ANNEX 1:
Renewable Energy Country Profiles

ANNEX 1 - COUNTRY PROFILES

INTRODUCTORY NOTE

Due to resource constraints, full profiles of renewable energy market and policy developments since 1990 were prepared only for a selection of the 35 countries discussed in the publication *"Deploying Renewables – Principles for Effective Policies"*. For the other countries, summary profiles depicting the main renewable energy market developments are available.

At the time of writing, verified renewable energy market statistics were available to the end of 2005. This means that market developments since that time – which have been significant for most of the renewable energy technologies analysed – are not reflected in the country profiles. Nevertheless, recently implemented policies – to the end of 2007 - are mentioned where relevant to indicate possible future market developments.

Framework policies, which have not yet been transposed into national legislation, *e.g.* the European Commission's 2008 proposal for a comprehensive integrated energy and climate package to 2020 and the related proposed targets, have not been taken into account.

NB: The individual country profiles make no claim to completeness.

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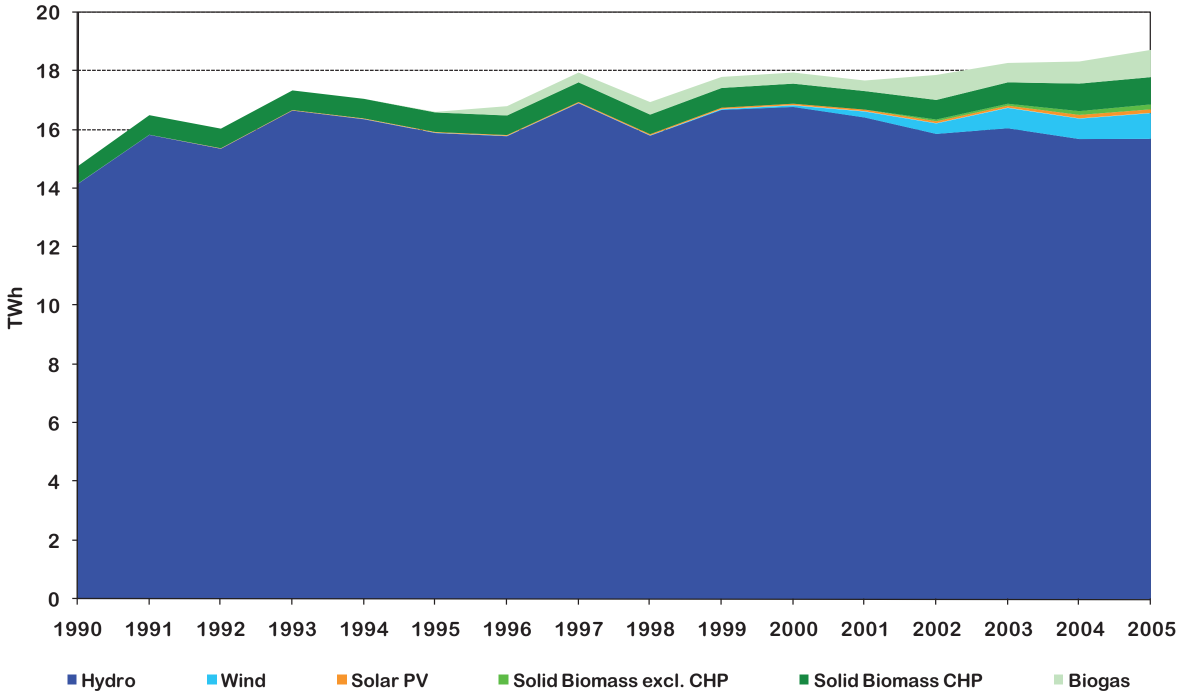
AUSTRALIA

RENEWABLE ELECTRICITY (RES-E) MARKET

RES-E Market Developments

Figure 1. Total RES-E Production, 1990-2005[1]



Source: IEA (2007a)

Renewable energy sources supplied 18.6 TWh of electricity in 2005, of which 84% stemmed from hydropower and 5% from biomass CHP plants, biogas and wind turbines each. 1% was generated by non-CHP solid biomass plants. Solar photovoltaics (PV) generated an estimated 121 GWh in 2005 representing 0.6% of renewable electricity generation[1].

In total renewable electricity represented 7.5% of total electricity supply in Australia in 2005. This share was 9.5% in 1990, peaked at 10.6% in 1993 and almost continuously declined thereafter.

The dominant role of hydropower in terms of renewables was even more distinct in 1990, when its share in renewable electricity production was 96% of 14.7 TWh from RES-E. While electricity production from hydropower was 1.5 TWh higher in 2005 compared to 1990 levels, the remaining 2.3 TWh of additional annual RES-E came from other RETs. Despite high growth in new RETs, overall growth in RES-E was only 1.6% over the considered period on annual average due to the high share of hydropower.

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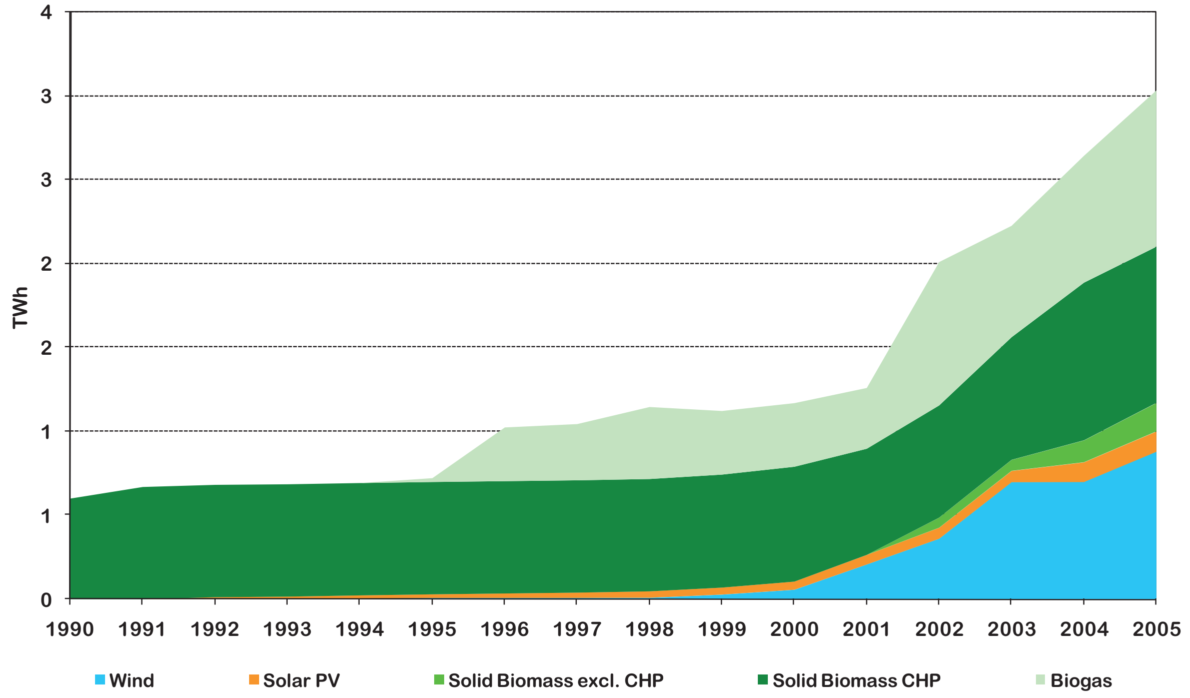
[1] Electricity production from solar PV is estimated with a 18.8% capacity factor

Figure 2. Total RES-E Production (excluding Hydropower), 1990-2005[1]



Source: IEA (2007a)

Wind energy production, which amounted to 4 GWh in 1994, increased 220 times within eleven years and contributed 881 GWh of RES-E in 2005 representing an average annual growth of 63% over the 11-year period. Wind power capacity grew even faster. But due to extraordinarily low full load hours in 2004 and 2005[2], growth in electricity generation lagged behind the wind power capacity development.

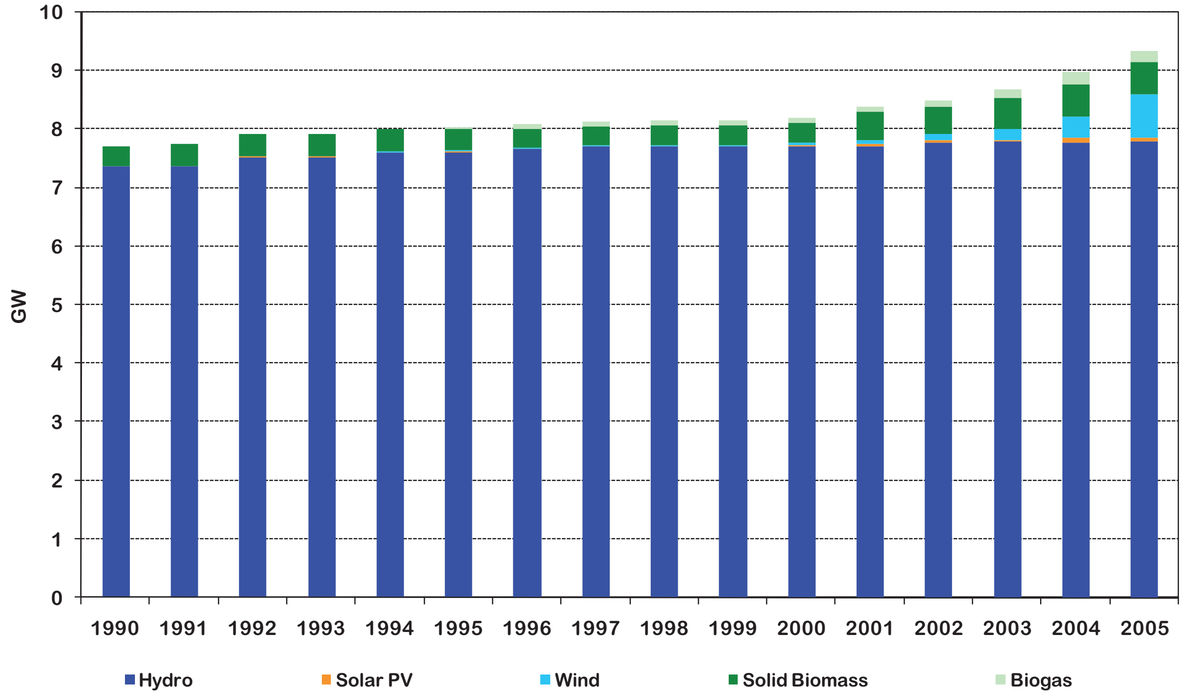
Electricity production from biogas started at 23 GWh in 1995 and reached 930 GWh in 2005, a 40-fold increase or 45% growth on annual average over the ten-year period.

Biomass combined heat and power (CHP) production provided another 931 GWh to the 2005 electricity supply, accompanied by a recent increase in non-CHP biomass power production contributing 169 GWh of RES-E in 2005. However, biomass started from a higher initial level (1990: 600 GWh of biomass RES-E) and grew on average at only 4% annually.

Growth of solar PV electricity production averaged 20% over the period from 1992 to 2005, but its overall contribution remained marginal. Solar PV capacity additions peaked in 2004 with 30 MW of additional installations.

[2] Full load hours of 1,800 and 1,200 hours per year in 2004 and 2005, respectively, compared with 3,700 hours per year in 2003.

Figure 3. Net Generating Capacity of RES-E Plants, 1990-2005



Source: IEA (2007a)

Development of Renewable Electricity Policies

Australia's Renewable Energy (Electricity) Act 2000 set the framework for the Mandatory Renewable Energy Target (MRET), one of the country's most comprehensive renewable energy support policies. It seeks to raise the contribution of renewable energy sources in Australia's electricity mix by an amount of additional generation requirements that increases from 300 GWh in 2001 to 9 500 GWh in 2010 and is maintained afterwards. Under this measure, tradable Renewable Energy Certificates (RECs) are issued for renewable energy generation above the 1997 baseline.

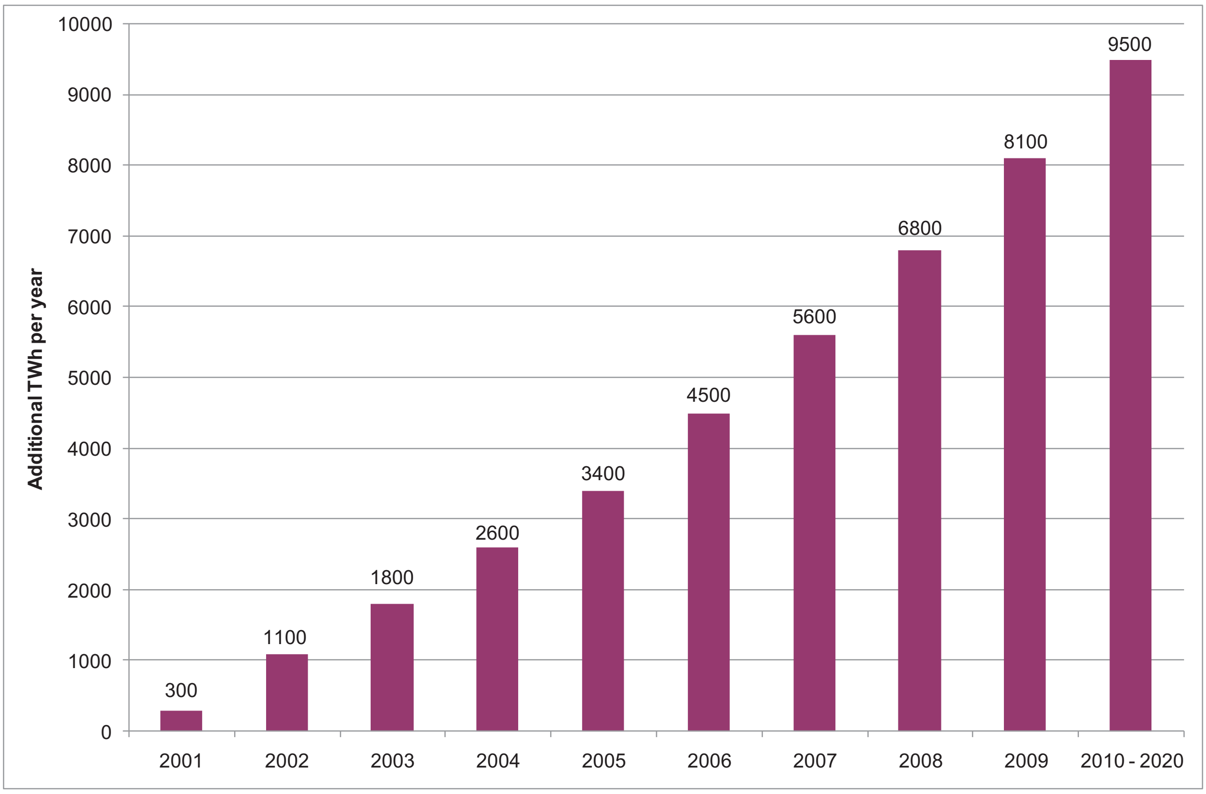
All wholesale electricity purchases on grids of more than 100 MW of installed capacity have to apply MRETs since 1 April 2001. In order to meet their obligation, liable parties (wholesale purchasers and electricity retailers) surrender RECs to the Office of the Renewable Energy Regulator (ORER), the statutory authority that governs the MRET scheme. The penalty payment for non-compliance is AUD 40[3] per MWh (IEA, 2008). The effective ceiling on REC prices, however, is around AUD 57 per MWh, since non-compliance payments are not tax deductible in contrast to the purchase of RECs (IEA, 2005).

Technologies eligible under the scheme include solar, wind, ocean, wave and tidal energy, small and large hydro, geothermal and bioenergy as well as solar water heating (RECs are issued for displaced electricity consumption) and other technologies like co-firing that replace fossil fuels.

3

As of year-end 2004, slightly more than 10 million RECs have been issued, representing 10 TWh of (cumulative) additional electricity production in the four-year period since the introduction of the MRET. The largest share of RECs (42%) was received by hydropower production, despite the fact that overall hydropower generation was constantly below 1997 levels[4]. The second largest amount was allocated to solar water heaters (21%, see subsequent section on renewable heat in Australia). Wind power received 12% of all RECs for that period, representing the third largest portion. The remaining RECs, accounting for one quarter of the total, went to producers of different biogas and biomass technology-based electricity generation.

Figure 4. Mandatory Renewable Energy Targets – Annual Additions in RES-E, 2001-2020



Source: adapted from IEA (2005)

Overall, RES-E generation did not increase in line with the additional generation requirements due to low hydropower production. In other words, the additional electricity production from renewables required under the MRET scheme did not imply an equivalent increase in total annual RES-E production.

Besides the MRET, a number of policy initiatives that provided renewable energy technology (RET) deployment incentives and addressed other important prerequisites for RES-E development have been introduced under the umbrella of three main framework policies: "Safeguarding the Future: Australia's Response to Climate Change" (1998), "Measures for a Better Environment" (2000), and the "Energy White Paper: Securing Australia's Energy Future" (2004).

[4] Spatial differences in precipitation levels may be an explanation for this counterintuitive result.

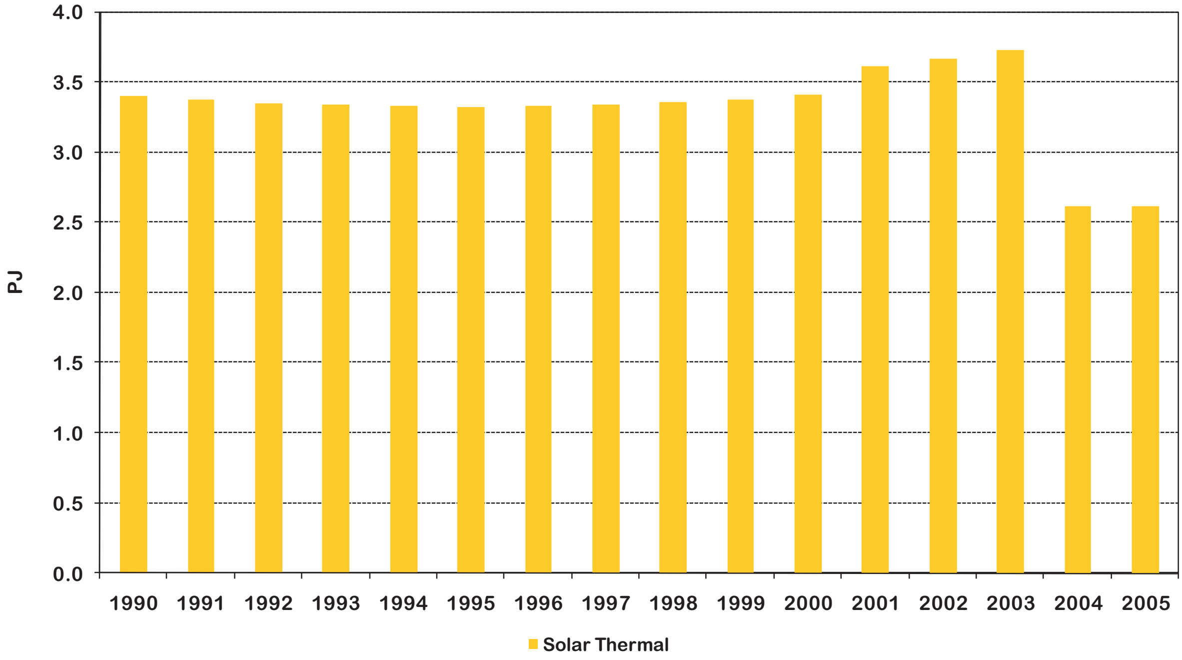
Under the 1998 framework, around AUD 80 million were allocated to RETs by public co-investments, preferential loans and investment grants with some programmes still running or extended under the policy package from 2000. The measures in 2000 introduced additional investment grants particularly focussing on solar PV and remote power installation with a total volume of around AUD 380 million. The “Photovoltaic Rebate Programme” was extended in May 2007 for another five years with additional funding of AUD 150 million. Grants were increased from 4 to 8 AUD/W up to a total of 1 kW for households and would cover up to 50% of investment costs of 2 kW in schools and communities. Further investment in RETs may have resulted from the AUD 243 million “Greenhouse Gas Abatement Programme” (IEA, 2008).

While the 2004 Energy White Paper did not increase the MRET, it did provide further funding. AUD 500 million of the total AUD 700 million were allocated to RETs and other low emission technologies by the “Low Emissions Technology Demonstration Fund” in several competitive funding rounds until 2020. The 2004 measures do also, but not exclusively, include programmes aimed at research and demonstration of storage technologies and improving wind forecasting capabilities.

In addition to federal government support, a number of state governments have enacted programmes to accelerate the development of RES-E.

RENEWABLE HEAT (RES-H) MARKET

Figure 5. Total RES-H Production, 1990-2005[5]



NB: Solar thermal includes direct final use.

Source: IEA (2007a)

According to official IEA statistics solar thermal heat production was consistently above 3 300 TJ since 1990 without any significant fluctuations and dropped rapidly in 2004 to 2 623 TJ (IEA, 2007). However, data from (IEA SHC, 2007) suggest that the total yield of solar thermal collectors installed in Australia was 7 096 TJ in 2005. Rising domestic sales of solar water heaters from over 70 000 sqm in 2000 to more than 160 000 sqm in 2005 indicate a trend that is inconsistent with the data displayed in the figure above.

Solar water heating is one of the technologies eligible under the MRET scheme, which encourages generation from smaller renewable generators through a so-called "deeming" system. The generation levels of smaller renewable energy technologies are determined by a benchmark corresponding to the technology, the model being used and its location. RECs are allocated according to electricity consumption that is displaced. The second largest share of RECs issued by end-2004 has been allocated to solar water heaters representing 21% of the total 10 GWh equivalent of certificates.

[5] Official IEA statistics on heat generation from renewable energy sources relate to **commercial heat sold** with additional data on **direct use** of solar thermal and geothermal available for most OECD countries.

The governments of Queensland, of South Australia, Western Australia and the Australian Capital Territory have additionally enacted regional rebate programmes on solar water heaters.

Renewable Transport Fuel (RES-T) Market

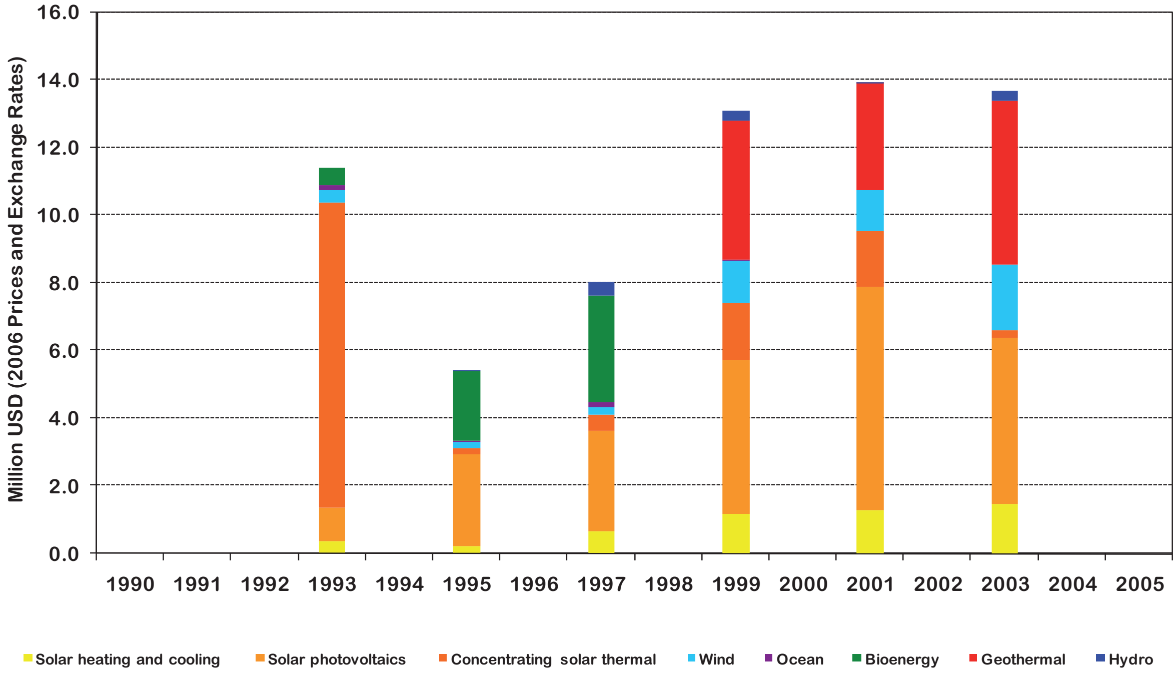
Data on biofuel use in Australia is limited to 2005, when production and consumption of ethanol was 10.88 ktoe.

Australia started to subsidise ethanol production and RD&D on biofuels in 1994 for a two-year period. The Measures for a Better Environment introduced in 2000 included the Alternative Fuels Conversion Programme, which targeted natural gas, liquefied petroleum gas and hydrogen.

A number of measures related to the wider fuel tax reform that commenced in 2002 affected biofuel production and consumption in Australia. The fuel tax reform introduced an energy-content based taxation of all transport fuels. But alternative fuels, such as ethanol and biodiesel, will be subject to a 50% reduction of the general fuel excise tax. Until mid-2011, however, biofuels remain effectively tax-exempted due to production grants that compensate for the exact amount of the fuel excise tax. Additionally, since 2006 the government provides grants for service stations that install infrastructure for the sale of E10, i.e. gasoline blended with 10% of ethanol, of up to AUD 20 000.

RESEARCH, DEVELOPMENT AND DEMONSTRATION TRENDS[6]

Figure 6. Annual Government RD&D Spending on Renewables, 1990-2005 (USD 2006 prices and exchange rates)[7]



Source: IEA (2007b)

The fraction of total public energy RD&D invested in RETs was 10% in 1993, 5% for the mid-1990s and again 10 to 11% thereafter (Figure 6). This is reflected by the fact that annual governmental spending on renewable energy (RE) RD&D more than halved from USD 11 million in 1993[8] to USD 5.3 million in 1995 and increased again to USD 12.6 million in 1999. In the subsequent years the governmental budget for RD&D on RETs stayed almost constant with USD 13.5 million and USD 13.2 million in 2001 and 2003 respectively.

34% of the reported cumulative budget on RE RD&D for the period from 1990 to 2005 was spent on solar PV technology, 22% on concentrating solar thermal (also called concentrating solar power or CSP), 18% on geothermal energy, 9% on bioenergy, 8% on wind energy and solar thermal heating technologies each, 2% on hydropower, and less than 1% on ocean energy technologies.

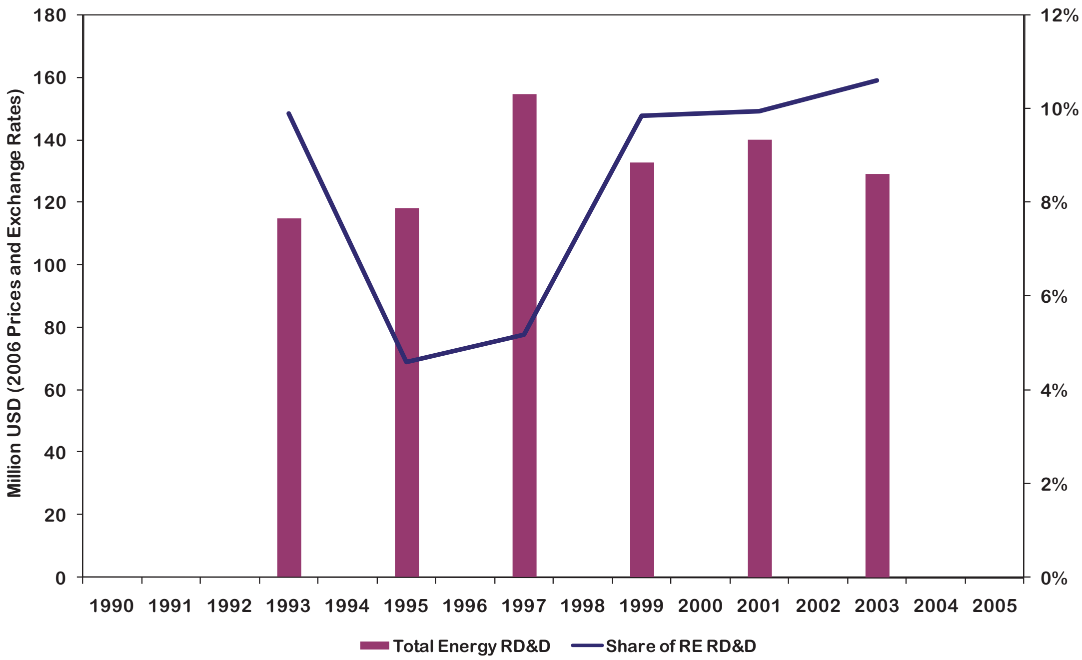
[6] Official IEA data on energy RD&D budgets include only **government** funding and not **private** RD&D spending.

[7] For Australia, official RD&D statistics were only available for every second year, with some exceptions in the case of concentrating solar power. Public financial incentives targeting private RD&D investments, like the "Low Emissions Technology Demonstration Fund" outlined above, appear not to be included in the governmental energy RD&D budgets.

[8] Conversion from national currency to USD is in USD (2006) prices and exchange rates.

In 1993, almost four-fifths of RE RD&D (79%) was allocated to CSP, which played only a minor role in subsequent years. Spending on bioenergy, which accounted for the second-largest share in terms of public RE RD&D in the mid-1990s (39% in 1997), halted completely in subsequent years. Instead, public funds went to RD&D on geothermal technology, which was the second-largest RET beneficiary from 1999 onwards behind solar PV.

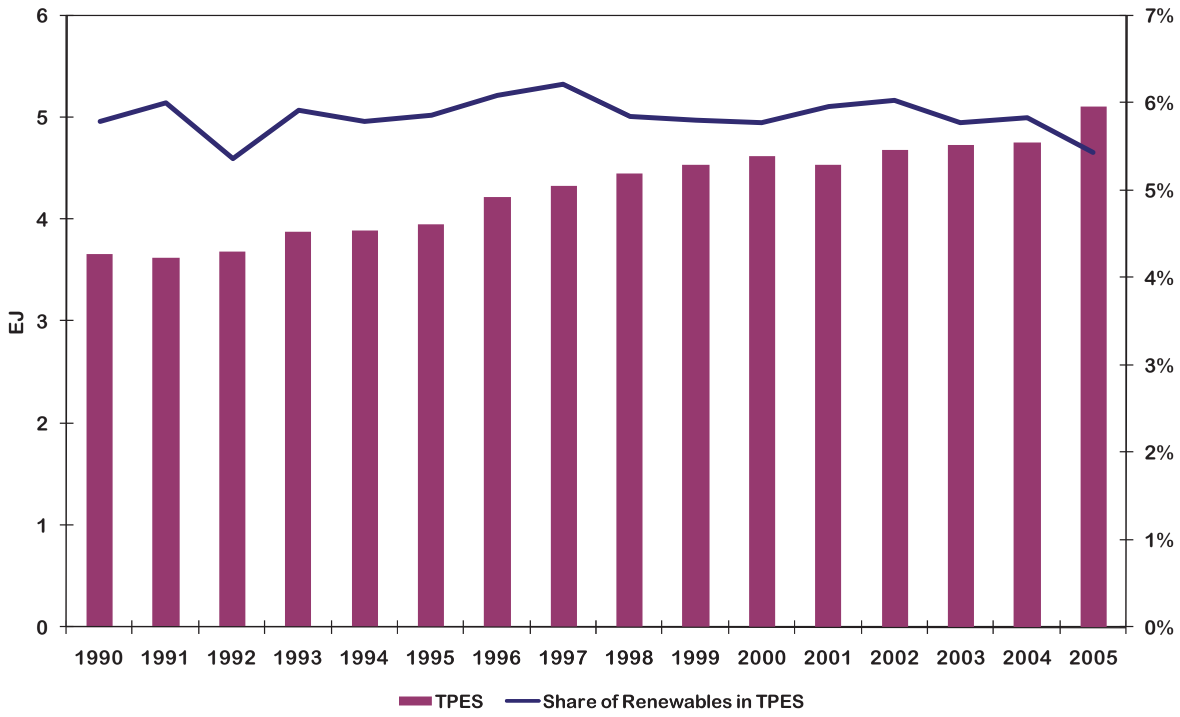
Figure 7. Renewable energy RD&D versus total government energy RD&D spending, 1990-2005



Source: IEA (2007b)

Renewables in Total Primary Energy Supply[9]

Figure 8. Share of Renewable Energy in Total Primary Energy Supply, 1990-2005



Source: IEA (2007a)

TPES in Australia increased on average by 2.1% annually from 3.7 EJ in 1990 to 5.1 EJ in 2005. Average growth of renewable energy supply of 1.4% per year led to an overall increase from 212 PJ in 1990 to 277 PJ in 2005, but it was not enough to keep up with the faster increase in TPES. Therefore, their share in TPES, which was 5.8% for the whole period with a peak of 6.2% in 1997, decreased to an all-time low of 5.2% in 2005.

[9] The official IEA statistics on TPES include, where applicable, traditional biomass but exclude pumped hydro.
Primary energy convention: The IEA uses the **physical energy content method** to calculate the primary energy equivalent of non-combustible energy sources, such as geothermal, hydro, solar and wind. As a consequence, there is an obvious link between the principles adopted in defining the primary energy forms of energy sources and the primary energy equivalent of these sources. For instance, in the case solar thermal and geothermal electricity production, as heat is the primary energy form selected by the IEA, the primary energy equivalent is the quantity of heat generated in the geothermal or solar thermal plant for electricity generation. In the case of hydro, wind, tide and solar PV, as electricity is the primary energy form selected, the primary energy equivalent is the physical energy content of the electricity generated in the plant, which amounts to assuming an efficiency of 100%. Readers may consult (IEA, 2007a) for more details.

Renewable Energy Policy Information

For further details on renewable energy support policies implemented in Australia, readers may consult the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

Glossary

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References

IEA (2005), *Energy Policies of IEA Countries: Australia – 2005 Review*, OECD/IEA, Paris.

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IEA (2008), "Global Renewable Energy Policies and Measures Database", www.iea.org/textbase/pm/grindex.aspx, International Energy Agency, accessed 15 March 2008.

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Weiss, W., Bergmann, I. and G. Faninger (2007), *Solar Heat Worldwide - Markets and Contribution to the Energy Supply 2005*, IEA Solar Heating & Cooling Programme (IEA SHC), AEE INTEC – Institute for Sustainable Technologies, Gleisdorf, Austria.

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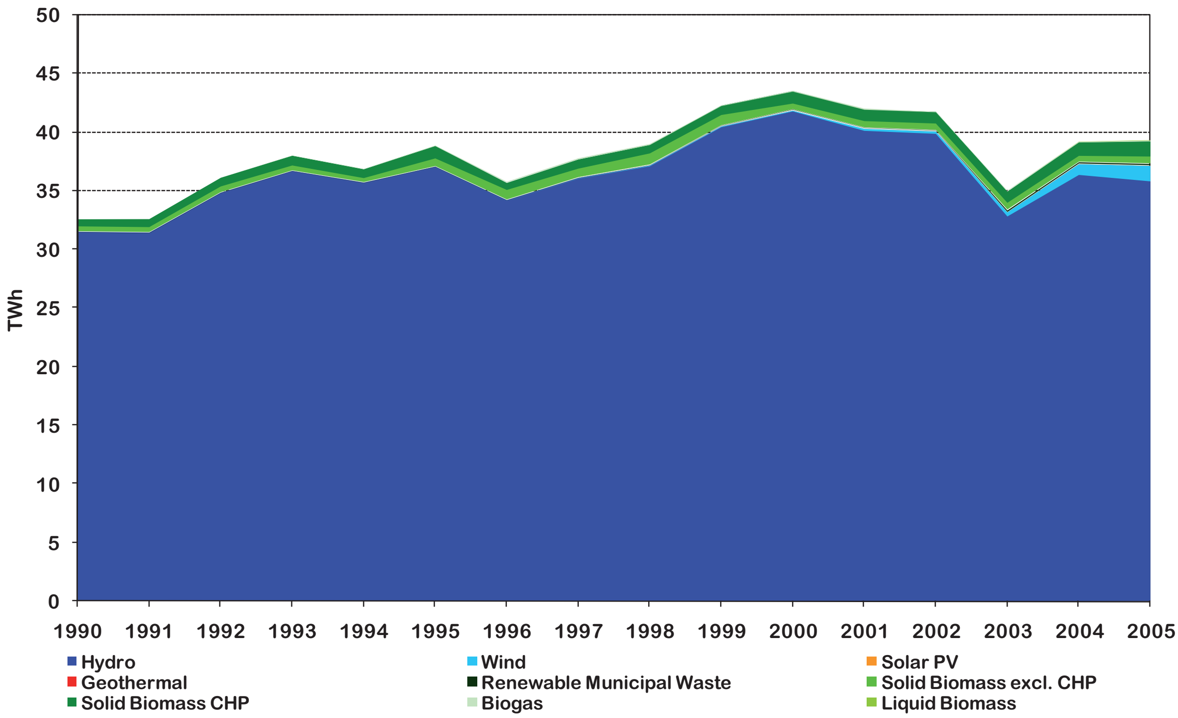
Renewable Electricity (RES-E) Market

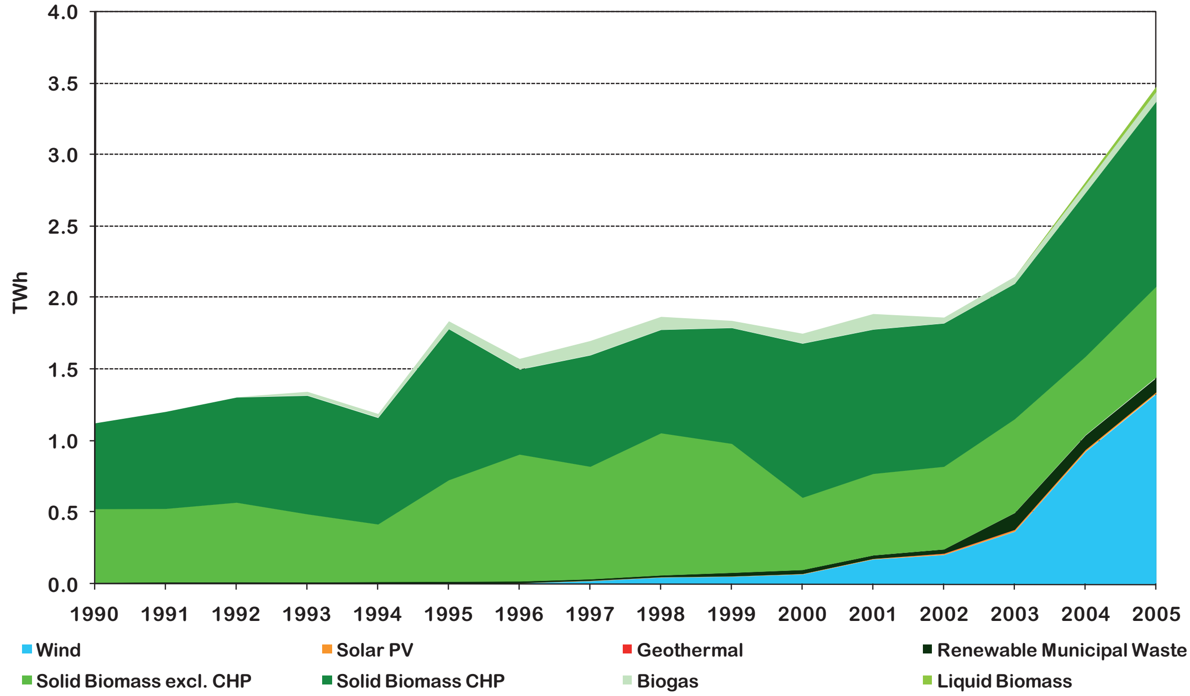
Figure 5. Total RES-E Production, 1990-2005



Source: IEA (2007a)

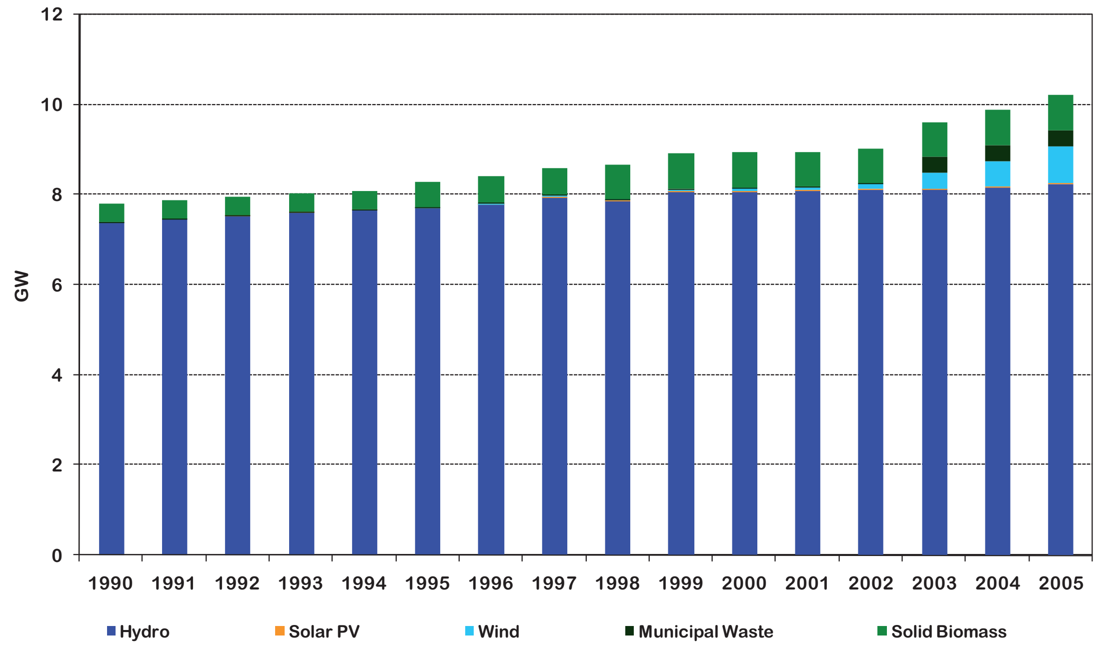
[1] A summary profile was prepared of Austria's renewable energy **market** developments from 1990 to 2005. Policy developments are available in the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

Figure 6. Total RES-E Production (excluding Hydropower), 1990-2005



Source: IEA (2007a)

Figure 7. Net Generating Capacity of RES-E Plants, 1990-2005

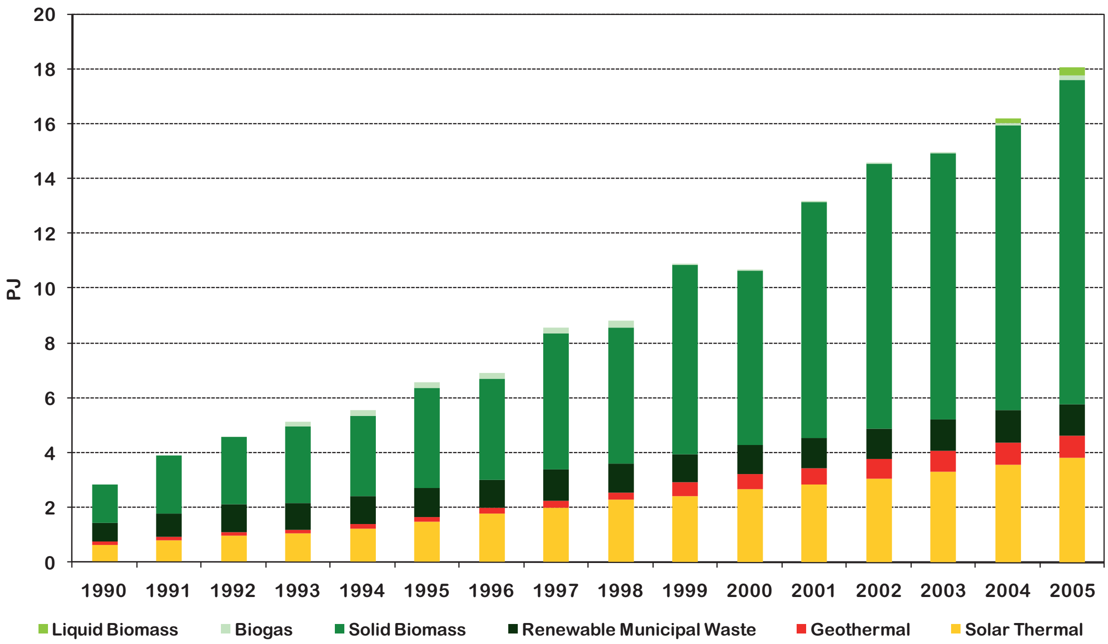


NB: Official IEA statistics on electricity generating capacity do not differentiate between *renewable* and *non-renewable* municipal waste.

Source: IEA (2007a)

RENEWABLE HEAT (RES-H) MARKET

Figure 4. Total RES-H Production, 1990-2005[2]



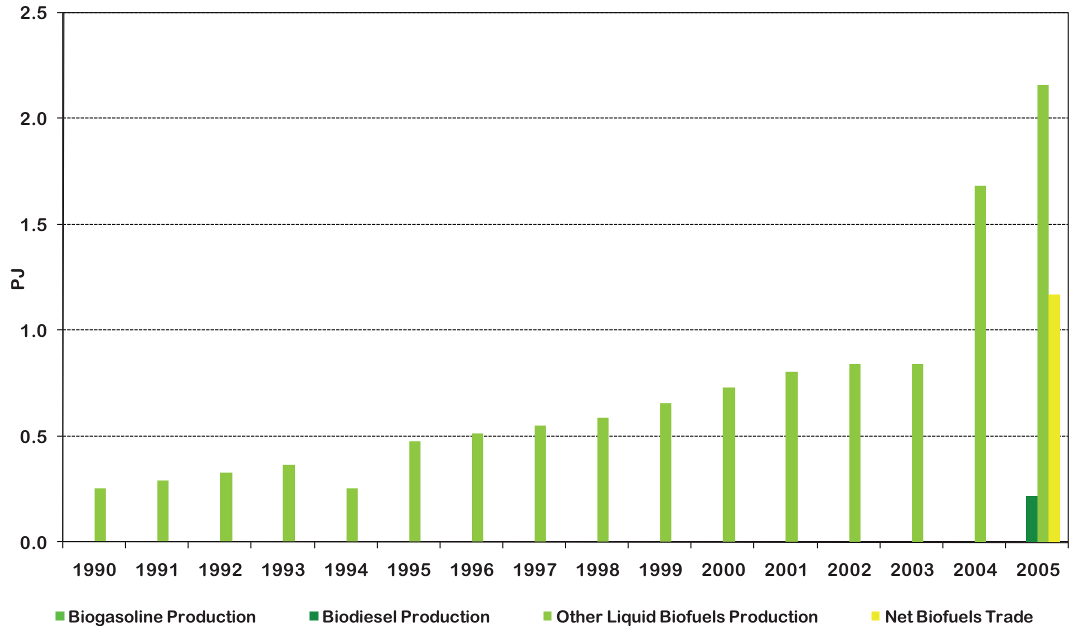
NB: Geothermal and solar thermal include direct final use.

Source: IEA (2007a)

[2] Official IEA statistics on heat generation from renewable energy sources relate to **commercial heat sold** with additional data on **direct use** of solar thermal and geothermal available for most OECD countries.

RENEWABLE TRANSPORT FUEL (RES-T) MARKET

Figure 5. Total RES-T Production, 1990-2005

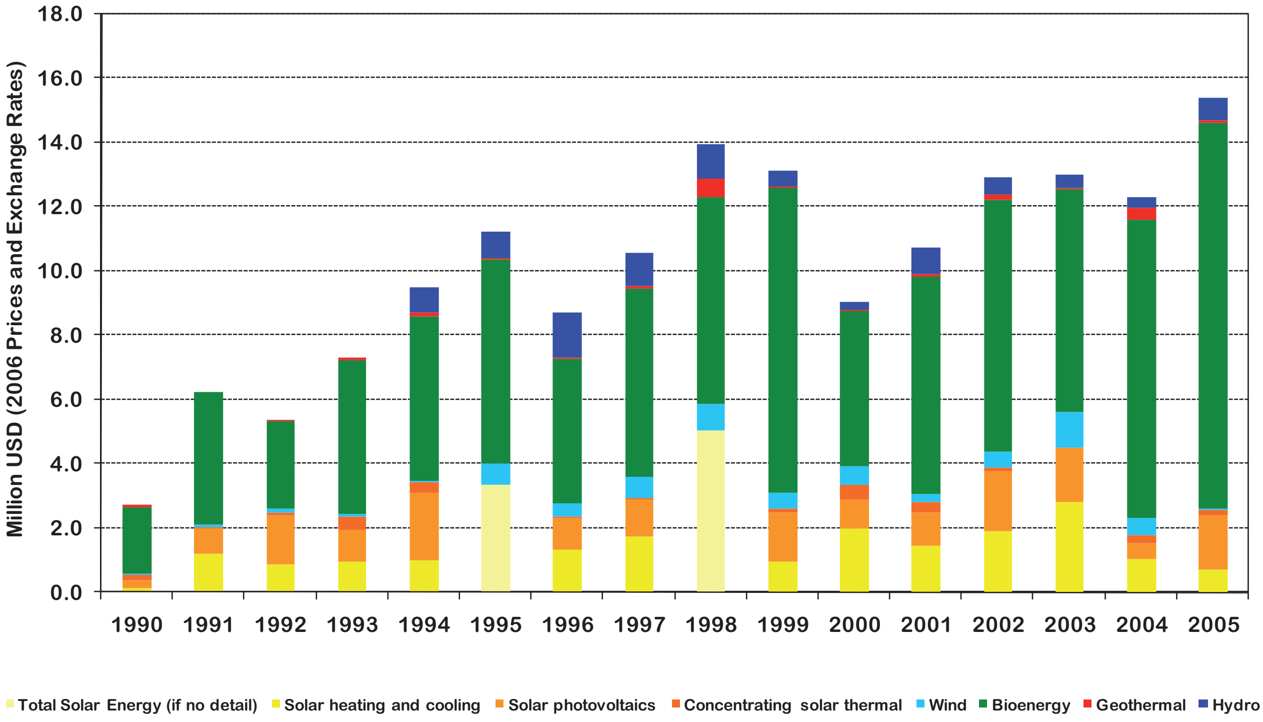


NB: Net Biofuels Trade refers to the balance of domestic biofuel consumption, i.e. biofuel exports subtracted from imports.

Source: IEA (2007a)

RESEARCH, DEVELOPMENT AND DEMONSTRATION TRENDS

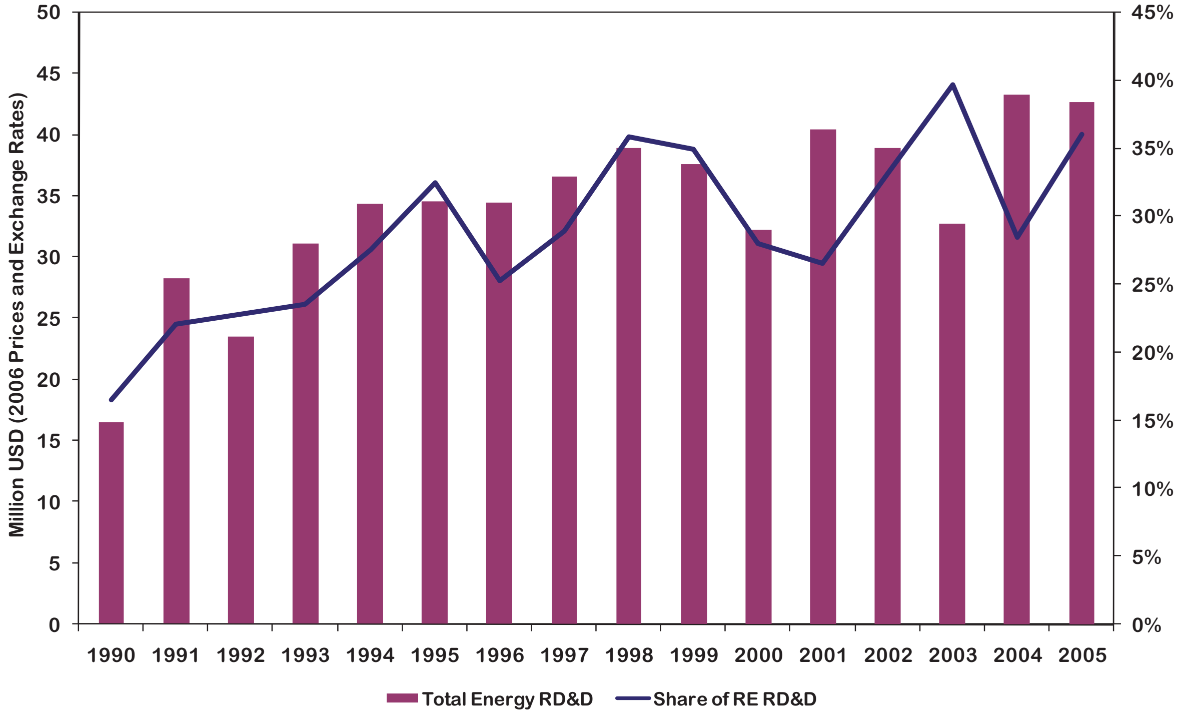
Figure 6. Annual Government RD&D Spending on Renewables, 1990-2005 (USD 2006 prices and exchange rates)[3]



Source: IEA (2007b)

[3] Official IEA data on energy RD&D budgets include only **government** funding and not **private** RD&D spending.

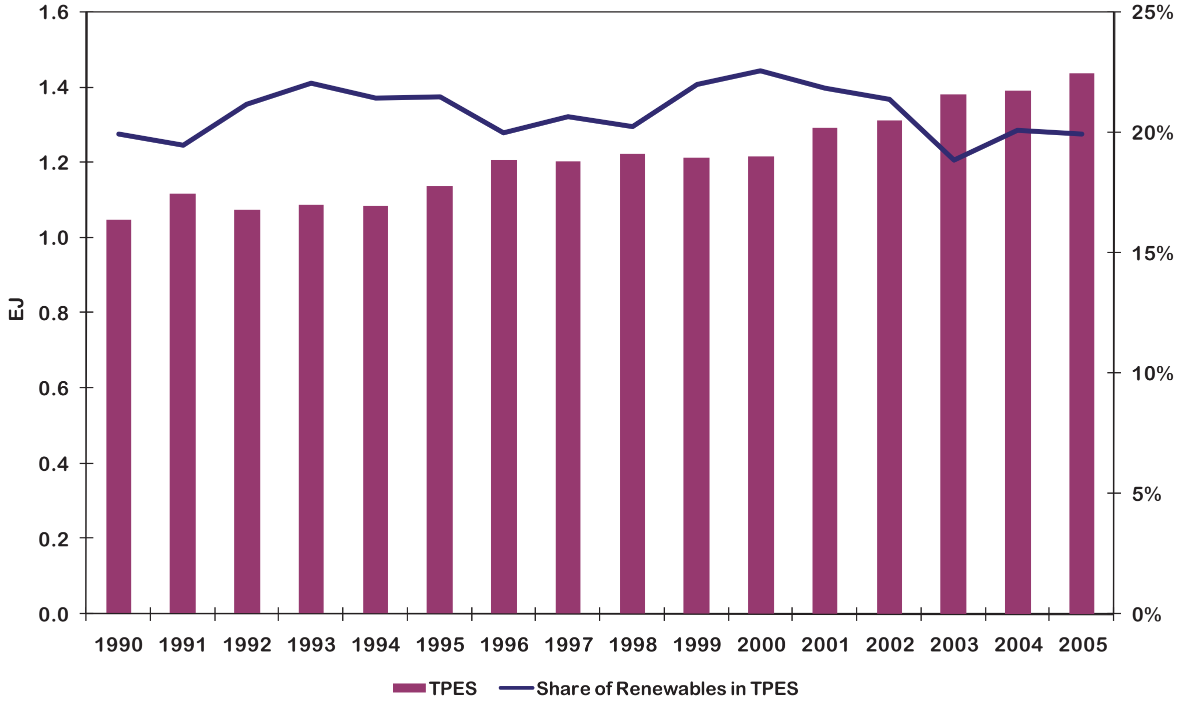
Figure 7. Renewable energy RD&D versus total government energy RD&D spending, 1990-2005



Source: IEA (2007b)

RENEWABLES IN TOTAL PRIMARY ENERGY SUPPLY[4]

Figure 8. Share of Renewable Energy in Total Primary Energy Supply, 1990-2005



Source: IEA (2007a)

RENEWABLE ENERGY POLICY INFORMATION

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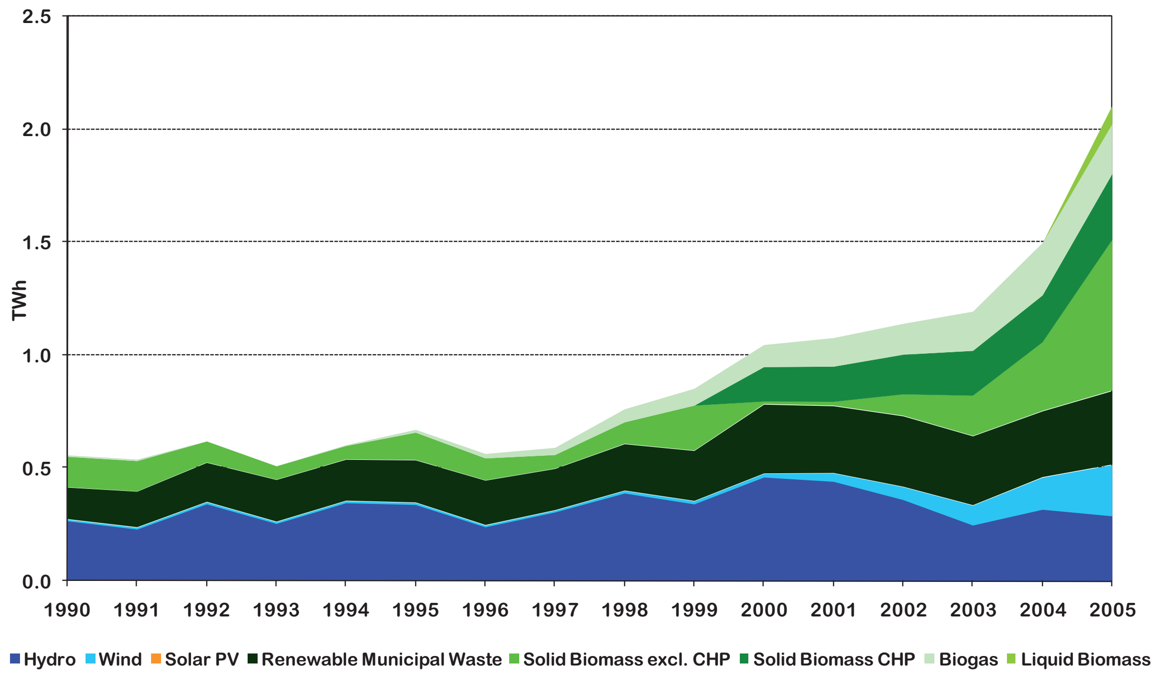
IEA (2008), "Global Renewable Energy Policies and Measures Database", www.iea.org/textbase/pm/grindex.aspx, International Energy Agency, accessed 15 March 2008.

BELGIUM[1]

RENEWABLE ELECTRICITY (RES-E) MARKET

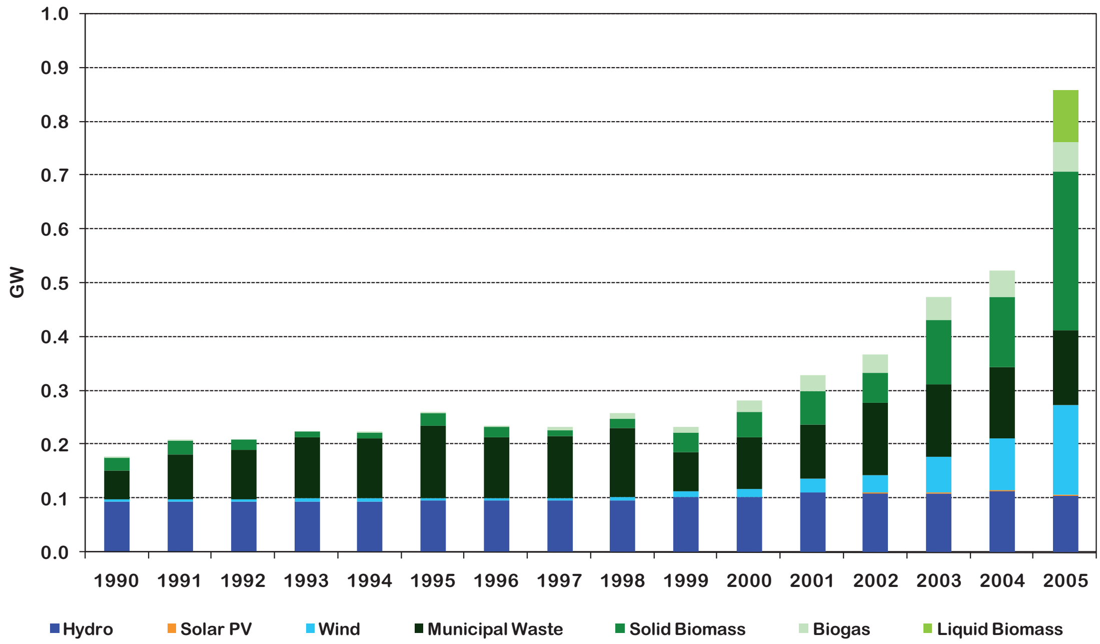
Figure 8. Total RES-E Production, 1990-2005



Source: IEA (2007a)

[1] A summary profile was prepared of Belgium's renewable energy **market** developments from 1990 to 2005. Policy developments are available in the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

Figure 2. Net Generating Capacity of RES-E Plants, 1990-2005



NB: Official IEA statistics on electricity generating capacity do not differentiate between *renewable* and *non-renewable* municipal waste.

Source: IEA (2007a)

RENEWABLE HEAT (RES-H) MARKET

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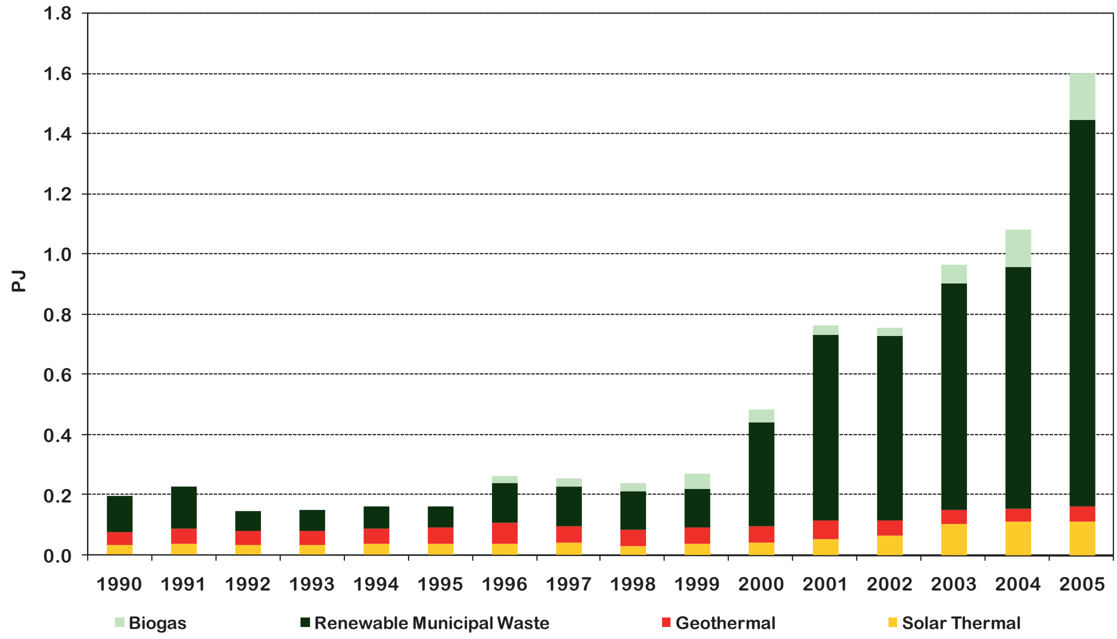


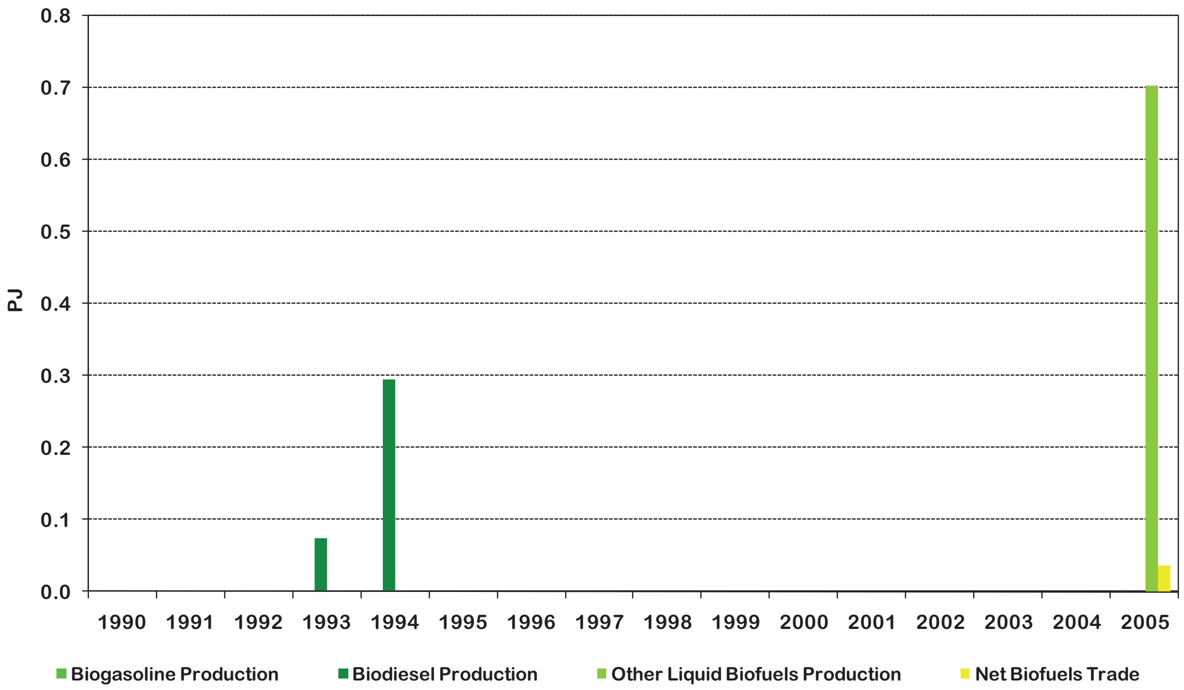
NB: Geothermal and solar thermal include direct final use.

Source: IEA (2007a)

[2] Official IEA statistics on heat generation from renewable energy sources relate to **commercial heat sold** with additional data on **direct use** of solar thermal and geothermal available for most OECD countries.

Renewable Transport Fuel (RES-T) Market

Figure 4. Total RES-T Production, 1990-2005



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RESEARCH, DEVELOPMENT AND DEMONSTRATION TRENDS

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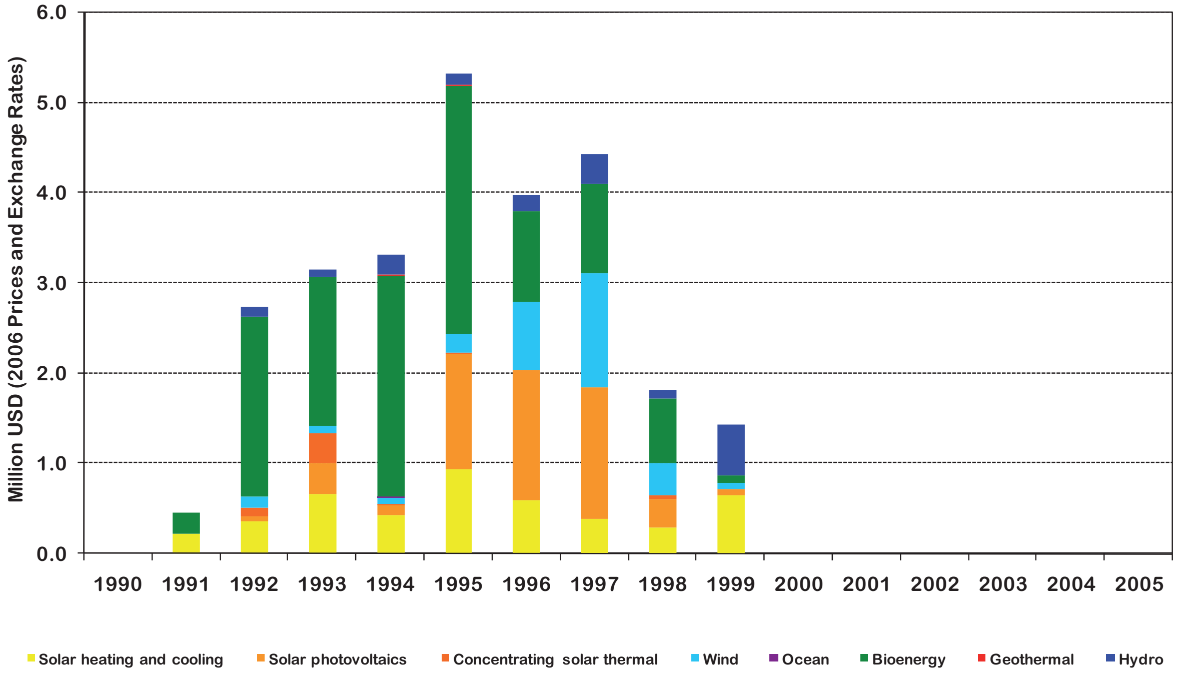

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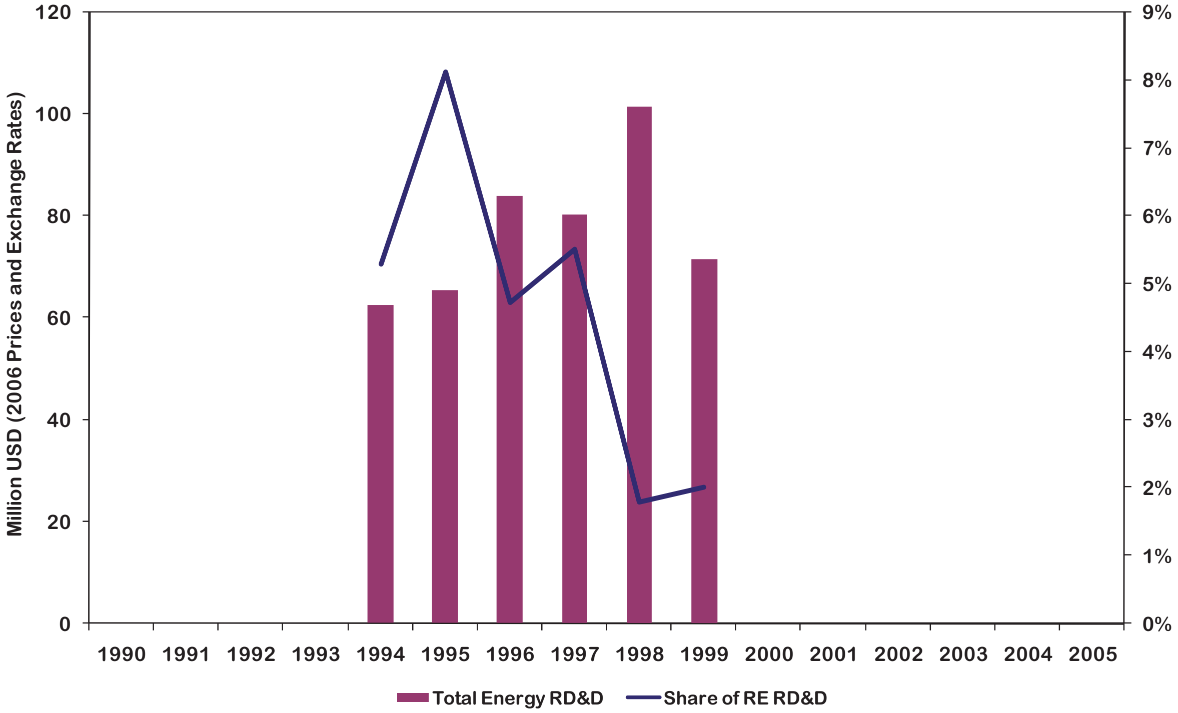

Source: IEA (2007b)

RENEWABLES IN TOTAL PRIMARY ENERGY SUPPLY[4]

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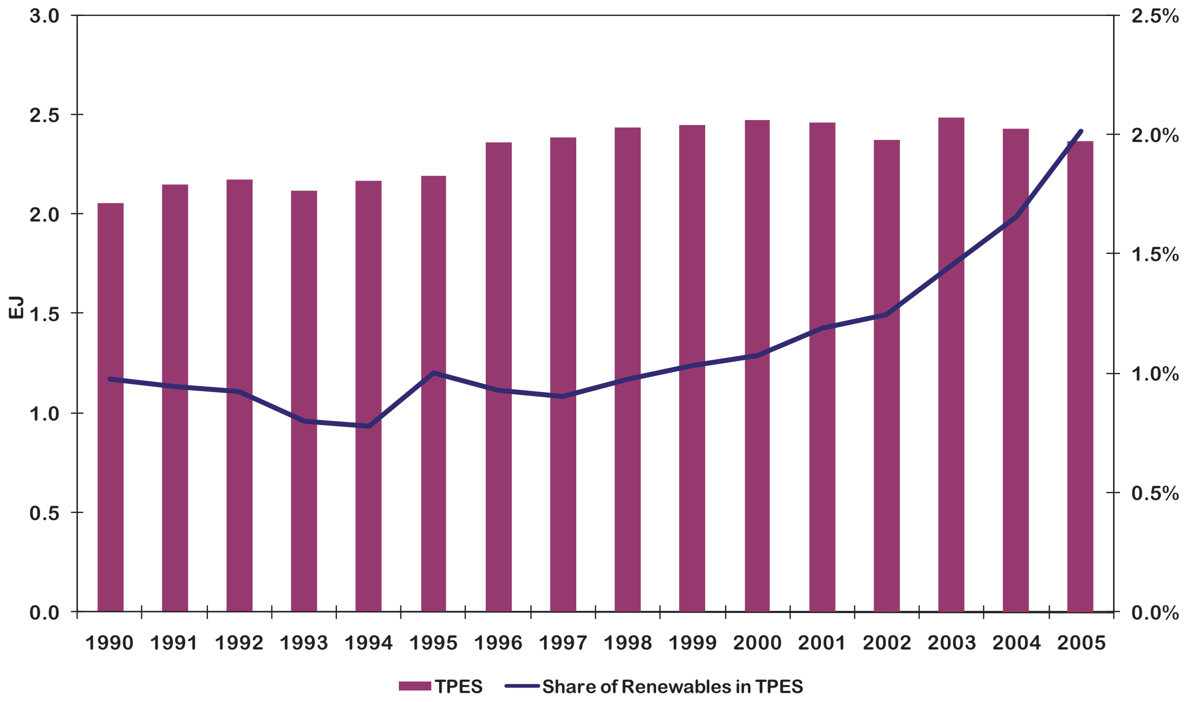

Source: IEA (2007a)

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IEA (2008), "Global Renewable Energy Policies and Measures Database", www.iea.org/textbase/pm/grindex.aspx, International Energy Agency, accessed 15 March 2008.

