the five main scenarios used in this study

Global RES Deployment scenario: / *EU RES Deployment scenario:*	IEA Reference Scenario	IEA Alternative Scenario
Hypothetical reference (no policy) Projection	No policy Pessimistic export share **1**	
Business as Usual policy (BAU) Projection	BAU-ME Moderate Export share **3** / BAU-OE Optimistic Export share **2**	
Accelerated Deployment Policy (ADP) Projection		ADP-ME Moderate Export share **4** / ADP-OE Optimistic Export share **5**

The five main scenarios analysed in this study are shown in Figure 5 above and are analysed as follows:

1. ***No policy*** - Pessimistic Export share (PE). All existing RES policies in Europe are abandoned while no change in the existing policies is anticipated worldwide. The EU therefore loses its technological competitiveness and its export share falls steeply. This is a hypothetical reference scenario used for comparison.

2. ***BAU-ME*** - Moderate Export share (ME). All existing RES policies are continued (BAU) to 2030, both in the EU and worldwide. As a result, exports in absolute terms increase, but the EU's export share declines over time.

3. ***BAU-OE*** - Optimistic Export share (OE). All existing RES policies are continued (BAU) to 2030 in the EU and worldwide. In order to account for uncertainty about projecting Europe's future export opportunities, this scenario contains more optimistic export assumptions than scenario 2.

4. ***ADP-ME*** - Moderate Export (ME) share. Accelerated deployment policies (ADP) are assumed in the EU and worldwide. The export share is assumed to be the same as in scenario 2.

5. ***ADP-OE*** - Optimistic Export share (OE). Accelerated deployment policies (ADP) are assumed in the EU and worldwide. The export share is assumed to be the same as in scenario 3.

The most important general assumptions:

- Energy demand is in line with 'The European Energy and Transport Trends by 2030' (2007). The *Baseline Case* and *Efficiency Case* have been used as demand projections for the BAU and the ADP scenario, respectively.
- Fossil energy prices are set according to 'The European Energy and Transport Trends by 2030' (2007) high energy price case, e.g. an oil price of $100 per barrel in the year 2020.
- The price of CO_2 in the ETS sector is set at €34/t in 2020 and €44/t in 2030.

Details of these assumptions are provided in the full report.

Renewable energy share, turnover and costs to 2030

This section presents the results of the future deployment of RES within the European Union up to 2030 as well as corresponding costs and turnover derived from the Green-X model.

Stronger policy support needed to achieve 2020 RES targets

Figure 6 and Figure 7 depict the future RES deployment in the EU up to 2030 for the *Accelerated deployment policy* scenario (ADP) and the *Business-as-usual* scenario (BAU). Figure 6 offers a comparison of RES deployment in absolute terms for selected years for both policy variants, whereby RES generation is split into the energy sectors heat, transport and electricity. Complementary to this, in Figure 7 the share of electricity from RES, heat from RES, energy used in transport from RES and RES in total in terms of the corresponding gross demand is shown for both policy options. Key findings include:

- Whereas the ADP scenario achieves 20% RES in final consumption by 2020 (30% by 2030), in the BAU scenario the EU targets are not achieved (14% by 2020 and 17% by 2030). Besides proactive RES support and framework conditions, vigorous energy efficiency measures appear to be beneficial in achieving the EU's RES commitment at low to moderate cost. Such measures are assumed in the ADP scenario.
- The RES electricity sector will contribute substantially to the achievement of the 20% RES target: 34.6% of gross electricity demand in the ADP scenario, with growth continuing to almost 50% in 2030. Novel technology options like wind offshore, concentrating solar power and photovoltaics, require increased RES policy support and improved framework conditions (as assumed in the ADP scenario) in order to provide significant contributions to Europe's energy supply in the years ahead.
- A significant contribution to achieving EU targets is also expected to come from RES in the heat sector (21.7% of gross heat demand by 2020 in the ADP scenario), which requires strongly accelerated growth compared to current trends (14.2% of gross heat demand by 2020 under BAU conditions). Growth in RES heat is expected to continue in the period beyond 2020, achieving a share of 30% by 2030 in the ADP scenario – compared to 17.2% under a BAU policy framework.
- According to the ADP scenario, the share of biofuels in transport fuel demand is expected to rise continuously, reaching 8% in 2020 and 12.3% by 2030. In the BAU scenario the biofuel share will reach saturation point at 6.4% after 2020.

Figure 6: RES deployment in absolute terms up to 2030 within the EU-27 in the Business as Usual (left) and the Accelerated Deployment Policy scenario (right)

