European Commission

Overview Report

Meeting the Targets & Putting Renewables to Work

MITRE
Monitoring & Modelling Initiative on the Targets for Renewable Energy

ALTENER Programme
Directorate General
for Energy and Transport
European Commission

More information can be obtained
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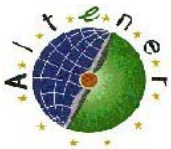

The Challenge

MITRE has set out to monitor the European Union renewable energy targets and to inform key policy and decision makers of the employment benefits of a proactive renewable strategy. The challenge is encompassed in the MITRE mission statement:

Meeting the Targets & Putting Renewables to Work

With positive action, the targets can be achieved, but the timeframe in which to implement these strategies is not long. The benefits of renewable energy growth are large, with potentially more than a million new jobs being created by the European renewable industry by 2010, coupled with increased European competitiveness and technological expertise, and improved security and diversification of supply. MITRE will achieve its goals if it helps to increase awareness of renewables in governments, promotes positive policies and expands the integration of renewable energy in Europe.

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Editorial

The rationale for the promotion of renewable energy technologies in the EU has focused on their potential contribution to the security of energy supply and environment. Increasingly, however, there is awareness that the widespread deployment of renewable energy technologies has the potential to offer additional benefits, such as improved industrial competitiveness and the development of a strong export industry, regional development and the creation of employment, especially in more remote areas. Agricultural regions in particular can benefit from the stimulation of biomass industries to halt the decline in jobs, by encouraging a switch from traditional food crop production to non-food biomass production.

In its White Paper and Action Plan on Renewable Energy Sources in 1997[1], the European Commission put forward the objective to double the contribution of renewable energy sources in Europe by 2010, to 12% of gross inland consumption. The Campaign for Take-Off, launched in 1999, presents detailed priorities for initiatives to achieve this objective. The rationale for the Action Plan is not only driven by the environmental dimension, but also by the important economic, employment and social benefits that an increase in renewable energy use can bring about.

A number of studies have looked at the impact of renewable energy on patterns of employment - these have generally investigated the effects of renewables either at the individual technology level, or in a specific region or country. Most studies have focused on direct employment benefits from renewable energy - i.e. they considered jobs at the plant level, and/or in manufacturing and associated industries. However, generally such studies have not identified the implications for employment of a subsequent decrease in energy use from conventional sources, nor have they considered the economic impacts of support given to renewables on the rest of the economy, nor have they analysed disaggregated employment effects (e.g. by skill level).

There is therefore a need to provide quantitative information to policy makers involved with renewable energy and interested in its impact on the wider economy - for example, what kind of impacts occur, in terms of jobs/GWh output or jobs/MW installed, as a result of investment in renewable energy? Renewable energy is now recognised as an important mainstream industry, and as such it must therefore compete with other sectors for public and private investment. A detailed understanding of the economic benefits provided by renewable energy is important for decision-makers in national, regional and local planning.

Despite the increase in RES output, and because total European energy consumption is rising so rapidly, renewable energy's share in the EU's overall energy output has hardly increased during the last few years, and is unlikely to meet its specified targets in 2010 unless careful attention is paid to promoting and accelerating the adoption of renewables. Therefore, it is important to monitor the share of renewables in the EU's energy mix and understand the

[1] Communication from the Commission, Energy for the Future: Renewable Energy Sources of Energy, White Paper for a Community Action Plan COM(97)599 (26/11/1997)

reasons for low penetration and actions that can be taken to improve renewable energy prospects.

MITRE has calculated the progress of renewables and has undertaken dynamic modelling of the factors that affect the future adoption of renewables based on the data from the monitoring exercise. Based upon these outputs for the renewable market penetration, the employment effects were analysed in detail, calculating the effects by Member State and by technology, and including a disaggregated skills analysis of potential jobs in the EU15.

The MITRE project, which is partially funded by DG TREN's ALTENER II programme, is a follow-up to the DG Energy project "The Impact of Renewables on Employment and Economic Growth" carried out during 1998-9, to evaluate and quantify the employment and economic benefits of renewable energy in the EU. The MITRE methodology builds on the previous project, applying the SAFIRE-RIOT models to updated data, and developing the modelling approach further. In addition, two new scenarios are considered:

- The **Current Policies (CP)** scenario, which involves a mixture of current and expected policies. The current policies are based upon what already exists and also includes future policies that can be expected to be implemented.
- The **Advanced Renewable Strategy (ARS)**, which is based on the Best Practice as defined in TERES II[2] and Impact of Employment[3] projects, however with significant updates in accordance with new renewable policies and the implementation of future proactive policies.

Detailed information on the scenarios can be found in the "Approach" section of this report.

Renewable Target Analysis

The first part of this project models the future market penetration of renewables with the SAFIRE model, based on two policy scenarios, and compares these results with the EU renewables targets.

The main conclusions from the SAFIRE model target analysis are that:

- Under the Advanced Renewable Strategy (ARS) scenario, both the RES-E Electricity Directive[4] and White Paper[5] targets are achieved
- In the Current Policies (CP) scenario, neither target will be met within the 2010 timeframe

[2] The (Second) European Renewable Energy Study, 1997
[3] The Impact of Renewables on Employment and Economic Growth, 1999
[4] Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market.
[5] Communication from the Commission Energy for the Future: Renewable Energy Sources of Energy, White Paper for a Community Action Plan COM(97)599 (26/11/1997)

- For transport biofuels, the reference Directive target of 5.75%[6] will be achieved under both scenarios, but not within the 2010 timeframe (2011 for ARS and 2020 for CP)

To summarise, the targets are all achievable, but the timeframe in which to meet them is tight. Therefore, a critical element of the achievement of any of the targets is the implementation of supporting policies in the short to medium term. Market inertia and increasing proximity of the target date of 2010 will make it more difficult to achieve the targets. Therefore, a key aim of government and policy makers should be to kick-start the wide scale implementation of renewable technology by reducing the risk of investment to developers. This will help to provide the focus to achieve the targets, resulting in increased employment opportunities, enhanced competitiveness and improved security of supply.

The calculations are based on the forecasts of total energy consumption among the 15 Member States[7]. The target analysis process is very dependent upon this factor as all of the renewable targets analysed by MITRE are connected with the share of consumption (%) and any divergence of energy consumption from the forecast model will have a direct effect on the renewable energy requirements. For example, if a Member State implements an energy efficiency programme that leads to a lower gross consumption, the relative market share of renewables will increase and in absolute terms the target will be lowered.

Another factor for policy makers to consider is that the current targets refer directly to 2010 only. In addition to aiming to meet the targets, Member States also need to monitor the longer term situation, as a lack of policy beyond 2010 could lead to a fall in renewable share, if total energy consumption grows at a faster rate than renewables.

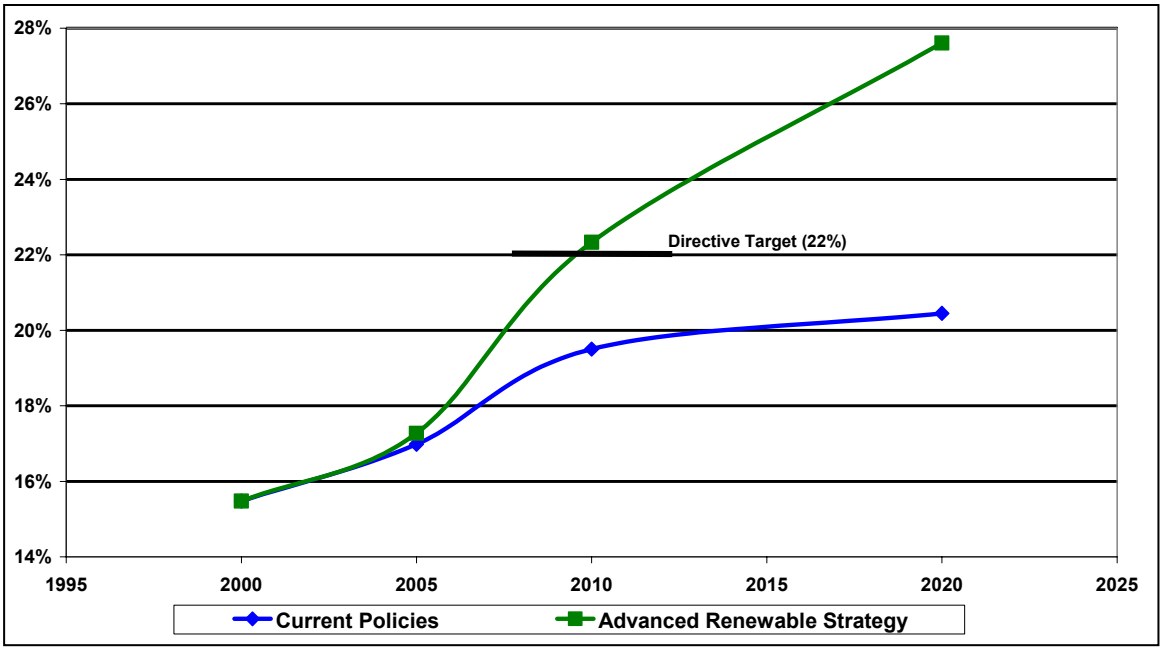
The details of the penetrations in each Member State are included in 15 separate Country Reports produced by the MITRE team. These can be downloaded from the MITRE web site – details are provided at the end of this report.