BRAZIL

General Country Information

Brazil is a federal democratic republic constituting 27 states and one federal district, comprising the country's capital Brasilia. It is the largest country in South America and the third largest of the American continent, smaller only than Canada and the United States. Total land area is 8 514 877 km^2, of which around 33% is tropical forest. The country's total population as of 2006 was 186.8 million. In 2006, gross domestic product (GDP) was USD 1 067 120 million[1], while per capita income was USD 5 714.

At the end of 2006, electricity generating capacity amounted to 93 158 MW of which hydroelectric power plants account for 87%, nuclear 2%, and fossil-fuelled thermoelectric power plants 11%.

Total end energy consumption in Brazil was 8.8 EJ in 2005, of which 26.5% was used in the residential, commercial and public sectors, 28.7% in the transport sector, 4.6% in the agriculture sector, and 40.2% in the industrial sector. Oil reserves are approximately 10.6 billion barrels and current production is close to 1,550 barrels of crude oil per day. Nevertheless, Brazil imports considerable amounts of natural gas, mainly from Argentina and Bolivia.

Nevertheless, Brazil is the world leader in the use of biofuels - it is a net exporter of bioethanol and has ambitious programmes to get the same position in biodiesel. The use of alcohol blended with gasoline in Brazil dates from 1933: the volume of alcohol at that time was in the range up to 5%, which increased over the years to the present time when vehicles can run on pure alcohol. The country's well-known ethanol programme from sugar cane for transport fuel (ProÁlcool) was launched more than three decades ago with the main purpose of reducing gasoline inputs.

Institutional Framework

General Information

The Ministry of Mines and Energy (MME) is the leading government body concerning renewable energy policy in Brazil. Since 2004, the MME is again directly responsible for granting of concession licenses as proposed by the National Electricity Regulatory Agency (ANEEL). Moreover, electricity supply and demand coordination falls within the scope of the MME's responsibilities according to the model presented by the Energy Research Company (EPE). Over and above, it is responsible for the main support scheme for the promotion of renewable electricity (PROINFA).

The Energy Research Enterprise (EPE) was created in 2004 to carry out studies and research in support of the planning process of the energy sector. EPE reports directly to the

[1] Figures in USD are calculated using an average 2006 market exchange rate. In 2006, 1 BRL equalled about USD 0.46 and EUR 0.36.

MME. It carries out studies for the optimum utilization of the country's hydroelectric potential, evaluating social impacts, technical-economical viability, and socio-environmental viability of electric energy and renewable energy projects. EPE also supports and fosters the use of renewable energy.

The National Council for Energy Policy was created in 1997, linked to the Presidency of the Republic and presided by the MME. It is in charge of formulating energy policy for the country, which is submitted to Congress for approval.

Two regulatory agencies have been set up in the energy sector as part of the reform of the power sector in 1996: one for electricity, ANEEL, the National Electric Energy Regulatory Agency, and ANP, the National Agency for Petroleum, Gas and Biofuels.

Electricity Sector

ANEEL, the National Electric Energy Regulatory Agency, is mainly occupied with drawing up proposals for the issuing of concessions for electricity generation and distribution, it sets tariffs for final consumers and issues permits for access to the grid (GTZ study). The Brazilian wholesale electricity market that was created during the reform period does also fall under the jurisdiction of ANEEL.

In addition, as part of the 1996 reform, a portion of the electric utilities in the country were privatised. However, at the end of 2005 still around 40% the country's installed generation capacity and most of the large transmission lines (69%) remain under the ownership and control of Elétrobras, the national electricity holding (public ownership: 52.45%). Hence, Elétrobras remains as an important institutional player in the process of implementation of renewable energy technology in the electricity sectors.

Regional Electric Utilities, such as the Electricity Company of the State of Parana and the Energy Company of Minas Gerais, have launched programmes within their own territories to foster the implementation of renewable energy projects.

The Brazilian Economic and Social Development Bank have also played an important role by making financing available for renewable energy projects, mainly small hydroelectricity projects.

Several universities throughout the country carry out scientific and technological research in the field of renewables, among others the Federal University of Pernambuco and the University of São Paulo.

Brazil has one of only two national laboratories for electricity in Latin America (CEPEL[2]); the other one is in Mexico. For a number of years, CEPEL has conducted research and technology development in different fields of renewable energy technologies, including grid-connected and off-grid systems.

[2] [Centro de Pesquisas de Energia Elétrica]

Transport Sector

The Ministry of Agriculture sets guidelines for agro-energy policy of Brazil. The goals are to expand the use of ethanol, to implant the value chain for biodiesel, to utilize forest residues, and to expand the activity in energy plantations. One main concern of this Ministry is to avoid any negative impacts on the Brazilian food chain, while at the same time increasing efficiency and productivity of bioenergy products in the benefit of the least privileged regions.

Within the Secretariat of Petroleum, Natural Gas and Renewable Fuels, a Department of Renewable Fuels has been created, with the purpose of coordinating the production and commercialization of renewable energy. This Department also oversees the process of mainstreaming of new renewable fuels.

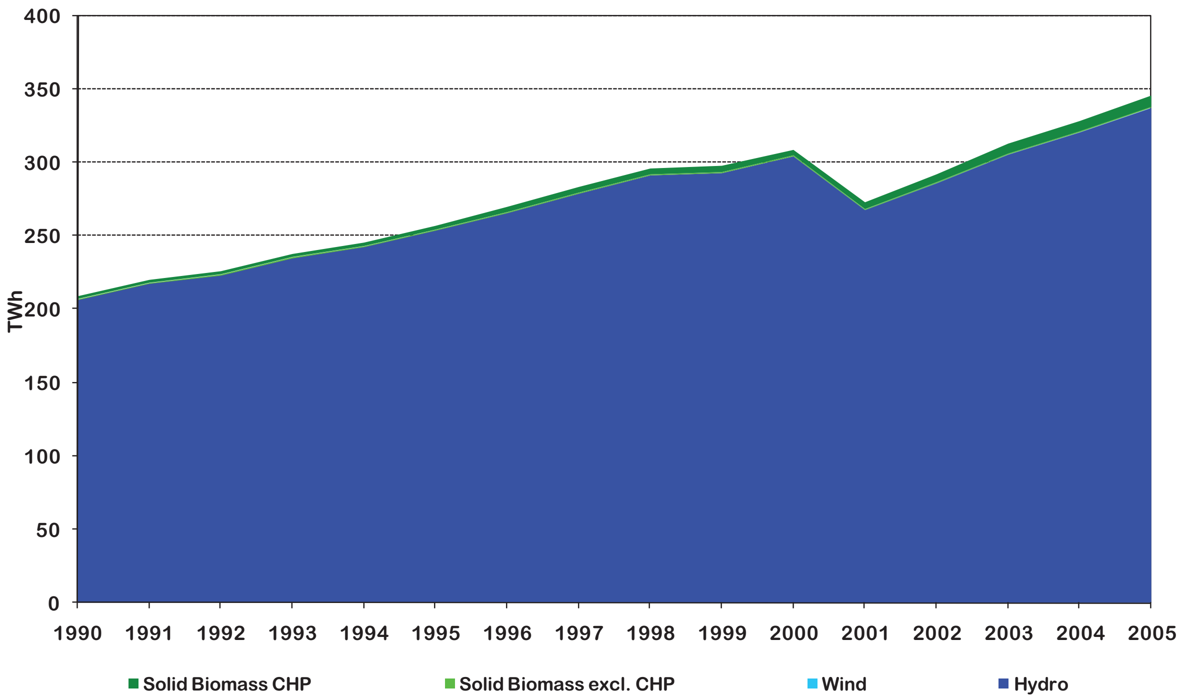
The ANP is in charge of regulating and overseeing operations related to production, processing, storing, distributing, and retailing of ethanol fuel as well as biodiesel.

The equivalent to Elétrobras in the oil and transport fuels sector is Petrobras, which was created in 1953 to carry out petroleum-related activities. The government still holds 55.7% of the company shares.

Renewable Electricity (RES-E) Market

Development of Renewable Electricity Markets

Figure 1. Total RES-E Production, 1990-2005

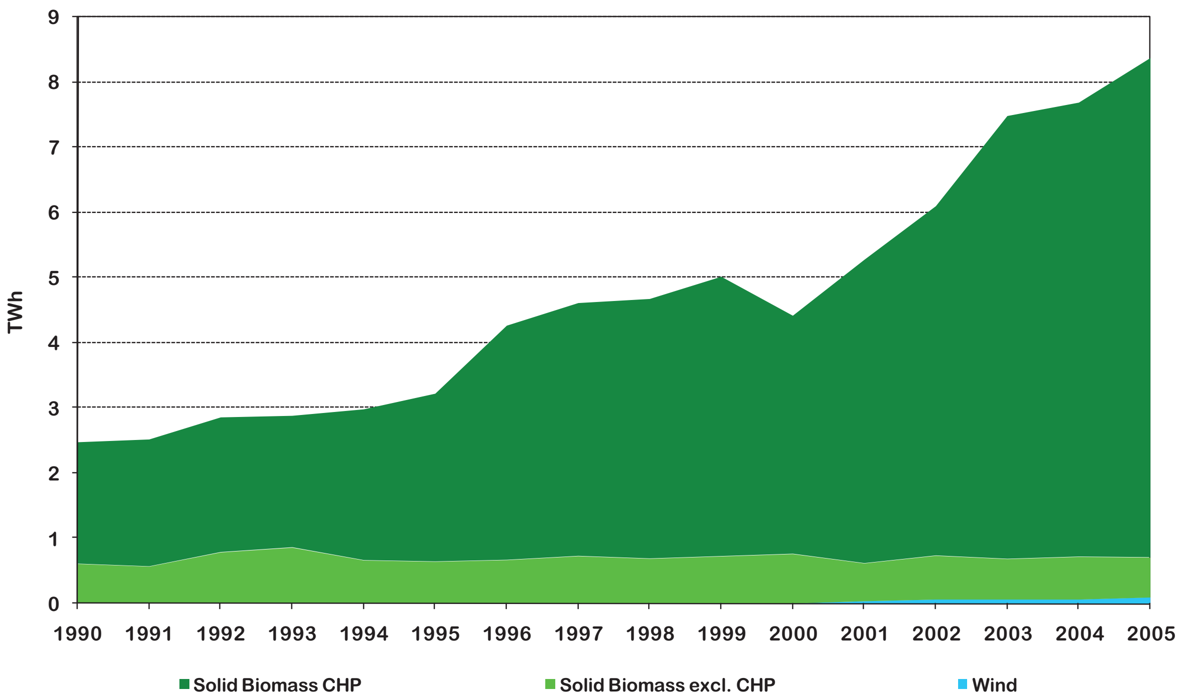


Source: Huacuz and Medrano (2007b)

Brazil generates more than 80% of all electricity from hydropower. In 2005, hydropower plants with a total capacity of 71 GW produced around 325 TWh of the total 403 TWh of electricity. Since 1990, when total hydropower capacities were around 46 GW, the average annual increase in capacities and electricity production were both about 3% representing around 1.4 GW of annual capacity additions or 6.5 TWh of additional annual electricity generation.

Among other large dams in Brazil, the Itaipu Dam is one of the worlds largest hydropower plants with a capacity of 14 000 MW[3]. In 2000, Itaipu achieved a record generation of more than 93 TWh of electricity, thus representing around 27% of the country's total electricity supply in that year. A total of 23 hydropower plants with more than 1 000 MW installed capacity each have been operational in 2002 accounting for more than 70% of the countries total capacity and providing around 50% to 60% of the country's total electricity generation[4]. Only a small fraction of hydropower stems from small plants (with less than 30 MW installed capacity). The cumulative capacity of more than 260 small hydropower stations equals 1.36 GW, with another 4 GW currently under construction or having received planning permission from the respective regulatory agency.

Figure 2. Total RES-E Production (excluding Hydropower), 1990-2005



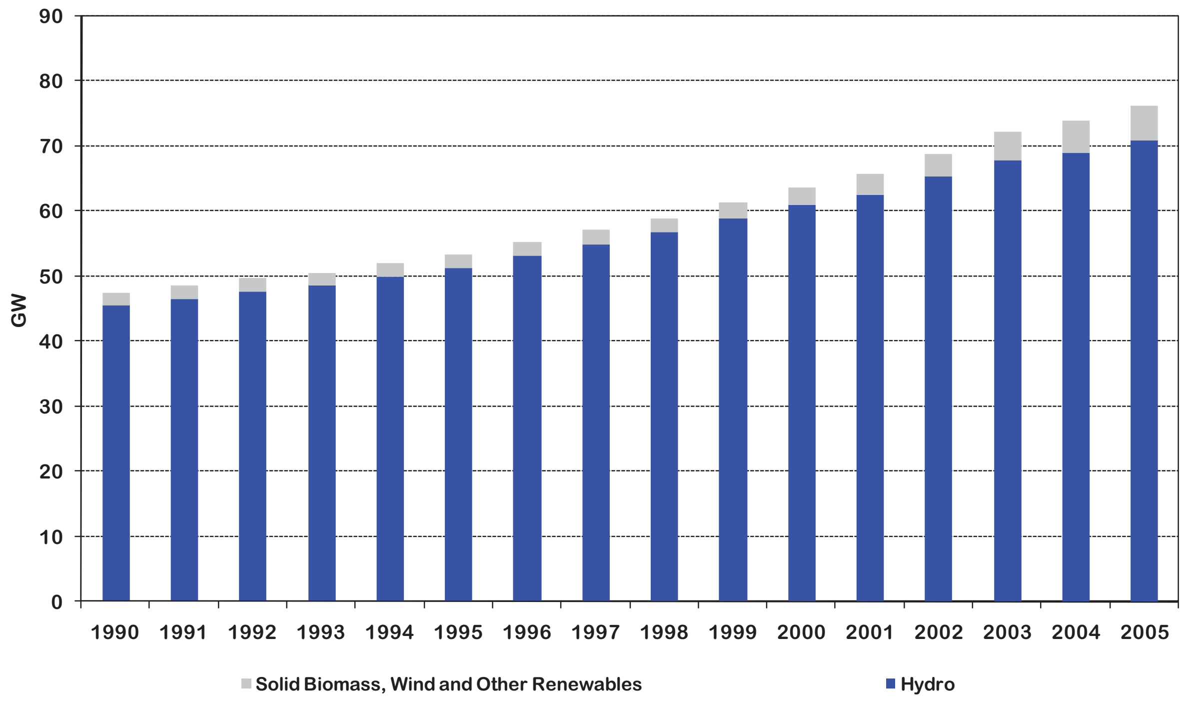
Source: Huacuz and Medrano (2007b)

[3] (Itaipu Binacional, 2008)
[4] (IAEA *et al.*, 2006)

The remaining renewable energy portfolio in the electricity sector is limited to solid biomass and wind power, representing 2.5% and 0.03% of total renewable electricity production in 2005. Furthermore, the MME estimates that about 15 MWp of small off-grid photovoltaic systems are installed in remote regions of the country.

With an average annual growth of 10% from 1990 to 2005, solid biomass doubled its share in renewable electricity generation, supplying 8.3 TWh in 2005. The bulk of additional biomass plants built since 1990 are CHP plants that produce both electricity and heat. The first wind power plants became operational in 1996, electricity production from wind power increased by around 30 TWh in 2001, 2002 and 2005 amounting to an annual generation of 93 TWh of electricity in 2005.

Figure 3. Net Generating Capacity of RES-E Plants, 1990-2005



Source: Huacuz and Medrano (2007b)

Development of Renewable Electricity Policies

The Brazilian electricity sector has undergone several significant reform waves, beginning with the liberalisation of private investments in infrastructure in 1988. Relevant reforms included the creation of ANEEL, the Brazilian Electricity Regulatory Agency, a national transmission grid operator and a wholesale power market.

The attempt to establish a wholly private and competitive electricity market, including steps towards unbundling of generation, transmission and distribution, faced a series of problems during the currency devaluation in 1999 and the energy crisis in 2001, which resulted in a nationwide power rationing programme. Since 2003, a new model for the Brazilian power sector has been discussed based on three principles: (i) access to electricity should be made available to all Brazilians; (ii) the MME should be ultimately responsible for energy planning; (iii) and private investments will be governed on the basis of long term contracts between generators and consumers.

During the 1990s, several subsidy schemes for renewable energies have been introduced. Law 9638/98 introduced subsidies for renewable energy sources in isolated communities in the north of Brazil. Resolution No. 245 increased funds for isolated electric systems where thermoelectric generation is fully or partially replaced by renewables.

In 2001 small hydropower projects were supported through investment grants from the Brazilian Economic and Social Development Bank (BNDES) in combination with purchase guarantees from Elétrobras. The success of this programme has been limited largely due to a lack of investor's interest. Consequently, it has been phased out in 2004.

Also in 2001, Resolution No. 24 targeted the installation of 1,050 MW of wind power within three years. In 2002, it has been incorporated in Law No. 10438 ("Programme for Incentives for Alternative Sources of Electricity Generation" or PROINFA[5]) which aimed at implementing a total of 3,300 MW of renewable energy projects by the end of 2006 (1,100 MW of wind, biomass and small hydro each) by offering periodically adjusted feed-in tariffs (FITs) for a period of 20 years. Additionally, low interest loans have been made available to wind energy and small hydropower projects by the BNDES. An important prerequisite to obtain approval, however, was that 60% of the value added for the plants was created in Brazil.

For the second phase of PROINFA, the scope of the programme is envisaged to be extended in order to reach a 10% share in electricity generation (excluding large hydropower) within a period of 20 years.

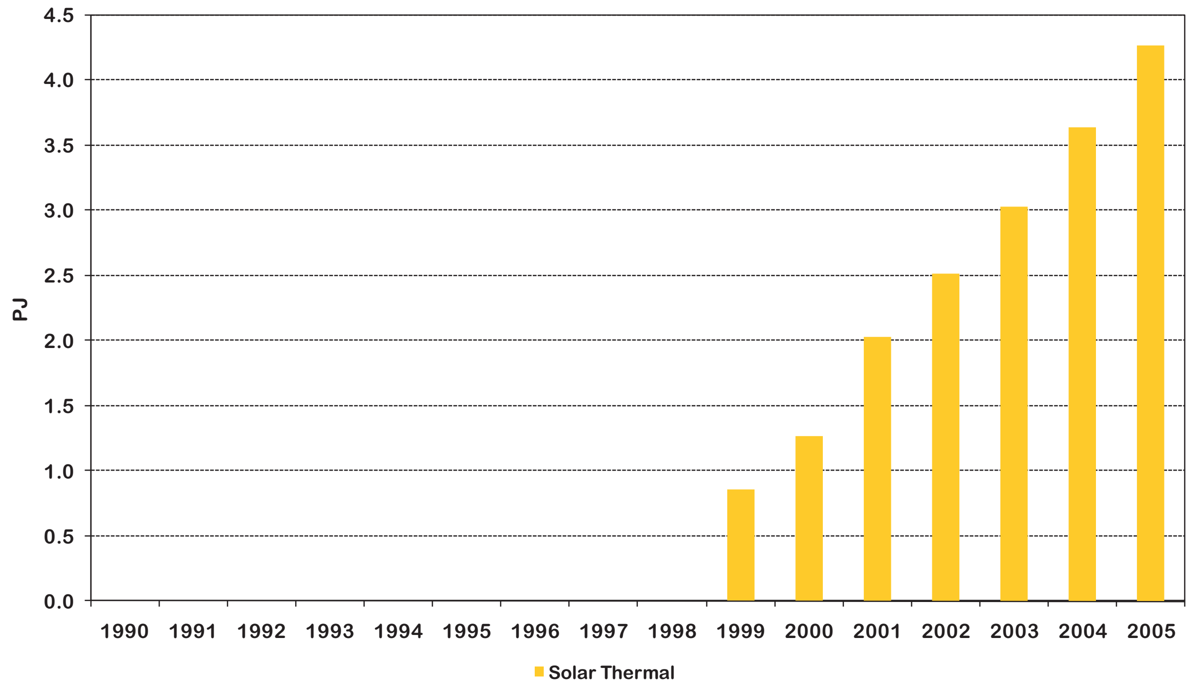
Since 2004, the "Light for All" Programme (the National Programme for Universal Electricity Access and Use)[6] includes off-grid renewable energy solutions to achieve access to electricity in rural areas.

In May 2007, a first tender for renewable energy projects was held. 143 offers were registered that could provide a total capacity of 4,570 MW. However, prospects for the wind projects offered are supposed to be poor, since the upper limit for the remuneration level is set at rates well below those for PROINFA projects.

[5] [Programa de Incentivo às Fontes Alternativas de Energia Elétrica]
[6] [Programa Nacional de Universalização do Acesso e Uso da Energia Elétrica - Luz Para Todos]

Renewable heat (RES-H) Market

Figure 4. Total RES-H Production, 1990-2005



NB: Solar thermal includes direct final use.

Source: Weiss *et al.* (2007)

Information on renewable heat in Brazil is limited. According to a report of the IEA Solar Heating & Cooling Programme around 2.7 million m^2 of solar thermal collectors for hot water, space and swimming pool heating have been installed at the end of 2005. Of these around 390,000 m^2 have been installed annually in 2004 and 2005. On average installed capacities grew by 31% annually over the 6 year period. The total operational solar thermal systems provided an estimated 4,270 TJ of renewable heat in 2005 (Weiss *et al*, 2007).

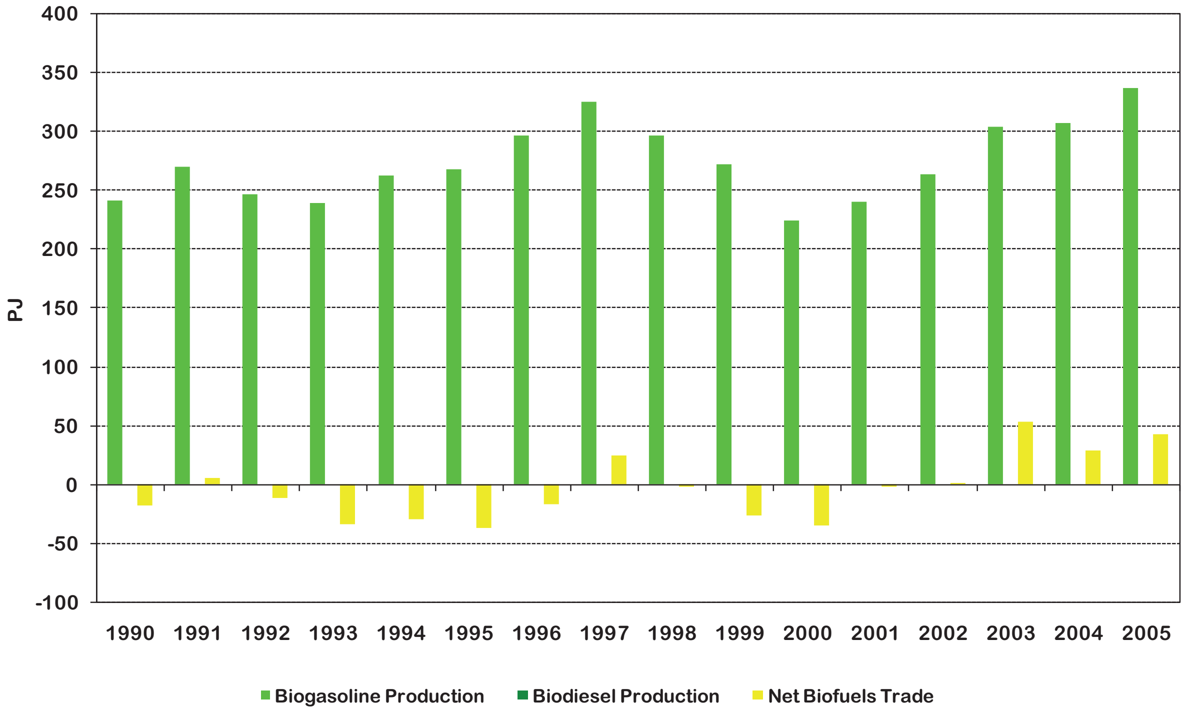
Water is commonly heated by simple, inexpensive electricity continuous-flow heaters leading to high electricity peaks in the morning and evening. Despite the high availability of the solar irradiation all year round, solar thermal applications are far from being widely introduced. Some power supply companies are beginning efforts on the installation of relatively simple systems in poor areas where electricity is often not being paid. Costs are covered by budgets that have to be spent on efficiency measures according to current regulations (GTZ, 2007).

Other actors showing increased interest in solar thermal water heating systems are individual municipalities, some, such as in Brazil's largest city São Paulo, having launched regional initiatives to promote the use of such systems (GTZ, 2007; REN21, 2008).

Renewable Transport Fuel (RES-T) Market

RES-T Market Developments

Figure 5. Total RES-T Production, 1990-2005



NB: Net Biofuels Trade refers to the balance of domestic biofuel consumption, i.e. biofuel exports subtracted from imports.

Source: Huacuz and Medrano (2007b)

Brazil is the world's largest producer of biofuels, closely followed by the United States. Its ethanol production was around 337 PJ in 2005. Since 1990, production increased on average by 2.2% annually from 242 PJ. Biofuel consumption was 294 PJ in 2005 and 260 PJ in 1990 representing an average increase of only 0.8%. Consumption peaked in 1996 at 314 PJ, 6% of which was imported, and dropped to 243 PJ in 2001.

During the 1990s, Brazil was a major importer of biofuels. During that decade, more than 5% of total ethanol consumption was imported, equalling net imports of 147 PJ. However, due to increased biofuel consumption and favourable policies for biofuel use in other countries Brazil has become a net exporter of biofuels in recent years. Net exports for the period 2001 to 2005 were estimated to be in the range of 124-156 PJ, representing 8.6% to 9.8% of total domestic biofuel production.

By the end of 2006, 325 ethanol plants were operational throughout the country and 86 new plants were under construction.[7]

Increases in production for export have intensified discussions about the sustainability of ethanol production in Brazil. Questions regarding the greenhouse gas (CO_2) savings effect of ethanol, competition of energy with food crops for available arable land, potential deforestation, and environmental effects of the use of agrochemicals as well as questions regarding labour conditions have been raised. A Dutch study assessing Brazilian ethanol production with respect to a set of sustainability criteria has found “no prohibitive reasons […] why ethanol from São Paolo principally could not meet the Dutch sustainability standards” (Smeets *et al.*, 2006). Other counterarguments include that the production of sugar cane involves low levels of pesticide use, little soil erosion, has little or no negative impact on water resources, recycles all of its wastes and accounts for the largest share of organic crop plantation in Brazil (GBEP, 2007).

In Brazil, 3.5 millions cars run on pure (hydrated) ethanol. In addition, all of the gasoline used in Brazil is blended with at least 20% (anhydrous) ethanol. Pure ethanol-fuelled cars have been sold since 1979 and, since 2003, so called flex-fuel cars that can be used with any mixture of gasoline and ethanol are available on the market. The exact obligatory blending quota can range between 20% and 26% and is set by the Inter-Ministerial Board for Sugar and Ethanol[8].

In 2004, ethanol accounted for 15.4% of the total transport fuel consumption in Brazil. More than half of all ethanol (8.8%) was used as blend for gasoline, the remainder for pure use. Ethanol blended gasoline accounted for 35.3% of total transport fuels, but the major fuel was diesel with 55.7% (Román, 2007).

Development of Renewable Transport Fuel Policies

Although Brazilian experience with biofuels dates back to the 1920s, the first and most prominent large scale programme to foster the use of ethanol as automotive fuel (ProÁlcool, National Alcohol Programme[9]) was established in 1975 after the first oil crisis. It was designed to foster the production of ethanol fuel from sugar cane, introduce gasoline blended with high volumes of alcohol, and incentivise development and production of suitable vehicles to run on alcohol. Sales of gasoline cars that are powered by the gasoline-ethanol blend rose until 1979 to 905,706 cars annually.

The period from 1979 to 1989 is argued to have seen the peak of ProÁlcool, since incentives were adapted “benefiting everyone from ethanol producers to final customers” (GBEP, 2007). Starting in 1979, the sales of ethanol-only cars rose sharply to a peak sales figure of 697,050 cars in 1986. However, a drop in oil prices and an increase in sugar prices lead to serious scarcity of ethanol supply in Brazil undermining consumer confidence and, thus, sales of ethanol-only cars.

[7] Huacuz & Medrano, 2007b
[8] The Brazilian acronym is “CIAA”.
[9] [Programa Nacional do Álcool]

In the 1990s, there was a trend of deregulating the ethanol market and, as a result of lower oil prices, production, distribution and sales activities were gradually transferred to the private sector. With the end of the subsidies sales of ethanol-only cars decreased to 12,000 only in 1996 representing some 0.5% of total car sales in contrast to the former shares of 95%. However, blending quotas were still in effect.

Since 2000, ethanol production was increasingly influenced by market mechanisms rather than policies. During this period ethanol-related industries underwent structural changes and modernization that eventually lead to today's internationally competitive ethanol prices in Brazil. Today, the ethanol industry "generates around one million direct jobs, and six million indirect jobs." (GBEP, 2007). The introduction of the flex-fuel car in 2003 notably changed market conditions. Flex-fuel cars now account for 77% of total cars and commercial light vehicle sales (Román, 2007).

Due to the high shares of diesel in the transport sector and the preceding success with the ProÁlcool Programme, the Brazilian government introduced the National Biodiesel Production and Use Programme (PNPB)[10] in 2003. It targets a sustainable implementation of biodiesel production with strong emphasis on social benefits and regional development by means of job creation and income generation. The PNBP was implemented through Law No. 11097 which introduced a blending quota of 2% for the period from 2005 to 2012 that is intended to become obligatory from 2008 onwards. For 2013 the obligatory quota will be 5%. In order to reach the 2008 target, annual production has to reach an estimated 820 million litres (corresponding to approximately 28 PJ[11]) by the beginning of 2008, which is expected to be achieved or even surpassed according to current government statements (GBEP, 2007). The ultimate target for 2020 is to reach a 20% blending quota (Román, 2007).

Besides blending quotas, the government has established a preferential credit line with the National Programme to Promote Household Agriculture (PRONAF)[12] that allows small farmers to invest at low interest rates. Furthermore a number of tax incentives depending on different criteria in relation to the development goals that are linked to the programme.

The social approach has further been strengthened by a subsequent modification of the corresponding Law No. 11.097. A "Social Seal" is granted to producers promoting social inclusion and regional development by the Ministry of Agriculture. These biodiesel producers are eligible for an additional amount of financial support by the BNDES. Furthermore, their biodiesel can be sold through public auctions set up by the ANP, thereby increasing the producers' profit margin.

Despite the social benefits the programme as been criticised for impeding large-scale production at low costs that could make biodiesel competitive. In other words, social ambitions of the PNBP and the necessary economies of scale needed for cost reductions and broad deployment of biodiesel are supposed to be somewhat contradictory (Román, 2007).

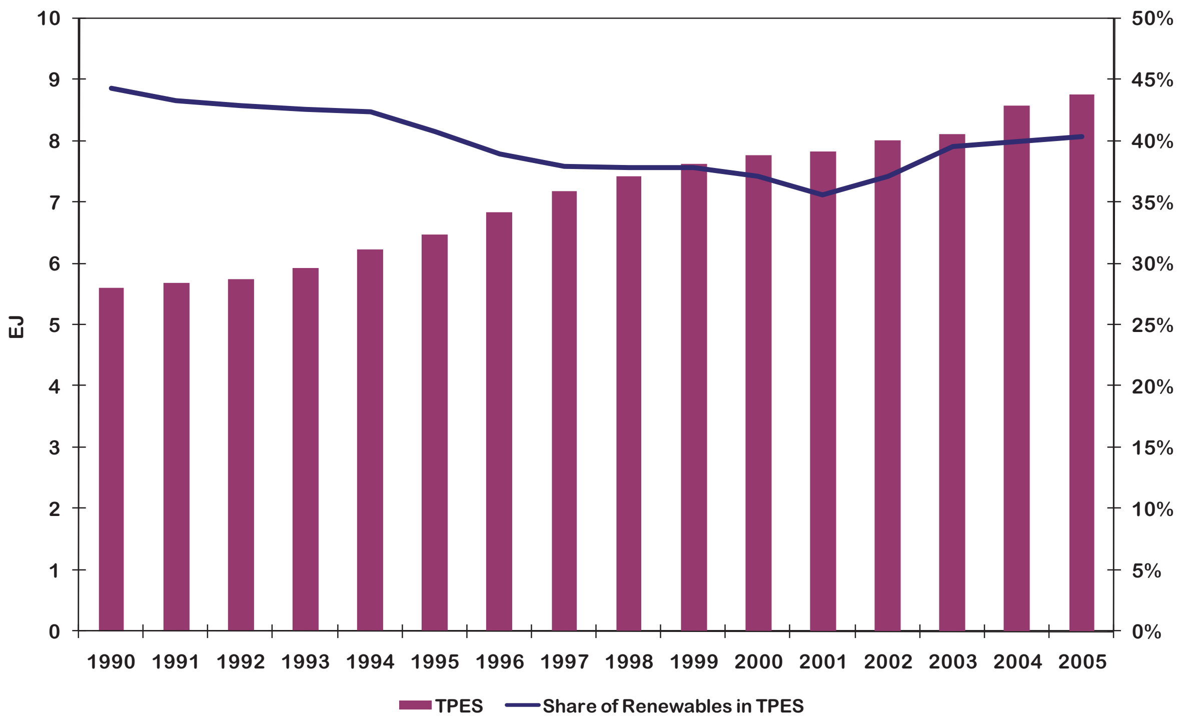
[10] [Programa Nacional de Produção e Uso de Biodiesel]
[11] For the applied biofuel conversion factors, refer to the Glossary which can be found after the country profiles.
[12] [Programa Nacional de Fortalecimento da Agricultura Familiar]

Research, Development and Demonstration Trends

No data was available on Brazil's public R&D funding for energy technologies. The IEA does not collect such data for Brazil.

Renewables in Total Primary Energy Supply[13]

Figure 6. Share of Renewable Energy in Total Primary Energy Supply, 1990-2005



Source: IEA (2007)

Total primary energy supply (TPES) in Brazil grew from 5.6 EJ in 1990 by an average 3% per annum to 8.8 EJ in 2005. During this period of time, the share of renewables decreased from its initial 44.3% to 35.6% in 2001. However, the renewable share increased again after 2001 to 40.4% in 2005. In comparison, the share of renewables in TPES in non-OECD

[13] The official IEA statistics on TPES include, where applicable, traditional biomass but exclude pumped hydro.

Primary energy convention: The IEA uses the **physical energy content method** to calculate the primary energy equivalent of non-combustible energy sources, such as geothermal, hydro, solar and wind. As a consequence, there is an obvious link between the principles adopted in defining the primary energy forms of energy sources and the primary energy equivalent of these sources. For instance, in the case solar thermal and geothermal electricity production, as heat is the primary energy form selected by the IEA, the primary energy equivalent is the quantity of heat generated in the geothermal or solar thermal plant for electricity generation. In the case of hydro, wind, tide and solar PV, as electricity is the primary energy form selected, the primary energy equivalent is the physical energy content of the electricity generated in the plant, which amounts to assuming an efficiency of 100%. Readers may consult (IEA, 2007) for more details.

countries is 19.5% in 2005 and in OECD countries only 6.2%. Thus, the Brazilian energy system is already one of the least carbon-intensive in the world.

13.9% of Brazilian TPES stems from hydropower, 26.5% from other renewables. According to a report of the Global Bioenergy Partnership, 14.5% of TPES stems from sugar cane. Thus, the majority of "other renewables" can be attributed to energy from sugar cane. In general, the shift from traditional to modern biomass limits the overall growth of total biomass supplied energy.

Non-renewable TPES in Brazil is to a large extent supplied by oil accounting for 42.2% of TPES, coal (7%), gas (8%) and nuclear (1%).

Renewable Energy Policy Information

For further details on renewable energy support policies implemented in Brazil, readers may consult the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

Glossary

Definitions, abbreviations, acronyms and units are explained in the Glossary which can be found after the country profiles.

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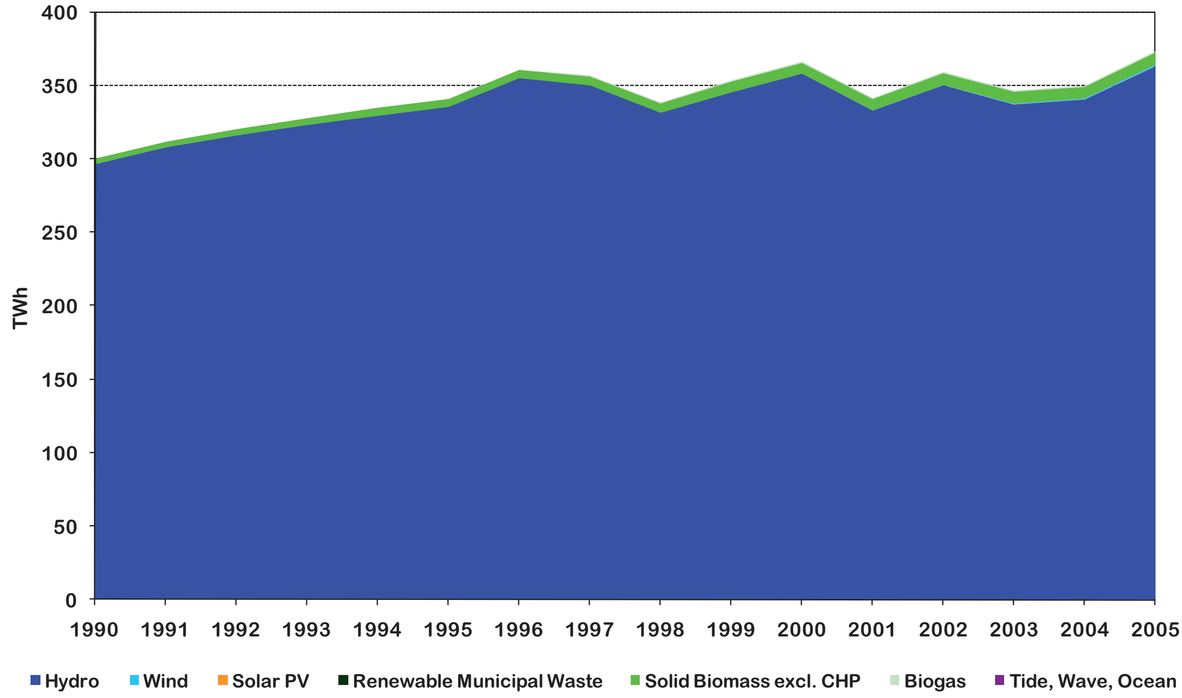
CANADA[1]

RENEWABLE ELECTRICITY (RES-E) MARKET

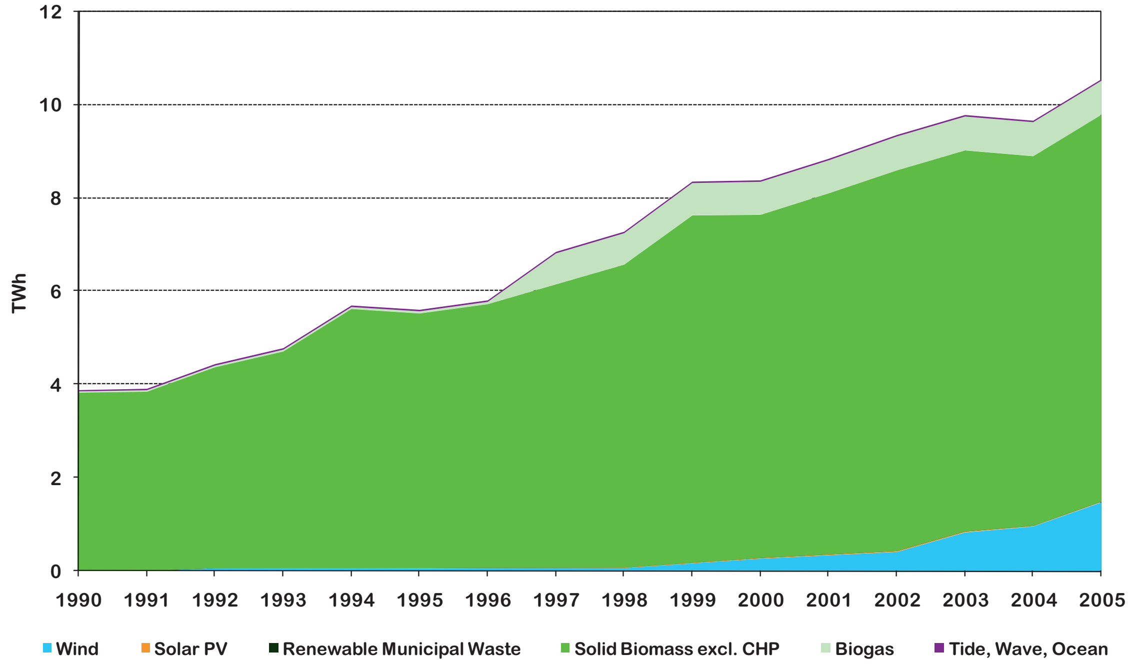
Figure 9. Total RES-E Production, 1990-2005



Source: IEA (2007a)

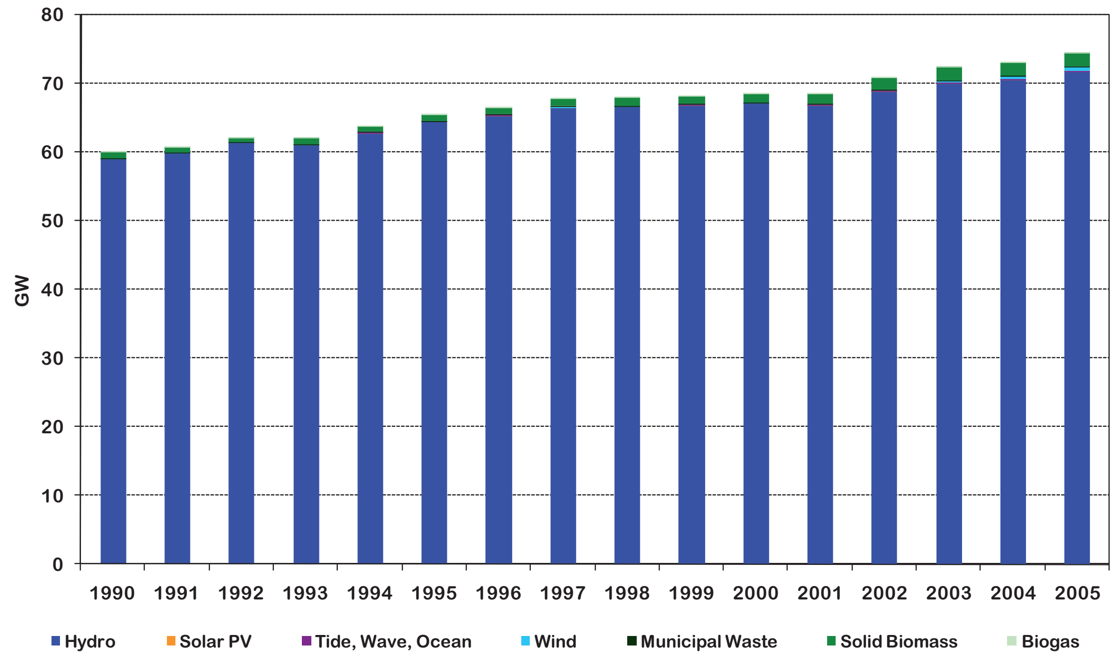
[1] A summary profile was prepared of Canada's renewable energy **market** developments from 1990 to 2005. Policy developments are available in the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

Figure 10. Total RES-E Production (excluding Hydropower), 1990-2005



Source: IEA (2007a)

Figure 3. Net Generating Capacity of RES-E Plants, 1990-2005

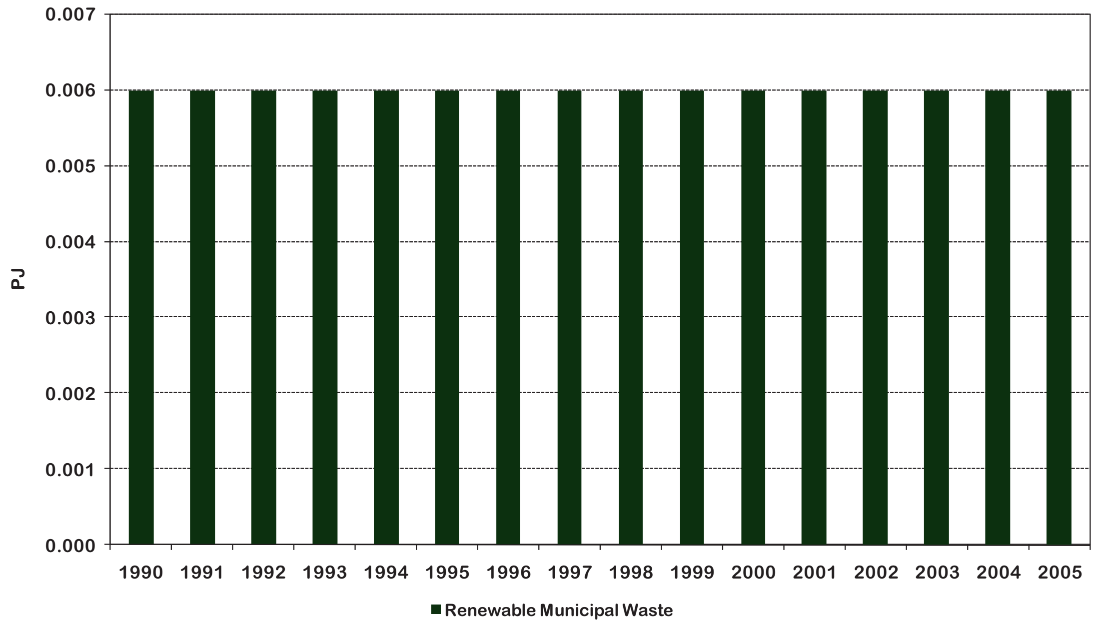


NB: Official IEA statistics on electricity generating capacity do not differentiate between *renewable* and *non-renewable* municipal waste.

Source: IEA (2007a)

RENEWABLE HEAT (RES-H) MARKET

Figure 4. Total RES-H Production, 1990-2005[2]

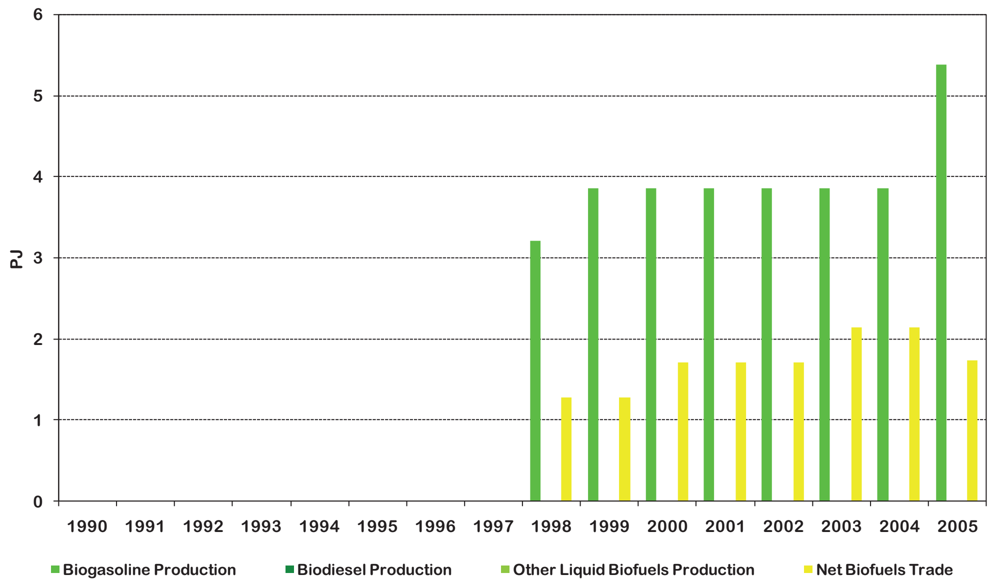


Source: IEA (2007a)

[2] Official IEA statistics on heat generation from renewable energy sources relate to **commercial heat sold** with additional data on **direct use** of solar thermal and geothermal available for most OECD countries.

Renewable Transport Fuel (RES-T) Market

Figure 5. Total RES-T Production, 1990-2005

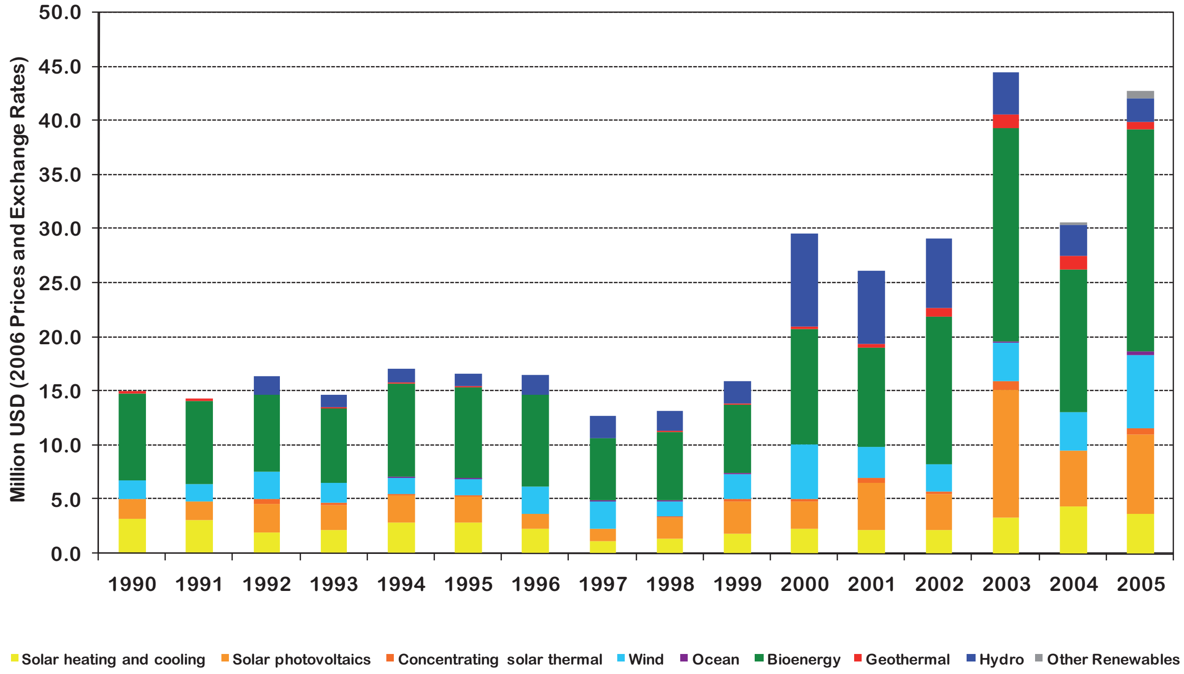


NB: Net Biofuels Trade refers to the balance of domestic biofuel consumption, i.e. biofuel exports subtracted from imports.

Source: IEA (2007a)

Research, Development and Demonstration Trends

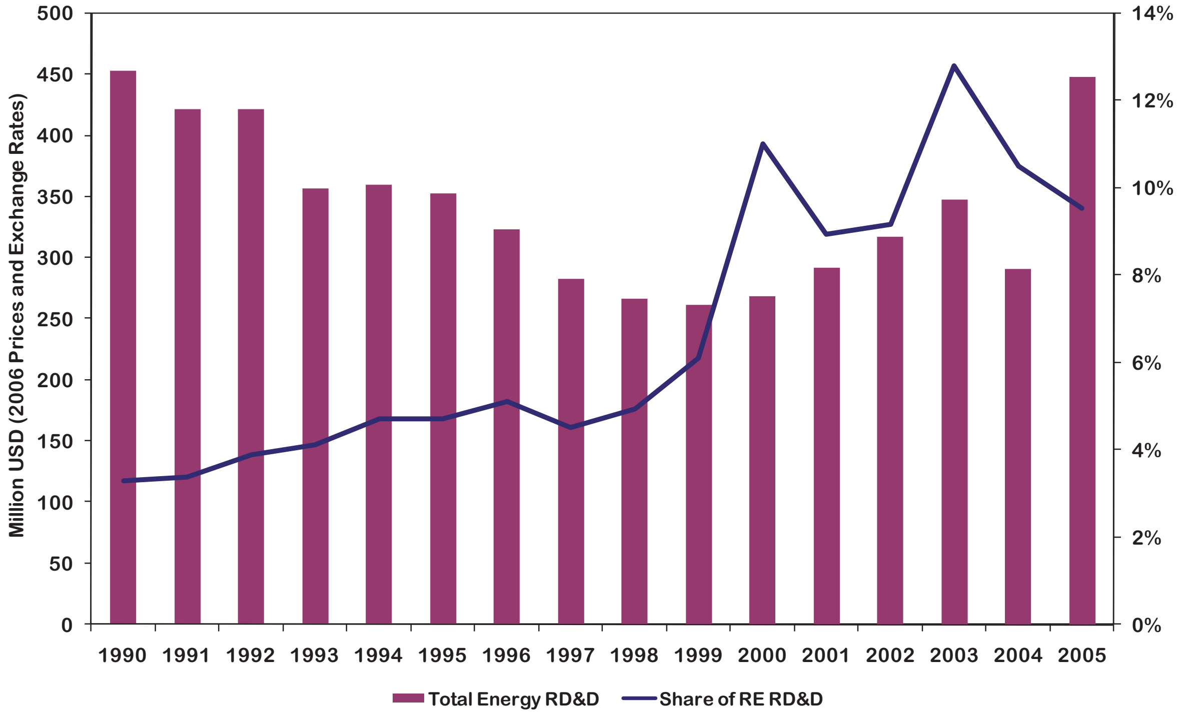
Figure 6. Annual Government RD&D Spending on Renewables, 1990-2005 (USD 2006 prices and exchange rates)[3]



Source: IEA (2007b)

[3] Official IEA data on energy RD&D budgets include only **government** funding and not **private** RD&D spending.

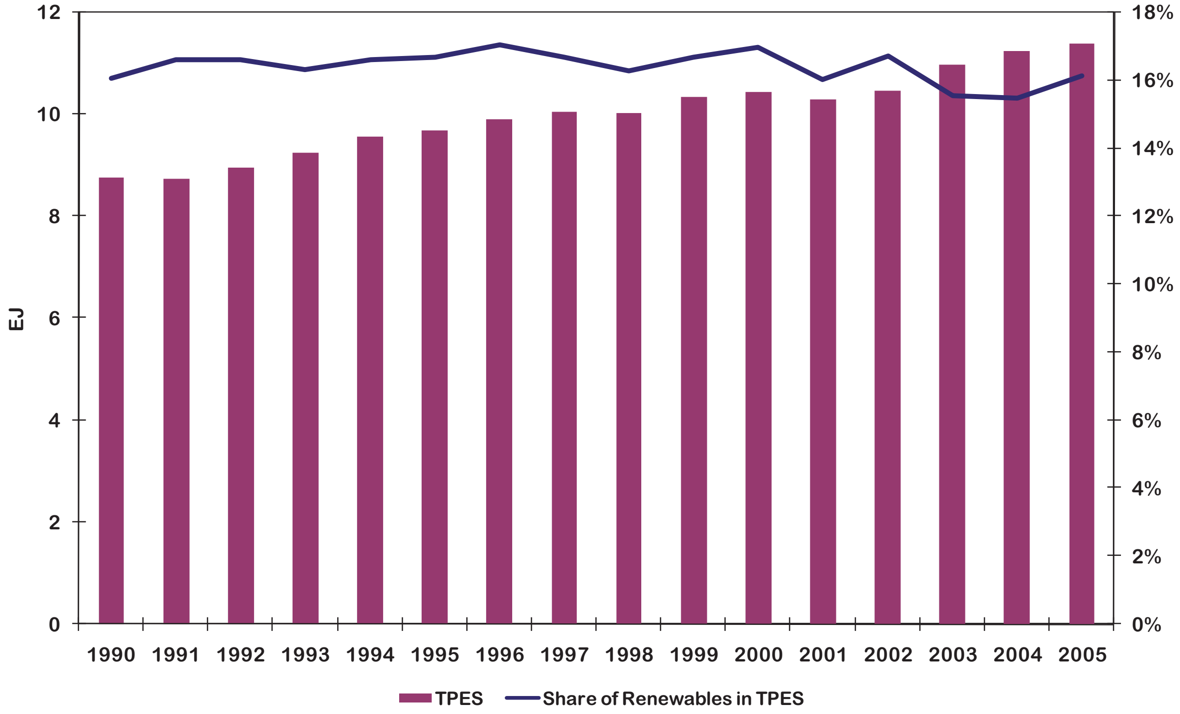
Figure 7. Renewable energy RD&D versus total government energy RD&D spending, 1990-2005



Source: IEA (2007b)

RENEWABLES IN TOTAL PRIMARY ENERGY SUPPLY[4]

Figure 8. Share of Renewable Energy in Total Primary Energy Supply, 1990-2005



Source: IEA (2007a)

RENEWABLE ENERGY POLICY INFORMATION

For details on renewable energy support policies implemented in Canada, readers may consult the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

[4] The official IEA statistics on TPES include, where applicable, traditional biomass but exclude pumped hydro.
Primary energy convention: The IEA uses the **physical energy content method** to calculate the primary energy equivalent of non-combustible energy sources, such as geothermal, hydro, solar and wind. As a consequence, there is an obvious link between the principles adopted in defining the primary energy forms of energy sources and the primary energy equivalent of these sources. For instance, in the case solar thermal and geothermal electricity production, as heat is the primary energy form selected by the IEA, the primary energy equivalent is the quantity of heat generated in the geothermal or solar thermal plant for electricity generation. In the case of hydro, wind, tide and solar PV, as electricity is the primary energy form selected, the primary energy equivalent is the physical energy content of the electricity generated in the plant, which amounts to assuming an efficiency of 100%. Readers may consult (IEA, 2007a) for more details.

Glossary

Definitions, abbreviations, acronyms and units are explained in the Glossary which can be found after the country profiles.

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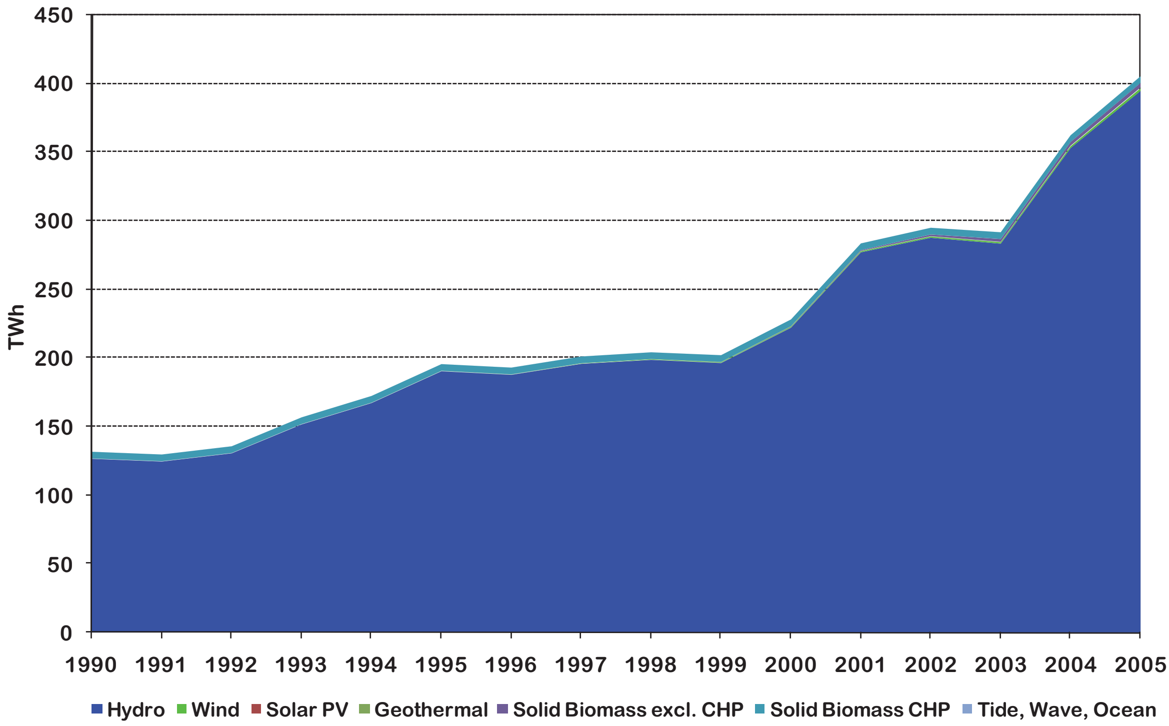
CHINA

RENEWABLE ELECTRICITY (RES-E) MARKET

RES-E Market Developments

Figure 1. Total RES-E Production, 1990-2005

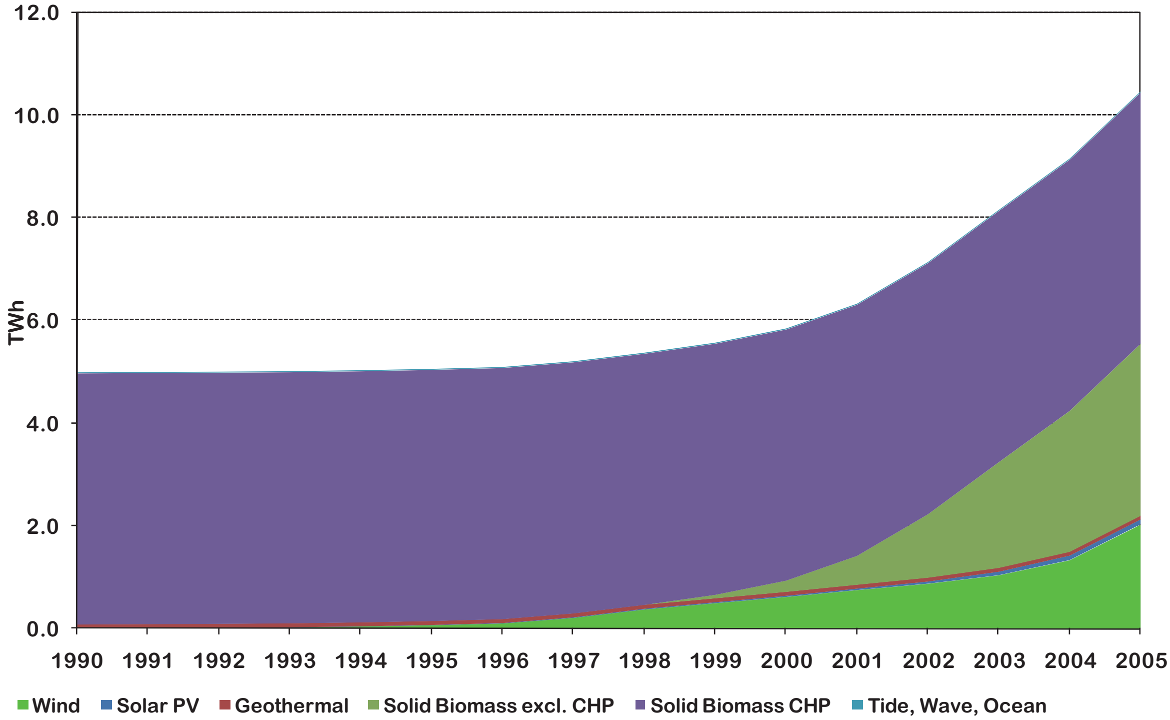


Source: Li *et al.* (2007)

In 2006, China's supply of renewable electricity (RES-E) amounted to 430 TWh representing 18.4% of the country's total electricity supply or 13.1% of the world's total renewable electricity supply. RES-E increased at an average annual rate of 8% over the period 1990 to 2006.

The lion's share of RES-E stems from hydropower, which remained largely unchanged over the whole period at around 97% of total electricity generation from renewables. Thus, overall development of renewable power and hydropower growth patterns are very similar. The steep rise in hydropower production in 2004 can be attributed to a large extent to additional generation from the Three Gorges Dam, which produced around 30 TWh of electricity in 2004, more than 40% of the annual increase in production from hydro projects compared to 2003. However, seasonal climatic fluctuations have a strong impact on total generation from hydropower. From 1995 to 1999, new hydropower sites were continuously developed without major peaks or drops in capacity growth (Figure 3). Nevertheless, it was not before 2000 and 2001 that production followed suit.

Figure 11. Total RES-E Production (excluding Hydropower), 1990-2005



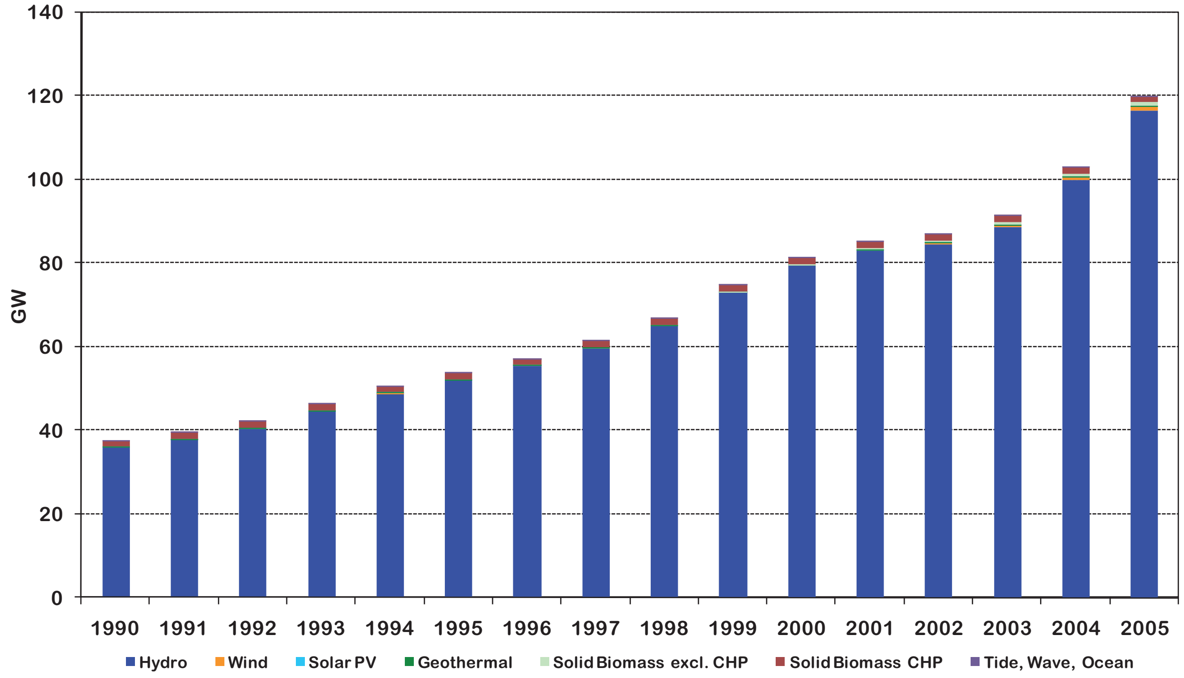
Source: Li *et al.* (2007)

The second-largest source of RES-E is solid biomass with 9 TWh in 2006, although its share decreased from 4% in 1990 to 2% in 2006. Generation from solid biomass CHP stayed constant at 4.9 TWh over the whole period from 1990 to 2005, but non-CHP biomass power production increased from around 69 GWh in 1999 to 3.9 TWh in 2006, resulting in 8.9 TWh of electricity from total biomass utilisation.

Wind power showed the most rapid growth in China's RE markets increasing with a 60% average annual growth rate resulting in 3.9 TWh of production in 2006. This amounts to one percent of total RES-E in 2006.

Wind was followed in terms of growth by solar PV which increased by 26% on average over the period. However, until 2006 total wind and solar PV electricity supply have only reached 3.9 TWh and 105 GWh respectively, leaving a large fraction of the country's potential untapped. But China has also become the third largest producer of solar cells with substantial manufacturing capacities, accounting for 15.1% of global PV cell production in 2006 already, thereby offering big potential for the further increase of domestic installations.

Figure 3. Net Generating Capacity of RES-E Plants, 1990-2005



Source: Li *et al.* (2007)

Development of Renewable Electricity Policies

The Renewable Energy Law (RE Law) of the People's Republic of China, which has become effective as of 1st January 2006, can be considered the first attempt to implement a comprehensive, national framework including explicit renewable energy targets. Therefore, it may have strong influence on the further development of renewable energy technologies in China and their market diffusion. However, this policy framework has to be considered in the wider context of the Chinese energy sector.

Until 2002, the country's power generation, transmission and distribution sector was integrated and operated by the State Power Corporation of China. Market liberalisation has begun in 2002 with a division of the former state monopoly that controlled 46% of the country's generation assets into two grid operators and five national electricity generators, all of which are still state owned. Private companies are allowed to invest in the power generation sector since the 1980s already, although subject to a number of regulations especially for foreign investors.

Electricity prices, both wholesale and retail prices, are still controlled by the National Development and Reform Commission (NDRC), which introduced price adjustment possibilities according to coal price developments in order to allow for demand side management. However, renewable as well as conventional power prices are not cost-oriented but largely policy-driven.

One of the **overall goals** of the RE Law is to increase the share of renewables in TPES to 10% in 2010 and 15% in 2020. It further details technology-specific power generation targets as set out in table 1.

Table 1. Renewable Energy Targets for Power Generation in China

	Level in 2005	Target 2010	Target 2020	Financial Support for RE
Hydro	116.52 GW	190 GW	300 GW	No premium pricing
Biomass	2.37 GW (of which biomass CHP: 1.7 GW)	5.5 GW	30 GW	Feed-in premium (CNY 0.25/ kWh)
Biogas	9 billion m^3	19.0 billion m^3	44 billion m^3	
Wind	1.264 GW	5 GW	30 GW	Competitive tendering
Solar PV	0.07 GW	0.3 GW	1.8 GW	Feed-in tariff based on reasonable production costs and profit (government-approved price)

Source: Li *et al.* (2007)

To reach these overall targets, the RE Law makes grid connection for renewable energy producers compulsory, sets out technology-specific power pricing regimes, and guidelines for the burden sharing of additional costs of renewable power generation.

The obligation of utilities to connect renewable energy facilities to the grid extends to the construction of new grid connections and related technical support. However, it is argued that there are no incentives for grid companies to connect renewable energy generators to the electricity grid and that a number of problems hinder the implementation of this obligation. The process of extending **grid connection** to new RE generators is generally supposed to be rather a matter of negotiation than one of well-defined procedures. In particular transmission networks are not designed in a way that takes into account the integration of large-scale RE facilities, and grid controllers lack training to develop systems for the management of such forms of power generation.