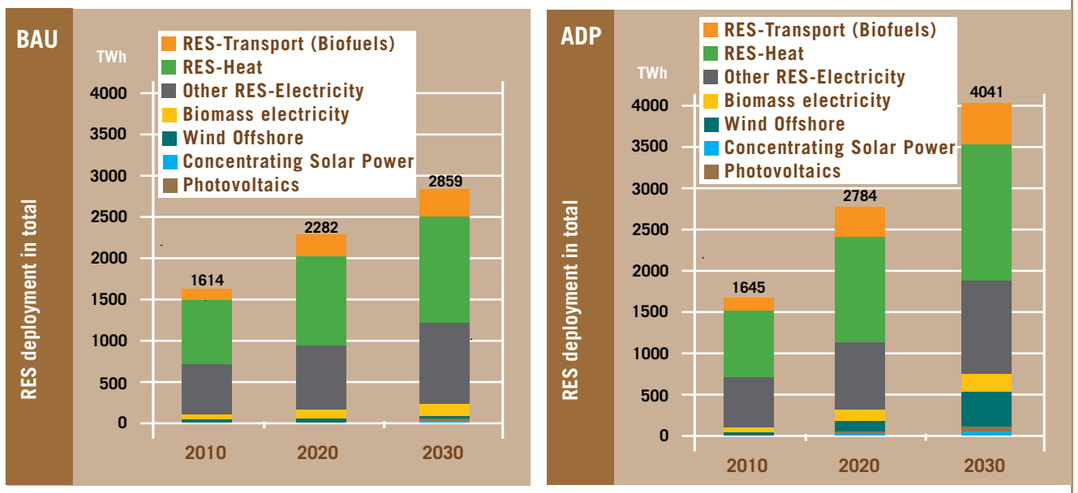
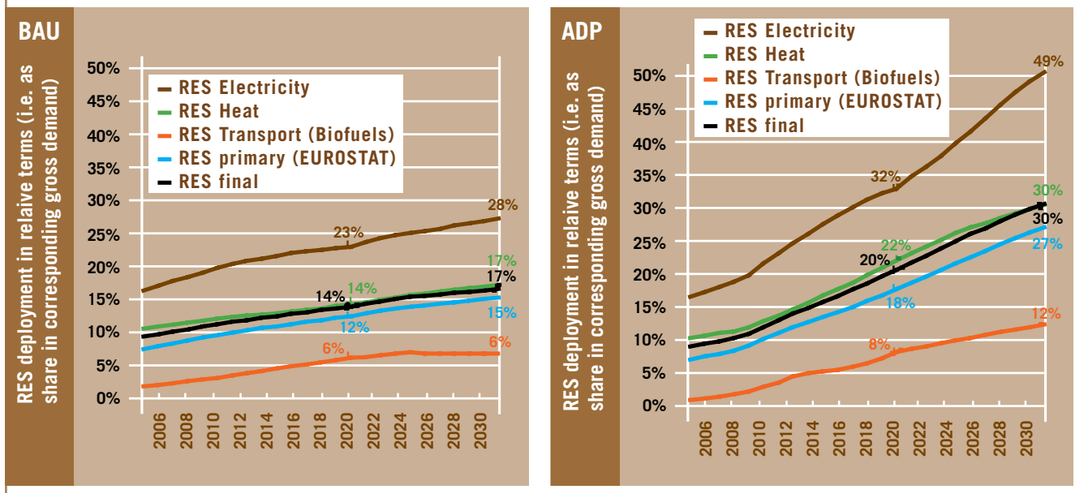


Figure 7: RES deployment at a sectoral level and in total - expressed as shares in corresponding gross demand up to 2030 within the EU-27 in the Business as Usual (left) and the Accelerated Deployment Policy scenario (right)

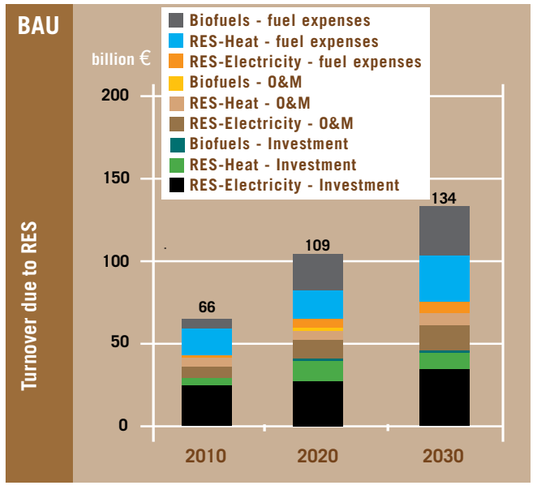


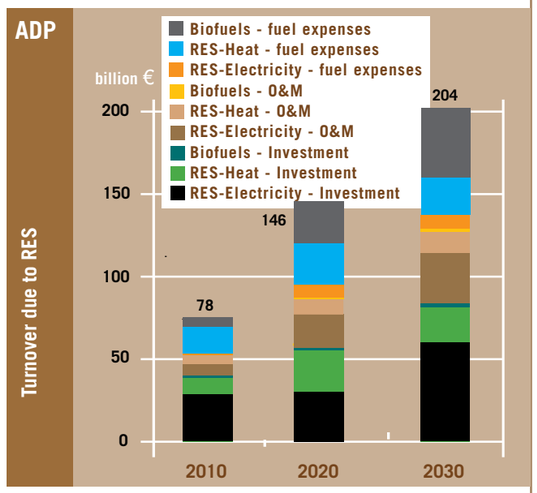
Strong increase in RES turnover

The increasing share of RES in the energy mix will be accompanied by strong growth in economic activity in the RES sector. In particular, investments in new capacities as well as expenditures for operation and maintenance (O&M) and fuels (i.e. referring to the energetic use of biomass) will grow strongly in forthcoming years.
Figure 8 depicts the future development of RES-related turnover at the EU level for the BAU and the ADP scenario, broken down at the sectoral level into expenditures for investments, O&M and biomass fuels.

Overall turnover will increase steadily to €109 billion by 2020 and further grow up to a level of €134 billion in 2030, assuming a continuation of current RES support (BAU). With a strengthened policy framework (ADP), comparatively stronger growth in RES-related turnover can be expected, achieving €146 billion in 2020 and €204 billion by 2030. While fuel expenditures dominate under BAU conditions, investments in capacity additions make up most in the ADP scenario.

Figure 8: Development of investment, O&M and fuel expenditures for RES up to 2030 in the EU-27 in the Business as Usual (left) and the Accelerated Deployment Policy scenario (right)





Investments in new RES capacities cumulate during 2006 to 2030 to about €900 billion in the BAU scenario and €1530 billion in the ADP scenario. In both scenarios about two thirds of these investments are made in the electricity sector (including combined heat and power plants) where novel technology options deserve key attention, especially with improved support conditions (ADP). Expenditures in O&M cumulate to about €470 billion under BAU conditions and €600 billion in the ADP scenario. Biomass fuels dominate overall turnover in the BAU scenario with a cumulated expenditure of approx. €1020 billion. The corresponding figure for the ADP scenario is €1210 billion.

