HELIO INTERNATIONAL

GERMANY

Sustainable Energy Watch
2002 Report

Energy and Sustainable Development in Germany

Germany has come a long way, but still has much to do…

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Executive Summary

The following table summarises the results of a review of the sustainability of Germans energy sector. Where:

Indicator 1 = per capita carbon emissions from the energy sector

Indicator 2 = most significant energy related local pollutants

Indicator 3 = households with access to electricity

Indicator 4 = investment in clean energy

Indicator 5 = energy security/energy trade

Indicator 6 = burden of energy investments

Indicator 7 = energy productivity

Indicator 8 = renewable energy deployment

Prior to 1991 Germany was divided and economic statistics for what was then Eastern Germany were not available. As a result the base year for indicators 5 and 6 was taken as year 1991 when comparable statistics were available.

Table A.1. Results for Germany According to HELIO International Indicators

	SUSTAINABLE DEVELOPMENT INDICATORS FOR THE ENERGY SECTOR							
	Environmental		Social		Economic		Technological	
Year	1 kg/capita	2 kg/capita	3 %	4 %	5 PJ	6 US$ mill	7 MJ/$ GDP	8 %
X (1990)	3,430	SO_2: 67.1 NO_x: 34.1 CO:136.6	100%	2.65	n/a	n/a	6.58	1.2
X (1991)	--	--	--	--	9,253	499.78	--	--
X (1999)	2,770	SO_2: 10.1 NO_x: 19.9 CO: 60.3	100%	2.89	10,399	447.8	--	--
X (2000)	n/a	n/a	n/a	n/a	n/a	n/a	3.39	2.2

n/a : Statistics not available

In terms of the environmental indicators 1 and 2, Germany has made progress in reducing emissions of both global carbon dioxide emissions and local pollutants sulphur dioxide, nitrogen oxide and carbon monoxide. However, Germany only meets the HELIO International sustainability target for sulphur dioxide (*for more details see section on Indicator 2*) and needs to continue to make reductions in the other pollutants in order to meet the levels defined as sustainable. The positive results for sulphur dioxide, primarily reflect increased efficiencies achieved in the energy sector following stricter enforcement of the *Federal Emissons Control Act* and the *Large Furnaces Ordinance* following reunification, as well as the significant shift away from heavy fuel oil, and lignite fuels (especially in Eastern Germany) to natural gas.

Germany has mixed results in terms of the social sustainability indicators 3 and 4. This is because whilst the target of 100% access to electricity in Germany was successfully attained, investment in clean energy is a long way from the HELIO International sustainability target of 95%. Increases in investments for clean energy as a percentage of GDP have only shown a marginal increase over the last 10 years and it seems unlikely that the target could be reached within the next decade.

Germany does not appear to be making much progress in improving the sustainability of economic policies governing the energy sector. The results for indicators 5 and 6 are a long way from the target levels for sustainability established by HELIO International, which require 0% investments in non-renewable energy imports and 0% government investment in non-renewable energy.

The technological indicators, like the social indicators, result in a mixed result. In terms of energy productivity, Germany has performed well achieving substantial decreases in wasteful energy consumption. However, Germany has to continue this trend if it will meet the the HELIO International target of 1.06MJ/$ GDP was obtained. It is recommended that Germany focus on improving energy efficiency where there are many opportunities for reducing wasteful energy consumption. In comparison the results for Indicator 8 are not so positive primarily because Germany remains firmly reliant on fossil fuels to meet national energy demand. This is revealed by the low levels of renewable energy deployment within Germany in Indicator 8. However, despite the levels of renewable energy at the moment, the growth in use of renewable energy sources in Germany has almost doubled over the last ten years, and the German government is a strong supporter of renewable sources. As a result, there is every reason to expect continued growth in the use of renewable energy sources in Germany.

General Overview of German Energy Sector

►Socio-economic Background

Germany has the largest population amongst the eu member countries with a population in the year 2000 of 83 million out of an eu total of 376 million. The life expectancy at birth is 77.17 years. The population density is 230/km^2 and the per capita gdp is 21,484.3 usd. The contribution of agriculture (primary production) to the total gdp is just 1%, while that of industry is 31.8% and services 67.2%. The unemployment rate was pegged at 9.6% while germany's balance of trade stood at +61.0 billion usd.

In general the economy has performed well in 2000 with a growth rate which was 1.5% in 2000, but growth faltered in 2001 since manufacturing output contracted whilst the inflation rate was 1.9%, the highest in several years. Inflation is directly attributed to the escalating energy costs, especially gasoline costs in the last few years. The reason for inflation is partly a result of the significant economic restructuring challenges faced by Germany, the rigid regulatory mechanisms and labour market plus one of the world's largest tax burdens.

►Energy Background

Consumption

As early as 1913 Germany with 15.7% of world manufacturing production was second only to USA (35.8%) and consequently demand for power was high. As the population increased so did demand for power. In 1999, Germany consumed 14,194 PJ making it one of the largest energy consumers in the world. However, German primary production of total energy consumed declined from 6,219 PJ in 1990 to 3,792 PJ in 1999, making Germany the largest energy importer in Europe. Average primary energy consumption per capita in 1990 and 1999 were 188 and 171 GJ. The key energy indicators are summarised in Tables 0-1 and 0-2 (at the end of this section) and energy consumption in Germany is presented in Figure 0-1 by fuel type.

Production

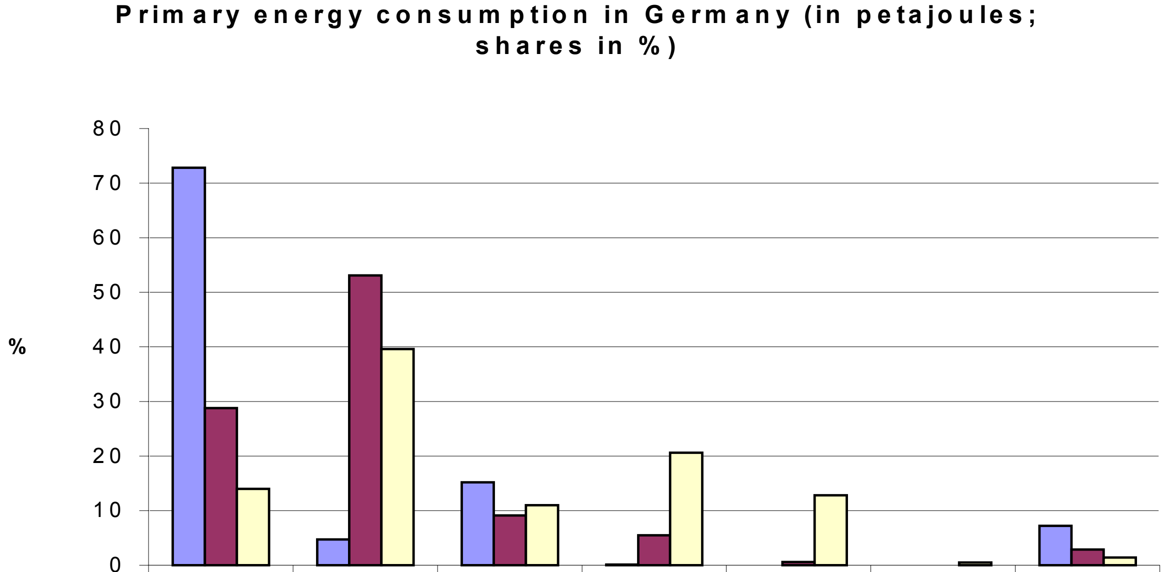
Germany's share of the total energy produced in Europe was 17.32% in 1999 or 3,792 PJ. The country's main source of energy is in the form of coal, whereas other fuel types have to be imported which makes Germany a highly energy import reliant country. Summaries of production capacity for different fuels is described below:

- ***Oil***: Germany is almost totally reliant on imports of oil, and produces only about 1.5% of what it consumes. However, it should be noted that German oil imports are diversified and approximately half comes from within the EU (including Norway) and Russia. Therefore, given European energy sector integration, consideration of pure import figure for Germany can be misleading but for the purposes of developing this report focusing on Germany, pure import figures have been used. Main users of oil in Germany are in the heating and transport sectors.