The **power price regimes** comprise feed-in tariffs for biomass as well as solar PV and solar thermal electricity production. Wind power projects are priced according to a tendering process. Other technologies featured by the RE Law, i.e. wave, hydro and geothermal power, have not yet been assigned to particular pricing regimes, but are still in the phase of methodological assessment

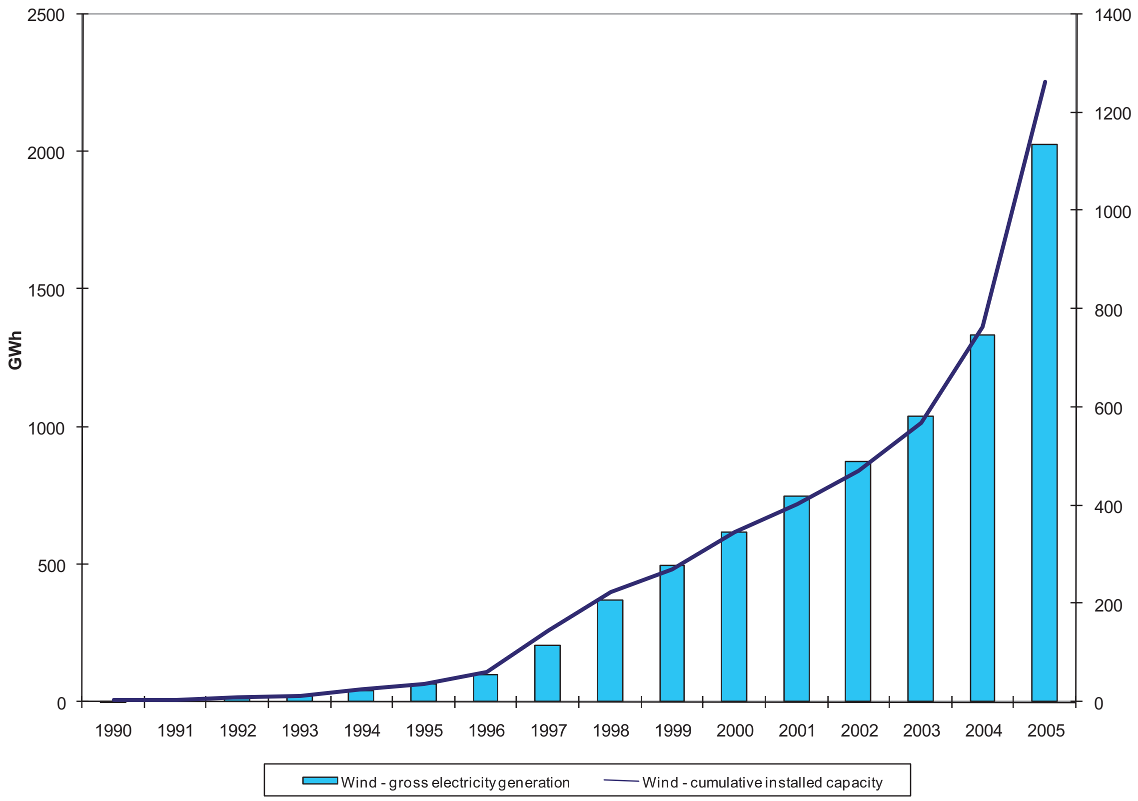
Tariffs for electricity from **biomass** are calculated as the province-specific price of power from desulphurised coal plus a decreasing standard premium that will be cancelled after 15 years. Prices paid for electricity from solar PV, however, are only being determined by the State Council on the basis of reasonable production costs plus reasonable profit after a project has been approved by the government. Thus, **feed-in tariffs** for **solar PV** include two major sources of uncertainty for potential investors, one being the general approval and the other being the resulting profit margin. The reasoning behind this multi-stage approach is that high costs of solar PV in China would result in high government expenditures if a guaranteed-margin system was to be set up.

The **tendering system for wind power** has led to extremely low prices resulting in a low number of contracts actually being implemented and the use of low quality equipment that increases the risk of operation. However, tenders have been favoured by the Chinese government over a coal price-related feed-in tariff due to a disparity in regional coal prices and wind energy potentials, i.e. in such a feed-in system high coal prices in southern parts would distract wind power investments from areas where major wind resources are located.

Additional incentives for the diffusion of RE that are currently being established under the umbrella of the Chinese RE Law include preferential tax treatment, low-interest loans, and preferential tariffs. Foreign investment dedicated to the construction and operation of renewable energy projects belongs to the class of "encouraged industries", i.e. it is in the Chinese government's interest to lower entry barriers for such investments. However, local content requirements are very substantial, e.g. 70% of wind turbine production must be located domestically (IEA, 2008).

Focus: Wind Power Development

Figure 4. Wind Power Development, 1990-2005



Source: Li *et al.* (2007)

As outlined above and indicated by Figure 4, **wind energy** has seen a comparatively strong, but unsteady growth over the period from 1990 to 2005. Cumulative installed wind power capacity was 1.3 GW by the end of 2005, while the government aims to have 30 GW capacity installed by 2020. During 2006, capacities of installed wind power were more than doubled to 2.6 GW. With approximately 1.3 GW of additionally installed wind power capacity in 2006, China ranked among the world's top five countries. Until now, a series of different measures and regulations have been used to promote the use of grid-connected wind energy generation.

In the early 1990s, wind power equipment were fully exempt from **custom duties**, in 1996 tariffs of 12% and 3% were imposed on wind turbine units and major components, respectively, until tariffs on turbines were cancelled again two years later in 1998. In 1994 power generated by grid-connected wind farms was guaranteed to be purchased by the local utility with prices set such that all costs were covered while also generating a profit. However, this policy came to an end in 1998. In 2002, the rate of **VAT** was reduced from 17% to 8.5%. To further increase the attractiveness of wind energy projects in China the **income tax** for wind projects was reduced from 33% to 15%.

Other measures included preferential loans for wind power projects, provided that equipment was of domestic origin.

In 2003, China began a policy of **wind concessions** for large projects with a minimum capacity of 100 MW at government-selected sites that are auctioned off through a competitive bidding process. 11 bidding rounds with a target capacity of 2 450 MW have been accomplished until 2006. A fifth bidding round has been announced by government officials targeting at an additional 1 000-1 500 MW generation capacity. However, not all projects of former bidding rounds have been implemented so far – around 2 000 MW in mid 2007 with some projects still under development. According to the Chinese Renewable Energy Industry Association (CREIA) the implementation of awarded contracts is often hampered due to a lack of clearly defined timelines, procedures, standards and costs of the grid connection process.

Wind power projects rated below a certain threshold of 50 MW were within the sphere of responsibility of the provincial governments until 2002, i.e. they did not need the national governments approval. However, under the current framework it remains unclear whether such projects' tariffs have to be determined in a bidding process as well.

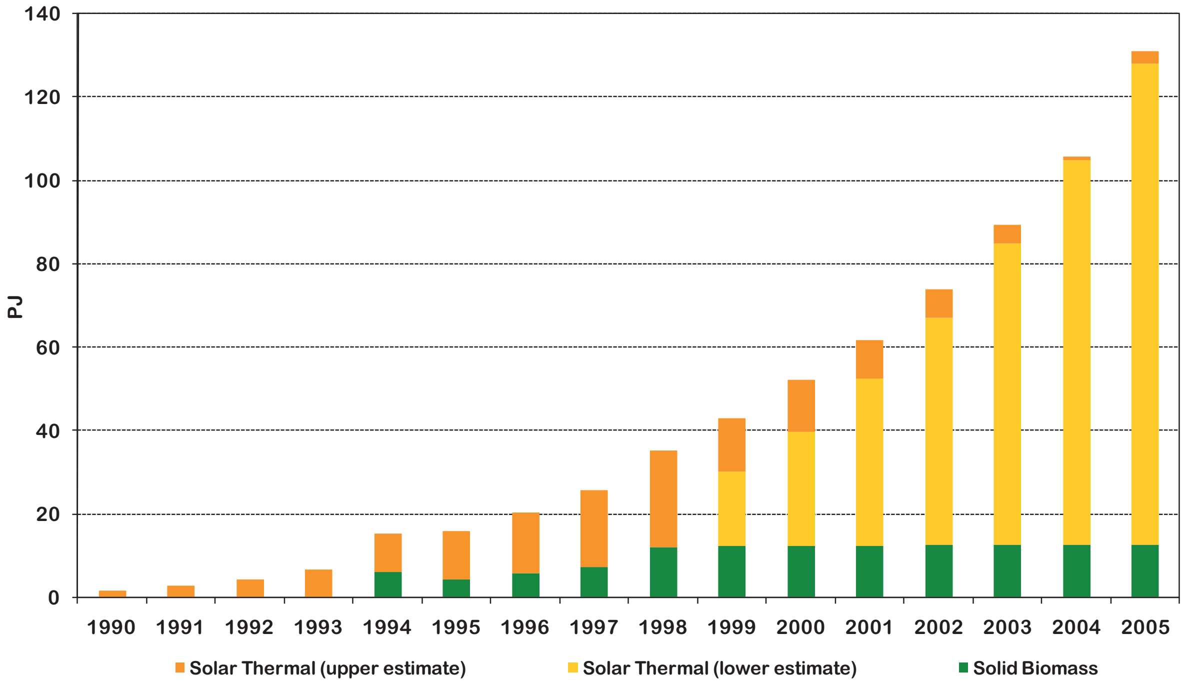
Wind power concessions are granted for **25 years** based on the economic life of the project. However, the concession tariff applies only to the first 30 000 full load operation hours or the equivalent, which could be 12-15 years for a 100 MW project. Thereafter, local non-concessional grid tariffs would apply.

In selecting the winning projects under these concessions, **local content percentages** (above the minimum standards of 50-70%) are a key determinant of the evaluation – and are responsible for 35% of the score used in evaluating bids in 2006, up from 20%.

The **bid evaluation criteria** were changed in 2005; notably, the bid evaluation weighting assigned to price was reduced from 40% to 30% as a reaction to very low profit margins that impede investments. Foreign investments that are distracted by such regulations could contribute to transfer of latest technological advancements and further boost wind energy development in China.

RENEWABLE HEAT (RES-H) MARKET

Figure 5. Total RES-H Production, 1990-2005



NB: Solar thermal and geothermal include direct final use.

Source: IEA (2007); Li *et al.* (2007); Weiss *et al.* (2007)

Solar thermal heat captures the lion's share of the renewable heat market in China. In 2005, solar thermal heat supply was approximately 115-118 PJ, representing 90% of total renewable heat. Biomass supplied heat has not grown since 1998, stagnating at around 12 PJ. Thus, the share of biomass heat dropped from approximately one third at the end 1990s to no more than 10% in 2005.

With an annual production of 15 million m² of solar thermal collectors at an estimated annual value of EUR 1.495 billion, the solar thermal market in China is the largest in the world by far (IEA and RETD, 2007).

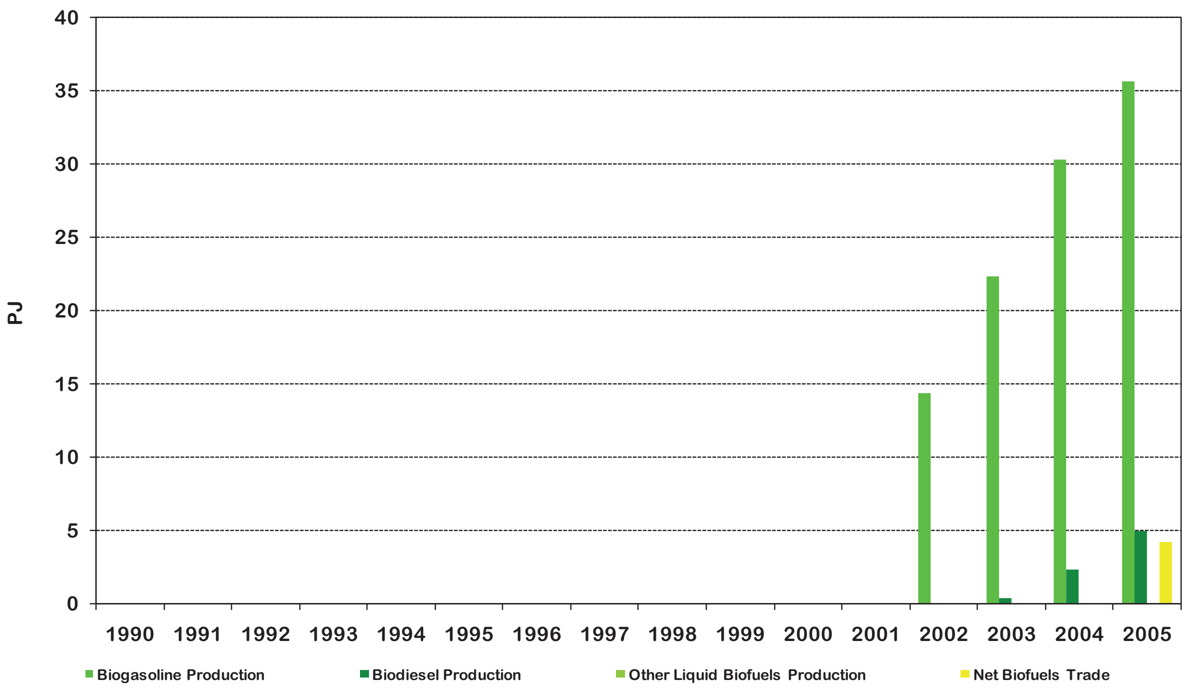
This market has developed since the 1980s with essentially no political backing and continues to have an annual average growth rate of nearly 27% per year. The drivers for solar water heater market penetration include an abundant solar resource in many regions, a lack of reliable conventional heating options, a well-developed domestic manufacturing industry, and changes in population demographics increasing the demand for hot water.

By 2006, the total installed capacity in China reached 100 million m² producing 153.8 PJ of heat (2005: 79.3 million m^2). Over 30 million households utilize solar thermal systems to supply domestic hot water. Installations per capita however remain relatively low. For example, in 2006, China had roughly 69 m^2 of solar thermal surface area installed per 1000 inhabitants whereas Cyprus had 900 m² per 1000 inhabitants and Austria 268 m² per inhabitants (IEA and RETD, 2007).

The RE Law sets out targets for installed solar thermal collector area to reach 150 million m^2 in 2010 and 300 million m^2 in 2020, which is in line with maintaining annual production at current levels (IEA, 2008).

Renewable Transport Fuel (RES-T) Market

Figure 6. Total RES-T Production, 1990-2005



NB: Net Biofuels Trade refers to the balance of domestic biofuel consumption, i.e. biofuel exports subtracted from imports. Data on net biofuels trade (here only **biogasoline trade**) is based on (GBEP, 2007).

Source: Li *et al.* (2007); GBEP (2007)

China is the world's third largest producer of ethanol after the United States and Brazil. In 2005, production of ethanol was equal to 37 PJ, while biodiesel production amounted to almost 5 PJ. In 2006, the level of production of biofuels grew to 43 PJ and more than 7 PJ of biodiesel. China started biofuel production with 15 PJ of ethanol in 2002. Production of biodiesel began in 2003 with 0.4 PJ. Since then, total annual biofuel production grew on average by 30% per year. However, annual additions in production volume have slowed down.

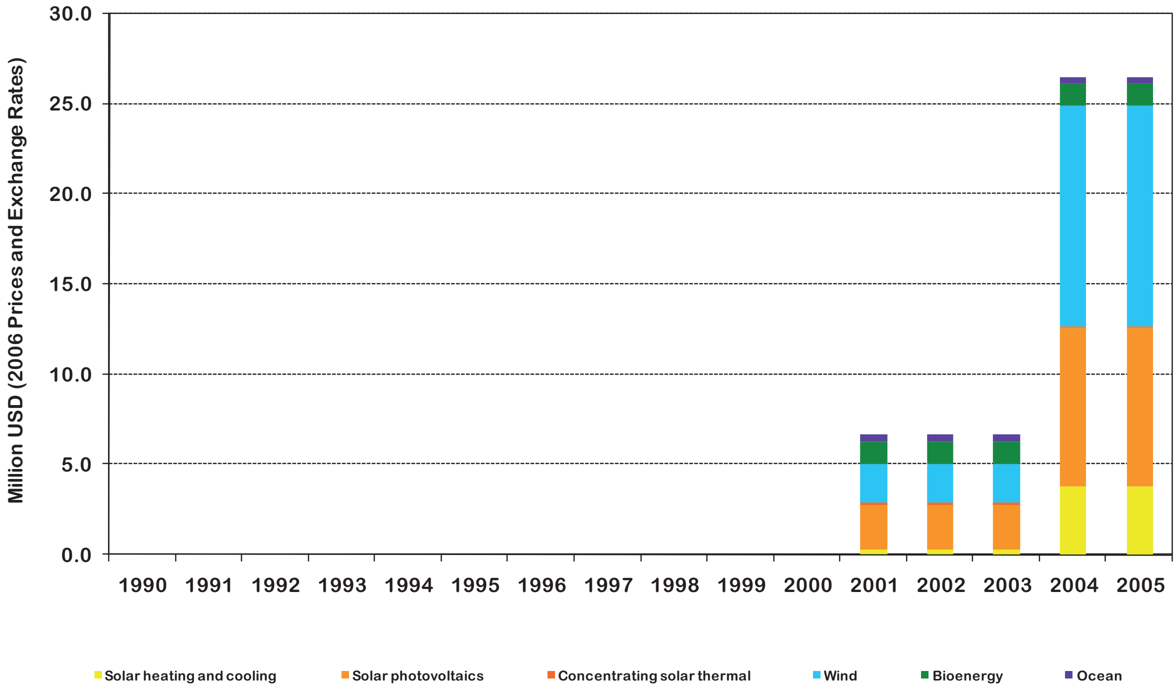
In 2005, an additional 3.8 PJ of biofuels have been exported. In 2006, 24 PJ of ethanol - more than 55% of domestic production - were net exports. This represents 14% of 171 PJ of global ethanol trade volume. As a result domestic ethanol consumption declined by 42% from 2005 to 2006 to a total of 19 PJ. Imports of ethanol were very limited (less than 100 TJ) due to high import duties of 30% on ethanol and restrictive import policies. Biodiesel is currently not imported and no official customs data is available.

The targeted production levels set out in the RE Law amount to 2 million tons of ethanol plus 200,000 tons of biodiesel in 2010 and 10 million tons of ethanol plus 2 million tons of biodiesel in 2020. This represents approximately 55 PJ of ethanol plus 7.6 PJ of biodiesel in 2010 and 276 PJ of ethanol plus 76 PJ of biodiesel in 2020. If annual additions in production remain constant, the 2010 target will easily be met. In order to achieve the level of production envisioned for 2020, however, considerably higher growth rates have to be achieved.

Government subsidies for bioethanol decreased to approximately EUR 137/tonne in 2006 from EUR 180/tonne in 2000, when subsidies were first introduced (GTZ, 2006). Subsidies are planned to be phased out until 2010, since bioethanol is expected to be competitive to fossil fuels by then. Governmental support of bioethanol was organised under the umbrella of the Chinese Fuel Ethanol Programme, including retrofitting of existing alcohol plants, field tests in selected cities, standard-setting, construction of new plants and wider market introduction of E10, a 10% blend of gasoline-ethanol. By mid 2005, five provinces (Heilongjiang, Jilin, Liaoning, Henan and Anhui) had completed the introduction of E10, while 27 other cities decided to take a phased introduction approach (Siang, 2007).

Concerning the use of biodiesel there are neither specific national policy instruments for promoting research and utilization nor have any quality standards on biodiesel been introduced. However, there are examples of support schemes on the regional level, *e.g.* in Hainan province.

Figure 7. Annual Government RD&D Spending on Renewables, 1990-2005 (USD 2006 prices and exchange rates)[1]



NB: Data prior to 2001 are not available.

Source: Li *et al.* (2007)

In the period from 2001 to 2006, China spent a total of approximately USD 113.9 million on public RD&D in the renewable energy sector. More than 75% of the total was spent on solar PV (39%) and wind power (36%). Solar heating and cooling technologies received increased attention from 2004/2005 onwards, averaging 14% of annual RE RD&D expenditures over these two years, while RD&D spending on bioenergy and ocean energy technologies remained constant at approximately USD 1.3 million and USD 0.4 million, respectively, from 2001 to 2005.

Total RE RD&D budgets increased almost four-fold from USD 6.7 million annually in 2001, 2002 and 2003 to USD 26.5 million per year for the following two years. In 2006, RE RD&D budgets increased again to a total of USD 40.8 million, which is more than six times the 2001 budget.

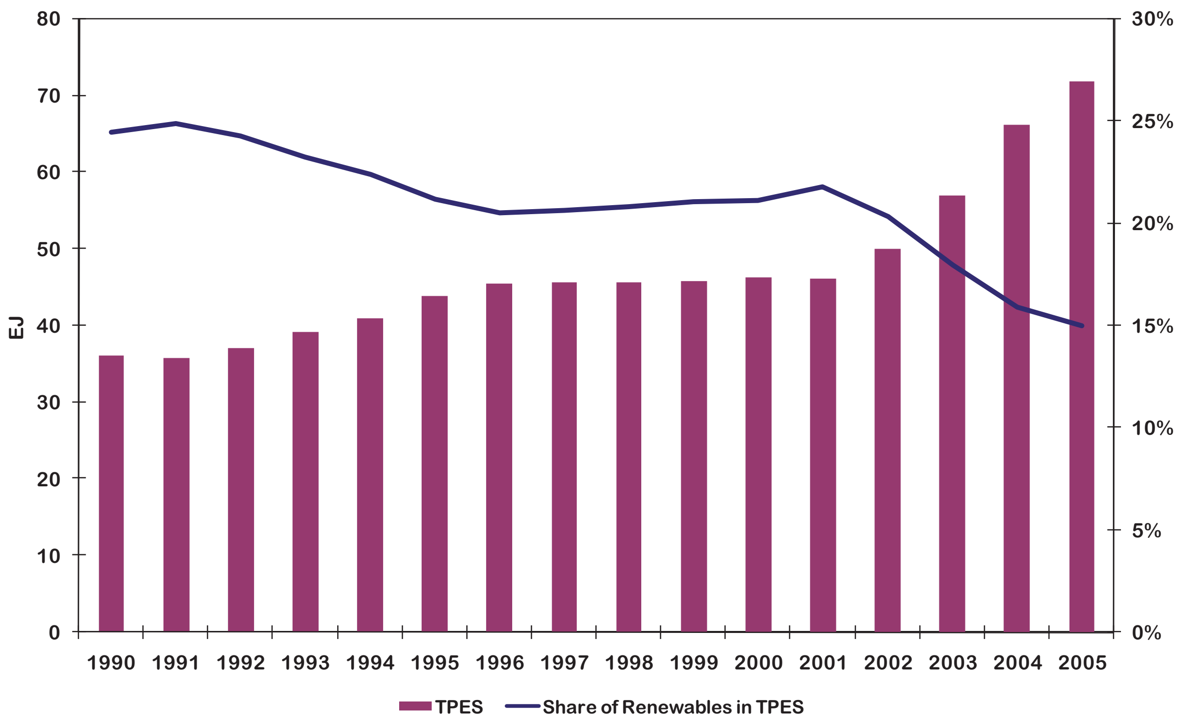
In 2006, spending on solar PV more than doubled to USD 18.9 million (46% of the total RE RD&D budget in 2006), while RD&D budgets on wind decreased slightly to USD 10.7 million (26%). Expenditure on solar heating and cooling was USD 1.9 million in 2006, which is only half the 2005 budget. Solar thermal power received significantly more RD&D financing in

[1] The conversion to USD was at the average 2006 market exchange rate of CNY 1 = USD 0.126.

2006 than before, with an annual budget of USD 3.8 million, which was 30 times the 2005 budget. Spending on ocean energy and bioenergy more than tripled relative to the average 2001-2005 spending, to USD 1.3 million and USD 4.4 million, respectively.

RENEWABLES IN TOTAL PRIMARY ENERGY SUPPLY[2]

Figure 8. Share of Renewable Energy in Total Primary Energy Supply, 1990-2005



Source: IEA (2007)

Total primary energy supply in China was 36 EJ in 1990 and has doubled to 72 EJ in 2005. Despite a slowdown in the mid 1990s, TPES growth has accelerated in recent years.

The share of renewable energy in TPES (including traditional biomass) has declined constantly from 24% in 1990 to 15% in 2005, which is almost exclusively due to a decrease in traditional biomass use.

[2] The official IEA statistics on TPES include, where applicable, traditional biomass but exclude pumped hydro.

Primary energy convention: The IEA uses the **physical energy content method** to calculate the primary energy equivalent of non-combustible energy sources, such as geothermal, hydro, solar and wind. As a consequence, there is an obvious link between the principles adopted in defining the primary energy forms of energy sources and the primary energy equivalent of these sources. For instance, in the case solar thermal and geothermal electricity production, as heat is the primary energy form selected by the IEA, the primary energy equivalent is the quantity of heat generated in the geothermal or solar thermal plant for electricity generation. In the case of hydro, wind, tide and solar PV, as electricity is the primary energy form selected, the primary energy equivalent is the physical energy content of the electricity generated in the plant, which amounts to assuming an efficiency of 100%. Readers may consult (IEA, 2007) for more details.

The share of renewables (excluding traditional biomass) has an overall upwards trend. The absolute contribution of renewables to TPES rose from 1.5 EJ in 1990 to 4.2 EJ in 2005, representing an average annual growth of 34%. The share of renewables in TPES (excluding traditional biomass) was approximately 7% in 2005, up from 5% in 1990.

Renewable Energy Policy Information

For further details on renewable energy support policies implemented in China, readers may consult the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

Glossary

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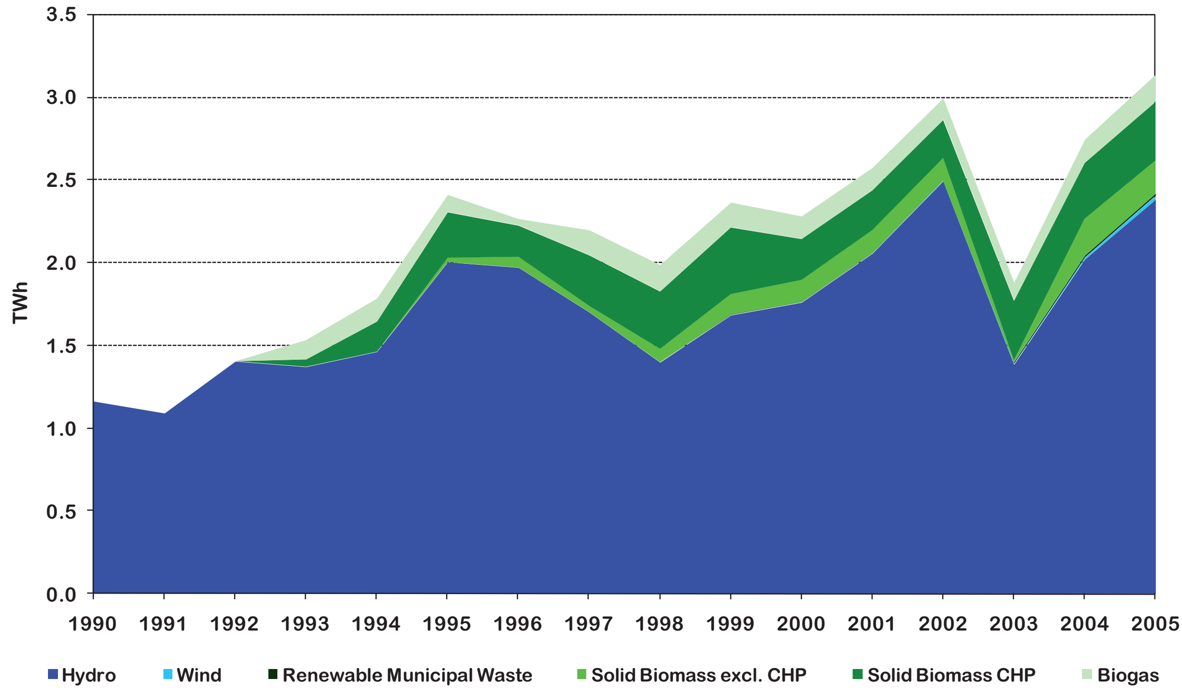
CZECH REPUBLIC[1]

RENEWABLE ELECTRICITY (RES-E) MARKET

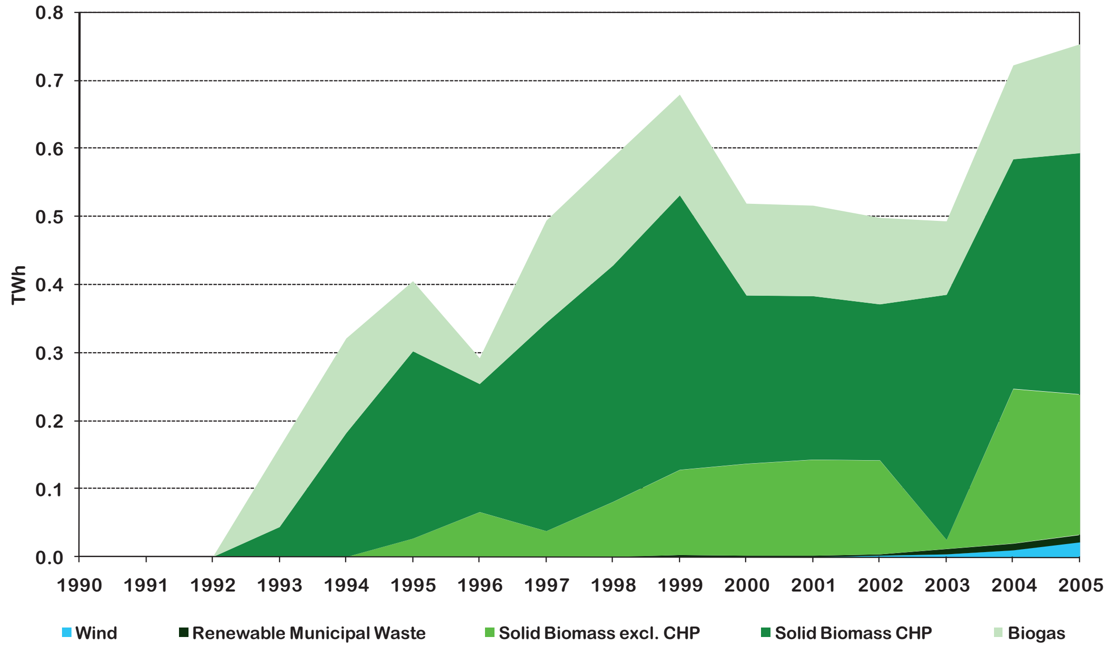
Figure 12. Total RES-E Production, 1990-2005



Source: IEA (2007a)

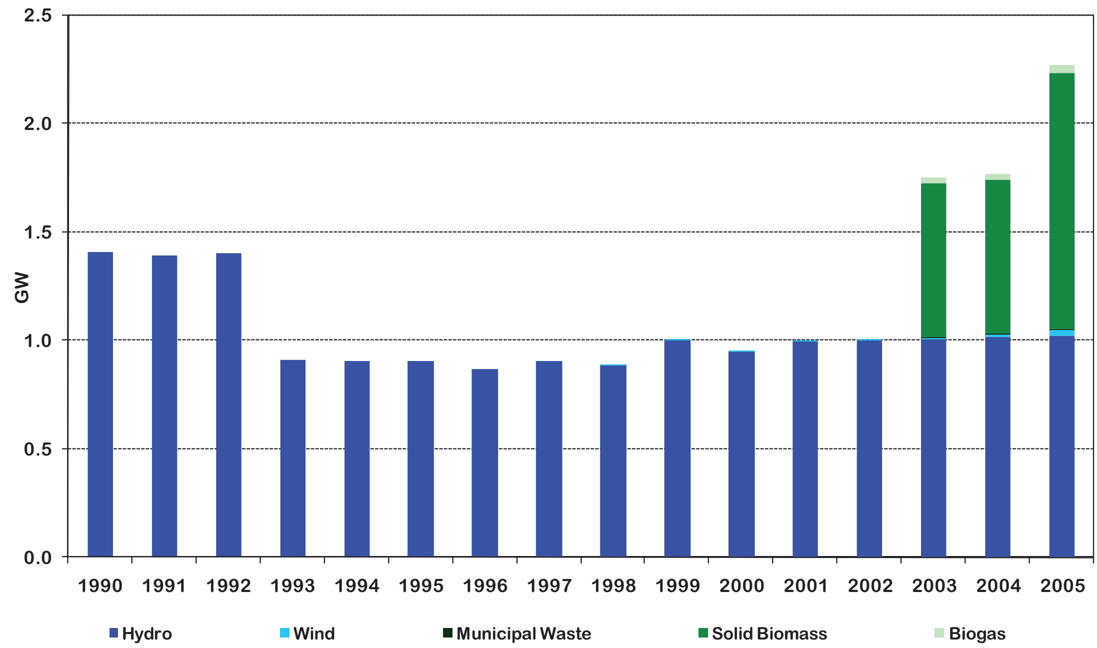
[1] A summary profile was prepared of the Czech Republic's renewable energy **market** developments from 1990 to 2005. Policy developments are available in the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org)..

Figure 2. Total RES-E Production (excluding Hydropower), 1990-2005



Source: IEA (2007a)

Figure 3. Net Generating Capacity of RES-E Plants, 1990-2005

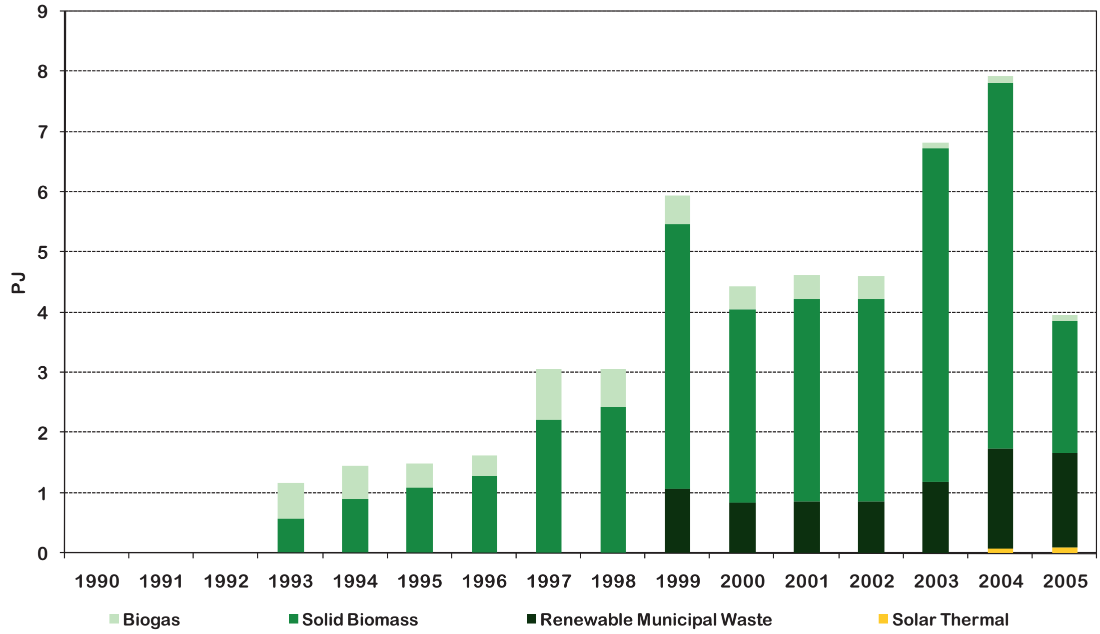


NB: Official IEA statistics on electricity generating capacity do not differentiate between *renewable* and *non-renewable* municipal waste.

Source: IEA (2007a)

RENEWABLE HEAT (RES-H) MARKET

Figure 4. Total RES-H Production, 1990-2005

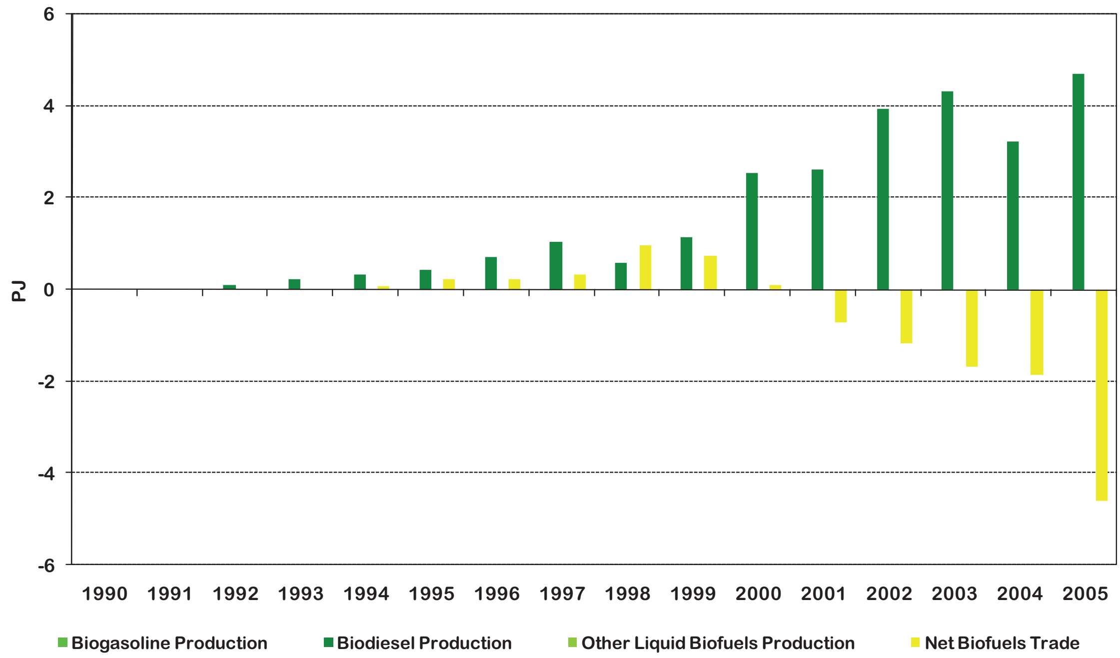


NB: Solar thermal includes direct final use.

Source: IEA (2007a)

RENEWABLE TRANSPORT FUEL (RES-T) MARKET

Figure 5. Total RES-T Production, 1990-2005[2]



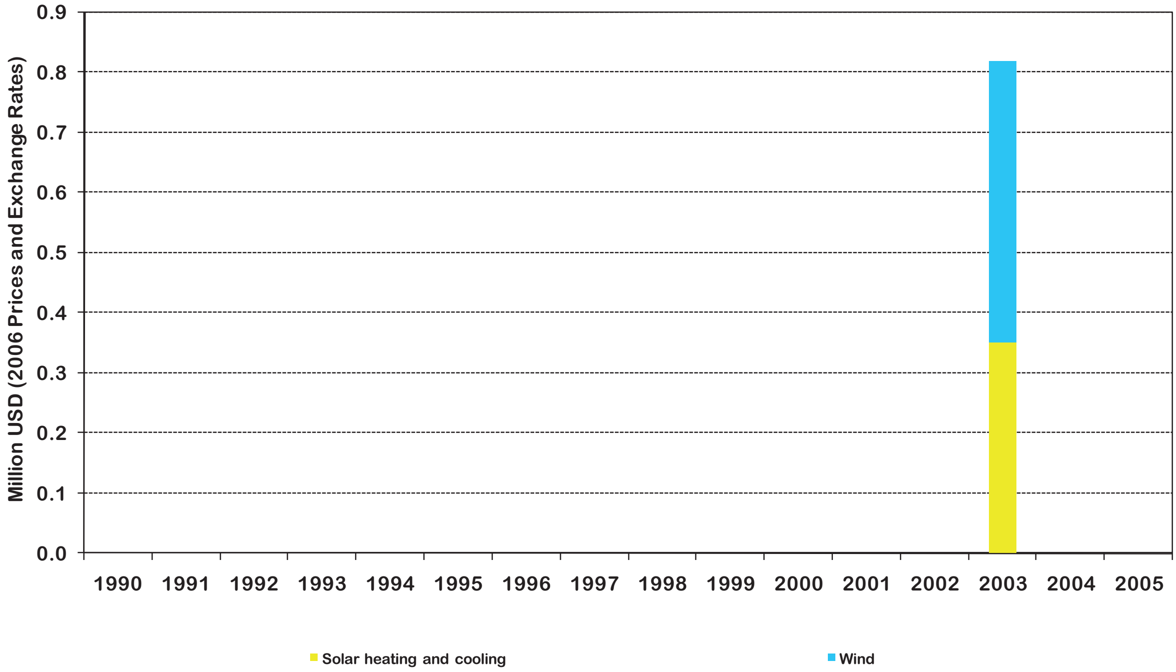
NB: Net Biofuels Trade refers to the balance of domestic biofuel consumption, i.e. biofuel exports subtracted from imports.

Source: IEA (2007a)

[2] Official IEA statistics on heat generation from renewable energy sources relate to **commercial heat sold** with additional data on **direct use** of solar thermal and geothermal available for most OECD countries.

Research, Development and Demonstration Trends

Figure 6. Annual Government RD&D Spending on Renewables, 1990-2005 (USD 2006 prices and exchange rates)[3]

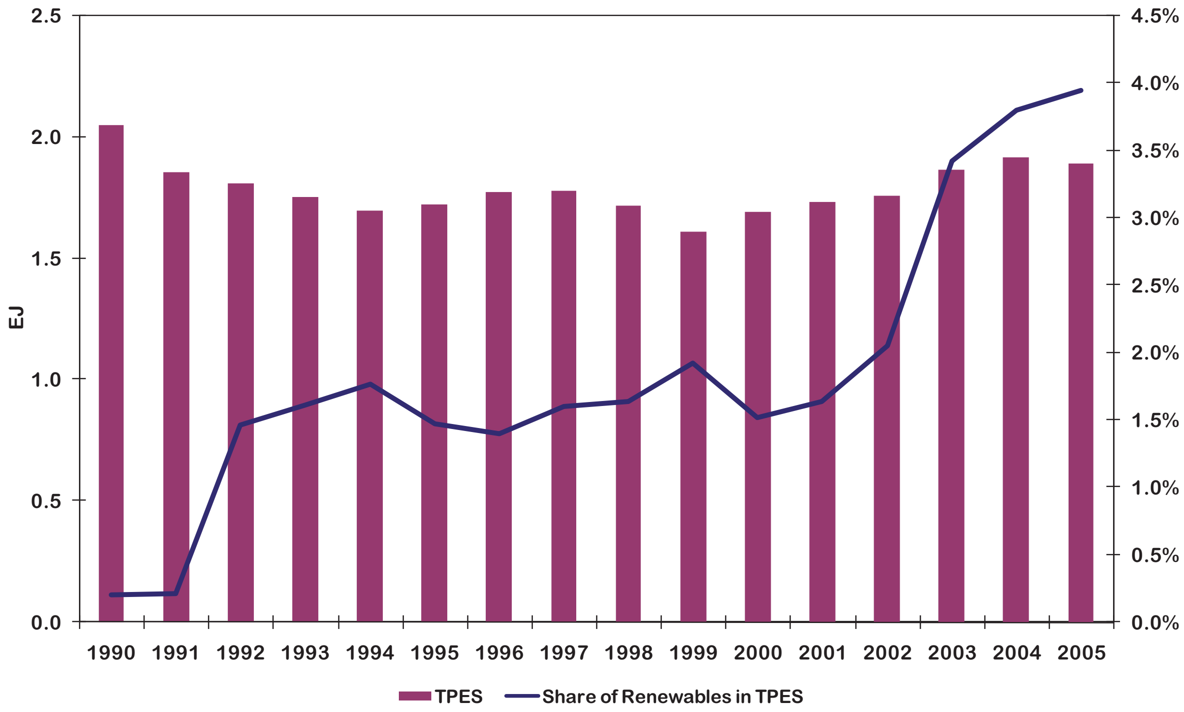


Source: IEA (2007b)

[3] Official IEA data on energy RD&D budgets include only **government** funding and not **private** RD&D spending.

RENEWABLES IN TOTAL PRIMARY ENERGY SUPPLY[4]

Figure 8. Share of Renewable Energy in Total Primary Energy Supply, 1990-2005[5]



Source: IEA (2007b)

RENEWABLE ENERGY POLICY INFORMATION

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References

IEA (2007a), *Renewables Information 2007*, OECD/IEA, Paris.

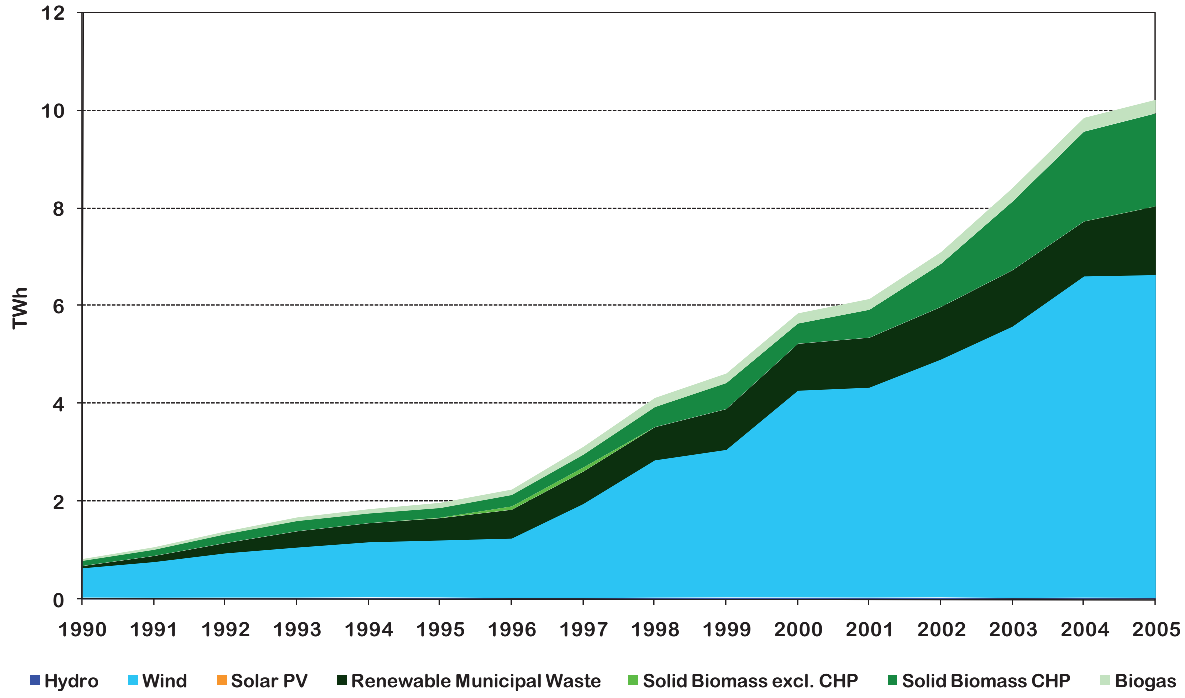
IEA (2007b), *IEA Energy Technology R&D Statistics,* IEA, Paris, http://www.iea.org/Textbase/stats/rd.asp, accessed 21 November 2007.

IEA (2008), "Global Renewable Energy Policies and Measures Database", www.iea.org/textbase/pm/grindex.aspx, International Energy Agency, accessed 15 March 2008.

DENMARK[1]

RENEWABLE ELECTRICITY (RES-E) MARKET

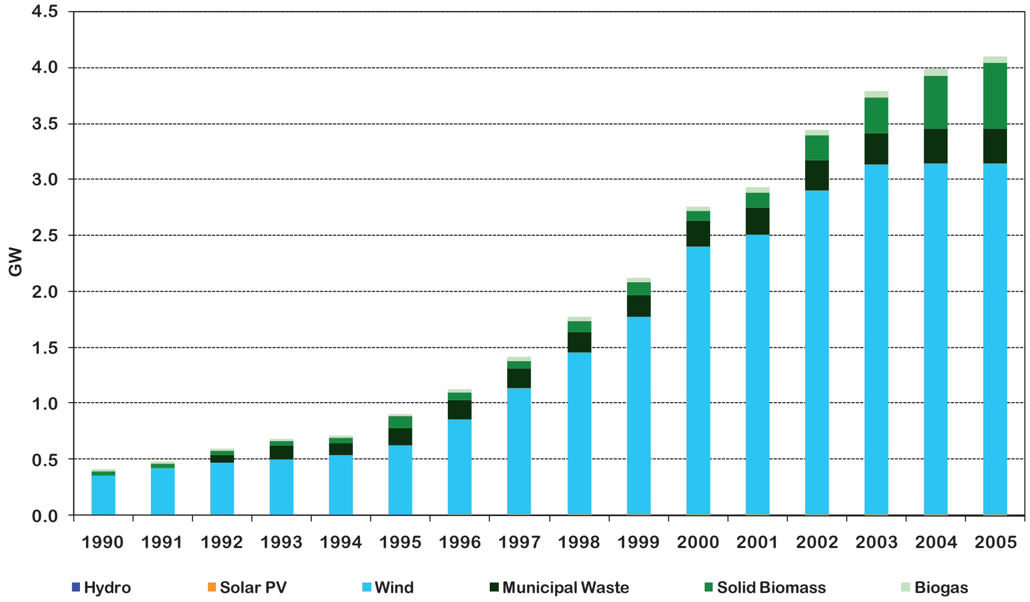
Figure 13. Total RES-E Production, 1990-2005



Source: IEA (2007a)

[1] A summary profile was prepared of Denmark's renewable energy **market** developments from 1990 to 2005. Policy developments are available in the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

Figure 2. Net Generating Capacity of RES-E Plants, 1990-2005

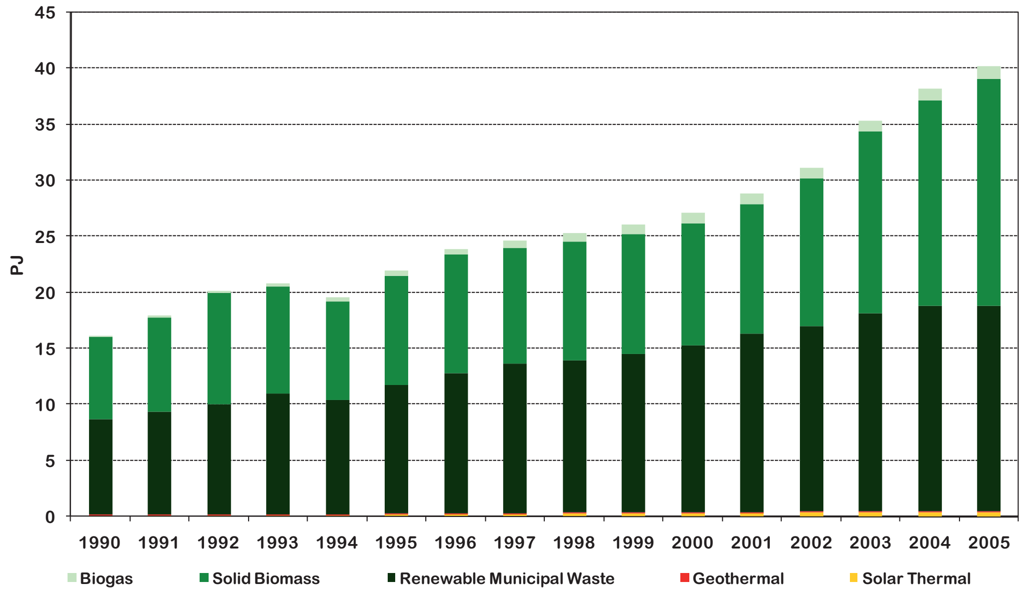


NB: Official IEA statistics on electricity generating capacity do not differentiate between *renewable* and *non-renewable* municipal waste.

Source: IEA (2007a)

RENEWABLE HEAT (RES-H) MARKET

Figure 4. Total RES-H Production, 1990-2005[2]



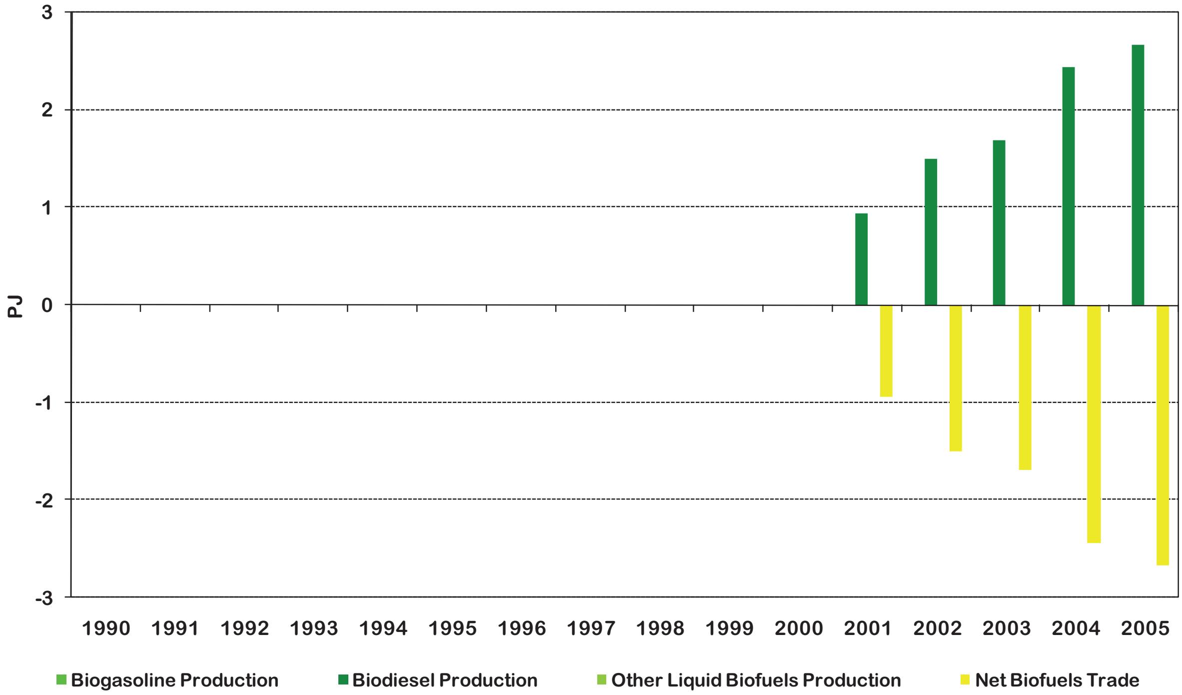
NB: Geothermal and solar thermal include direct final use.

Source: IEA (2007a)

[2] Official IEA statistics on heat generation from renewable energy sources relate to **commercial heat sold** with additional data on **direct use** of solar thermal and geothermal available for most OECD countries.

RENEWABLE TRANSPORT FUEL (RES-T) MARKET

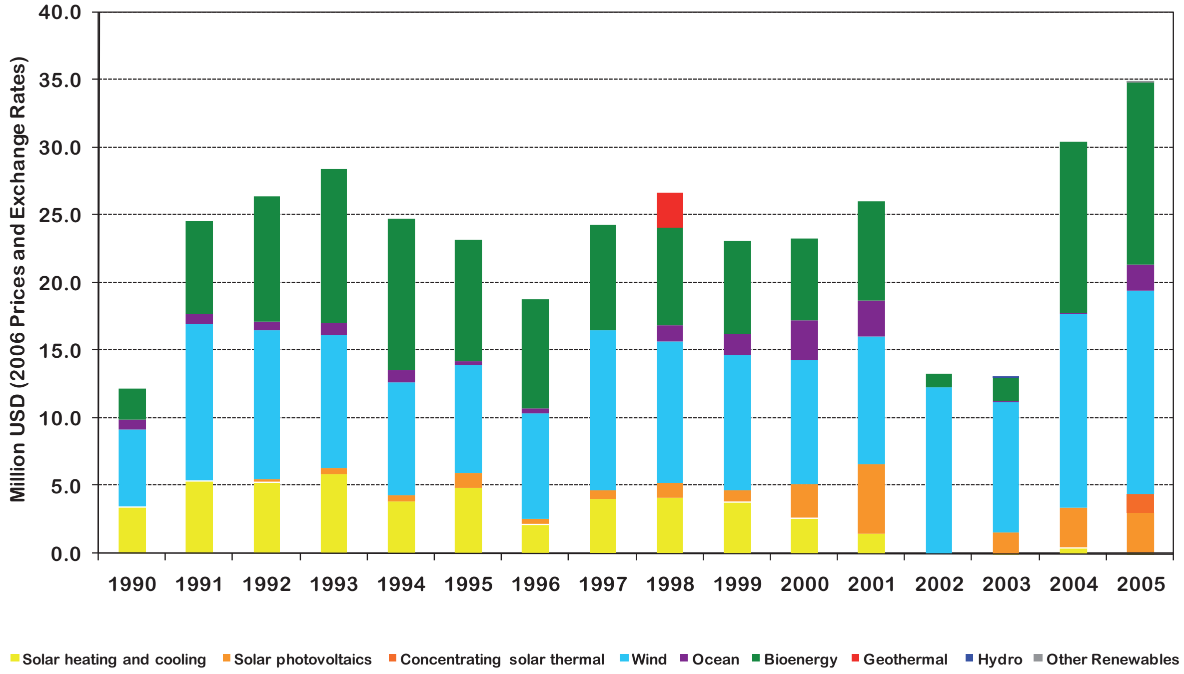
Figure 5. Total RES-T Production, 1990-2005



NB: Net Biofuels Trade refers to the balance of domestic biofuel consumption, i.e. biofuel exports subtracted from imports.

Source: IEA (2007a)

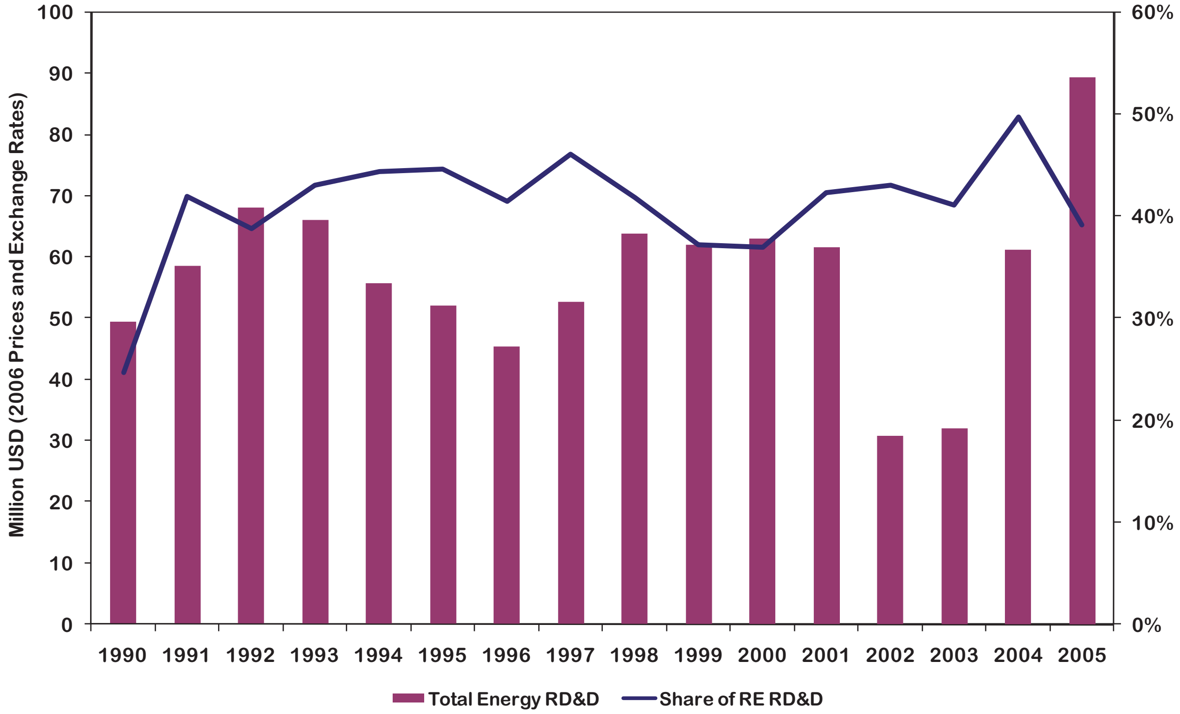
Figure 6. Annual Government RD&D Spending on Renewables, 1990-2005 (USD 2006 prices and exchange rates)[3]



Source: IEA (2007b)

[3] Official IEA data on energy RD&D budgets include only **government** funding and not **private** RD&D spending.

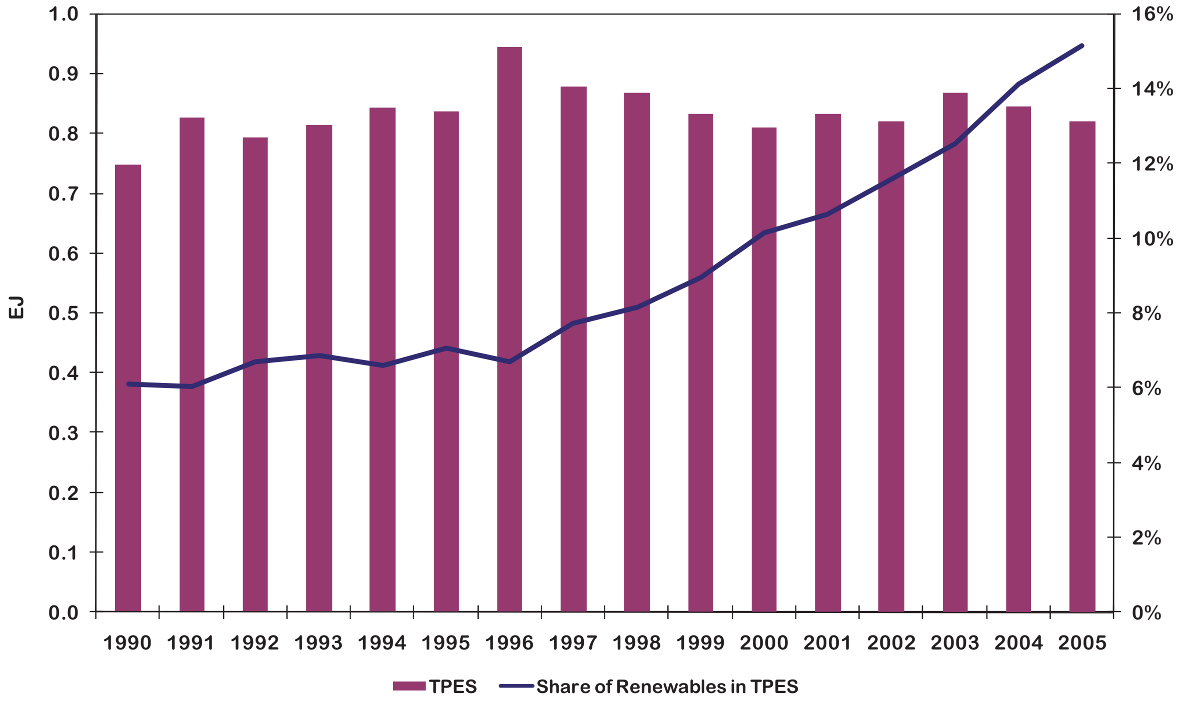
Figure 7. Renewable energy RD&D versus total government energy RD&D spending, 1990-2005



Source: IEA (2007b)

RENEWABLES IN TOTAL PRIMARY ENERGY SUPPLY[4]

Figure 8. Share of Renewable Energy in Total Primary Energy Supply, 1990-2005



Source: IEA (2007a)

RENEWABLE ENERGY POLICY INFORMATION

For details on renewable energy support policies implemented in Denmark, readers may consult the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

[4] The official IEA statistics on TPES include, where applicable, traditional biomass but exclude pumped hydro.

Primary energy convention: The IEA uses the **physical energy content method** to calculate the primary energy equivalent of non-combustible energy sources, such as geothermal, hydro, solar and wind. As a consequence, there is an obvious link between the principles adopted in defining the primary energy forms of energy sources and the primary energy equivalent of these sources. For instance, in the case solar thermal and geothermal electricity production, as heat is the primary energy form selected by the IEA, the primary energy equivalent is the quantity of heat generated in the geothermal or solar thermal plant for electricity generation. In the case of hydro, wind, tide and solar PV, as electricity is the primary energy form selected, the primary energy equivalent is the physical energy content of the electricity generated in the plant, which amounts to assuming an efficiency of 100%. Readers may consult (IEA, 2007a) for more details.

Glossary

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References

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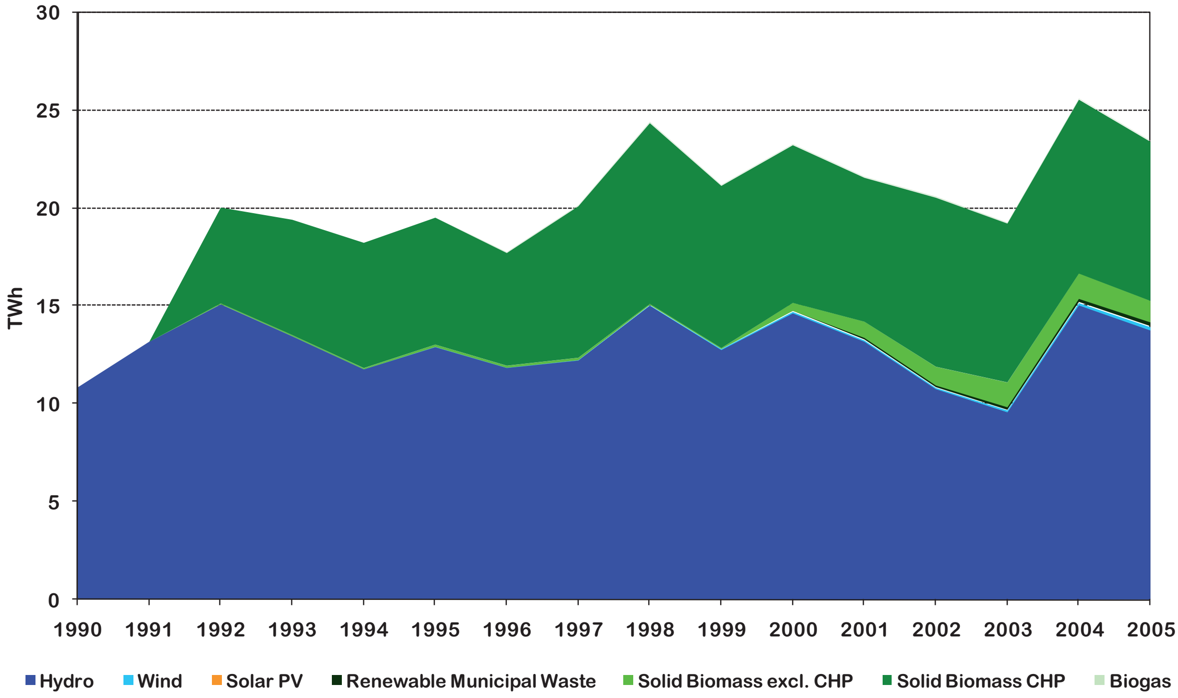
IEA (2008), "Global Renewable Energy Policies and Measures Database", www.iea.org/textbase/pm/grindex.aspx, International Energy Agency, accessed 15 March 2008.

FINLAND[1]

RENEWABLE ELECTRICITY (RES-E) MARKET

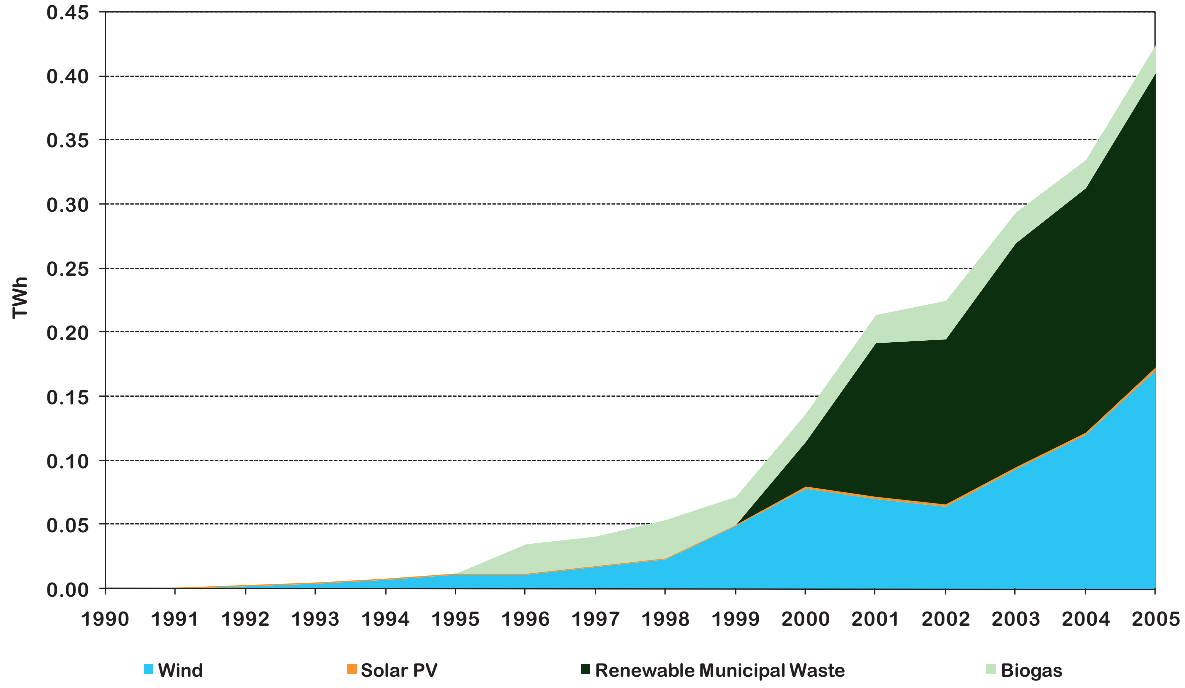
Figure 14. Total RES-E Production, 1990-2005



Source: IEA (2007a)

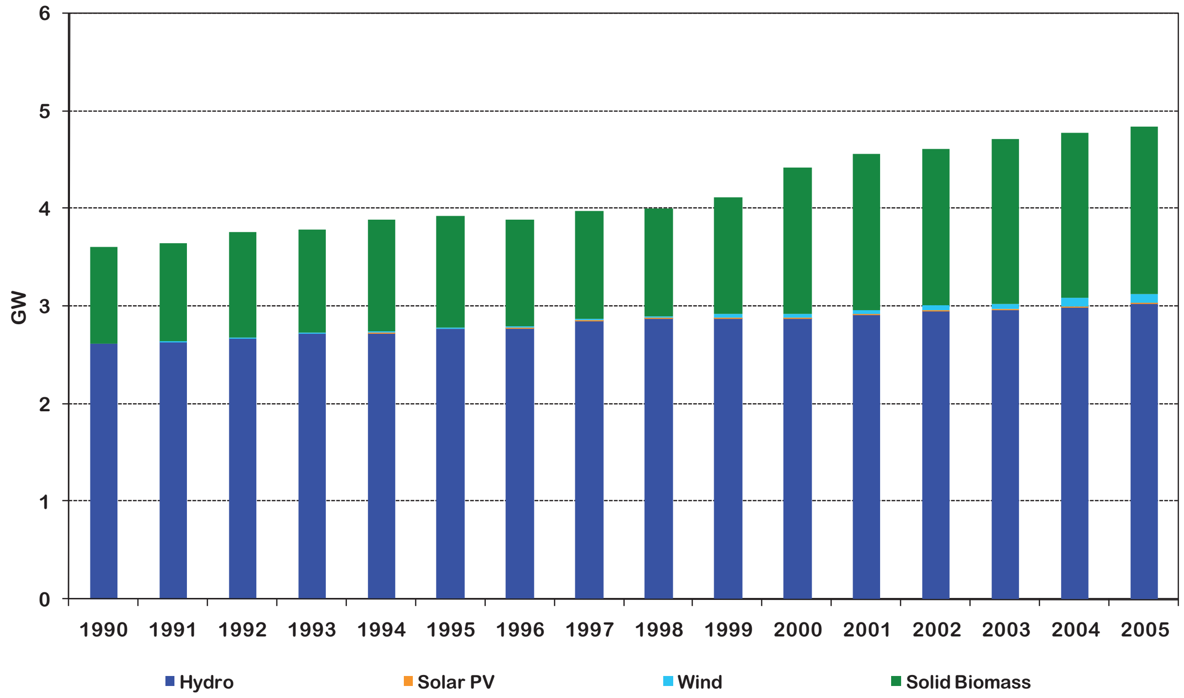
[1] A summary profile was prepared of Finland's renewable energy **market** developments from 1990 to 2005. Policy developments are available in the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

Figure 15. Total RES-E Production (excluding Hydropower), 1990-2005



Source: IEA (2007a)

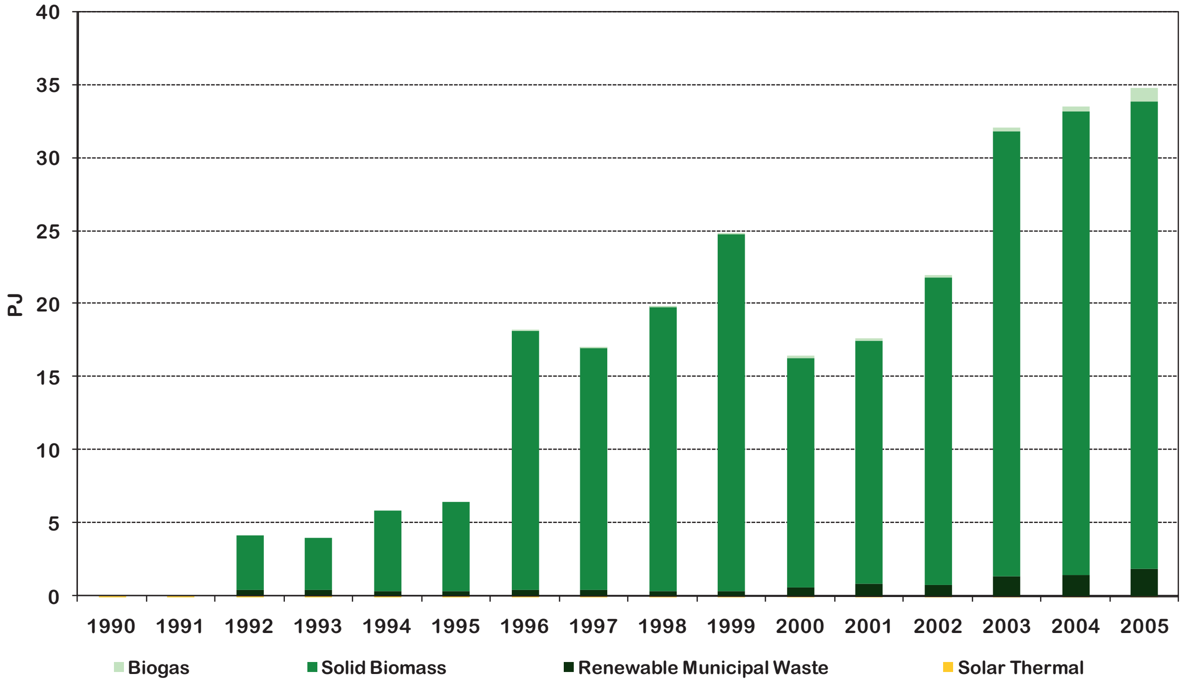
Figure 16. Net Generating Capacity of RES-E Plants, 1990-2005



Source: IEA (2007a)

RENEWABLE HEAT (RES-H) MARKET

Figure 4. Total RES-H Production, 1990-2005[2]



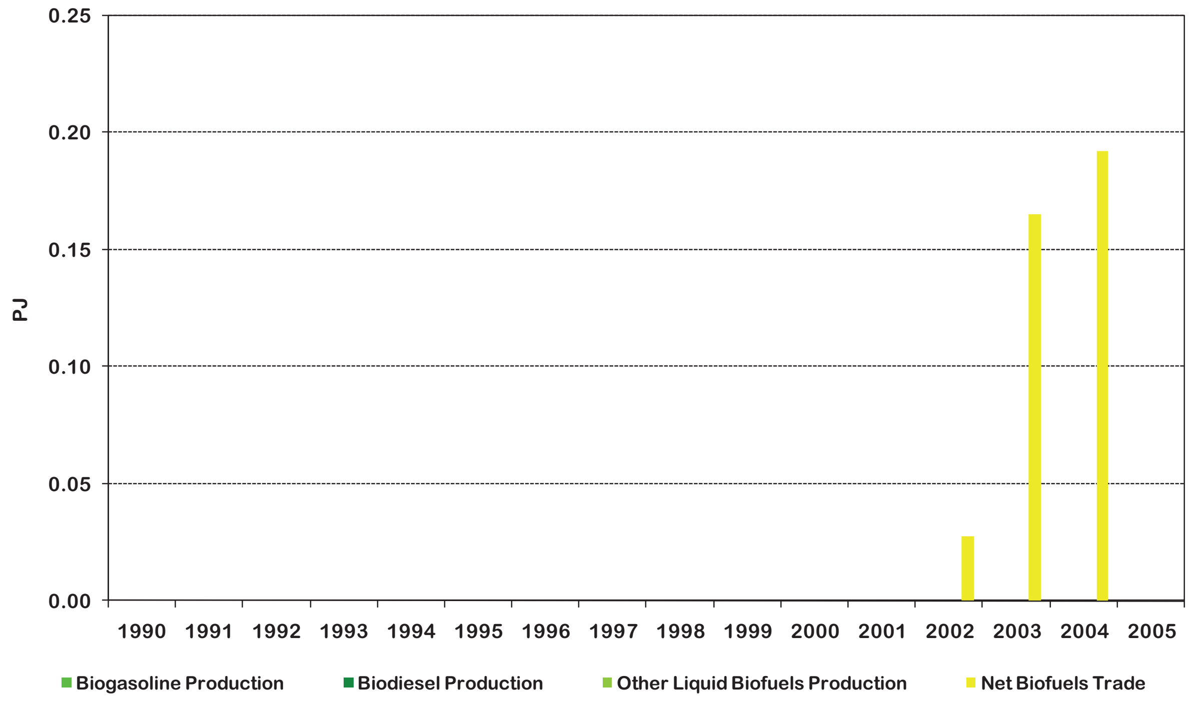
NB: Solar thermal include direct final use.