- **RES-E Directive - Targets for electricity produced from renewable energy sources**

In the Advanced Renewable Strategy (ARS) scenario, the EU15 RES-E Electricity Directive target (22.1%) is achieved by 2010 (Figure 1), supplying 22.3% (685 TWh) of gross electricity consumption. Growth then continues, reaching 27.6% (963 TWh) of gross electricity consumption in 2020. In the Current Policies (CP) scenario, renewable electricity growth is slower and is insufficient to meet the target, achieving 19.5% (598 TWh) of gross electricity consumption by 2010, against a starting point of 13.9% in 1997. After 2010, renewable electricity growth slows down, so that as electricity consumption continues to increase, the rate of increase of the renewable share slows, achieving 20.4% (713 TWh) in 2020. This 0.9% increase from 2010 to 2020 occurs, despite an actual gross electricity consumption increase of almost 20%, owing to an equivalent large increase in total electricity consumption.

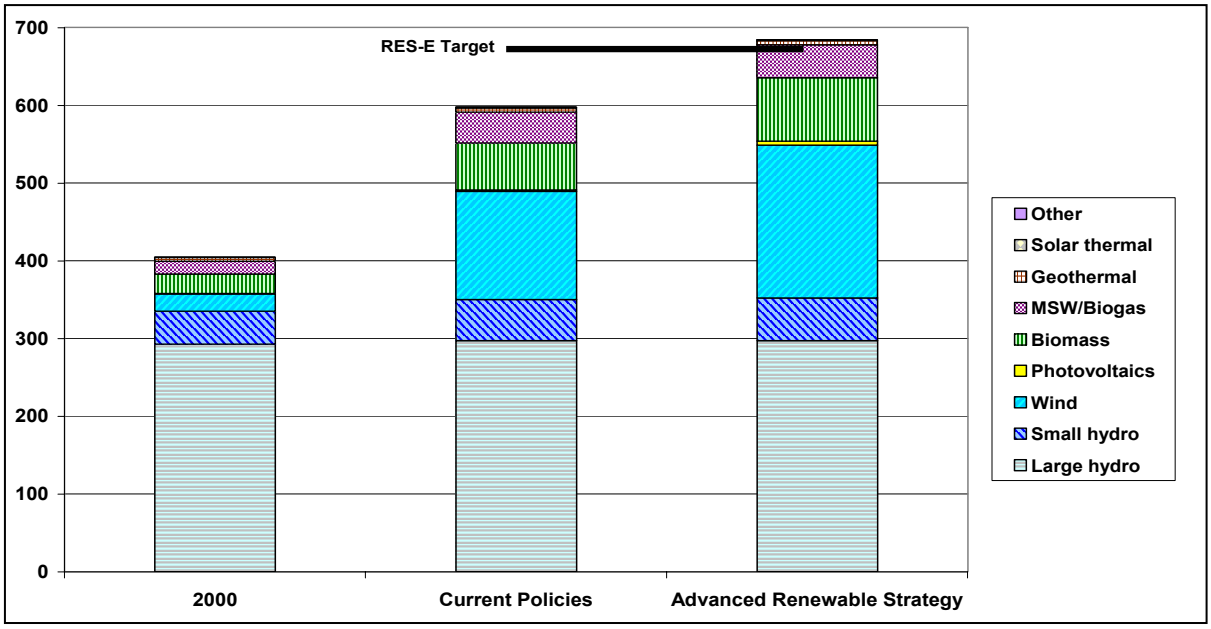
[6] Directive on the promotion of the use of biofuels or other renewable fuels for transport, 2003/30/EC, Article 1.(b).(ii)
[7] Baseline scenario, PRIMES model, 2003: published in "European energy and transport: Trends to 2030", Luxembourg, Eur-OP, 2003, ISBN 92-894-4444-4

Figure 1 - EU Renewable Electricity (% of gross consumption)



On a technology basis (Figure 2), the main growth areas for renewable electricity are wind energy and biomass (wood and wood wastes). Wind energy's current high growth rates are expected to continue. Under ARS wind represents a share of 29% of total renewable electricity production by 2010 and 38% by 2020 from a base of less than 6% in 2000.

Figure 2 - EU Renewable Electricity by Technology in 2010 (TWh)



Biomass and wood wastes form the second major growth area for renewable electricity, supplying 12% of renewable electricity consumption in 2010. In both scenarios solid wastes and biogas supply 7% of renewable electricity in 2010. Other technologies, such as photovoltaics and wave/tidal electricity, do not begin to penetrate significantly until after 2010, so do not contribute significantly to the achievement of the RES-E electricity targets.

The degree of success in meeting the targets by 2010 varies among Member States as shown in Table 1 and Figure 3. Based upon the assumptions in the ARS scenario, seven Member States meet their indicative targets by 2010 (Denmark, Germany, Spain, Netherlands, Austria, Finland & Sweden). The remaining Member States also meet their targets, but later than the target date of 2010. In all cases, the targets are expected to be met by 2013 at the latest.

Figure 3 - Renewable Directive Indicative Targets (% of gross electricity consumption in 2010)

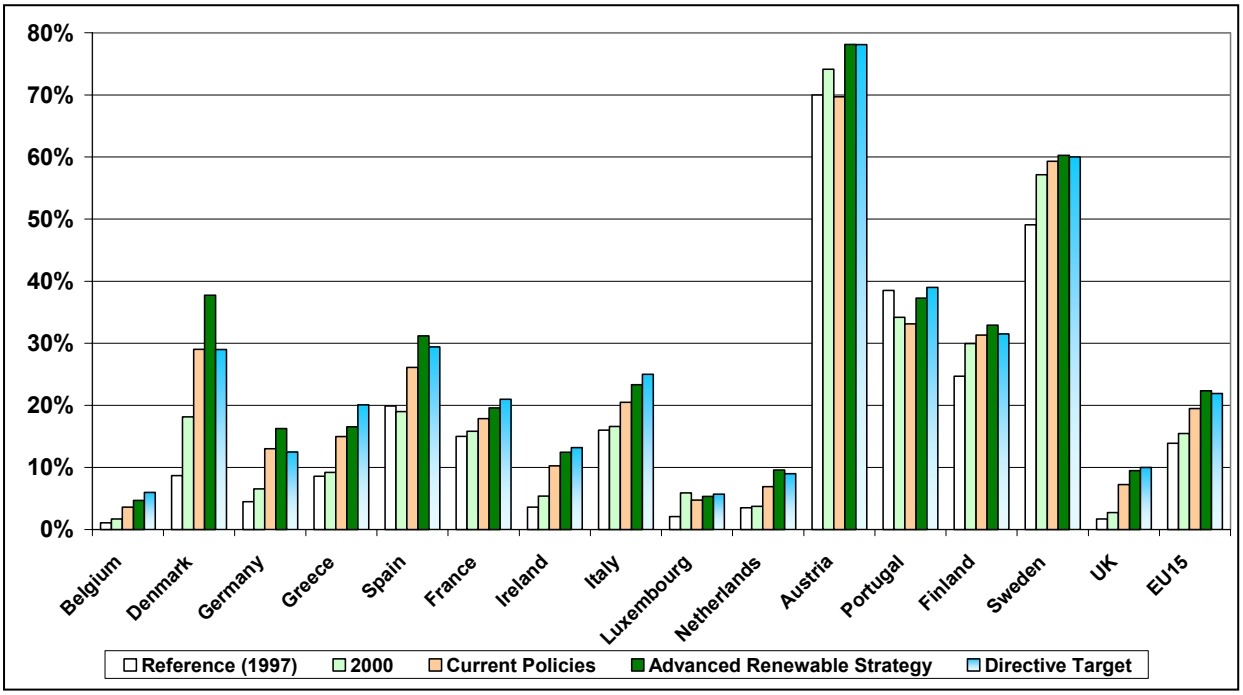


Table 1 – Renewables as proportion of gross electricity consumption (%)