- ***Gas***: Germany produces approximately 27 % of all natural gas it consumes and imports the remainder. Homes and non-commercial users account for 53% of the natural gas users while industry accounts for 38% and power stations 9%. Within the European Community Union Germany is second largest natural gas consumer. However, as for oil, German gas imports come exclusively from within the EU (including Norway and CIS sources). The demand for gas is expected to increase as nuclear energy is phased out.

- ***Coal***: Germany's main energy fuel sources is coal and as a result Germany is the third largest coal consuming country in the world behind USA and China. Hard coal production in Germany is still extremely subsidised and Germany is the world's largest producer of lignite, accounting for 1/5th of the global output. However, coal production is expected to continue to decline[1] in the face of cheaper coal from abroad and a decision to halve current subsidies to USD 2.48 billion by 2005.

Figure 0-1. Primary energy consumption in Germany



	Hard coal	Oil	Lignite	Natural Gas	Nuclear power	Wind/water	Other
1950	72,8	4,7	15,2	0,1	0	0	7,2
1970	28,8	53,1	9,1	5,5	0,6	0	2,9
1997	14	39,6	11	20,6	12,8	0,5	1,4

- ***Renewable energy***: The contribution of renewables to energy supplies is approximately 2 % of total primary energy consumption and renewables contribute 7.5 % of total electricity production in 2001 (up from 4.1% in 1996). This figure is particularly high given that Germany has no large hydro-power potential, unlike other European countries. The highest rates of growth have been in wind energy[2]. An Eco-Tax is levied on natural gas, heating oil, and electricity, as well as on road fuels

[1] Lignite production fell from 3,142 PJ in 1991 to 1,451 PJ in 1999.

[2] The total wind energy capacity installed in Germany in 2000 was 1,668 MW. There are 9,350 wind turbines in operation, producing 11.5 billion kWh of electricity and meeting 2.5% of domestic demand. The price support mechanism guarantees a set price for electricity generated from wind and this has spurred the growth of wind energy. Germany has targeted a one-third share of Europe's wind power production goal of 60,000 MW by 2010.

(diesel, gasoline), but not on coal, and nuclear. The electricity tax has been 0.9 US cent a kilowatt hour since 1 April 1999. The tax on natural gas is 0..16 USD per 100 kWh. But considering that Germany emitted 227 million metric tonnes of C in 1999, renewable energy is being promoted. However, in order to compensate renewables to some extent from the negative impact of eco-taxes, the coalition agreed that all taxes from renewable energies would be channelled into a new Market Incentive Program for renewables (i.e. taxing renewables in order to support them). However, this program never received the full amount of eco-taxes from renewables (In 2000, eco-taxes from renewables were some DM800-900m, while the Market Incentive Program was set at DM300m. The government even proposed cutting it down to DM180m in 2002, but after public protests parliament instead increased it to DM400m). The result is that Germany's federal government actually receives considerably more money from taxing renewables than it spends supporting them, and these surplus eco-taxes outnumber all other federal subsidies for renewables.

- ***Nuclear power****:* Germany ranks 4th worldwide in the installed nuclear capacity, with 19 generating plants. The private company E.ON has stakes in 11 of these plants. The present coalition government was elected on a platform to phase out nuclear power (Social Democrats: 10 years, Greens:short-term). The government introduced a law to phase-out nuclear power plants by approximately 2021; in negotiations with the utilities they were guaranteed the right to produce about the same amount of nuclear electricity in the future as they have already produced, and that the government would refrain from unilaterally changing the fiscal circumstances for nuclear power, such as abandoning existing special tax privileges and government-backed liability ceilings, or introducing nuclear fuel taxes.

- ***Electricity***: Germany produces more electricity than it consumes. In 1999 it produced 531.4 billion KWh of electricity, which represents 22.38% of the European production. 50% of electricity generated is from lignite and hard coal, 30% from nuclear energy, 9.8% from gas, 3.1% from hydro and 2.8 % by Wind. The governmental position (BMU) is that nuclear electricity is to be replaced by efficiency, cogeneration, natural-gas CC plants, and renewable electricity.

R&D Expenditure

Public R&D expenditures on energy declined by nearly 30 % between 1991 and 2000, to approximately 0.377 billion USD not taking into account expenditures to support scientific institutions researching in the energy field. Due to the successful auction of UMTS licences, the German Government cashes in some 50 billion € in 2000/2001 – and from this extra revenue, a special energy RD&D programme was funded (so-called ZIP) which is around 100 million € in 2001-2003. Special emphasis is given to offshore wind, biomass, geothermal, and solar-thermal electricity. The decline has been a direct consequence of the financial challenges associated with German reunification. Private R&D investments grew however by 5% between 1995 and 1997. Germany relies increasingly on natural gas to meet energy demand (both for environmental and economic reasons), and is further reducing subsidies for coal and phasing out support for other fossil energy programs. Currently, the prime areas of German investment is to support renewable energy and energy efficiency programmes. R&D in these areas, accounted for 14% of the energy budget in 1981 but now accounts for 36% of public energy R&D.

Climate Change and Environment

Global climate change has become a major factor in German energy policy. Germany's national climate target, announced by Chancellor Helmut Kohl during the first Conference of the Parties (CoP 1) to reduce CO2 emissions by 2005 by 25%, compared to 1990. This national CO2 reduction goal has remained official policy after the change in government in 1998, but it remains uncertain whether it will be achieved – as for now, the reduction is around 18%, but energy demand is growing, and the carbon intensity as well (due to new lignite-fired power plants). Under the Kyoto Protocol and the European Union's Community internal burden sharing strategy on Climate Change, Germany has committed itself to a 21% reduction in greenhouse gas emissions from 1990 levels by 2008-2012. Liberalisation of the electricity sector has had only minimal impact on the environment, but emissions of CO_2 are decreasing and fell from the 1990 level of 400 Mt to 325 Mt, and energy related SO_2 emissions fell from 2800 kilo tons to 409 kilo tons in 1999. Also that of NO_x fell from 576 kilo tons to 250 kilo tons. Particulate matter emissions fell from 469 kilo tons to 29 kilo tons.

Table 0-1. Key energy indicators for 1999

Total energy consumption	14,194 PJ (3.6% of world consumption)
Energy related C-emissions	227 million metric tons (3.7% of world total)
Per capita energy consumption	171 GJ
Per capita C-emissions	2.8 metric tons (USA 5.5 metric tons)
Energy intensity	7.68 MJ/$ (USA 13.3 MJ/$)
Carbon intensity	0.12 metric tons/1000$ (USA 0.19 metric tons/1000$)
Sectoral energy consumption	Industrial 41.9% , Residential 24.2%, Transportation 21.5%, Commercial 12.3%
Sectoral C emissions	Industrial 37.4% , Residential 24.5%, Transportation 25.6%, Commercial 12.5%
Fuel share of energy consumption	Oil 39.4%, Coal 23.7%, Natural Gas 21.5%, Nuclear 13.0%, Others (including renewables) 2.4%
Fuel share of carbon emissions	Oil 45.1%, Coal 36.3%, Natural Gas 18.6%
Renewable energy consumption	312 PJ