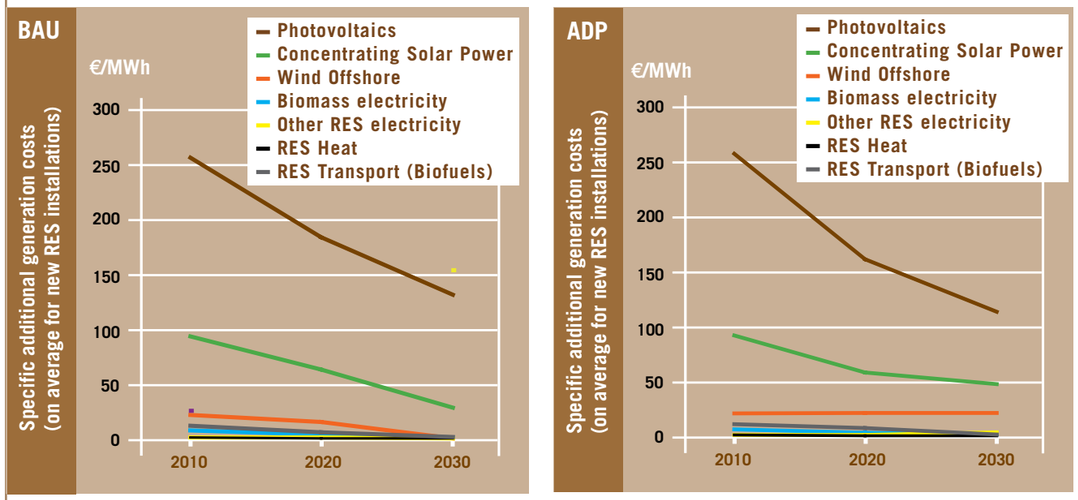
Additional generation costs, especially for innovative RES technologies

Additional generation costs are the cost of producing one unit of RES minus the cost of producing one unit of energy with a (conventional) reference technology. The development of the average additional generation costs at EU level in the period up to 2030 is shown for both scenarios in Figure 9 in specific terms, i.e. per unit of RE energy produced. This graph includes besides average figures on sectoral level also details for selected innovative RES technology options. Key findings include:

- Total additional generation costs remain moderate. In particular, in those RES technologies that are currently characterised by a high degree of market maturity additional generation costs are very low, due to the moderate to high (conventional) energy prices assumed in these scenarios. The moderate-to-high (conventional) energy prices are also the reason why there is comparably high deployment of RES even in the no-policy scenario.
- For all technologies, but especially for innovative ones, a decline in specific additional generation cost over time is apparent. Two trends are relevant in this respect: For the bulk of mature RES technologies the assumed increasing energy prices on the conventional market appear to be relevant, while for innovative RES options technological learning due to the accelerated market deployment is more important for the rapid decline in additional generation costs. At first glance, the lower specific cost for wind offshore in the BAU case compared to the ADP scenario seems surprising. This is the result of massive deployment in the latter case and, consequently, using sites which are more distant from shore and more expensive to exploit.
- In the BAU scenario the level of total additional costs can be maintained at rather constant levels of about €5 billion per year up to 2030, despite the fact that expensive solar technologies are brought into the technology portfolio.
- In the ADP projection to 2030 the total additional generation costs increase up to a level of €18.4 billion per year. This is mainly based on four technologies whose deployment increases rapidly after 2015: photovoltaics, wind offshore, concentrating solar power and liquid biofuels. The additional costs in this scenario are therefore associated with significant development of innovative technologies with considerable potential in the long term.
- The additional generation costs in the RES heat sector are very low compared to the electricity and biofuel sector.

- The cumulative additional generation costs for RES for the overall period 2006 to 2030 amount to about €80 billion in the BAU and €210 billion in the ADP scenario.

Figure 9: Development of specific additional generation costs up to 2030 in the EU-27 in the Business as usual (left) and the Accelerated Deployment Policy scenario (right)



6. Past and present gross economic and employment effects

The gross effects of RES use provide an impression of the size or economic relevance of the RES industry (in terms of value added and employment) and the industries that depend on it as suppliers. The direct gross effect relates to the economic sectors and activities directly involved in investment in RES plants, their operation and maintenance and the production of fuels for biomass technologies. The indirect gross effect includes the industries involved in the supply chains of the (direct) RES industry. The calculation of gross effects therefore includes all RES-related economic activities and all currently available and future RES technologies.

The main economic activities along the supply chain are grouped into:
- installation of new and replacement of existing RES plants
- operation and maintenance (O&M) of RES plants
- production of fuels for biomass technologies

The current and future technologies are classified into the three sectors:
- electricity generation
- heat generation
- energy in transport

In 2005 the RES sector employs 1.4 million people and generates € 58 billion value added

Since 1990 the RES industry has seen substantial growth, mainly due to public promotion policies. The fivefold increase in investment expenditures for new RES plants to almost €30 billion in 2005 was the main driver for this expansion. But operational and maintenance expenditures also increased continuously, due to the growing number of plants in operation. Furthermore, European suppliers gained considerable global market shares in booming RES technology fields such as wind and photovoltaics. Total value added generated by RES deployment has roughly doubled since 1990. Due to increasing labour productivity, total employment has grown by approximately 40%.