	Actual 1997	Indicative Target 2010	Current Policies		Advanced Renewable Strategy		
			2010	2020	2010	2020	*Target achieved?
Belgium	1.1	6.0	3.6	5.0	4.7	7.8	2013
Denmark	8.7	29.0	29.0	31.6	37.7	55.9	Yes
Germany	4.5	12.5	13.0	14.8	16.3	20.2	Yes
Greece	8.6	20.1	15.0	15.5	16.5	22.3	2013
Spain	19.9	29.4	26.1	26.6	31.2	33.2	Yes
France	15.0	21.0	17.9	18.8	19.6	23.1	2012
Ireland	3.6	13.2	10.3	16.1	12.5	23.6	2011
Italy	16.0	25.0	20.5	20.6	23.3	29.2	2012
Luxembourg	2.1	5.7	4.7	4.5	5.3	6.2	2013
Netherlands	3.5	9.0	6.9	7.1	9.6	10.7	Yes
Austria	70.0	78.1	69.7	62.8	78.1	80.7	Yes
Portugal	38.5	39.0	33.1	35.6	37.3	42.3	2011
Finland	24.7	31.5	31.3	34.9	32.9	41.4	Yes
Sweden	49.1	60.0	59.3	56.1	60.3	58.9	Yes
United Kingdom	1.7	10.0	7.3	9.9	9.5	22.5	2011
EU15	**13.9**	**22.1**	**19.5**	**20.4**	**22.3**	**27.6**	**Yes**

Sources: RES-E Electricity Directive, SAFIRE model
Notes: 1997 proportion is as indicated in the Renewable Electricity Directive
*The target achieved estimate is based upon a straight line extrapolation between 2010 & 2020

Only two Member States achieve their targets under CP (Denmark, Germany). They do this by having long term and ambitious renewable energy policies, or by already having achieved significant historical growth, which continues to 2010. Owing to the slower renewable growth under CP, only two other States achieve their indicative targets by 2020 (Ireland and Finland).

However, it should be noted that achievement of the indicative targets is linked directly to the growth of gross electricity consumption. The effect of this link is that renewable electricity growth needs to achieve growth levels that are significantly higher than those for total electricity consumption, which is quite possible, despite proactive national policies that support renewable energy. This factor is particularly relevant for Portugal in the both scenarios, where the renewable share of total electricity in 2010 is lower than in 1997, despite an actual increase in renewable electricity of 34% in CP and more than 50% in ARS, as shown in Table 2.

Table 2 – Gross renewable inland electricity consumption (TWh)

		Current Policies		Advanced Renewable Strategy	
	1997	2010	2020	2010	2020
Belgium	0.86	3.5	5.4	4.6	8.4
Denmark	3.2	11.6	14.5	15.1	25.6
Germany	24.9	80.4	97.0	100.3	132.5
Greece	3.9	11.4	13.6	12.5	19.6
Spain	37.2	79.6	97.1	95.1	121.5
France	66.0	101.4	123.0	111.3	150.9
Ireland	0.84	3.4	6.4	4.1	9.4
Italy	46.5	72.3	81.1	82.3	114.9
Luxembourg	0.14	0.4	0.4	0.4	0.6
Netherlands	3.5	9.3	11.5	12.9	17.3
Austria	39.1	48.9	51.6	54.8	66.3
Portugal	14.3	19.1	25.9	21.6	30.7
Finland	19.0	29.1	34.7	30.6	41.1
Sweden	72.0	94.6	98.3	96.2	103.2
United Kingdom	7.0	32.8	53.0	42.9	121.3
EU15	**338**	**598**	**713**	**685**	**963**

Sources: RES-E Electricity Directive, SAFIRE model

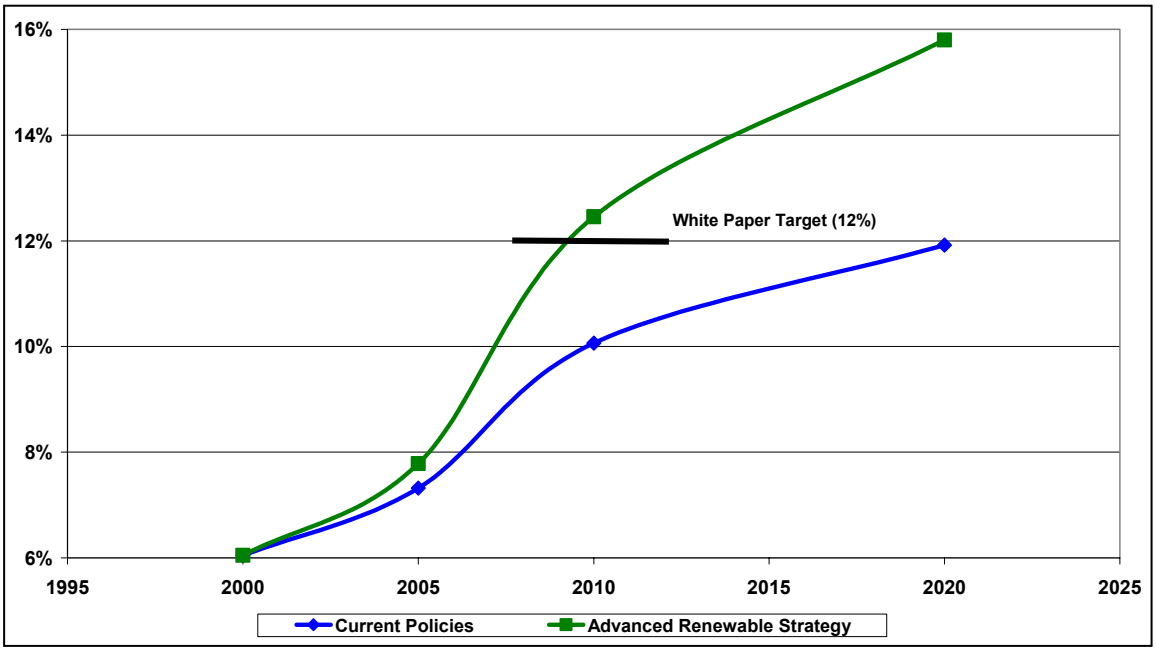
- **White Paper – targets for renewable energy**

The White Paper[8] target of 12% of energy consumption (including electricity, heat and fuel for transport) can also be achieved by 2010 (ARS scenario), potentially even one or two years early, but only if new strategies and policies are implemented over the forthcoming years (Figure 4). Otherwise, under the Current Policies (CP) scenario, there is a delay of 10 years in meeting the target, again depending upon the strategy taken by national governments. For this scenario, a share of only 10.5% of total energy consumption is expected in 2010, with the target being achieved around 2020.

[8] Communication from the Commission, Energy for the Future: Renewable Energy Sources of Energy, White Paper for a Community Action Plan COM(97)599 (26/11/1997)

