Resource productivity, environmental tax reform and sustainable growth in Europe

Structure and Function of the Environmental Industry

The Hidden Contribution to Sustainable Growth in Europe

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Overview

1. Introduction - The New Face of the Environmental Industry

This chapter tries to clarify the definition, structure, function and trend of "eco-industries" – now a important sector contributing to sustainable growth in Europe (Ayres / van den Bergh 2005). Its potentials of multiple win-win effects will be illustrated for four cases of best practice. The chapter includes concepts to define eco-industry and an outline of future trends.

The "Environmental Industry" (EI) is till now an essentially "invisible industry" in terms of statistics and sectoral analysis, as mentioned. The size depends on the definition, while different approaches seem to be available.

To get a clearer picture we differentiate between two sub-sectors: pollution management and resource management. Another differentiation is between a statistically operationalised core area and satellite areas such as "eco-tourism" or "eco-construction" (where e. g. only growth rates of components are available).

The environmental industry is a fast-growing quasi sector of about 2-3% GDP in the EU and 4% in Germany. In terms of functional analysis the activity of the eco-industry – especially regarding eco-efficient innovations - is a *condition* for sustainable growth because it prevents external damage costs which in the long run finally restrict economic growth. Its fast growing parts contribute also *directly* to sustainable growth. This paper gives an outline of future trends, instead of historically data, which so far are not available or not reliable. These data on probable trends could also be used by econometric models.

The competitiveness of EI can be shown by indicators such as export rates. Whether it is also contributing to the general competitiveness of the national economy is of high interest, so far however difficult to answer.

The environmental industry is essentially policy-driven. Therefore questions of governance play an important role. To assess the impact of environmental policy on economic success variables we will focus on selected cases: renewable energy, eco-construction, fuel-efficient diesel cars and waste management/recycling. "Policy" in our context does not mean only the use of environmental taxes. Environmental policy - especially if it is oriented towards innovation – typically uses a policy mix following a “multi-impulse approach” (Klemmer 1999). But in the light of environmental policy analysis it seems highly plausible that environmental taxes or emission trade - together with specified regulation and supportive instruments like labels or networking - provide the most important political incentive to develop new eco-efficient technologies. It can be shown that within the policy mix in Germany the environmental tax has a relevant impact regarding fuel efficient cars and eco-construction. In case of electricity from renewables there is a clear influence of the change of relative prices (by the feed-in regulation) – together with the rise of prices for fossil energies. In all cases environmental policy is a clear driving force in Germany.

Regarding the impacts of the environmental industry the picture is ambivalent: There are two faces of EI which become visible if we differentiate between the just mentioned sub-class of pollution management - mainly end-of-pipe treatment - and resource management including clean(er) technology.. Whereas resource management typically intends to influence resource productivity, pollution control mostly has no such influence - or even a negative one. Therefore EI as such gives no reliable explanation. Pollution management on the other hand e. g. has an important impact on specified pollutants, the impact of resource management here being insignificant or even negative. In terms of environmental policy efficient resource use means lower specific impacts on a broader variety of environmental stress factors: from mining to transport, from waste to dissipative losses of all kinds.

2. Function, Structure and Dynamics of the Environmental industry

As „Environmental industry“ we define (similar to Eurostat and the OECD) the sum of enterprises that produce marketable goods and services both for traditional additive pollution management (“clean-up” or “end-of-pipe-treatment”) and integrated resource management or eco-efficient production and consumption.

The differentiation between pollution management and resource management seems plausible and useful (Ernst & Young 2006). But contrary to Ernst & Young and Eurostat we propose to include „clean(er) technology“ into the resource management sector (see also DTI/DEFRA 2006). This revised classification would include all “integrated” environmental technologies into the sub-class of resource management. This also would underline the special character of the clean-up/ end-of pipe-type of environmental technology: As a rule it causes not only additional costs, in most cases it leads also to additional resource use (e. g. the lime input for desulphurization, additional electronic equipments or materials for sound-absorbing barriers). Resource management on the other hand means more efficient resource use and thereby also higher productivity (Meyer et al. 2007). Innovations can take place also in the area of pollution management (clean-up technology). Often they are highly effective as far as *special pollutants* are concerned. Eco-efficient innovations and resource management typically have a *broader scope of environmental effects*. And they tend to be economically more efficient.

2.1 The Environmental Industry as Functional Condition of Sustainable Growth

Industrial growth is only possible and sustainable if negative external effects and damage costs are steadily “neutralised” and environmental impacts remain at a constant if not lower level. This necessitates a permanent reduction of emissions, waste or other negative ecological effects relative to the produced unit of GDP, either by pollution management or resource management. The production and innovation of pollution control technologies and ex ante eco-efficient products or investment goods (including the related services) is so far essentially the function of specialised producers: the environmental industry, which encompasses the green technology division of companies. This quasi sector of the economy, therefore, is the functional prerequisite of sustainable growth. It is a sector producing marketable technical solutions for global environmental needs. The market potential is different from many other products: It is characterised by its global dimensions, a long-term future perspective and a permanent pressure for environmental innovation.

Due to market failures EI is to a high degree policy-driven (Ernst & Young 2006, Jänicke/Jacob 2006). Markets are the most important mechanism to stimulate competitive innovations of clean/cleaner technologies. But this has preconditions: Markets in general have neither (a) the capability to detect long-term environmental damage nor do enterprises have an (b) adequate inherent interest to develop marketable solutions. Typically they also are (c) unable to create sufficient demand for such solutions - which need high market penetration to be effective in terms of environmental protection.

Here the constitutional obligations and legitimation mechanisms of democratic government become relevant. The role of public policy is especially important when the pressure for change is high and the rate of technical progress too low (e. g. climate change). Governments, individually or by concerted action, typically translate environmental threats into regulations. Such policy regulations support the demand for marketable solutions. At the same time they provide a standardised information about problems, solutions and the probable reaction of competitors and clients.

The growth of the EI can be primarily explained by this functional necessity of damage prevention which in the past often has manifested itself by ecological crises or political protest (e.g. Japan, USA or Germany). Recent examples are China or Southern Europe. Since the sinks are restricted and the resources are not always available (or characterised by volatile prices) global industrial growth necessitates eco-efficiency at ever higher levels. This causes permanent pressure for environmental innovation (Jänicke 2008). EI, therefore, is not only a fast growing but also a highly innovative sector. According to DTI the EI is highly knowledge-intensive contributing more than average to the added value and productivity of the national economy (DTI/DEFRA 2006, 6). Since EI provides marketable solutions not only for governments but also for enterprises facing the risk of environmental regulation or other kinds of pressure this sector may also have a modernising function for the whole economy.

The fist function of the EI is to prevent or reduce environmental damage. But there is also a more constructive function especially in highly developed countries to improve environmental conditions. The growing global middle class is characterised by its higher demand for a healthy and “natural” environment.

So far all this is true only for highly developed countries, which play the role of trend-setters for environmental innovations, thereby creating lead markets for environmental innovations (Jacob et al. 2005, Beise/Rennings 2003). Successful export – starting from national lead-markets – may be the most plausible test whether the growth of the sector has a positive impact to sustainable growth in economic terms.

The special characteristics of EI and eco-efficient innovation – global and future market potential, role in the competition for innovation etc. – may explain why the often announced regulatory “race to the bottom” did not take place. It should be remembered in this context that countries with stricter environmental policies on average are more competitive than others (Esty et al. 2006, Jänicke/Jacob 2006). New findings indicate that countries with innovative environmental technologies prove successful in total factor productivity (the efficiency of production on given capital and labour inputs) and therefore in economic growth (Allianz 2008, 33).