Source: IEA (2007a)

[2] Official IEA statistics on heat generation from renewable energy sources relate to **commercial heat sold** with additional data on **direct use** of solar thermal and geothermal available for most OECD countries.

RENEWABLE TRANSPORT FUEL (RES-T) MARKET

Figure 5. Total RES-T Production, 1990-2005

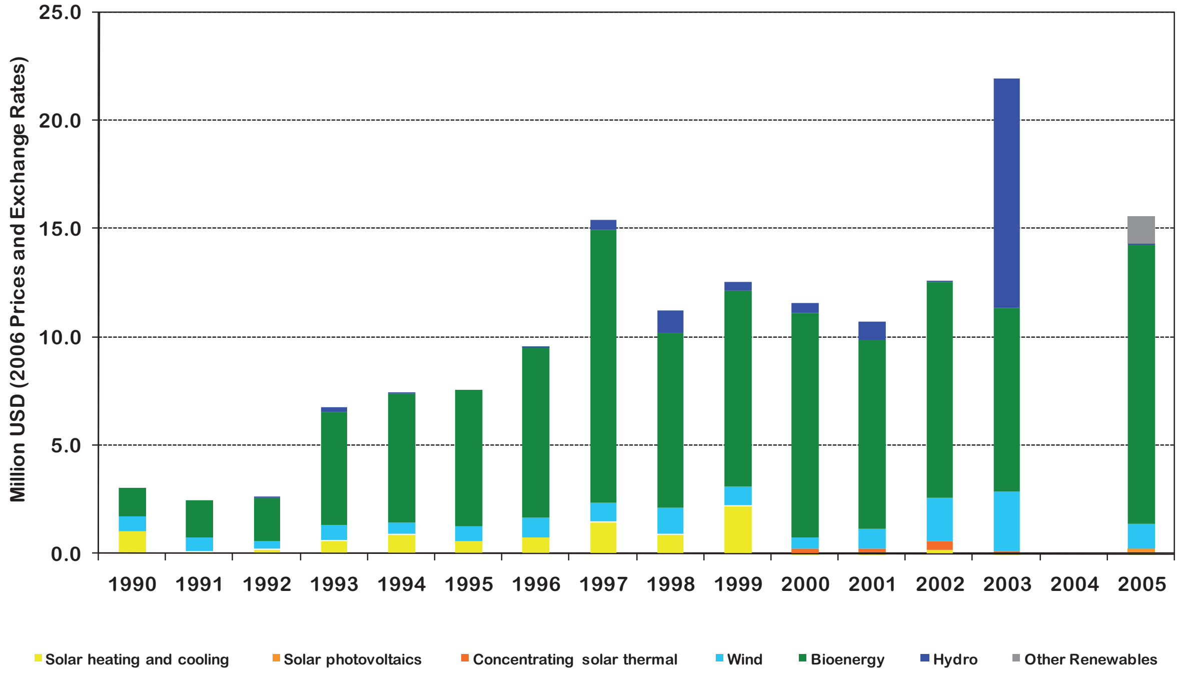


NB: Net Biofuels Trade refers to the balance of domestic biofuel consumption, i.e. biofuel exports subtracted from imports.

Source: IEA (2007a)

RESEARCH, DEVELOPMENT AND DEMONSTRATION TRENDS

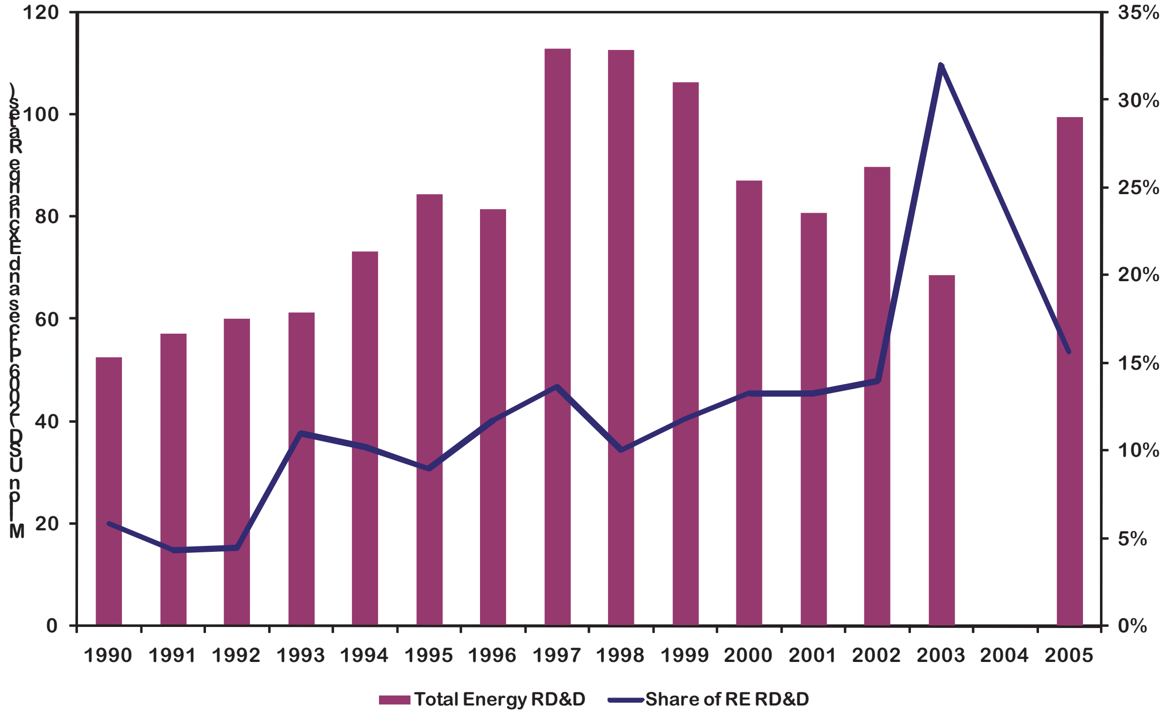
Figure 6. Annual Government RD&D Spending on Renewables, 1990-2005 (USD 2006 prices and exchange rates)[3]



Source: IEA (2007b)

[3] Official IEA data on energy RD&D budgets include only **government** funding and not **private** RD&D spending.

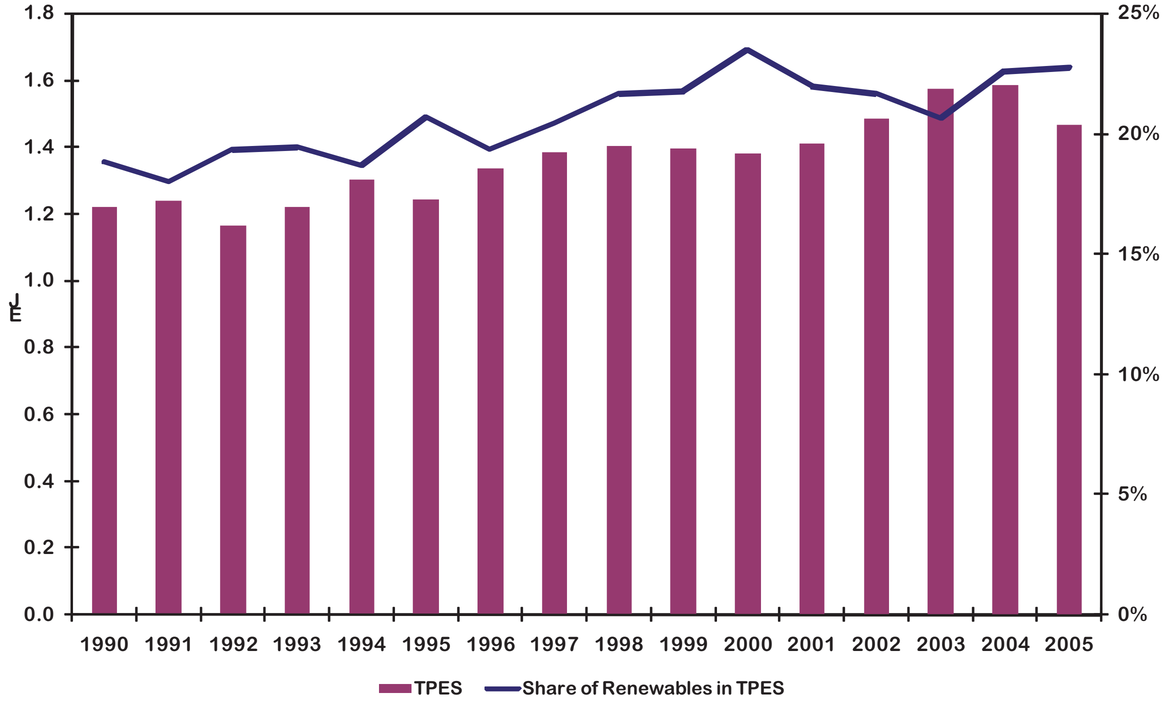
Figure 7. Renewable energy RD&D versus total government energy RD&D spending, 1990-2005



Source: IEA (2007b)

RENEWABLES IN TOTAL PRIMARY ENERGY SUPPLY[4]

Figure 8. Share of Renewable Energy in Total Primary Energy Supply, 1990-2005



Source: IEA (2007a)

RENEWABLE ENERGY POLICY INFORMATION

For details on renewable energy support policies implemented in Finland, readers may consult the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

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[4] The official IEA statistics on TPES include, where applicable, traditional biomass but exclude pumped hydro.

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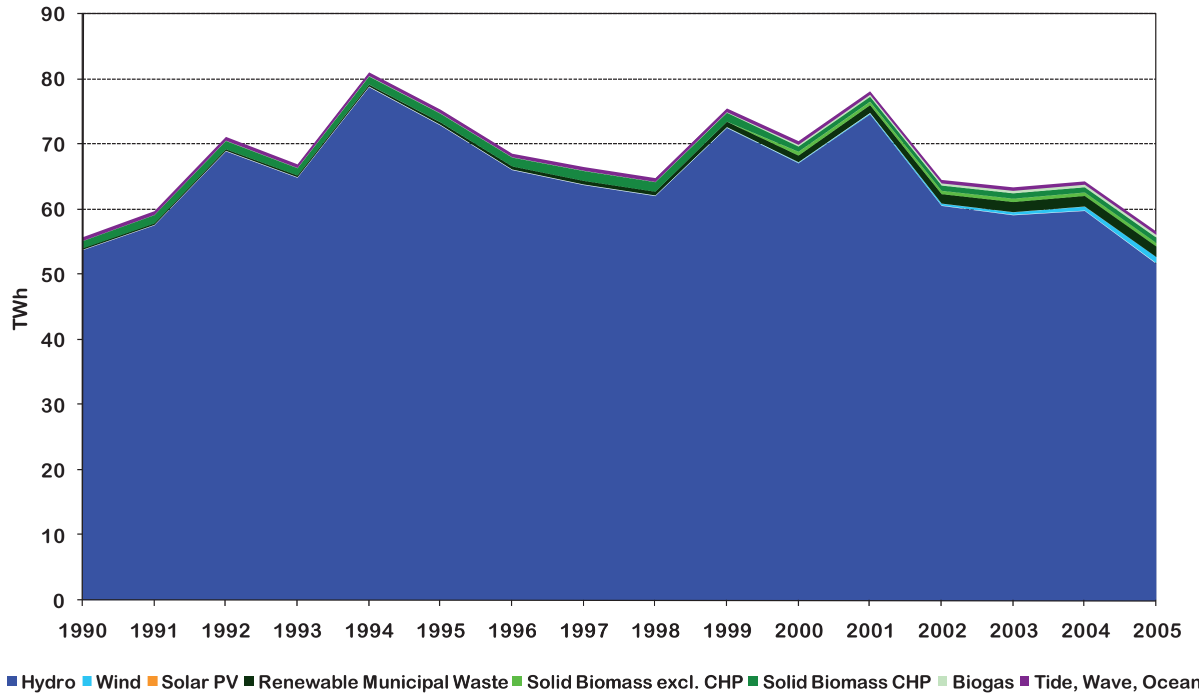
IEA (2008), "Global Renewable Energy Policies and Measures Database", www.iea.org/textbase/pm/grindex.aspx, International Energy Agency, accessed 15 March 2008.

FRANCE

RENEWABLE ELECTRICITY (RES-E) MARKET

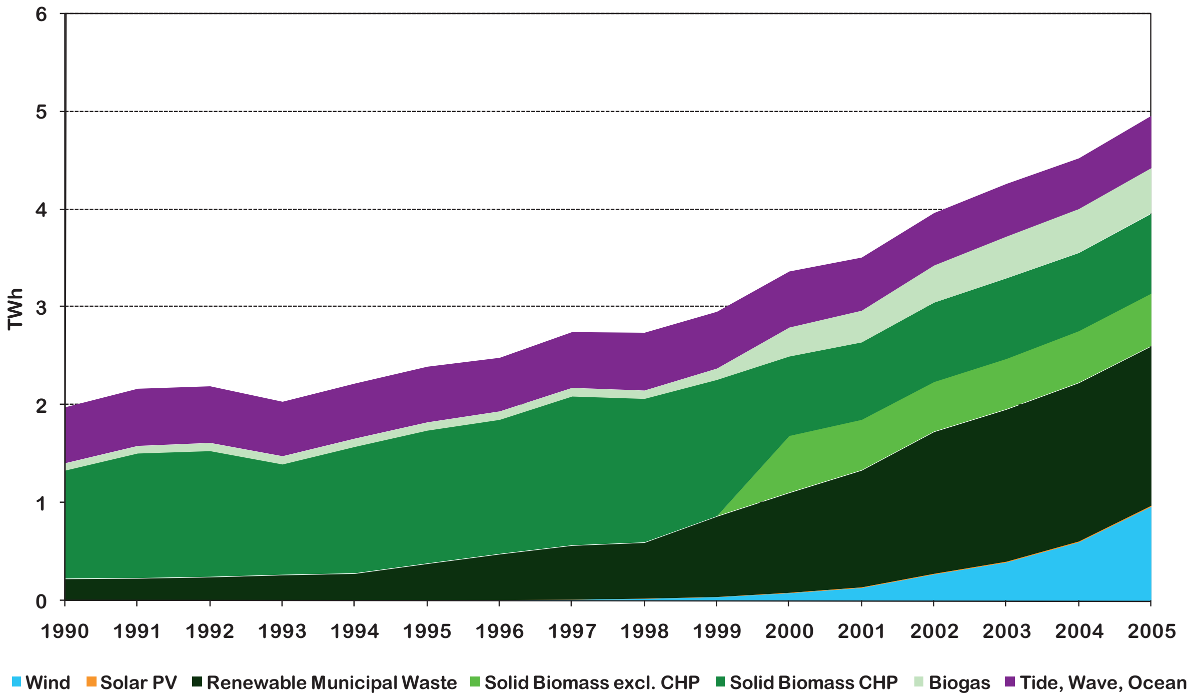
RES-E Market Developments

Figure 17. Total RES-E Production, 1990-2005



Source: IEA (2007a)

Figure 2. Total RES-E Production (excluding Hydropower), 1990-2005



Source: IEA (2007a)

Electricity from renewable energy sources (RES-E) amounted to 56.7 TWh in 2005, 91% of which was generated by hydropower plants. This represented 9.8% of total electricity production in France. Due to the large impact of hydropower, the total annual RES-E generation as well as its share of total electricity supply fluctuated with changing precipitation levels over the considered period[1]. However, the overall share of RES-E declined, since hydropower production grew by only 0.1% on an annual average compared to an average 2.1% annual growth of overall electricity supply.

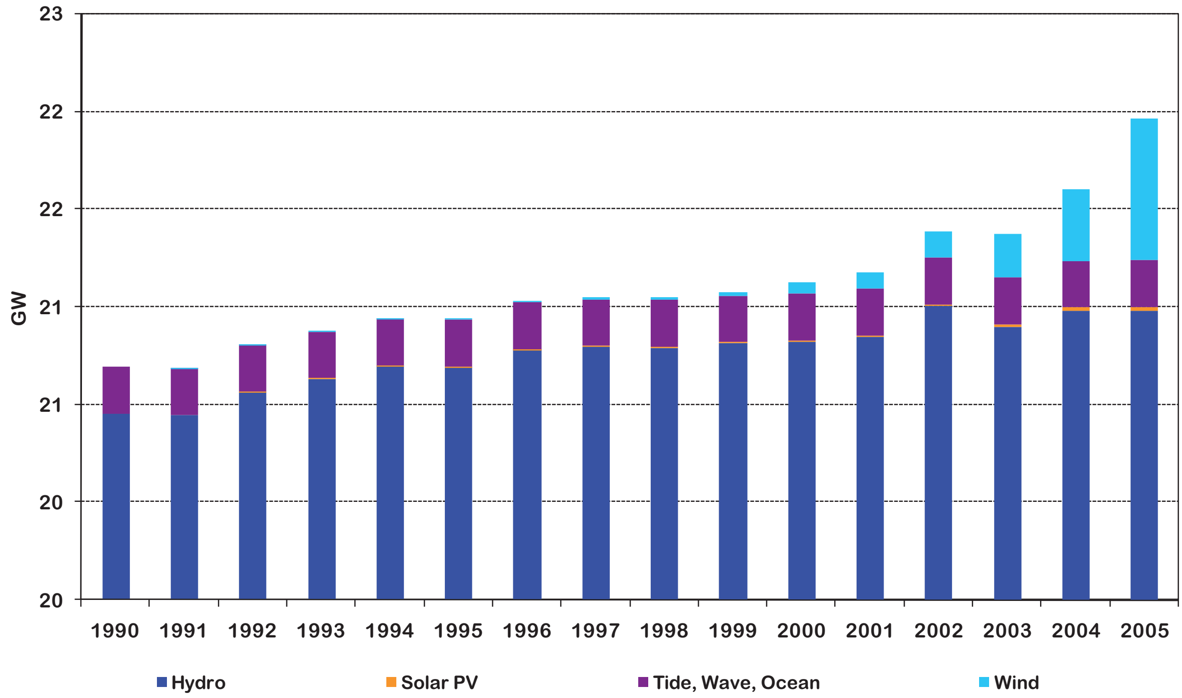
Non-hydro RES-E was 5.0 TWh in 2005 representing 0.86% of total electricity supply. Renewable municipal waste captured the largest share among these electricity sources with 1.6 TWh, CHP and non-CHP solid biomass contributed 1.4 TWh, wind power amounted to slightly below 1.0 TWh, followed by wave, tidal and ocean technologies and biogas plants with slightly above and slightly below 0.5 TWh of power production, respectively. Solar PV produced 15 GWh of electricity in 2005.

Despite their marginal contribution in terms of today's power supply, non-hydro renewables have seen some growth since the early 1990s. In 1990 their cumulative electricity production was 2.2 TWh. Wind power production grew by 67% on annual average from 2 GWh in 1993 to 2005 levels. Nearly the same level of growth has been maintained over the last five years.

[1] Other impacts on RES-E from hydropower include stricter regulations and increased competition for water rights (IEA, 2004).

Growth of RES-E from solar photovoltaics (PV) was averaged 28% per year since 1994, when production reached 1 GWh. Renewable municipal waste has seen a 14% increase in electricity generation on annual average since 1994. However, growth has slowed down since its peak in 1999 and has almost come to a halt in 2005. Growth of RES-E from biogas was on 15-year average about 13% per annum. But in fact, production only started to take off in 1999 and has since slowed down to 3.6% in 2005. Ocean energy has fluctuated within normal limits, since no capacity has been added to the only major tide-powered electricity generation station in the world, the 240 MW La Rance plant in Brittany. Solid biomass production has also not kept pace with the overall growth in electricity supply, since biogas RES-E increased at only 1.3% on annual average since 1990.

Figure 3. Net Generating Capacity of Renewable Energy Plants[2]



Source: IEA (2007a)

Development of Renewable Electricity Policies

France's indicative target to 2010 for the share of renewables in gross electricity consumption as published in the EU directive 2001/77/EC[3] was set at 21%. In 1994, the share of gross electricity production[4] peaked at 17.0%. However, in 2005 it had fallen to 9.8% of total electricity generation.

[2] Data on combustible renewable energy sources is missing due to data unavailability.
[3] (European Commission, 2001)
[4] The share of renewable energy sources in gross electricity consumption and gross electricity production differs. Besides, different statistical accounting methods are used by the IEA and the EU.

Support for RES-E is based on a combined approach using feed-in tariffs (FITs) and tendering procedures for large renewable projects. The Electricity Law enacted in 2000 introduced free access to electricity grids by independent power producers as well as an obligation for EdF (Électricité de France) and other network operators to buy RES-E fed into the grid at fixed tariffs. The structure of renewable energy FITs was agreed upon in 2001 and 2002 and amended again in 2005. According to this regulation FITs do only apply to facilities smaller or equal to 12 MW. Larger project approvals are granted through a tendering process based on competitive bidding.

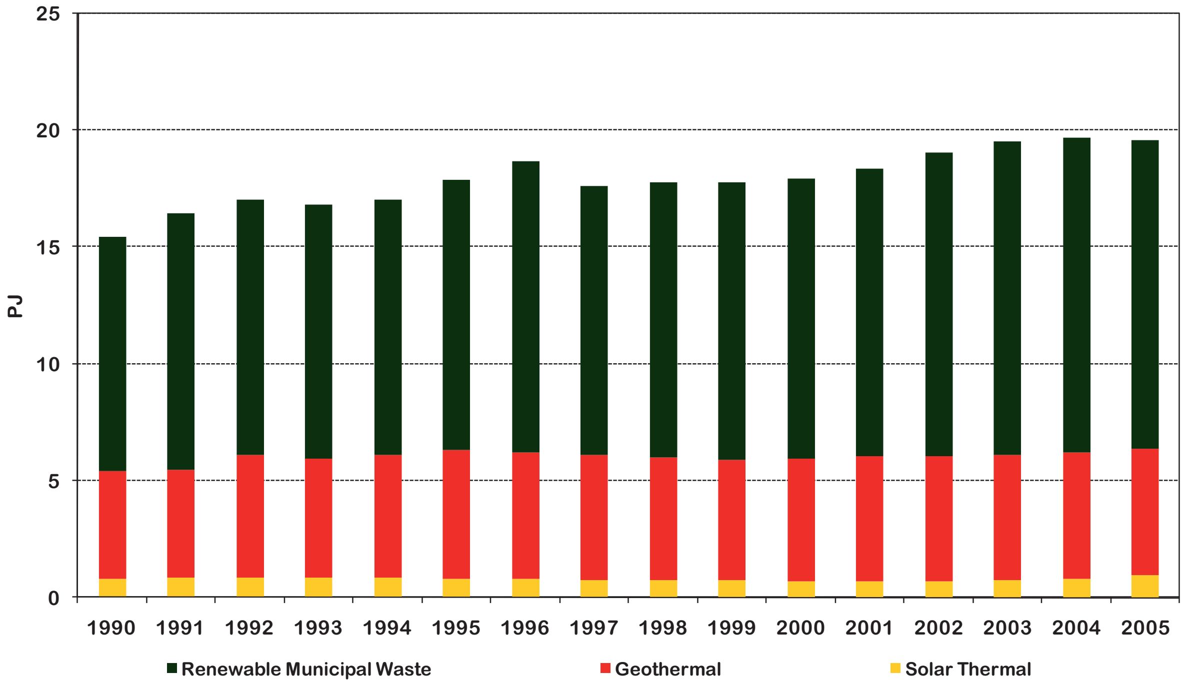
In 2003, the government called for tenders on two 500 MW onshore wind parks, one 500 MW offshore wind installation, a 200 MW biomass project, and 50 MW biogas capacity.

Since 1995 several tax credits and exemptions as well as capital grant and preferential loan schemes supporting renewable energy deployment have been introduced. Besides, a first call for tender on biogas power plants has been launched by the Agency for Environment and Energy Management (ADEME) and Electricity de France (EdF) in 1999.

In 2006, the French government introduced a further differentiation of FITs by technology, location and size of the installation, and the number of years the generator has been in service. The revised tariffs pay EUR 0.55/kWh for building-integrated solar PV, and doubled payment for electricity from rooftop solar panels to EUR 0.30/kWh. It provides a 50% capital subsidy on the cost of panels and other equipment. The new tariff increased for offshore wind turbines to EUR 0.13/kWh, while the basic FIT for onshore wind energy in continental France remained at EUR 0.082/kWh. The amount of time that wind projects receive the premium payment was doubled for both, on- and offshore projects from five to ten years.

RENEWABLE HEAT (RES-H) MARKET

Figure 4. Total RES-H Production, 1990-2005[5]



NB: Geothermal and solar thermal include direct final use.

Source: IEA (2007a)

Total renewable heat supply was around 20 PJ in 2005, 5% of which was supplied by solar thermal installations, 28% by geothermal sources and 67% by biomass. The shares of each single renewable heat source remained largely unchanged over the whole period from 1990 to 2005, despite the fact that the growth of biomass heat was on average close to 2% per annum, while solar and geothermal heat supply grew at 1% only. However, this growth did not suffice to change the market structure radically.

The most notable trend is the shift from a slightly decreasing generation of solar thermal heat during the 1990s to a recent upswing with growth rates that reached 20% in 2005. The French industry ministry announced in 2006 that France aims to be the leading solar thermal market in Europe by 2010.

The contribution to total heat supply of traditional biomass (excluded from figure 5) fluctuated around 350 PJ throughout the 1990s. However, modern biomass heat supply was an order of magnitude smaller.

[5] Official IEA statistics on heat generation from renewable energy sources relate to **commercial heat sold** with additional data on **direct use** of solar thermal and geothermal available for most OECD countries.

Geothermal heat supply stagnated more or less over the considered period, despite a 14% increase from 4 624 TJ in 1990 to 5 249 TJ in 1992 (5442 TJ in 2005). However, supply from non-commercial heat pumps in private households is not covered. According to the IEA Report "Renewables for Heating and Cooling" (2007) installed devices providing space heating more than doubled from 2000 until 2005.

Renewable heat in France has been supported by tax credits for renewable heating, reduction in VAT, and direct subsidies.

Thermal Regulations for new buildings have been in place in the residential sector since 1974 and in the commercial sector since 1989 (EREC, 2004a). A Risk Coverage Fund was developed in the 1980s for risks associated with the long-term exploitation of geothermal resources. Revived policy interest in renewable heat support measures has been seen in 1995 with the Wood Energy Programme (*Programme Bois Énergie et Développement*) Local supporting the development of a wood fuel supply chain and the installation of new automated-feed, wood-fired boilers (EREC, 2004a).

Following the 2005 switch in financial support by the 2005 Finance Law from direct investment incentives to a 40% tax rebate (recovered with an income tax declaration), the solar thermal market growth in France has grown significantly. The tax rebate scheme has simplified the process for consumers, because it is no longer necessary to apply for incentives prior to the installation of the system.

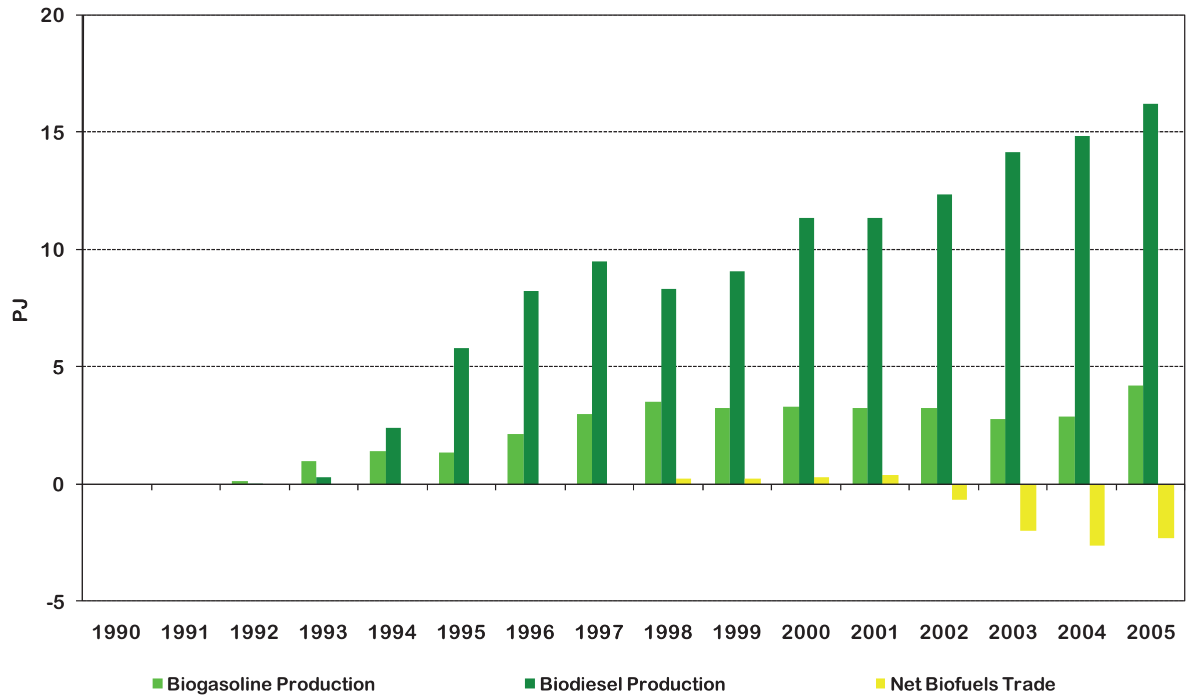
A relatively novel instrument for the promotion of renewable heat was the introduction of the White Energy Saving Certificate Scheme in January 2006. Providers are required to initiate energy savings by their end consumers in proportion to their market quota (sales) in the residential and tertiary sectors. Renewable heat installations such as solar thermal systems qualify as eligible measures to meet energy conservation requirements.

For 2006-2008, an energy saving target of 54 TWh (194.4 PJ) in final energy use was established. Targets were extended to an overall reduction of 2% by 2015 and 2.5% by 2030 of energy intensity with respect to present consumption levels.

The *Engagement National sur le Logement* introduced a substantial VAT tax reduction that applies a reduced VAT rate of 5.5% for subscriptions to district heating grids with a heat supply of at least 60 % biomass, geothermal energy, waste and/or recovered energy. This rate was previously only supplied to gas and electricity. Compared with a normal VAT rate of 19.6%, this offers significant incentives for making renewable heat more cost competitive with conventional fuels.

Renewable Transport Fuel (RES-T) Market

Figure 5. Total RES-T Production, 1990-2005



NB: Net Biofuels Trade refers to the balance of domestic biofuel consumption, i.e. biofuel exports subtracted from imports.

Source: IEA (2007a)

France used to be Europe's largest producer of biofuels, but was overtaken by Germany around 2001. France has put particular emphasis on biodiesel production amounting to 16.2 PJ in 2005, since almost 70% of registered vehicles in France ran on diesel in 2005. In contrast, ethanol production was only 4.2 PJ in 2005, representing around 20% of total biofuel production. The average annual growth for the period from 1992 to 2005 was 30% for bioethanol, while biodiesel grew on average at almost 60% per annum. In 2006, the Global Bioenergy Partnership reports production figures of 21.0 PJ of biodiesel and 8.4 PJ of ethanol.

With increasing domestic production France has become a net exporter of biofuels since 2002. In 2005, 89% of total production was consumed domestically, while the remaining 11% were exported.

Targets for biofuel blends are even more ambitious in France than the indicative shares set out in the European directive on biofuels 2003/30/EC[6]. French targets are set to reach a biofuel share of 7% by 2010 and 10% by 2015. In 2005, the share of biofuels in total transport fuels (calorific value) was only 1%. The government allows a blending quota for

[6] 2% by 2005, 5.75% by 2010.

diesel of up to 5% that could be sold unmarked at French filling stations and is working towards a European standard for a 10% biodiesel blend (B10).

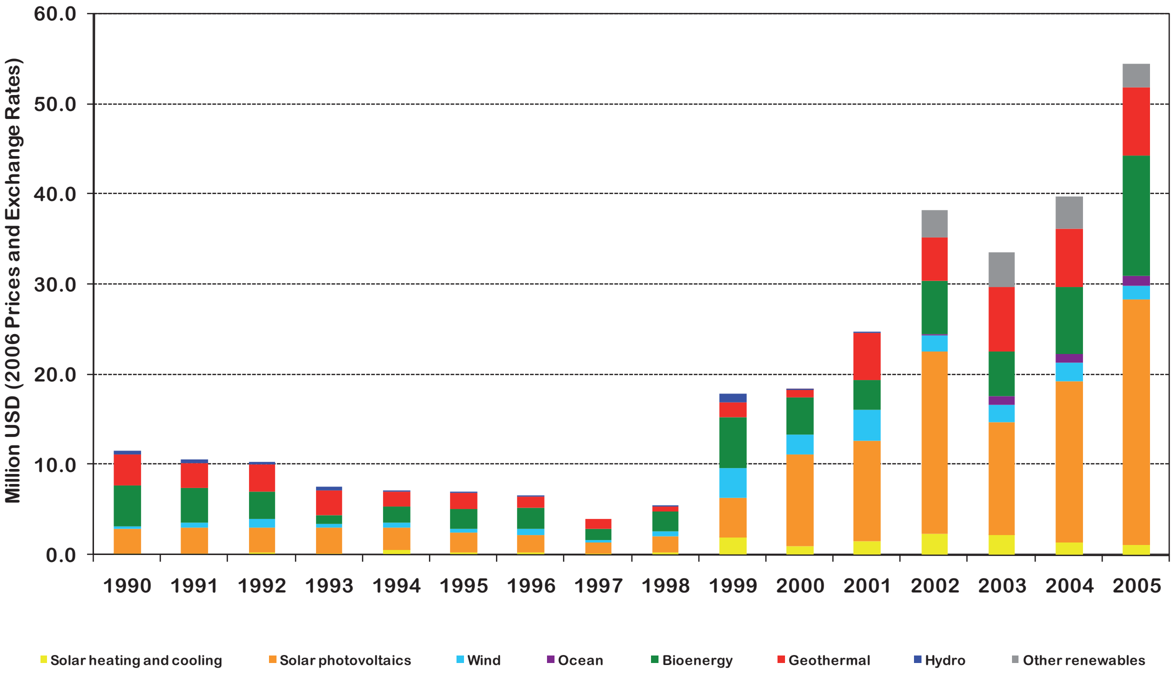
Both tax reductions and capital grants are in place in order to promote biofuels. In the 1990s, the Biofuel Production Programme introduced a capital subsidy for the production of biodiesel and ethanol. A tax reduction on the TIPP (interior tax on petroleum-based products) has first been introduced in 1992 by the annual Financial Law. However, the government set a limit for a maximum amount of tax-deductible biofuel production. For the period 2005-2007, the limit for tax deductibility was set at 480 000 tonnes (around 18.1 PJ[7]) of biodiesel and 320 000 tonnes (approximately 8.5 to 9.4 PJ[7]) of bioethanol. As additional incentive, a tax penalty ["taxe generale sur les activites polluantes" or TGAP] is imposed on fuel distributors who don't meet the required biofuel rate.

Flex-fuel cars that are able to run on much higher biofuel blends have been authorized by the French government in 2006, but were not yet available on the French market during 2006.

[7] For the applied biofuel conversion factors, refer to the Glossary which can be found after the country profiles.

RESEARCH, DEVELOPMENT AND DEMONSTRATION TRENDS

Figure 6. Annual Government RD&D Spending on Renewables, 1990-2005 (USD 2006 prices and exchange rates)[8]



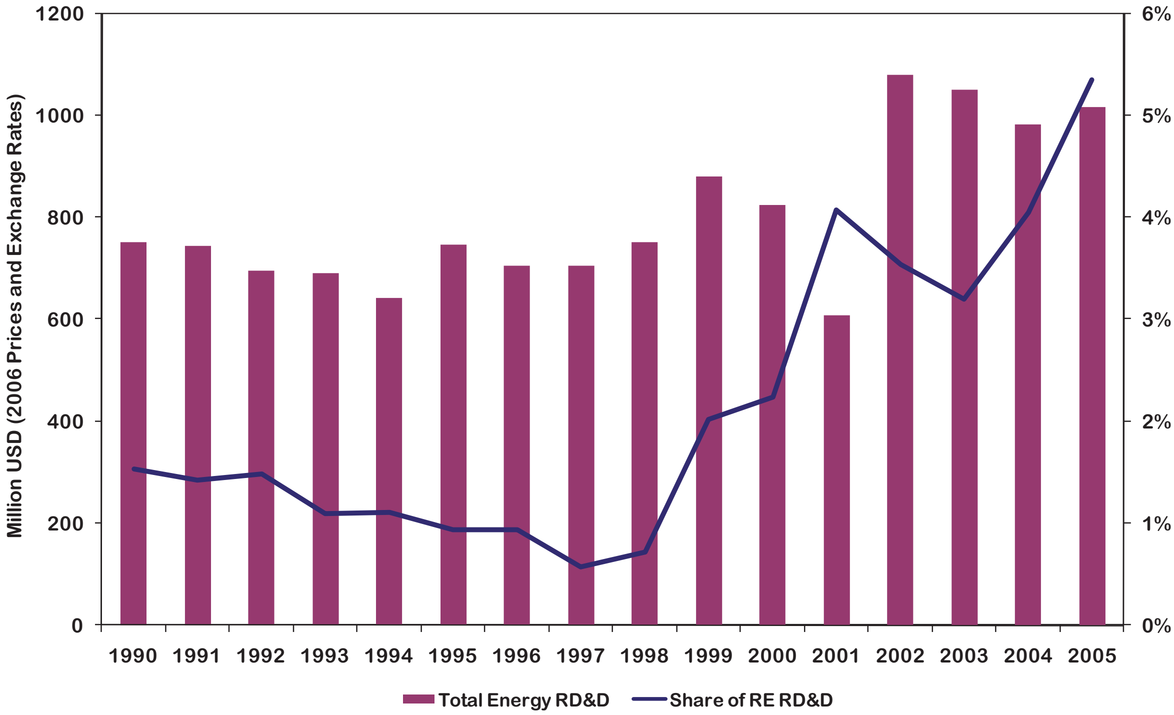
Source: IEA (2007b)

Annual public spending on RE RD&D decreased until the late 1990s to around one third of 1990 levels, while the total public energy RD&D expenditures remained fairly constant. Since 1998 spending on RE RD&D started to increase notably and more than quadrupled until 2005 reaching USD 54.4 million[9]. The share of RE RD&D in terms of total energy RD&D spending was 1.5% in 1990 and even 0.6% in 1997, but increased afterwards to 5.4% in 2005.

The most striking change in terms of technological focus of RE RD&D since the late 1990s is a strong increase in spending on solar PV technology, which accounted for 50% of total RE RD&D in 2005. The second-largest share (25%) was invested in bioenergy RD&D, 14% were spent on geothermal energy technologies.

[8] Official IEA data on energy RD&D budgets include only **government** funding and not **private** RD&D spending.
[9] Conversion from national currency to USD is in USD (2006) prices and exchange rates.

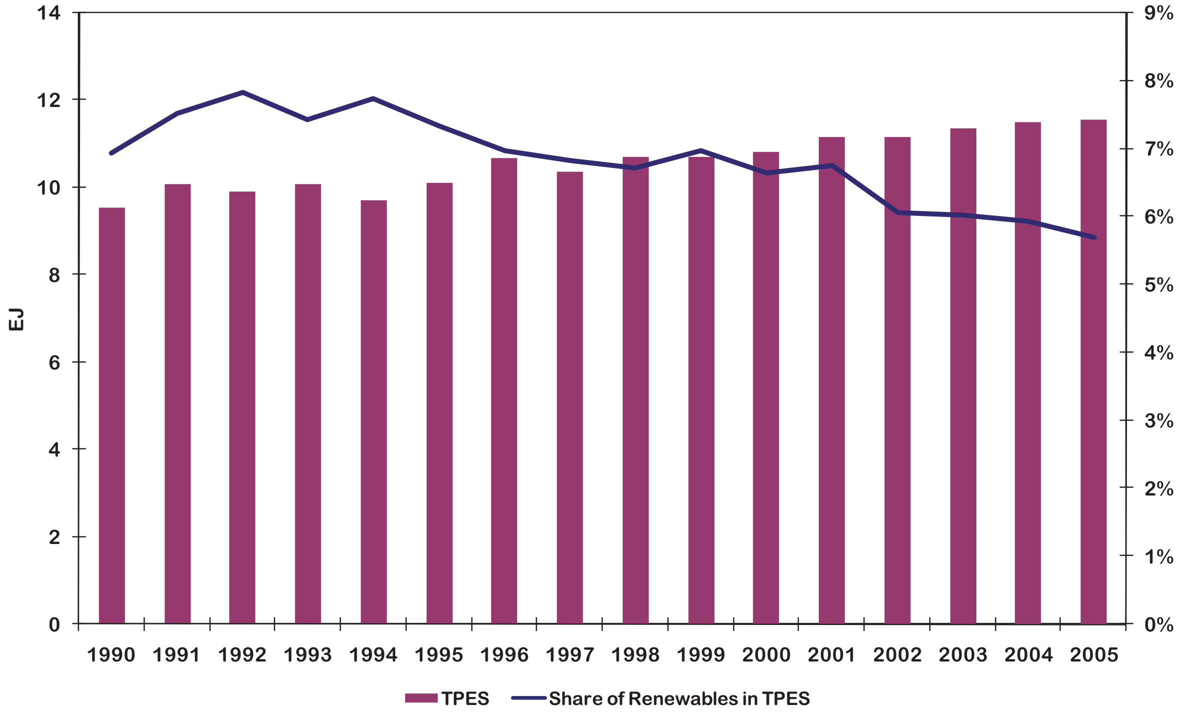
Figure 7. Renewable energy RD&D versus total government energy RD&D spending, 1990-2005



Source: IEA (2007b)

RENEWABLES IN TOTAL PRIMARY ENERGY SUPPLY[10]

Figure 8. Share of Renewable Energy in Total Primary Energy Supply, 1990-2005



Source: IEA (2007a)

The share of renewable energy in total primary energy supply (TPES) decreased slightly since the early 1990s from a peak of 7.6% in 1992 to an all-period low of 5.7% in 2005. France's TPES increased from 9.5 EJ in 1990 to 11.5 EJ in 2005 representing an annual average growth of 1.3%. Renewable primary energy supply, in contrast, increased on average by only 0.2% per year.

[10] The official IEA statistics on TPES include, where applicable, traditional biomass but exclude pumped hydro.

Primary energy convention: The IEA uses the **physical energy content method** to calculate the primary energy equivalent of non-combustible energy sources, such as geothermal, hydro, solar and wind. As a consequence, there is an obvious link between the principles adopted in defining the primary energy forms of energy sources and the primary energy equivalent of these sources. For instance, in the case solar thermal and geothermal electricity production, as heat is the primary energy form selected by the IEA, the primary energy equivalent is the quantity of heat generated in the geothermal or solar thermal plant for electricity generation. In the case of hydro, wind, tide and solar PV, as electricity is the primary energy form selected, the primary energy equivalent is the physical energy content of the electricity generated in the plant, which amounts to assuming an efficiency of 100%. Readers may consult (IEA, 2007a) for more details.

RENEWABLE ENERGY POLICY INFORMATION

For further details on renewable energy support policies implemented in France, readers may consult the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

GLOSSARY

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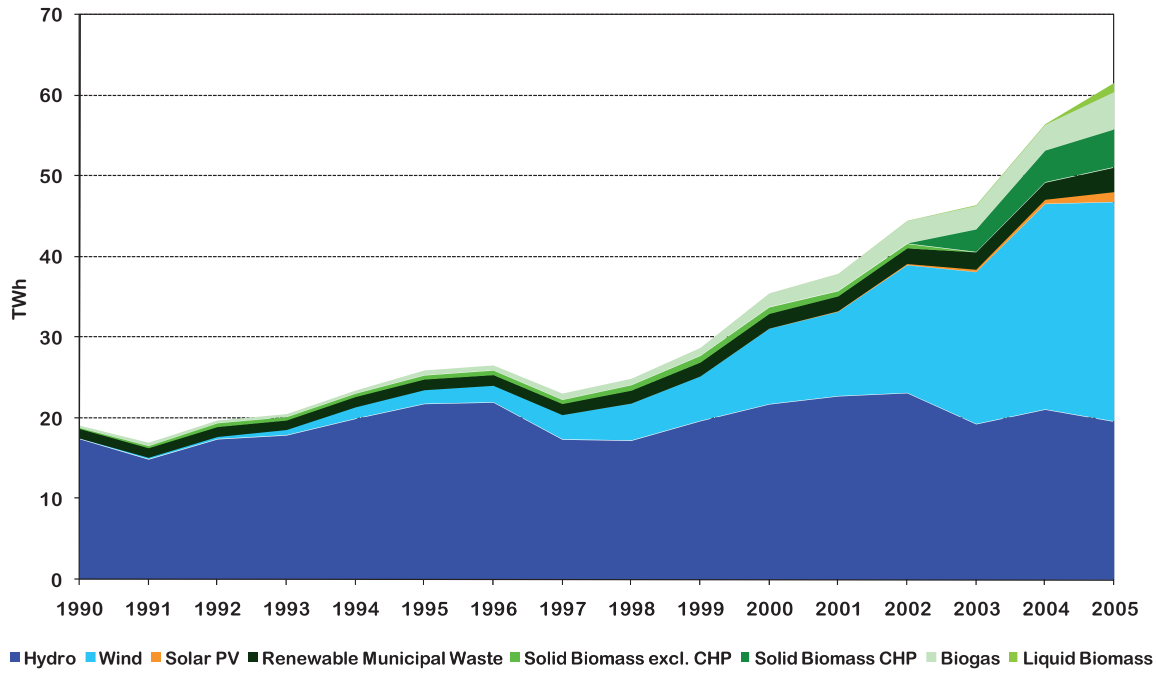
GERMANY

RENEWABLE ELECTRICITY (RES-E) MARKET

RES-E Market Developments

Figure 1. Total RES-E Production, 1990-2005



Source: IEA (2007a)

Renewable electricity (RES-E) supply was 61.6 TWh in 2005 representing 10.0% of total electricity generation. Supply from renewables increased at an average annual rate of 8.1% from 1990 to 2005.

With 27.2 TWh in 2005, representing 4.4% of total electricity production, **wind** replaced **hydropower** as the major source of renewable electricity. This development is due to an average annual growth rate of 48.8% from 1990 to 2005. In contrast, hydropower production remained fairly constant partly because of a lack of additional sites for production. Nevertheless, hydro contributed the second largest share of renewable electricity – amounting to 19.6 TWh, which is 3.2% of total electricity generation in Germany. Fluctuations in electricity generation from renewables can largely be attributed to changing precipitation levels that affect hydro power generation, e.g. in 1996 compared to 1997. With wind power now being the largest source of renewable electricity wind conditions might have a stronger impact on total generation from developed sites.

Solar **PV** represents one of the smallest sources of renewable energy. Its share in total electricity generation in 2005 is only 0.2%. However, solar PV has seen the fastest increase in production over the period from 1990 to 2005, growing at an average 61.1%.

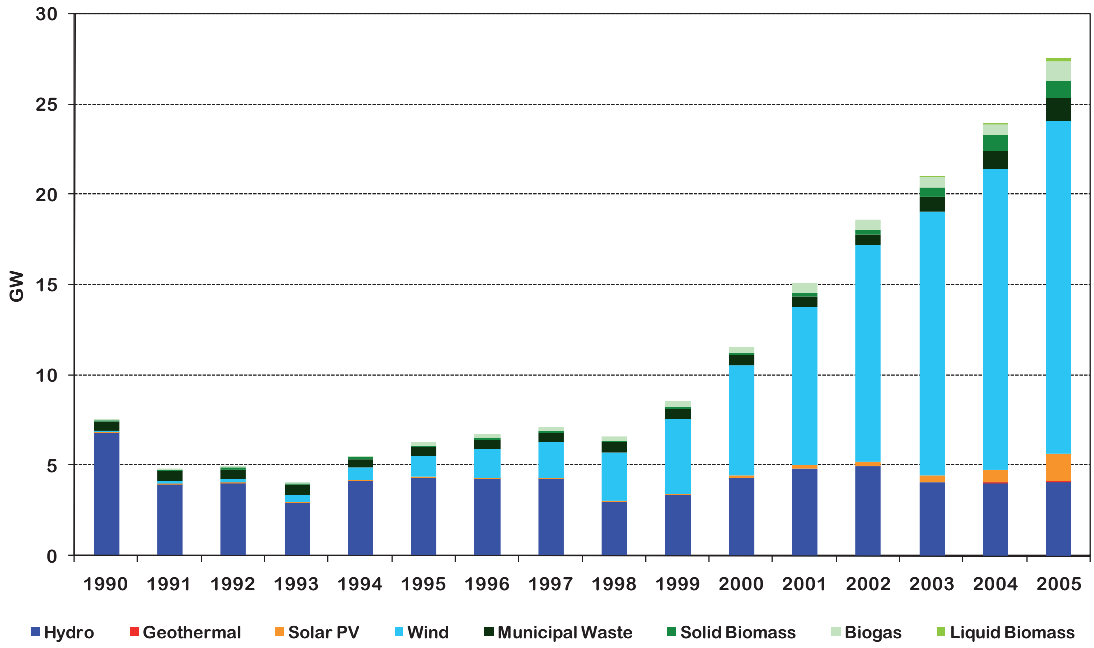
In recent years, this development has only been topped by the rapid market introduction of solid **biomass** combined heat and power (CHP) plants. After the CHP Law was implemented in 2002, promoting the use of large scale CHP plants, electricity generation from this source reached 4.6 TWh within the subsequent three years.

The 1991 Feed-In Law and its successor, the Renewable Energy Sources Act 2000 (EEG, Erneuerbare Energien Gesetz), have been the major drivers behind the growth in renewable energy for electricity generation. The EEG was amended on 1 August 2004 specifically to increase the share of renewable energies in the total electricity supply to at least 12.5% by the year 2010 and to at least 20% by the year 2020. Compared with the previous EEG, the amendment provides for a more differentiated fee structure, taking account of technological development and efficiency aspects by strengthening the tariff digression. Re-evaluation of the Act takes place every two years based on a report of the German Ministry of Environment with the next progress report due by the end of 2007.

Renewables were also supported through several soft loan schemes for wind power plants, hydropower plants and biomass-fired power plants and through grants and soft loans for photovoltaic installations, *i.e.* the “1 000 Roofs Programme” and “100 000 Roofs Programme”.

In late 2006 the Act on Acceleration of Infrastructural Planning (AIP, Infrastrukturplanungs-beschleunigungsgesetz) was passed. This Act forces grid-operators to construct the infrastructure necessary for connecting offshore wind parks to the grid and for transmitting the generated electricity on their own expense. Therefore, using offshore wind resources has become feasible and strong activities in this sector are expected for the near future.

Figure 2. Net Generating Capacity of RES-E Plants, 1990-2005



NB: Official IEA statistics on electricity generating capacity do not differentiate between *renewable* and *non-renewable* municipal waste.

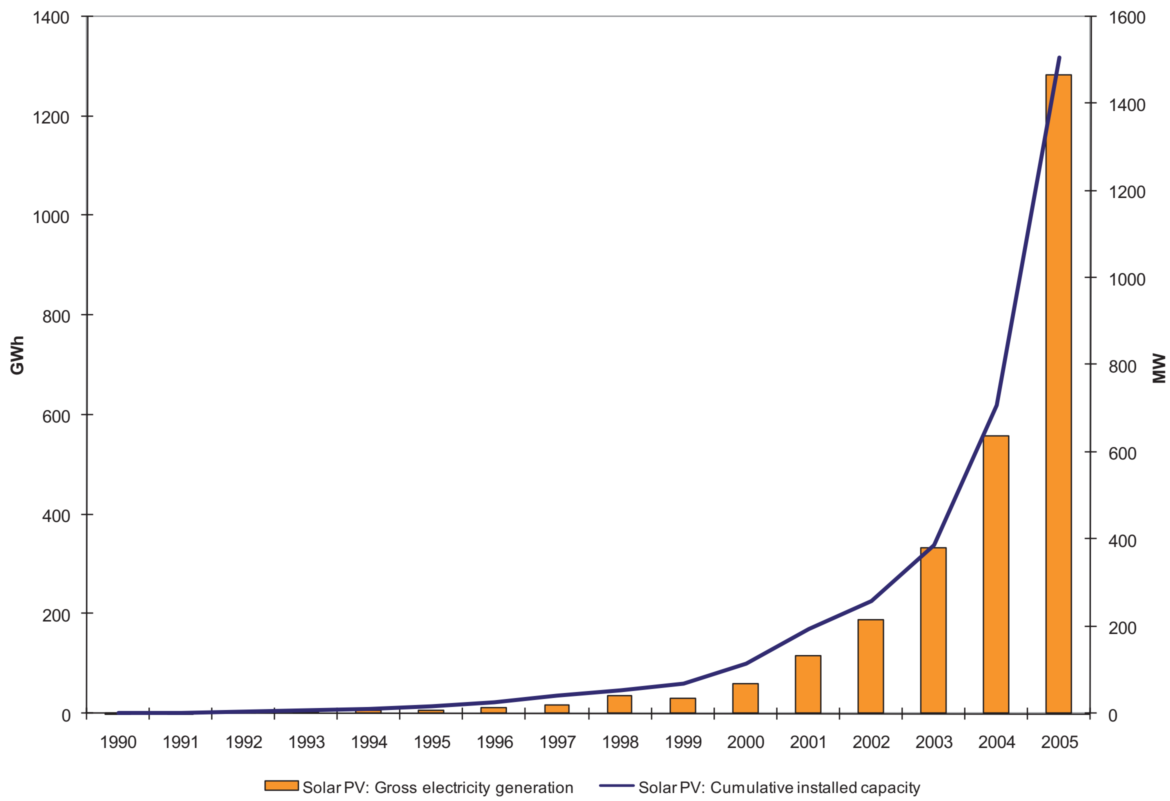
Source: IEA (2007a)

In August 2007 new renewable energy targets were set out in the Integrated Energy and Climate Programme including an increase in the share of renewables in electricity production to 25% – 30% in 2020. Additionally, in July 2007 a target for 2030 of a minimum RES-E share of 45% has been proposed in the draft version of the Progress Report on the Renewable Energy Sources Act.

In this review of the current regulatory framework further proposals included upwards adjustment of tariffs for offshore wind energy, hydroelectricity, and geothermal energy by 2009, which are balanced – with respect to budgetary constraints – by higher annual digression steps of the tariffs for solar PV. This is expected to boost the development of offshore wind energy in particular without increasing total governmental spending.

Focus: Solar Photovoltaics Market and Policy Development

Figure 3. Solar PV Market Development, 1990-2005



Source: IEA (2007a)

The German market for solar PV with its continued strong growth constitutes the world's most important market worldwide with more than 50% of global installed capacity.

The **100 000 Roofs Programme**, introduced in 1999, expanded the 1 000 Roofs Programme of 1991. It was targeted to develop 300 MW of additional capacity. When the support scheme ended in July 2003, total support amounted to 55 000 installations with a total capacity of **261 MW**. The programme supported the installation or extension of PV systems larger than 1 kW through preferential loans covering 100% of investment costs up to 500,000 Euro with decreasing upper cost limits per kW installed.

In 2000 the introduction of the German Renewable Energy Sources Act (**EEG**) replaced the Feed-In Law of 1991. Its aim was to double the share of electricity produced from renewable energy sources by 2010. The obligation to give grid access and purchase the electricity at premium prices was shifted from the utilities to the grid operators. Individual tariffs that would be paid for 20 years to individual plant operators were set for each technology based on its actual generation costs. Remuneration levels were reduced annually for newly commissioned plants to increase cost reduction incentives.

Originally, the remuneration to photovoltaic plants was limited to total capacity of 350 MW. In 2002, this cap was increased to 1000 MW. In November 2003, remuneration for photovoltaic installations was further differentiated depending on site specifics.

A larger amendment came into force on 1 August 2004 including extended targets for the total share in renewable electricity generation. Feed-in tariffs for small solar façade systems were set to EUR 0.5953/kWh, the basic compensation for solar electricity was set to EUR 0.457/kWh.

Besides a number of other adaptations the new EEG also allowed authorised bodies to issues guarantees of origin for renewable energy sources to increase consumer awareness.

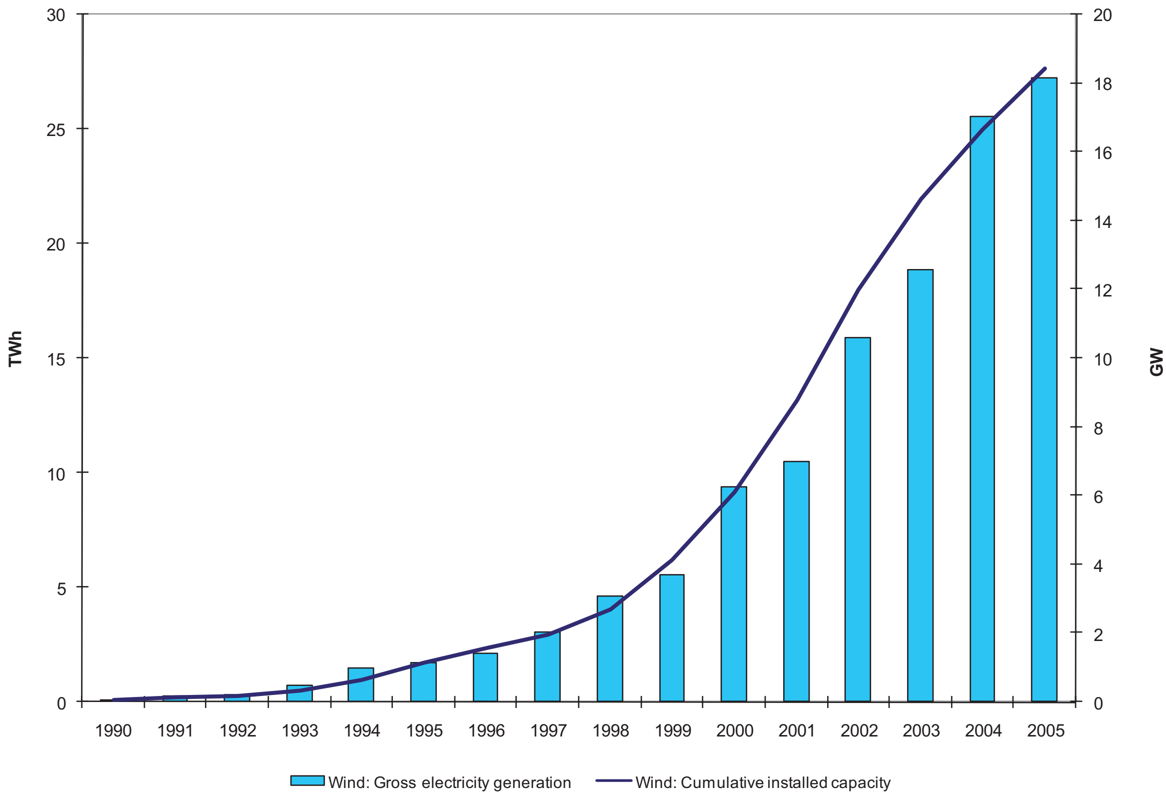
In 2005 another preferential loan scheme primarily addressing small investments up to EUR 50,000 was introduced. Until July 2006 more than 25,000 loans adding up to a total amount of EUR 784 million were taken for additional 199 MW of PV installations.

Germany has also become one of the world's most important countries for solar-cell production. At the end of 2006, one of the world's largest and most modern wafer, cell and module production facilities was built in Frankfurt/Oder, which will fully utilise its 300 MW capacity (for wafers, 250 MW for modules) in 2008.

As mentioned above, accelerated degression of tariffs for electricity from solar PV sources has been proposed in mid-2007 as a result of the review process of the current EEG and its implications for RE development increasing the pressure for cost reductions on the PV industry.

Focus: Wind Power Market and Policy Developments

Figure 4. Wind Power Market Development, 1990-2005



Source: IEA (2007a)

By the end of 2006, total installed wind power capacity in Germany amounted to 20 622 MW adding more than 2 GW of capacity to the market. Despite a strong growth in many other countries and an even larger market in the US with 2.5 GW capacity additions in 2006, Germany remains the country with the highest cumulative installed wind power capacity worldwide and a share of 28%.

Wind energy developments in Germany profited from the EEG and succeeding legislation as did other renewable energy sources. Preferential loan schemes also applied to wind energy projects further bolstering market growth and deployment of onshore wind power projects.

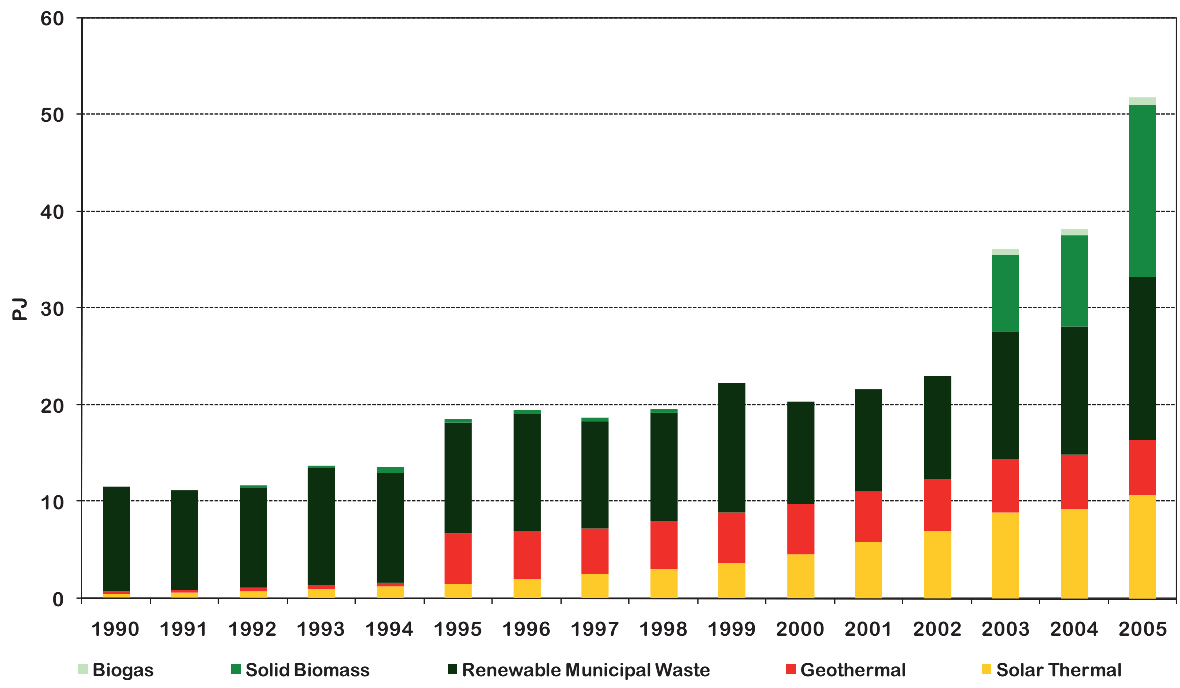
The recent slowdown in annual capacity additions may be altered by intensified interest in offshore project development. After the introduction of the AIP enforcing grid connection of offshore projects in late 2006, offshore sites were increasingly targeted. In late September 2007 18 offshore wind power projects were already approved, but first installations are not expected to start before 2008/09. Nevertheless, German wind turbine manufacturers participated in the growing world market with some doubling their production capacity.

However, growth in production from existing plants is also spurred by ever larger wind turbines. New production capacity for 5 MW wind turbines is under construction while turbines with a capacity of less than 2 MW are supposed to be increasingly difficult to place in the market. Medium installed capacity has increased to 1,917 kW per turbine in the first half of 2007. In addition, re-powering had a marked impact with 135 MW in 2006 for the first time, but it is still behind its technical possibilities.

In late 2007, the progress report on the Renewable Energy Sources Act was published including several recommendations in terms of policy support for wind energy. It proposes a reduction of the digressive rate of remuneration for new onshore wind power plants from 2% to 1% per annum (p.a). due to increased prices in raw materials and slower expected technological progress. Further suggestions concern improvements in re-powering incentives, changes in the fee structure paid to offshore wind energy plants and the introduction of incentives for improving grid stability. Feed-in tariffs for offshore wind energy are proposed to be increased to EUR 0.11–0.14/kWh for the first years of production, with sharper degression[1] rates in later years compared to the initial FIT structure.

Renewable heat (RES-H) Market

Figure 5. Total RES-H Production, 1990-2005[2]



NB: Geothermal and solar thermal include direct final use.

Source: IEA (2007a)

[1] Degression refers to a pre-determined (often annual) percentage decrease in the support level for a given renewable energy installation.

[2] Official IEA statistics on heat generation from renewable energy sources relate to **commercial heat sold** with additional data on **direct use** of solar thermal and geothermal available for most OECD countries.

After the entering into force of the CHP Law in 2002 the heat contribution of newly installed plants increased the supply of renewable heat considerably to 51.8 PJ in 2005. Within the period from 1990 to 2001 the heat contribution from biomass remained fairly constant, but in the following 3-year-period the average annual growth rate climbed to 49.2%.

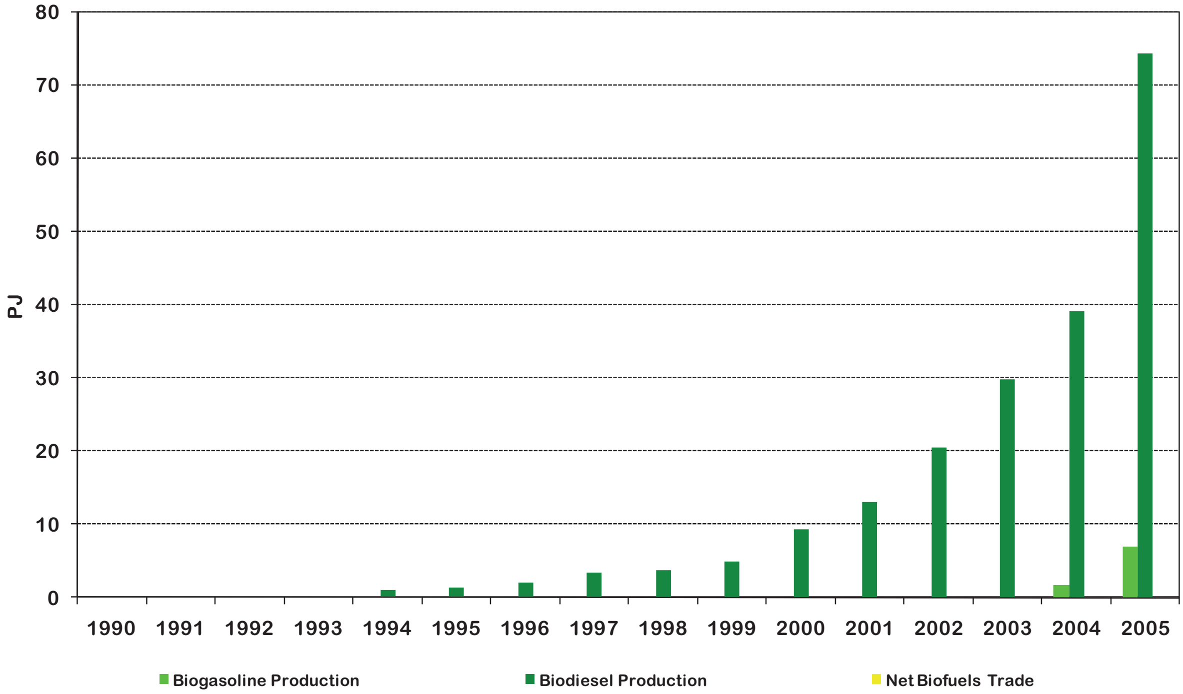
The CHP Law obliges grid operators to priority purchases of electricity generated in CHP plants. Grid operators must pay a premium in addition to the market price for electricity. The amount of the premium depends on the technology in use and on the age of the plant.

The growth of solar thermal heat can be contributed to a large extent to the "Solarthermie2000" program and its successor the "Solarthermie2000Plus". It provides public institutions, foundations, public utilities, property companies and private companies with non-repayable grants covering 50% of the investment cost of eligible solar thermal systems (minimum area $100 m^2$). It is aimed at enabling researchers to test their results under real conditions and modify the technology to develop well-functioning and market orientated systems.