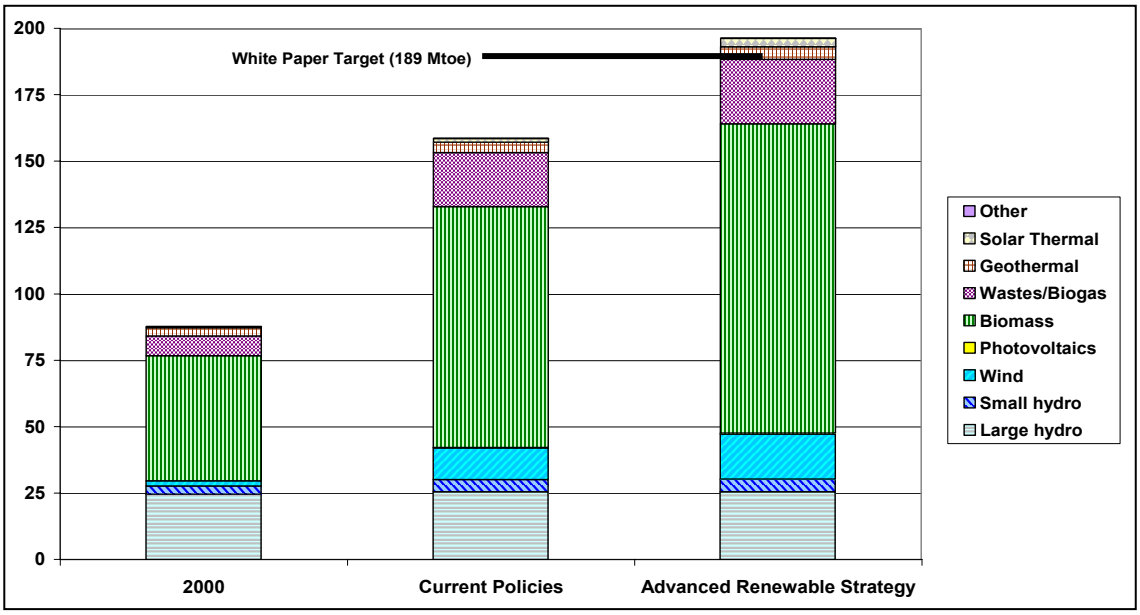
In the ARS scenario, total EU gross renewable consumption is expected to increase to 196 Mtoe by 2010 (CP 159 Mtoe) from a 2000 base of 87.6 Mtoe[9].

Figure 4 - EU Renewable Energy (Proportion of gross inland consumption - %)



Regarding the future penetration by technology and fuel mix (Figure 5), biomass[10] is the option that is expected to show the strongest growth, more than doubling from 47.1 Mtoe in 2000 to 116 Mtoe in 2010 under the ARS scenario, and by 90% to 91 Mtoe with CP (Table 3). In both scenarios, approximately a third of this growth is covered by biomass fuels for the transport market.

Figure 5 - Renewable Gross Consumption by Technology in 2010 (Mtoe)



[9] Eurostat
[10] Biomass is defined as wood, wood wastes and biofuels (for transport)

Significant growth is also shown by wastes and biogas. For the total energy calculation, wind energy has a low impact, owing to the importance of other renewables sources in heat and transport sectors. The main difference between the two scenarios is the penetration of biomass energy, with the ARS scenario achieving twice the growth of CP.

Table 3 - Renewable gross inland consumption (Mtoe)

	2000	Current Policies		Advanced Renewable Strategy	
		2010	2020	2010	2020
Large hydro	24.7	25.6	25.8	25.6	25.9
Small hydro	3.1	4.5	5.5	4.7	6.1
Wind	1.9	12.0	17.4	16.9	31.8
Photovoltaics	0.0	0.1	0.4	0.4	1.9
Biomass	47.1	90.7	114.8	116.4	144.6
Wastes/Biogas	7.5	20.3	26.6	24.2	32.3
Geothermal	3.1	3.9	4.4	4.7	12.9
Solar Thermal	0.5	1.4	2.5	3.2	5.7
Other	0.0	0.0	0.1	0.0	0.7
Total	**87.8**	**159**	**198**	**196**	**262**

Sources: Eurostat, SAFIRE model

In addition to the general 12% target, the Renewable White Paper also specifies estimated contributions for renewable penetration in 2010. Table 4 compares these estimates with the outputs from the modelling process. Generally the SAFIRE model predicts that the majority of the estimated contributions can be achieved under the ARS scenario. For some technological options, even the CP scenario will overshoot the proposed numbers. This is particularly for the case of wind energy, which has seen significant growth since the publication of the White Paper in 1997.

Table 4 – White Paper estimated gross renewable consumption in 2010

	Units	White Paper	Current Policies	Advanced Renewable Strategy
1. Wind	GW	40	57	80
2. Hydro	GW	105	97	98
2.1 Large	GW	(91)	84	84
2.2 Small	GW	(14)	13	14
3. Photovoltaics	GW_p	3	1.7	4.6
4. Biomass(/Wastes/Biogas)	Mtoe	135	111	141
5. Geothermal				
5.a Electric	GW	1	0.9	0.9
5.b Heat (incl. heat pumps)	GW	5	*2.1	*5
6. Solar thermal collectors	Million m^2	100	27	68
7. Passive solar	Mtoe	25	-	-
8. Others	GW	1	0.4	0.4

Sources: White Paper Table 1A, SAFIRE model
Note: *SAFIRE geothermal heat outputs *exclude* heat pumps

Since 1997, wind energy has passed all expectations. Many forecasts have been made to predict the expected wind capacity in 2010. Following the rapid growth seen in the market, these have been frequently revised upwards as each target is passed or neared well in advance of the target date. For example, in September 2000 and based upon this growth, the European Wind Energy Association set its 2010 capacity target at 60 GW_e (revised from 40 GW_e). This growth has since continued to accelerate, achieving 23 GW_e total capacity in 2002, making the revised target realistically achievable. This is further supported by the 57 GW_e forecast in the CP scenario, which indicates that even under current policies, the White Paper figure will be achieved. Estimated growth from 2000-2003[11] provides an average capacity growth of more than 5 GW_e of wind turbines per year. If this growth level continues, a capacity of 67 GW_e would be installed in the EU by 2010. Therefore, with the large scale implementation of offshore wind in the next few years, the potential for further growth is large.

Solar thermal collectors are the only technology with a sizeable shortfall. Despite a six-fold increase by 2010 (ARS), solar collectors do not reach the estimated 100 million m^2. To achieve this estimate, installations would need to have averaged about 9 million m^2 per year from 2000-2010. Since 2000, actual annual installations have been about 5-6[12] million m^2. Therefore, unless installations increase to an average of 12 million m^2 per year, the 100 million m^2 objective remains very ambitious.

- **Biofuels Directive – target for transport sector biofuel consumption**

The Biofuels Directive, which was formally adopted on 8 May 2003, states a 2010 reference target for biofuel consumption of 5.75% of sold gasoline and diesel[13].

For the biofuel modelling, the MITRE team has assumed three main fuel sources for transport biofuels, comprising crops grown for transport purposes, secondary agricultural organic crop wastes and waste oils. Including these latter two sources in the modelling process has greatly increased the potential for biofuels and enabled the results stated in this report. Without the inclusion of biomass and oil wastes, the likelihood of achieving the targets decreases significantly. For both scenarios, the modelling calculation is based upon biofuel production and consumption within each Member State, and does not take into account any consumption resulting from the biofuels trade. It is also assumed that all production capacity is fully used.

Figure 6 and Table 5 show the SAFIRE biofuel forecasts for the Member States in 2010. These show that under the ARS scenarios, the 5.75% target is achieved, but not until the following year (2011). This delay in meeting the target, even under ARS, is owing to the short time available to set up the infrastructure for the production of biofuels (despite the assumed full detaxation of biofuels by 2007) and also to the allocation of agricultural land for biofuel crops. Under the CP scenario, the target is not even reached by 2020. In this scenario, total biofuel consumption rises from 0.9 Mtoe in 2000 to 8.2 Mtoe (2.9%) in 2010 and 12.9 Mtoe (4.6%) in 2020.

[11] 2003 estimate provided by Observ'ER (MITRE team member)
[12] 2003 estimate provided by Observ'ER (MITRE team member)
[13] Directive on the promotion of the use of biofuels or other renewable fuels for transport, 2003/03/EC

As a direct comparison between the two scenarios, biofuel consumption in ARS is almost twice that of CP in both 2010 (15.9 & 8.2 Mtoe respectively) and 2020 (21.9 & 12.9 Mtoe). On a country level, four Member States achieve the 5.75% by 2010 (Germany, France, Austria, Sweden), with another six achieving the target in 2011. The remaining five Member States achieve between 3% and 5% of sales by 2010, with estimated achievement dates ranging from 2013 to 2015 and even 2019 for one Member State.