Source: Energiedaten 2000, BMWi; EIA 2001

Table 0-2. **Key figures in the energy scenario of Germany**

- see next page -

Table 0-2. Key figures in the energy scenario of Germany

Year	Population *(Million)*	Gross GDP *(Billions of 1990 US$)*	Primary energy consumption *(per $ of GDP)*	Primary energy cons. *(1000 barrels/ day of oil equivalent)*	Primary energy prod. *(1000 barrels/ day of oil equivalent)*	Oil Consumption *(1000 barrels per day)*	Imports of oil *(1000 barrels per day)*	Oil costs import *(Billion US $*	Natural Gas Production *(Billion cubic meters)*	Hard Coal Production *(Million metric tons)*	Brown Coal and Lignite Production *(Million metric tons)*	Electricity Production *(Billion kWh)*	Installed nuclear electricity generating capacity *(1000 MW)*
1850	35.3												
1900	56.0												
1950	68.4												
1970	77.7			6300	3500	2,570	2885		14	118.02	371.49	310.3	8.4
1980	78.3	1202.2	9.4	7370	3685	2,605	3137	35.1	27	94.49	389.73	467.6	10.4
1990	79.4	1503.6	7.6	7100	3325	2,715	2652	21.8	16	76.55	357.47	549.9	22.4
1993		1714.7	8.19		2109	2,840	2904	19.6	19	64.17	221.8	525.7	22.7
1999			7.28	13.8Btu	5.34Btu								
2000	83.4	1920.7				2,770	2,631						

Source : EIA DOE Data, 2000

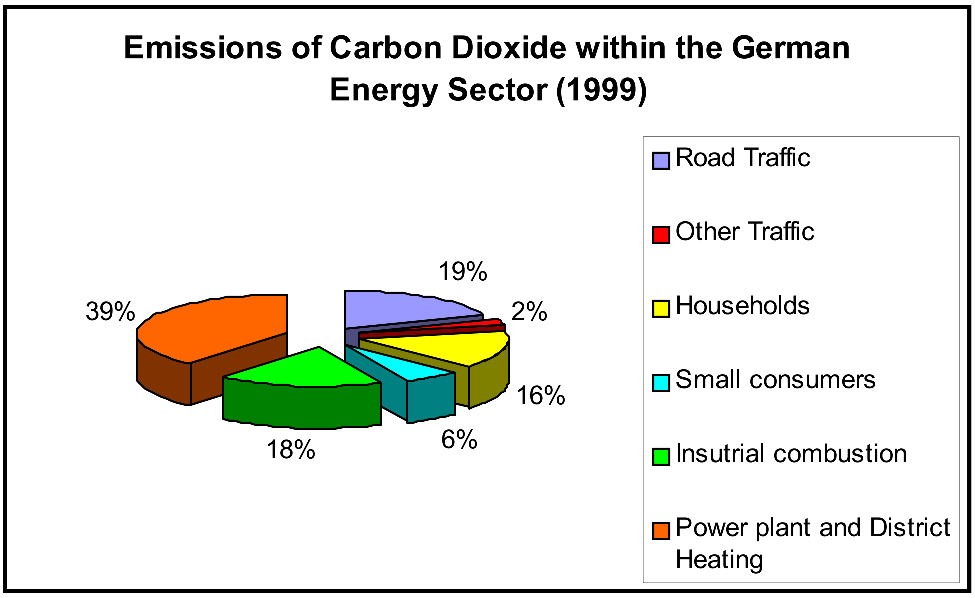
Environmental Sustainability

▸Indicator 1: Per Capita Energy Sector Carbon Dioxide Emissions

Climate change, as defined by the United Nations Framework Convention on Climate Change (UNFCCC), is "a change of climate attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable periods" (UNFCCC 20001). Research work by scientists has revealed that climate change is occurring more rapidly because of increases in man made emissions of greenhouse gases (GHG). One of the key GHG is Carbon Dioxide and emissions from the energy sector[3] contributes 37.5% of total man made carbon emissions in the world. As a result this is the sector where most efforts to achieve reductions have been focused.

In Germany carbon emissions from the energy sector are approximately 95% with the remaining emissions being generated by large industry and international transport, which emit approximately 3% and 2% of total German carbon emissions respectively. A breakdown of the different players within the German energy sector according to the amount of carbon dioxide emitted is presented in Table 1.1. Since 1990, Germany has achieved a significant downward trend in greenhouse gas emissions. The main reasons for this trend results from East Germany's integration into the Federal Republic, while in the western states CO2 emissions have remained essentially stable – a phenomenon sometimes dubbed "wall-fall profits". As a result, German carbon dioxide emissions from energy and manufacturing industries declined by 83 Tg and 57 Tg respectively between 1990 and 1999. However, the downward trend to a very large extent

Table 1-1



[3] The IPCC Define the Energy related emissions as those that are:

A. Combustion related – energy/transformation, Industry, transport, residential/commercial/institutional users, Other including military users, combustion of biomass

B. Extraction/distribution of fuels

Large Industry and International transport (that is maritime bunkering and air transport) is not included in the energy sector.

The indicator per capita energy sector carbon dioxide emissions measures a countries contribution to the environmental aspects of sustainable development in terms of national efforts to reduce emissions of carbon dioxide. To calculate the German vector for this HELIO International indicator the following national data was collected. (see table 1.2).

Table 1-2. Data to Calculate Per Capita Energy Sector Carbon Dioxide Emissions

	1990	1999	Change 1990 - 1999
Total Emissions CO_2 from fossil fuel consumption in Germany (million metric tonnes carbon dioxide)	986.5	833.5	- 15.5%
Total Carbon Emissions (million metric tonnes carbon)	269.02	227.3	-41.72
German Population East Germany*	16.111	N/A	N/A
German Population West Germany	63.254	N/A	N/A
Total German Population (millions)	78.365	82.087	+2.722
Germany's CO_2 emissions per capita (tonnes carbon per capita)	3.43	2.77	-0.66

Source : Adapted from Bundesministerium für Wirtschaft, 2001

* ***Source taken from Mainz &Ullrich research by Berlin University für Bundesministerium***

Calculation of Indicator 1 vector value

W [4] = the global average emissions of CO_2 per capita = 1,130 Kg Carbon per capita

X (1990) = Germany's per capita emissions 1990 = 3,430 Kg Carbon per capita

X (1999) = Germany's per capita emissions 1999 = 2,770 Kg Carbon per capita

Y = 3/10 W = 339 Kg Carbon per capita

Z = 7/10 W = 791 Kg Carbon per capita

Indicator Vector (I) = (X –Y) ÷ Z

I (1990) = (3,430 – 339) ÷ 791 = 3.91

I (1999) = (2,770 – 339) ÷ 791 = 3.07

[4] Figure for W provided within the HELIO International data within the Guidelines for Observers

▸Indicator 2: Most Significant Energy Related Local Pollutant

The main pollutants from energy related sectors in Germany include CO, CO_2, NO_X, SO_2, particulates, lead and mercury as well as the indirect pollutant ozone, that is generated from the chemical reaction between NO_X and VOCs in the presence of sunlight. The energy sectors included in the vector calculation include private and public traffic, industrial processes, local households and power and heat plants. Indicator 4 was calculated for CO, SO_2 and NO_X. The rationale for choosing these pollutants is first because these pollutants cover all major energy-relevant sectors taking into account both urban and rural allocation and second because of the existence of reliable and available data sources for these pollutants.

According to the guidelines for the HELIO International observers report, data for all three pollutants are collected and then combined to create one single vector for Germany.

Indices are defined as follows:

- I: Relative value of the combined index from CO, SO_2 and NO_X
- X: Actual emission of either CO, SO_2 or NO_X (for the most recent year for which data is available, here 1999)
- Y: Represents the national objective where sustainability is achieved
- Z: is the 0 to 1 segment and equals W-Y

The unit mass/capita is used for the calculation instead of ambient pollution.