Further growth in the renewable heat market may be fostered by plans of the German government to increase the use of biogas not only as a fuel but also for CHP generation as outlined in the Integrated Energy and Climate Programme (IECP) in August 2007. The IECP also proposes the introduction of a target for a renewable energies' share in heat consumption of 14% by 2020. Measures to reach this share could include an obligation to source a certain percentage of consumed heat from renewable sources.

Renewable Transport Fuel (RES-T) Market

Figure 6. Total RES-T Production, 1990-2005



NB: Net Biofuels Trade refers to the balance of domestic biofuel consumption, i.e. biofuel exports subtracted from imports.

Source: IEA (2007a)

Overall renewable fuel production in 2005 was 81.3 PJ. This represented 3.8% of total fuel supply (IEA, 2007b). Biodiesel production began in 1992 with 186 TJ and grew at an average annual rate of 58.5% until 2005 reaching 74.3 PJ. Reported biogasoline production commenced only recently with 1.7 PJ in 2004 and more than tripled in the following year, amounting to 7.0 PJ.

In the 2003 EU Directive 2003/30/EC[3] national indicative targets for biofuels of 2% by the end of 2005 and 5.75% by the end of 2010 were set across all EU member states. Germany was the only EU member state which more than achieved the 2005 indicative target and is on track to fulfil 2010 targets well ahead of time (European Commission, 2007).

In order to promote the role of renewables in transport, biofuels were exempted from the mineral oil tax until the end of 2008 in the "Eco-tax Reform" that entered into force in 2002. Since the law increased the price of fossil fuels, it enhanced the competitive position of renewable energy technologies in the heating sector and the transport sector. Biodiesel

[3] (European Commission, 2003)

particularly benefited as taxes on transport fuels are regularly high. Tax incentives were EUR 0.47/litre of biodiesel and EUR 0.65/litre of bioethanol (IEA, 2008).

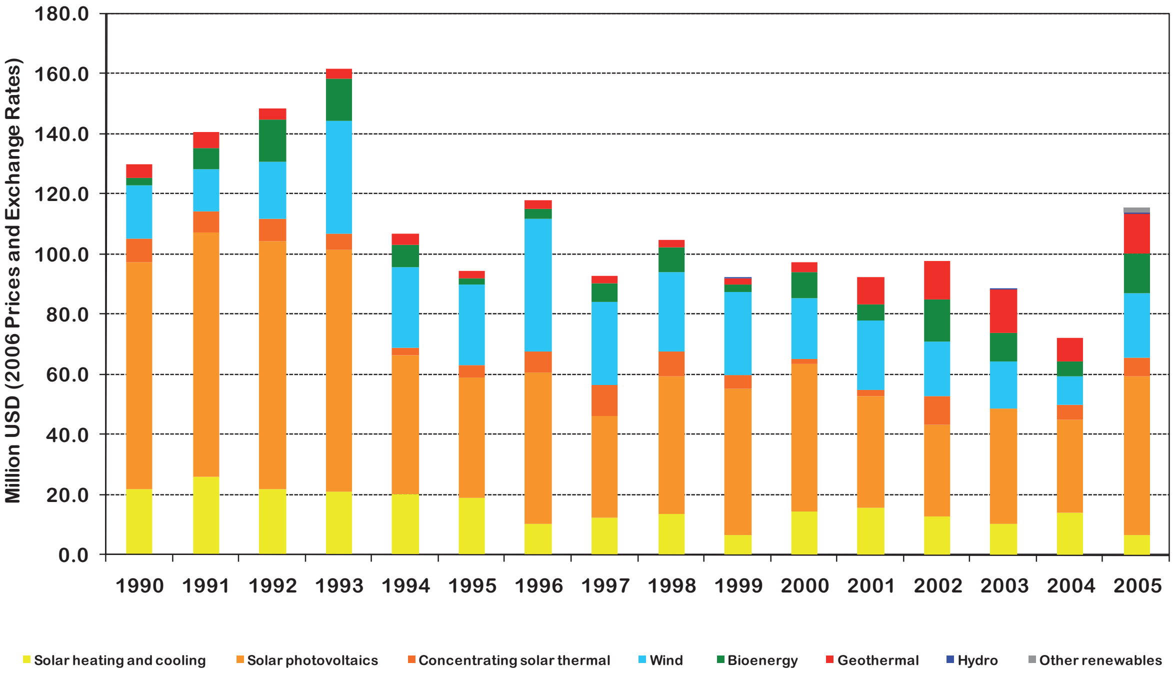
In order to avoid over-compensation of biofuels and high tax revenue losses (EUR 1.3 billion in 2005), the preferential tax treatment for biofuels was eliminated under the "Act on the Regulation of the Taxation of Energy Products" and the amendment of the "Act on Electricity Taxation", which entered into force in August 2006. The phasing-out of the tax exemption is planned in several phases to 2012, depending on the type of biofuel. For unmixed fuels like biodiesel and vegetable oil, this involves a phased increase in the amount of tax charged, reaching EUR 0.45/ litre by 2012, almost matching the full tax rate for diesel fuel (as of 2007: EUR 0.47/litre) (IEA, 2007b). For second-generation biofuels, the tax exemption continues until 2015, but adjustment takes place on an annual basis according to over-compensation monitoring. The tax treatment is monitored and subject to adjustment if it is found to overcompensate for the cost differential between biofuels and fossil fuels (IEA, 2007b).

Another Act which significantly influences on the further development of biofuels is the "Biofuels Quota Law". This act, which came into force in December 2006, replaces the tax exemption with a quota system introducing a minimum percentage of biofuels (biodiesel: 4.4% by energy content; bioethanol: 1.2% by energy content), which must be added to fossil fuels. The required share of bioethanol in gasoline rises to 3.6% in 2010.

The German government originally proposed to increase the total share of biofuels in transport fuels to 6% by energy content by 2010. In December 2006 the parliament enacted the legislation, but raised the overall obligation to 6.75% in 2010 and 8% in 2015. The overall biofuels obligation can be met by either exceeding the individual bioethanol or biodiesel obligations, as well as by a combination of the two. The 6.75% obligation for 2010 puts it further ahead of the EU's biofuels directive target of 5.75% for the same year (IEA, 2007b).

RESEARCH AND DEVELOPMENT TRENDS

Figure 6. Annual Government RD&D Spending on Renewables, 1990-2005 (USD 2006 prices and exchange rates)[4]



Source: IEA (2007c)

Germany spent a total of USD 7.058 billion[5] on government energy RD&D from 1990 to 2005. About 26% of the total German RD&D budget over this period was allocated to renewable energy RD&D. This fraction peaked in 1999 with 37% of the German government's annual RD&D budget (Figure 8).

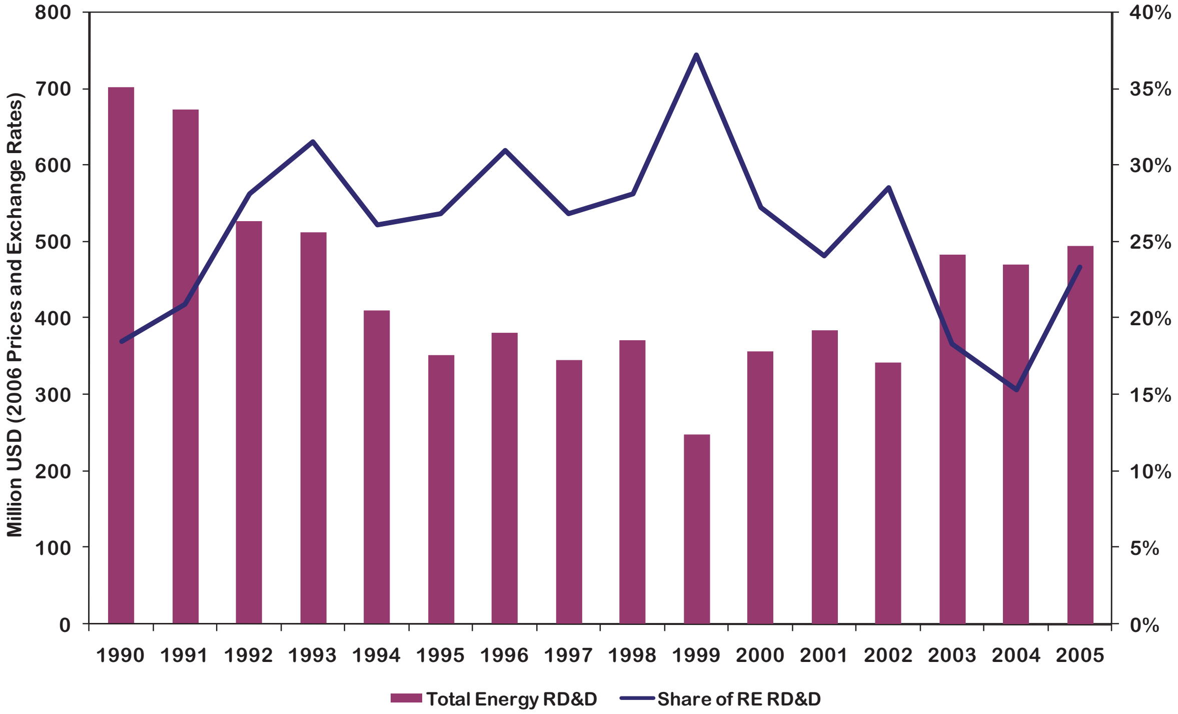
Absolute expenditures on total energy as well as renewable energy RD&D were particularly high in the early 1990s. Whilst total energy RD&D budgets were already showing a clear downwards trend, RE RD&D budgets did still increase until 1993. In 1994, however, RE RD&D budgets were adjusted down as well and decreased about one third compared to the previous year (Figure 7). The lowest annual amount of RD&D on renewable energy technologies was spent in 2004, followed by a sharp increase in 2005 of 74% compared to the previous year. In this year the long-discussed Fifth Energy Research Programme became effective, setting the framework for public RD&D support in energy technologies as a whole. As set out in this programme, RD&D expenditures on renewable energy technologies shall increase annually to a total annual budget of USD 211.5 million in 2008.

[4] Official IEA data on energy RD&D budgets include only **government** funding and not **private** RD&D spending.
[5] Conversion from national currency to USD is in USD (2006) prices and exchange rates.

Between 1990 and 2005, 65% of the USD 1.755 billion total government expenditures on RE RD&D were spent on solar PV and solar thermal. 22% of the cumulative budget were invested in wind energy RD&D, 7% in bioenergy, and 6% in geothermal RD&D activities.

In recent years, geothermal and bioenergy have gained in significance relative to wind, solar PV and solar thermal, accounting for 12% of 2005 annual RD&D expenditures on renewables.

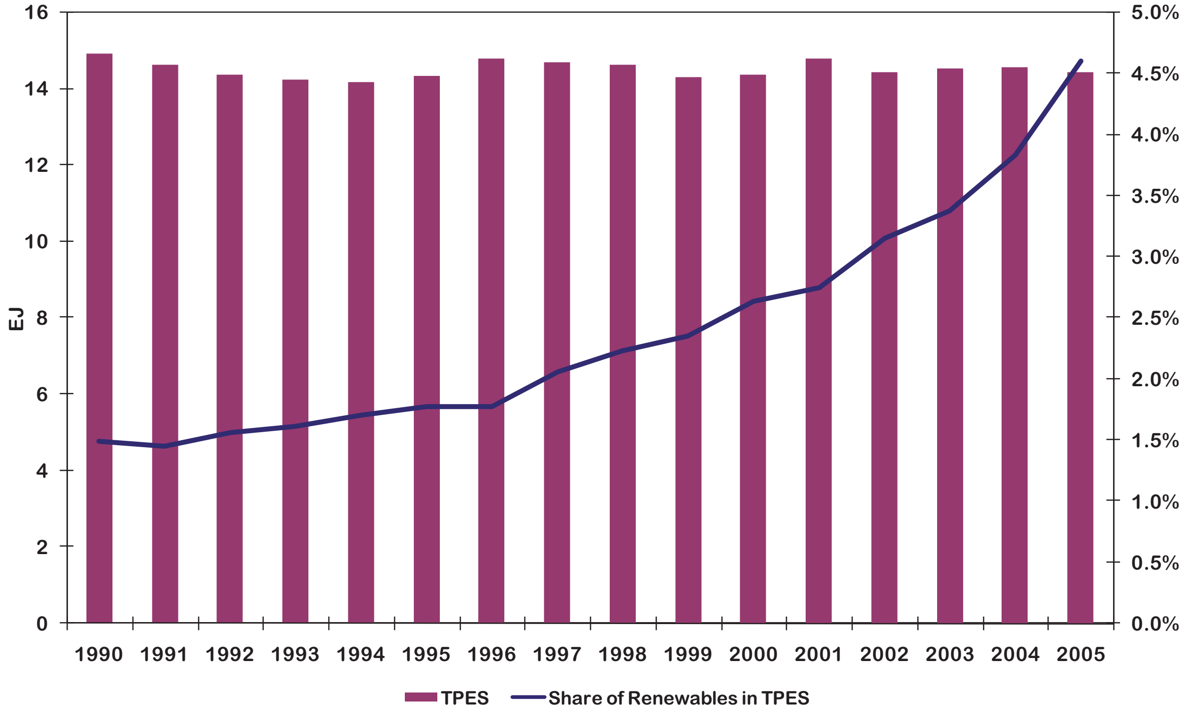
Figure 8. Renewable energy RD&D versus total government energy RD&D spending, 1990-2005



Source: IEA (2007c)

RENEWABLES IN TOTAL PRIMARY ENERGY SUPPLY[6]

Figure 9. Share of Renewable Energy in Total Primary Energy Supply, 1990-2005



Source: IEA (2007a)

Total primary energy supply (TPES) in Germany was 14.9 EJ in 1990 and 14.4 EJ in 2005. Besides the stabilisation of TPES, the contribution of renewable energy sources to TPES has been constantly increasing. In 1990 renewable energies accounted for 1.5% of TPES, in 2005 their share had increased to 4.6%. Within this period of time the total amount of renewable energy supply almost tripled reaching 665 PJ in 2005, growing on 15-year-average by 7.4% annually.

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[6] The official IEA statistics on TPES include, where applicable, traditional biomass but exclude pumped hydro.

Primary energy convention: The IEA uses the **physical energy content method** to calculate the primary energy equivalent of non-combustible energy sources, such as geothermal, hydro, solar and wind. As a consequence, there is an obvious link between the principles adopted in defining the primary energy forms of energy sources and the primary energy equivalent of these sources. For instance, in the case solar thermal and geothermal electricity production, as heat is the primary energy form selected by the IEA, the primary energy equivalent is the quantity of heat generated in the geothermal or solar thermal plant for electricity generation. In the case of hydro, wind, tide and solar PV, as electricity is the primary energy form selected, the primary energy equivalent is the physical energy content of the electricity generated in the plant, which amounts to assuming an efficiency of 100%. Readers may consult (IEA, 2007a) for more details.

RENEWABLE ENERGY POLICY INFORMATION

For further details on renewable energy support policies implemented in Germany, readers may consult the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

GLOSSARY

Definitions, abbreviations, acronyms and units are explained in the Glossary which can be found after the country profiles.

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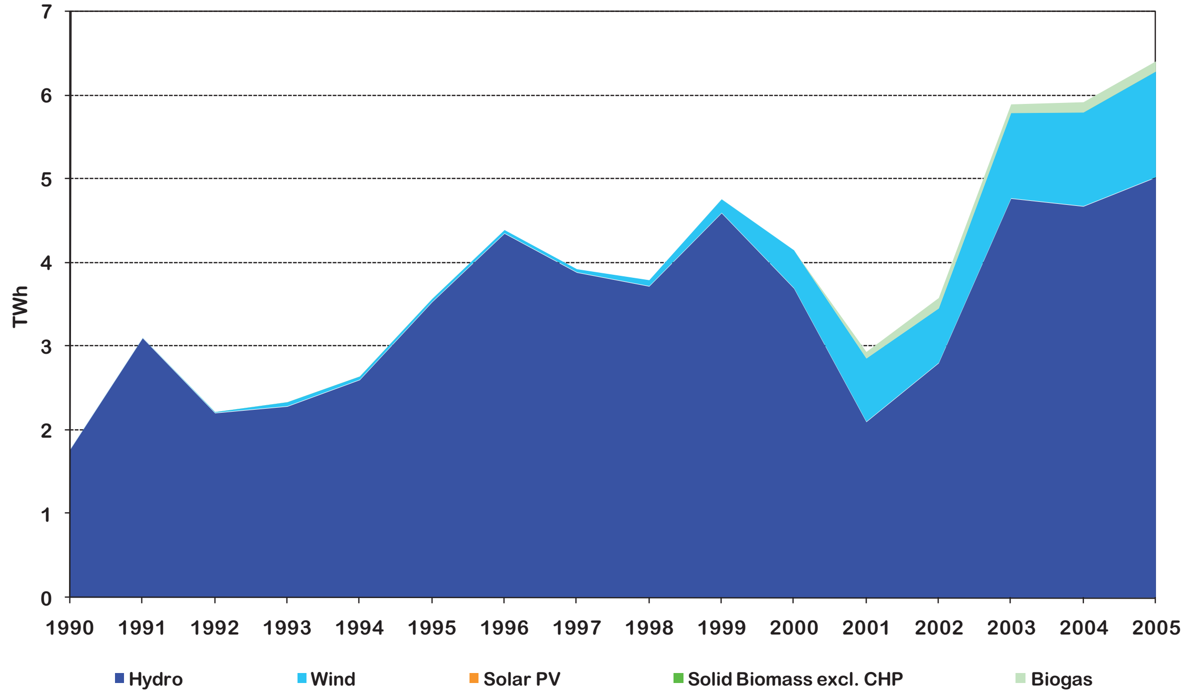
GREECE[1]

RENEWABLE ELECTRICITY (RES-E) MARKET

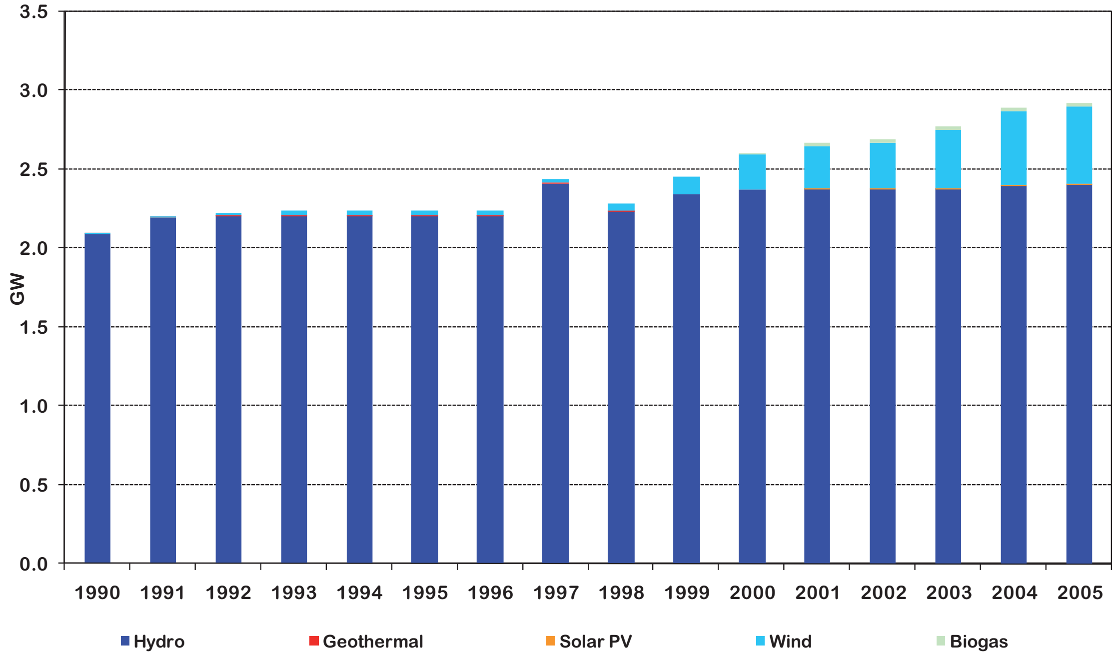
Figure 18. Total RES-E Production, 1990-2005



Source: IEA (2007a)

[1] A summary profile was prepared of Greece's renewable energy **market** developments from 1990 to 2005. Policy developments are available in the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

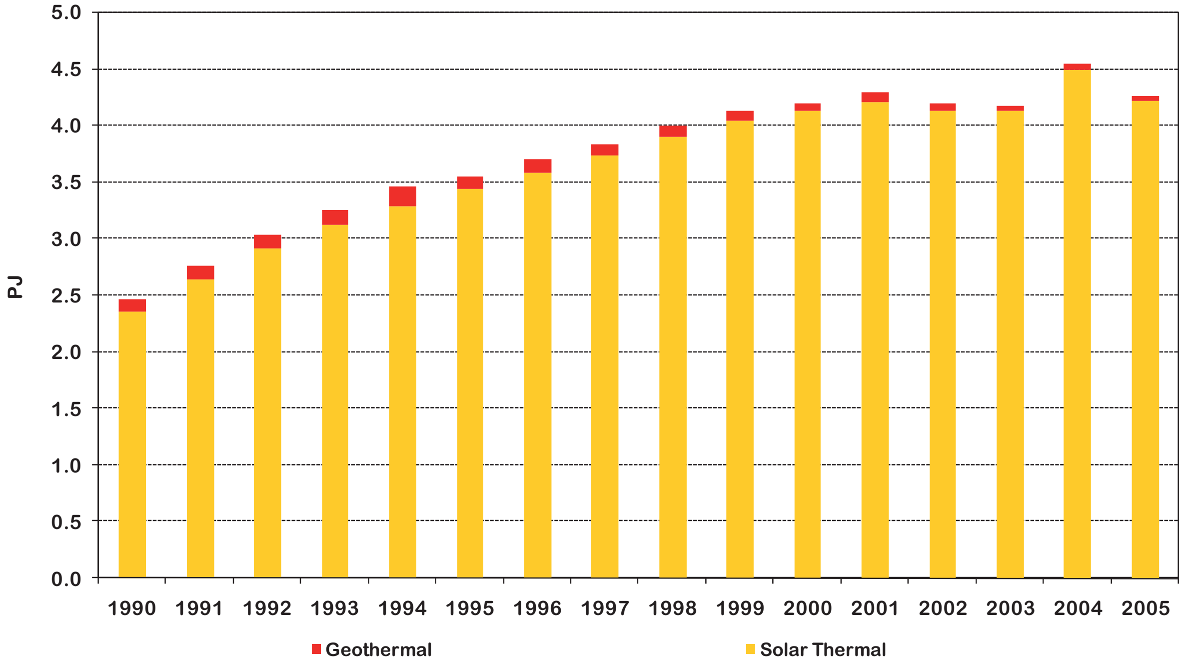
Figure 2. Net Generating Capacity of RES-E Plants, 1990-2005



Source: IEA (2007a)

RENEWABLE HEAT (RES-H) MARKET

Figure 3. Total RES-H Production, 1990-2005[2]



NB: Geothermal and solar thermal include direct final use.

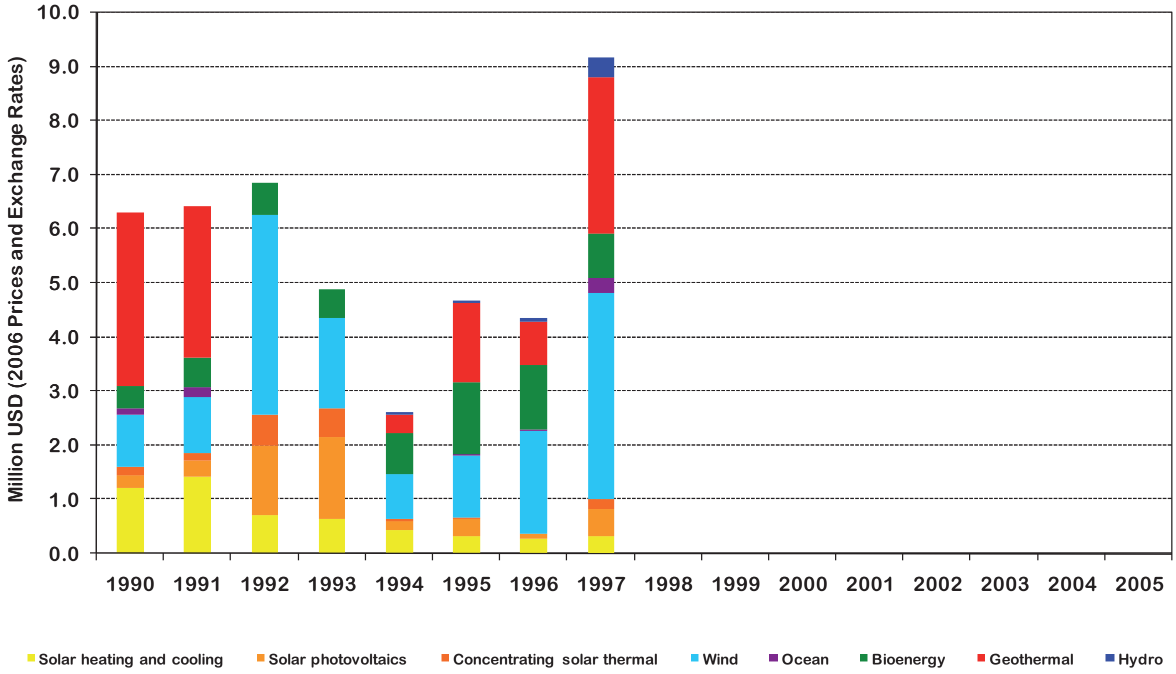
Source: IEA (2007a)

RENEWABLE TRANSPORT FUEL (RES-T) MARKET

Official IEA statistics do not report any biofuel production and consumption in Greece from 1990 to 2005.

[2] Official IEA statistics on heat generation from renewable energy sources relate to **commercial heat sold** with additional data on **direct use** of solar thermal and geothermal available for most OECD countries.

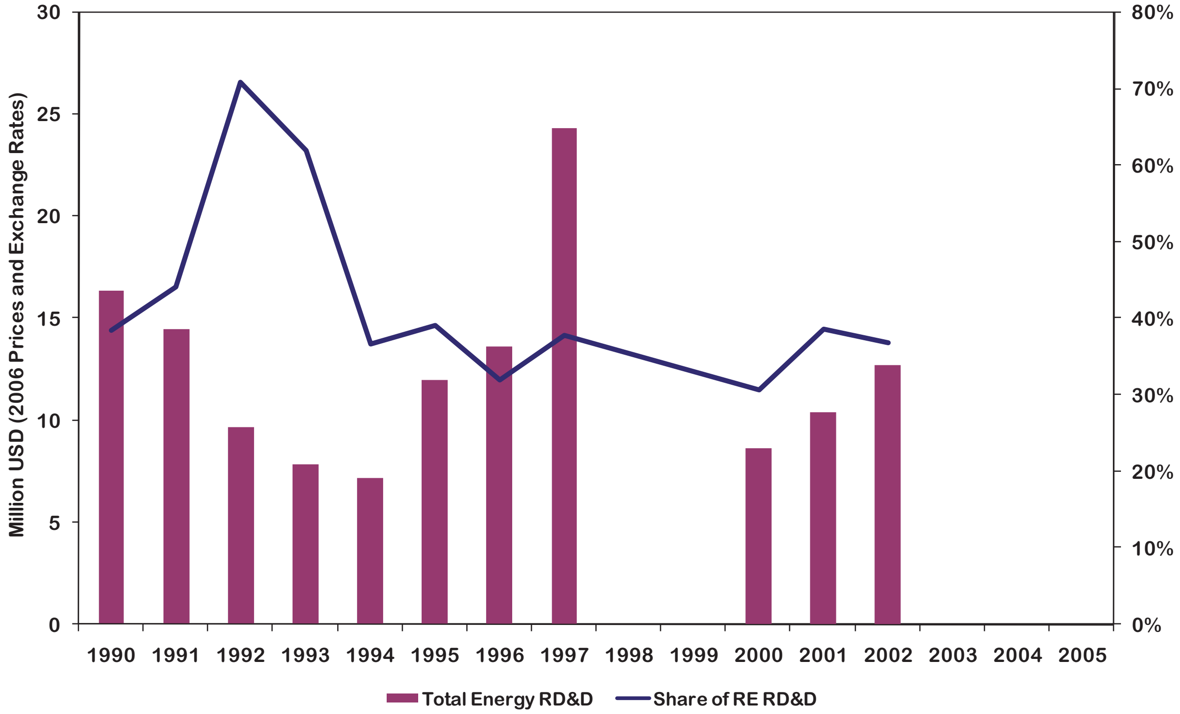
Figure 4. Annual Government RD&D Spending on Renewables, 1990-2005 (USD 2006 prices and exchange rates)[3]



Source: IEA (2007b)

[3] Official IEA data on energy RD&D budgets include only **government** funding and not **private** RD&D spending.

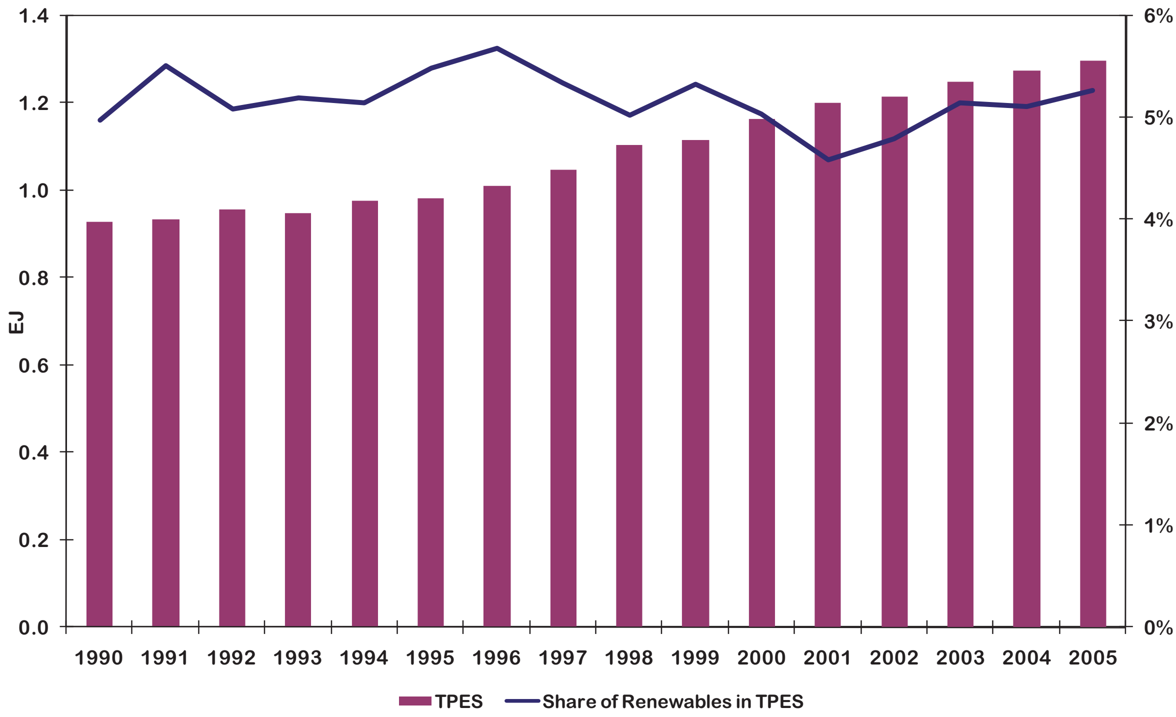
Figure 5. Renewable energy RD&D versus total government energy RD&D spending, 1990-2005



Source: IEA (2007b)

RENEWABLES IN TOTAL PRIMARY ENERGY SUPPLY[4]

Figure 6. Share of Renewable Energy in Total Primary Energy Supply, 1990-2005



Source: IEA (2007a)

RENEWABLE ENERGY POLICY INFORMATION

For details on renewable energy support policies implemented in Greece, readers may consult the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

GLOSSARY

Definitions, abbreviations, acronyms and units are explained in the Glossary which can be found after the country profiles.

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[4] The official IEA statistics on TPES include, where applicable, traditional biomass but exclude pumped hydro.
Primary energy convention: The IEA uses the **physical energy content method** to calculate the primary energy equivalent of non-combustible energy sources, such as geothermal, hydro, solar and wind. As a consequence, there is an obvious link between the principles adopted in defining the primary energy forms of energy sources and the primary energy equivalent of these sources. For instance, in the case solar thermal and geothermal electricity production, as heat is the primary energy form selected by the IEA, the primary energy equivalent is the quantity of heat generated in the geothermal or solar thermal plant for electricity generation. In the case of hydro, wind, tide and solar PV, as electricity is the primary energy form selected, the primary energy equivalent is the physical energy content of the electricity generated in the plant, which amounts to assuming an efficiency of 100%. Readers may consult (IEA, 2007a) for more details.

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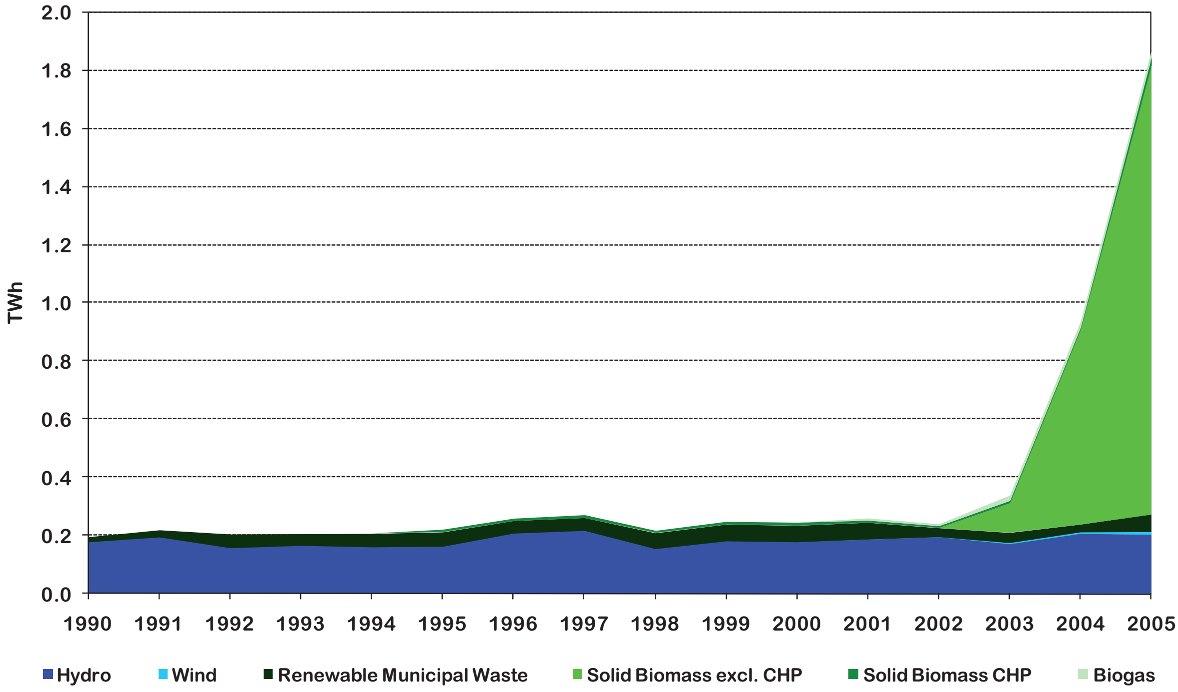
IEA (2008), "Global Renewable Energy Policies and Measures Database", www.iea.org/textbase/pm/grindex.aspx, International Energy Agency, accessed 15 March 2008.

HUNGARY[1]

RENEWABLE ELECTRICITY (RES-E) MARKET

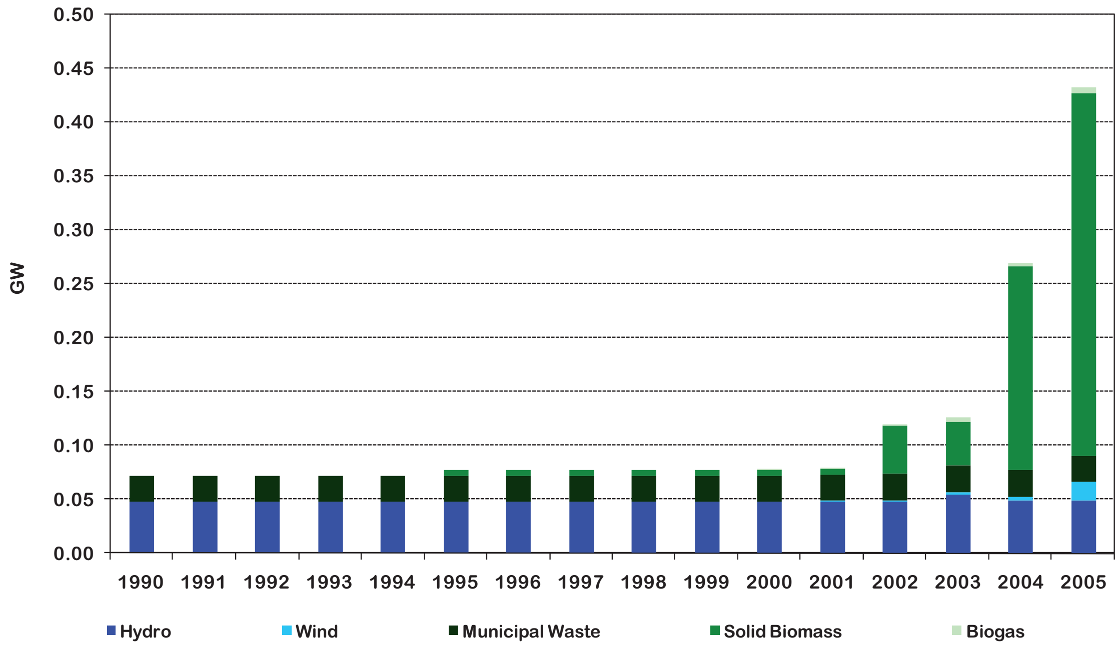
Figure 19. Total RES-E Production, 1990-2005



Source: IEA (2007a)

[1] A summary profile was prepared of Hungary's renewable energy **market** developments from 1990 to 2005. Policy developments are available in the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

Figure 2. Net Generating Capacity of RES-E Plants, 1990-2005

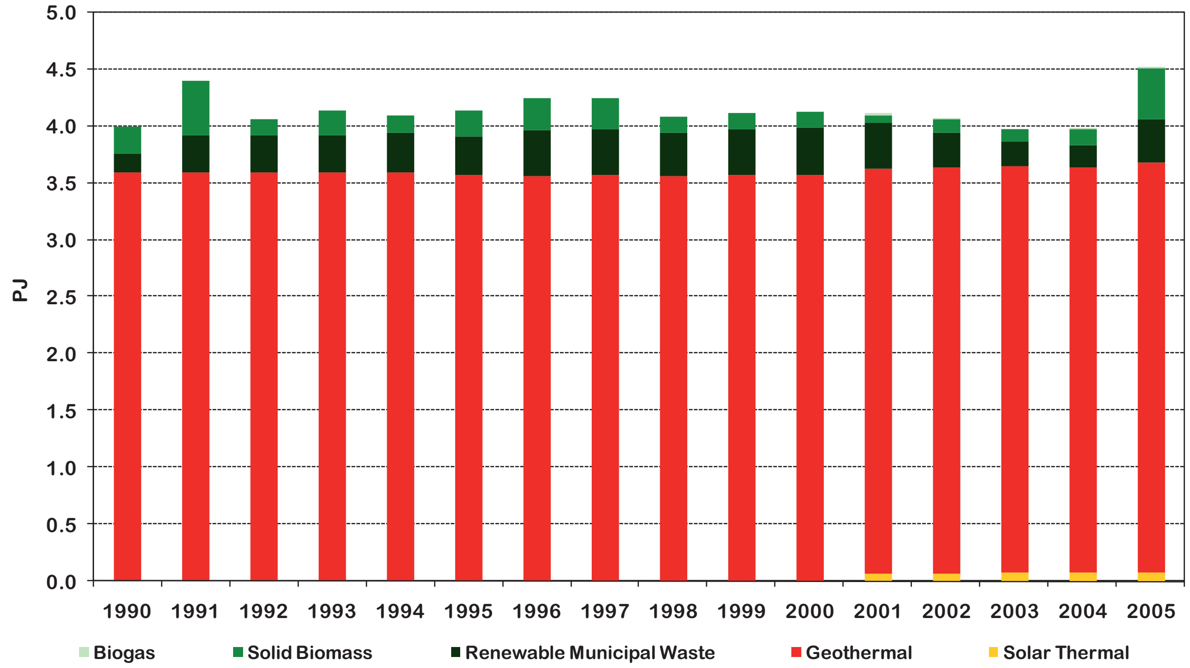


NB: Official IEA statistics on electricity generating capacity do not differentiate between *renewable* and *non-renewable* municipal waste.

Source: IEA (2007a)

RENEWABLE HEAT (RES-H) MARKET

Figure 3. Total RES-H Production, 1990-2005[2]



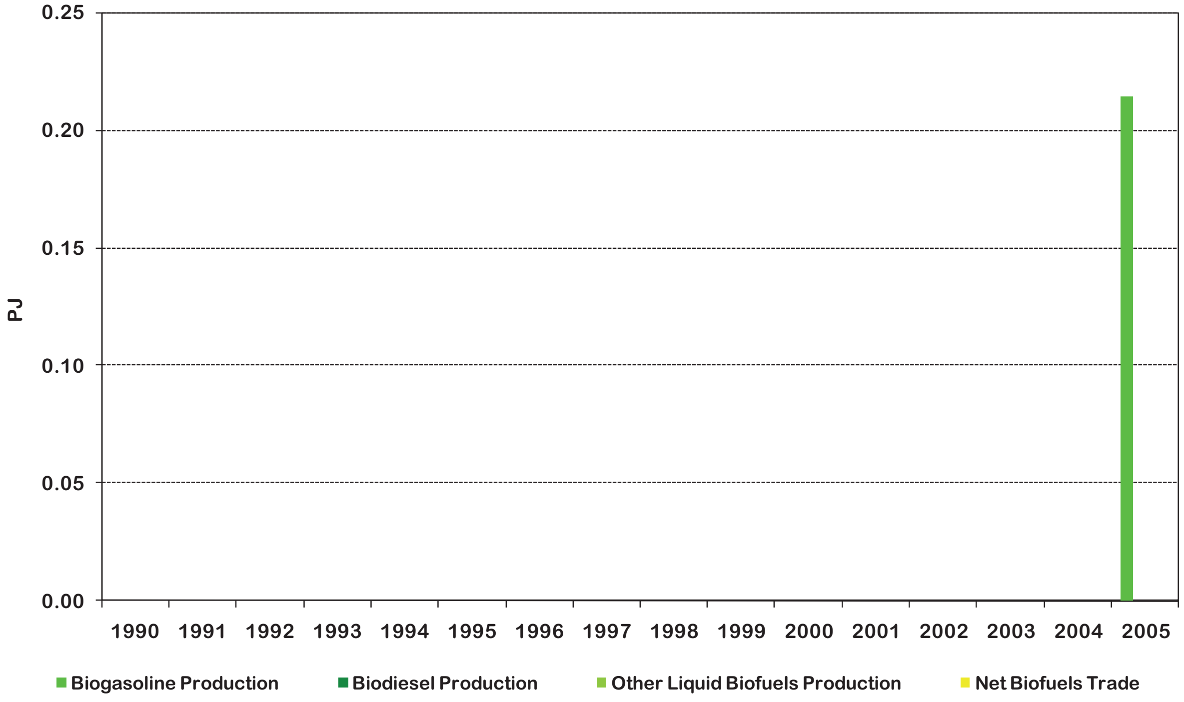
NB: Geothermal and solar thermal include direct final use.

Source: IEA (2007a)

[2] Official IEA statistics on heat generation from renewable energy sources relate to **commercial heat sold** with additional data on **direct use** of solar thermal and geothermal available for most OECD countries.

Renewable Transport Fuel (RES-T) Market

Figure 4. Total RES-T Production, 1990-2005

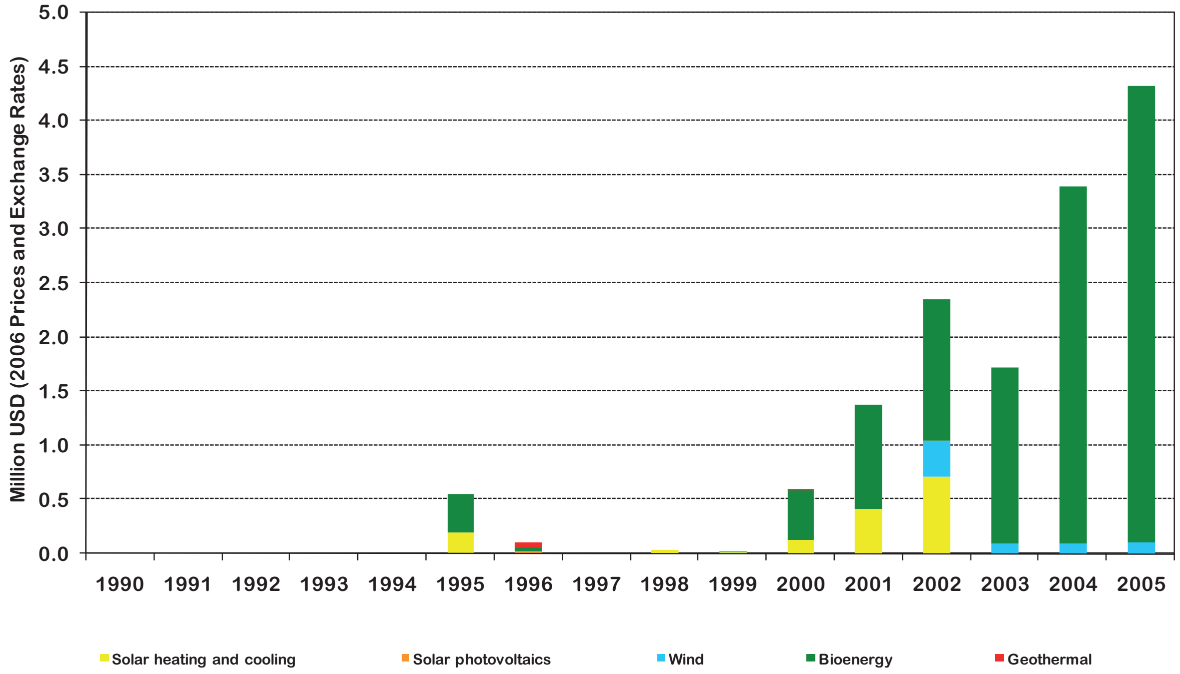


NB: Net Biofuels Trade refers to the balance of domestic biofuel consumption, i.e. biofuel exports subtracted from imports.

Source: IEA (2007a)

RESEARCH, DEVELOPMENT AND DEMONSTRATION TRENDS

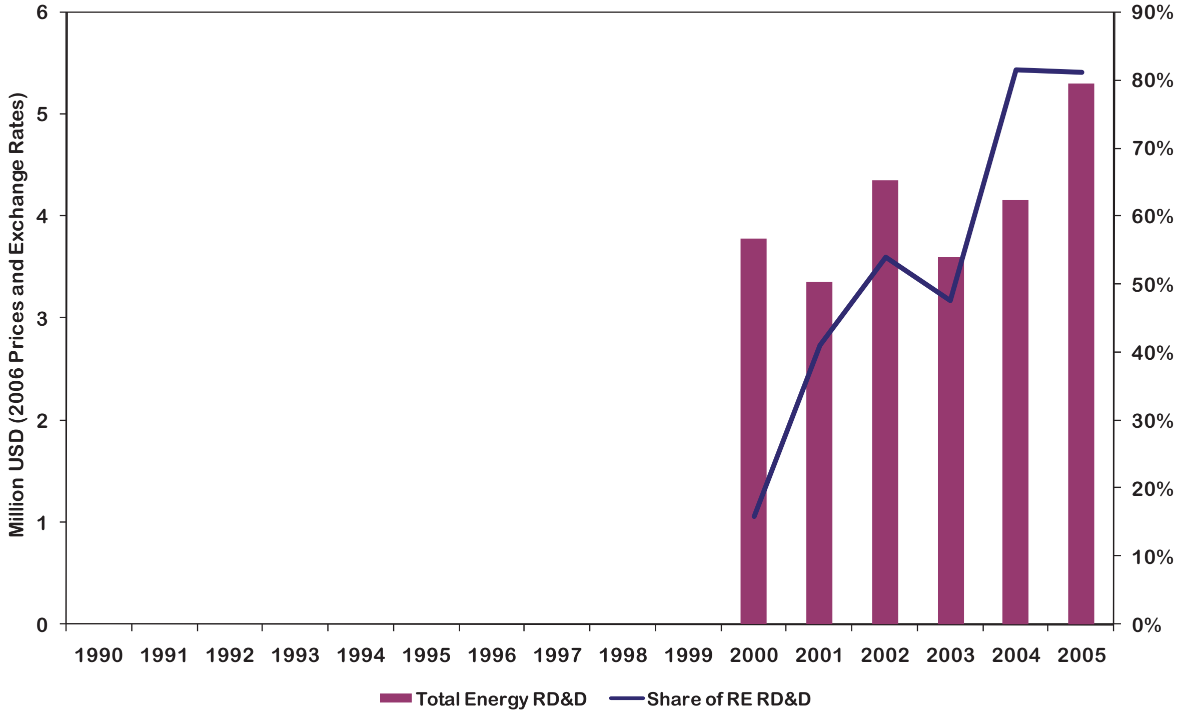
Figure 5. Annual Government RD&D Spending on Renewables, 1990-2005 (USD 2006 prices and exchange rates)[3]



Source: IEA (2007b)

[3] Official IEA data on energy RD&D budgets include only **government** funding and not **private** RD&D spending.

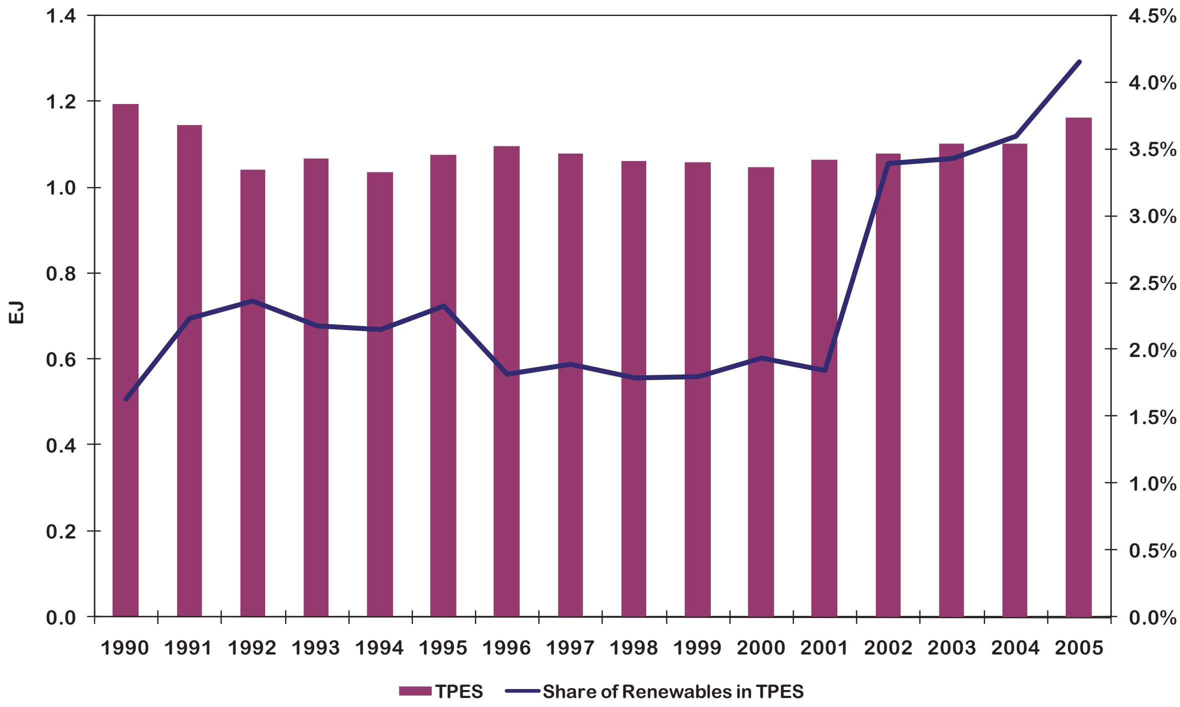
Figure 6. Renewable energy RD&D versus total government energy RD&D spending, 1990-2005



Source: IEA (2007b)

RENEWABLES IN TOTAL PRIMARY ENERGY SUPPLY[4]

Figure 7. Share of Renewable Energy in Total Primary Energy Supply, 1990-2005



Source: IEA (2007a)

RENEWABLE ENERGY POLICY INFORMATION

For details on renewable energy support policies implemented in Hungary, readers may consult the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

[4] The official IEA statistics on TPES include, where applicable, traditional biomass but exclude pumped hydro.
Primary energy convention: The IEA uses the **physical energy content method** to calculate the primary energy equivalent of non-combustible energy sources, such as geothermal, hydro, solar and wind. As a consequence, there is an obvious link between the principles adopted in defining the primary energy forms of energy sources and the primary energy equivalent of these sources. For instance, in the case solar thermal and geothermal electricity production, as heat is the primary energy form selected by the IEA, the primary energy equivalent is the quantity of heat generated in the geothermal or solar thermal plant for electricity generation. In the case of hydro, wind, tide and solar PV, as electricity is the primary energy form selected, the primary energy equivalent is the physical energy content of the electricity generated in the plant, which amounts to assuming an efficiency of 100%. Readers may consult (IEA, 2007a) for more details.

Glossary

Definitions, abbreviations, acronyms and units are explained in the Glossary which can be found after the country profiles.

References

IEA (2007a), *Renewables Information 2007*, OECD/IEA, Paris.

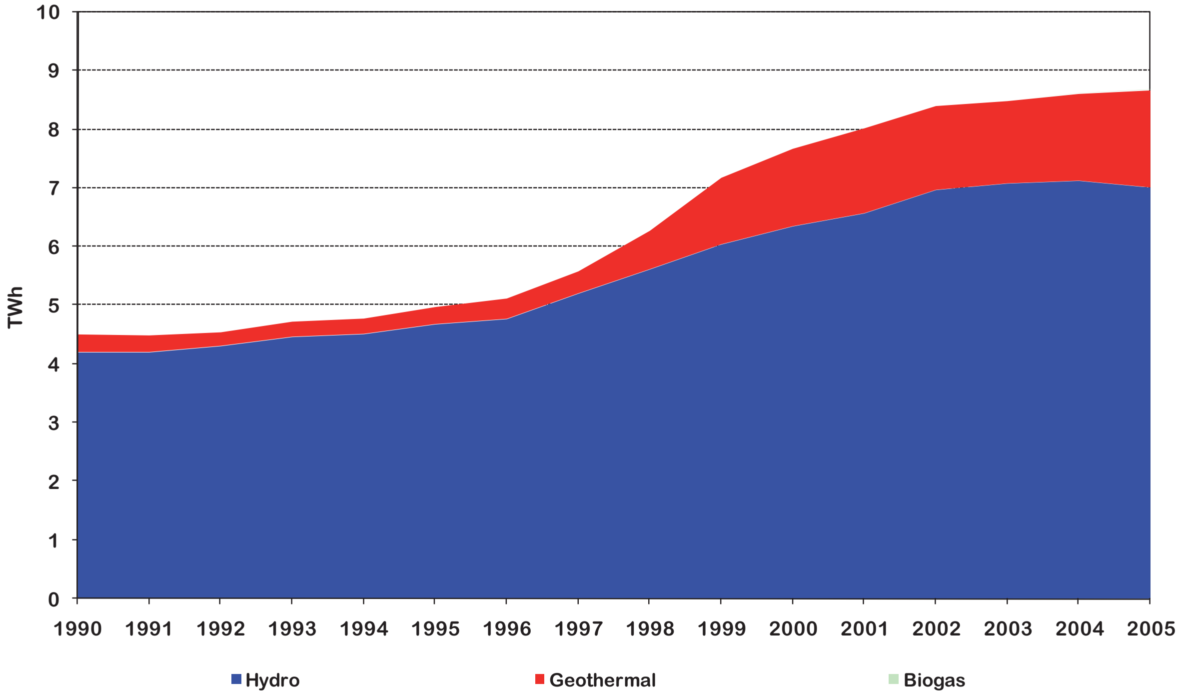
IEA (2007b), *IEA Energy Technology R&D Statistics,* IEA, Paris, http://www.iea.org/Textbase/stats/rd.asp, accessed 21 November 2007.

IEA (2008), "Global Renewable Energy Policies and Measures Database", www.iea.org/textbase/pm/grindex.aspx, International Energy Agency, accessed 15 March 2008.

ICELAND[1]

RENEWABLE ELECTRICITY (RES-E) MARKET

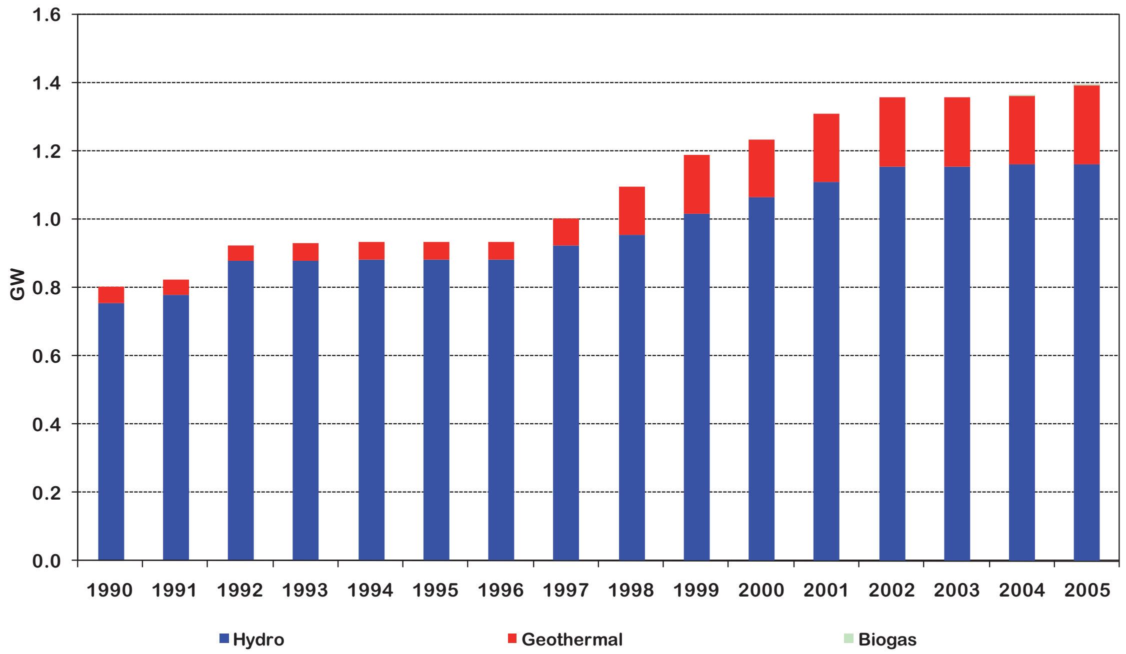
Figure 20. Total RES-E Production, 1990-2005



Source: IEA (2007a)

[1] A summary profile was prepared of Iceland's renewable energy **market** developments from 1990 to 2005. Policy developments are available in the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

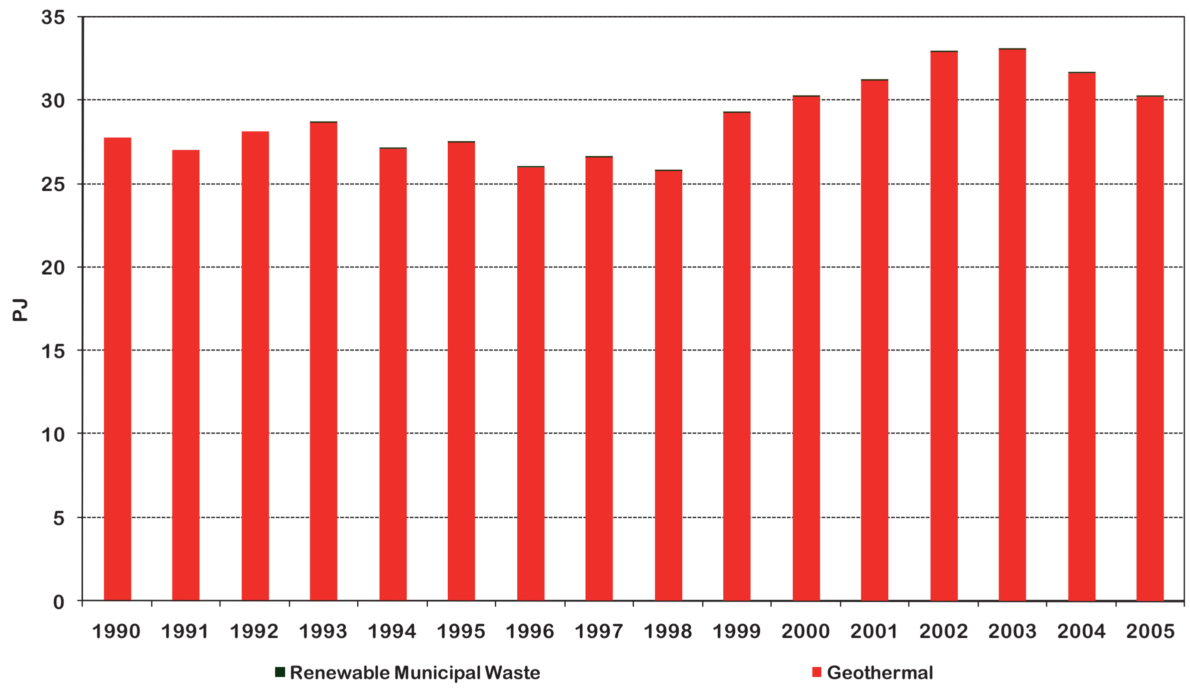
Figure 2. Net Generating Capacity of RES-E Plants, 1990-2005



Source: IEA (2007a)

RENEWABLE HEAT (RES-H) MARKET

Figure 3. Total RES-H Production, 1990-2005[2]



NB: Geothermal includes direct final use.

Source: IEA (2007a)

RENEWABLE TRANSPORT FUEL (RES-T) MARKET

Official IEA statistics do not report any biofuel production and consumption in Iceland from 1990 to 2005.

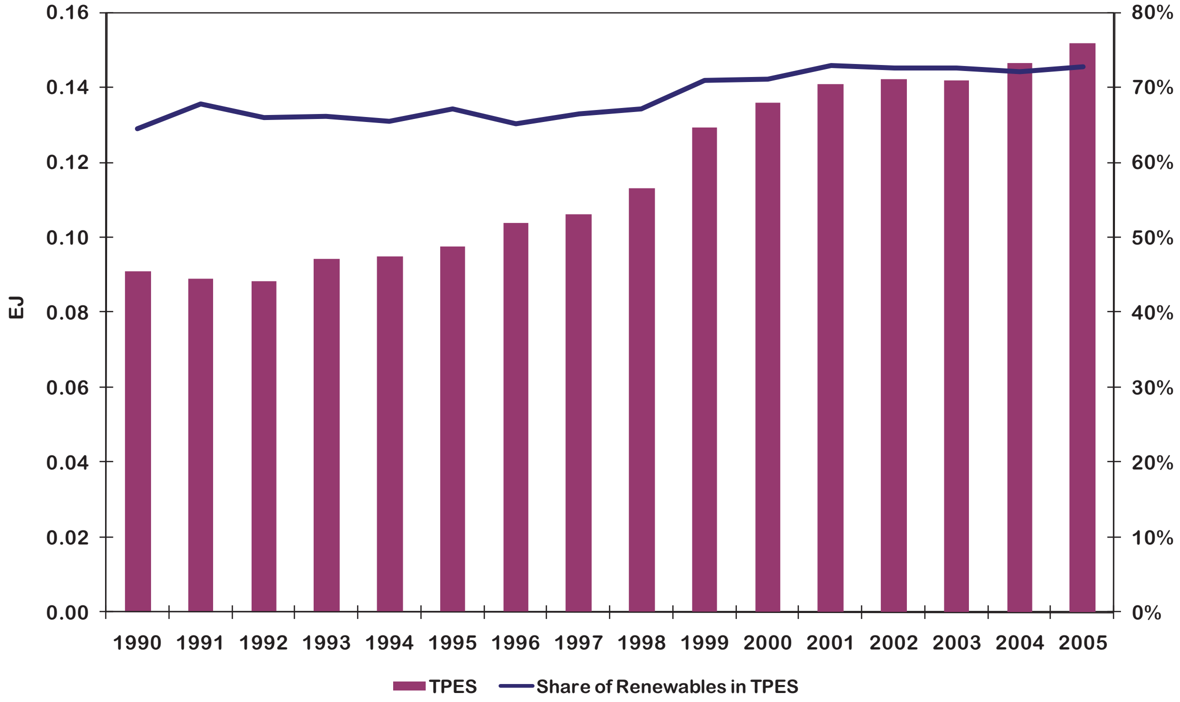
RESEARCH, DEVELOPMENT AND DEMONSTRATION TRENDS

Official IEA statistics do not report any government R&D funding for renewable energy technologies in Iceland.

[2] Official IEA statistics on heat generation from renewable energy sources relate to **commercial heat sold** with additional data on **direct use** of solar thermal and geothermal available for most OECD countries.

RENEWABLES IN TOTAL PRIMARY ENERGY SUPPLY[3]

Figure 4. Share of Renewable Energy in Total Primary Energy Supply, 1990-2005



Source: IEA (2007a)

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[3] The official IEA statistics on TPES include, where applicable, traditional biomass but exclude pumped hydro.

Primary energy convention: The IEA uses the **physical energy content method** to calculate the primary energy equivalent of non-combustible energy sources, such as geothermal, hydro, solar and wind. As a consequence, there is an obvious link between the principles adopted in defining the primary energy forms of energy sources and the primary energy equivalent of these sources. For instance, in the case solar thermal and geothermal electricity production, as heat is the primary energy form selected by the IEA, the primary energy equivalent is the quantity of heat generated in the geothermal or solar thermal plant for electricity generation. In the case of hydro, wind, tide and solar PV, as electricity is the primary energy form selected, the primary energy equivalent is the physical energy content of the electricity generated in the plant, which amounts to assuming an efficiency of 100%. Readers may consult (IEA, 2007a) for more details.

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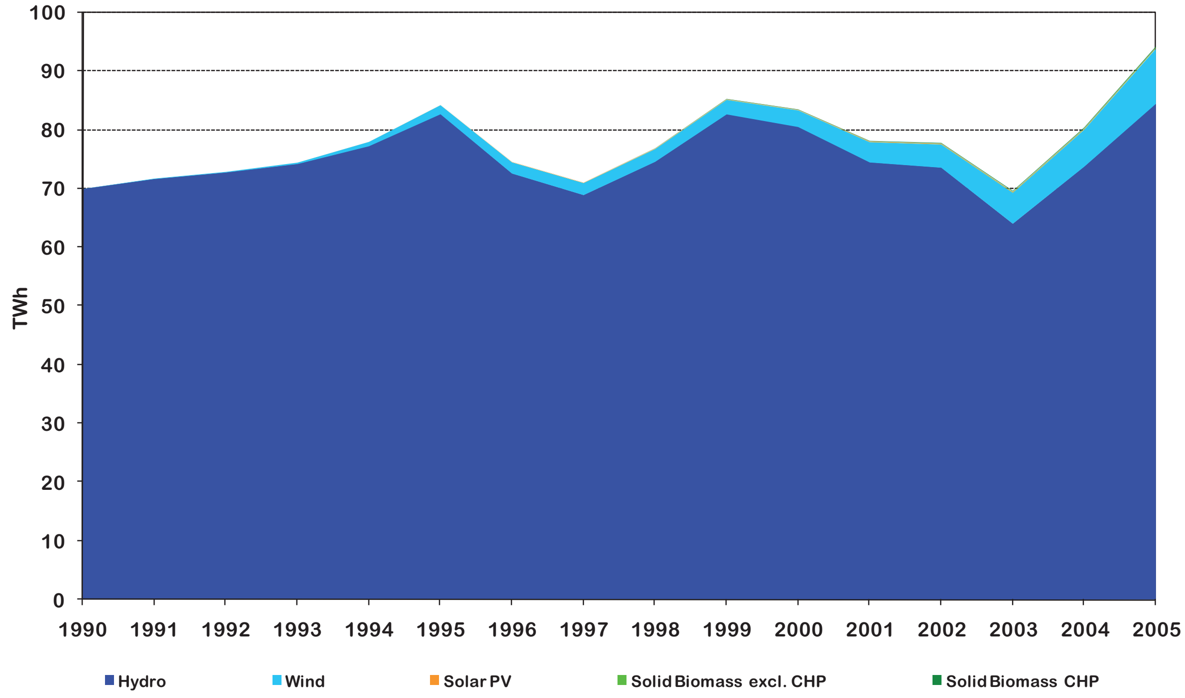
IEA (2008), "Global Renewable Energy Policies and Measures Database", www.iea.org/textbase/pm/grindex.aspx, International Energy Agency, accessed 15 March 2008.

INDIA

RENEWABLE ELECTRICITY (RES-E) MARKET

Figure 1. Total RES-E Production, 1990-2005[1]



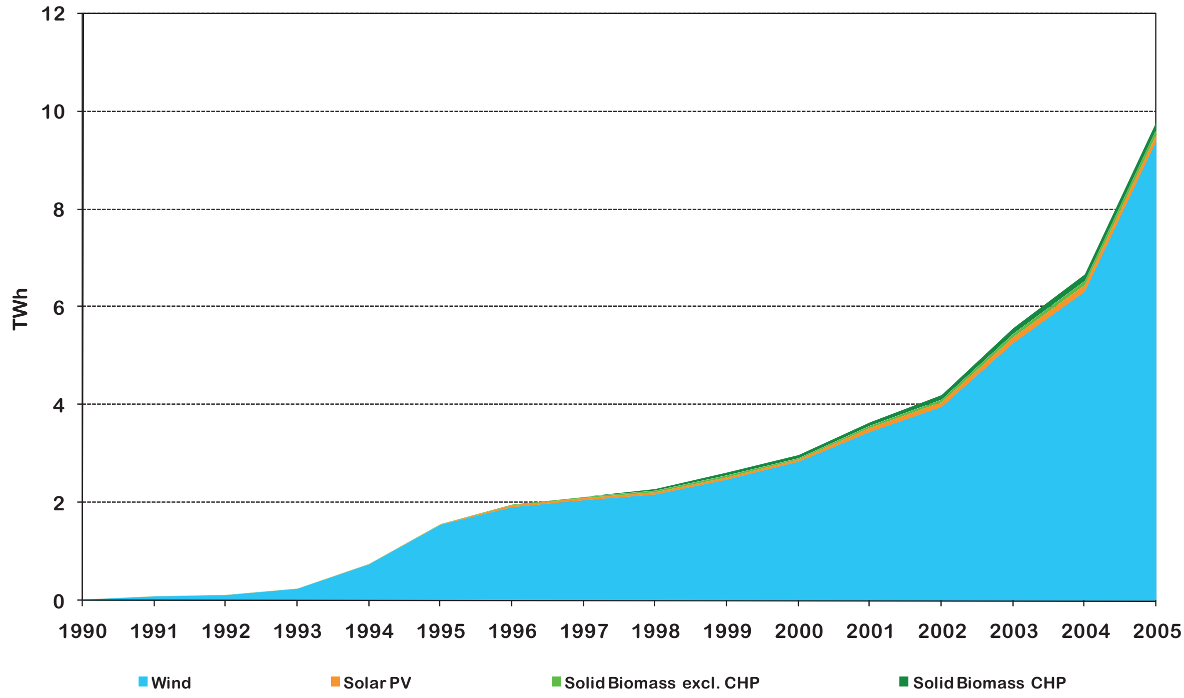
Source: TERI (2007)

Electricity production from renewable energy sources (RES-E) in India was 89 TWh in 2005 representing 12.7% of total electricity production. This share was 24.2% in 1990, since electricity production from conventional sources increased much faster (at an annual average growth rate of 6.6% since 1990) than that generated by renewable sources (corresponding growth rate of 1.6%).

Despite significant fluctuations in terms of electricity generated by renewables, total installed capacities of renewable energy sources increased constantly since 1990 at an average annual growth rate of 4.6%. In 2006, India had the world's fifth largest amount of existing renewable power capacity installed on a country by country basis. Fluctuations can largely be attributed to the strong influence of climatic conditions on the availability of hydro power, which accounts for the lion's share of renewables in India.

[1] Electricity production has been estimated for single values according to capacity developments due to data unavailability.