Figure 6 – Biofuel share of gasoline and diesel sold for transport (2010)

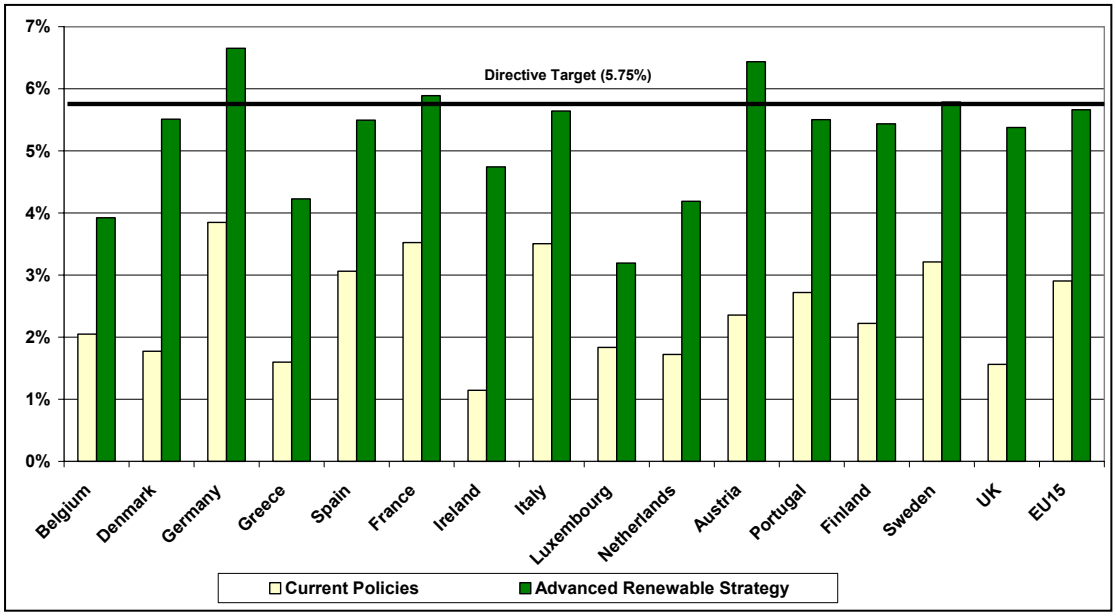


Table 5 – Biofuel consumption as a proportion of gasoline and diesel sold (%)

	Current Policies		Advanced Renewable Strategy		
	2010	2020	2010	2020	*Target achieved?
Belgium	2.0	5.1	3.9	8.0	2015
Denmark	1.8	4.9	5.5	6.4	2011
Germany	3.8	4.9	6.7	7.4	Yes
Greece	1.6	5.5	4.2	8.6	2013
Spain	3.1	5.2	5.5	6.8	2011
France	3.5	3.9	5.9	6.9	Yes
Ireland	1.1	4.1	4.7	7.2	2013
Italy	3.5	5.8	5.6	9.5	2011
Luxembourg	1.8	2.8	3.2	4.9	2019
Netherlands	1.7	4.5	4.2	8.0	2013
Austria	2.4	6.3	6.4	8.6	Yes
Portugal	2.7	5.4	5.5	7.2	2011
Finland	2.2	5.3	5.4	10.4	2011
Sweden	3.2	5.3	5.8	7.0	Yes
United Kingdom	1.6	2.6	5.4	8.3	2011
EU15	**2.9%**	**4.6%**	**5.7%**	**7.8%**	**2011**

Source: SAFIRE model
Note: *The target achieved estimate is based upon a straight line extrapolation between 2010 & 2020

For this analysis, transport fuel consumption growth rates are taken from the baseline scenario of the PRIMES model[14] (Table 6), which show total annual growth rates of 1.8% from 2000 to 2005, 1.1% to 2010, and 1.7% from 2010 to 2020.

Table 6 – Energy Demand in Transport (Mtoe)

	2000	2010	2020
Belgium	9.7	10.3	10.7
Denmark	4.7	5.0	5.1
Germany	65.8	71.7	75.8
Greece	7.2	8.4	9.0
Spain	32.8	37.3	40.8
France	51.3	55.7	57.9
Ireland	3.9	4.9	5.4
Italy	41.3	45.5	47.1
Luxembourg	1.9	2.1	2.4
Netherlands	13.8	15.6	16.9
Austria	6.8	7.4	7.9
Portugal	6.5	7.4	8.4
Finland	4.4	4.8	4.9
Sweden	7.7	8.3	8.4
United Kingdom	51.5	54.1	56.7
Total	**309.1**	**338.4**	**357.2**

Employment from Renewables

The predicted increase in renewable energy penetration gives rise to a net increase in jobs throughout the EU. This result takes account of the direct and indirect impacts in the renewables sector and its supply chain and also the potential negative effects of support mechanisms on employment, and jobs displaced in conventional energy technologies. A full definition of each employment category is described in the section on The Approach. It should also be noted that the analysis excludes employment arising from exports to countries outside EU-15 and from the large hydro sector.

The Advanced Renewable Strategy scenario, in which Government increases the support to renewable energy, gives rise to even greater employment even after allowing for a greater amount of financial support being paid for renewables.

This section focuses on four levels of employment output from the modelling process. These are:

[14] Baseline scenario, PRIMES model, 2003: published in "European energy and transport: Trends to 2030", Luxembourg, Eur-OP, 2003, ISBN 92-894-4444-4

- Overall employment
- By technology
- By Member State
- By skill level

• Overall Employment

Table 7 shows the impact on employment in 2010 and 2020. Current measures to encourage renewable energy (CP) will give rise to 1072 thousand additional gross jobs in 2010 before knock-on effects, of which almost 70% will be in the renewables industry (including EU trade) and the remainder in the agriculture sector. From this employment growth in the renewables industry (both direct and indirect employment) and agriculture, the model subtracts potential job losses, owing to displacements in the conventional energy sector and owing to support mechanisms which result in lower spending elsewhere in the economy. Despite the potential losses of 122 thousand jobs in the CP scenario in 2010, this would still leave a net employment growth of 950 thousand jobs in this year. In comparison, the ARS scenario will increase employment by almost 2 million gross jobs. The distribution between the renewable industry and agriculture is very similar, while the knock-on effects of reduced employment elsewhere in the economy are substantially larger at 273 thousand job losses. However, the negative employment effects are more than compensated by the employment gains elsewhere in the economy. In other words, a more pro-active encouragement of renewables gives rise to significant net employment gains.

Table 7 – Employment growth in 2010 from 2000 (1000 FTE[15]/year)

	Current Policies		Advanced Renewable Strategy	
	2010	2020	2010	2020
[16]Renewable national market (gross)	572	899	1111	1724
Renewable EU trade export market (gross)	154	121	265	263
Agriculture (gross)	346	510	557	761
Conventional displacement	-37	-45	-48	-63
Support mechanisms	-85	-41	-225	-220
Total net employment growth	**950**	**1443**	**1660**	**2463**

Source: RIOT model

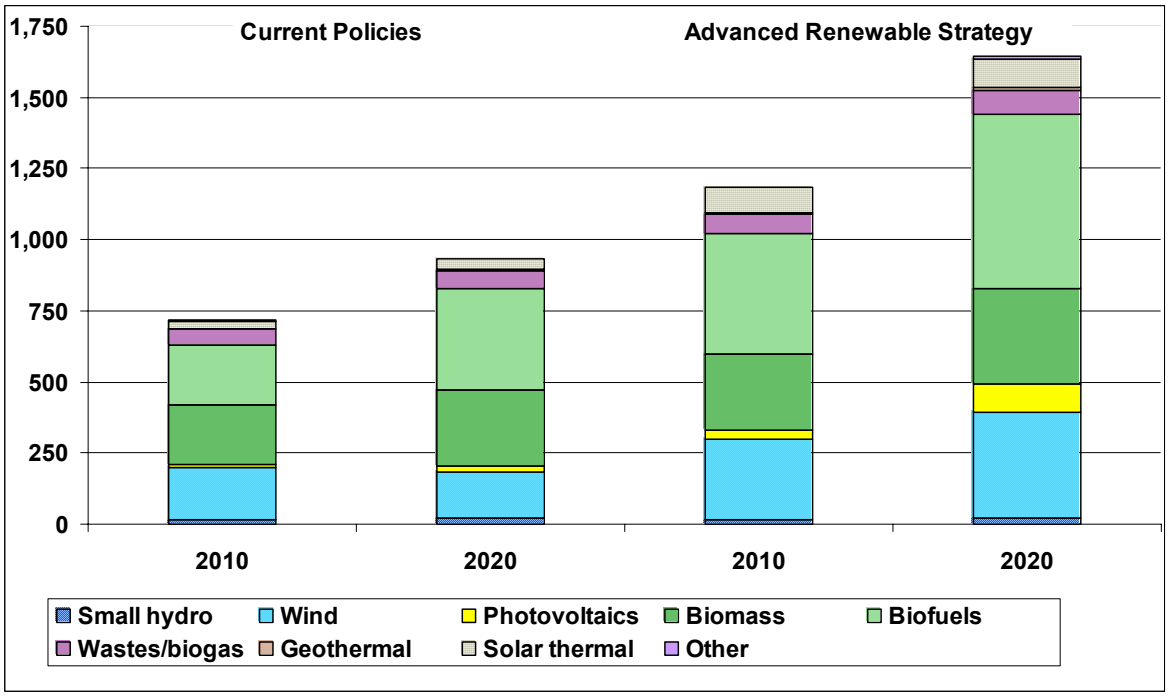
• Employment by Technology

Renewable industry employment growth is shown in Table 8 and Figure 7. These show net employment in each renewable industry, including gross national employment, gross EU market employment and conventional displacement effects, as it is not possible to disaggregate this last factor from the technology employment calculation.