2.2 Structure of the Environmental Industry

The „Environmental Industry” (EI, see box 1) has no clear statistical status and is not part of the traditional sectoral system. A certain sectoral identity however can be attributed not only by the kind of output but also because there are some sectorally specific activities (e.g. collective lobby activities). For a long time EI was defined as the sum of producers of “end-of-pipe”- technology typically adding clean-up measures to “dirty technologies” (related services included). Meanwhile EI is defined by two different functions:

1. Pollution Management: „...sectors that manage material streams from processes (the techno-sphere) to nature... typically using ‚end of pipe' technology“.
2. Resource Management: „sectors that take a more preventive approach to managing material streams from nature to techno-sphere“ (Ernst & Young 2006).

In a broad empirical Study Ernst & Young described the EU-15 EI as a sector with a turnover of 214 Mrd. or 2,3% of the GDP (see Table 1, 2004). The EU-25 „full-time job equivalents“ are 3,4 million. Germany, France and UK having the largest EI and also the highest contribution to foreign trade within the EU (Ernst & Young 2006, see also DTI/DEFRA 2006 and GHK, Cambridge Econometrics, IEEP 2007). According to Roland Berger the size of the German EI was 4% of the GDP in 2005 (BMU/ Berger 2006), according to Ernst & Young (2006, 28) it was 3% in 2004. The DIW counted 1,5 Mio employees, after a steady increase (BMU 2006, 13). A Study for Austria revealed similar results about the size and dynamics of the EI (Köppl 2006).

Table 1:
Eco-Industry Turnover EU 25, Germany, UK 2004 (bn. €)

	EU 25	**Germany**	**UK**
A) Pollution Management:	**82,0**	**26,5**	**4,7**
* Waste Water Treatment	52,2	19,3	1,6
* Air Pollution Control	15,9	4,5	1,7
* Remediation & Clean Up of Soil & Groundwater	5,2	1,1	0,3
* Noise & Vibration Control	2,0	0,4	0,1
* Environmental Monitoring & Instrumentation (est.)	(1)		
* Nature Protection (1)	5,7	1,2	1,0
B) Resource Management:	**168,5**	**35,3**	**14,8**
* Solid Waste Management & Recycling (1)	52,4	14,9	6,4
* Recycled Materials	24,3	6,8	3,5
* Renewable Energy Production	6,1	2,2	(0,4)
* Water Supply	45,7	11,4	4,5
* Eco-construction (estimated)	(40)		
C) Administration, Management, Research (1)	**19,8**	**4,4**	**2,0**
* General Public Administration	11,5	4,4	1,6
* Private Environmental Management	5,8		0,4
* Environmental Research & Development (est.)	(2,5)		
	270,3	**66,2**	**21,5**

Source: Ernst & Young 2006

own compilation + (1) revised classification, estimations in brackets.

Additional to the existing problems of statistical classification and definition of the environmental industry, the main difficulty is to define a significant environmental improvement.[1] Which kind of cars or buildings is energy efficient enough to be included? This blurring seems to have caused some underestimation of the size of this “sector”. Even the remarkable Study of Ernst & Young shows this underestimation. Their turnover figure for the British EI is 21,5 bn. € (2004). DTI/DEFRA have a significantly higher figure of 35 bn. € in 2005 (DTI/DEFRA 2006). The figure of the annual turnover of the German EI is 66,2 bn. € (Ernst & Young 2006). Roland Berger however has a remarkably higher figure of 150 bn. € (2005) (BMU 2007). Some relevant environmental friendly technologies and services are not included in the EU calculation, e.g. eco-construction, the EU-wide turnover of which is estimated at 40 bn. €. The figure for renewable energy is by far too low, For Germany it is not 2,2 bn. € but 12,3 bn. € (2004), even higher than the EU figure (6,1 bn. €). Eco-tourism or “green” financing (e.g. in Germany the public “Kreditanstalt für Wiederaufbau” (KfW) or the influential semi-public Deutsche Bundesstiftung Umwelt) are not included as well (Ernst & Young 2006). Bio-products or other specified environmental-friendly products (e.g. energy-efficient „Top Runner“) so far have no statistical “visibility”. This leads to underestimation. Only the inclusion of “eco-construction” would increase the weight of the EI to 2,7% of the EU-15 GDP. Unfortunately the growth of eco-efficient technologies seems to be rather high especially in some fields where operationalized definitions are difficult or so far lacking.

Table 1 shows the different parts of the EI according the classification of Ernst & Young and their EU-25 turnover in 2004. The available figures for Germany and the UK are added. The classification has been revised as follows: “Solid waste management and recycling” has been added to the “resource management” part and “nature protection” to the traditional pollution management” part (both seems to be highly plausible). Estimates of turnover have been added where available (and mentioned in the EU study). Administration, management and research have been taken into a separate class, because they have to do with both, the pollution management and resource management (before they were added to the clean-up sector). Finally, additional parts of “environmental industry” are mentioned, which are not (or not fully) included in the calculation of Ernst & Young.

This makes clear that:

- The environmental industry has two faces: traditional pollution control and resource management, the latter being the larger part if we use a more plausible systematic classification, putting e.g. waste management and recycling in the resource management part. Also a recent Study on seven OECD countries using a similar dual classification comes to the conclusion that “cleaner production” today has a larger proportion than “end-of-pipe” (Frondel et al. 2007, see also DTI/DEFRA 2006).
- The total calculable turnover of the EU-25 EI is clearly higher than the study shows (at least 270 bn. € instead of 227 bn €). Figures for renewable energy, for example, are too low, others are not included. The EI is larger if sub-groups are included which are less “visible” in terms of statistics.
- Taken this into account it is highly probable that the EU-15 EI (2004) is a remarkable industry of not less than 2.7% of the GNP.

2.3 Dynamic: Environmental Industry, a fast Growing Sector

The real growth of the European EI between 1999 and 2004 was 7% (Ernst & Young 2006). Parts of the EI have a much higher growth. According to Roland Berger the annual real growth of the German EI could be about 8% up to 2030. The turnover of this "sector" was 150 € bn. in 2005. His share of GDP was 4% and could rise to 16% or € 1.000 bn. in 2030 (Roland Berger 2006). In the UK the EI increased – partly due to the inclusion of new statistical sub-classes (see Table 2) - from 15 bn. BP in 2000 to 24 bn. BP in 2005 (35,3 bn. €). UK average annual growth between 2000-05 was about 7%.