Figure 21. Total RES-E Production (excluding Hydropower), 1990-2005



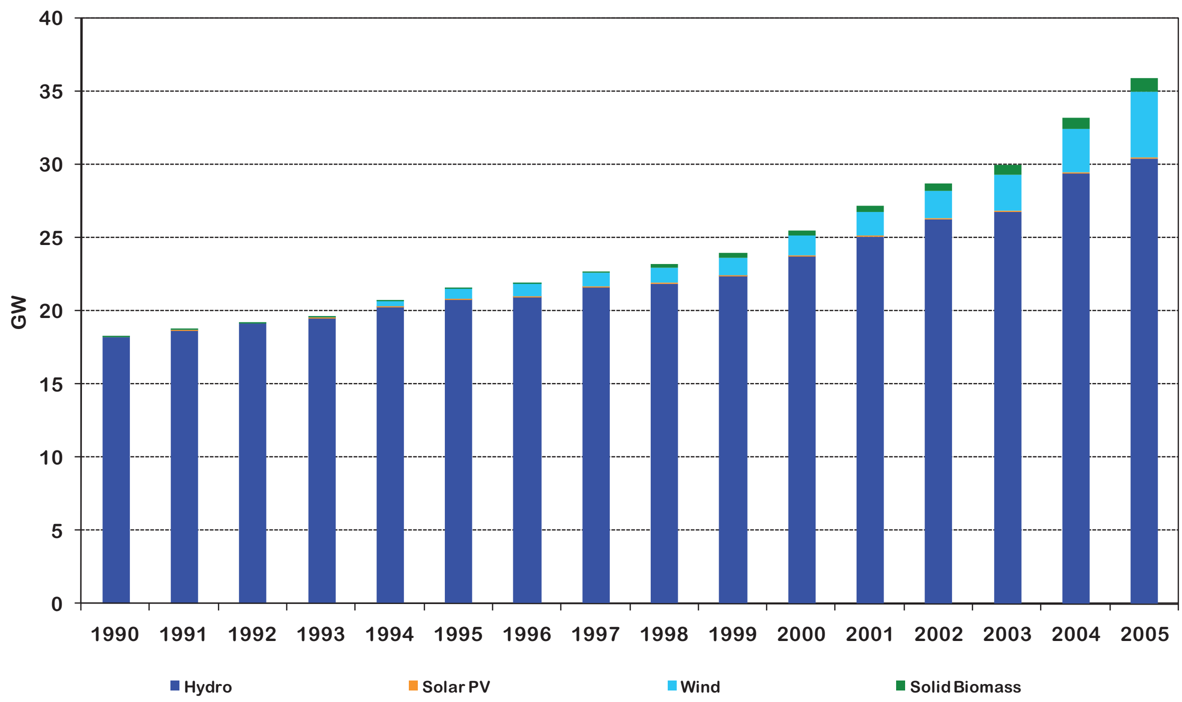
Source: TERI (2007)

The major source of renewable electricity is hydropower, which was basically the only renewable source of electricity in 1990 and still provided 95% of RES-E production in 2005. However, wind power has seen considerable growth over the 15-year period increasing on average by 41% per year. In 2005 wind contributed 4.8% to renewable power generation, which represents 0.6% of total electricity production. In 2006, India was the world's third largest market for wind power measured in terms of annually added wind power capacity.

Electricity from other renewable sources remains at a marginal level. Nonetheless, solar photovoltaics (PV) and solid biomass, both CHP and non-CHP, were all growing at high average annual rates of 41.6%, 24.5% and 35.9%, respectively, over the considered period[2]. Moreover, India ranks fourth in terms of total installed solar PV capacity after Germany, Japan and the USA, which are covering 88% of global installations.

[2] The annual average growth figures refer to the period from 1990 to 2005 for solar PV and non-CHP solid biomass and to the period from 1998 to 2005 for solid biomass CHP.

Figure 3. Net Generating Capacity of RES-E Plants, 1990-2005



Source: TERI (2007)

The Indian electricity sector is still facing numerous, interrelated challenges to continue the establishment of a reliable, secure, cost-efficient and environmentally sustainable electricity market. Presenting and discussing the whole variety of interconnections of the Indian power market structure with renewable power market developments is clearly beyond the scope of this country profile[3]. However, major policy developments that directly target renewable power production are presented in the subsequent paragraphs.

Since 1992 the Ministry of New and Renewable Energy (MNRE, prior to 2006: Ministry of Non-Conventional Energy Sources) is responsible for the entire renewable energy sector. Under its auspices a number of institutions have been set up to provide assistance to the MNRE:

- the Indian Renewable Energy Development Agency (IREDA) provides preferential financial support to the renewable energy sector; and
- the Solar Energy Center, the National Institute of Renewable Energy and the Centre for Wind Energy Technology (C-WET) conduct research and development, technology development, testing and certification, etc.

[3] A comprehensive overview is provided in (IEA, 2002) and (GTZ, 2007).

Besides these institutions, public and private organizations as well as NGOs form a network that is working towards the implementation of various renewable energy projects and programmes. MNRE has furthermore set up nine regional support offices.

The policy planning process in India is based on Five-Year Plans with the 11th Five-Year Planning period running from 2007-2012. The Electricity Act (EA) 2003 that replaced all previous electricity acts has become the most important legal framework in the area of renewable energy. According to the EA 2003, rules for the remuneration of renewable energy technologies (RETs) have to be set up by each state. At the time of writing, several states had introduced preferential feed-in tariffs (FITs) for electricity from renewable energy sources (Table 1). The level, adjustment and duration of the tariffs vary significantly among states and RETs.

Table 1. Regional Overview of FIT Introduction in Indian States

State	Feed-In Tariffs		
	Wind	Biomass	Bagasse
Andhra Pradesh	2004	2004	2004
Gujarat	2006	-	2007
Haryana	2007	2007	2007
Karnataka	2005	2005	2005
Kerala	2006	-	-
Madhya Pradesh	2004	-	-
Maharashtra	2003	2005	2005
Rajasthan	2006	2006	2006
Tamil Nadu	2006	2006	2006
Uttar Pradesh	2005	-	-
West Bengal	2006	2006	-

Source: TERI (2007)

Several states have also extended their FIT schemes to include small hydropower[4]. During 2007, India announced the implementation of a premium for solar PV of INR 12/ kWh (USD 0.27/kWh[5]) and INR 10/ kWh (USD 0.22/kWh) for solar thermal power, limited to 10 MW per state (IEA, 2008).

Besides, different **renewable energy targets** (usually referred to as renewable portfolio standards - RPS) that were required under the EA 2003 have been enacted in all of the states listed in table 1 as well as in Himachal Pradesh and Orissa. In order to fulfil these requirements, the National Tariff Policy of 2006 proposes **competitive bidding** processes among suppliers of the same renewable energy technology to be used whenever applicable. The simultaneous application of a mix of policy instruments, as in India, does not necessarily

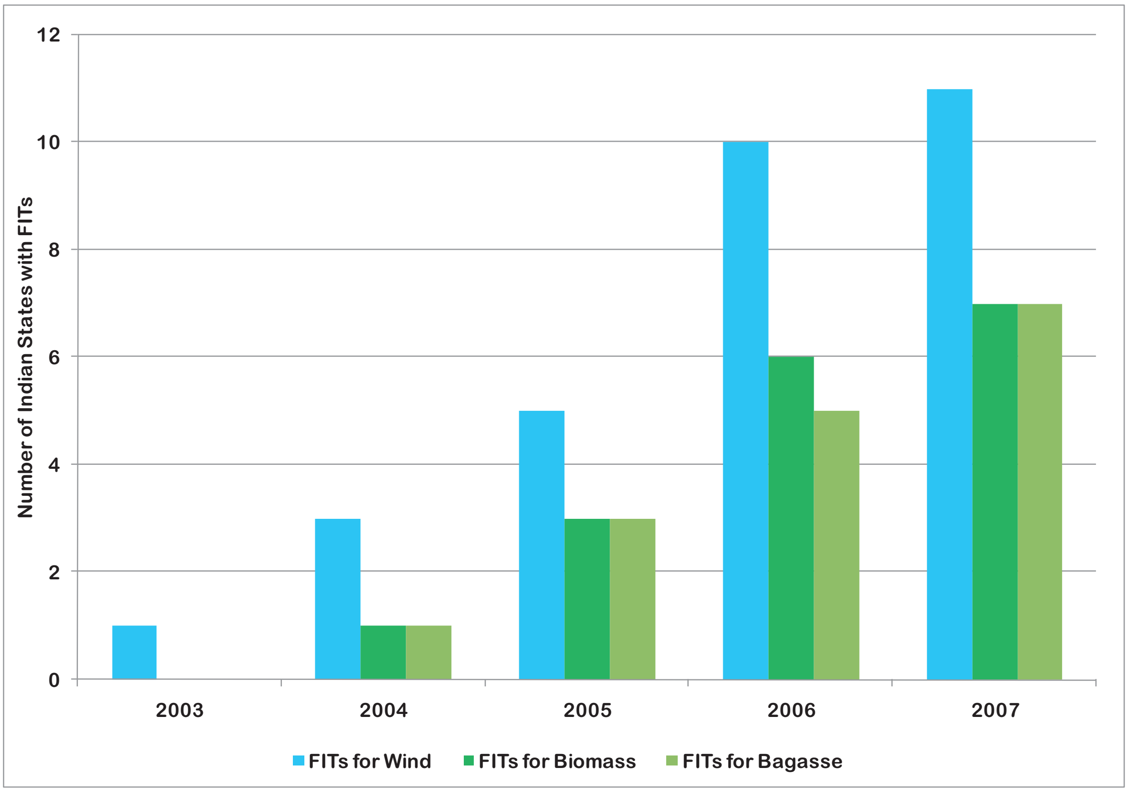
[4] These include Andhra Pradesh, Himachal Pradesh, Karnataka, Maharashtra, Madhya Pradesh, Tamil Nadu, Uttar Pradesh.
[5] The conversion to USD was at the average 2006 market exchange rate of INR 1 = USD 0.0222 except where stated otherwise.

interfere with each other in a regulated electricity market. Prices/tariffs are set by state authorities and not by an RPS-constrained market process.

Additionally, development of renewable energy technologies was pursued through various measures including at the central governmental level **subsidies, credits and fiscal incentives** like tax exemptions, reduced import duties and accelerated depreciation. On the state level incentives extended to preferential treatment in terms of **selling electricity to the grid, transmission, wheeling, banking etc**.

The increasing implementation of national policy guidelines through state-level FITs is expected to have considerable impact on the further dissemination of renewable energy technologies in India. The targets set out in the country's 11th Five-Year Plan covering the period up to 2012 include capacity additions of 14 185 MW of large hydro power plants, 1 400 MW of small hydro power, 10 500 MW of wind power projects, 50 MW of solar PV power, 900 MW of solid biomass (excl. CHP) and 1 200 MW of solid biomass CHP plants.

Figure 4. Chronological Overview of FIT Introduction in Indian States



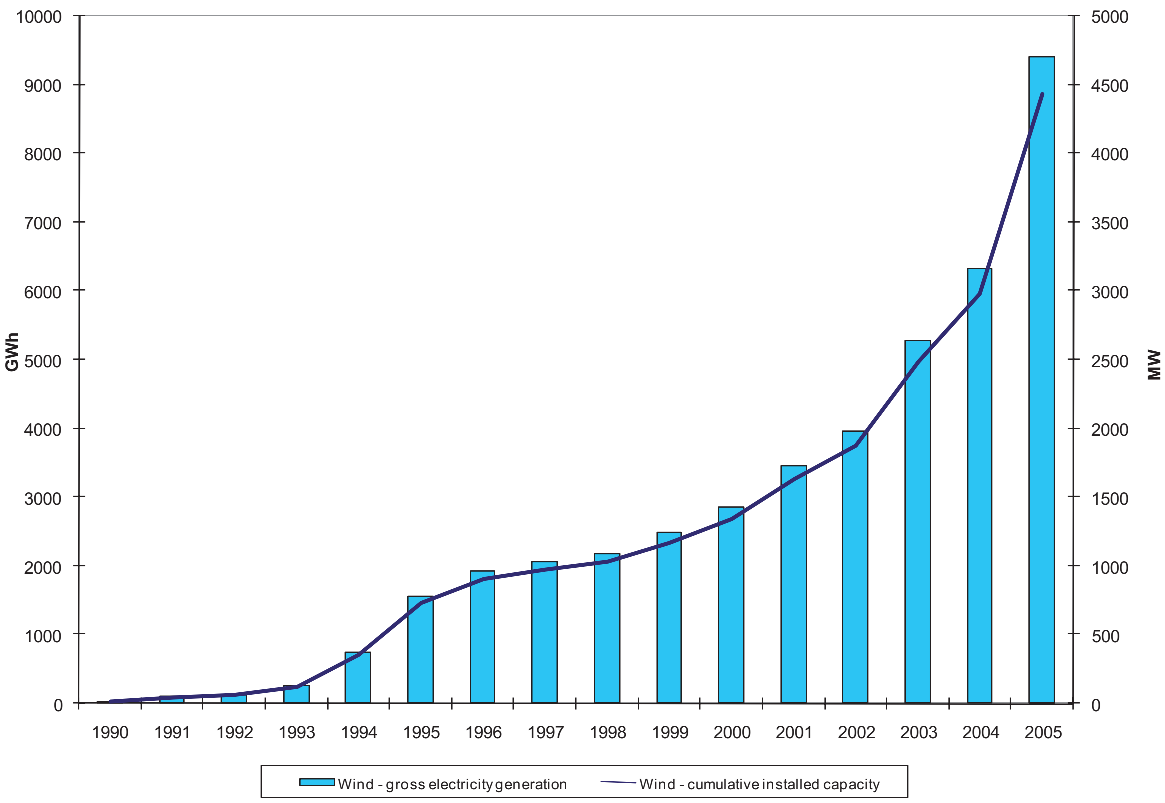
Source: TERI (2007)

By 2020, the Indian government plans to reach 150 GW of large hydro capacity. This compares to initial targets of around 80 GW of total hydro capacity set out in the Report of the Working Group on Power for the 11th Five-Year Plan. Reaching the new target requires capacity additions of around 120 GW until 2020 compared to 2005 levels representing more than five-times the target capacity of the Chinese Three Gorges Dam. However, experts suggest that resettlement issues and environmental concerns linked to large hydro power projects are dealt with in a proactive manner by Indian authorities.

In this context, it has to be mentioned as well that actual capacity additions for the last three Five-Year Plans (8th, 9th and 10th) have not even come close to the respective targets. Only 53.8%, 47.5% and 51.6% of targeted capacity additions have been realised, respectively. In particular, none of the hydro projects for which execution started during the 10th Five-Year Plan was commissioned. However, the picture looks different for other renewable energy sources reaching more than double the target of the 10th Five-Year Plan.

Focus: Wind Power Market and Policy Developments

Figure 5. Wind Power Market Development, 1990-2005



Source: TERI (2007)

Due to India's rapid wind energy market growth, the country ranked fourth in terms of total installed wind power capacity worldwide and was the world's third largest market for wind power measured in terms of annually added wind power capacity in 2006. Besides, India's turbine manufacturer Suzlon is one of the major global wind power companies with increasing production capacities. India has been exporting components and turbines for many years.

Around 80% of wind power installations in India are used for captive use by companies to avoid high prices of state power suppliers for commercial customers. Besides, users of wind energy are the last to be taken off the grid in terms of power shortages. Early support measures in the 1990s included, furthermore, guidelines for state electricity boards to ensure grid compatibility with planned wind power installations[6], 100% depreciation of wind power equipment allowed in the first year and 5-year tax holidays.

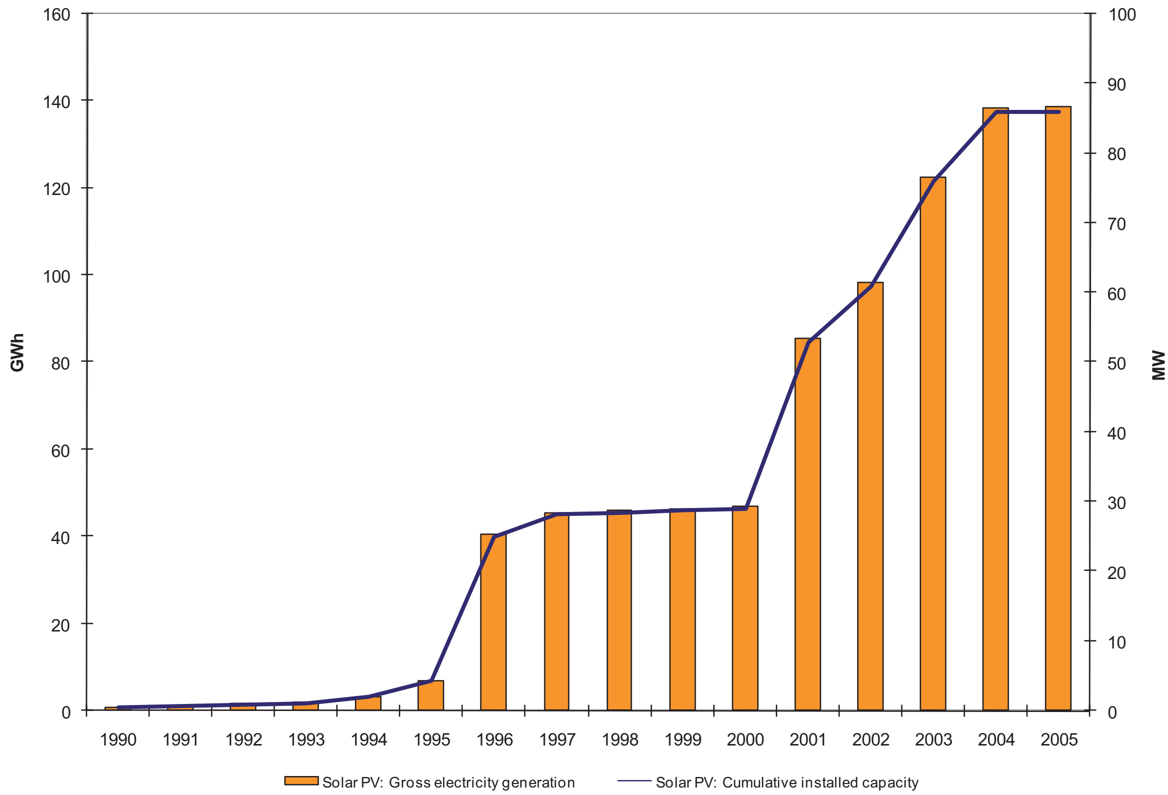
However, these policies have been adjusted over the years, e.g. only 80% of equipment can still be depreciated within the first year. Furthermore customs and excise duties have been changed in favour of local production. Wind power development has also encountered problems with inaccurate wind resource data, poor installation practices and poor power plant performance.

More aggressive and stable policy mechanisms under the umbrella of the EA 2003 have boosted recent market development again. As a result, only India is found to have moderately tapped its significant realisable onshore wind potential among BRICS countries.

[6] National Guidelines for Clearance of Wind Power Projects (implemented in 1995, adjusted in 1996)

Focus: Solar PV Market and Policy Developments

Figure 22. Solar PV Market Development, 1990-2005



Source: TERI (2007)

Solar PV installations have seen a stepwise development with a five-time increase in 1996 and almost a doubling of capacities in 2001 compared to the respective previous year. In between these two years solar PV installations stagnated and returned to a more continuous growth path in 2001. However, 2005 has once again seen almost no new installations.

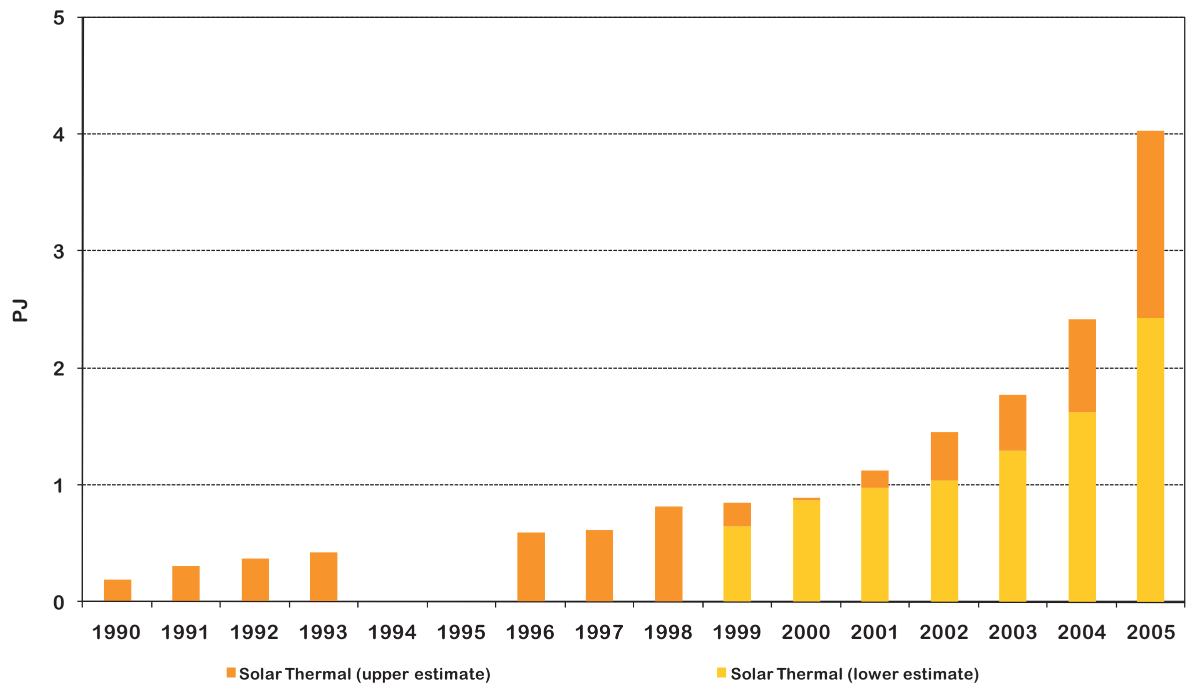
Solar PV has already been introduced in the 1980s through a demonstration programme of the then Department of Non-Conventional Energy Sources (DNES). Support focused on decentralised applications including solar power plants with mini grids, solar home systems, solar lanterns and streetlights as well as PV water pumping systems. The most important reason was high grid losses in transmission and distribution increasing the costs of rural electrification through grid expansion in India dramatically.

The major policy instrument to promote solar PV took the form of capital grants. Micro-credits and loans are also being used to make products available to rural customers. Subsidies covered up to 90% of installation costs of off grid power generation facilities. However, since 2006 the subsidy scheme has been discontinued.

Nevertheless, the Indian government announced an additional 50 MW of solar PV capacities until 2012 as policy target under the 11th Five-Year Plan. This includes powering all streetlights in Indian cities with PV modules until that date.

RENEWABLE HEAT (RES-H) MARKET

Figure 7. Total RES-H Production, 1990-2005



NB: Solar thermal includes direct final use.

Source: Weiss *et al.* (2007)

In 2005, solar thermal heat generation amounted to 2.4 – 4.0 PJ. The average annual growth since 1990 was 18 – 22%. However, the growth trend is increasing in recent years. Estimates from the IEA Solar Heating and Cooling Implementing Agreement (upper estimate) show growth rates of 67% for 2005 (Weiss *et al*., 2007). India was the world's fourth largest market for solar hot water heating in 2006 (in terms of annually added capacity) (REN21, 2006).

Data for other renewable heating technologies were not available at the time of writing.

Prior to 1993, solar water heating systems were supported though capital grants of up to 80%, which were steadily reduced and completely terminated in 1993 due to commercial viability of such systems. Interest subsidies that were introduced in 1987 are still continued today.

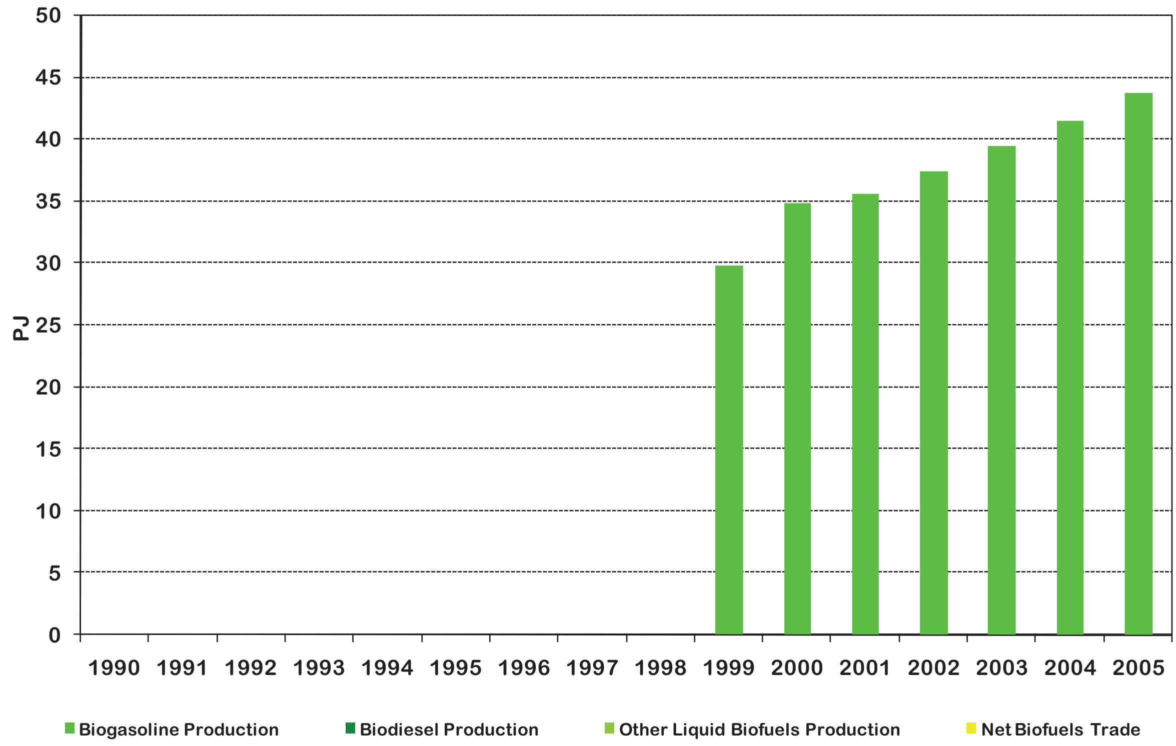
On the state level, incentives for the use of solar water heating systems have been introduced by two regional governments. In Haryana and the National Territory of Delhi these systems are mandatory for buildings above a certain size since 2006/2007; in Karnataka their installation is encouraged by rebates on electricity tariffs since 1997.

At the national level, the MNRE launched a soft loan scheme in 2005 aiming at an additional one million m² of solar collector area that could provide approximately 3.2 PJ of energy for water heating purposes. This target is envisaged to be achieved until March 2007.

Solar cookers have also been supported by capital grants from the central and state governments.

Renewable Transport Fuel (RES-T) Market

Figure 8. Total RES-T Production, 1990-2005



NB: Data were available from 1999 onwards. Net Biofuels Trade refers to the balance of domestic biofuel consumption, i.e. biofuel exports subtracted from imports.

Source: TERI, 2007

Data on renewable transport fuels are available since 1999. Ethanol production in India was 29.9 PJ (1.42 billion litres[7]) in 1999 und increased on average by 6.6% annually until 2005 to 43.2 PJ (2.05 billion litres[7]). India is considered one of the regional leaders in bioethanol production with an expected output equivalent to 48.5 PJ (2.3 billion litres[7]) in 2007.

Initial activities in the area of biofuels in India date back to 1975. However, major initiatives have only begun recently with pilot projects of the Indian Ministry of Petroleum and Natural Gas covering 3 oil depots and 350 petrol stations to study different aspects of ethanol blending. In 2002, a "Committee on the Development of Biofuels" was set up and blending of 5% ethanol was mandated by the Indian government in nine states and four union territories. However, this programme had to be suspended in 2004 due to shortages in feedstock supply of molasses by the sugar industry. In 2005, the ethanol programme was re-launched in some of the designated states with a fixed purchase price for ethanol of INR 18.25/litre (USD 0.41/litre).

[7] For the applied biofuel conversion factors, refer to the Glossary which can be found after the country profiles.

In a second stage, the Ministry of Petroleum aimed to introduce 5% blending nationwide. With effect from November 2006, the 5% blending quota was introduced in 20 of the total 28 Indian states and eight union territories subject to commercial viability. In effect, in 10 out of the 20 targeted states offers for domestic ethanol production were considered commercially viable. Once the second stage has extended to all target states, a 10% blending quota is targeted for the third stage of the ethanol promotion programme.

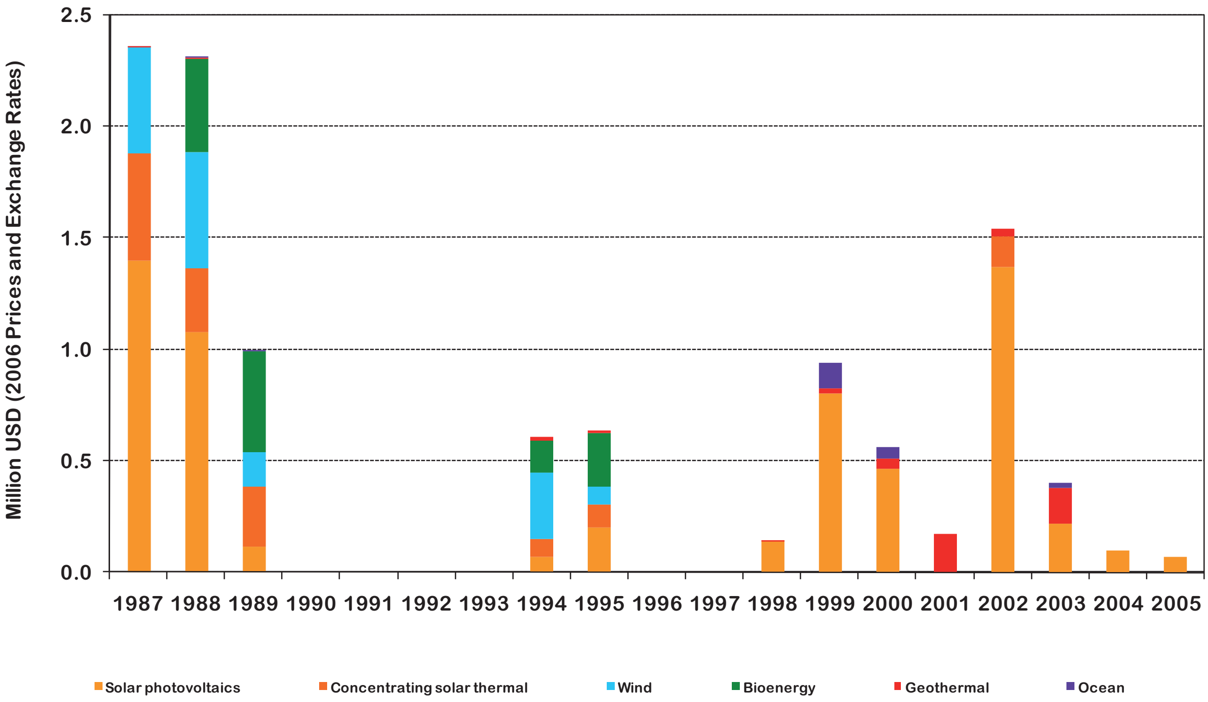
Moreover, a "National Mission on Bio-Diesel" was launched in 2003 comprising six micro missions covering all aspects of plantation, procurement of seed, oil extraction, trans-esterification, blending and trade, and research and development. Jatropha was identified as most suitable feedstock and a target of 11.2 million hectares of jatropha production by 2012 was set by the governmental Planning Commission to enable an envisaged 20% blending quota.

In 2006, the government announced a biodiesel purchase policy which fixed the biodiesel purchase price (reviewed every six months) at INR 25/litre (USD 0.57/litre) for 5% blending in 20 procurement centres. Since production prices were estimated to be 40% to 80% higher and no other financial assistance was provided, little biodiesel was sold at designated centres.

Initial targets of 11 million hectares for jatropha production and corresponding 20% blending quota have been revised in 2007. The National Biofuels Draft Policy then envisaged 5% and 10% biodiesel blending in 2012 and 2017 respectively, minimum prices for bio-fuel crops, such as jatropha and non-edible oil-seeds, as well as the setting up of a National Bio-Fuel Development Board.

RESEARCH, DEVELOPMENT AND DEMONSTRATION TRENDS

Figure 23. Annual Government RD&D Spending on Renewables, 1990-2005 (USD 2006 prices and exchange rates)[8]



Source: TERI, 2007

According to available data, the Indian government spent a cumulative total of USD 10.8 million on renewable energy RD&D from 1987 to 2005. The distribution of annual government investments is very irregular.

49% of these expenditures were spent on solar PV RD&D, 12% on wind, 11% on concentrating solar thermal technologies, 10% on biogas, 8% on biofuels for transport, 5% on other bioenergy technologies, 4% on geothermal RD&D, and the remaining 2% on ocean energy technology development[9].

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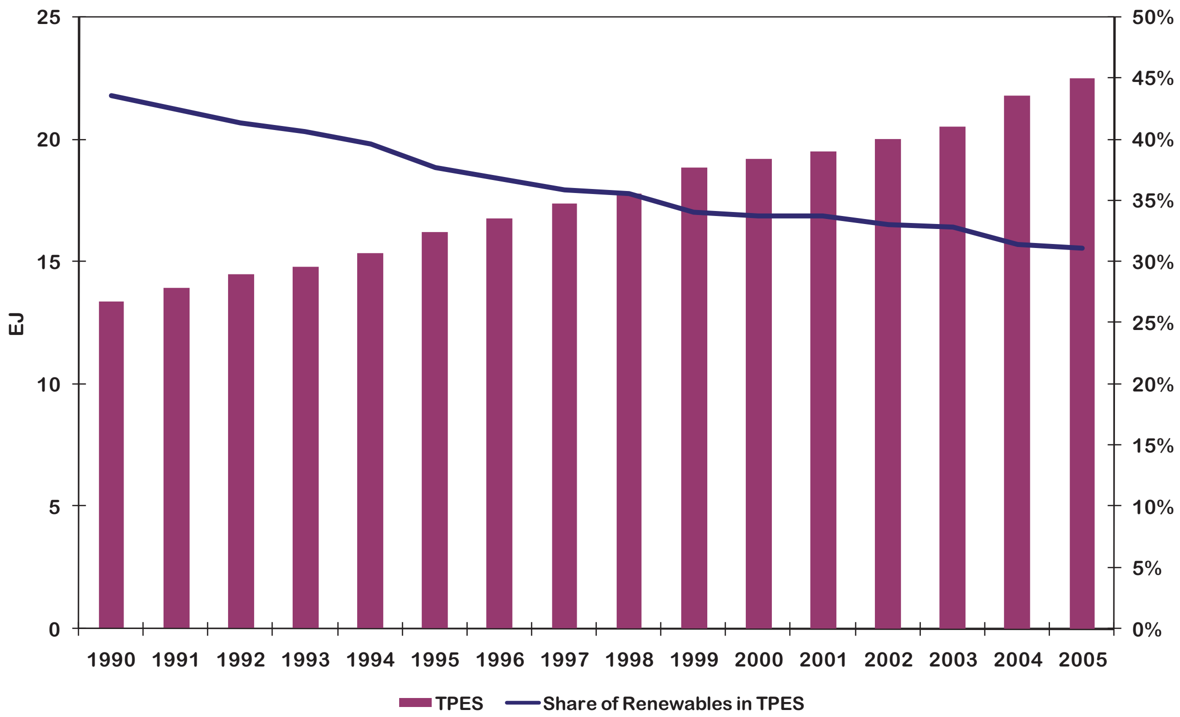
[8] The conversion to USD was at the average 2006 market exchange rate of INR 1 = USD 0.0222 and EUR 0.0177.

[9] Deviations from 100% are due to rounding.

RENEWABLES IN TOTAL PRIMARY ENERGY SUPPLY[10]

Figure 10. Share of Renewable Energy in Total Primary Energy Supply, 1990-2005



Source: IEA (2007)

India's total primary energy supply (TPES) rose from 13.4 EJ in 1990 at an average annual growth rate of 3.3% to 22.5 EJ.

The share of renewables (including traditional biomass) in TPES declined from 43.6% in 1990 to 31.1% in 2005. The total contribution of renewables to TPES, however, did grow at an average annual growth rate of 1.1% since 1990. But this increase did not keep up with the growth of total primary energy supply over the considered period.

[10] The official IEA statistics on TPES include, where applicable, traditional biomass but exclude pumped hydro.

Primary energy convention: The IEA uses the **physical energy content method** to calculate the primary energy equivalent of non-combustible energy sources, such as geothermal, hydro, solar and wind. As a consequence, there is an obvious link between the principles adopted in defining the primary energy forms of energy sources and the primary energy equivalent of these sources. For instance, in the case solar thermal and geothermal electricity production, as heat is the primary energy form selected by the IEA, the primary energy equivalent is the quantity of heat generated in the geothermal or solar thermal plant for electricity generation. In the case of hydro, wind, tide and solar PV, as electricity is the primary energy form selected, the primary energy equivalent is the physical energy content of the electricity generated in the plant, which amounts to assuming an efficiency of 100%. Readers may consult (IEA, 2007) for more details.

RENEWABLE ENERGY POLICY INFORMATION

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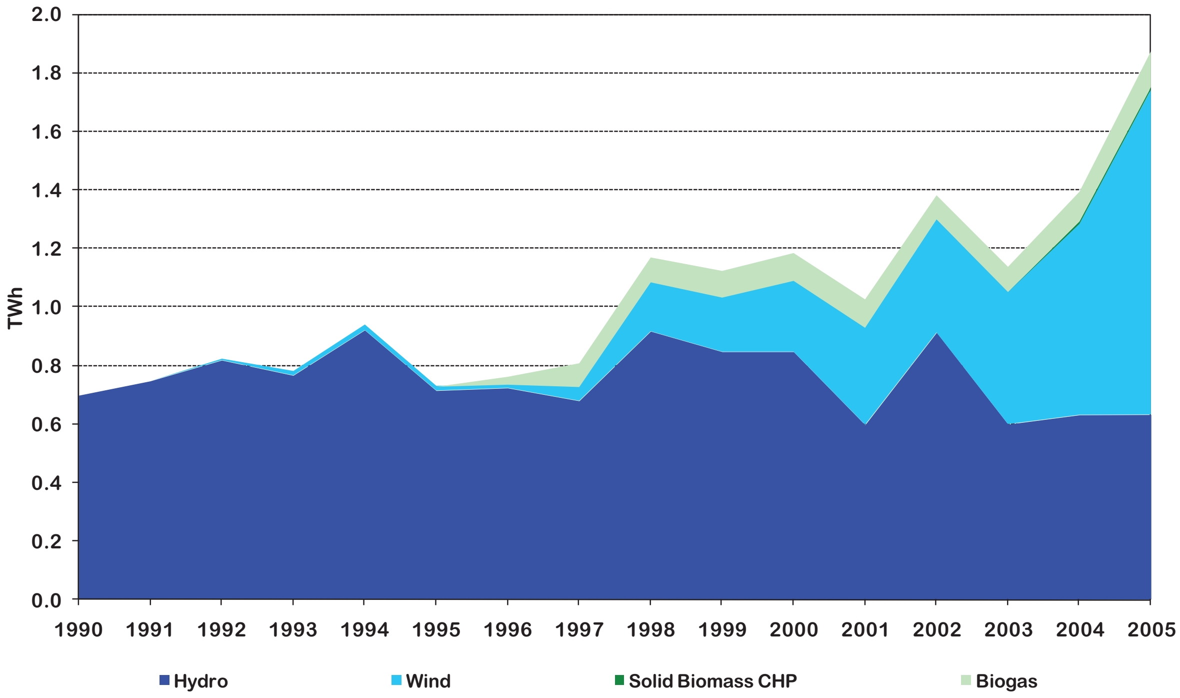
IRELAND[1]

RENEWABLE ELECTRICITY (RES-E) MARKET

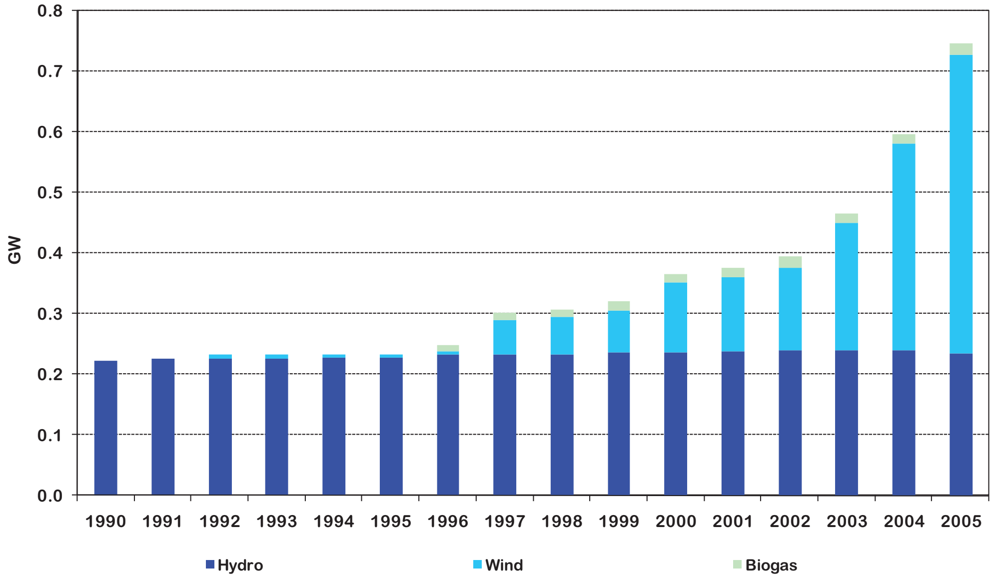
Figure 24. Total RES-E Production, 1990-2005



Source: IEA (2007a)

[1] A summary profile was prepared of Ireland's renewable energy **market** developments from 1990 to 2005. Policy developments are available in the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

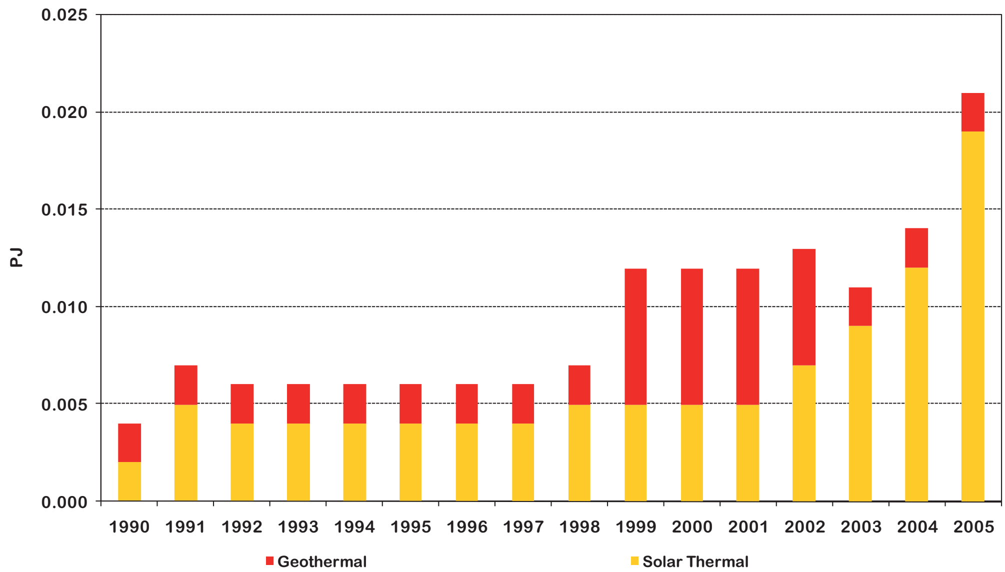
Figure 2. Net Generating Capacity of RES-E Plants, 1990-2005



Source: IEA (2007a)

RENEWABLE HEAT (RES-H) MARKET

Figure 3. Total RES-H Production, 1990-2005[2]



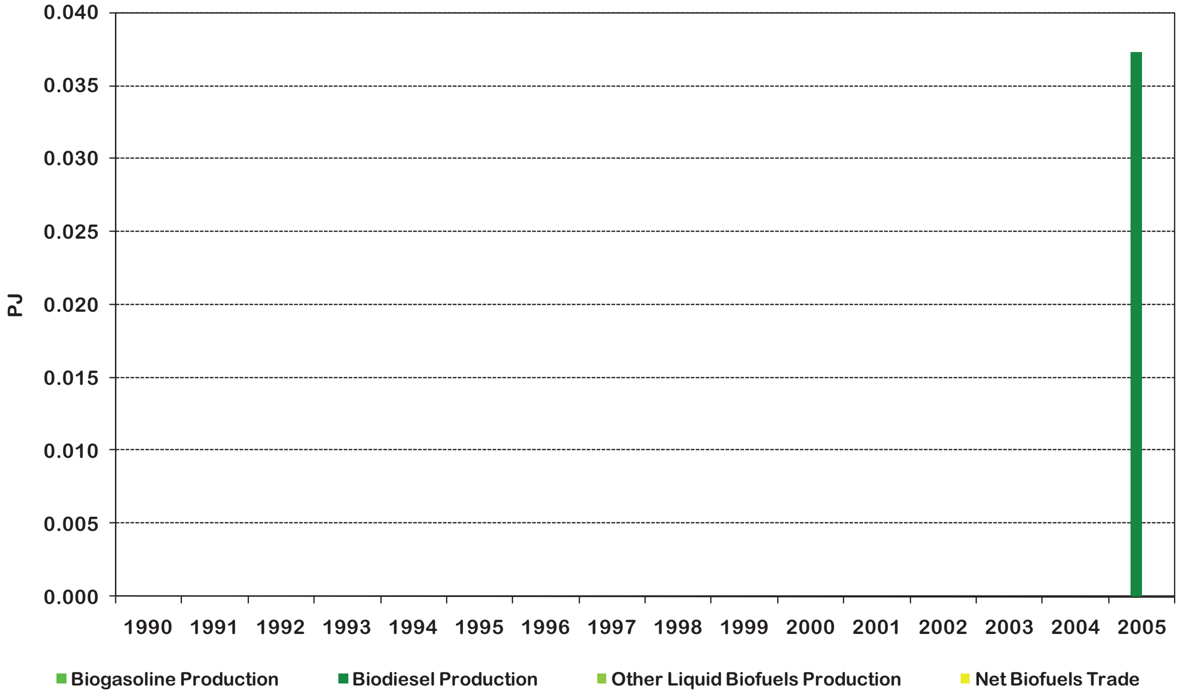
NB: Geothermal and solar thermal include direct final use.

Source: IEA (2007a)

[2] Official IEA statistics on heat generation from renewable energy sources relate to **commercial heat sold** with additional data on **direct use** of solar thermal and geothermal available for most OECD countries.

RENEWABLE TRANSPORT FUEL (RES-T) MARKET

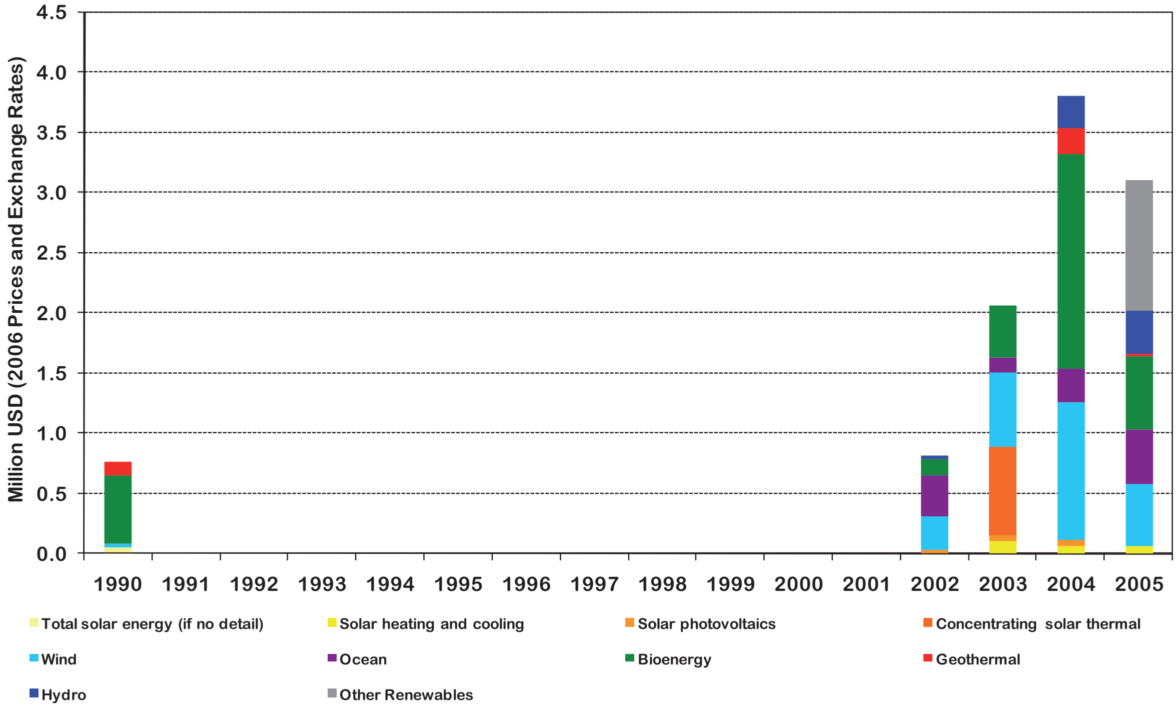
Figure 4. Total RES-T Production, 1990-2005



NB: Net Biofuels Trade refers to the balance of domestic biofuel consumption, i.e. biofuel exports subtracted from imports.

Source: IEA (2007a)

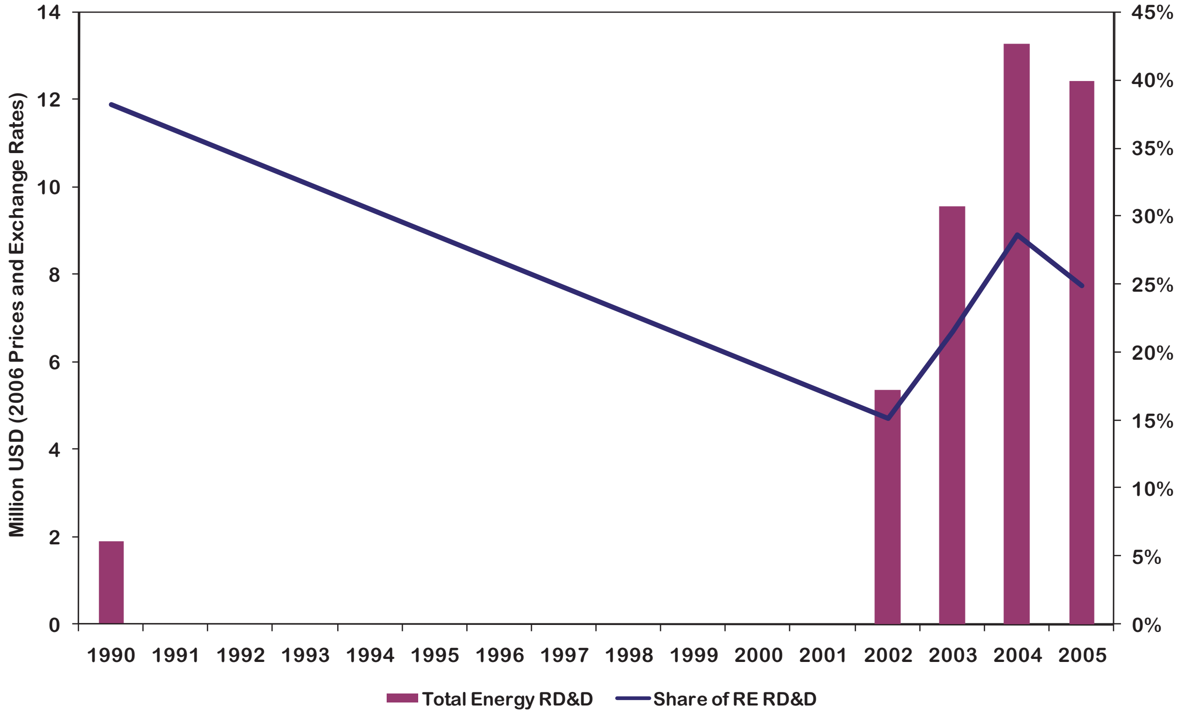
Figure 5. Annual Government RD&D Spending on Renewables, 1990-2005 (USD 2006 prices and exchange rates)[3]



Source: IEA (2007b)

[3] Official IEA data on energy RD&D budgets include only **government** funding and not **private** RD&D spending.

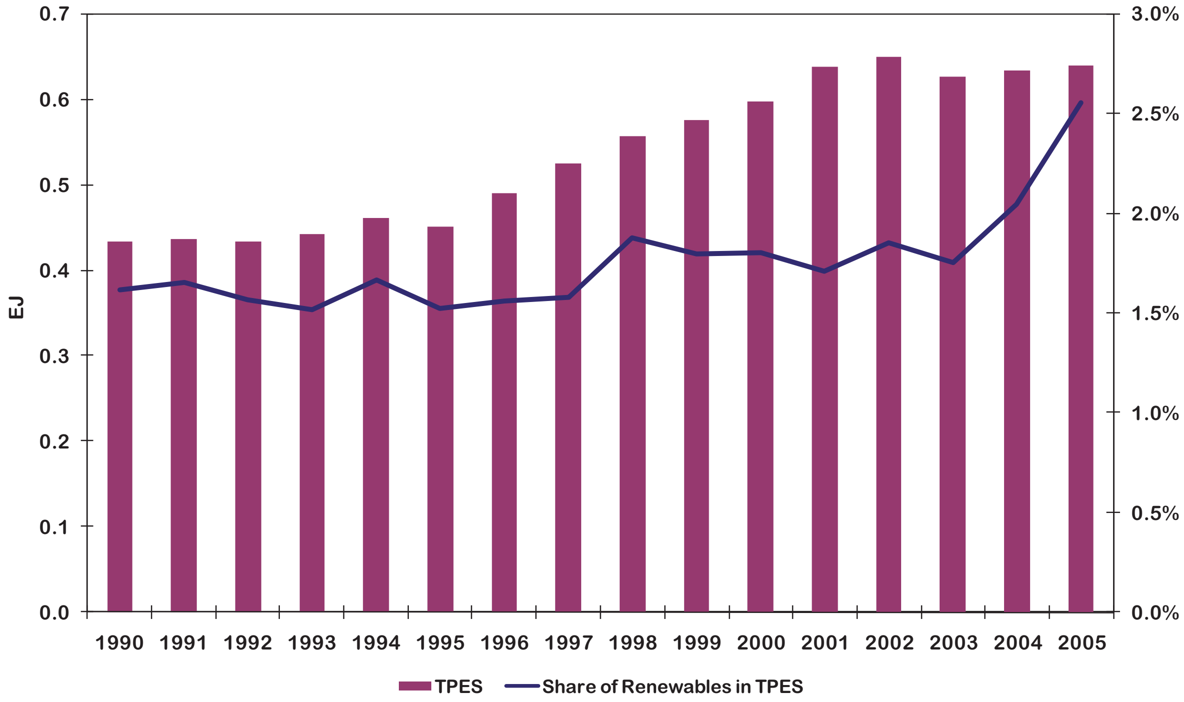
Figure 6. Renewable energy RD&D versus total government energy RD&D spending, 1990-2005



Source: IEA (2007b)

RENEWABLES IN TOTAL PRIMARY ENERGY SUPPLY[4]

Figure 7. Share of Renewable Energy in Total Primary Energy Supply, 1990-2005



Source: IEA (2007a)

RENEWABLE ENERGY POLICY INFORMATION

For details on renewable energy support policies implemented in Ireland, readers may consult the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

[4] The official IEA statistics on TPES include, where applicable, traditional biomass but exclude pumped hydro.
Primary energy convention: The IEA uses the **physical energy content method** to calculate the primary energy equivalent of non-combustible energy sources, such as geothermal, hydro, solar and wind. As a consequence, there is an obvious link between the principles adopted in defining the primary energy forms of energy sources and the primary energy equivalent of these sources. For instance, in the case solar thermal and geothermal electricity production, as heat is the primary energy form selected by the IEA, the primary energy equivalent is the quantity of heat generated in the geothermal or solar thermal plant for electricity generation. In the case of hydro, wind, tide and solar PV, as electricity is the primary energy form selected, the primary energy equivalent is the physical energy content of the electricity generated in the plant, which amounts to assuming an efficiency of 100%. Readers may consult (IEA, 2007a) for more details.

Glossary

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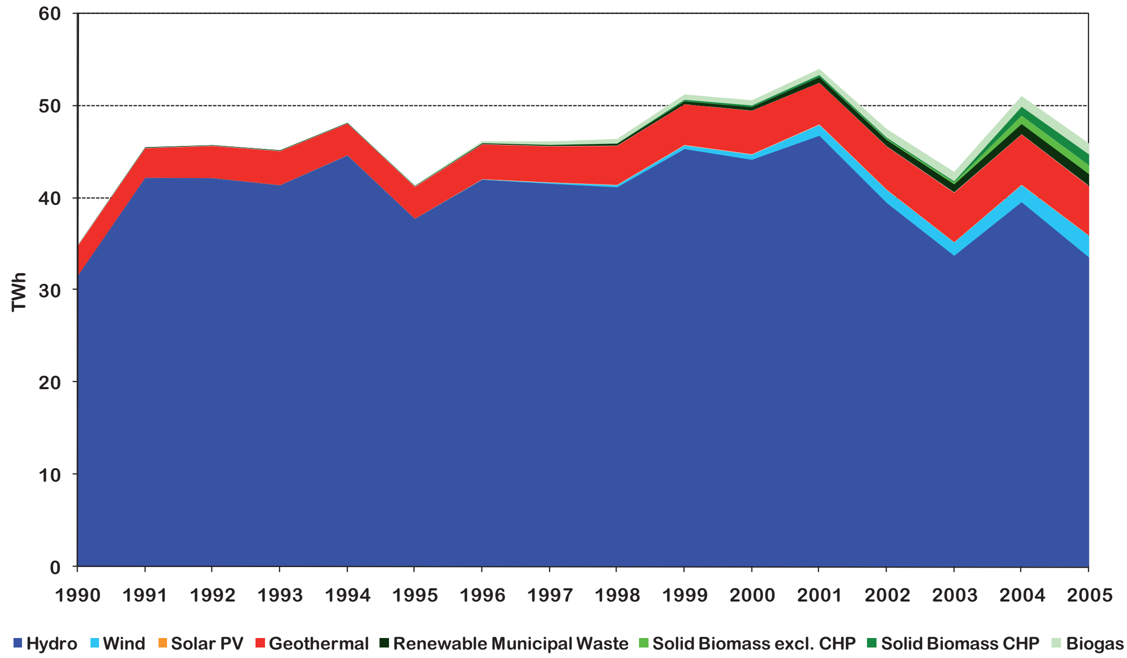
ITALY

Renewable Electricity (RES-E) Market

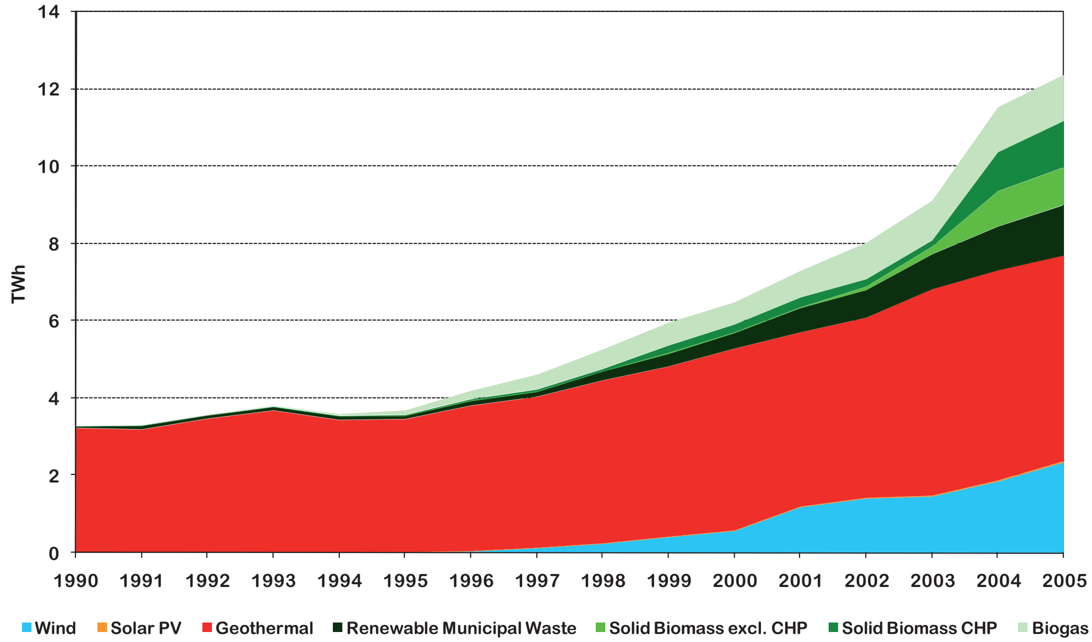
RES-E Market Developments

Figure 1. Total RES-E Production, 1990-2005



Source: IEA (2007a)

Figure 2. Total RES-E Production (excluding Hydropower), 1990-2005



Source: IEA (2007a)

Italy's major source of renewable electricity is still hydropower, accounting for 73% of the total 46 TWh of RES-E in 2005. The share of RES-E in total electricity generation was 15.2% in 2005, but fluctuating with irrigation levels. While total electricity generation grew on annual average by 2.25% over the period from 1990 to 2005, hydropower grew at only 0.41% per annum. Despite the strong growth of non-hydro renewables, total RES-E supply increased slightly slower than total electricity generation. On average 18.0% of electricity was generated by renewables in the period 1990 to 2005.

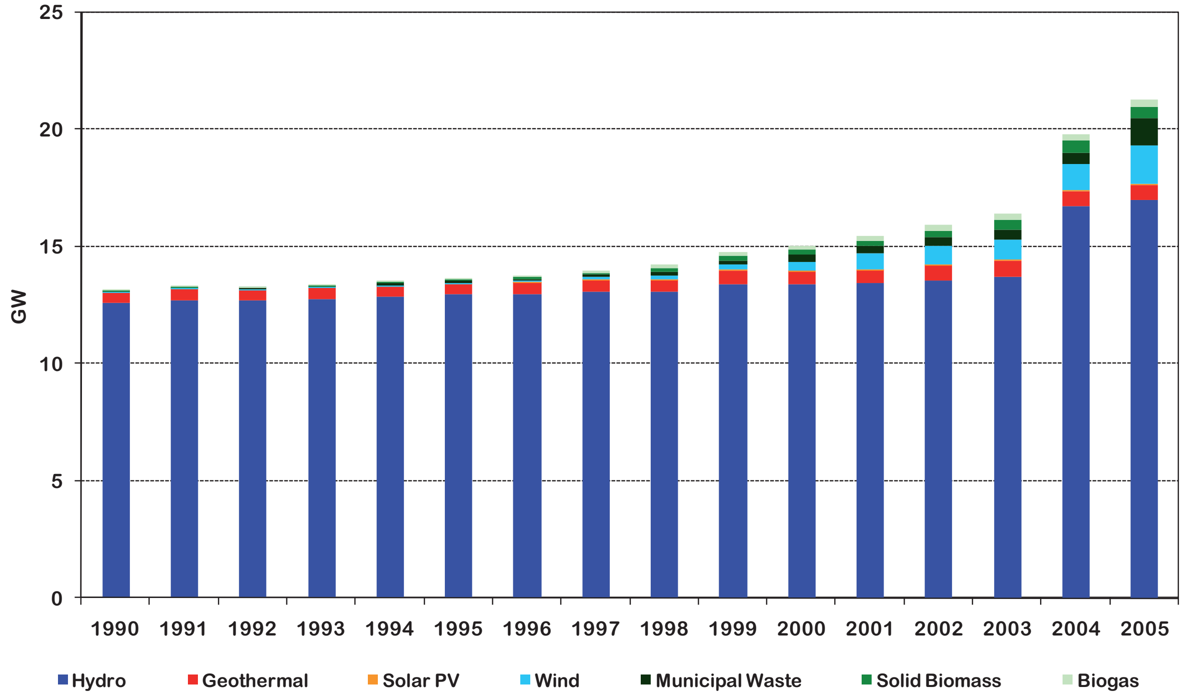
Power from geothermal energy contributes the second largest and increasing share in the mix of renewables of 5.3 TWh annual production representing 11.6% in 2005. Compared to 1990 levels this is a 2.4% increase of geothermal power in RES-E.

Wind power has seen the strongest growth over the whole period – on average 60% per year – which led to its 5.1% share in the mix of renewable energy sources in 2005 representing 2.3 TWh of electricity supply.

Biomass plants captured a 4.7% share of RES-E in 2005, including CHP and non-CHP plants. However, until 2003 their share in RES-E was below 1%. This changed with a massive increase of biomass electricity production in 2004 from 347 GWh to 1 912 GWh in 2004. Biogas has grown at 53% on annual average for the whole period and accounted for 2.6% of RES-E in 2005. But growth of biogas was considerably lower – only 16% on annual average – for the five year period from 2000 to 2005. Renewable waste accounts for 2.8% of RES-E in 2005, while its growth was on average 27% per year since 1990.

Solar PV produced 31 GWh in 2005 and grew comparatively slow at only 15% per annum over the considered period.

Figure 3. Net Generating Capacity of RES-E Plants, 1990-2005



NB: Official IEA statistics on electricity generating capacity do not differentiate between *renewable* and *non-renewable* municipal waste.

Source: IEA (2007a)

Development of Renewable Electricity Policies

Italy's indicative targets for RES-E, as set out in the EU Directive 2001/77/EC[1], aim at a 25% share of gross electricity consumption by 2010.

Italy's major policy to support the deployment of renewable energies is based on a quota obligation system combined with a green certificate trading (TGC) scheme that was enacted in conjunction with the 1999 Electricity Liberalisation Act and has been implemented since 2002[2]. Italian energy suppliers producing or importing more than 100 GWh per year are obliged to ensure that 2% of their annual electricity supply for the domestic market is derived from eligible new renewable energy plants. Sanctions for non-complying liable parties are foreseen, "but enforcement in practice is considered difficult because of ambiguities in the legislation" (European Commission, 2007).

In 2003, the government passed Legislative Decree 387/2003[3] adjusting the required renewable energy obligation imposed on liable parties. The renewable obligation was set out to increase annually by 0.35% from 2005 to 2007. Decisions on further development of increments until 2012 were subject to specified deadlines.

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1 (European Commission, 2001)
2 MICA Decree 11/11/99 (Parlamento della Repubblica Italiana, 1999)
3 (Parlamento della Repubblica Italiana, 2003)

A broader technology-specific FIT system had been in place for renewable energy projects proposed since 1992, but was progressively phased out

In mid-2005, a specific fixed FIT approach was introduced for solar PV generation by the Italian government. A total of 1,200 MWp of solar PV installations is eligible for support under the scheme and a final target of 3,000 MWp has been proposed. The tariff structure was adjusted again in early 2007, offering tariffs that are guaranteed for 20 years ranging from EUR 0.36-0.49/kWh for plants larger than 1 kW installed capacity. The current tariff granted to PV electricity producers depends on the size of the facility and its degree of building integration. More specifically, this FIT scheme is a promising way to promote energy efficiency measures in buildings. An additional tariff bonus can be obtained in case energy efficiency interventions in the buildings are implemented. On the basis of the energy saving level achieved, it is possible to obtain a maximum increase of the 30% of the original tariff.

Even more preferential tariffs are offered for certain applicants such as self-producers, public schools and others. Net metering or fixed prices for sales to utilities further increases the resulting value of the FIT system.

In addition, Italy has issued plans to offer investment subsidies of up to 30% of initial costs for small renewable energy plants including small wind energy, solar thermal collectors and biomass plants.

In December 2007, the Italian government revised the support schemes for RES-E. Budget Law 2008[4] modified the system by granting a differentiated amount of green certificates to power plants in reason of the technology maturity (Table 1) and widening the incentive period to 15 years. At the same time, the same law introduced an alternative FIT system to foster small-scale installations, with a guaranteed price over 15 years differentiated by technology (Table 2).[5]

Table 1. The TGC system as specified in Budget Law 2008[4]

Source	Ratio to be applied to the electricity produced for the TGC calculation
Wind >200kW	1.00
Wind off-shore	1.10
Geothermal	0.90
Tidal	1.80
Hydro	1.00
Biodegradable waste and biomass	1.10
Biomass under special regime	1.80
Landfill gases and biogas	0.80

Source: Parlamento della Repubblica Italiana, 2007

Table 2. The feed- in mechanism for small-scale plant as specified in Budget Law 2008[4]

Source	Tariffs (EUR/kWh)
Wind <=200kW	0.30

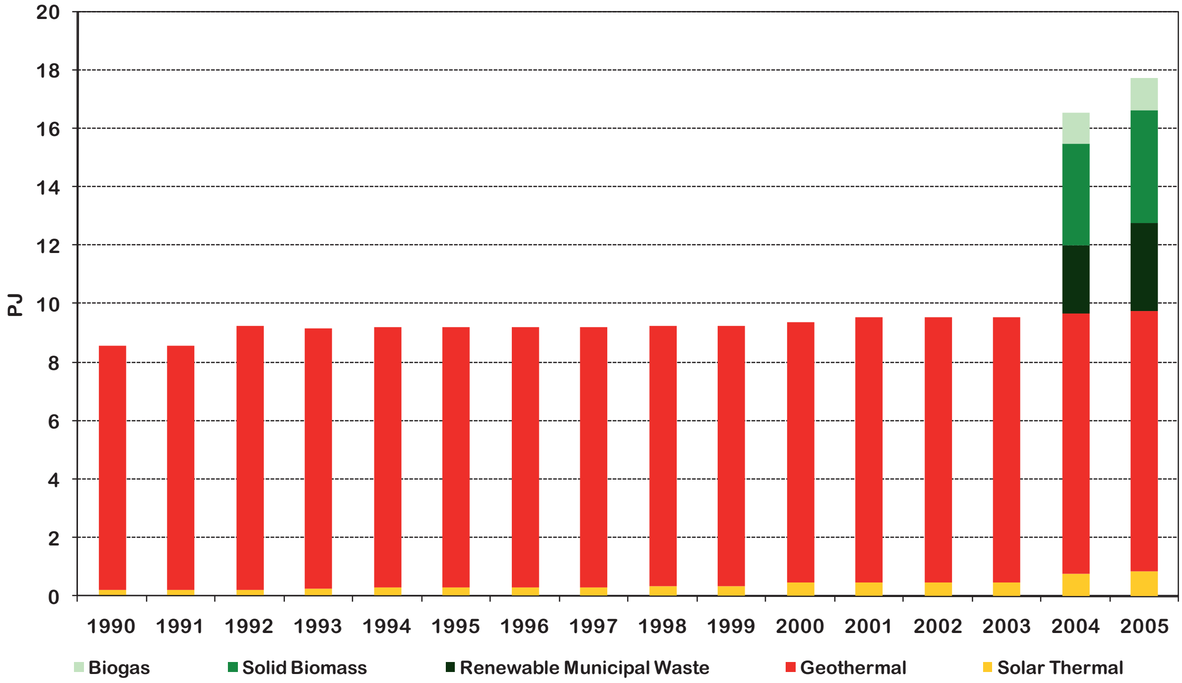
[4] (Parlamento della Repubblica Italiana, 2007)
[5] By June 2008, the modifications introduced had only been partially implemented due to operational ministerial decrees still being promulgated.

Geothermal	0.20
Tidal	0.34
Hydro	0.22
Biodegradable waste and biomass	0.22
Biomass under special regime	0.30
Landfill gases and biogas	0.18

Source: Parlamento della Repubblica Italiana, 2007

RENEWABLE HEAT (RES-H) MARKET

Figure 4. Total RES-H Production, 1990-2005[6]



NB: Geothermal and solar thermal include direct final use.

Source: IEA (2007a)

Heat production from renewable energy sources was 17.7 TJ in 2005, more than double the amount of renewable heat in 1990. This increase is mainly due to a change in data coverage, namely that data on commercial heat production, mainly from biomass CHP-based district heating, was not available and, thus, not reported to the IEA up to and including 2003 (IEA, 2007a). For the same data coverage reason, 95% of renewable heat was attributed to geothermal sources in 2003. Geothermal heat remained more or less constant, with 2005 production only 6% above 1990 levels. With the sudden increase of biomass heat, which in 2005 accounted for 45% of total renewable heat production, the share of geothermal fell to 50%. Solar thermal heat production quadrupled in the period from 1990 to 2005, amounting to 850 TJ at the end of the period. Again in 2004, production increased notably by 72%. However, its share increased to only 5% of total renewable heat production in 2005.

Italy has introduced a relatively novel instrument for RES-H promotion. This has been the integration of renewable heat installations in the 2005 White Certificate Scheme which grants tradable certificates to eligible energy saving and efficiency measures, such as solar

[6] Official IEA statistics on heat generation from renewable energy sources relate to **commercial heat sold** with additional data on **direct use** of solar thermal and geothermal available for most OECD countries.