[15] Full Time Employment

[16] The Renewables Industry is divided into 2 categories: "national market" within each of the 15 Member States, " EU market" referring to trade between EU Member States, as defined in the Approach section

Figure 7 – Renewable industry employment growth from 2000 (1000 FTE)



Renewable industry employment growth is greatest for the biomass sector (wood fuels and biofuels) in both scenarios, providing an additional 422 thousand jobs in 2010 in the CP scenario, and 695 thousand jobs with ARS. In both scenarios, this reflects almost 60% of the total renewable industry employment growth in 2010.

Table 8 – Total employment growth from 2000 (1000 FTE)

	Current Policies		Advanced Renewable Strategy	
	2010	2020	2010	2020
Small hydro	16	21	15	23
Wind	182	162	282	368
Photovoltaics	9	20	31	103
Biomass	210	268	271	334
Biofuels	212	354	424	614
Wastes/biogas	56	67	67	83
Geothermal	2	3	5	10
Solar thermal	27	37	90	97
Other	0	3	0	12
***Renewable industry**	**715**	**934**	**1186**	**1645**
+Agriculture	320	550	699	1039
Support mechanisms	-85	-41	-225	-220
Total net employment	**950**	**1443**	**1660**	**2463**

Source: RIOT model
Notes: *Renewable industry data contains gross national, EU market & conventional displacement employment
+Agriculture data contains gross national, EU market & conventional displacement employment

The next largest industry regarding employment growth is the wind industry, where an additional 282 thousand (ARS) and 182 thousand (CP) jobs are projected by 2010 in addition to

the employment levels of today. In both cases, this comprises approximately 25% of total new renewable industry employment. In the CP scenario, onshore wind applications account for about 65% of the wind employment growth, decreasing to 55% by 2020. Employment growth from 2000 also shows a fall between 2010 and 2020. The main reason for this situation is that the trade among EU Member States declines after 2010, mainly owing to the lower pick-up of penetration from offshore wind. Therefore, to maintain levels of employment in the European wind industry after 2010, the EU needs to focus on an increased role in the world market. In the ARS scenario, the majority of the employment growth comes from the offshore industry, where approximately 55% of the growth occurs in both years.

The agricultural sector also accounts for large employment growth in both 2010 and 2020 in both scenarios. With a total growth of 320 thousand jobs under CP and 699 thousand jobs under ARS in 2010, this can have a significant effect on overall agricultural employment in the EU. In the CP scenario, approximately 75% of the employment growth occurs in energy crops and forest residues, with the remainder from solid and liquid agricultural wastes (straw, slurry, etc). For the ARS scenario, the energy crops and forest residues share is approximately 60%.

- **Employment by Member State**

Table 9 shows the net employment growth in the renewables and agricultural industries to 2010 across the EU15. This data includes trade within the EU and the knock-on effects as a result of fuel displacement and financial support. Germany, Spain and France see the largest growth in total employment in the EU15, with increases of more than 150 thousand FTE by 2010 under ARS. Within the renewable energy industry, the same three countries witness the largest growth, but with the addition of Denmark to the list with upwards of 110 thousand FTE.

Table 9 - Net employment growth by Member State 2000-2010 (1000 FTE/year)

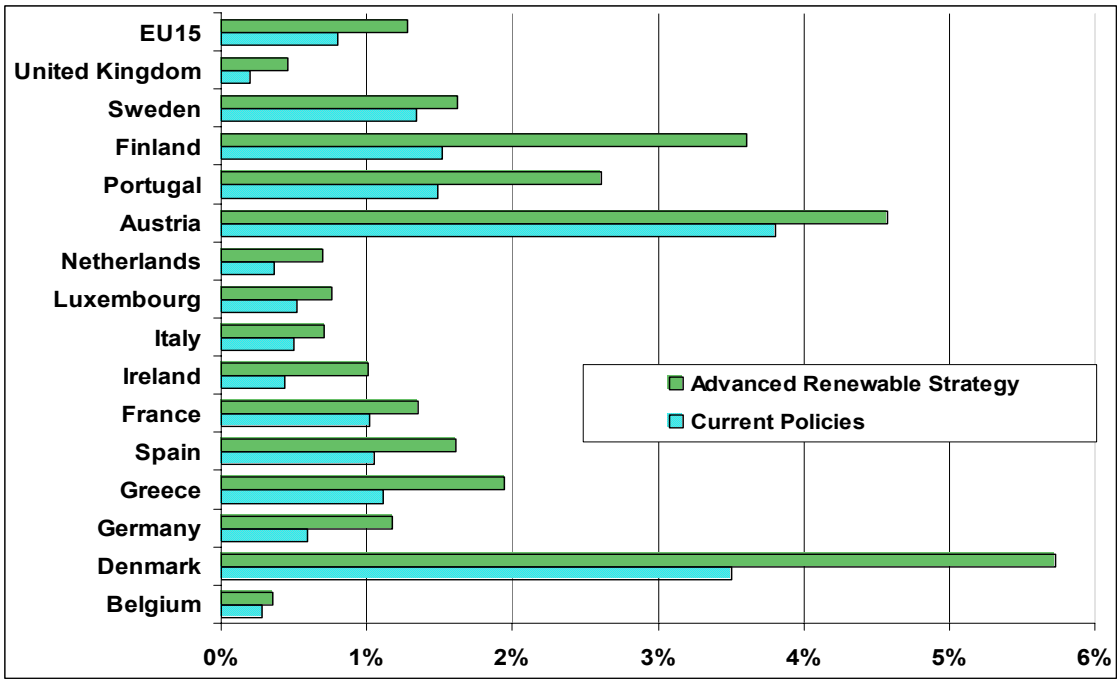
	Renewables		Agriculture		Total employment	
	CP	ARS	CP	ARS	CP	ARS
Belgium	5.6	5.9	2.8	5.3	8.4	11
Denmark	69	113	7.8	23	77	136
Germany	107	259	71	127	178	386
Greece	28	58	9.2	13	37	71
Spain	78	119	42	73	120	193
France	93	147	76	96	168	243
Ireland	3.0	7.0	1.8	5.0	4.8	12
Italy	34	58	39	56	73	114
Luxembourg	0.4	0.4	0.5	1.0	1.0	1.5
Netherlands	8.5	22	7	11	15	33
Austria	50	66	44	54	94	120
Portugal	42	83	14	23	57	106
Finland	15	43	7.9	20	23	63
Sweden	35	44	9.7	12	45	57
United Kingdom	35	76	14	38	49	113
Total	**604**	**1102**	**346**	**558**	**950**	**1660**

Source: RIOT model

Figure 8 shows how the employment in the renewable energy industry is shared between the Member States in 2010. The graph shows the absolute numbers of people employed in

renewable energy, including agricultural fuel production and exports within the European Union (but not outside the region), as a proportion of the total national workforce. For the EU15 as a whole, in the CP scenario, renewables account for 0.8% of employment, while in ARS the figure is 1.3%. In terms of employment, the renewables sector is most significant in Denmark (5.7%), followed by Austria (4.6%) and Finland (3.6%).

Figure 8 - Proportion of labour force supporting renewable energy sector in 2010



• Employment by Skill Level

The skills mix of net national employment growth, by Member State, has also been investigated. Table 10 presents the results of this analysis for the EU and reveals that, excluding the agricultural sector and export markets, the increase in skilled employment amounts to 228 thousand jobs in 2010 and more than 400 thousand in 2020 under the ARS scenario. Under the CP scenario, skilled employment is 40% lower at 126 and 236 thousand jobs in 2010 and 2020 respectively. In both scenarios, the proportion of skilled jobs to net employment is 27-29%, accounting for approximately a third of net employment growth. At Member State level, the proportion of skilled employment ranges from 18% to 45%. Details of the skills analysis by Member State are included in the separate country reports.