This development has led to the establishment of a strong cross-sectoral RES industry in Europe. It comprises all the activities needed for planning, manufacturing and installing facilities that use RES, for operating and maintaining them and for supplying them with biomass (direct economic impact). It is furthermore connected with several industries that form its upstream supply chain (indirect economic impact).

In 2005 building and operating RES facilities contributed about 0.6% to total GDP and employment in Europe. About 55% of this impact is directly related to the RES industry, 45% are related to the supply chain industries. In absolute numbers RES deployment leads to a gross value added of €58 billion and 1.4 million people employed. With 0.9 million people employed, small and medium-sized enterprises have a significant share of two-thirds of this employment impact. As important suppliers of biomass, agriculture and forestry roughly employ 200,000 people. Other important economic sectors involved are the investment goods manufacturing industry, construction and trade.

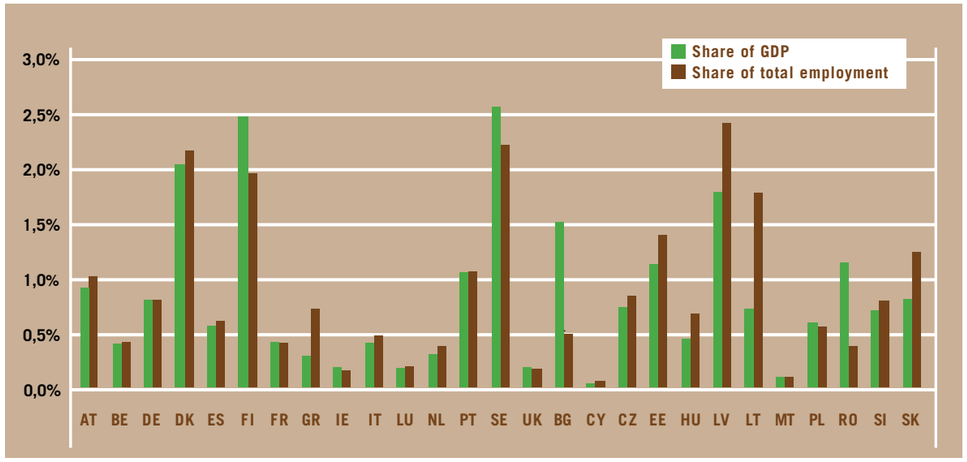
Table 2: Overview of gross economic and employment impacts in 2005 in the EU-27

		Direct impact	Indirect impact	Total impact
Gross value added	bln. €2000	31.9	26.4	58.3
Employment	mln. employees	0.8	0.6	1.4
Employment in SME	mln. employees	0.5	0.4	0.9
Employment in Agriculture/Forestry	mln. employees			0.2
Relative impacts:				
Gross value added compared to total GDP		0.32%		0.58%
Employment compared to total employment		0.36%		0.64%

The significance of RES sector varies among Member States

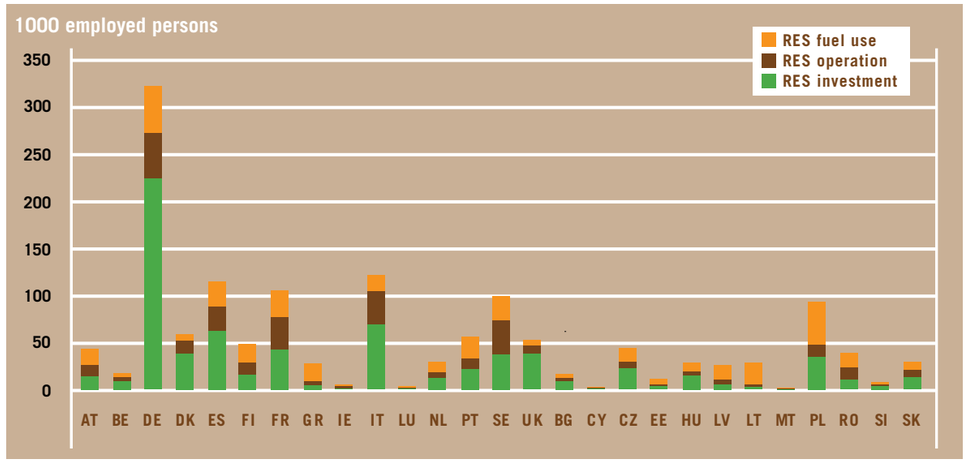
The economic relevance of the RES industry varies strongly among countries as shown in Figure 10 and mainly reflects the differences regarding RES deployment level, technology structure and differences in market shares of the RES industries. Shares in GDP and total employment vary from almost zero in countries such as Cyprus and Malta to almost 2.5% in countries such as Finland, Sweden or Latvia, which partly are characterised by an extended use of biomass. The differences between the GDP and the employment shares reflect the relationships between RES-related labour productivities and average labour productivities in the different countries.

Figure 10: RES-related gross economic and employment impacts in EU Member States, 2005



In absolute terms the economic impact in the EU is currently dominated by Germany, which has the largest share of RES-related expenditures and, with 320,000 employed, accounts for roughly one quarter of the total employment impact (Figure 11). The figure also shows the different employment patterns in the EU countries regarding the contributions of investment, operation and maintenance and biomass fuel use.