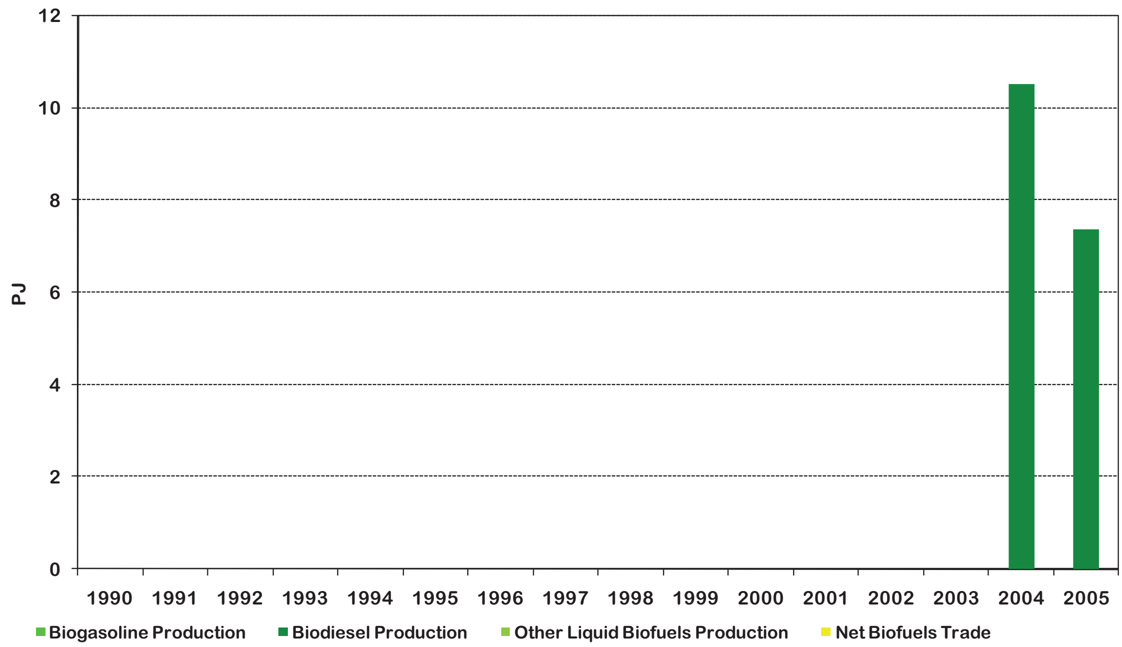
thermal collectors, geothermal heat pumps, biomass systems, district heating and CHP plants, based on specified saving factors.

Besides this deployment incentive, mandatory regulations have been used as well. Legislative Decree 192/05[7], and modifications and additions to the former in Legislative Decree 311/06[8], enacted mandatory renewable heat installations on new and refurbished buildings to provide 50% of their domestic hot water needs.

Furthermore, VAT reductions, income tax credits, several programmes offering investment subsidies, particularly for solar thermal technologies, and policy measures offering guidance in terms of renewable heat technology deployment are in place in Italy (IEA and RETD, 2007). The most effective measure is the income tax credit on any expenditure on renewables or energy efficiency installations in buildings.

Renewable Transport Fuel (RES-T) Market

Figure 5. Total RES-T Production, 1990-2005



NB: Net Biofuels Trade refers to the balance of domestic biofuel consumption, i.e. biofuel exports subtracted from imports.

Source: IEA (2007a)

Reported biofuel production began in 2004 with 10.5 PJ of biodiesel, all of which has been consumed domestically. In 2005, production declined to 7.4 PJ, whilst still no ethanol has been produced.

[7] (Parlamento della Republica Italiana, 2005)
[8] (Parlamento della Republica Italiana, 2006a)

Italy set a national target of a 1% share of biofuels by 2005 in its decree 128/2005 compared to an actual achievement of 0.51% in 2005 (European Commission, 2007). The reference values in the European Union (EU) Directive 2003/30/EC[9] on biofuels have been set to a 2% share of biofuels by 2005 and 5.75% by 2010.

In order to promote a national biofuels industry and market, and in view of the high cost of producing fuels from biomass, the Italian government has introduced fiscal incentives[10] and obligatory quotas (established in the Budget Law 2007[11]).

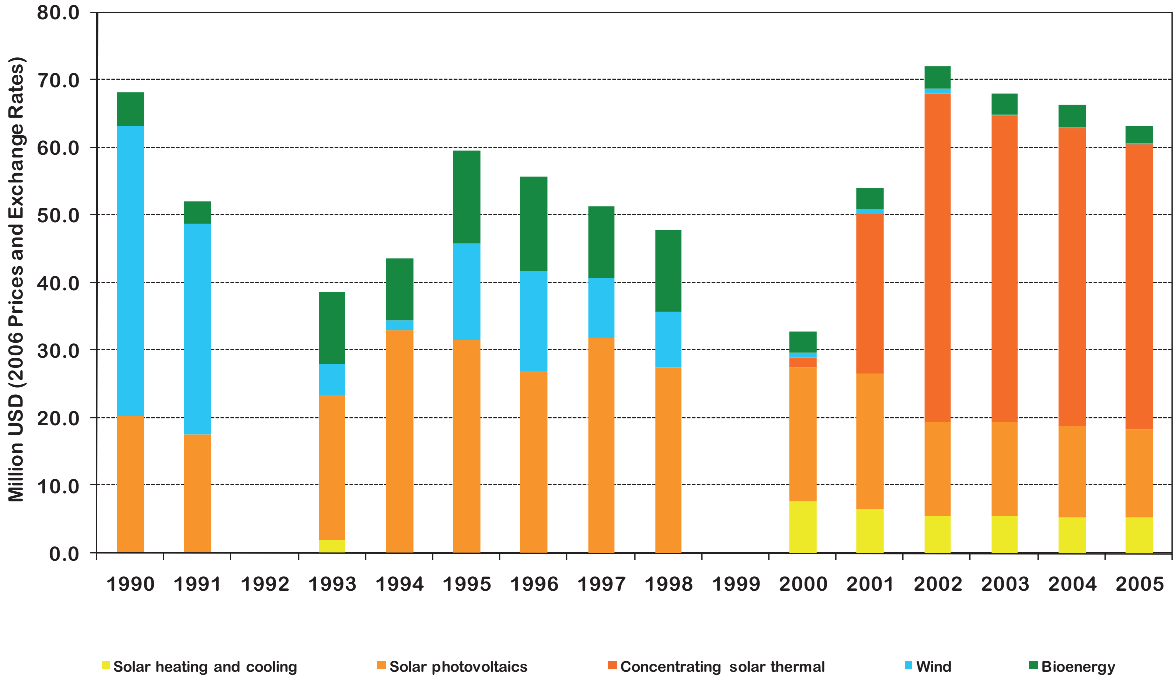
Although legislation in favour of biodiesel has been in place since 1993, it has not been enforced until recently, causing a delay in the implementation of these measures. Particularly, fiscal measures have targeted biodiesel and vegetable-based ethanol, substituting diesel oil and petrol respectively.

Regarding biodiesel, Budget Law 2007[12] (article 22*bis*) establishes an excise duty reduction of 80% for biodiesel production up to 250 000 tonnes per year. A decree issued by the Minister for Economic Affairs and Finance may decrease this amount to prevent over-compensation of the additional costs involved in the production of biodiesel (compared with the cost of diesel oil). Average industrial production costs of biodiesel will be monitored to provide a basis for assessing whether or not there is overcompensation (GBEP, 2007).

[9] (European Commission, 2003)
[10] In accordance with EU legislation, Italian legislation established a number of provisions reducing the final cost of the products concerned by cutting taxation. This renders certain fuels produced from biomass competitive with the fossil fuels they replace and encourages their use.
[11] (Parlamento della Repubblica Italiana, 2006b)

Research, Development and Demonstration Trends

Figure 6. Annual Government RD&D Spending on Renewables, 1990-2005 (USD 2006 prices and exchange rates)[12]



Source: IEA (2007b)

Public RE RE&D spending was USD 67.7 million in 2006[13], which was considerably above the Italian average annual RE RD&D expenditures of USD 56.1 million[14]. Compared to the total energy RD&D spending, renewable energy RD&D captured 12% of cumulative investments from 1990 to 2006. As indicated by figure 7, the annual share of RE RD&D in total annual energy RD&D was higher than the average 12% in the mid 1990s and further increased towards the end of the period. 2005 marked an all-time high with a 19% share of renewable energy RD&D. In 2006, however, the RE share dropped to 13% due to a significant increase in total annual energy RD&D.

The focus of RE RD&D has changed twice in the considered period.

In the first two years of the 1990s, wind energy still accounted for the largest share of the total USD 120 million expenditures - 62% were spent on this technology, 31% on solar PV and the rest on bioenergy technologies. The share of RE RD&D was relatively low, whereas total energy RD&D was twice as high as in subsequent years.

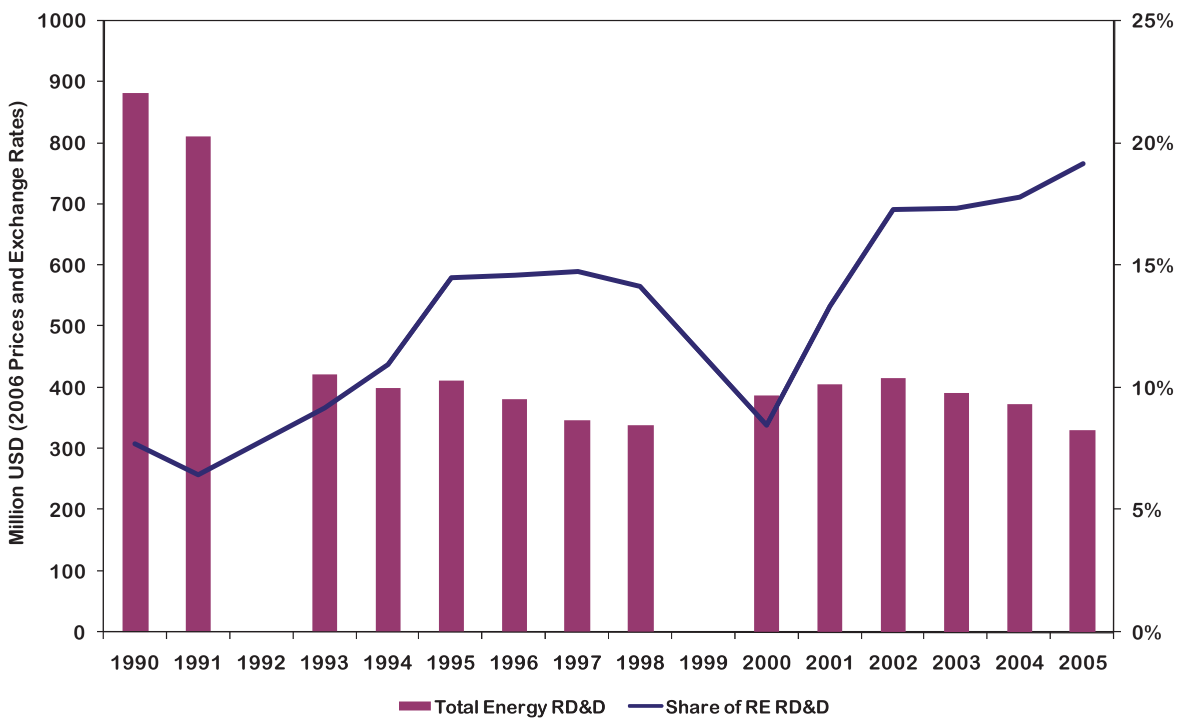
In the period from 1993 to 1998, the main focus of RE RD&D was on solar PV, which accounted for 58% of the total. The remaining budget was spent on bio-energy and wind energy technologies with a 24% and 18% share, respectively. The average annual budget

[12] Official IEA data on energy RD&D budgets include only **government** funding and not **private** RD&D spending.
[13] Conversion from national currency to USD is in USD (2006) prices and exchange rates.
[14] The average is based on those 15 years for which expenditures have been reported.

for this period of USD 49.5 million was below the 15-year average of USD 56.1 million[14]. But due to an even stronger decrease of total energy RD&D expenditures after 1991 the share of RE RD&D increased (Figure 7) from 1993 to 1998.

From 2001 to 2006, 62% of total RE RD&D expenditures were spent on solar thermal power, while the share of RD&D spending on solar PV was 24%. The annual average spending on solar thermal RD&D amounted to USD 40.3 million initiated by a capital grants scheme from 2001 that allocated the solar thermal RD&D budget to ENEA (the National Agency for New Technology, Energy and the Environment). Minor shares of the total RE RD&D budget went to bio-energies, wind energy and solar heating and cooling. The annual expenditures in this period were significantly above the average annual budget on RE RD&D for the whole period from 1990 to 2006.

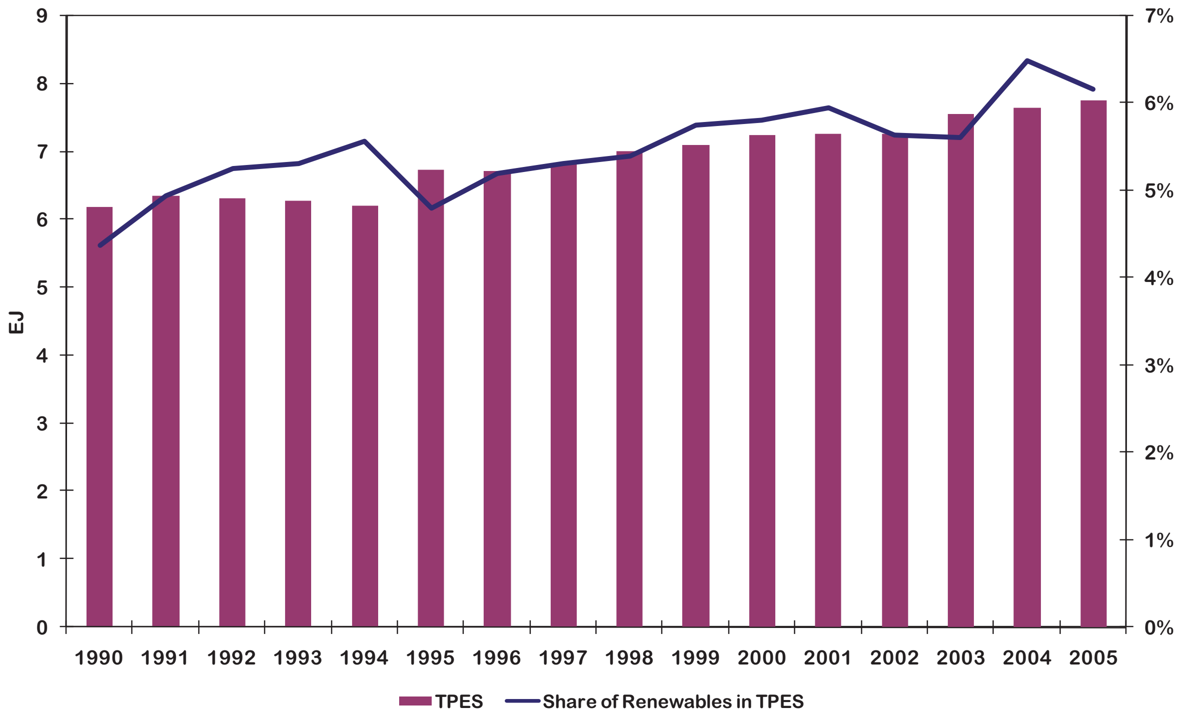
Figure 7. Renewable energy RD&D versus total government energy RD&D spending, 1990-2005



Source: IEA (2007b)

RENEWABLES IN TOTAL PRIMARY ENERGY SUPPLY[15]

Figure 8. Share of Renewable Energy in Total Primary Energy Supply, 1990-2005



Source: IEA (2007a)

Renewable energy supply grew by 3.9% on annual average over the period from 1990 to 2005, while TPES grew at a slower path of 1.5% per year. Accordingly the renewable share in TPES rose from 4.4% in 1990 to 6.2% in 2005. Drops of the renewables' share in 1995 and 2002 coincide with those years, in which hydropower production decreased by more than 15% compared to the respective previous year, while total primary energy supply grew above average.

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[15] The official IEA statistics on TPES include, where applicable, traditional biomass but exclude pumped hydro.

Primary energy convention: The IEA uses the **physical energy content method** to calculate the primary energy equivalent of non-combustible energy sources, such as geothermal, hydro, solar and wind. As a consequence, there is an obvious link between the principles adopted in defining the primary energy forms of energy sources and the primary energy equivalent of these sources. For instance, in the case solar thermal and geothermal electricity production, as heat is the primary energy form selected by the IEA, the primary energy equivalent is the quantity of heat generated in the geothermal or solar thermal plant for electricity generation. In the case of hydro, wind, tide and solar PV, as electricity is the primary energy form selected, the primary energy equivalent is the physical energy content of the electricity generated in the plant, which amounts to assuming an efficiency of 100%. Readers may consult (IEA, 2007a) for more details.

Renewable Energy Policy Information

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Glossary

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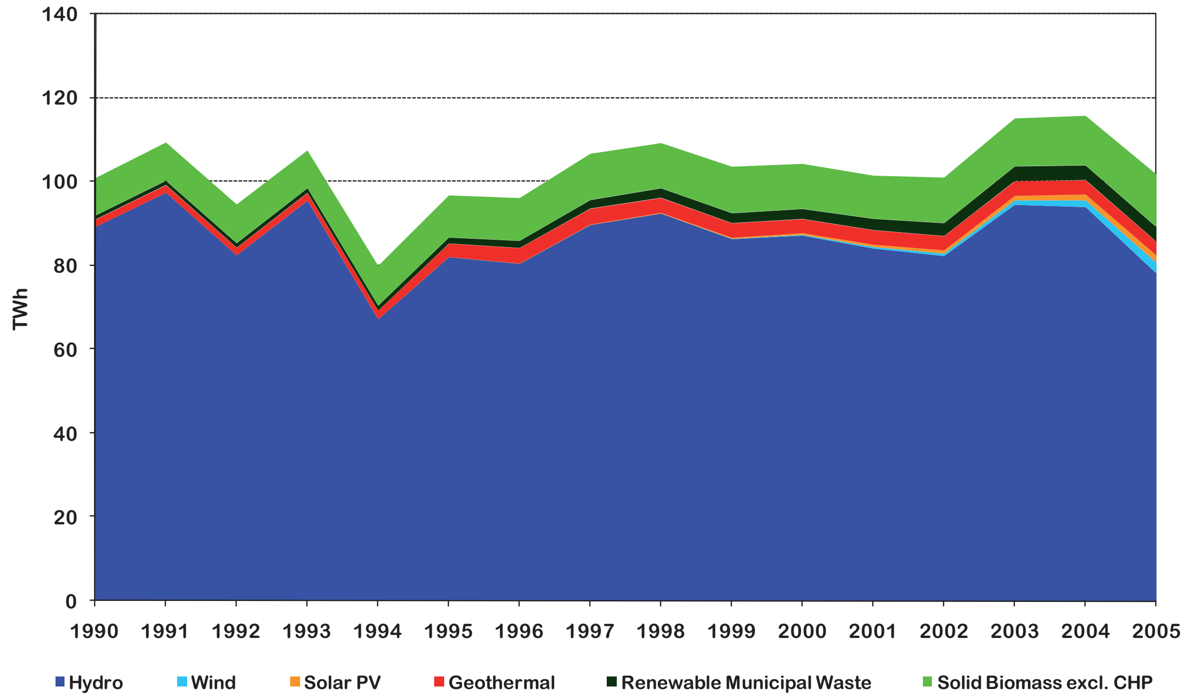
JAPAN

RENEWABLE ELECTRICITY (RES-E) MARKET

RES-E Market Developments

Figure 1. Total RES-E Production, 1990-2005[1]



Source: IEA (2007a)

In 2005, renewable electricity (RES-E) production was 101.7 TWh, representing 9.6% of total electricity generation. Supply from renewables fluctuated around the 16-year average of 103.7 TWh mainly due to varying electricity generation from hydropower. However, annual variations do not show a significant upwards or downwards trend over the whole period.

Hydropower remained the largest source of renewable electricity providing 78.2 TWh in 2005, representing 77% of total renewable electricity supply. Its total and relative contribution to generated electricity declined over the considered period, although installed capacity of hydropower increased constantly from 20.8 GW in 1990 to 22.1 GW in 2005.

12% of renewable electricity stemmed from solid biomass, adding a further 12.5 TWh in 2005. To 2005, total electricity generated from biomass increased at an annual average of 2% per year from 8.9 TWh in 1990.

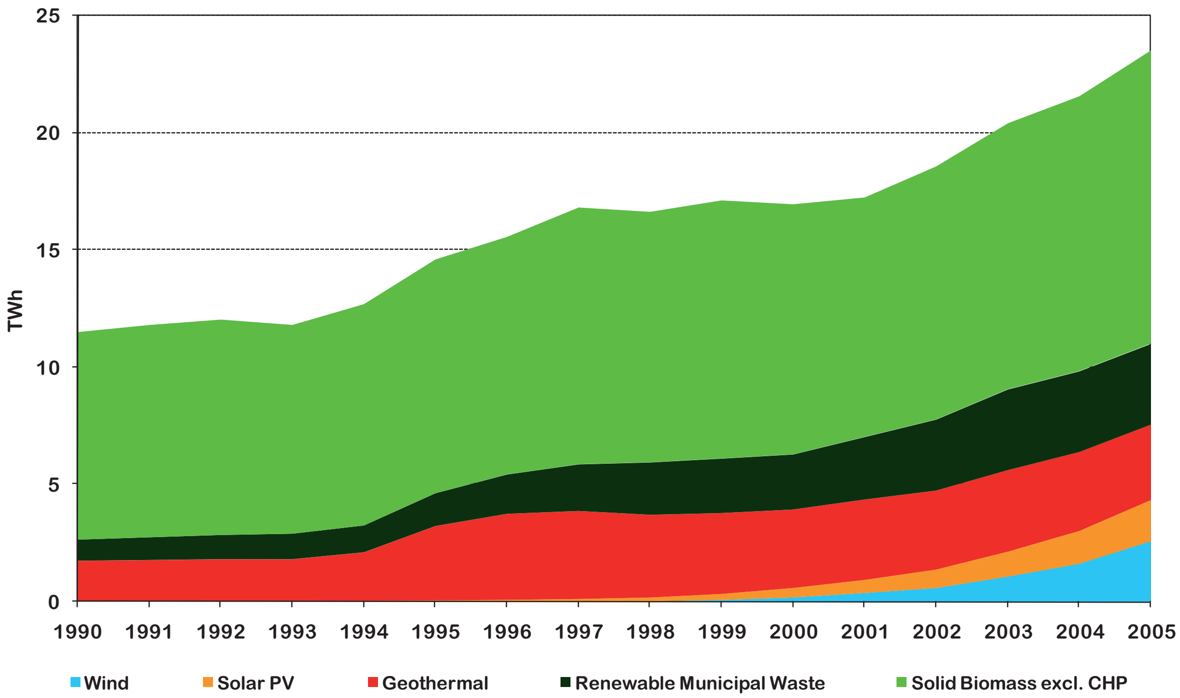
[1] Electricity production from solar PV and wind power is estimated (capacity factors: 14.2% and 23.3%, respectively).

Electricity from geothermal power plants and renewable municipal waste contributed 3.2 TWh and 3.4 TWh respectively contributing 3.2% and 3.4% of renewable electricity supply in 2005, respectively. Installed geothermal capacity remained almost constant since 1996; renewable municipal waste installations stagnated since 2001.

Wind power capacity, in contrast, increased rapidly at an average annual growth rate of 81%. Electricity generated from wind power amounted to 2.6 TWh in 2005 representing another 2.5% of total renewable electricity.

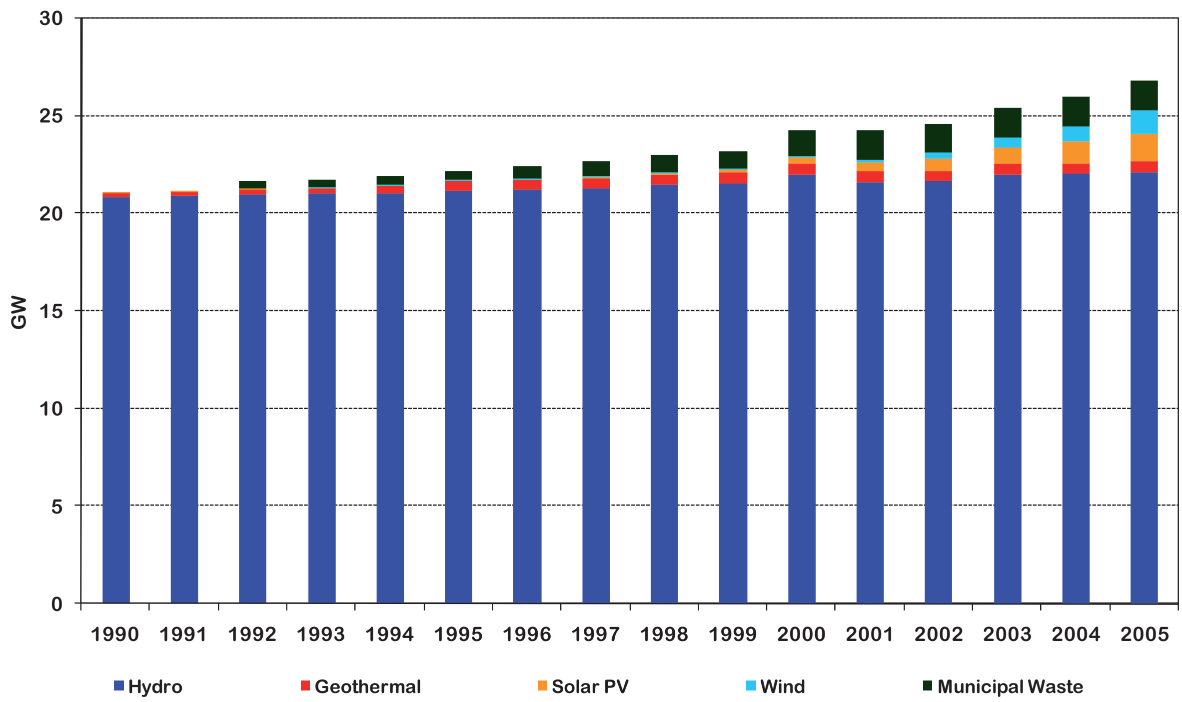
Only solar PV installations kept pace with this rapid growth at an average rate of 62% per year over the period from 1990 to 2005, reaching a cumulative installed capacity of 1.4 GW in 2005. This equalled 1.8 TWh of electricity generation in 2005 representing 1.7% of renewable electricity generation.

Figure 2. Total RES-E Production[1] (excluding Hydropower), 1990-2005



Source: IEA (2007a)

Figure 3. Net Generating Capacity of RES-E Plants, 1990-2005



NB: Official IEA statistics on electricity generating capacity do not differentiate between *renewable* and *non-renewable* municipal waste.

Source: IEA (2007a)

Development of Renewable Electricity Policies

Early actions of the Japanese government concerning the support of RES-E generation focussed on geothermal and hydro power in 1980. Currently, the most important policy measure of the Japanese government concerning the promotion of electricity generation by renewable energy technologies is the “Renewable Portfolio Standards (RPS) Law”[2] enacted in 2002. This law established a quota system imposing an annual obligation on electricity retailers to use a certain amount of renewable energy. The law enables regulated entities to meet their obligations not only through electricity generation from renewable energy sources but also by the purchase of renewable electricity or “New Energy Certificates” of other parties. Sources of renewable energy that fall within the scope of this tradable green certificate (TGC) scheme include solar PV, wind, biomass, geothermal and small to medium-sized hydro power (up to 1 MW capacity).

[2] Special Measures Law Concerning the Use of New Energy by Electric Utilities

Annual targets and measures set by the government[3] are revised every five years. By 2010 renewable energy eligible under the law is supposed to generate 12.2 TWh of electricity. The target for 2014 established in March 2007 aims at 16 TWh from renewable energy sources.

Further changes enacted in 2007 to the RPS system included that each kWh of electricity generated by solar PV would count for 2 kWh from 2011 to 2014 to encourage the purchase of solar PV power, since the costs of solar power generation were found to be double the costs of wind power in Japan at that time. Besides these technology specific adjustments the scope of eligible renewable energy sources was broadened.

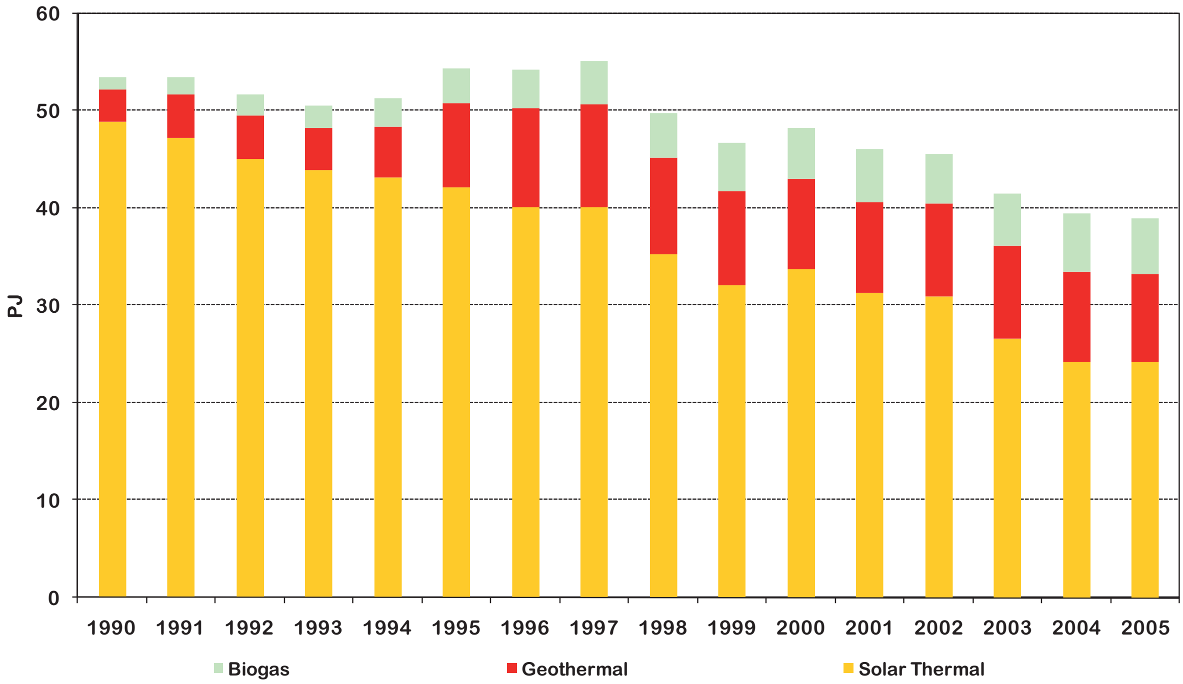
Prior to the implementation of the RPS Law utilities using renewable energy sources received financial support through the "New Energy Law"[4], which entered into force in 1997. Under this law the Japanese government employed incentives in three main categories: grants and subsidies, preferential tax treatment, and loan schemes applicable to major renewable energy technologies for electricity generation.

For the future, the Japanese government plans to expand the potential for new energy by reviewing various non-economic barriers, in addition to providing financial assistance. Particular efforts will be made to tackle the following: promotion of the use of tradable green certificates for RES-E; measures to promote the deployment of wind power, including policies related to grid integration; and technology development for PV cost reductions.

[3] Targets are set by the Minister of Economy, Industry and Trade.
[4] "Special Measures Law for Promoting the Use of New Energy"

RENEWABLE HEAT (RES-H) MARKET

Figure 4. Total RES-H Production, 1990-2005[5]



NB: Geothermal and solar thermal include direct final use.

Source: IEA (2007a)

In 2005, total renewable heat supply in Japan was 39.0 PJ. Since 1990, when renewable heat generation amounted to 53.5 PJ, heat supply from renewables declined almost constantly. Average annual growth was minus 2.1% over the respective period.

Solar thermal heat, which contributed 48.9 PJ (representing 91%) of renewable heat production in 1990, still accounted for the lions share with 62% of the total in 2005. However, absolute solar thermal heat generation more than halved between 1990 and 2005, declining at an average annual rate of minus 4.6% to 24.2 PJ in 2005. According to the IEA Solar Heating and Cooling Programme, the collector yield of all solar thermal systems (including systems for hot water, space heating and swimming pool heating) was 13.3 PJ in 2004 and decreased to 12.0 PJ in 2005 (Weiss *et al.*, 2007).

The brief upward trend in total renewable heat generation in the mid 90s can largely be attributed to the strong growth of geothermal heat production, which peaked in 1997 at 10.5 PJ after a seven-year average annual growth of 18% and fell back thereafter to 9.0 PJ in 2005 representing 14.8% of total renewable heat.

[5] Official IEA statistics on heat generation from renewable energy sources relate to **commercial heat sold** with additional data on **direct use** of solar thermal and geothermal available for most OECD countries.

Heat production of biomass accounted for 2.4% of total renewable heat, but increased at an average annual rate of 11% from 1990 until 2005 to 5.8 PJ. However, production levels peaked at 6.0 PJ in 2004.

The 1997 New Energy Law, as described in the electricity section, has also offered support for solar thermal technologies. Nonetheless, it has been unsuccessful in countering the strong influence of cost competitiveness with conventional heating technologies in Japan after a period in the mid 1990s marked by a strong currency and comparatively low world crude oil prices (IEA and RETD, 2007).

Biomass did not qualify for public support under the 1997 New Energy Law as it was originally promulgated. It was not until the 2002 revisions that biomass heat was able to receive funding from projects under its umbrella.

Geothermal heat was also not defined as a "new energy" technology under the 1997 law. Thus, most of the incentives offered for renewable heat in Japan were not applicable to geothermal technology. This may partly explain the decline in its utilisation after 1997. An amendment to include geothermal heat as an eligible RET was tabled in May 2006 but had not yet been decided on at the time of writing. Such a policy move may have important implications for the future of the technology in Japan (IEA and RETD, 2007).

Renewable Transport Fuel (RES-T) Market

The introduction of biofuels to the Japanese market has already been a matter of discussion for a couple of years. In 2005 the Environment Ministry of Japan (MOE) allowed the introduction of gasoline blended with 3% of bioethanol (a so-called E3 blend) in the Japanese market. However, scarce availability of resources for domestic bioethanol production has been hampering the distribution of bioethanol.

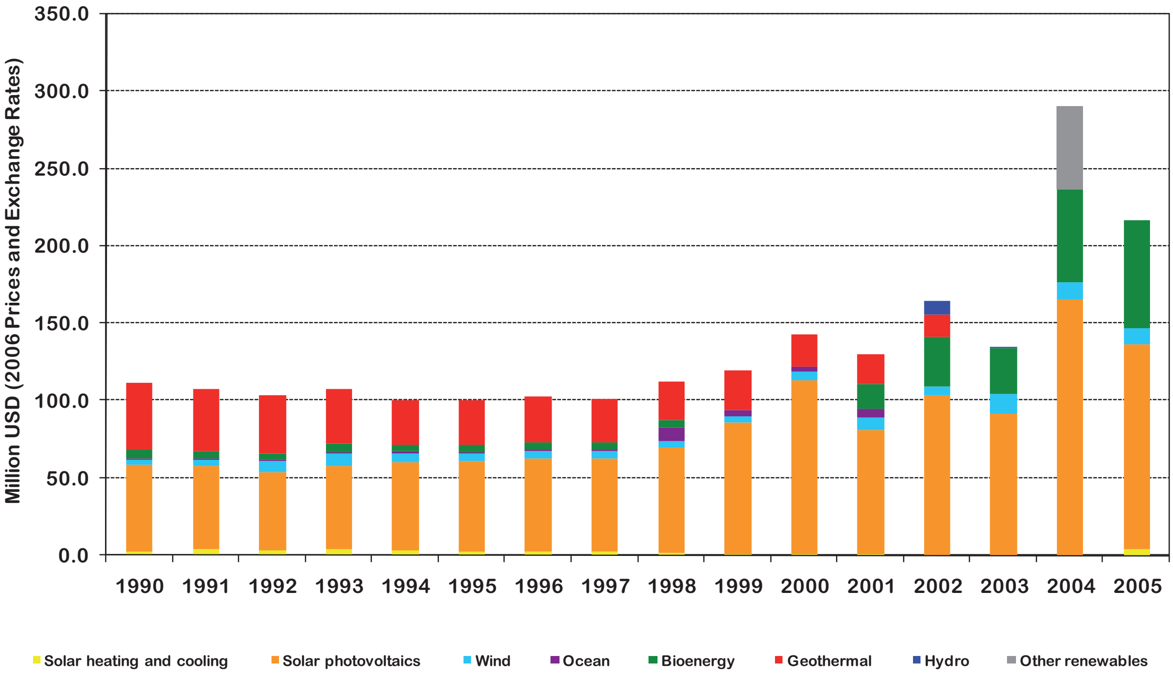
As of March 2006, Japan produced only 30 kilolitres (kl) (633 GJ)[6] of bioethanol at subsidized pilot plants and around 4 000-5 000 kl (138 TJ-172.5 TJ)[6] of biodiesel annually. In January 2007, the first commercial plant started production of bioethanol in Osaka with an annual capacity of 1 400 kl (29.5 TJ)[6]. A second one with a larger capacity of 15 000 kl (316.5 TJ)[6] per year is planned to commence production in 2009.

In 2006 Japan's oil industry set a target to produce 360 000 kl (7.6 PJ)[6] of ETBE, a gasoline additive produced from ethanol, per year by 2010. In February 2007 the government released detailed plans on the expansion of domestic bioethanol production until 2030 to 10% of domestic petroleum consumption, which equals 6 million kl (210 PJ)[7]. Initial short term targets were expected to be set to substitute 500 000 kl (17.5 PJ)[7] of conventional fuel with imported and domestic biofuels by 2010.

[6] For the applied biofuel conversion factors, refer to the Glossary which can be found after the country profiles.
[7] The applied conversion factor is 35 MJ/litre.

RESEARCH, DEVELOPMENT AND DEMONSTRATION TRENDS

Figure 5. Annual Government RD&D Spending on Renewables, 1990-2005 (USD 2006 prices and exchange rates)[8]



Source: IEA (2007b)

From 1990 to 2005, Japan spent a cumulative total of USD 2.147 billion[9] on renewable energy technology (RET) RD&D. This amount equalled 3% of total government energy RD&D expenditures over the same period.

RD&D spending on solar PV accounts for 61% of total expenditures on renewable energy RD&D in 2005 and has consistently received the largest amount of annual investments in the previous years. Until 2001, investments in RD&D of geothermal energy accounted for the second largest RD&D expenditure on renewable energy technologies. In 2001, however, the focus of RD&D investments in renewables changed with 12% spent on bioenergy (up from 0% in 1999 and 2000, and around 4% in the previous years). Since 2002 bioenergy has become the second largest receiver of public renewable energy RD&D expenditures, whereas investments in geothermal RD&D have largely ceased.

Between 1990 and 2005, 60% of cumulative government expenditures on RE RD&D were spent on solar PV. Geothermal still accounts for 18% of the cumulative budget, despite the recent RD&D policy change. 12% of the total has been invested into bioenergy RD&D, 5%

[8] Official IEA data on energy RD&D budgets include only **government** funding and not **private** RD&D spending.
[9] Conversion from national currency to USD is in USD (2006) prices and exchange rates.

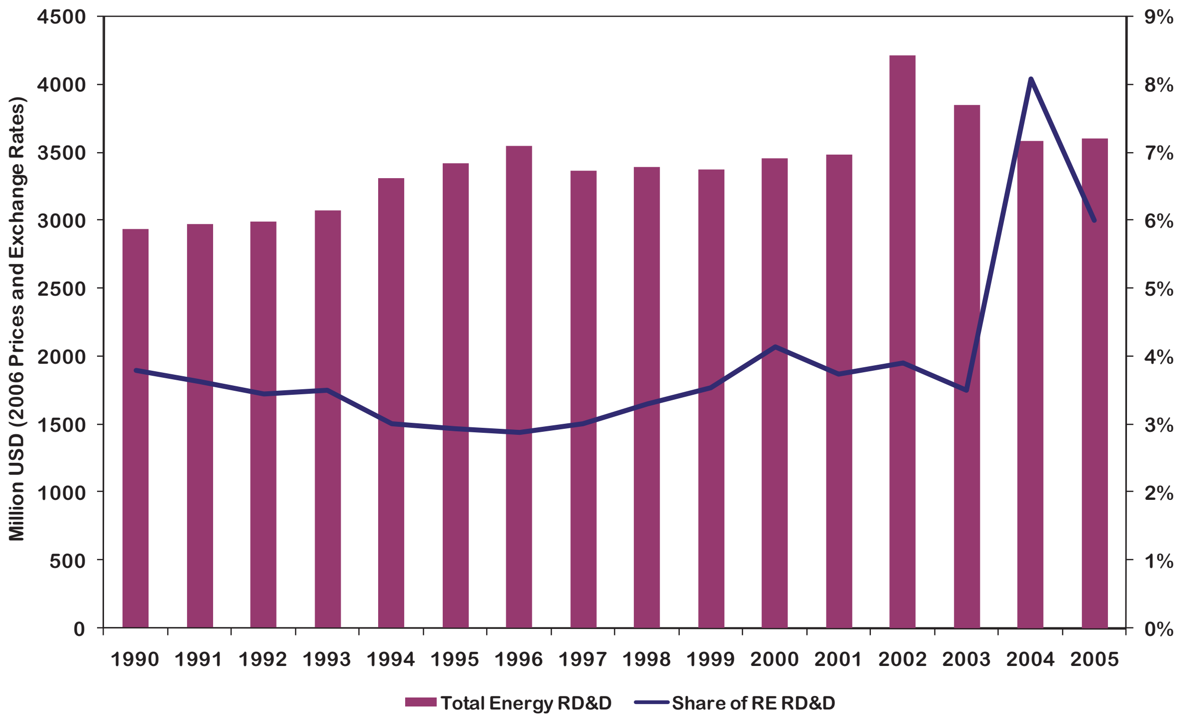
into wind energy, and 1.5% each into solar thermal heating and cooling as well as ocean energy RD&D activities. 2% were spent on other renewable technologies.

The increase in bioenergy RD&D expenditures in 2001 coincides with the amendment of the "New Energy Law" after which bioenergy was eligible under this regulatory framework. The allocation of grants and subsidies to renewable energy technologies, which are offered in the area of technological development (RD&D), demonstration and field test projects, and introduction and dissemination, is to a large extent governed by this law (IEA and RETD, 2007).

Absolute renewable energy RD&D spending remained fairly constant until 2003 compared to recent budgetary changes. The average RD&D spending on renewables amounted to USD 117.1 million per annum for this period. In 2004 and 2005, however, average annual RD&D investments in renewable energies have almost doubled compared to the previous 14-years' average.

Total energy RD&D budgets did not see dramatic changes over the considered period. Therefore, the increase in total RE RD&D spending is reflected in an equally large increase of the RE share in total energy RD&D budgets (Figure 6). However, renewable energy technologies still received only 6% of the total energy RD&D expenditures.

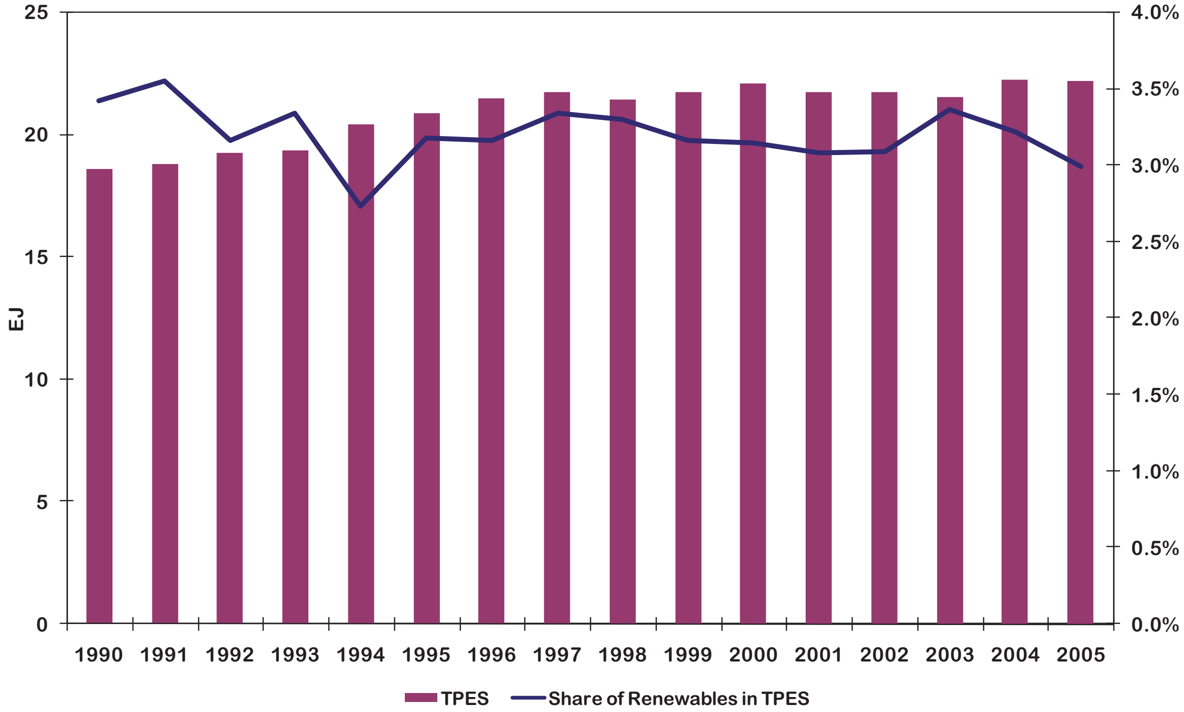
Figure 6. Renewable energy RD&D versus total government energy RD&D spending, 1990-2005



Source: IEA (2007b)

RENEWABLES IN TOTAL PRIMARY ENERGY SUPPLY[10]

Figure 7. Share of Renewable Energy in Total Primary Energy Supply, 1990-2005



Source: IEA (2007a)

Total primary energy supply (TPES) in Japan was 18.6 EJ in 1990 and 22.2 EJ in 2005. The contribution of renewable energy sources to TPES has been fairly constant, fluctuating around the average of 3.2% renewables in TPES according to IEA definitions of renewable energy supply. The New Energy Indicator Law, however, which aims at 3% of TPES to come from "new energy sources", excludes hydroelectric and geothermal energy. The corresponding share in 2002 was 1.6% of TPES by "new energy sources".

Japan's TPES has increased at an average annual growth rate of 2.3% over the 7-year period from 1990 to 1997. Afterwards TPES growth has slowed down increasing at an average annual rate of 0.2% over the following 8-year period.

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[10] The official IEA statistics on TPES include, where applicable, traditional biomass but exclude pumped hydro.

Primary energy convention: The IEA uses the **physical energy content method** to calculate the primary energy equivalent of non-combustible energy sources, such as geothermal, hydro, solar and wind. As a consequence, there is an obvious link between the principles adopted in defining the primary energy forms of energy sources and the primary energy equivalent of these sources. For instance, in the case solar thermal and geothermal electricity production, as heat is the primary energy form selected by the IEA, the primary energy equivalent is the quantity of heat generated in the geothermal or solar thermal plant for electricity generation. In the case of hydro, wind, tide and solar PV, as electricity is the primary energy form selected, the primary energy equivalent is the physical energy content of the electricity generated in the plant, which amounts to assuming an efficiency of 100%. Readers may consult (IEA, 2007a) for more details.

Renewable Energy Policy Information

For further details on renewable energy support policies implemented in Japan, readers may consult the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

Glossary

Definitions, abbreviations, acronyms and units are explained in the Glossary which can be found after the country profiles.

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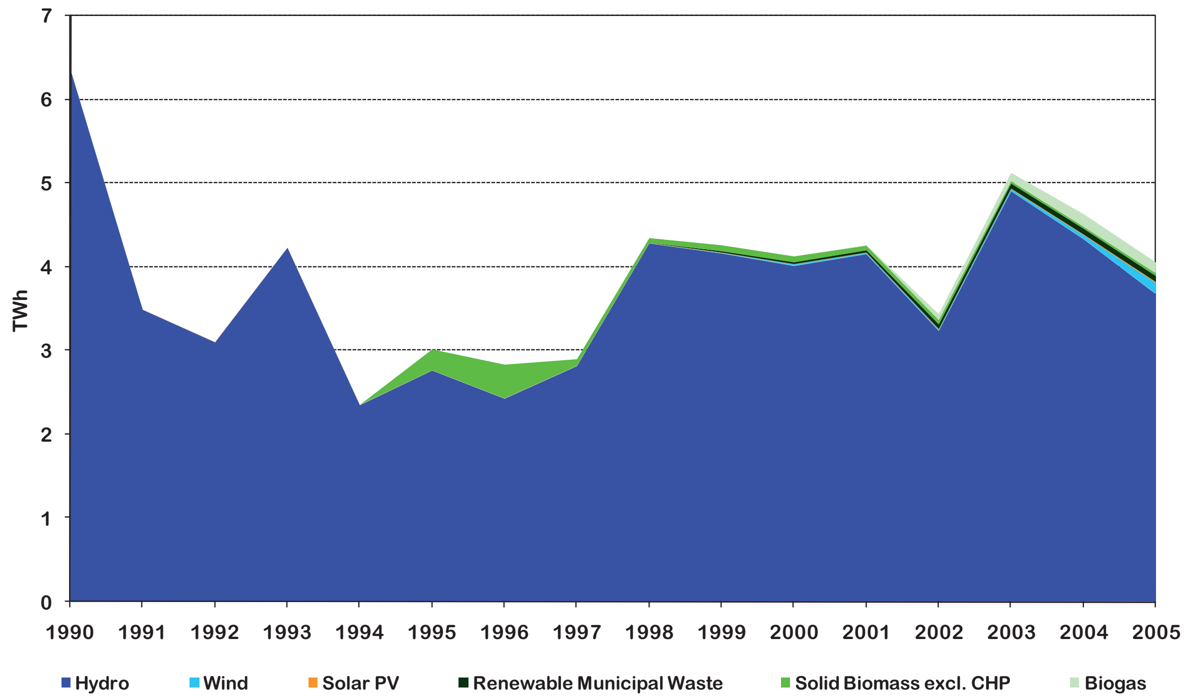
KOREA (REPUBLIC OF)

RENEWABLE ELECTRICITY (RES-E) MARKET

RES-E Market Developments

Figure 1. Total RES-E Production, 1990-2005



Source: IEA (2007a)

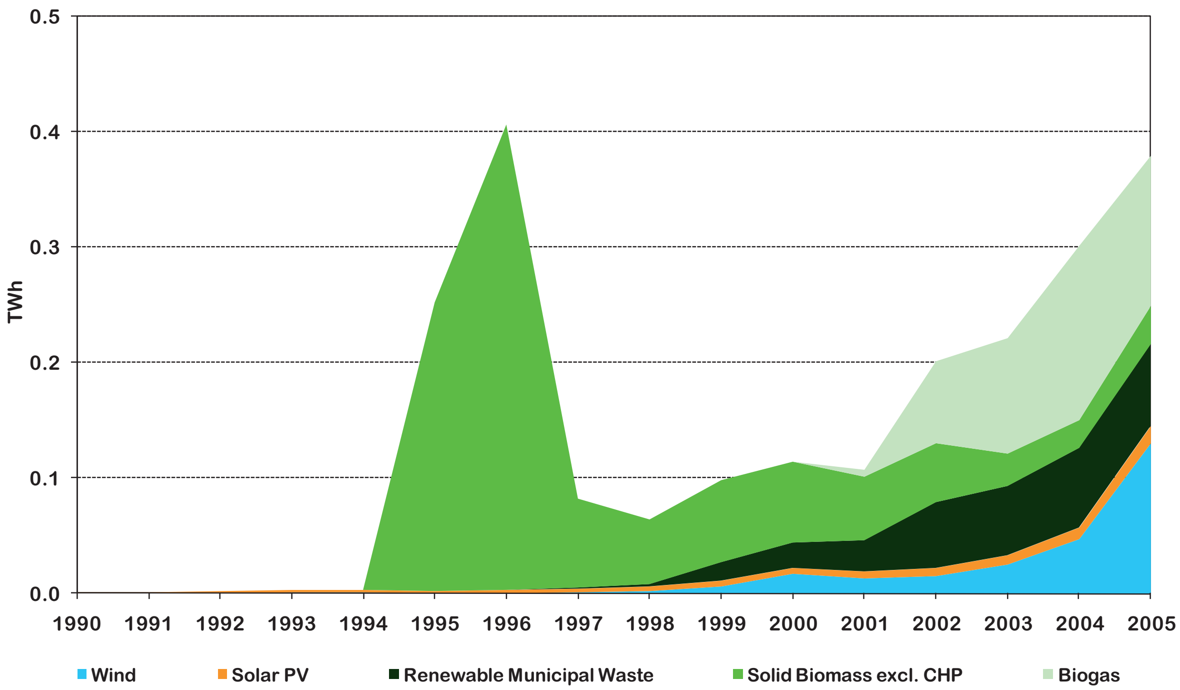
Gross renewable electricity (RES-E) production in 2005 was low, amounting to only 4 052 TWh, which represented no more than 1.0% of total gross electricity generation. The RES-E mix in Korea is largely dominated by hydropower. In 2005, hydropower still generated 90.6% of all renewable electricity, 3.2% each stemmed from hydro and wind power, 1.8% from renewable municipal waste products, 0.8% from non-CHP solid biomass plants and 0.4% from solar PV. Against this backdrop of modest growth in RES-E, Korea's target of 7% RES-E by 2010 will require strong and consistent policy support.

Despite strong fluctuations in annual power generation, installed hydropower capacity did not expand significantly, with annual growth averaging 1.1% since 1990. Nevertheless, the absolute hydropower capacity additions for the period from 1990 to 2005 were still higher than those of all other RES-E technologies combined (Figure 3).

Wind power showed the strongest and most continuous growth in recent years with average annual rates of 83.8% since 1997. In 2005, wind power capacity more than tripled in comparison to the previous year – adding 70 MW of capacity. In 2006, another 77 MW of capacity were installed. Korea's two major large-scale projects in Gangwon with 98 MW and in Yongdeok with 39.6 MW represent almost 80% of total domestic capacity. Both of these projects receive additional support via the Clean Development Mechanism (CDM)[1]. Increasingly serious public resistance, military radar issues and difficult mountainous site characteristics are mentioned as major obstacles slowing down recent development trends.

Electricity production from biogas started in 2001 and provided 130 GWh in 2005 – the same amount as wind power. Renewable municipal waste products were used to generate 71 GWh in 2005. Electricity generation from this resource started in 1997 as well, but reached only about half the scope of wind power production. Power generation from solid biomass in non-CHP plants shows a high and sudden peak in 1996 and 1997 dropping again steeply afterwards. No explanation could be found for this data development[2].

Figure 2. Total RES-E Production (excluding Hydropower), 1990-2005



Source: IEA (2007a)

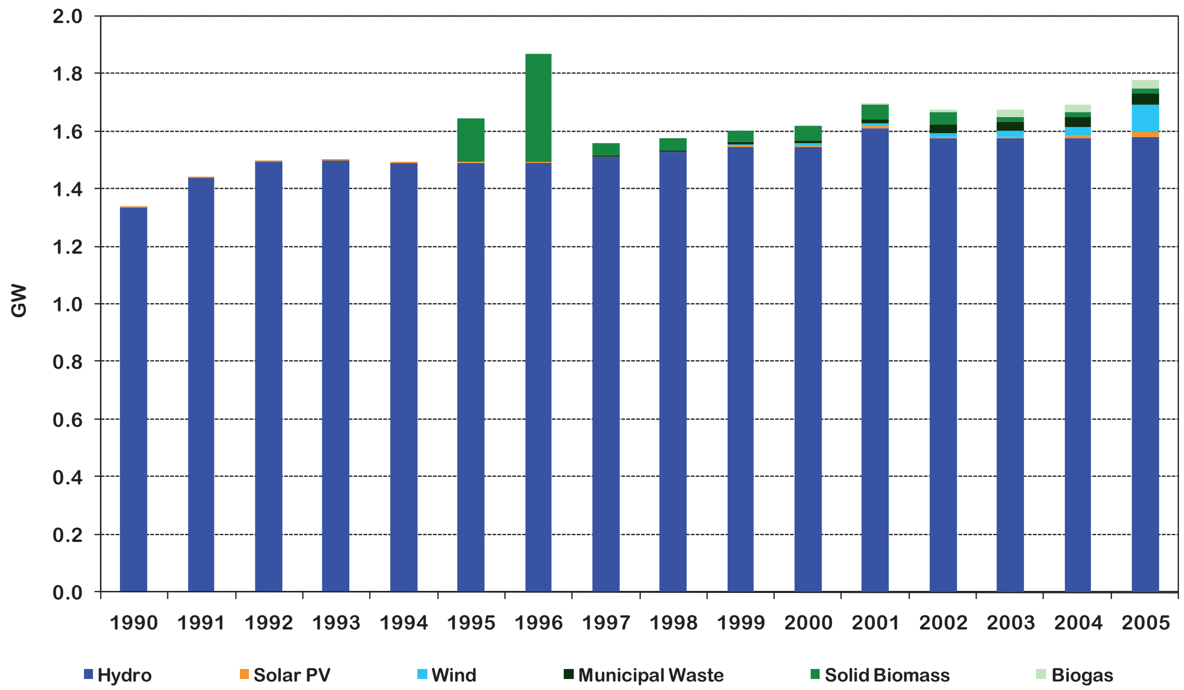
Despite its marginal contribution in overall terms (15 GWh produced in 2005, 14 MW of total capacity by the end of 2005), electricity production from solar PV grew constantly, and increasingly so since the turn of the century. On average, annual growth was 19.8% since

[1] Korea is a non-Annex I Party to the United Nations Framework Convention on Climate Change (UNFCCC). As such Korea can host CDM projects that serve as emission reduction mechanism for countries with fixed emission targets under the Kyoto Protocol.
[2] Possible reasons may include false reporting, inclusion of traditional biomass, or experiments with co-firing.

1990. In 2006 annual installations reached approximately 21 MWp up from 5 MWp in 2005 – making Korea the fifth-largest market worldwide, though it only accounted for 1% of the global installations in 2006. During 2007, South Korea announced the construction of one of the world's largest solar PV projects in Sinan, near the south-western tip of the country, with a capacity of 20 MWp.

South Korea is also investing in the construction of a 254 MW tidal power plant that is under construction on the country's west coast. This project is scheduled to be completed by 2009 and will surpass the currently largest tidal energy plant in the world, which is located in France. Further plans on RES-E development were unveiled by the city of Incheon in 2007 which is planning to construct an 812 MW tidal energy plant by 2014. The KRW 1.78 trillion (USD 1.91 billion)[3] plant would connect four islands with a 7.8 km barrier harnessing tidal energy with its turbines.

Figure 3. Net Generating Capacity of RES-E Plants, 1990-2005



NB: Official IEA statistics on electricity generating capacity do not differentiate between *renewable* and *non-renewable* municipal waste.

Source: IEA (2007a)

[3] In 2007, the average exchange rate was USD 1 = KRW 931.

Development of Renewable Electricity Policies

In December 2003, the government set targets for new and renewable energy supply[4] to reach 3% of total primary energy supply (TPES) in 2006 and 5% in 2011. Indicative technology-specific targets for the electricity sector have been derived and laid down in the "Second Basic Plan for New and Renewable Energy Technology Development and Dissemination". Wind and solar PV have been chosen as two of three focus technologies[5] that are designated to receive 70% of total government spending on new and renewable energy technologies (IEA, 2006).

The Korean government has introduced a solar PV target of 1.3 GW grid-connected capacity by 2011, including 100,000 solar homes. Wind power shall contribute a total of 2 250 MW by that date with 30% coming from offshore installations. Besides RD&D support, a number of deployment policies have been enacted to achieve this targets (see below and the section on RD&D spending).

Since 2002 Korea's main support instrument for renewable energy in the electricity sector is a technology-specific feed-in tariff (FIT). Small hydropower, biomass and waste are guaranteed to receive fixed rates for five years, while wind and photovoltaic energy systems can benefit for a period of 15 years from feed-in tariffs. Upper limits of support for renewables have been set in 2002 at 250 MW for wind and 20 MW for solar. The caps and tariffs have been adjusted by the government in October 2006. Solar PV systems are since differentiated according to size with larger systems receiving a reduced tariff rate. Besides *ad hoc* adjustments, tariffs are scheduled to be reduced annually on a technology-specific percentage basis after 2009 taking into account different maturity statuses and cost-reduction potentials, e.g. 4% annually for solar PV and 2% annually for wind.

Other support mechanisms include investment grants, preferential loans and tax incentives. Investment grants are in particular provided for small-scale demonstration projects. Funding in the form of loans is mostly focused on solar PV and biomass. Furthermore, the government has focussed on the building sector. In 2001 it introduced a 100 000 photovoltaic houses project that provides subsidies to generate part of the energy for residential services from solar PV power. Since 2004, new public buildings larger than 3 000 m^2 are obliged to spend 5% of the total construction budget on installing new and renewable energy facilities. In 2005, a non-mandatory "Renewable Portfolio Agreement" was signed between the government and nine major energy providers aiming at increased use of and research on renewable energy technologies (RETs). However, companies that deploy renewables under this scheme can still benefit from the FIT system. As Korea is a non-Annex I Party to the UNFCCC, renewable energy projects developed in Korea may further benefit from the financial value of CDM credits.

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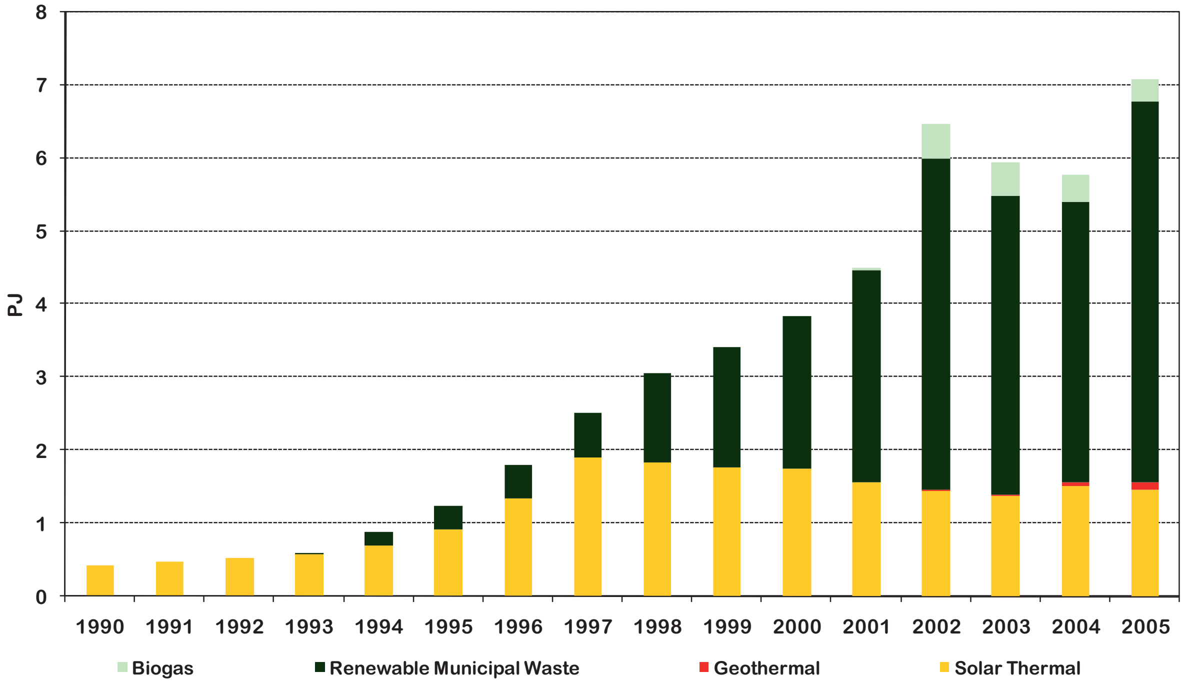
[4] New and renewable energy includes small hydro, solar photovoltaics, wind, bioenergy (including combustible renewables and waste), geothermal, ocean and fuel cells, among other technologies.
[5] The third RD&D focus is hydrogen fuel cells.

RENEWABLE HEAT (RES-H) MARKET

Figure 4. Total RES-H Production, 1990-2005[6]



NB: Geothermal and solar thermal include direct final use.

Source: IEA (2007a)

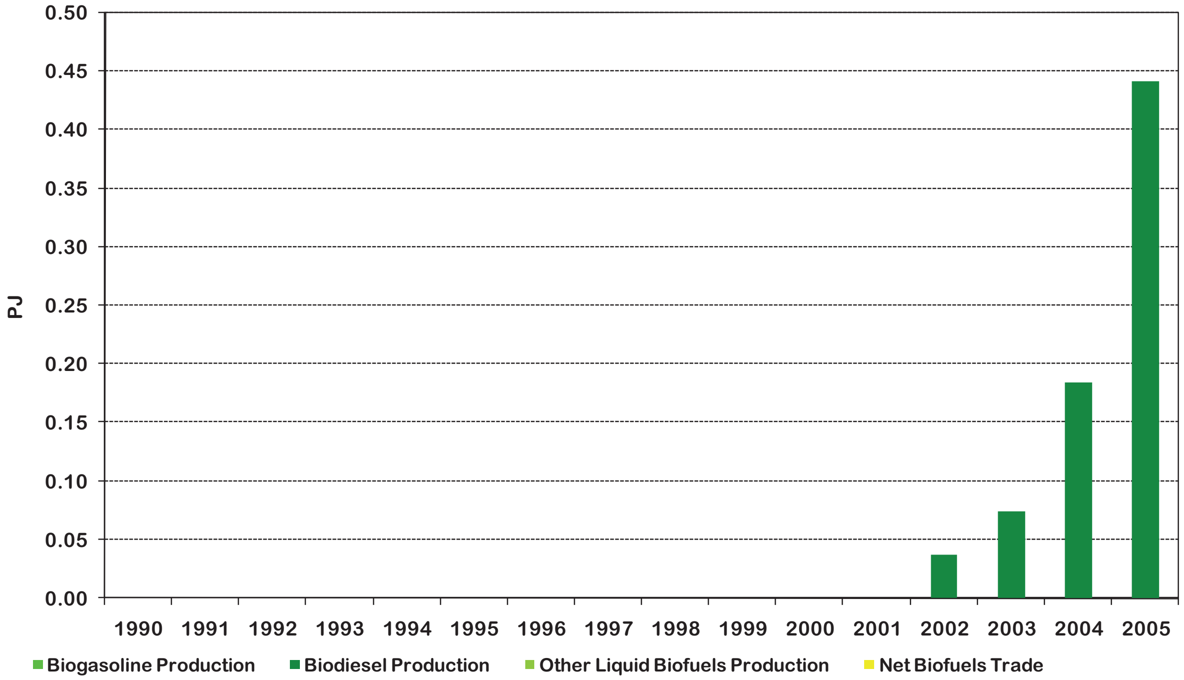
In 2005, total renewable heat supply was 7.1 TJ. Almost three quarters were supplied by renewable municipal waste, 20.5% stemmed from solar thermal installations, 4.1% from biogas and the remaining 1.5% from geothermal heat. Solar thermal heat supply increased on average by 24.3% from 1990 to 1997 and declined again thereafter. Since the beginning of this century, there was essentially no growth in solar thermal heat supply. Instead, growth occurred mainly in renewable municipal waste incineration for heating purposes. 78.4% of additional renewable heat supply since 1990 stemmed from renewable municipal waste. Heat from this source grew on average by 75.8% annually since 1993. Use of geothermal energy and biogas for heat supply started in 200 and 2001, respectively. However, their contribution to overall renewable heat supply remained marginal.

The "Promotional Law on New and Renewable Energy Development" from 1987 already promoted the installation of waste incineration facilities. However, major support policies in the heat sector have so far not been enacted.

[6] Official IEA statistics on heat generation from renewable energy sources relate to **commercial heat sold** with additional data on **direct use** of solar thermal and geothermal available for most OECD countries.

TRANSPORT MARKET

Figure 25. Biofuel Production and Net Biofuel Trade



NB: Net Biofuels Trade refers to the balance of domestic biofuel consumption, i.e. biofuel exports subtracted from imports.

Source: IEA (2007a)

Domestic biodiesel production in Korea was 442 TJ in 2005 – a 140% increase compared to the previous year. According to the Global Agriculture Information Network, production had increased to 1,523 TJ (40,304 metric tons) in 2006 and is estimated at almost 3.0 PJ (79,200 metric tons) for 2007. If targets (see below) are to be met, production has to increase further in 2008 (GAIN, 2007).

Diesel accounts for more than half of the total transport fuel consumption in Korea. However, in 2006 the government also initiated feasibility study on bioethanol as a transport fuel.

Deployment of biofuels commenced in 2002 with the Ministry of Commerce, Industry and Energy (MOCIE) building a first full-scale commercial biodiesel plant. In 2003 work on a biofuel standard started and, in 2006, eventually resulted in a governmental decree, the Petroleum Business Act (PBA), which established a standard that resembles the European biofuel standard EN14214. Also, under this act a blending quota of a 0.5% was set for selected refineries. The government is intending to increase the blending quota, but attempts to set a 5% quota in the 2006 decree were successfully opposed by the country's refining and automobile lobby. Instead, the government acquiesced and reduced the mandatory obligation to a 0.5% blend. Five oil refiners were included in an agreement to blend 158 400 metric tonnes (roughly 5.5 PJ[7]) over a two-year period that began in July 2006 (*ibid.)*.

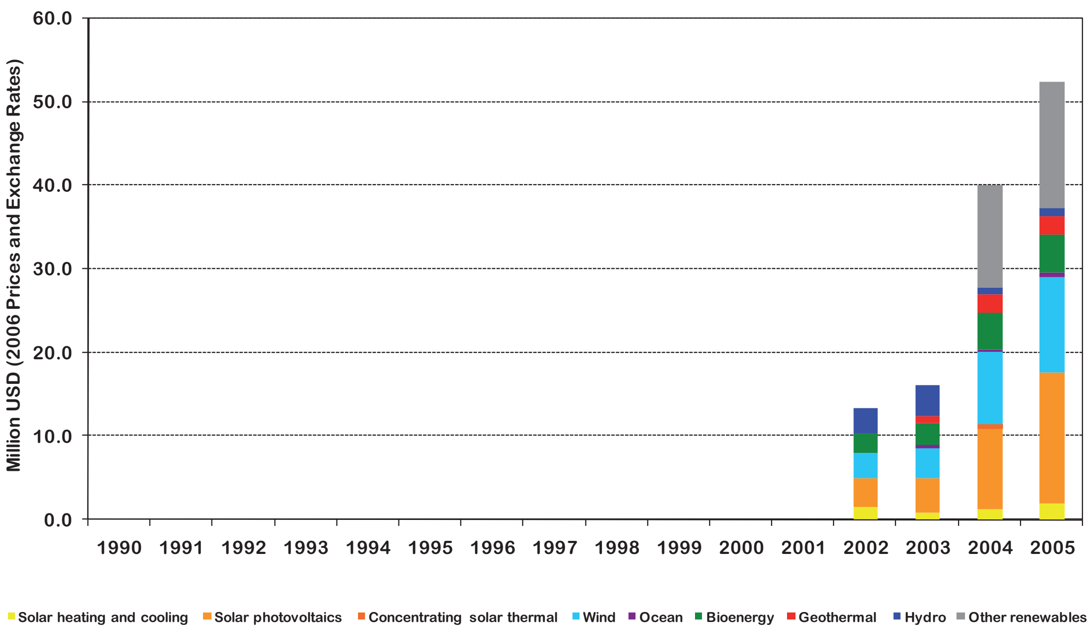
Biodiesel is currently – and supposedly for the near future – tax-exempt. However, biodiesel blends sell at the same price as conventional diesel due to the low blending quota and higher biodiesel prices compared to conventional fuel.

Basically, all raw materials for biofuel production have been imported from South America and southeast Asia so far. However, Korea does not import or export any biofuels. In March 2007, the Korean government has announced plans to built three 500 hectare farms for an expected production of 2.4 million litres of rapeseed oil annually. According to the Ministry of Agriculture and Forestry, construction of the USD 2.6 million investment projects shall be completed by 2009. The 5% blending target remains on the political agenda, but depends, however, on Korea's ability to build up a domestic biofuel production chain.

This development has to be considered in the wider energy context, since Korea is entirely dependent on imported oil products. Thus, the move towards increased biofuel production can be seen as part of the struggle to ease its reliance on imported oil.