Table 10 - Growth in net employment by skill level (1000 FTE/year)

	Current Policies		Advanced Renewable Strategy	
	2010	2020	2010	2020
Skilled	126	236	228	402
Unskilled	324	577	610	1037
Total	**450**	**813**	**838**	**1439**

Source: RIOT model
Note: Figures exclude employment in the agricultural sector & from the EU export market

The Approach

• Methodology

MITRE has taken a two-stage approach to calculating the employment effects from renewables:

- ***Stage 1: Projecting the future energy market, and the market share of renewable energy to 2020***. The modelling uses the ***SAFIRE*** [17] *energy model* to predict the levels of market penetration for renewable energy technologies, and the resulting displacement of conventional energy technologies based on two policy scenarios. These penetrations are compared with the targets specified in the RES-E Electricity Directive and Renewables White Paper on an EU-15 and national basis, and the recently adopted Biofuels Directive.
- ***Stage 2: Calculating the employment impact of the market changes.*** The RIOT input-output model (*Renewables enhanced Input-Output Tables*) calculates the employment impacts of renewables. It is based upon the calculation of production functions that represent the value of inputs (including employment) from different sectors of the economy needed to produce a unit of energy, for different energy technologies (both renewable and conventional).

Descriptions of the scenario variables & assumptions used for the modelling are outlined below.

• Technologies/Fuelling

Sixteen technology and fuelling options have been analysed by SAFIRE and RIOT in MITRE. For the analysis of the modelling outputs, these are aggregated into nine main technology/fuelling options, as shown in Table 11.

Table 11 – MITRE/SAFIRE technologies/fuelling

MITRE Analysis	SAFIRE Technologies	MITRE Analysis	SAFIRE Technologies
Large hydro	Large hydro	**Biomass**	Wood/wood wastes
Small hydro	Small hydro		Biofuels
Wind	Onshore wind	**Wastes/Biogas**	MSW (biodegradable)
	Offshore wind		Landfill gas
Photovoltaics	Photovoltaics		Sewage gas
Solar thermal	Solar panels		Slurry
	Solar thermal electricity	**Geothermal**	Geothermal heat
Other	Wave/tidal		Geothermal electricity

[17] SAFIRE (Strategic Assessment Framework for Rational Use of Energy) is an established model, which analyses the impact of different modes of energy consumption, the introduction and spread of energy technologies, and energy policies on a number of indicators. It was used as the basis for the development of the TERES and TERES II modelling projects - TERES II formed the basis of the development of the targets presented in the EC's White Paper on Renewable Energy Sources.

• Assumptions and Data

The primary sources for the modelling process are shown in Table 12. Contact details for these are available on the MITRE web site. Many other sources have also been used in the modelling analysis.

Table 12 – Main Information Sources for Modelling Process

Source	Use for modelling
ENER-IURE project	Renewable legislation by Member State
PRIMES model results, 2003	Energy consumption forecasts
Eurostat, REStat 99 project	Renewable energy statistics, energy prices
National statistical offices	Renewable statistics (used in conjunction with Eurostat), energy prices
Eur'Observ'ER Barometer	Recent renewable installations, renewable growth comparisons, general technology information
Renewable Trade Associations	Technology information & statistics
Journals & reports	General background information

• Policy Scenarios for SAFIRE modelling

Two different modelling scenarios are analysed in MITRE, looking at different views of future energy policies and developments. These are:

- Current Policies
- Advanced Renewable Strategy

The two scenarios make a number of policy, technological and non-technological assumptions. They both start with the current reality, but then diverge as the calculation period progresses. The two scenarios are described below. Table 13 also includes a general overview summary of the two scenarios, focusing on the main policy and technology developments for the whole modelling period of 2000 to 2020.

The primary source for the development of the two scenarios, particularly their base year starting point (2000), is the outputs from the ENER-IURE[18] project (partially funded by the European Commission). One of the core ENER-IURE objectives has been to synthesise existing regulations that affect renewable energy sources in Europe and to report on the key aspects of national policy and legislative framework in each Member State. By structuring these regulations according to the various administrative levels on which the European Union currently operates, it has been possible to develop the two scenarios, which reflect the real position of renewable policy in Europe and has enabled MITRE to develop realistic views of future policy options to 2020.

[18] ENER-IURE: Stock-Taking & analysis of the present technical & legal situation of renewable energy sources in Europe - http://www.jrc.es/cfapp/eneriure

Table 13 – Overview of Policy Scenarios for SAFIRE Modelling (2000-2020)

Policy area	Current Policies	Advanced Renewable Strategy
RTD & technology development	- Current RTD expenditure maintained, leading to expected technology cost reductions	- Increased RTD effort & faster technology cost reductions - Increased learning by doing effects - Major improvement in capability to deal with interruptible supplies
Energy markets & finance	- Renewable electricity premium phased in between 2005-2015 through emissions trading scheme - Internalisation of energy costs through carbon tax implemented by 2010-2020 - Current subsidies implemented as per current policy, or phased out between 2005-2010 - Phased removal of excise duties on biofuels for transport by 2010	- 20 % renewable electricity premium phased in from 2005-2010 through emissions trading scheme - Biomass cogeneration plant supported through improved buyback for electricity exports (2005-2010) - Internalisation of energy costs implemented through carbon tax by 2010 - Current subsidies continued to 2010, or longer if specified in current policy - Reduced interest rates and tax breaks on investment provided for renewables - Removal of transport biofuel excise duties by 2007 - Shift towards decentralised markets
Government policy	- Existing government programmes, phasing out as planned - Acceptance that renewable industry is a key economic area is slow - Full gas and electricity liberalisation achieved by 2010	- Reduction of uncertainty through longer term standardised planning - Policy harmonisation across the region - Renewable energy becomes a key policy driver for employment and international competitiveness - Full gas and electricity liberalisation achieved by 2006
Environmental & other regulations	- -8% greenhouse gas emissions target is maintained and extended to 2020	- Greenhouse gas emissions reduction targets tightened & extended to 2020 - Energy-to-waste schemes supported through higher landfill costs
Agriculture	- Financial support for energy crop schemes for heat, electricity & transport markets, phased out by 2010 - Energy crop yields increase by 10% for both wood and biofuels by 2020	- Higher level of financial support for energy crop schemes (heat, electricity & transport markets) phased out in 2010 - Land guarantees for energy crops - High set-up costs alleviated - Yields increase by 20% for wood and 25% for transport biofuels by 2020.
Non technical & policy aspects	- Developer risk to slowly decreases, improving willingness to invest - Gradual improvement in consumer attitudes towards renewable energy	- Government initiatives to reduce risk as information flows are improved, enhancing willingness to invest - Public opinion supports renewables, ownership & knowledge are widespread - Improved consumer attitude towards renewable energy, leading to easier planning & higher sales

"Current Policies" Scenario

The Current Policies (CP) scenario involves a mixture of current and expected policies. The current policies are based upon what already exists and also includes future policies that will be implemented or can be expected to be implemented. Where policies have a specified end-point, it is either assumed that the policy finishes at this point or that it is phased out for a number of years after this closing point. For all current policies, it is assumed that they are all phased out by 2010, unless already stated in the current legislation, targets or elsewhere. In addition to the current and definite future policies, CP also assumes that further policies and technological developments will occur in the future, even if they are yet to be implemented.

For example, the recently adopted Biofuels Directive[19] states that "tax arrangements" are one of the optimum methods for increasing the share of biofuels. In the SAFIRE modelling, this

[19] Directive on the promotion of the use of biofuels or other renewable fuels for transport, 2003/30/EC, section 20

statement has been interpreted as the future reduction of excise duty on transport biofuels. Therefore, despite such a policy not being active in most Member States, it is assumed that such a plan is relevant to the CP scenario owing to the high probability of its implementation.

The main strategic and policy options in the CP scenario can be outlined as follows:

- implementation of renewable rights trading, amongst all the Member States, between 2005 and 2015 (most likely through an EU-wide tradable green certificate scheme)
- gradual internalisation of the environmental costs of energy (through the introduction of a carbon tax, applied, on average at Euro 30/tonne CO_2)
- phased removal of excise duties on transport biofuels, with full phase out by 2010
- gradual decrease in renewable technology costs over the period
- gradual improvements in technology efficiencies and performance, and agricultural yields
- greenhouse gas emissions trading at €5-10/tonne CO_2e (equivalent)

Owing to current and expected policy and legislation, the CP scenario includes a lot of the future expected changes that are highlighted in the ARS scenario. The main difference is that these strategies and effects are implemented at lower levels and introduced at a slower rate than in the ARS scenario.