Table 2-1. Local pollutants (SO_2, NO_X, CO) in Kt

Sector	1990			1999		
	SO_2	*NO_x*	*CO*	*SO_2*	*NO_x*	*CO*
Traffic	113	1541	6936	31	1045	2992
Power and Heat Plants	2780	576	155	409	250	102
Industry	1980	483	1755	315	260	1262
Local Households	449	106	2366	76	82	796
Total	***5322***	***2706***	***11213***	***831***	***1637***	***4952***

***Source: Environmental Data 2000, published by the Federal State Environmental Agency 2000,* www.umweltbundesamt.de**

Table 2- 2. Data for calculation of per capita local pollutants

	1990	1999	Change
Total German population *	79.365 million	82.087 million	+ 2.722 million
Per capita SO_2 emissions	67.057 kg (W)	10.123 kg (X)	- 56.934 kg
Per capita NO_X emissions	34.096 kg (W)	19.942 kg (X)	- 14.154 kg
Per capita CO emissions	136.599 kg (W)	60.326 kg (X)	- 76.273 kg

***Source:* *www.demographie.de/info/epub/pdfdateien/depop.pdf**

Calculation of Vector 2 for local pollutant SO_2

The '1' circle equals the 1990 value which is 67.057 kg SO_2/capita

Y = 67.057 kg SO_2/capita * 0.1 kg SO_2/capita = 6.7057 kg SO_2 / capita → equals the sustainability objective

Z = 67.057 kg SO_2/capita * 0.9 kg SO_2/capita = 60.351 kg SO_2 / capita

County's per capita SO_2 emissions in year 1999
X = 10.123 SO_2/ capita

Actual calculation of the vector I_{SO2} for year 1999
Formula: (X-Y) / Z
I $_{SO2}$ = (10.123 - 6.7057) / 60.351 = **0.057 kg SO_2 / capita** (1999)

Optional vector calculation for 1990
I_{SO2} = (67.057 – 6.7057) /60.351 = 1 kg SO_2/kg

Calculation of Vector 2 for local pollutant NO_x
The '1' circle equals the 1990 value which is 34.096 kg NO_X/capita

Y = 34.096 kg NO_X/capita * 0.1 kg NO_X/capita = 3.4096 kg NO_X / capita → equals the sustainability objective

Z = 34.096 kg NO_X/capita * 0,9 kg NO_X/capita = 30.6864 kg NO_X/ capita

County's per capita SO_2 emissions in year 1999
X = 19.942 NO_X/ capita

Actual calculation of the vector for year 1999
I $_{NOX}$ = (19.942 - 3.409) / 30.686 = **0.538 NO_X / capita** (1999)

Optional vector calculation for 1990
I_{NOX} = (34.096 – 3.4096) / 30.686 = 1 kg NO_X/kg

Calculation of Vector 2 for local pollutant CO
The '1' circle equals the 1990 value which is136.599 kg CO/capita

Y = 136.599 kg CO/capita * 0.1 kg CO/capita = 13.66 kg CO / capita → equals the sustainability objective

Z = 136.599 kg CO/capita * 0,9 kg CO/capita = 122.939 kg CO / capita

County's per capita CO emissions in year 1999
X = 60.329/ capita

Actual calculation of the vector I_{SO2} for year 1999
Formula: (X-Y) / Z
I $_{CO}$ = (60.326 – 13.66) / 122.939 = **0.38 kg CO / capita** (1999)

Optional vector calculation for 1990
I_{CO} = (136.599 – 13.66) / 122.939 = 1 kg CO/kg

Combination of SO_2, NO_X and CO to a single index for indicator 2
According to the guidelines for the observers report the metric of the indicator 1 is set 100% for each pollutant and indicator 0 is set 20% for each pollutant. Therefore the following values for W, Y, X and Z apply:

1990 emissions:
W (SO_2) = 67.057 kg/capita
W (NO_X) = 34.096 kg/capita
W (CO) = 136.599 kg/capita

Objectives to achieve:
Y (SO_2) = 20% * 67.057 = 13.411 kg/capita
Y (NO_X) = 20% * 34.096 = 6.819 kg/capita
Y (CO) = 20% * 136.599 = 27.32 kg/capita

1999 emissions:
X (SO_2) = 10.123 kg/capita
X (NO_X) = 19.942 kg/capita
X (CO) = 60.326 kg/capita

The segment Z = W – Y:
Z (SO_2) = 67.057 – 13.411 = 53.646 kg/capita
Z (NO_X) = 34.096 – 6.819 = 27.283 kg/capita
Z (CO) = 136.599 – 27.32 = 109.279 kg/capita

The vector values in 1999 are
$I_{(SO2)}$ = (X – Y) / Z = (10.123 – 13.411) / 53.646 = -6.13 E-5
$I_{(NOX)}$ = (X – Y) / Z = (19.942 – 6.819) / 27.283 = 0.48
$I_{(CO)}$ = (X – Y) / Z = (60.326 – 27.32) /109.279 = 0.302

Average value of vector (1999):
I = (I_{SO2} + I_{NOX} + I_{CO}) / 3 = **0.26kg pollutant/capita**
Average value of vector (1990)
I = 1.0 kg pollutant/capita

Discussion of the Indicator

The indicator shows that Germany has reduced emissions of Sulphur Dioxide, Nitrogen Dioxide and Carbon Monoxide. However, the average of the emission reductions are not sufficient to register Germany as reaching a sustainable level of emissions overall although Germany has achieved sustainable levels of sulphur dioxide emissions. Since the indicator works with an average, and the levels of NOx and CO are insufficient to qualify as sustainable level of emissions the average figure indicates that emissions are all currently unsustainable. This is a weakness of this indicator.

The positive emissions levels for sulphur dioxide, primarily reflect increased efficiencies achieved in the energy sector following stricter enforcement of the Federal Emissions Control Act and the Large Furnaces Ordinance following re-unification, as well as the significant shift away from heavy fuel oil, and lignite fuels (especially in Eastern Germany) to natural gas. The less positive results for NOx and CO are primarily a reflection of the general difficulty to reduce emissions of these pollutants.

Social Sustainability

►Indicator 3: Households with Access to Electricity

In Germany, virtually all households have access to electricity and mostly from the grid. The only houses that are not connected are some remote cabins in the mountains which rely on their own generators or renewable energy sources for electricity. Additionally, despite rising prices for crude oil (i.e. an increase of 40% in prices in 1990) gasoline and diesel, electricity prices have in general shown a sharp decrease as a consequence of improved market efficiencies resulting from market liberalisation between 1999 and 2001. Reductions in prices after liberalisation of energy markets were not so significant for households as they were for industry. Household electricity prices between 1990 to 1999 shown in Table 3-1, were nearly stable with minor changes

Table 3-1. Selected gross energy prices for household electricity in US cent / kWh

	1990	**1995**	**1996**	**1997**	**1998**	**1999**
Electricity Prices [Pfennig/kWh] [5]	24.56	29.11	28.00	28.55	26.71	29.53
Electricity Prices [US cent/kWh]	16.38	20.31	18.03	15.93	15.93	15.16

Source: ENERDATA, World Energy Database

As a result, the percentage of annual expenditures for household energy in relation to the annual income has been decreasing over the last decade as shown below in Table 3.2.