Table 2:

Turnover (£ million) and employment in the environment industry in the UK

Sector	2000*	2005**
Water & wastewater treatment	7334	9400
Waste management	4600	8100
Env. consultancy services	600	1230
Air pollution control	907	583
Other	523	523
Contaminated land remediation	638	494
Cleaner technology & processes		177
Noise & vibration control	77	369
Renewable energy	200	290
Env. monitoring & instrument.	100	189
Marine pollution control		22
Research & development		
Energy management		2648
Total	**14979**	**24025**

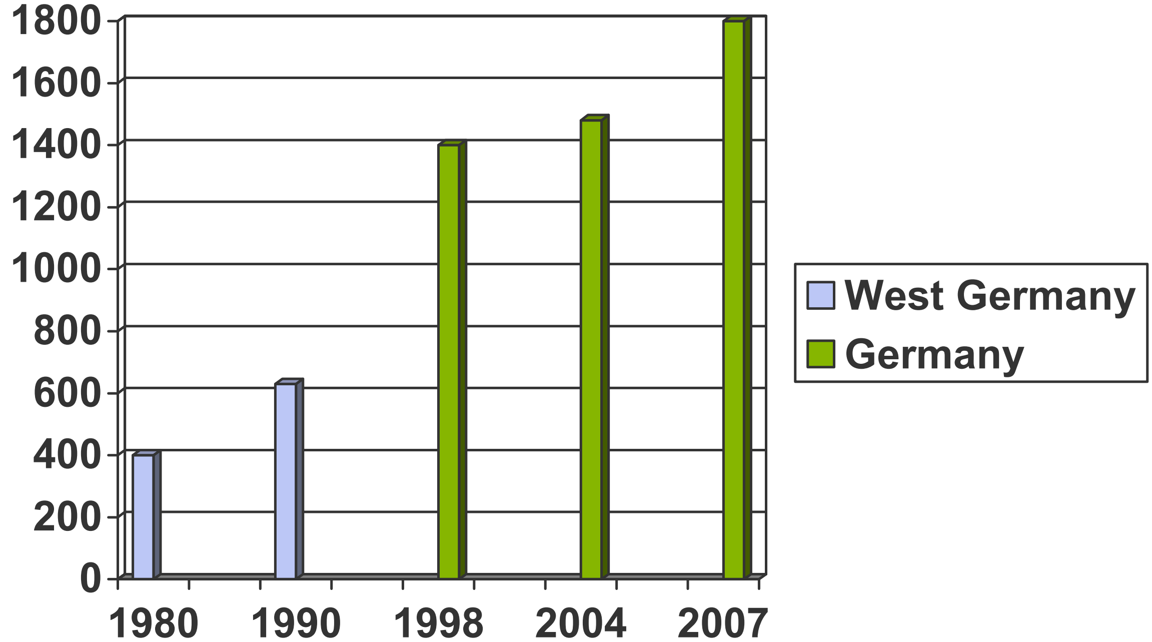
Sector	2004**
Water industry	**50,000**
provision of services	28,000
sewage	22,000
Waste management	**69,000**
collection	52,000
recycling	17,000
Renewable energy	**6,370**

* Source: 'Global Environmental Markets and the UK Environmental Industry', DTI and DEFRA 2002

** Source: 'Emerging markets in the environmental sector', UKCEED for DTI and DEFRA 2006

The slow growth of the employment in the German EI in the last years is not least due to the fact that the calculation is relying mainly on traditional and in the meanwhile slow growing end-of-pipe technologies (Figure 3)

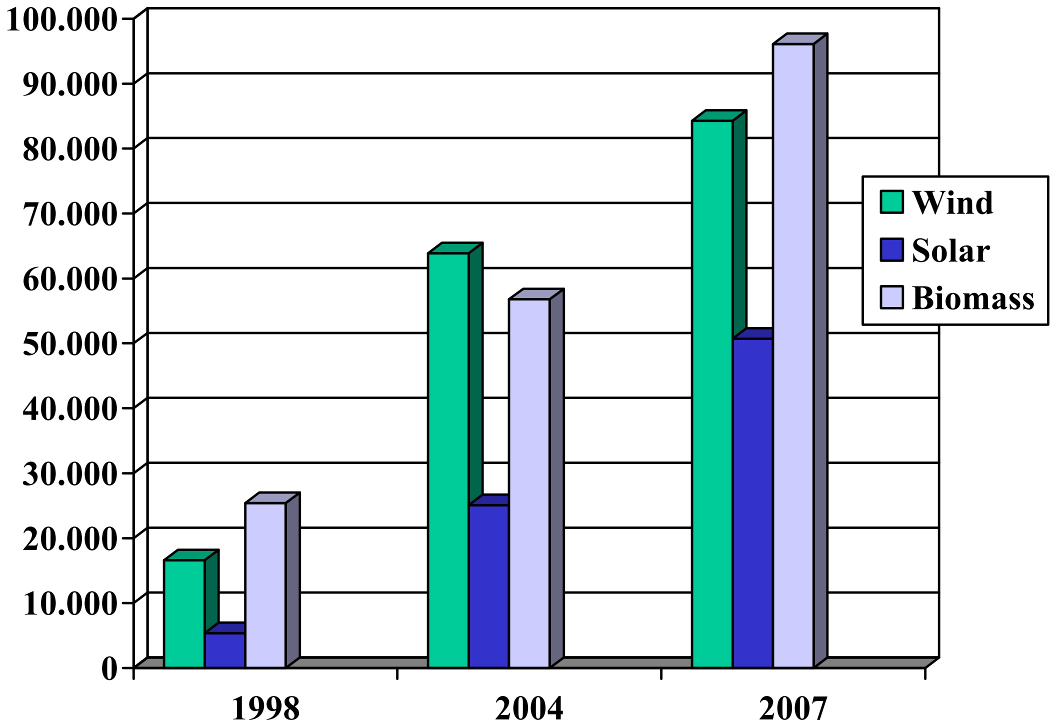
Figure 3: Employment in the German Environmental Industry (in thousands)



Source: Own compilation; BMU 2008

The growth of employment in the sector of eco-efficient technologies ("GreenTech") is quite different and significantly higher, renewable energy having the highest growth rates (Figure 4). In 2007 the sector provided 249.000 jobs (2004: 160.000, BMU 2008).

Figure 4:
Employment in the German Renewable Energy Sector 1998-2007



Source: BMU 2008

A survey of 1 500 German firms producing environmental technology and services provided the following picture (Table 3) of this industry, here being titled as „Green-Tech“ industry:

Table 3:
Structure and Growth of the German „GreenTech“ Industry

	German Share of GreenTech World market (%)	Annual Turnover Growth 2004-2006 (%)	Expected Annual Turnover Growth 2007-2009 (%)
Environmental friendly energy supply	30	30	27
Energy efficiency	10	21	22
Material efficiency	5	11	17
Recycling	25	13	11
Sustainable water supply	5	12	15
Sustainable mobility	20	29	20

Source: BMU 2007, p. 3 and 14 (Roland Berger)

Again the high importance of the special resource management part becomes visible. The growth dynamics here is especially high. In Germany it is clearly higher than the growth of the pollution sector, which is confronted with *decreased domestic demand* and is successful only as export sector. We can plausibly assume that the growth of the resource management sector (Table 4) is higher also in other highly developed countries where domestic markets for clean-up technologies tend to stabilise (or even decrease). The world market of resource-efficient technologies is rapidly expanding (Table 5). As companies often benefit directly from the cost-saving potential of production-integrated environmental technologies, related innovations are set to gain enormously in importance worldwide (Allianz 2008, 30). Germany – together with other European countries and mainly U.K. – here have a strong export position (see ADAME 2007).

A significant additional driving factor seems to be the scarcity of resources: A survey of German companies on the strategic relevance of aspects due to the ‘Global Change’ revealed, more than 80% of the companies fear of resource scarcity (they seem to be more affected only by aspects of demographic change, Biebeler et.al. 2008, 14-26).