"Advanced Renewable Strategy" Scenario

This scenario has three underlying themes behind its creation. Firstly, it is based upon the Best Practice scenario from two previous applications of the SAFIRE model - TERES II[20] and Impact of Renewables[21] projects. Secondly, from this starting point, it has been significantly reviewed and updated to include any policies, thinking and culture that have been implemented since the second of these projects ended in 1999. The main source for this update has been the CP scenario. The third theme behind this scenario has been to introduce advanced and pro-active policies and frameworks that support the widespread and long term implementation of renewable energy in the European Union.

Additional assumptions behind ARS are that the policies included in CP are not phased out as planned and that their lifetime is extended by a further 5-10 years. The environmental impacts of fuels are recognised and a higher level EU wide carbon tax is introduced between 2005 & 2010. Owing to increased penetrations, technological costs are assumed to reduce at a faster rate than in CP, through both economies of scale and learning by doing. Government policy is assumed to be proactive and consistent, consumer opinion is positively encouraged through ownership and information campaigns, and electricity markets/policy are aimed at developing and promoting small-scale decentralised systems. Renewable proactive policies are harmonised across the region. The key components of this scenario include the following:

- implementation of renewable rights trading among Member States between 2005 & 2010
- internalisation of the environmental costs of energy between 2005 & 2010 (through the introduction of a carbon tax, applied, on average at €60/tonne CO_2)

[20] The (Second) European Renewable Energy Study, 1997
[21] The Impact of Renewables on Employment and Economic Growth, 1999

- full removal of excise duties on transport biofuels by 2007
- decrease in renewable technology costs over the period, mainly through learning by doing
- significant improvements towards 2010 in technology efficiencies and performance, and agricultural yields
- greenhouse gas emissions trading at €15-20/tonne CO_2e (equivalent)

Where current national policy is similar to the principles of the ARS scenario, there will be no difference between the scenarios on such policy, technology or market items.

- **Employment modelling**

The employment modelling is divided into two key areas of analysis. These are:

- Net employment
- Employment by skill level

Net Employment

This section of the analysis disaggregates the total net employment in fives key areas of the economy:

- Gross national employment
- Gross EU market employment
- Agriculture
- Conventional displacement
- Support effects

These numbers are displayed in various forms to show the overall employment effects and the effects disaggregated by technology and by Member State.

The **national market** is defined as the gross employment growth that occurs from the development of renewable energy technologies in the national market. This includes the construction, installation and operating of renewable plant. This employment figure takes into account the fact that some Member States import renewable technology, which limits the amount of jobs created within the national economy.

The **EU market** is the gross employment growth arising from renewable technology exports to other EU countries. This benefits some Member States more than others, particularly those with significant renewable manufacturing capacity. However, this number does not include the employment generated from exports into the world market, as it is not possible to model this factor in the RIOT and SAFIRE models. Additionally, the employment modelling assumes that growth in demand for equipment needed to supply renewable energy will be met by growth in plant output by the countries that presently produce the equipment. The modelling makes no assumptions about the pattern or relative share of renewable manufacturing changing across the EU. No analysis has been made of the employment effects of exports outside the EU.

Employment in the **agricultural** sector occurs from the supply of three different fuels into the energy sector, be it for heat, electricity or transport. These fuels are energy crops, forest

residues (where relevant), and agricultural wastes. Agricultural wastes can also be subdivided into liquid and solid wastes, for example, slurry and straw/olive husks respectively. The growth in agricultural employment for the renewable energy sector does not necessarily mean that new people are brought into agriculture, as some of the growth will be from increased utilisation of part-time and seasonal agricultural workers. The main difference will be that the agricultural employment security will be greatly improved, as the energy sector will enable the development of long term contracts and steady incomes within a high risk and low income sector.

Conventional displacement refers to the employment losses occurring from the substitution of demand in the conventional energy sector within each Member State. This is typically jobs substituted in the fossil fuel and nuclear sectors, where relevant for each country.

Support effects relates to employment losses occurring from the macroeconomic effects of support mechanisms for renewables. The size of this effect is dependent upon the level and type of support in each country. For example, if a Member State applies a feed-in tariff for renewable electricity that is payable by the consumer, then the consumer's spending power on other goods will be reduced owing to higher electricity bills. This decrease in spending will have a direct knock-on effect on employment in other sectors of the national economy.

For example, "support effects" includes feed-in laws (which have the effect of increasing the price paid for electricity) and operating or capital support. RIOT treats these as reducing spending and hence employment elsewhere in the economy. The analysis does not take account of present and historic subsidies paid to conventional energy sources or of implicit subsidies such as Government acting as insurer of the last resort to the nuclear industry. As a result, the support effects calculation tends to overstate employment losses from renewables.

Employment by Skill Level

Further analysis of the net national employment growth has also been performed, investigating the skills mix of national employment. This analysis had divided the net employment growth into skilled and unskilled employment, which can be defined as:

- Skilled employment
- Unskilled employment

Skilled employment is described people working either as professionals, managers, officials and technicians or associate professionals. These correspond to classes 1, 2 and 3 in the standard ISCO international occupational classification system.

Unskilled employment consists of people occupied as clerks, service workers and manual workers. These occupations are covered by ISCO classes 4 through to 9, excluding class 6. ISCO class 6 is defined as "Skilled agricultural and fishery workers". Unfortunately, the Eurostat data used for the MITRE employment analysis does not include any data on class 6, since few countries include agricultural workers in their standard employment surveys (the data is often collected separately), so it has not been possible to include agricultural employment in the skill mix employment analysis.

What is MITRE?

MITRE (Monitoring & modelling Initiative on the Targets for Renewable Energy) provides information about the impact of policies on renewable energy growth to 2020 and employment created as a result of such investment in renewable energy technologies. MITRE has monitored renewable progress and undertaken dynamic modelling of the factors affecting the future adoption of renewables based upon the data obtained in the monitoring exercise. The primary objective of MITRE is to support decision makers in setting up and improving the frameworks necessary to achieve the renewable energy targets specified in the Renewables Electricity and Biofuels Directives and the White Paper on renewable energy. MITRE aims to be of practical interest to many different groups, including:

- **Policy-makers and other decision-makers** - who need to understand the relationship between investment in renewable energy and employment
- **The energy industry** - the study provides comparative data on employment created per unit of energy output
- **Regional and local authorities** - since new renewable energy developments make a significant contribution to the local economy
- **Investors in new energy technologies** - as the renewable energy market expands both in the EU and world-wide
- The **general public** - to raise awareness about the wider benefits of increased deployment of renewable energy technologies

Further information

This report is produced as part of a group of reports produced by the MITRE team. There are three levels of these reports, providing differing amounts of information:

- **MITRE overview summary** – four page document highlighting the main conclusions of the project in terms of meeting the targets and the resulting employment impacts
- **MITRE Overview report** – this document
- **Country reports** – outlining the modelling results in the individual EU Member States

All of these reports can be downloaded (PDF) from the MITRE project web sites:

http://mitre.energyprojects.net http://eufores.org

The Team

Energy for Sustainable Development (ESD) Ltd
Mark Whiteley
Overmoor, Neston
Corsham SN13 9TZ
United Kingdom
Tel: +44 1225 812102
Fax: +44 1225 812103
E-mail: mark@esd.co.uk

NTUA-RENES
Prof. Arthouros Zervos
P.O. Box 64011
15701 Zografou
Greece
Tel: +30 1 772 10 30
Fax: +30 1 772 1738
E-mail: renes@central.ntua.gr

EUFORES
Marc Timmer
9-11 rue Louvigny
L- 1946 Luxembourg
Luxembourg
Tel: +32 2 284 6422
Fax: +32 2 284 9921
E-mail: eufores@eufores.org

BEST
Prof. Federico Butera
via Bonardi 3
I - 20133 Milano
Italy
Tel: +39 2 23 99 72 57
Fax: +39 2 23 99 72 55
E-mail: butera@tin.it

European Commission
ALTENER II Programme, DG Energy & Transport
Fax: +32 2 295 5852
E-mail: altener@cec.eu.int

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The MITRE team is an independent consortium of organisations.