Table 3-2. Expenditures[6] for energy in German households in % of total income (Old Federal States)

	1991	**1993**	**1995**	**1997**	**1998**
Old Federal States					
Type 1[7]	7.3	7.5	6.9	6.5	6.2
Type 2 [8]	6.0	5.9	6.1	6.1	5.5
Type 3 [9]	4.6	4.6	4.4	4.6	4.1
Average	*6.0*	*6.0*	*5.8*	*5.7*	*5.3*

Source: Energiedaten 2000, Wirtschaftsministerium

Table 3-3. Expenditures for energy in German households in % of total income (New Federal States)

	1991	**1993**	**1995**	**1997**	**1998**
New Federal States					
Type 1	-	7.5	6.7	6.5	6.4
Type 2	-	7.6	6.9	6.8	6.2
Type 3	-	6.5	5.7	5.8	5.3
Average	-	*7.2*	*6.4*	*6.4*	*6.0*

Source: Energiedaten 2000, Wirtschaftsministerium

[5] Prices in Pfennig / kWh have been calculated using the corresponding exchange rates per year

[6] Expenditures for electricity, gas, heating oil, district heat, and others as averages for selected households participating in annual economic calculations

[7] Average household of 2 persons (retired persons or recipients of social welfare payment) with low annual income

[8] Average household of 4 persons (workers and employees) with a medium income

[9] Average household of 4 persons (employees, academics, civil servants) with a higher annual income

Calculating Vector Value for Indicator 3

In order to calculate the indicator the following data was used.

Fraction of households with access to electricity in 1990 and 1998 = 100%
Number of households with access to electric power in 1990 = Total number of households in 1990

X* = *Y = 34.9 Million

Number of households with access to electric power in 1998 = Total number of households in 1998

P* = *Q = 37.5 Million

Full access to electricity by households (100%) represents the centre of the star and therefore the sustainability objective. The vector is calculated by the equation:

$$I\ (1990) = 1 - (X/Y) \quad \text{and}$$
$$I\ (1998) = 1 - (P/Q)$$

which solves to 0 in the case for Germany and sustainability objectives reached.

▸Indicator 4: Investment in Clean Energy

Germany's most efficient instrument for the promotion of renewable energies is the Erneuerbare Energien-Gesetz (EEG; Renewable Energies Act). It was approved by Parliament in an earlier form almost unanimously in 1991 and was adapted to the conditions of the liberalized electricity market in 1999. It forces electricity grid operators to buy electricity from renewable sources from any producer at fixed prices which the grid operator then charges from the companies selling electricity using its power lines. The EEG, its predecessor law and other key national programmes as compiled in Table 4-1 are the main reasons for the boom in wind and other renewable energies in Germany. They caused numerous private investors to become power producers themselves and gave them an effective instrument against reluctant grid operators to get decent prices for their clean electricity.

Subsidies, on the other hand, are imposed on hard coal in Germany for instance which are not considered as expenditures at the federal level since the guidelines for the observer report do not explicitly define how subsidies should be accounted for. The federal government gets more money from imposing eco-taxes on renewable energies than it spends subsidising them. The renewables boom caused by the EEG also increases eco-tax revenues for the federal government. There is a labyrinth of subsidies for renewables on state and municipal level, which is very difficult to quantify. Roughly 1.5 billion DM (0.68 billion USD including both national expenditures and local investments) was invested in clean energy in 1999.

Table 4-1. Key national programmes to promote renewable energy use in Germany

Programmes [10]	Time span	Total invested amount
Market stimulation Programme to foster renewables	1994 – 1999 1999	45.12 Mio USD 90.33 Mio USD (annually)
100,000 solar roof programme	1999 – 2004	451.7 Mio. USD + 1.13 Mio USD additionally generated investments
Programme to promote solar energy use in parishs	1999	4.5 Mio USD
Ecotax imposed on renewable energies	annually	Negative: US$360-400m tax income

Source: Frithjof Staiß: Annual Year Book Renewable Energies, 2000

In order to determine the share of clean energy investments out of total energy related investments both private investments and federal government expenditures on R&D were considered. R&D is being supported according to the following main themes:

- Increase profitability of photovoltaic and specific annual electricity generation
- Development of wind power facilities for potential offshore application
- Geothermal applications
- Support the use of biomass, Combined Heat & Power, fuel cells and solar thermal
- Energy saving related to processes in industry

[10] The list of national government programmes is not complete but illustrates the largest programmes in terms of total investment in renewable energy use. Regional government investment programmes differ enormously between regions and are not explicitly listed. In total, regional governments have provided roughly 400 Mio USD for clean energy use and research between 1991 to 1997. A key area of investment was local heat production from solar and biomass, unfortunately disaggregated data on expenditures was not available at the time of writing this report.

Private investment in the energy sector is significant and primarily comprises investments in small scale entities or private households. Such investments are mainly undertaken by electricity utilities, suppliers, fossil fuel producing companies and renewable-energy entities. Data sources on private investments are however very limited. Data used for this report is based on publications by electricity utilities and suppliers. Table 4-2 and 4-3 illustrate federal government expenditures in R&D activities on the one hand and private sector investments in facility improvements on the other hand.

Terms for determining the social indicator of investment in clean energy have been defined as follows for Germany:

- ***Total energy related investments/expenditures*** includes all public and private investment/expenditures in fossil, nuclear and renewable energy. These investments include a) improvements of stationary power plants and transmission lines by electricity utilities and suppliers; b) exploitation of fossil and nuclear fuels and related activities; c) activities to increase the market share of renewables; and d) Research and Development (R&D) as a public expenditure.

- ***Total Investment/expenditure in clean energy*** is one element of ***total energy related investments /expenditures*** and includes investments undertaken by private or public sources to increase the market share of clean energy, that is, solar, wind, biomass and geothermal energy. It includes mainly R&D in renewables as a public expenditure as well as investments in personnel, equipment manufacture and supply. Figures for private investment in renewables were not available at the time of writing the report and therefore only public expenditures have been used for the vector calculation.

Table 4-2. Federal government expenditures in R&D in conventional and renewable energy use [Million DM] [11]

Federal government expenditures [12]						
	1991	**1993**	**1995**	**1997**	**1999**	**2000**
Conventional Energy Carriers (Coal, other fossil fuels, nuclear, large hydro)	871.2	659.0	524.0	496.7	544.0	529.7
Clean Energy Carriers (wind, geothermal, solar thermal, fuel cells, energy saving measures, photovoltaic, biomass)	332.5	355.6	302.4	294.4	317.7	304.6
Total	***1,203.7***	***1,014.6***	***826.4***	***791.1***	***861.7***	***834.4***

Source: Federal Ministry for Education and Research, Federal Report 2000

[11] In this case the currency does nor affect the results of the vector calculation therefore German Mark (DM) was used as currency for USD. This avoids taking exchange rates for the corresponding years into account.

[12] The term ‘expenditures’ has been used for investment to better characterise public funding since all money was spent for R&D. No regional government expenditures and expenditures of municipalities were taken into account since disaggregated data was not available. State subsidies on i.e. hard coal are not been accounted for investments in clean energy.

Table 4-3. Private investments in conventional electricity supply [Million DM]

Private investments						
	1991	**1993**	**1995**	**1997**	**1999**	**2000**
Power plant improvements	2,990.0	4,790.0	4,680.0	3,560.0	3,200.0	N/A
Distribution line improvements	6,150.0	7,800.0	7,060.0	5,900.0	5,000.0	N/A
Others (i.e. measurement equipment)	2,010.0	2,650.0	2,470.0	2,130.0	1,500.0	N/A
Total	***11,150.0***	***15,240.0***	***14,210***	***11,590***	***9,700.0***	N/A

Source: VDEW, Verband Deutscher Elektrizitätswerke "Strommarkt Deutschland 1999", Investments refer to non-renewable energy investments

N/A Not Available

Table 4-4. Total investments in conventional and clean energy use [Million DM]

Investment Source						
	1991	**1993**	**1995**	**1997**	**1999**	**2000**
Public	1,203.7	1,014.6	826.4	791.1	861.7	834.4
Private	11,150.0	15,240.0	14,210	11,590	9,700.0	N/A
Total	***12,353.0***	***16,254.0***	***15,036.4***	***12,381.1***	***10,561.7***	-

N/A Not Available

Calculation of Vector for Indicator 4

The HELIO International Guidelines for observers defines the standard "1" value as being the investment in clean energy in 1990 as a percentage of total energy related investment in 1990. The sustainability objective, the "0" value, is a target for government expenditure on clean energy expenditures to reach 95% of total energy-related investments.