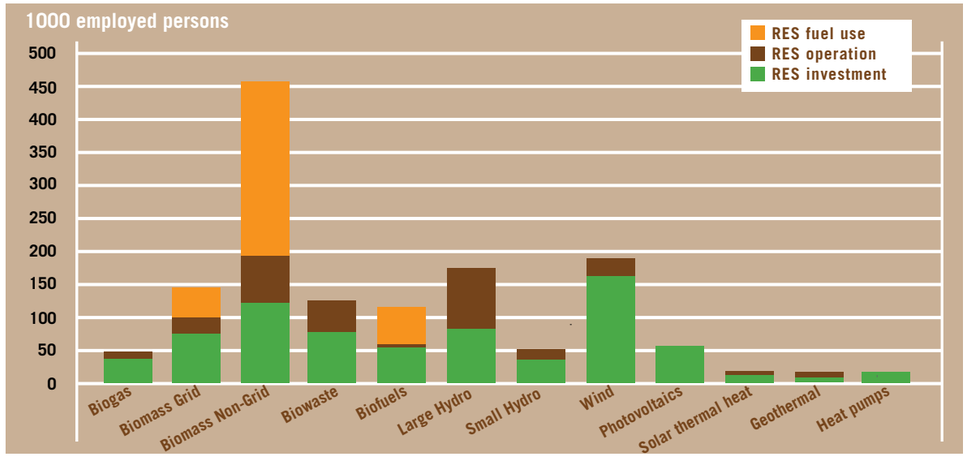
Figure 11: Gross employment impact of RES deployment in 2005 by Member State and RES expenditure category



Biomass, wind and hydro most important for current employment

Figure 12 finally shows the distribution of total employment by technology. It highlights the significant role of biomass technologies for employment generation and especially of its decentralised non-grid-use. Over 60% of the total impact is due to biomass technologies. The major share of employment is triggered by the supply of biomass for fuel use. This share is subject to considerable uncertainty, since significant amounts of biomass for non-grid use appear not to be purchased at market prices, but may be obtained from own resources or informal channels, especially by private households. This study assumes that 50% of biomass obtained by private households is purchased at market prices.

Figure 12: Gross employment impact of RES deployment in 2005 by technology and RES expenditure category



7. Gross economic and employment effects to 2030

Clear increase in gross employment and value added with stronger RES support

The past and future gross effects on value added and employment in the EU27 are depicted in Figure 13 and 14, respectively. While for the past development of the gross effects there is only one result per year, for the future effects the results for each year will be shown for three of the five scenarios described in section 4. The results of the two other scenarios (optimistic export projections) are described in detail in the final report.

- The results show a clear increase in employment and value added under RES-promoting policies.
- Differences between the development of the value added and employment are owing to diverging labour productivities in the economic sectors and technologies. For example, biomass fuel is responsible for a larger share in total employment than in total value added since labour productivity in the agricultural and forestry sector is clearly lower than in other RES-related sectors.

- Currently, employment is more triggered by traditional biomass fuels. As future biomass potentials are limited, this sector clearly looses in relative significance over time.
- Future employment growth, especially in the years after 2020 is mainly triggered by investments which are due to the use of technology- and knowledge-intensive RES generation technologies under strong RES promotion policies in the ADP scenario.
- Even in the *No-policy* scenario employment increases, but stays far below the employment in the *BAU* and *ADP* scenario.
- In the *BAU* scenario gross employment reaches a saturation point at around 2025, while it continues to grow in the *ADP* scenario.
- The impact of biomass fuel use on the results for value added and employment depends on the assumption of the ratio of commercial and non-commercial biomass production. In this study 50% of total biomass use is assumed to be non-commercial until the year 2010. For the future non-commercial biomass use will only be assumed for the currently existing stock of non-grid biomass boilers.
- In the case of an optimistic export projection (OE) an additional increase of value added of €9.6 billion and 113,000 jobs can be expected for the ADP scenario in 2030. Increased exports in particular in knowledge-intensive RES technologies are the main driver for this development.
- About two thirds of the jobs created in the RES sector are based on small and medium-sized enterprises (SME).

Figure 13: Past and future gross value added for the EU-27 by economic activity

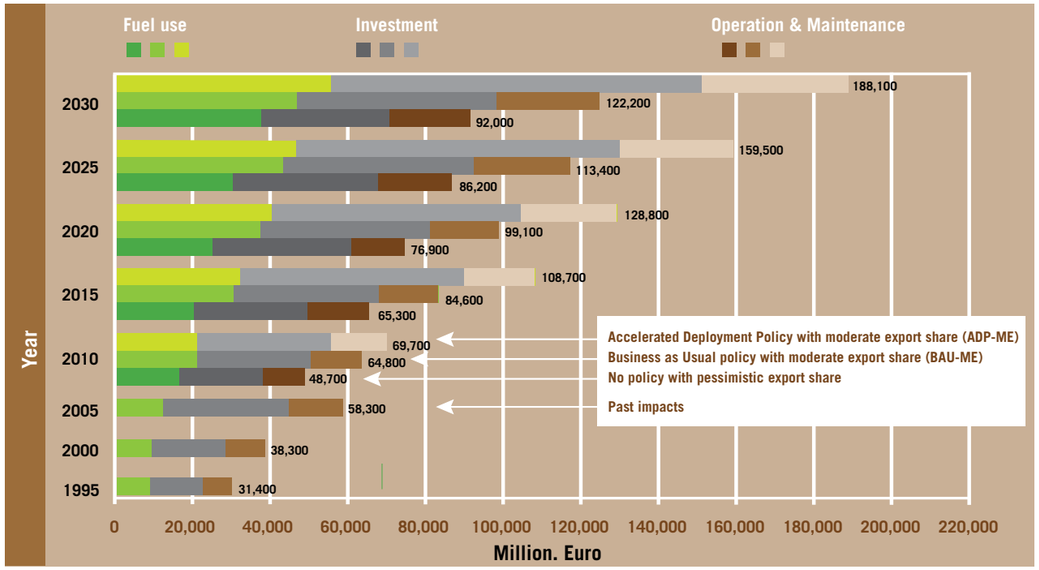
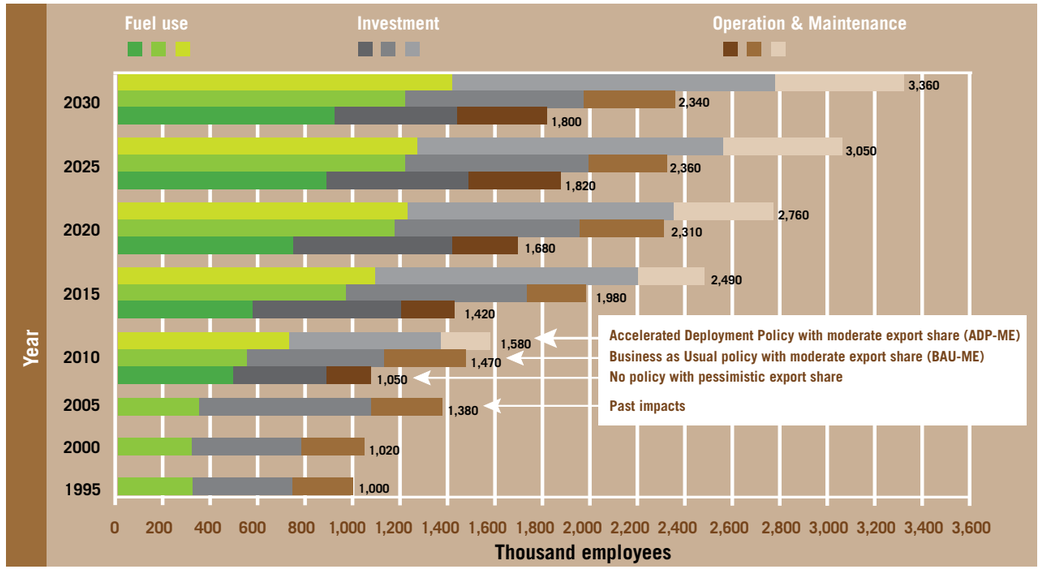