Table 4: Annual Growth Rates of Selected Eco-efficient Technologies in Germany 2005-2007

• PV:	50%
• Heat pumps:	44% (2005/6)
• Biogas power:	37%
• Bio diesel:	21,6% (2005/6)
• Wind energy:	19%
• Passive houses:	19%
• Bio Food:	15-16%
• Contracting:	about 15%

Source: Own compilation, BEE, KfW, BMU 2008

The high growth of resource management technologies and the different growth of pollution control becomes visible if we take a snapshot of the present real turnover growth of selected eco-efficient technology in Germany (Table 4). This has to be compared with the constant demand in pollution control technology: The public, private and expenditures of privatized public companies for pollution control together remained stable in Germany between 1994 and 2004 (33,9 m. € compared to 34,4 m. €, Statistisches Bundesamt 2007, 15).

Table 5:
Expected Global Annual Growth of selected Environmental Technologies

• PV (grid-connected capacity, 2005-07):	51%
• Investment in renewable energies (2005-07):	30%
• Wind energy (capacity)(2005-07):	26%
• Bio plastics (forecast 2005-20):	22%
• Hybrid cars (- 2020):	22%
• Bio diesel (- 2020):	20%
• Automatic waste separation (- 2020):	15%
• Decentral water management (- 2020):	15%

Source: Roland Berger 2007, REN21 2007

Energy-efficient measures and innovations will therefore gain the position of a *key strategy* for sustainable growth in Europe: A cross-sectional analysis of economic performance in 15 EU-countries points out: Investing in more productive and hence more economical use of energy is a driving factor for economic growth (Allianz 2008,31) . Calculations on the return of investment on a global scale have shown, that - with an average internal rate of return of 17 % - the annual investment of 170 billion $ could result in savings of up to 900 billion $ annually by 2020 (Mckinsey Global Institute 2008,.7-8). In addition the costs for otherwise presumably required new power plants could be avoided. (At a micro-economic level however energy-efficient investments will bear costs as well as benefits, depending on the sector, company or policy instrument, see also Jochem et al. 2008, 27).

3. Governance

In the following section we analyse the relationship between regulation and the growth of the Eco-industry. After a general introduction we will look at four selected cases of best practice regarding environmental policy, growth and innovation.

"Compliance with policy objectives and legal requirements set by EU and national authorities will be the main drivers of eco-industry growth in the near future" (Ernst & Young 2006, p. 48). If this is true, then the question of governance arises. In a recent publication we have argued (Jänicke 2008), that an environmental innovation is best supported under following conditions:

- clear, demanding and calculable goals
- hybrid instrumentation: economic instruments (like eco tax reforms and/or emission trade) to stimulate a *general tendency* ("Tendenzsteuerung") and *specified "detail regulation*" ("Fine-tuning", "Detailsteuerung") to use specific innovation potentials which otherwise will not be fully mobilised
- a policy mix supporting all phases of the innovation process and providing additional supporting instruments (e.g. labelling or networking of all kinds).

Therefore monetary instruments like environmental tax reform (ETR), together with specified regulation (e.g. the Japanese Top-Runner-Programme), is regarded as the most influential tool for environmental innovations. Ekins and Venn (2006) have shown the importance of both instruments in a comparative study. Not least the technological effects of high energy prices in the 1970s and today have confirmed the special role of the price mechanism. However, it is not easy to find data reliable enough to prove the plausible relationship between changes in relative prices and the growth of EI in general. Again it is the two faces of EI that create the difficulty.

Therefore, the differentiation between pollution management and resource management becomes essential. As mentioned above there is no plausible positive relationship between resource prices or taxes and the growth of traditional clean-up technologies. However, the correlation between resource prices and resource management (or eco efficiency) is highly plausible.

Changes in (relative) resource prices can be effected both by market mechanisms and by government intervention. Government intervention can function as positive incentive (subsidies, or feed-in tariffs) or as negative incentive (taxes, emission trade). Positive incentives give support to a specific innovation. Negative incentives like taxes create economic pressure for innovation in a certain field of technology. Their advantage is the openness of the field of innovation and the public revenue. But both kinds of intervention change the relative prices, which has steering effects. In our context we focus on the steering effect of changing relative prices, irrespective of their causes (positive/negative government intervention, market mechanism). This is necessary because the steering (and innovation) effect e. g. of rising of oil prices cannot be ignored.

In the following part we will illustrate the broad spectrum of influences supporting eco-efficient innovation and the growth in the eco-industry. Policy regulation and the price mechanism are clearly essential. But the policy mix is different from case to case.

4. Successful Eco-efficient Innovation: Four Cases (Germany)

Four selected cases of best practice of eco-efficient innovation in Germany will be sketched in this section to illustrate the win-win potential and the role of policy intervention. We will look at the policy-mix and the price mechanism but also at the outcomes and impacts – the potential co-benefits - of ambitious environmental policy measures. The German eco tax has contributed to innovation and growth in the field of **(1) low-energy buildings** and **(2) fuel-efficient diesel cars** (Jacob et al. 2005). In both cases additional supporting instruments came into effect: Energy minimum performance standards for buildings together with subsidies for energy-saving investments and a tax differentiation for new cars stimulating fuel-efficiency were additional instruments in the policy mix. **(3) Recycling** is dominated by regulation but in the case of industrial recycling also the rapid increase of material prices has stimulated more efficient solutions. Finally we describe the case of **(4) renewable energies**, where monetary mechanisms – here subsidies as feed-in-tariffs – have caused a rapid modernisation. Again, a policy mix with additional instruments was relevant. We also will have a look at factors like export, job creation and of course the environmental impacts (see Table 6).

Table 6:
Eco-Industry: Four German Success Stories

	Fuel-efficient Diesel Cars	***Low-Energy Buildings***	***Recycling***	***Renewable Energies***
Taxes / Price Mechanism	**Car Tax, Eco Tax**, Oil Price	**Eco Tax** Oil Price	Raw Material Prices	Oil Price
Other dominant instruments		**Standards, Subsidies**	**Regulation**	**Feed-in Tariffs, Subsidies**
Growth	++	+	++	++
Employment		+		++
Innovation	+	+	++	++
Export	++	+	++	++
Environmental Impacts	+	++	+	++

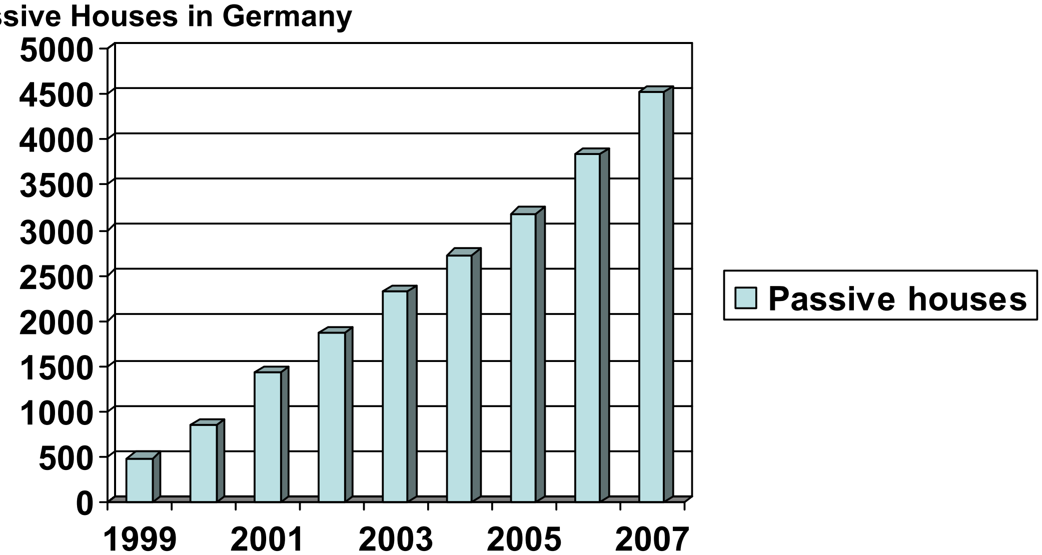
Source: Jänicke 2007. Judgement: + = above average, ++ = far above average

4.1 Low-Energy Buildings

A policy to improve the energy efficiency of buildings was part of the climate programme of the red-green coalition government after 1998. The effect of this policy was a reduction of heating energy in Germany by about 20% between 1996 and 2005 (SRU 2008). The policy mix included energy efficiency standards (insulation, heating system) together with monetary mechanisms. Most prominent was the eco tax (1999) and a market incentive programme. Support for low energy houses was a special activity of the state-owned bank Kreditanstalt für Wiederaufbau (KfW). As in the case of Diesel cars the oil price was unimportant in the first years. But later on it had a strong additional influence.