Defining the variables :

X represents the investment in clean energy of any given year
W equals the value X in 1990 thus representing the upper limit of the vector value
Y represents the sustainability target which is defined as 95 % of clean energy investment and thus equals the sustainability objective which is the centre of the star.

X (1990) = W = 332.5 Million DM / 12,353.0 Million DM = 0.027 (2.7%)

X (1999) = 317.9 Million DM / 10,561.7 Million DM = 0.03 (3 %)

Z = 2.7% - 95 % = - 92.3

Actual calculation of the vector/s:

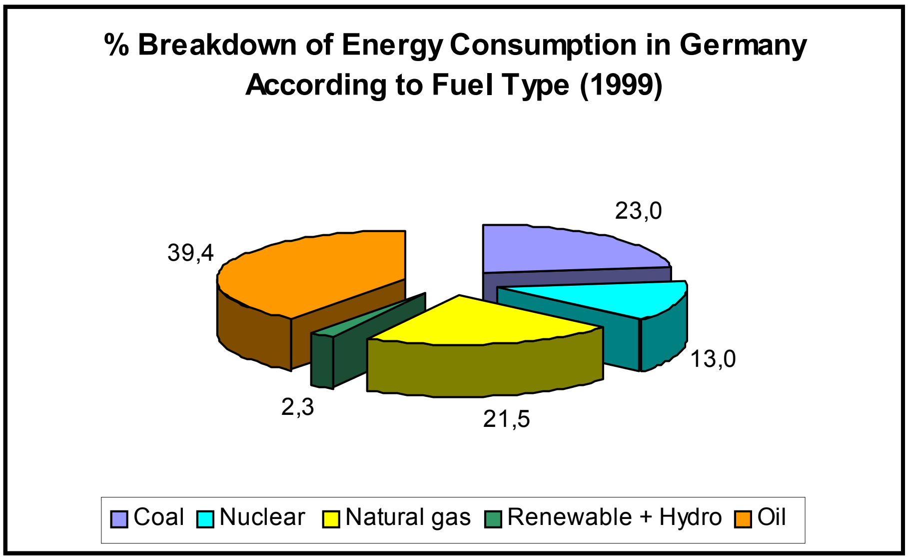
I (1999) = 3% - 95% / - 92.3 = 0.996
I (1990) = 2.7 % - 95% / - 92.3 = 1.0

Economic sustainability

▸Indicator 5: Energy Security and Energy Trade

German energy consumption has shown a slightly decreasing trend, with consumption reductions from 14, 912 PJ in 1990 to 13, 863 PJ in 1999. In 1999, coal accounted for approximately 47% of domestic energy production in 1999, nuclear power 30%, natural gas 14%, renewable sources (including hydro) 6% and oil 2% (see Figure 5.1).

Figure 5-1



Source: Bundesministerium für Wirtschaft (2001)

Germany is reliant on energy imports from Europe, Norway and CIS countries to meet almost 70% of its energy needs. However, as a result of the creation of a common Energy Market within Europe, and the diversification of import sources from different countries within the common European energy market, reliance on imports is not considered an energy security issue. The fuels imported by Germany include oil, natural gas and hard coal. The current German government has agreed to phase out the use of nuclear reactor, primarily due to public and political concerns regarding nuclear waste disposal. Renewable energy sources are strongly supported by laws forcing private grid operators to buy renewable electricity at government-imposed prices. As stated above, the federal government does not provide net subsidies for renewables, as the subsidies are more than compensated for by eco-taxes. Currently, Germany's main renewable resource is hydro and wind power and the German government is looking to further develop wind resources, and the vast biomass potentials. Research and development is also increasing for geothermal, and solar-thermal electricity.

The HELIO International indicator 5 is used to assess whether Germany promotes sustainable energy use through its import policy. In other words whether imports of energy generated from fossil fuels are decreasing over time (and if the import of energy from renewable energy sources is increasing). However, for countries within Europe, this vector value can be misleading, since countries within the European Energy market are working to achieve sustainable development for Europe through an integrated energy policy which encourages countries to import cleaner energy from their neighbours. An improvement in emissions for some countries might simply mean using cleaner fossil fuel rather than renewables in the first instance. As a result, a country such as Germany may be more dependent on fossil fuel imports than other countries, and yet the overall balance within Europe would show a positive trend towards sustainable energy systems. Due to this issue, the authors of this report strongly recommend that in the next HELIO International Observer reports, a section reviews the European energy market as well as assessing individual European countries.

In order to calculate the vector in the star the following data as presented in Table 5.1 was used:

Table 5-1. Data used For Assessing Sustainability of Energy Imports in Germany

	1991	**1999**
Total Energy Imports from Non Renewable Sources (PJ)	9,253	10,399
Percentage of Non Renewable Energy Consumed that is Imported (PJ)	63%	73%
Total Energy Imports from Renewable Sources (1000 t)	0	0
Total Energy Consumption (PJ)	14,610	14,194

Source: Bundesministerium für Wirtschaft : Wochenbericht (2001)

<u>Calculation of Vector for Indicator 5</u>

Data for E. Germany was not available for 1990 and therefore figures for 1991 have been used. The following calculation is defined by HELIO International for countries that, like Germany, are net energy importers:

$\mathbf{X_{im}}$ = total non renewable energy imports

Y_{im} **=** total non renewable energy consumption

$\mathbf{I = (X_{im} \div Y_{im})}$

I (1991) = 0.63

I (2000) = 0.73

▸Indicator 6: Burden of Energy Investments

The indicator 'Burden of Energy Investments' compares government expenditures in non-renewable energy supply to total Gross Domestic Product as a measure of the burden of energy development in the economy. This indicator illustrates how public funds spent in the energy supply sector are used to encourage cost effective renewable energy supply and end user efficiency.

The calculated vector value for this indicator considers national expenditures and investments in non-renewable energy sources. This includes expenditures for R&D, energy supply, transmission and distribution systems, power plant re-construction, and removal of nuclear waste. Regional and municipal investments were not included in the vector calculation since no disaggregated data was available at this point in time.

The vector is characterised as follows:

1 is 10 % of federal government expenditures in non-renewable energy as a fraction of GDP
0 is 0 % of federal government investment in non-renewable energy as a fraction of GDP

Table 6-1. Data for calculating the vector of burden on energy investments

	1991	**1993**	**1995**	**1997**	**1999**
Federal R&D expenditures [Million DM] In coal, other fossil fuels and nuclear	871.2	659.0	524.0	496.7	544.0
GDP [Billion DM]	3,346.0	3,383.8	3,522.9	3,601.0	3,728.2

Sources: Zahlen und Fakten (2000), Bundesministerium für Wirtschaft und Technologie, Federal Report (2000) Bundesministerium für Bildung und Forschung

<u>Calculation of Indicator 6 Vector Value</u>

The burden of government investment in non-renewables is calculated by using the formula

I = (X / Y)*10

Where

I represents the vector value
X represents government investments in non-renewable energy and
Y represents the GDP

The vector value goes from zero to 10% of GDP with zero being the sustainability objective. The vector value is calculated as the fraction of government investment in non-renewables multiplied by 10. The actual vectors for 1991 and 1999 are follows:

$\mathbf{I}_{(1991)}$ = (0.8712 billion DM / 3,346.0 billion DM) * 10 **= 0.0026**
$\mathbf{I}_{(1999)}$ = (0.544 billion DM / 3,728.2 billion DM) * 10 **= 0.0015**

Technological Sustainability

▸Indicator 7: Energy Productivity (energy consumption / GDP)

Energy productivity refers to the quantities of economic activity per unit of energy consumed. In order to calculate this indicator figures for commercial energy consumption must be divided by a measurement of economic activity, which is usually expressed in terms of Gross Domestic or National Product (GDP or GNP). However, as recommended in the *HELIO International Guidelines for Reporters/Observers*, GDP output at purchasing power parity rates is preferable to GDP, since it has been shown to be a better indicator for comparisons that include developing nations.