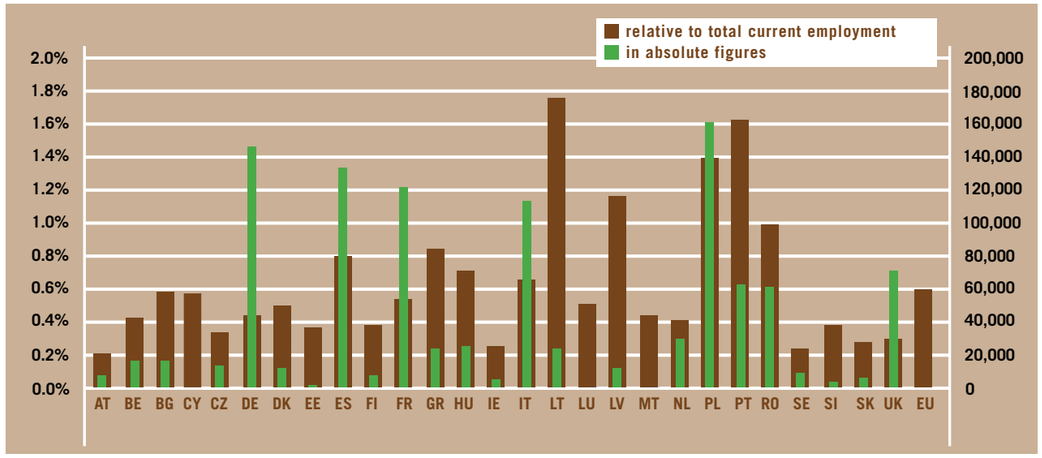
Figure 14: Past and future gross employment in the EU-27 by economic activities



Large relative employment increase especially in New Member States, high absolute increase in large countries.

In Figure 15 below the increase in gross employment is depicted for the individual Member States in absolute figures for 2020 and in relation to employment in 2007. The relative impact is especially large for Eastern European countries, while the impact in absolute figures is – as anticipated - strong in countries with a large population. All countries benefit from RES promotion according to their comparative cost/production advantages.

Figure 15: Absolute differences in employment between the scenarios ADP-ME and No-policy for 2020 by countries and in relation to total employment in 2007

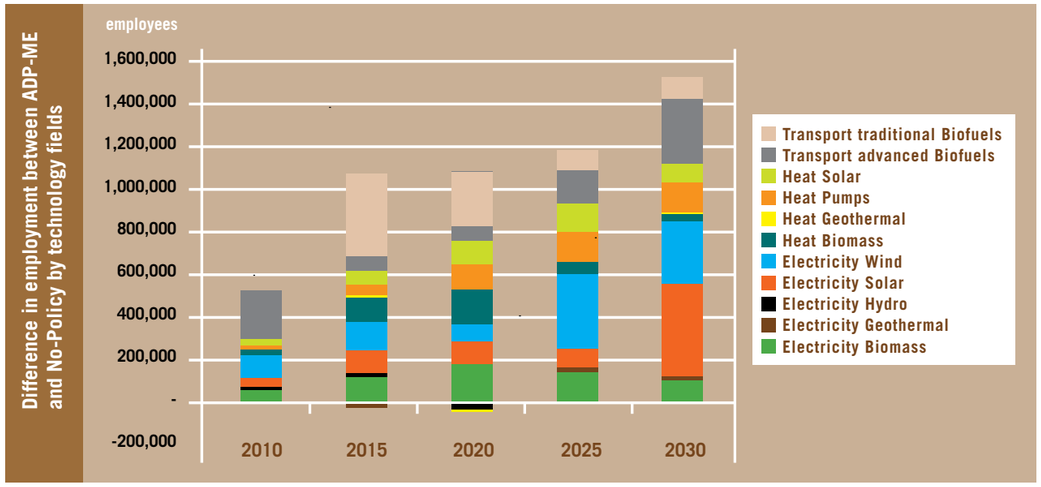


Future employment depends on stronger policy support for innovative technologies

Regarding the employment effects per technology, it becomes clear that current RES policies (BAU-ME) do not provide sufficient impulses to push future development of and employment in research and knowledge-intensive technology while a strong RES promoting policy such as in the ADP scenario triggers development and employment