There has been a rapidly expanding market for low energy houses in Germany after 1999. More than 14.000 very low-energy houses (that means 27.000 flats, <4 l/oil/m^2) have been supported by the KfW between 1999 and 2007. The annual growth rate was above 30%, the sub-group of passive-energy houses (<1,5 l oil/m^2) amounted more than 4.200 (6.300 flats) in 2007 (Figure 4). The cost difference compared with a normal house is only 8% (KfW 2007, BMU 2007, 59ff.). The subsidy has been increased in 2007, together with tightening of the efficiency standard by 30% (which after 2012 shall be strengthened again by 30%).The present energy standard (2002) is about 7 l oil/m^2 for single houses. The average energy consumption of older houses in Germany is 25 l oil/m^2 (BMU 2007).

Figure 5:
Passive Houses in Germany



Source: Kreditanstalt für Wiederaufbau 2007; (2007: Forecast.)

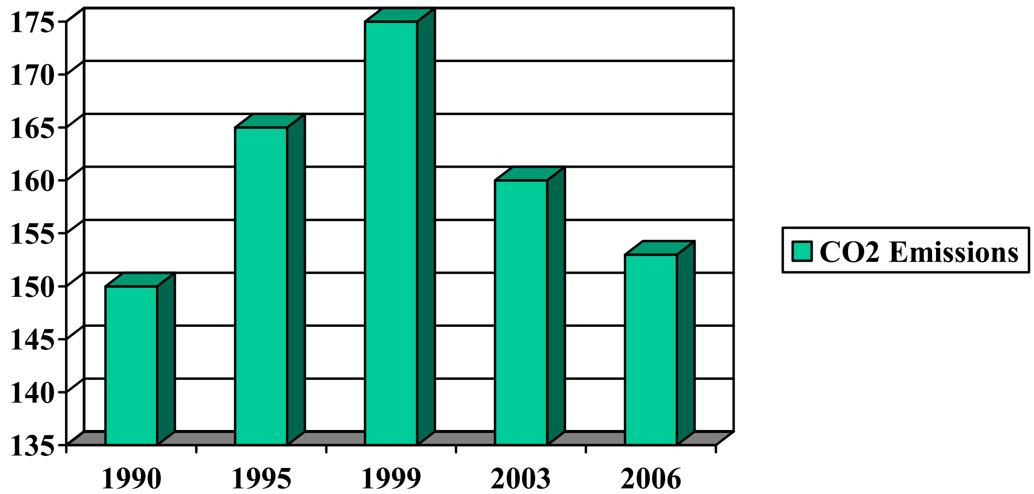
The market of special components for low energy houses (e. g. insulation materials) is rapidly increasing. The market for heat pumps was similarly dynamic (2006: plus 44%). As to the competitiveness of the (often pre-fabricated) German low energy houses: Germany has by far the highest proportion of this type. Since the EU commission envisages the low energy house standard for 2015, this may be at least a good start. In the meanwhile (2008) the EU commission envisages a CO_2-reduction for Germany in the housing and construction sector of 14% until the year 2020.

4.2 Fuel-efficient Diesel Cars

The following case is also an illustration of the difficulty to draw a clear line between EI and the rest. But cars with a fuel efficiency double as high as the existing car fleet may be worth to be discussed in our context.

Diesel cars with a fuel consumption of 3 or 5 l/100 km came on the market in Germany in 1999 following a car tax differentiation which had been introduced in 1997. It explicitly supported fuel-efficient cars with a high tax bonus. De facto this was a bonus for Diesel (according to an earlier agreement between state governments and the German car industry). Only Diesel cars with fuel injection achieved the supported performance level. Paradoxically, the success of the most energy-efficient 3-liter Diesel cars (Volkswagen) was limited but the regulation of 1997 coincided successfully with the introduction of the eco tax by the red-green government. The eco tax was introduced in 1999 and added to the mineral oil tax which had already been strongly increased in the early 1990s. This led to a successive reorientation of German car drivers also in other segments of the car fleet. The result was not only a market success of fuel-efficient Diesel cars (already having strong market position in Germany) but a general decrease of fuel consumption since 1999 (shortly after the start of the red-green government) which also influenced the CO_2 emissions of cars in general (see Figure 6).

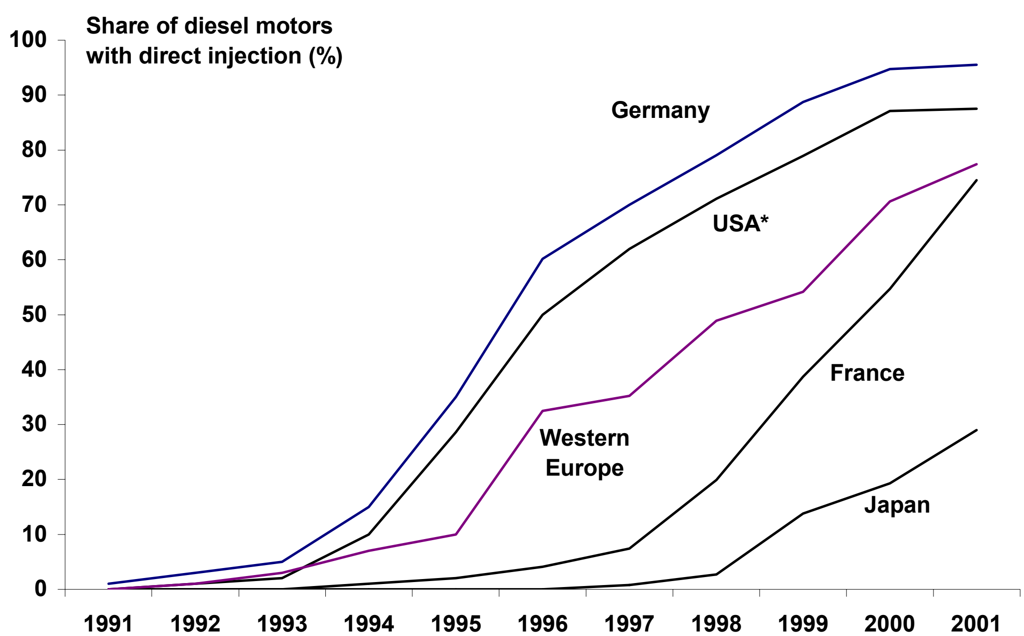
Figure 6:
CO_2 Emissions of Car Traffic in Germany 1990-2006
(In g/km)



Source: SRU 2005, 63, Statistisches Bundesamt

The effect of both economic instruments was already visible before the oil price increased. Therefore the improved eco-efficiency can be explained to a high degree with the policy intervention, though the later effect of the oil price cannot be ignored.