When considering energy consumption, care must be taken to ensure that statistics for energy consumption incorporate all energy products and not just primary energy sources such as oil, coal and gas. For the purposes of this report a distinction is made between *Commercial Energy Consumption* that does not include products such as biomass, waste etc and *Real Energy Consumption* which includes data for energy generation from biomass, waste, gas, sludges etc. A summary of the data collected for the calculation of this indicator is given in Table 7.1.

Table 7-1. Data for the Calculation of Energy Productivity in Germany

	1990	**1992**	**1994**	**1996**	**1998**	**2000[1]**
Commercial Energy Consumption PJ[2]	14,783	14,200	13,997	14,575	14,218	12,934
Real Consumption PJ[3]	14,912	14,314	14,182	14,745	14,461	14,180
GNP (billion US$) [4]	1,016	1,397	1,496	1,613	1,698	1,783
GDP (billion DM)	2,426.0	3,155.2	3,394.4	3,586.8	3,784.4	3,982.0
PPP (OECD Figs)	1.07	1.06	1.06	1.04	0.992	0.952
GDP PPP billion US$	**2,267**	**2,977**	**3,202**	**3,449**	**3,815**	**4,183**

Sources : Zahlen und Fakten (2001) Bundesministerium für Wirtschaft und Technologies and OECD PPP Information (2001).

1. First estimates, not yet confirmed figures

2. Commercial energy figures include mineral oil, coal, gas, nuclear, hydro and wind (from 1995) .

3. Real energy consumption figures are the same as 1 but includes biomass, sludge, wood, waste and others

4. € converted to $ using rate of 1 €: 0.8832 US$

Calculation of Indicator 7 Vector Value

Energy Productivity for 1990 and 1999 is calculated according to the following equation:

Energy Productivity = Total energy consumption ÷ economic activity (GDP PPP) = **X**

Using the data from Table 7.1 it is possible to calculate values for X(1990) and X (2000).

Table 7-2. Energy Productivity in Germany

	X (1990)	X (2000)
Energy Productivity	6.58 MJ/$ GDP	3.39 MJ/$ GDP

Standard parameters based on the international average energy productivity are given by HELIO International and are:

W = Average energy consumption in 1990 correlates to the "1" circle = 10.64 MJ/US$
Y = W/ 10 = 1.06 MJ/$
Z = W – Z = 9.58 MJ/$

The Vector **I** is calculated as follows: (**X** – 1.06) / 9.58

Therefore the vector **I** (1990) = 0.58
I (2000) = 0.24

Discussion of the Vector

Energy consumption in Germany is below the world average of 10.64 MJ/US$, but does not yet meet the target of 1.06 MJ/$ as set by HELIO International. However, the trend is progressive and Germany has made substantial progress in terms of reducing wasteful energy consumption which reflects the strong emphasis in Germany on energy efficiency.

▸Indicator 8: Renewable Energy Deployment

In the year 2000 the share of total renewable energy consumption from total primary energy consumption in Germany was 2.2%. Within the power- and heat sector, renewable energy made up a larger proportion than in the traffic sector. The traffic sector renewable energy source share was from bio diesel (rape seed methyl ester, RME) and totalled a mere 0.1% of the total. The table below presents the share of all renewables in the total renewable primary energy consumption.

Table 8-1. German primary energy supply from renewable energy sources in 2000

	(PJ)	(% of total)
solid biomass	165.09	52.49
bio fuels	14.83	4.72
Biogas	8.43	2.68
sewage gas*	0.46	0.15
landfill gas*	6.8	2.16
geothermal energy	1.71	0.54
solar thermal energy	4.77	1.52
Photovoltaic	0.32	0.10
Wind	33.12	10.53
Water	78.97	25.11
Total	314.5	100

***** ***figure from 1999***
Source: /Erneuerbare Energien 2001/

The implementation of the "Erneuerbare Energien Gesetz (EEG) – Renewable Energy Sources act" in the year 2000 and the "biomass energy regulation" in 2001, fixed the minimum rate of reimbursement in renewable energy and guaranteed entry to the grid for power from renewable energy sources. These regulations have therefore reduced risks associated with renewable energy investments. As a result, Germany is now expecting an accelerated increase in power generation from renewable energy sources and especially from wind and biomass power generation.

Table 8.2 shows that even before these laws production of power from renewable energy sources has doubled over the last 10 years in Germany. Hydro power is the most established renewable energy technology and remains the most important in terms of quantity of electricity produced. Windpower has experienced a rapid increase since 1990 and now contributes approximately 30 % of total power generation from renewables. Biomass power generation has also accelerated and now contributes 4,5 % of total renewable power generation. Photovoltaic use in Germany has been stimulated by an investment subsidy, the so-called "100.000 photovoltaic roofs program", but still remains a minor energy source.

Table 8-2. Produced electricity from renewable energy (GWh)

	1990		2000	
Water	15,580	98.34%	21,930	67.03%
Biomass	222	1.40%	1,500	4.8%
Wind	40	0.25%	9,200	28.12%
Photovoltaic	1	0.01%	89	0.27%
geothermal power	0	0.00%	0	0.00%
Total	15,843	100,.%	32,719	100.0%

Source: /Erneuerbare Energien 2001/

Heat production from renewables in Germany is dominated by biomass (96%). In contrast, both solar and geothermal heating contributed just 4% to total heat production in 2000.

Table 8-3. Heat from renewables (GWh)

	1990		2000	
biomass – solid fuels	12,880	99.31%	41,600	94.5%
biomass – liquid fuels			63	0.1 %
biomass – gaseous fuels			720	1.6 %
solar thermal heating	90	0.69%	1,200	2.73 %
geothermal heating	0	0.00%	436	0.99 %
Total	12,970	100.0%	44,019	100.00%

Source: /Erneuerbare Energien 2001/

Further substantial increase in the use of Biomass is expected over the next few years. However, the increase of some renewable sources, such as solar heating over the last ten years (1990: 257.785 m², 2000: 3.267.483 m² installed solar collectors, 600.000 in 2000 only), is primarily due to subsidies for investments in renewable energy technologies ("Marked stimulation program for the introduction of renewable energy technologies"). Further increases in the use of solar will largely depend on the continuation of these subsidies because of the relatively high specific costs of this technology. The potential to utilise geothermal sources for heating is considerable for both near surface heat as well as in the deep geothermal energy production, however, at present the overall contribution to heat production is negligible and more research and development is required before these sources can be utilised.

Calculation of Indicator 8 requires the collection of data on total renewable energy consumption and total primary energy consumption. The data is shown in table 8.4.

Table 8-4. Data for Vector Calculation

	1990	**2000**
Total renewable energy consumption in PJ	180	314.5
Total primary energy consumption in PJ	14911.9	14295.5

Source: /Erneuerbare Energien 2001/

Calculating the Vector for Indicator 8

The parameters for the calculations are:

Y (1990) = 95% = 0.9500

Y (2000) = 95% = 0.9500

X (1990) = 1.2% = 0.012

X (2000) = 2.2% = 0.022

Z (1990) = 0.8636

The German values for indicator 8 are calculated using (Y-X) ÷ Z [13]as follows:

I(1990) = (Y 1990 - X 1990)/Z 1990 = (0.9500-0.012)/0.8636 = 1,0862

I(2000) = (Y 2000- X 2000)/Z 1990 = (0.9500-0.022)/0.8636 = 1,0746

[13] Since no country can have a value of less than zero percent renewable energy, the usual equation (X-Y) ÷ Z is multiplied by – to give (Y-X) ÷ Z.