in knowledge-intensive and competitive technologies in the future. As Figure 16 shows, a strong increase in RES technologies such as wind power, photovoltaics and solar thermal electricity is responsible for roughly 50% of the gross employment increase in 2030 compared to a No-Policy situation. The technology pattern of RES deployment under this ADP-ME scenario reflects (and justifies) the high promotion and hence the additional generation costs for these knowledge-intensive technologies (see section 5) which are being established successfully in the market, contributing to export and technological competitiveness and thus also to employment.

Figure 16: Differences between the scenarios ADP-ME and No-policy in EU-27 by technologies



8. Net economic and employment effects to 2030

The net effects of RES policies on the economy have been analysed, based on the models NEMESIS and ASTRA. In both models the investments become part of the sectoral final demand and indirect effects of investments are spread into the economy. The main indicators selected to present the net effects of the RES policy are gross domestic product (GDP) and employment.

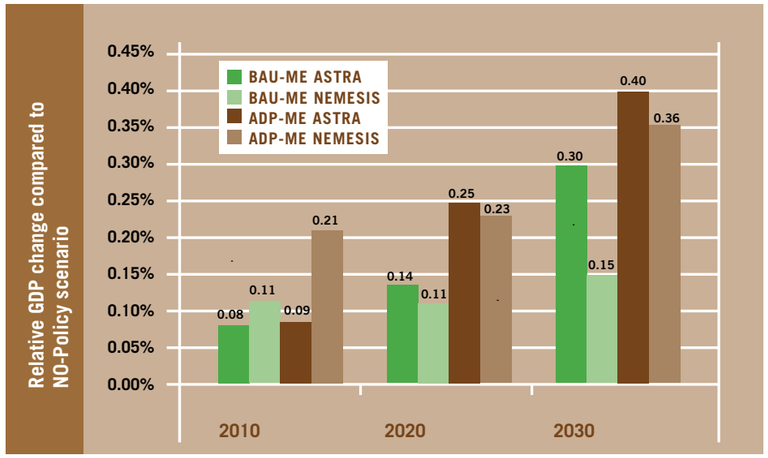
RES policies have a slight effect on stimulating GDP

The main conclusion is that GDP would be slightly stimulated by the RES policies. Figure 17 shows the impact of policies designed to foster RES on the development of the GDP for the EU-27. The results of the two macro-economic models ASTRA and NEMESIS used in this study are shown. The main effects on GDP can be summarised as follows:

- Current RES policies (BAU-ME) in EU Member States result into an increase of GDP by 0.11% - 0.14% by 2020 and by 0.15 % - 0.30% by 2030.
- More ambitious policy assumptions (ADP) result in an even stronger increase of the GDP by 0.23% - 0.25% in 2020 and 0.36% - 0.40% in 2030 for the case of a moderate development of exports (ME) of RES technologies.
- In the case of more optimistic assumptions on future exports (OE) the ADP scenario leads to an increase of the GDP by 0.25% - 0.26% by 2020 and 0.44% by 2030.
- The results for ASTRA and NEMESIS are rather consistent revealing larger differences only for 2030 in the BAU scenario. In the short run, i.e. until 2010, the NEMESIS model projects more positive development, while in the longer run the ASTRA model generates higher GDP growth.

- Looking at the component analysis of GDP growth, it can be seen that the increase of GDP is most strongly influenced by the investment impulse as well as by the improved trade balance. The energy price increase is less effective in influencing GDP development.
- At the country level, the impacts depend on both the country-specific economic system, which does not behave exactly the same in both models, and the impulses fed into the models. Some countries may be stimulated more positively than others, because (1) the investment and trade impulse is significant in relation to their GDP, (2) the investment impulse is significant in relation to their general investment, or (3) the energy price increase remains moderate (i.e. +1-2% compared to no-policy) because due to country specifics only RES technologies with low additional generation cost will be deployed.

Figure 17: GDP impact of RES policy for the scenarios BAU and ADP, using moderate export assumptions



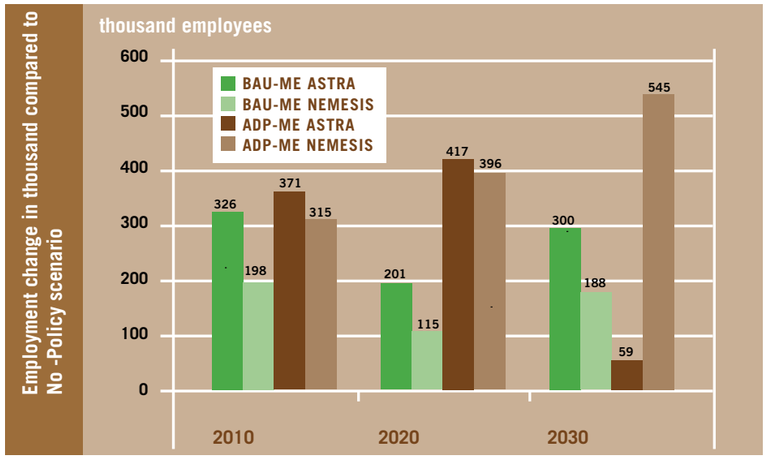
RES policies slightly stimulate employment

For employment the basic conclusion is that it would also be slightly stimulated by RES policies, but the effects would be moderate compared to the GDP effects. Figure 16 shows the impact of policies for renewable energy sources on the development of the employment for the EU-27. The main results can be summarised as follows:

- Business as usual RES policies (BAU-OE) in EU Member States combined with moderate export expectations result into a roughly constant positive employment effect of 115,000 – 201,000 employees in 2020 and 188,000 – 300,000 employees in 2030.
- The ADP scenario combined with moderate export expectations leads to a slightly higher increase of averaged employment by 396,000 – 417,000 employees by 2020 and by 59,000 – 545,000 employees in the las years before 2030. In general, the models generate comparable results, apart from those for 2030.