Figure 7: Market Shares of Fuel-Efficient Diesel Cars



Source: ZEW, Bosch
* USA: predominantly light trucks

The economic result was a clear world market success of German Diesel cars, Germany here being the lead-market with the US market as early follower (Figure 7).

It is interesting that this economic approach has been even more successfull in reducing CO_2 emissions if compared to the regulation-oriented policy of Japan: In July 2007 the Ministry of Economy, Trade and Industry, and the Ministry of Land, Infrastructure and Transport promulgated Japan's New Fuel Economy Standards for cars, as a part of the Law Concerning the Rational Use of Energy. Car producers are obliged to improve fuel efficiency, the new Top Runner Standard Values mean 16,8 kilometers per litre for cars by fiscal year 2015. (This is close to the 120 g/km target of the EU for 2012).

4.3 Recycling

The strategic economic role of recycling for sustainable growth is widely acknowledged. But so far policy success was limited. Changes in modern economies will however underpin the worth of recycling:
The material used by the German industry causes nearly 45% of all production costs. This share has even increased. Labour costs on the other hand amount for less than 20%. That means, energy and raw materials which are included in waste will become a forgotten resource.

In times of rising resource prices these sunken costs could also reach a *new* market price. It will be of basic interest for a society to substitute new energy and raw materials. Additionaly, in times of rising CO_2-costs as induced by the EU-Emission Trading System, especially energy and material intensive industries will get problems to sustain their competitiveness. Using recycled metal for example could cut emissions by four-fifths.

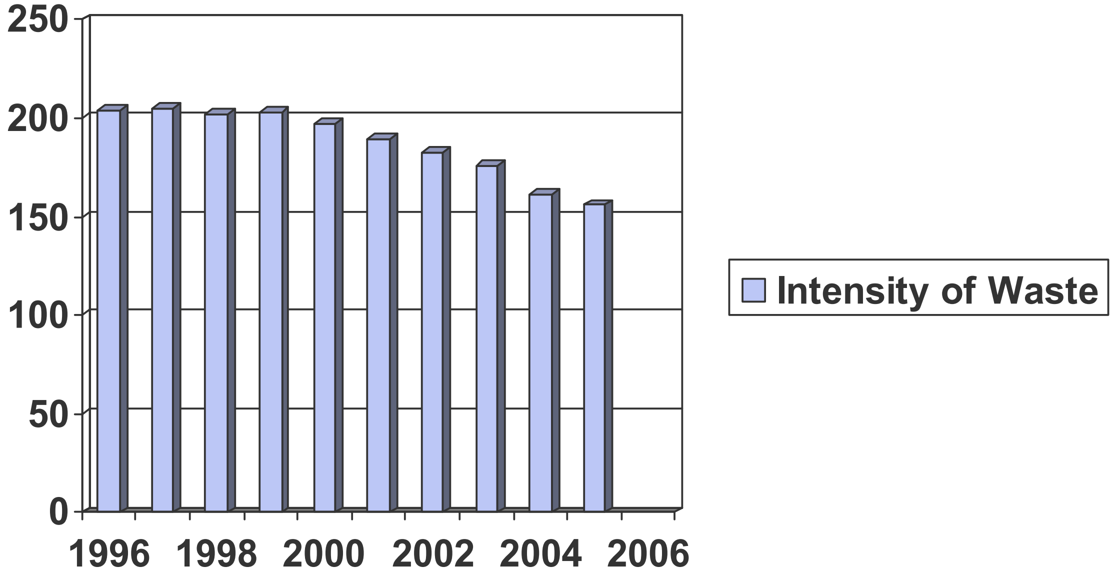
Recycling is therefore a essential to *resource efficiency:* Resource productivity as a strategy to minimize the transformation of products from the natural system to the industrial system is accompanied by a strategy to minimize material flows from the sphere of production and consumption to nature.

In 1994, Germany has introduced an ambitious recycling policy, which was strengthened in 2001 by a regulation which included the target, to prevent any landfill without pre-treatment up to 2005. This was essentially a regulatory policy (a successful voluntary agreement of the construction industry being the exception). Töller (2007) in an examination of steering modes in German waste policies during the last 15 years, concludes that a perhaps supposed “withdrawal of the state”, symbolised by deregulation, privatisation, or an increased intensity of societal self-regulation can not be witnessed in the case of German waste policies.

The German sustainable development strategy also formulated a target to increase the resource productivity by 100% between 1994 and 2020.

The policy caused an increase of recycling rates together with heat recovery from incineration, and it reduced the rate of final disposal to landfill from 63,5 mt. in the year 1998 to 45,7 mt. in 2005 (Statistisches Bundesamt 2007, 7) . This had also a positive effect on the waste intensity of the economy (Figure 8). There was a clear decoupling of GNP-growth and waste generation beginning in 2000. The total waste generation in 2005 (332 mt.) was nearly 14% lower than in 1996 (385 mt.) (BMU 2007, 95f.). The second environmental benefit is a reduction of greenhouse gas emissions. According to the German ministry of environment 40 mt. CO_2-equivalents have been avoided by waste management, mainly by closing down land-fill deposition sites (compared with 1990; BMU 2006, 37).

Figure 8:
Germany: Intensity of waste generation 1996-2005
(kg/ 1000 € GDP)

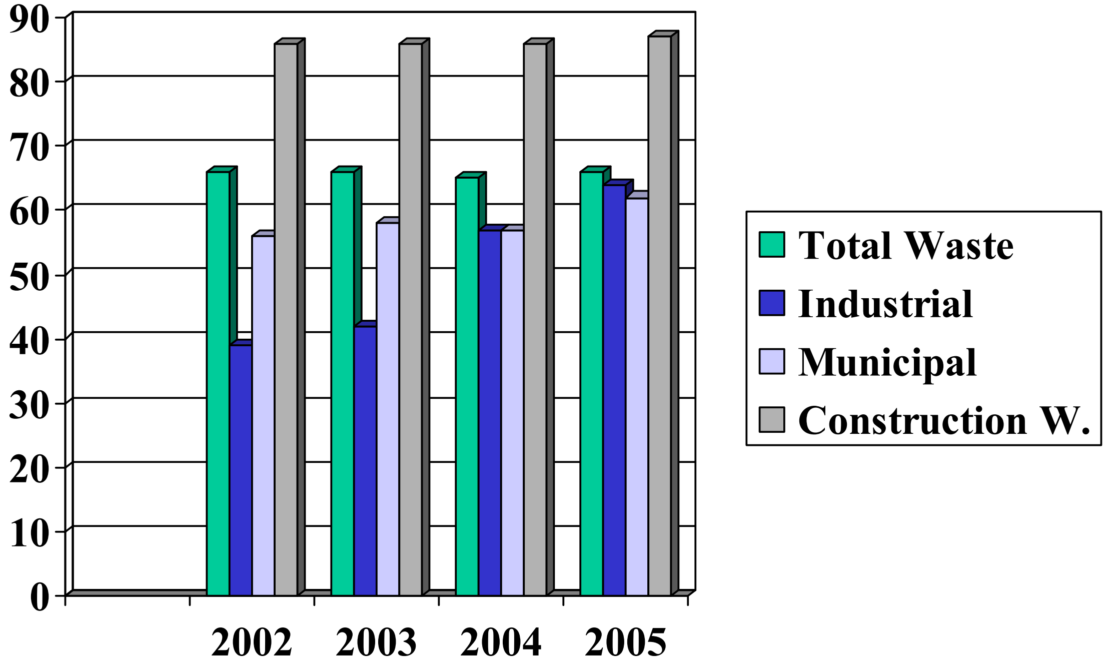


Source: Statistisches Bundesamt 2006, 2007

One reason for the trend mentioned is the decrease of construction waste due to the stagnation of the German economy after 2001. The advanced waste management policy (e.g. the phasing-out of landfill without pre-treatment), however, seems to have been the dominant cause. The third and in the future most relevant factor is presumably the change in commodity prices in the last years (BGR/DESTATIS/UBA 2007, 17), especially the increase of economic important metals and materials.