Germany Star

▸Discussion of Vector Values

Indicator 1: With nearly 3.0 points in 1999 Germany is, considering the scale of the star, very far from the centre which represents the sustainability objective. However, there has been a downward trend since 1990 which is expected to continue as Germany strives to meet its targets under the Kyoto Protocol.

Indicator 2: The Guidelines for the Observers Reports permit the calculation of the vector by using either the average of two or more pollutants or using data for the pollutant that has the most significant impact on environment and health within in a country. A multi-pollutant approach was applied for Germany. In order to assess the vector distance with the sustainability target one can either compare each single vector value or the average vector value on the scale of 0 to 1, with zero being the sustainability target. If we would have selected SO_2 emissions only, sustainability for this indicator would have been achieved. If we would have chosen NO_x or CO emissions results are indicating Germany is acting un-sustainable. This example shows, that as a result of the subjectivity associated with defining which pollutants have the most environmental and health impacts, single pollutant indicators could be justified but also misleading. The average vector value (SO_2, NO_X and CO) which were considered for Germany amounts to 0.26 indicating that Germany needs to further reduce emissions of the most relevant pollutants in order to achieve the sustainability target.

Indicator 3: The sustainability target of providing full access of German households to the electricity grid has been achieved since the late 70s in, therefore the sustainability target has been achieved and maintained since then.

Indicator 4: The fraction of clean energy investment as a portion of total energy investment with a value of 92% (i.e. 0.92 in 1999), is still too low according to the standards established by HELIO International which aim for a value of 95% of all energy investments to be made into clean energy. However, comparing the values for 1999 and 1990 indicate that Germany has made some minimal improvements in terms of increasing clean energy investment over the last ten years.

Indicator 5: The results for determining energy security indicate an upward trend in terms of increase imports of fossil fuels to Germany over the past decade. Germany's dependence on energy imports are from diverse sources primarily within the EC (although also from Norway and CIS countries) and thus are in keeping with the Europeans integrated energy planning policies which encourage countries to trade within Europe to utilise the cleanest and most efficient energy sources. In other words, although the imports are fossil fuels it is possibly better for the environment and sustainable development for Germany to import these products than to rely on local coal. However, according to HELIO International criteria, the sustainability target established for this indicator is not reached by Germany.

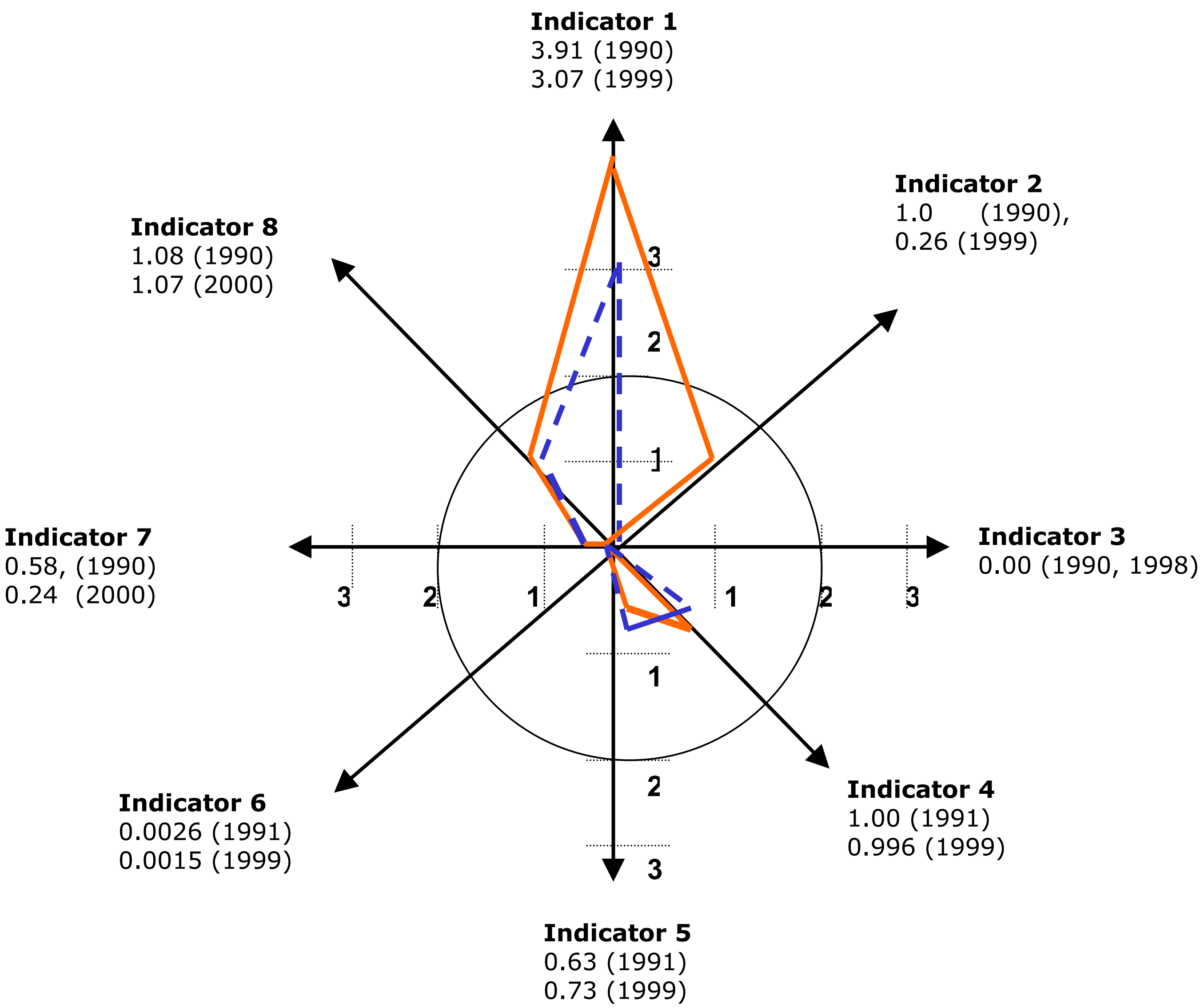
Indicator 6: The vector results for the burden on investments in both years1990 and 1999 are close to zero, and thus are close to the sustainability target at the centre of the star.

Indicator 7: Germany has performed well achieving substantial decreases in wasteful energy consumption. However, Germany has to continue this trend if it will meet the HELIO International target of 1.06MJ/$ GDP. It is recommended that Germany focus on improving energy efficiency where there are many opportunities for reducing wasteful energy consumption.

Indicator 8: In terms of renewable energy deployment, Germany has not achieved the sustainable target, since the vector values are higher than 1. However, the current government is keen to increase the share of renewables as a portion of total energy consumption in the country and it can be expected that in the future the results for Germany, as measured by this indicator will improve.

▸Star Diagram

The Star graphically illustrates the vector results of all 8 indicators assessed for Germany. It must be noted that vector values for vector 2, 3, 6 and 7 are either zero, slightly above or under zero therefore their values fall into the centre of the star. Indicator 1, per capita energy sector carbon emissions, is the vector indicating the poorest performance according to HELIO International standards. However, decreases in emissions are expected in the next decades due to the emission reduction targets imposed by Germany under the Kyoto Protocol.



Legend:

The orange line connects the vector values 1 to 8 for the base years (1990 or 1991) depending on data availability.

The blue line connects the vector values 1 to 8 for the most recent situation. The years 1998, 1999 or 2000 were used depending on availability of data.

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