- The shifts of demand between different economic sectors as well as the moderate energy cost increase in the ADP scenario result in additional employment caused by RES policies not growing compared to the GDP. In the ASTRA model the stronger impact of the energy cost increase after 2026 significantly dampens the employment increase.
- The effect on employment strongly depends on the energy cost increase. If there are significant cost increases, these may dampen the employment increase. This is more obvious and dominant in the results of the ASTRA model for the case of employment in the last years, while the impact on GDP was less significant.
- At the sectoral level, the areas in which employment increases most due to RES policy would be the agriculture and the energy sector, the former due to increased demand for biomass, the latter due to the higher labour intensity of RES and increased expenditures on electricity. Sectors losing employment would suffer from the higher energy expenditures of households, the higher sectoral elasticities in response to higher goods prices driven by energy cost increases and the prevailing budget constraint of households. Examples would be the trade and retail sector as well as the hotels and restaurant sector.

Figure 18: Employment impact of RES policy for the scenarios BAU and ADP, using moderate export assumptions



Similar conclusions from the NEMESIS and ASTRA model

In general, the NEMESIS and the ASTRA model arrived at comparable conclusions concerning the probable slightly positive effect of the RES policy on economic growth and employment in the EU. In particular, this holds true for the investment impulse, which generates the strongest positive stimulus in both models. The difference between the models, which becomes apparent in particular for the case of the additional employment after 2020, is based mainly on the different impact of the rising energy cost increase on the overall economy. In NEMESIS energy cost are an influencing factor in the trade model in such a way that higher energy prices reduce competitiveness and thus exports, and to some extent diminish household consumption. In ASTRA, the energy costs have to be compensated for mainly by changes in the marginal consumption of households. This leads to sectoral shifts of consumption away from labour intensive sectors. Thus, the stronger impact of increased energy costs on employment in ASTRA is mainly caused by sectoral shifts of consumption. In this respect the results of the ASTRA model can be considered to give a more conservative view on the possible impact of renewable energies on employment. Thus, the results of the two models depict a possible range of the impact of strong renewable energy policies on the economy.

9. Policy conclusions

Increased confidence in the economic impacts of RES

This study delivers the first detailed analysis of all the macroeconomic effects of RES deployment at EU level. It analyzes the past, present and future employment and economic impacts of RES policies in the EU, looking at both gross (direct and indirect) and net effects (including both conventional replacement and budget effects). In this respect it helps to bridge substantial knowledge gaps about the overall economic implications of RES policies in Europe.

The high current economic benefits of the RES sector will continue to grow in the future ...

The study shows that the RES sector is already a very important one in terms of employment and value added. New industries with a strong lead market potential have been created, which contribute about 0.6% to total GDP and employment in Europe. This development is likely to be accelerated if current policies are improved in order to reach the agreed target of 20% RES in Europe by 2020.

...if support policies stimulate innovative technologies in the right way

Despite the large gross figures in terms of employment and value added, the net figures are significantly smaller due to replaced investments in conventional energy technologies as well as due to the dampening effect of the higher costs of renewable energies compared to conventional ones. Currently the strong investment impulses - based on installations in Europe and exports to the rest of the world - dominate the economic impact of RES policies and therefore lead to positive overall effects. In order to maintain this positive balance in the future it will be necessary to uphold and improve the competitive position of European manufacturers of RES technology and to reduce the costs of renewable energies by exploiting their full learning potentials. Therefore policies which promote technological innovation in RES and lead to a continued and rapid reduction of their costs will be of major importance. Besides implementing strong policies in the EU, it is essential to improve the international framework conditions for RES in order to create large markets, exploit economies of scale and accelerate research and development.

The benefits of RES regarding the security of supply and mitigating climate change can go hand in hand with economic benefits

Two objectives for increasing the share of RES are the reduction of CO_2-emissions and other environmental impacts and the increased security of supply due to reduced dependency on imported fossil fuels. It is often stressed that these two key energy policy objectives – security of supply and environmental sustainability – should be targeted without sacrificing the third one - economic sustainability. It is therefore of immense value that increasing the share of RES not only does not harm the economy, but actually benefits it by creating jobs and increasing GDP. Besides the CO_2-price in the EU Emission Trading System, the economic value of RES benefits in terms of their contribution to the environment and security of supply are not included in the analysis. If these so-called external costs and benefits were included, the economic benefits of RES would probably be even higher.

"Policies that support renewable energy give a significant boost to the economy and the number of jobs in the EU. Improving current policies so that the target of **20% renewable energy in final energy consumption in 2020** can be achieved will provide a net effect of about **410,000 additional jobs and 0.24% additional gross domestic product.** This Employ-RES study, which was conducted on behalf of the European Commission's Directorate-General Energy and Transport, is the first study to assess the economic effects of supporting renewable energy in this detail, looking not only at jobs in the renewable energy sector itself, but taking into account its impact on all sectors of the economy."

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