The following Figure 9 shows a remarkable increase in the recycling rate of industrial waste in the last few years parallel to the rapid increase of raw material prices (2000-05: +80%, BMU 2007). The difference between industrial and municipal, or construction waste is not least remarkable. The most plausible explanation is the immediate pressure of raw material prices on the industry as a hard cost factor. The price signal seems much less visible and relevant for the other sectors:

Figure 9:
Recycling Rates in Germany 2002-2005
(in %)

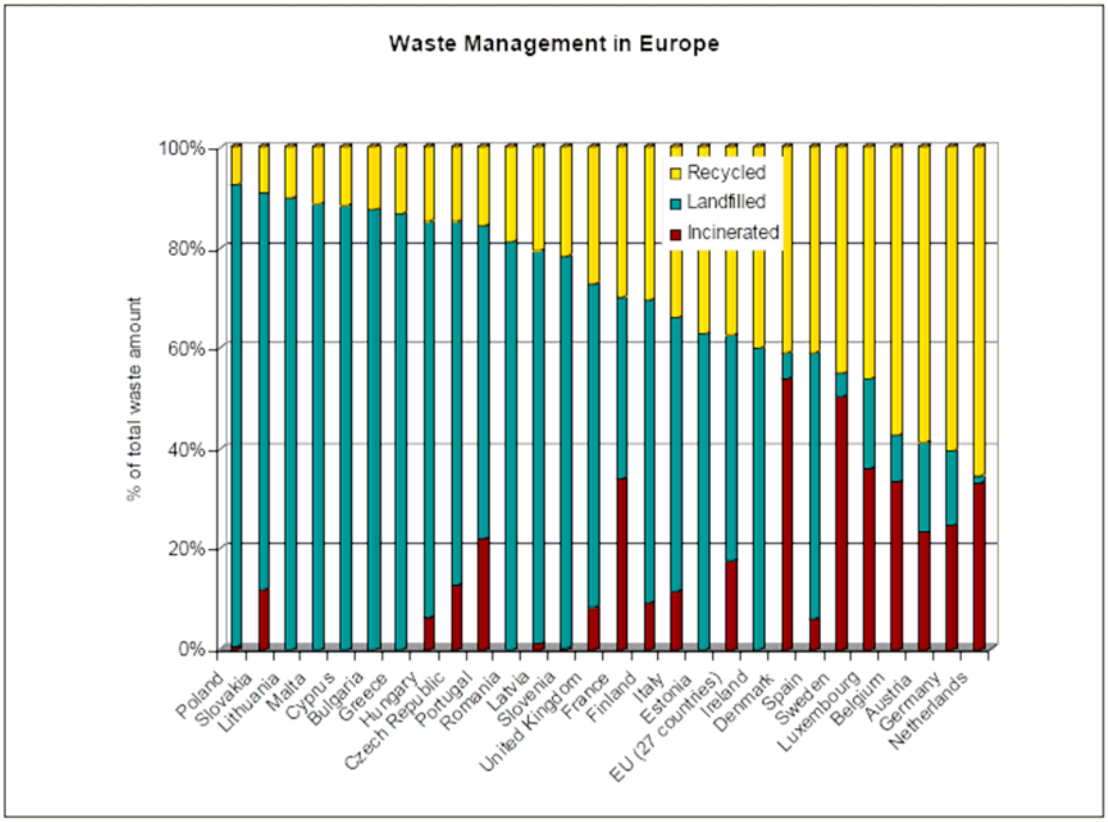


Source (Data): Statistisches Bundesamt 2007

Compared with UK (and most other EU member states) the German regulation caused a significant higher share of recycled or incinerated waste and consequently a significantly lower proportion of waste deposited in landfills. Regarding municipal waste this is shown in Figure 10.

The price mechanism - as an additional steering factor - becomes visible in the last years as regards industrial waste.

Figure 10:
Municipal Waste in EU Countries: Recycling, Incineration and final Deposition



Source: Sander 2008, p.8 / following EUROSTAT 2007

The economic co-benefit of this policy was a rapid growth and an increased employment of the waste industry and the recycling sector. The ministry of environment calculates a turnover of the waste industry of about 50 bn. € and an employment effect of about 250.000 jobs. In addition there was an annual saving of raw material imports of about 3,7 bn. €.[2] The special recycling sector reached an annual growth of turnover of 13% between 2004 and 2006 (employment: 9%) and is expected to grow by 11% between 2007 and 2009 (employment: 7%) (BMU 2007, 15, 95-97). German recycling technologies have a share of 25% in the global market. The share of automatic separation technologies – a fast growing market - is even 64% (ibid. 13, 105).
Statistics from DEFRA also show a high growth of the British waste management sector from 6,8 bn. € (2000) to 11,9 bn. € (2005). The employment figure is 69.000,

[2] Also the German Institut der Deutschen Wirtschaft (2007) underpins the rising economic importance of re-use and recycling of raw materials.

including 17.000 jobs in the recycling sector. The share of landfilled municipal waste is higher in UK, the proportion of recycling or incineration with heat recovery is lower than in Germany.

4.4 Green Power

An ambitious regulation to stimulate renewable energy in the German power sector was introduced by the red-green coalition government (1998). This policy was very effective and has caused a rapid increase of renewable electricity: The original target of the law (EEG) of 12,5% share of electricity in 2010 has been achieved already in 2007 (about 14,2%). A new target was fixed (2007): 25 - 30% in 2020 instead of > 20%.

The main instrument - changing the relative prices of green power - have been feed-in-tariffs which already existed in the 1990s (Electricity Feed In Act 1990) but have been significantly increased and broadened in 1998 by the Renewable Energy Resources Act (EEG). This meant attractive prices and obligatory feed-in for renewable electricity. In 2005 total fees achieved an amount of 4,19 bn. € (3% additional electricity costs for households, BMU 2006, 2007). This instrument has been broadly adopted in other countries (Reiche 2005).

The second instrument – again monetary incentives – was support for investments by the “Market Incentive Programme” 2000-04: support for investment (about 665,4 mill. €). Again the public bank Kreditanstalt für Wiederaufbau played an important role. Monetary incentives for alternative heating in buildings will rise to an amount of 350 mill. € in 2008 and up to 500 mill. In the year 2009. The role of rising oil prices cannot be ignored but there is no strong correlation with the investment in renewable power.

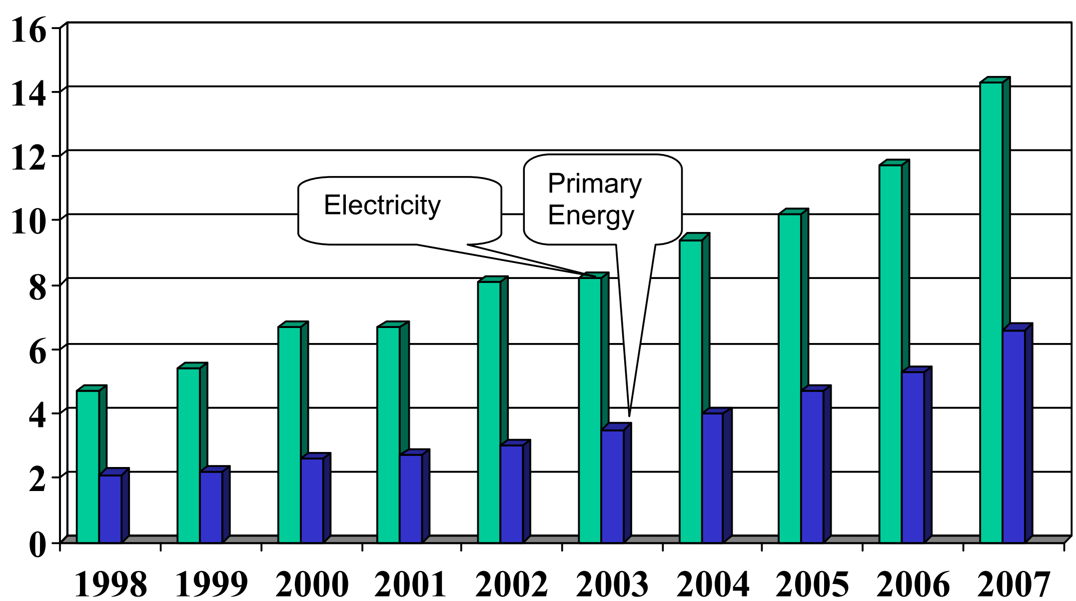
The increase of renewable power was remarkable. While from 1991 to 2001 there was a doubling of green power production (from 19 to 37 TWh/a), the next doubling took place only within five years (2006: 73, 2007: 86,7 TWh/a), again with a slight speeding-up in the last years (see Figure10).

The Environmental benefit of this policy was important: 58 mt. CO_2 emissions have been avoided in 2007, 14 mt. more than in 2006 (BEE 2008). No other instrument of the Germany climate policy is more effective (BMU 2007). There is of course also a positive impact on air pollution. In addition, external costs of some 8,6 bn. € for the fiscal year 2007 could be avoided.

The *Economic impact* may have been the most important*:* In 2007 the turnover over the green power sector was: 25 bn. € bn. (2004: 12,3 bn.€). The direct and indirect employment effect (2007) was 250.000 jobs. The forecast for 2020 (400.000) may already be too pessimistic (BMU 2007, 2008).

The additional costs per kWh of the feed-in tariffs (to be paid by the grid, i.e. by all households) was one cent in 2007 (1,5 cent in 2020). In 2008 the existing degression of the feed-in tariffs was revised; it is now 8-10 cent lower each year for PV. This subsidy as such could be viewed an investment into the first-mover advantage of a strong export position of Germany as regards PV and wind energy. It could also be seen as a public investment in a remarkable innovation process: Immediately after 1998 a rapid increase of inventions (patents) in the area of renewable energy could be observed in Germany (OECD 2005). The global market share of Germany for bio-gas technologies is 65%, for PV 41% and for wind energy 24% (BMU 2007, 41).

Figure 11: Share of Renewable Energy in Germany 1998-2007
(per cent)



Source: BMU / BEE 2008

The structure of renewable energy industry will change rapidly, when current dynamics relating to innovation processes and the ‘economy of scale’ go on: Expert estimations anticipate that in 2010 in South Germany the reduction of production costs of solar energy will reach the level of 0,15 € per kwh (or in California 0,11 € and in Spain about 0,10 € per kwh). In this case solar energy will reach the *‘grid parity’* and will be fully competitive with coal-fired power plants, especially if accompanied by a realistic price scheme of CO_2-emission trading. The market for the production of solar energy plants seems to be ‘unlimited’.

5. Conclusions

Regarding the structure, function and dynamics of the environmental industry we come to following conclusions:

- There is an inherent statistical boundary problem: The size of the EI depends amongst others on the degree of environmental improvement of a certain technology. We rely however on well-established sub-groups such as clean-up technology, renewable energy or recycling. But the picture is incomplete. And even in the so far best European study on EI the total calculable turnover of the EU-25 EI is clearly higher than the study shows (at least € 270 bn. instead of € 227 bn). Figures for renewables e.g. are too low, others are not included due to insufficient data. The EI is larger if specified sub-groups are included which are less "visible" in terms of statistics. Taking this into account it is highly plausible that the EI in the EU is a remarkable quasi-sector beyond the traditional sectoral structure, which may be not smaller than 2,7% of the EU-15 GNP (2004).
- The environmental industry essentially has two faces: traditional pollution control and resource management, the latter being the larger part if we use a more plausible classification (including e.g. waste management/recycling into the resource management part). Resource management is also characterised by high growth. The demand for pollution control technologies on the other hand is rather stagnating in advanced European economies like Germany.
- Pollution control or end-of-pipe treatment has its stable function in the process of industrial growth and remains a field of possible innovation (e.g. membrane technology or CCS). But as a rule it has no positive effect on resource productivity (often the contrary is true), whereas resource management is central for resource productivity and sustainable growth. Therefore it makes sense to differentiate both sub-classes of the EI more systematically.

To get a better picture of the dynamics within the resource management part of the EI we have used four (German) success stories: low-energy houses, fuel-efficient Diesel cars, recycling and renewable energy. They at least illustrate the large potential of resource efficient innovation effected by ambitious environmental policy measures. In this way they can be cautiously interpreted as follows:

- There is a multiple win-win potential of strict technology-based environmental policy. Our cases show the economic co-benefits of growth, successful export and employment (the net job effect may give a different but not a contradicting picture). The advantage of increased resource productivity has not been calculated but it is implicit in the selection of our cases. In this context it is worth mentioning that higher efficiency of resource use also contributes to the environmental quality by reducing the relative importance of transport, waste, emissions, or process related energy and water consumption.

- Strict and calculable environmental policy measures can also stimulate innovation, especially the feed-back of the innovation cycle from diffusion to invention (OECD 2005).

- Government intervention was essential, generally through a policy mix of different instruments. The combination of the price mechanism and regulation was crucial. The change of relative prices – whether by taxes, subsidies or the market – had a dominant influence. Taxation was a strong driver in the first two cases (fuel-efficient cars and buildings). Regulation was important in the case of recycling, but the role of the price mechanism was visible in the case of industrial waste management.

- Sustainable growth in our cases was not only policy-driven but also depended on an innovative type of industry, the resource management sector of the environmental industry.

Changes of relative prices – together with regulation - had clear steering effects notwithstanding their causes: taxes, subsidies, or market dynamics. It makes however a distributional difference whether the price difference creates income e.g. in OPEC countries or in the national public budget. Therefore ETR in principle is the better solution. Though subsidies (including feed-in tariffs) have proven important as specific market support for certain technologies, ETR seems the best general mechanism to stimulate a broader range of innovations. It is not the only mechanism to support sustainable, resource efficient growth. But as a rule it seems to be the most important basic incentive.

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