RESEARCH, DEVELOPMENT AND DEMONSTRATION TRENDS

Figure 6. Annual Government RD&D Spending on Renewables, 1990-2005 (USD 2006 prices and exchange rates)[8]



Source: IEA (2007b)

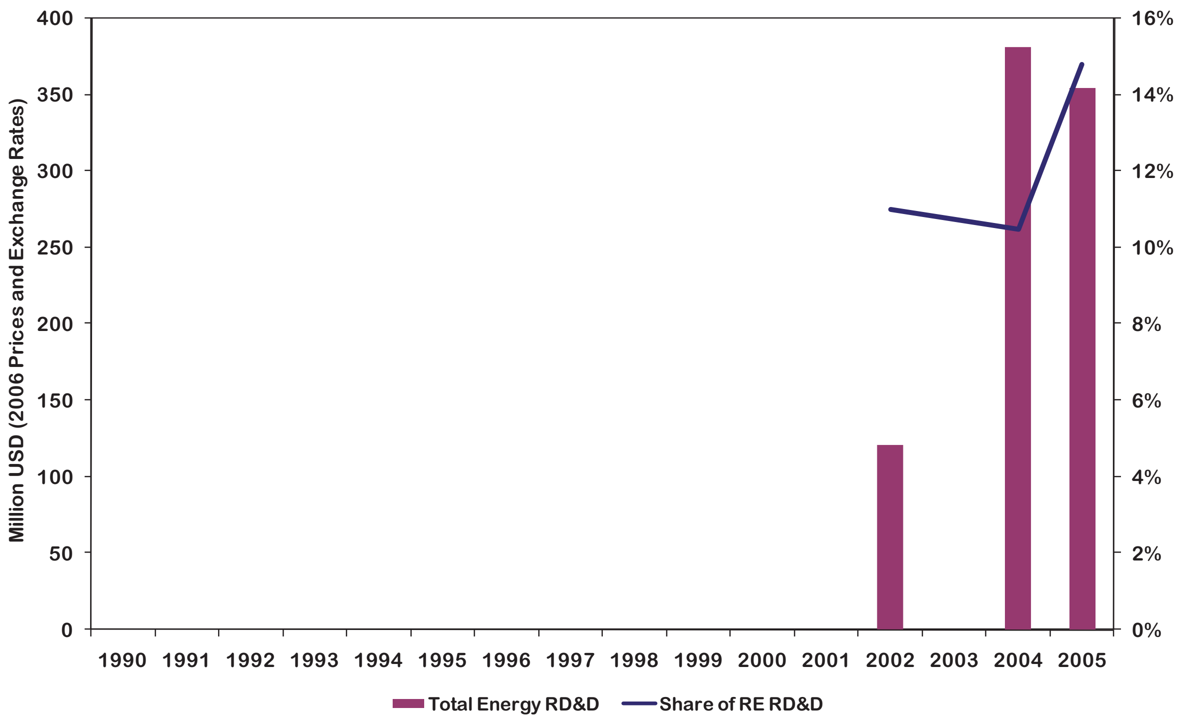
[7] For the applied biofuel conversion factors, refer to the Glossary which can be found after the country profiles.

[8] Official IEA data on energy RD&D budgets include only **government** funding and not **private** RD&D spending.

Data on RD&D are available since 2002. In 2005, total governmental RD&D spending on renewable energy technologies was USD 52.5 million[9] – approximately four times the budget of the year 2002. The share of RE RD&D in total energy RD&D increased from 11% to almost 15%.

The proportion of wind and solar PV remained fairly stable at 22% and 24-30%, respectively. Spending on hydropower RD&D decreased in absolute as well as relative terms. The budget on geothermal energy RD&D increased absolutely and relatively. All other technologies gained in terms of absolute budgets, while their fraction of the total RE RD&D budget decreased. This reflects the general renewable energy policy of the Korean government with its selected focus technologies.

Figure 7. Renewable energy RD&D versus total government energy RD&D spending, 1990-2005

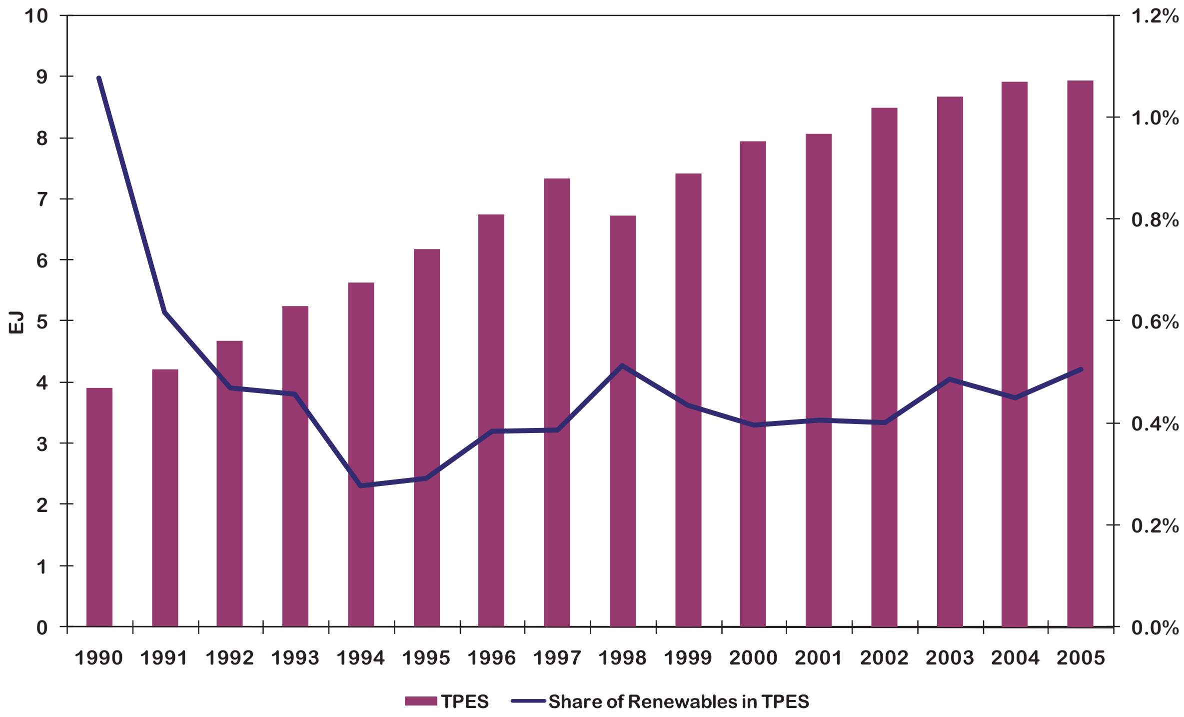


Source: IEA (2007b)

[9] Conversion from national currency to USD is in USD (2006) prices and exchange rates.

RENEWABLES IN TOTAL PRIMARY ENERGY SUPPLY[10]

Figure 8. Share of Renewable Energy in Total Primary Energy Supply, 1990-2005



Source: IEA (2007a)

Korea's share of renewables in TPES is the lowest among all IEA countries. In 2005, it was only 0.5% (including traditional biomass, but excluding pumped storage). In the early 1990s, their share dropped from an already low 1.1% to 0.3% in 1994. However, from 1996-2005, renewable primary energy supply increased on average at 5.7% annually, while TPES increased at 3.7% on annual average.

In absolute terms, TPES increased consistently since 1990, although a slowdown of growth in primary energy supply was visible in recent years. In 2003, targets for the share of new and renewable energy in TPES were set at 3% in 2006 and 5% in 2011 (IEA, 2006).

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[10] The official IEA statistics on TPES include, where applicable, traditional biomass but exclude pumped hydro.

Primary energy convention: The IEA uses the **physical energy content method** to calculate the primary energy equivalent of non-combustible energy sources, such as geothermal, hydro, solar and wind. As a consequence, there is an obvious link between the principles adopted in defining the primary energy forms of energy sources and the primary energy equivalent of these sources. For instance, in the case solar thermal and geothermal electricity production, as heat is the primary energy form selected by the IEA, the primary energy equivalent is the quantity of heat generated in the geothermal or solar thermal plant for electricity generation. In the case of hydro, wind, tide and solar PV, as electricity is the primary energy form selected, the primary energy equivalent is the physical energy content of the electricity generated in the plant, which amounts to assuming an efficiency of 100%. Readers may consult (IEA, 2007a) for more details.

RENEWABLE ENERGY POLICY INFORMATION

For further details on renewable energy support policies implemented in Korea, readers may consult the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

GLOSSARY

Definitions, abbreviations, acronyms and units are explained in the Glossary which can be found after the country profiles.

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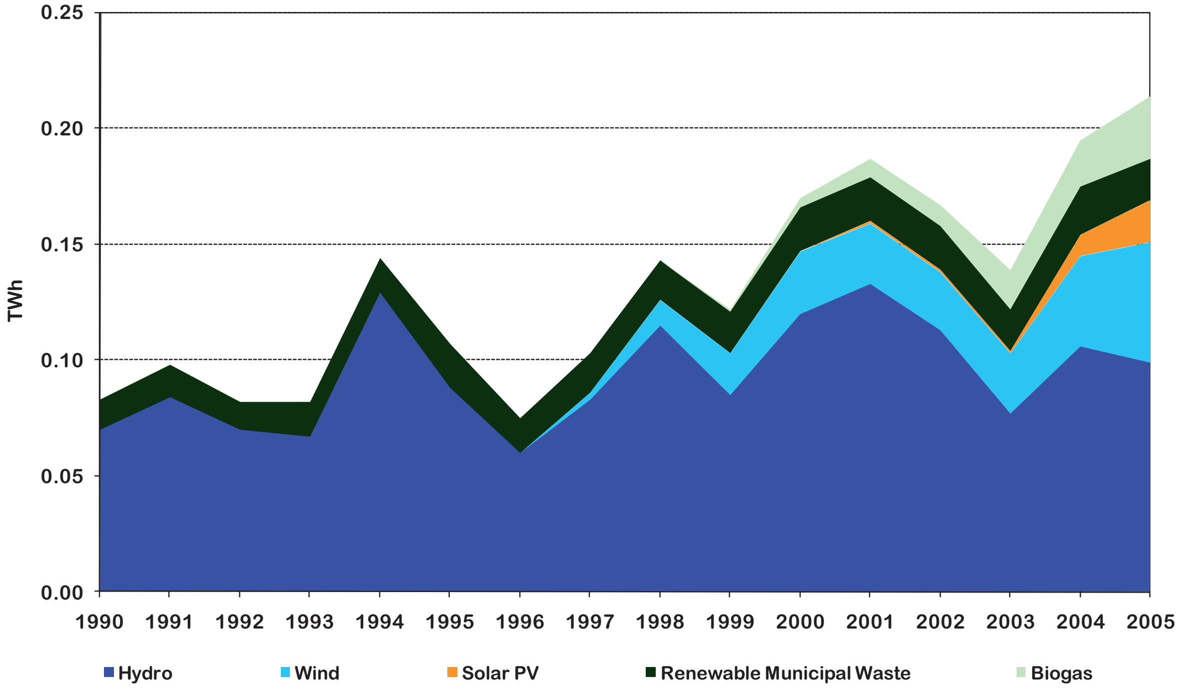
LUXEMBOURG[1]

RENEWABLE ELECTRICITY (RES-E) MARKET

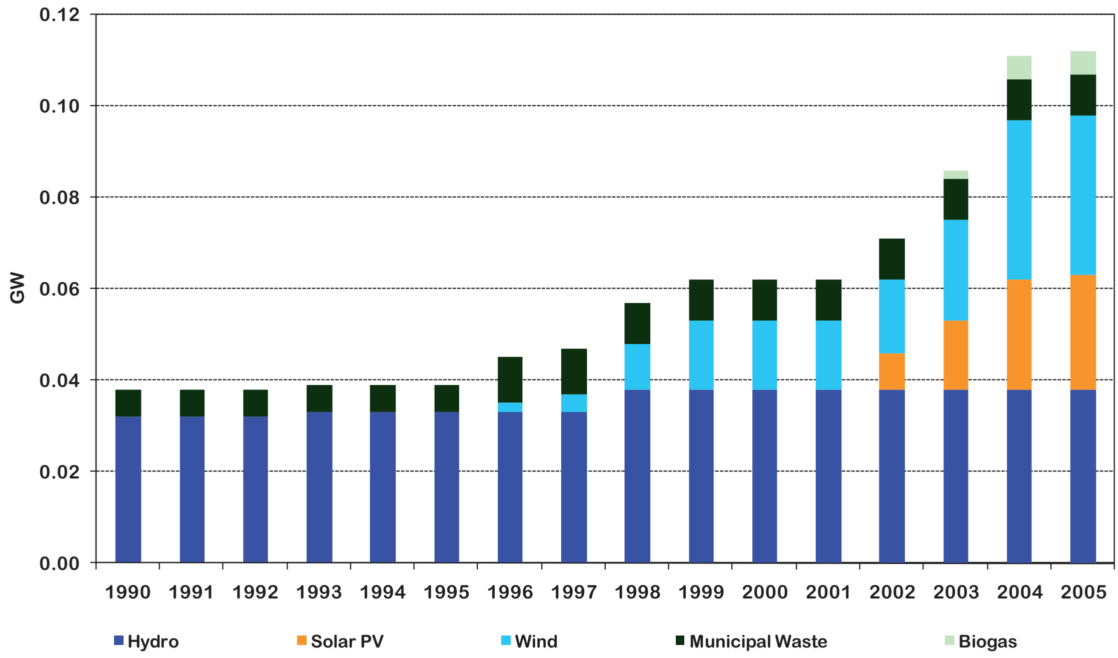
Figure 26. Total RES-E Production, 1990-2005



Source: IEA (2007a)

[1] A summary profile was prepared of Luxembourg's renewable energy **market** developments from 1990 to 2005. Policy developments are available in the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

Figure 2. Net Generating Capacity of RES-E Plants, 1990-2005

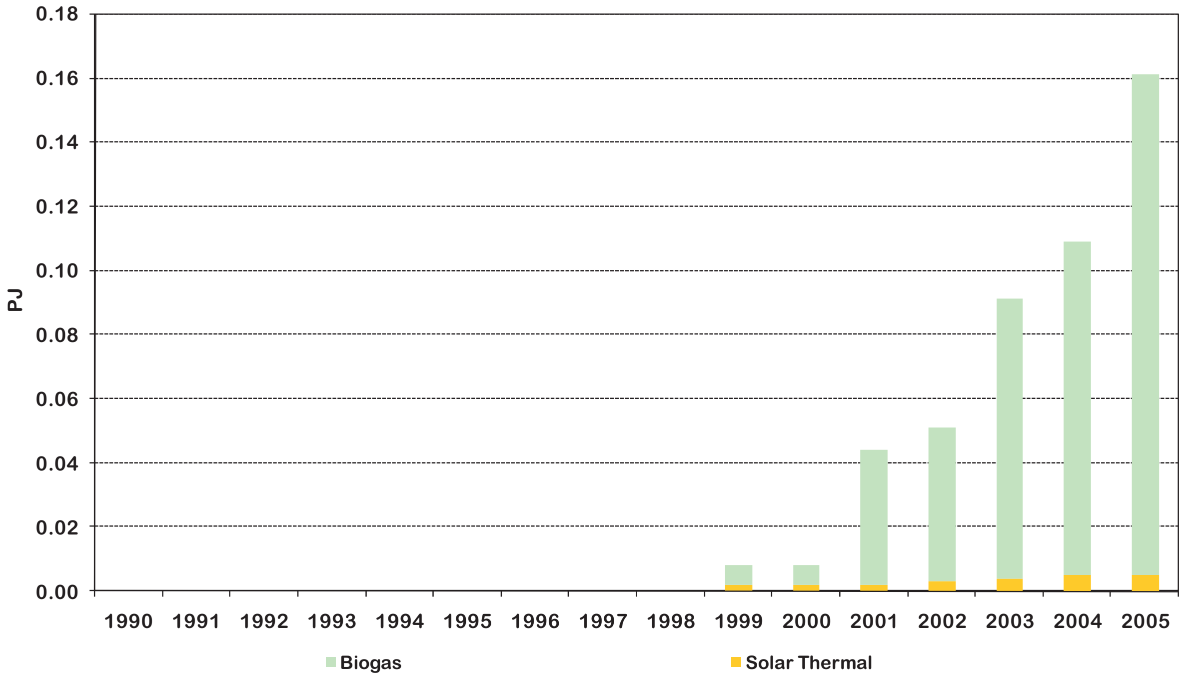


NB: Official IEA statistics on electricity generating capacity do not differentiate between *renewable* and *non-renewable* municipal waste.

Source: IEA (2007a)

RENEWABLE HEAT (RES-H) MARKET

Figure 3. Total RES-H Production, 1990-2005[2]



NB: Solar thermal includes direct final use.

Source: IEA (2007a)

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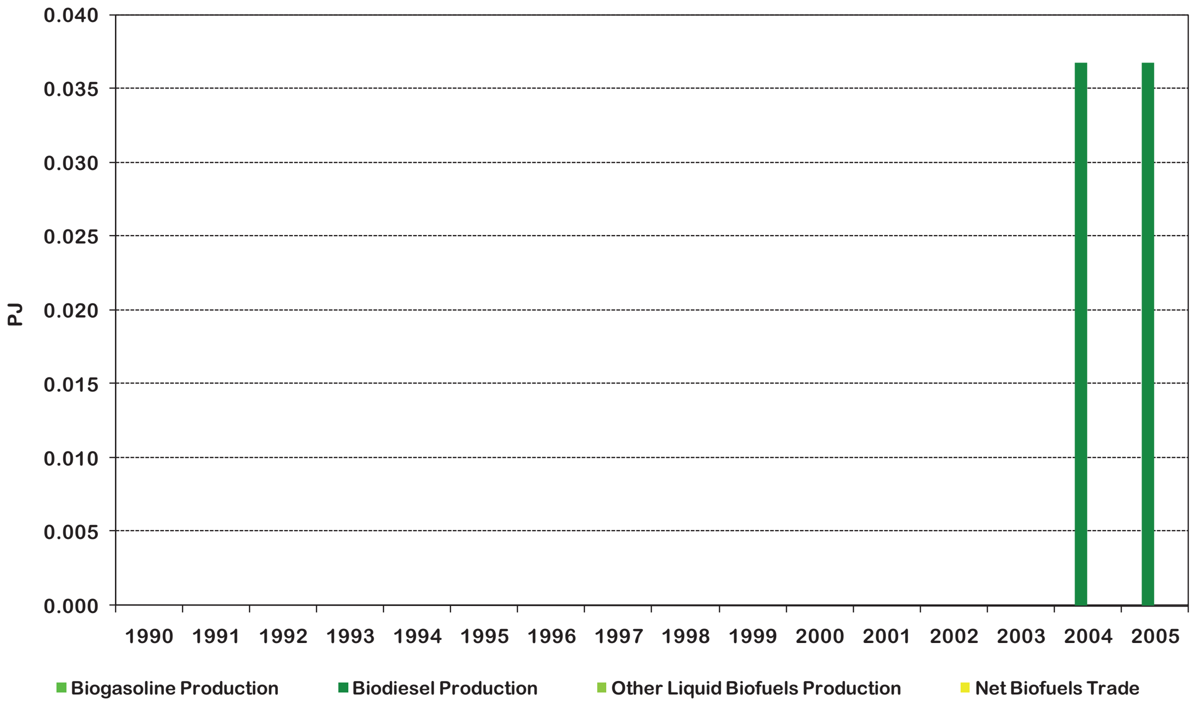
[2] Official IEA statistics on heat generation from renewable energy sources relate to **commercial heat sold** with additional data on **direct use** of solar thermal and geothermal available for most OECD countries.

RENEWABLE TRANSPORT FUEL (RES-T) MARKET

Figure 4. Total RES-T Production, 1990-2005

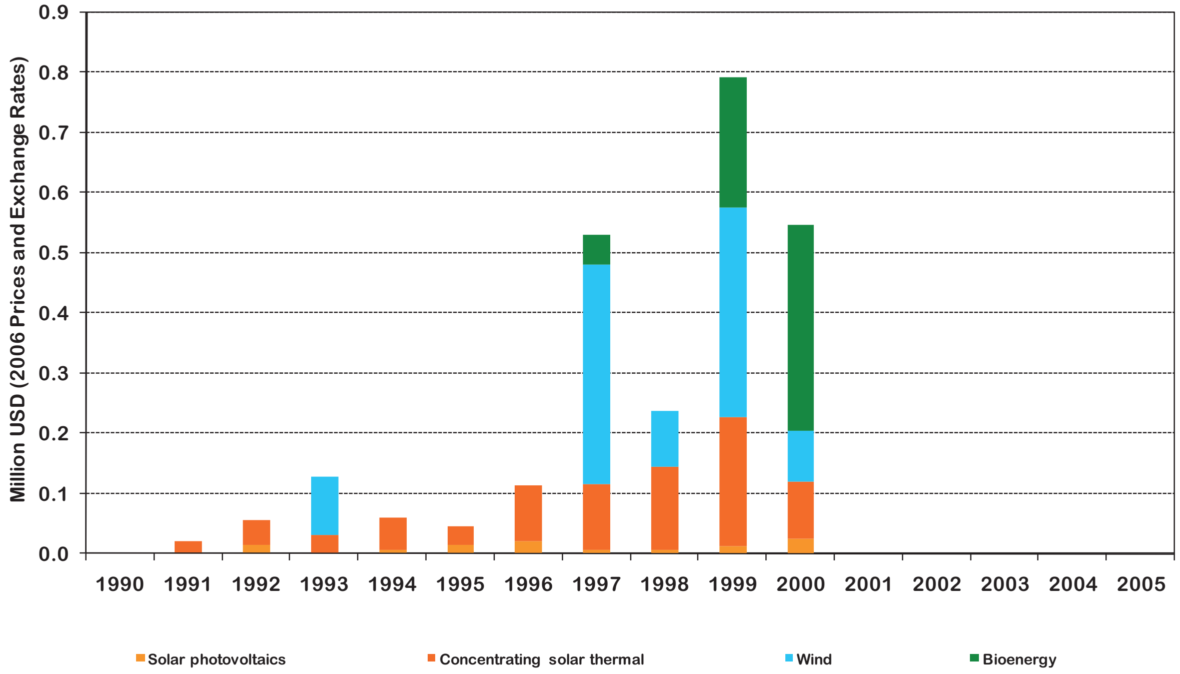


NB: Net Biofuels Trade refers to the balance of domestic biofuel consumption, i.e. biofuel exports subtracted from imports.

Source: IEA (2007a)

RESEARCH, DEVELOPMENT AND DEMONSTRATION TRENDS

Figure 5. Annual Government RD&D Spending on Renewables, 1990-2005 (USD 2006 prices and exchange rates)[3]

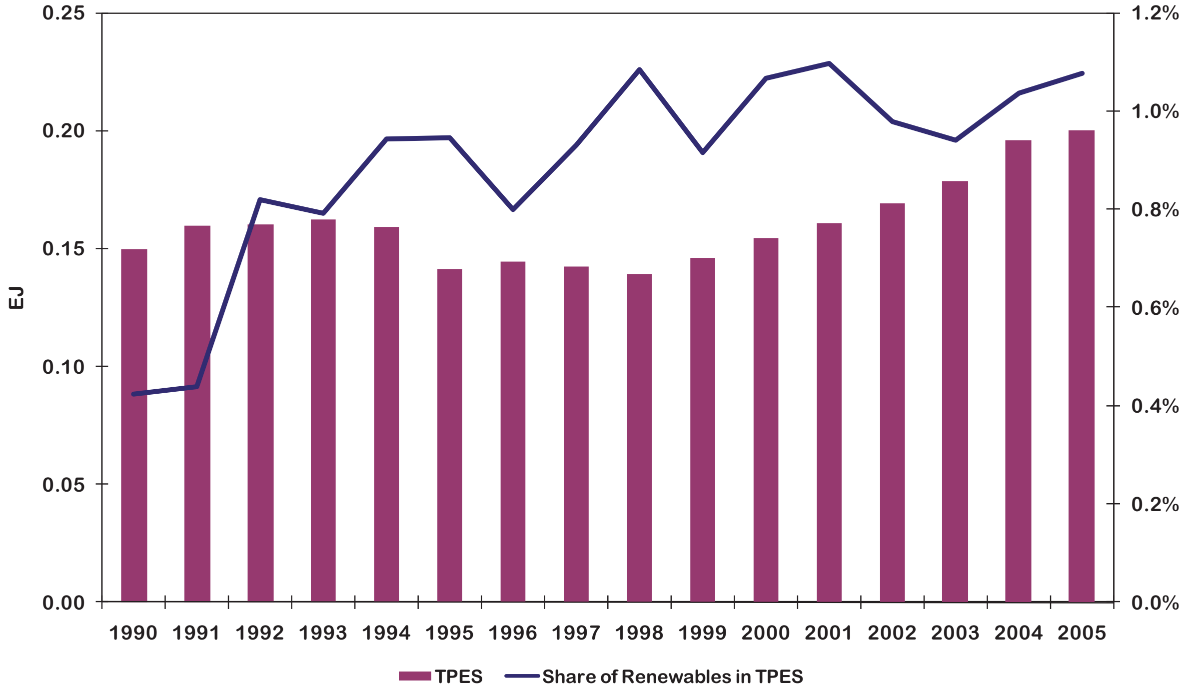


Source: IEA (2007b)

[3] Official IEA data on energy RD&D budgets include only **government** funding and not **private** RD&D spending.

Renewables in Total Primary Energy Supply[4]

Figure 7. Share of Renewable Energy in Total Primary Energy Supply, 1990-2005



Source: IEA (2007a)

Renewable Energy Policy Information

For details on renewable energy support policies implemented in Luxembourg, readers may consult the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

[4] The official IEA statistics on TPES include, where applicable, traditional biomass but exclude pumped hydro.
Primary energy convention: The IEA uses the **physical energy content method** to calculate the primary energy equivalent of non-combustible energy sources, such as geothermal, hydro, solar and wind. As a consequence, there is an obvious link between the principles adopted in defining the primary energy forms of energy sources and the primary energy equivalent of these sources. For instance, in the case solar thermal and geothermal electricity production, as heat is the primary energy form selected by the IEA, the primary energy equivalent is the quantity of heat generated in the geothermal or solar thermal plant for electricity generation. In the case of hydro, wind, tide and solar PV, as electricity is the primary energy form selected, the primary energy equivalent is the physical energy content of the electricity generated in the plant, which amounts to assuming an efficiency of 100%. Readers may consult (IEA, 2007a) for more details.

GLOSSARY

Definitions, abbreviations, acronyms and units are explained in the Glossary which can be found after the country profiles.

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MEXICO

RENEWABLE ELECTRICITY (RES-E) MARKET

General Electricity Market Framework

Generation, transmission and distribution of electricity in Mexico are the responsibilities of the federal government carried out by its two vertically integrated utilities, the Federal Electricity Commission (Comisión Federal de Electricidad, CFE) and Central Light and Power (Luz y Fuerza del Centro, LFC).

The national electricity grid covers approximately 97% of the population, while the remaining 3% depend on off-grid power supply. Losses in transmission and distribution are estimated to have reached in 17.6% in 2006 with technical losses likely accounting for a large part of this (GTZ, 2007).

Since 1992, the Public Electricity Service Act ("Ley del Servicio Público de Energía Eléctrica" or "LSPEE") allows private sector participation in electricity generation under specified circumstances and regulated by the Energy Regulatory Commission (Comisión Reguladora de Energía, CRE). Investors that want to build new capacity greater than 0.5 MW need to obtain governmental approval. In addition, foreign investors that want to acquire more than 49% ownership of generation facilities can only do so with governmental consent. In general, five classes of electricity generation projects can be distinguished:

- Projects included in CFE's capacity expansion planning. These are either (i) achieved by private parties (financing and construction) and handed over to CFE after completion, or (ii) private parties remain operators (independent power producers or IPPs), but are obliged to sell their electricity exclusively to CFE.
- Private electricity export projects.
- Grid-connected projects for self-supply. Trade of electricity is not permitted, though the current framework allows for wheeling, i.e. enabling off-site generation and transmission via the national grid, and banking of electricity from intermittent sources, i.e. feeding surplus electricity into the grid and retrieving it when self-supplied electricity does not suffice.
- Off-grid mini-grids or home systems.
- Private projects with less than 30 MW capacity need not be included in CFE's expansion planning. Such projects are not existent in practice, since tariffs paid by CFE are too low to enable their financial viability.

In 2006, roughly 66.5% of generation capacities belonged to CFE and 1.6% to LFC. Independent power producers accounted for approximately 18.4% of total generation capacity, self-generators for 11% (including CHP plants) and capacities used for electricity export were about 2.4% of the total.

As of mid 2007, there were no renewable electricity (RES-E) projects operated by IPPs, neither for domestic nor for export purposes. However, some state-owned renewable electricity plants and renewable off-grid systems exist in Mexico. One of the most important regulations, at least in terms of impact on the renewable energy sector, is the obligation for CFE and LFC to purchase electricity according to the least-cost principle and from “secure” energy sources. RES-E (excluding pumped hydro) accounted for roughly 16% of the 235 TWh of total power generation in 2005, mainly based on large hydropower, geothermal electricity and solid biomass use.

Expansion plans up to 2016 include a total of 22 GW of additional capacity due to rising demand (2006 total system capacity was roughly 56 GW). Roughly half of this (11 GW) is intended to be based on gas-fired combined-cycle power plants, despite their already high share in power generation (approximately 40% in 2006). Renewable power capacities are to be increased by 2 664 MW of new hydropower plants and by five wind farms in Oaxaca totalling 489 MW. However, whether these plans will be realised depends on the development of current legislation on renewable energy (see below).

Electricity tariffs for final consumers are set by the Ministry of Finance and Secretariat of Economy and differentiated across consumer groups benefiting poorer households and rural customers. The LSPEE mandates that utilities have to buy the least cost power option for public supply. Nevertheless tariff income is insufficient for cost recovery. Therefore, the power sector is heavily subsidised with government payments contributing approximately 31% of total costs in 2006.

RES-E Market Developments

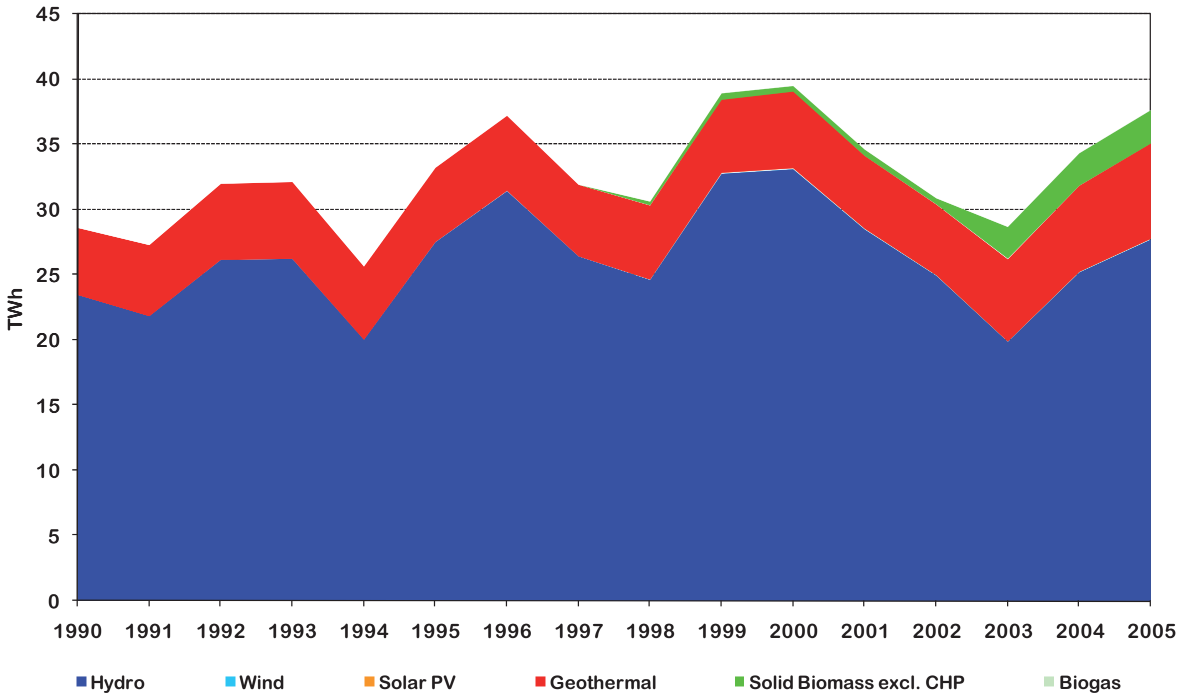
Total renewable electricity generation in Mexico was 37.7 TWh in 2005, representing 16% of total electricity production (including large hydropower, but excluding pumped storage and traditional biomass). The renewable electricity share was 23% in 1990. Since then total electricity generation has grown by 4.5% on annual average, while RES-E increased at 1.9% only[1]. In comparison, Mexico’s growth domestic product (GDP) grew by 2.9% per year on average between 1990 and 2005.

74% of RES-E was supplied by hydroelectric plants in 2005, 19% by geothermal plants and 7% by solid biomass combustion. In fact, Mexico has the world’s third largest geothermal power capacity. Other technologies played a marginal role generating in total only 70 GWh of electricity in 2005.

Compared to 1990, total RES-E increased by 9.0 TWh until 2005. Although hydropower capacities grew on average at 2.0% only during this period, almost half of the total RES-E additions since 1990 came from hydropower (4.3 TWh). However, only 7 small hydropower plants (up to 30 MW) were in operation in 2000 with 84 MW of capacity. 13 other small hydropower plants have been granted approval by CRE for self-supply and exports, of which only 7 with a total capacity of 59 MW had entered into operation by the end of 2006. Despite large hydropower expansion, CFE has been barely inactive in building small-scale hydroelectric plants in the last 30 years.

[1] The growth rate is 2.5% if hydropower generation is normalised with average full-load hours.

Figure 1. Total RES-E Production, 1990-2005[2]



Source: IEA (2007)

Electricity generation from solid biomass was the fastest growing source of RES-E since 1998[2]. 37.4% average annual growth in RES-E from solid biomass added 2.6 TWh of additionally generated electricity in 2005 compared to 1998.

Despite a relatively slow growth of 2.4% on annual average, geothermal electricity increased by 2.2 TWh from 1990 to 2005. All geothermal electricity plants currently in operation are run by CFE. Due to the large number of geothermal sources with sufficiently high temperatures in Mexico, geothermal electricity production is a competitive technological option with generation costs ranging from 0.04-0.07 USD[3]/kWh (Huacuz & Medrano, 2007).

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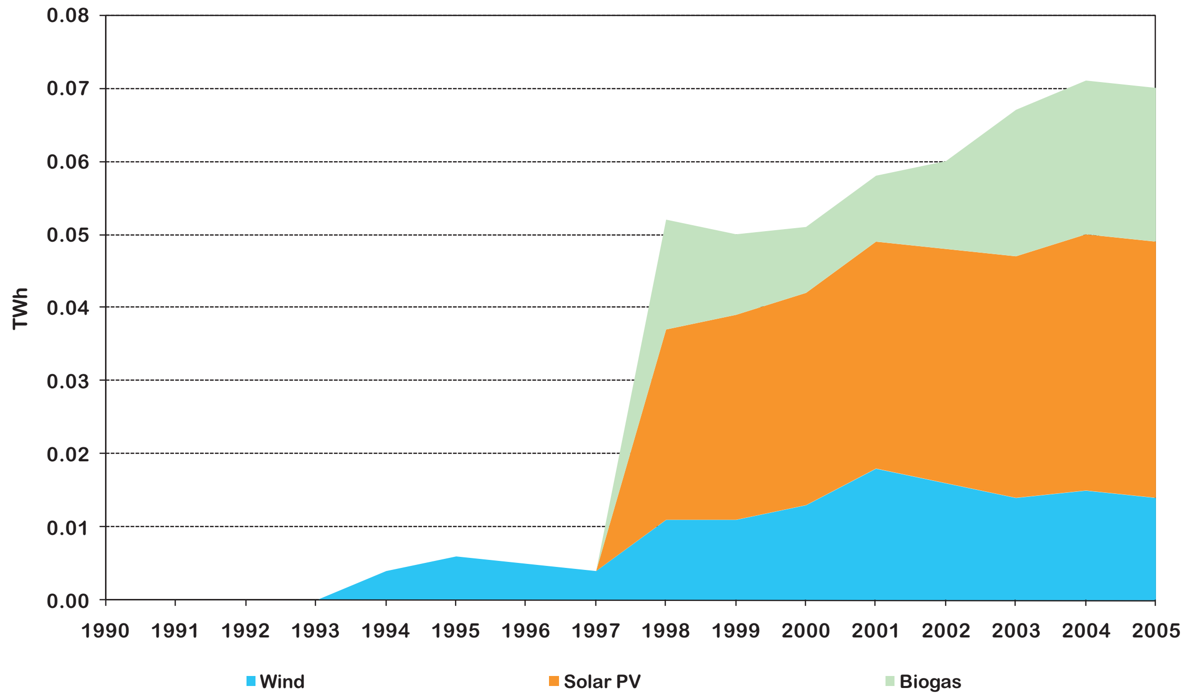
[2] Data for electricity production from wind is available from 1994; data for solid biomass, biogas and solar PV is available from 1998.

[3] All conversions from national currency to USD are at 2006 market exchange rates, except where specified otherwise.

Figure 2. RES-E Production from Wind, Solar PV and Biogas, 1990-2005



Source: IEA (2007)

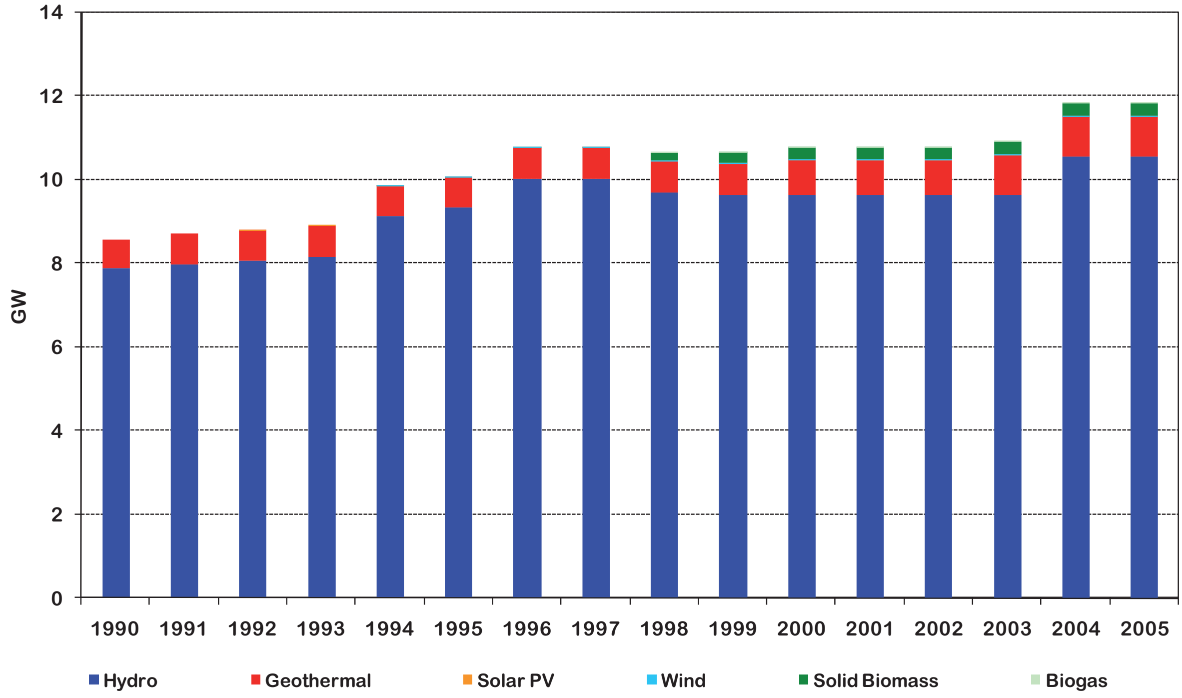
Wind and biogas technology deployment is still in its very initial phase. Biogas-derived electricity amounted to no more than 21 GWh in 2005, RES-E from wind power plants was only 14 GWh.

By the end of 2006, Mexico's first large-scale wind farm "La Venta II", owned by CFE, has been commissioned at the Isthmus of Tehuantepec in Oaxaca with a rated capacity of 83.3 MW. Follow up projects are planned, but will largely depend on availability of financial incentives. Previous activities were limited to the demonstration project "La Venta I" with seven turbines totalling 1.6 MW capacity that started operation in 1984 and another 600 kW turbine was added in 1998 to an isolated urban grid near Guerrero Negro (Borja, 2007).

Biogas utilisation started in 1997 with two plants extracting sewage gas and commenced in 2003 with the commissioning of Latin America's first biogas plant on a waste disposal site (8 MW) combusting landfill gas.

Solar PV installations in Mexico amounted to 16 MW in 2005 (18.7 MW according to IEA Photovoltaic Power Systems Programme), which is almost exclusively off-grid. These systems produced 35 GWh of electricity – the equivalent of wind and biogas. Mexico ranked 11th among IEA countries in terms of total installed solar PV capacity in 2005, despite the fact that more than 90% of total 2005 solar PV capacities in IEA countries were installed in three member states – Germany, Japan and the USA (IEA PVPS, 2006).

Figure 3. Net Generating Capacity of RES-E Plants, 1990-2005



Source: IEA (2007)

Development of Renewable Electricity Policies

Despite the obligation to purchase electricity at least cost and, if possible, from "secure" generating sources, CRE is implementing ad-hoc regulatory instruments that help to foster the growth of renewables in the self-supply segment. In September 2001, CRE issued special rules for granting discounts on transmission charges for intermittent sources of electricity. In 2002, the government published plans to roughly double the contribution of non-conventional[4] renewable energy sources by 2006 (1 GW additional capacity). However, these targets have not been achieved.

Since 2005, investments in renewable energy projects can depreciate 100% of investment costs in the first year if the plant remains in production for at least five years. This tax-based incentive, that was included in the Income Tax Law, however, depends on the actual extent that income tax is due. If the depreciation is higher than tax liability, only part of the total investment can be immediately depreciated.

Furthermore, at the end of 2005 the Law for the Use of Renewable Sources of Energy (LAFRE) has been adopted by the Lower Chamber of Congress, but was still waiting for approval by the Senate at the time of writing.

Despite setting a target of 8% renewable electricity generation by 2012 (excluding large hydropower) in the overall electricity mix, LAFRE would give CFE an explicit mandate to

[4] Non-conventional means all renewable energy sources except large hydro power.

include renewables in its expansion planning (beyond self-supply investments). The bill includes provisions for priority access of renewable electricity to the grid as well as for the creation of a "Renewable Energy Fund" (FAFRE Fund). The latter would give financial incentives to renewable energy projects and could close the gap between CFE's least cost principle and the actual costs of renewable energy projects.

The origin of the resources for such a fund, however, would have to be established by means of an additional legal instrument, such as the Article 253-B bill that has been proposed at the Lower Chamber in October 2005 and would generate funding via a carbon levy on fossil fuels.

Recent policy action included the issuance of the "National Energy Plan 2007-2012" (Energy Sector Programme 2007-2012, SENER (2007)) that acknowledges the benefits of increased utilisation of renewable energy sources and recommends that the share of renewable energy in electricity production capacities should reach 26% by 2012. Since 2006, CRE has provided guarantees to CFE to build the transmission infrastructure necessary to further develop the wind potential in the Isthmus of Tehuantepec[5] through private investments. Besides, in June 2007, CRE issued a contract for interconnection of small-scale solar sources (up to 30 MW and tensions below 1 kV).

So far, only a limited number of new, large-scale renewable energy projects could be realised, depending on the availability of international sources of additional funding. The latest project that has been realised with the help of international funds was the 83.3 MW "La Venta II" wind farm. A follow up project "La Venta III" with a rated capacity of 101 MW is encouraged by funding from the Global Environment Facility (GEF) of the World Bank. The GEF-funded Large-Scale Renewable Energy Development Project (LSREDP) will provide USD 20 million in performance-based incentives (0.011 USD/kWh for the first five years of operation). "La Venta III" will be the first IPP-owned renewable energy project in Mexico. In a second phase of LSREDP, it is foreseen to provide another USD 45 million to support 400 MW of additional capacity with a smaller per-kWh incentive. Besides, GEF supports pilot small-scale wind power projects via the "Action Plan for Removing Barriers to the Implementation of Wind Energy". Altogether, approximately 1 400 MW of additional wind power capacities have been approved by CRE at the end of 2007. Their implementation, however, will depend on international financing as well as the development of the Mexican legislative process that envisages the introduction of domestic financing schemes (see above) (GTZ, 2007).

Another USD 50 million grant will be provided to an integrated CSP[6]/ combined-cycle gas-turbine power plant including a 25 MW CSP component. Moreover, the Clean Development Mechanism (CDM) of the Kyoto Protocol can act as an additional revenue stream for RES-E projects. As of December 2006, 61 renewable energy projects (34 of which were for the utilisation of biogas on Mexican pig farms) have been registered with the UNFCCC[7] secretariat in order to get CDM approval (*ibid.*).

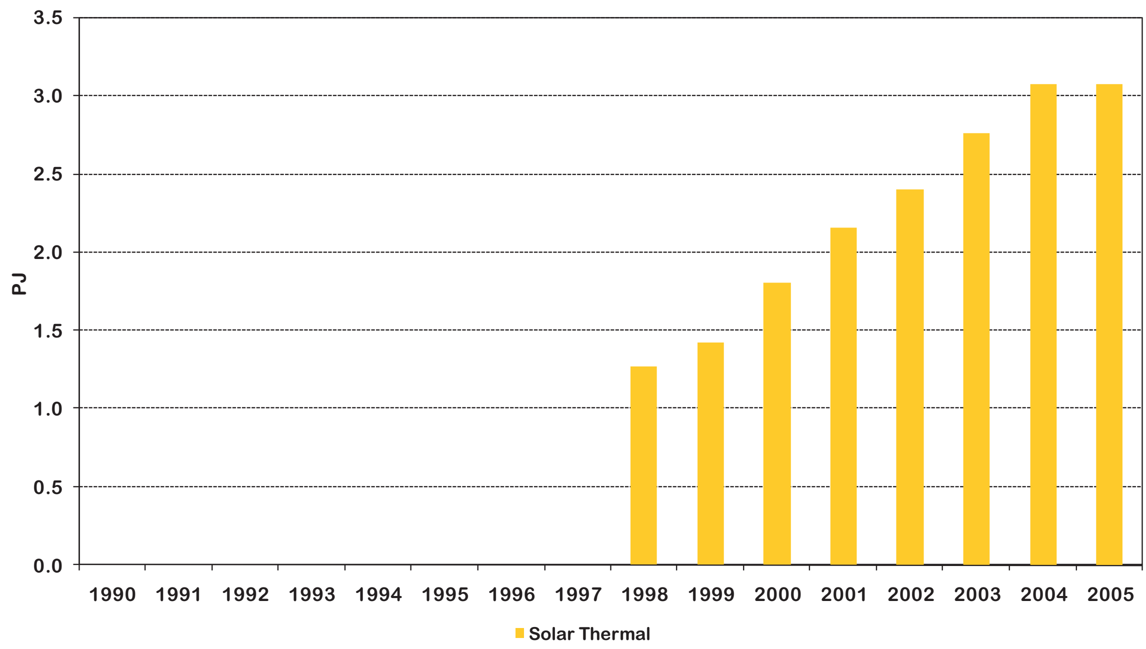
In contrast, many small PV systems mainly for agricultural applications have been installed without national or international financial support.

[5] "La Vesta II" is so far the only project realised at the Isthmus of Tehuantepec.
[6] Concentrating solar power
[7] United Nations Framework Convention on Climate Change

Other initiatives pursued in Mexico mainly address administrative barriers. Banking provisions and the preparation of net metering regulations, for instance, facilitate the legal use of grid-connected PV rooftops in the residential and commercial sectors. An assessment of Mexico's wind resources was conducted through an IIE-GEF/UNDP[8] project and CFE has prepared a grid code for the interconnection of wind farms to the national grid. Furthermore, technical assistance and guidance on the deployment of renewable energy sources is provided by documents such as a "Best Practices Guide for Developing Wind Energy Projects" and a "Guide of Official Procedures to Construct Renewable Energy Projects in Mexico".

RENEWABLE HEAT (RES-H) MARKET

Figure 4. Total RES-H Production, 1990-2005[9][10]



NB: Solar thermal includes direct final use.

Source: IEA (2007)

Direct final heat use provided by solar thermal systems amounted to 3.069 PJ in 2005. Since 1998 direct final use of solar thermal heat grew on average by 13.4% annually, despite its recorded stagnation in 2005.[11]

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[8] IIE: [Mexican] Electrical Research Institute, GEF: Global Environment Facility, UNDP: United Nations Development Programme

[9] Data for direct use of solar thermal is available from 1998.

[10] Official IEA statistics on heat generation from renewable energy sources relate to **commercial heat sold** with additional data on **direct use** of solar thermal and geothermal available for most OECD countries.

[11] Data from the IEA Solar Heating and Cooling Programme (IEA SHC) differ from the official IEA statistics presented in the text. According to IEA SHC data, total installed solar thermal collector area increased again by 13.4% in 2005 to 728,644 m^2, but yielded only 1.178 PJ (Weiss *et al.*, 2007).

Since April 2006, all newly built and radically refurbished houses in Mexico City, in which hot water is used for commercial purposes, are obliged to meet a minimum of 30% of their energy needs for hot water from solar water heating systems. In order to incentivise compliance, the state government offers tax credits in addition to the federal preferential depreciation scheme. In 2007, a programme aiming at the residential sector was enacted on the federal level and implemented by the National Commission for Energy Conservation (CONAE). The National Housing Institute offered borrowers for new housing to extent their credit lines in order to provide the necessary funds solar water installations (IEA, 2008).

Geothermal or modern biomass utilisation for heating purposes has not been reported, nor have support policies for this area been introduced.

Renewable Transport Fuel (RES-T) Market

Mexico currently does not produce ethanol for fuel production. Even though production capacities for approximately 3.6 PJ (170 million litres[12]) exist, ethanol production is exclusively destined to the alcoholic beverage and pharmaceutical industries (GAIN, 2007). Additional demand in those industries makes Mexico a net importer of ethanol with imports mainly coming from the United States, Brazil and – since 2006 – also from China.

Biodiesel is currently only produced in small-scale demonstration projects with a total production of approximately 124.7 TJ per year (3 300 metric tonnes[12]) (*ibid.*).

It is estimated that a 20-fold increase in production would be necessary in order to meet ethanol demand from the fuel industry, if a 6% blending mandate were introduced in the three main metropolitan areas (Mexico City, Monterey, and Guadalajara) (GAIN, 2007). Additional investments would have to be made in the feedstock production chain.

Several announcements about investments in ethanol production capacities throughout the country have been made in response to increased ethanol demand in the USA and policy initiatives in Mexico. However, only one plant is so far under construction in the State of Sinaloa, while other projects are still in their early phases.

The Mexican Congress approved the “Bio-Fuels Promotion and Development Law” (LPDB) in April 2007 in response to a feasibility study requested by Ministry of Energy (SENER) to the German Technical Cooperation Enterprise (GTZ[13]). As initially proposed, this law mandated a 10% blending quota for the three main metropolitan areas. Eventually, the LPDB included only a gradual phase-in schedule, which is to be defined in subsequent legislation. Although it does not call for any immediate actions but rather gives framework recommendations, the LDPB was sent back to Congress by a veto of President Calderón in September 2007.

The President argued that it gives to much emphasis to corn and sugarcane production rather than fostering the development of other sources for ethanol production. Negative implications of increased ethanol production on food security due to insufficient supply of

[12] For the applied biofuel conversion factors, refer to the Glossary which can be found after the country profiles.
[13] The German acronym stands for “Deutsche Gesellschaft für Technische Zusammenarbeit“.

corn and sugarcane are supposed to be the major concern. Mexico recently saw a rise in the prices of corn and tortilla, two major food staples, arguably due to strong demand for corn from US ethanol producers.

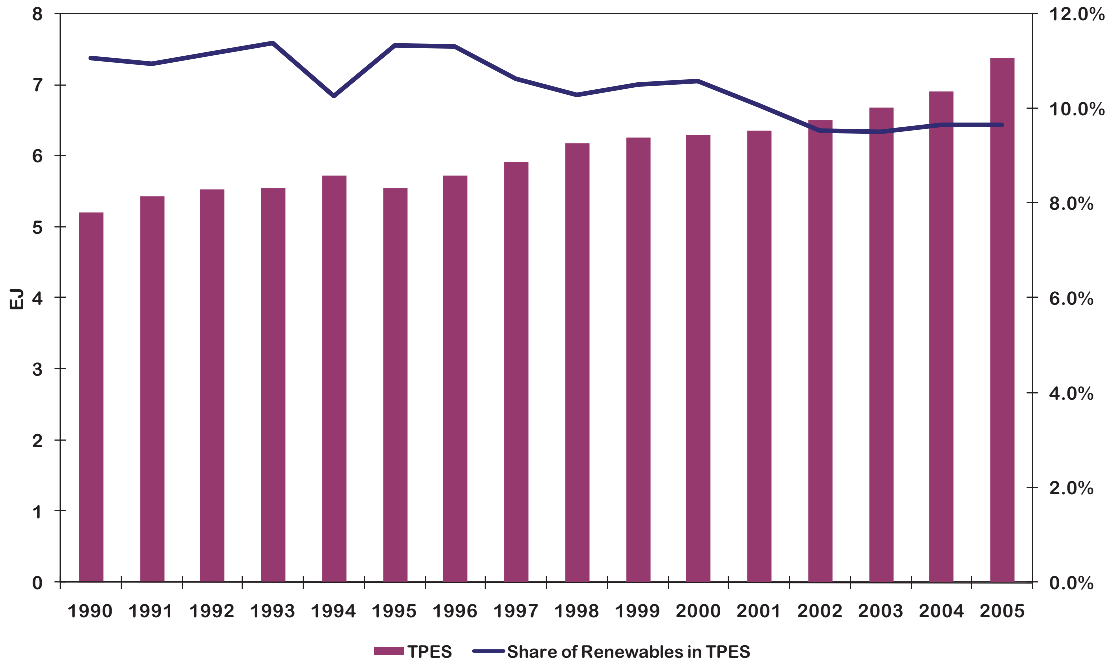
However, there is an ongoing discussion in Mexico about the future contribution of biofuels to the sustainable development of the transport sector. The "National Energy Plan 2007-2012" includes a section on biofuels acknowledging their role in lessening the dependence on fossil fuels, decreasing pollution and increasing the value added in economic activity.

RESEARCH, DEVELOPMENT AND DEMONSTRATION TRENDS

No data was available on Mexico's public R&D funding for energy technologies. Official IEA statistics do not report government R&D funding for renewable energy technologies in Mexico.

RENEWABLES IN TOTAL PRIMARY ENERGY SUPPLY[14]

Figure 5. Share of Renewable Energy in Total Primary Energy Supply, 1990-2005



Source: IEA (2007)

Total primary energy supply in Mexico was 7.4 EJ in 2005 – 6.8% higher than in the previous year. From 1990 to 2005, TPES increased 42% with an average annual growth of 2.4%. Primary energy supply from renewables (excluding pumped storage, but including traditional biomass) was 713.7 PJ in 2005 representing 9.7% of TPES. Growing by 6.9% compared to 2004, RPES could keep up with TPES growth. However, since 1990, renewables' supply has only grown by 24% with an average annual growth of 1.4%. Thus, the share of renewables in TPES has declined, due, in large part, to the substitution of traditional biomass by kerosene and liquefied petroleum gas (LPG).

[14] The official IEA statistics on TPES include, where applicable, traditional biomass but exclude pumped hydro.

Primary energy convention: The IEA uses the **physical energy content method** to calculate the primary energy equivalent of non-combustible energy sources, such as geothermal, hydro, solar and wind. As a consequence, there is an obvious link between the principles adopted in defining the primary energy forms of energy sources and the primary energy equivalent of these sources. For instance, in the case solar thermal and geothermal electricity production, as heat is the primary energy form selected by the IEA, the primary energy equivalent is the quantity of heat generated in the geothermal or solar thermal plant for electricity generation. In the case of hydro, wind, tide and solar PV, as electricity is the primary energy form selected, the primary energy equivalent is the physical energy content of the electricity generated in the plant, which amounts to assuming an efficiency of 100%. Readers may consult (IEA, 2007) for more details.

RENEWABLE ENERGY POLICY INFORMATION

For further details on renewable energy support policies implemented in Mexico, readers may consult the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

GLOSSARY

Definitions, abbreviations, acronyms and units are explained in the Glossary which can be found after the country profiles.

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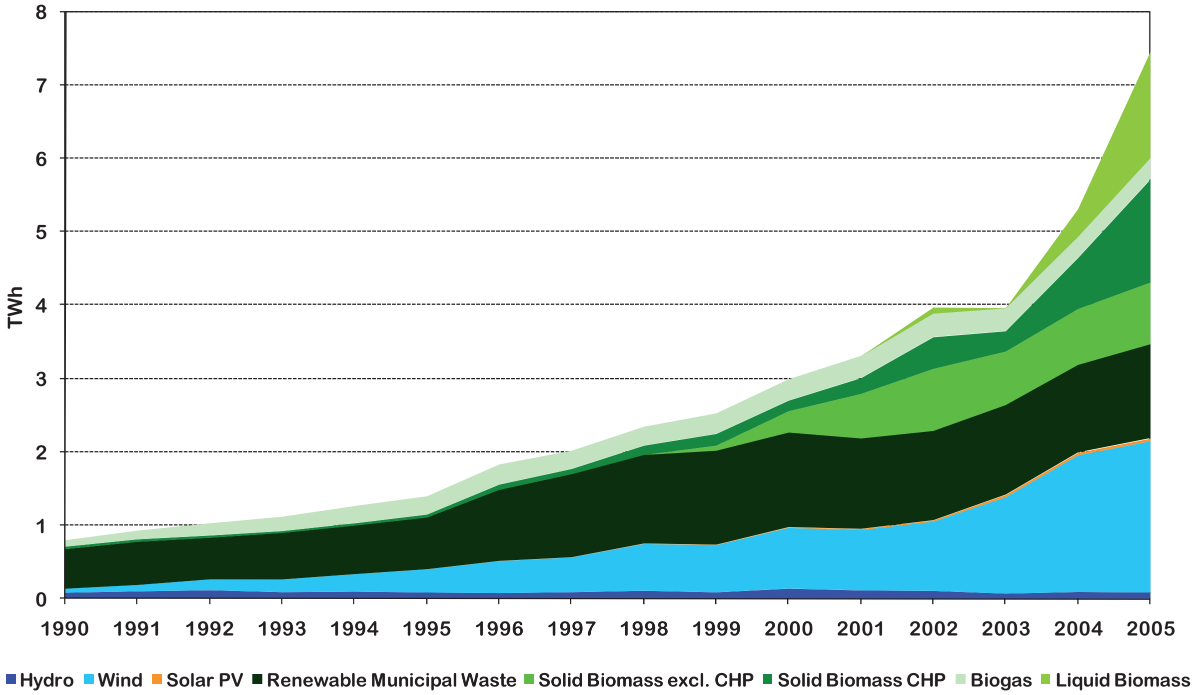
NETHERLANDS[1]

RENEWABLE ELECTRICITY (RES-E) MARKET

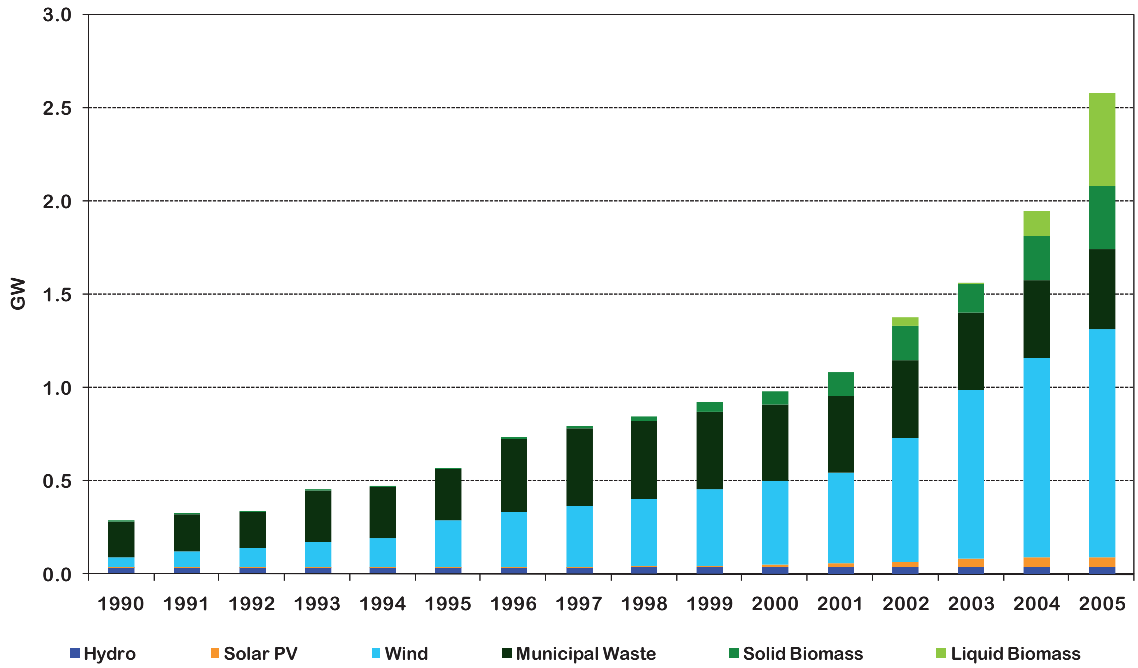
Figure 27. Total RES-E Production, 1990-2005



Source: IEA (2007a)

[1] A summary profile was prepared of the Netherlands' renewable energy **market** developments from 1990 to 2005. Policy developments are available in the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

Figure 2. Net Generating Capacity of RES-E Plants, 1990-2005

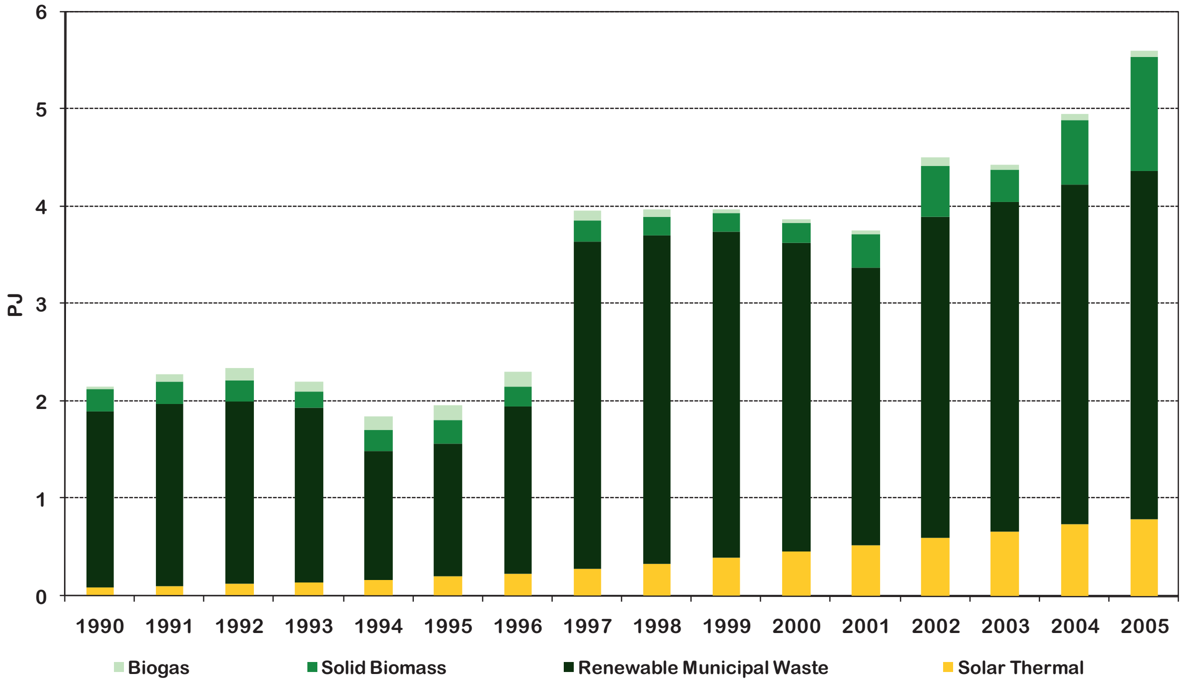


NB: Official IEA statistics on electricity generating capacity do not differentiate between *renewable* and *non-renewable* municipal waste.

Source: IEA (2007a)

RENEWABLE HEAT (RES-H) MARKET

Figure 3. Total RES-H Production, 1990-2005[2]



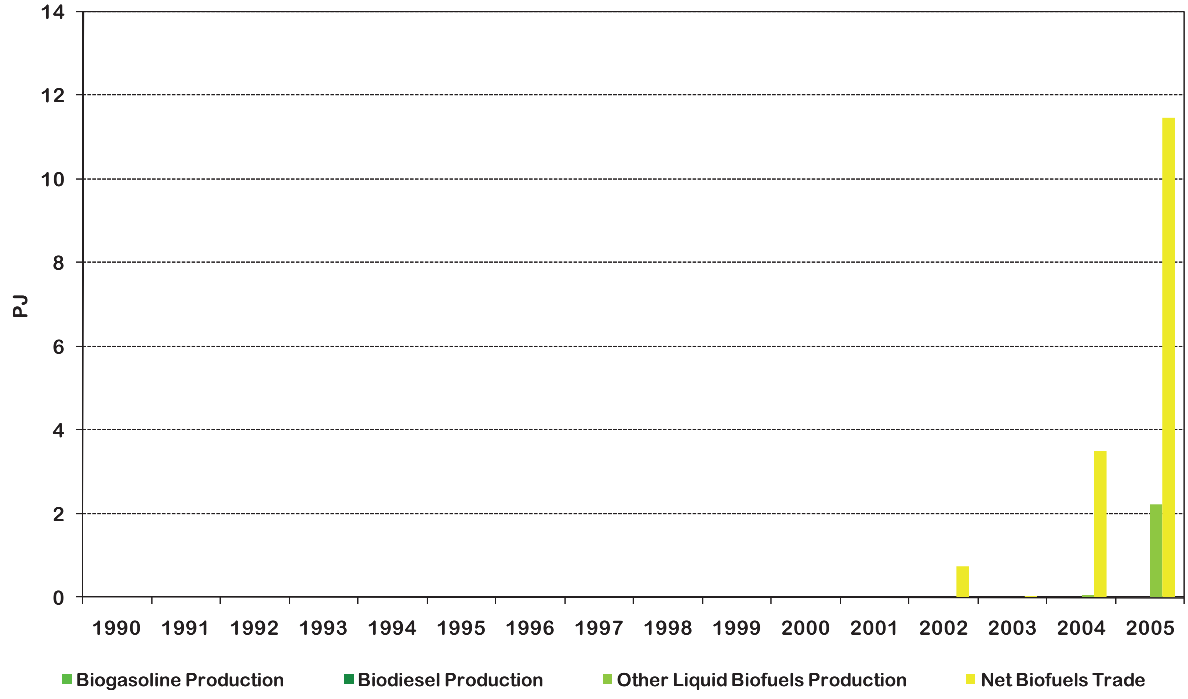
NB: Solar thermal includes direct final use.

Source: IEA (2007a)

[2] Official IEA statistics on heat generation from renewable energy sources relate to **commercial heat sold** with additional data on **direct use** of solar thermal and geothermal available for most OECD countries.

RENEWABLE TRANSPORT FUEL (RES-T) MARKET

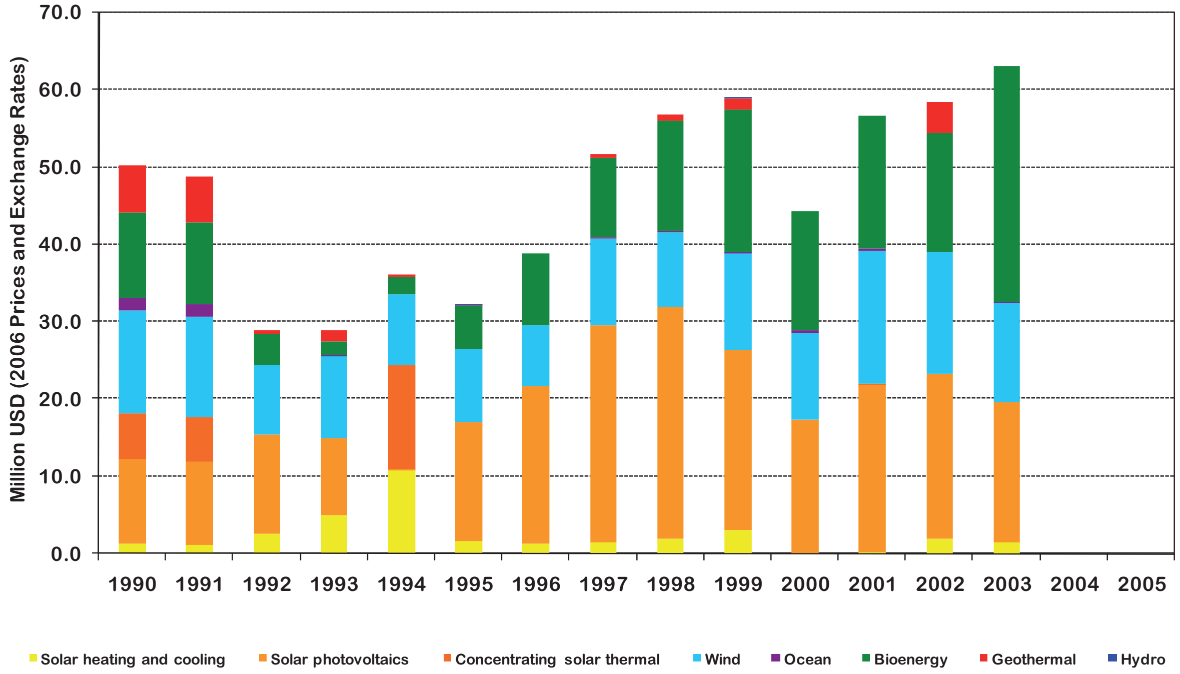
Figure 4. Total RES-T Production, 1990-2005



NB: Net Biofuels Trade refers to the balance of domestic biofuel consumption, i.e. biofuel exports subtracted from imports.

Source: IEA (2007a)

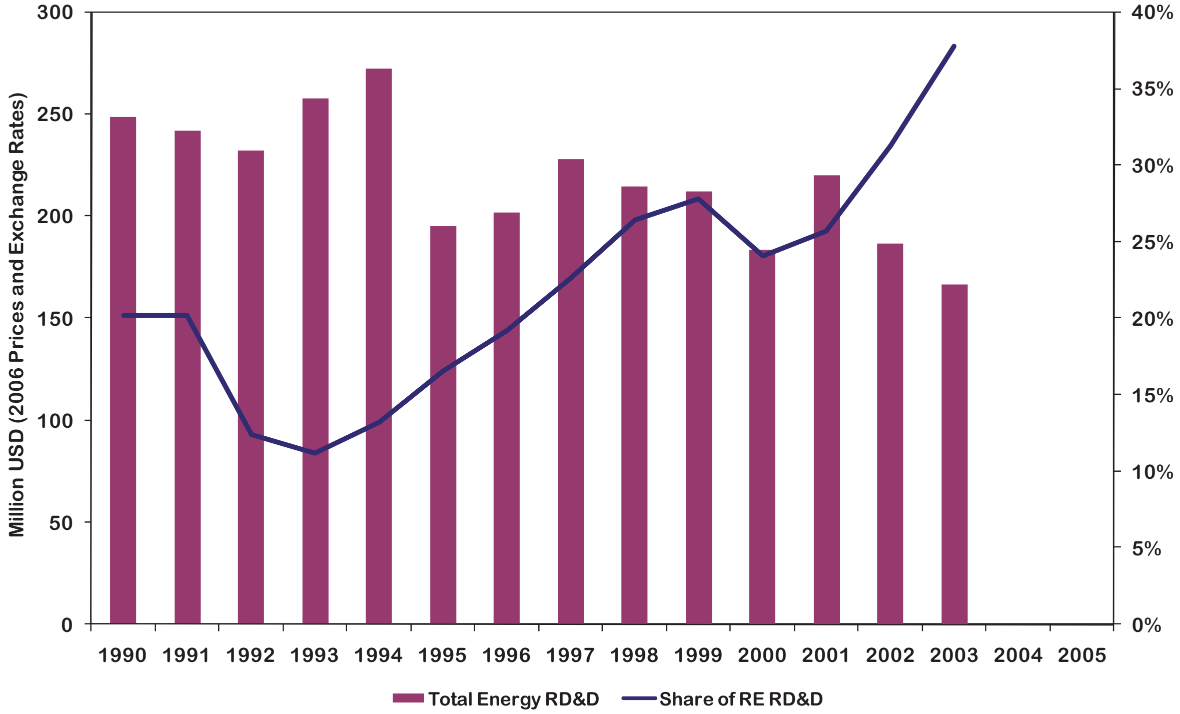
Figure 5. Annual Government RD&D Spending on Renewables, 1990-2005 (USD 2006 prices and exchange rates)[3]



Source: IEA (2007b)

[3] Official IEA data on energy RD&D budgets include only **government** funding and not **private** RD&D spending.

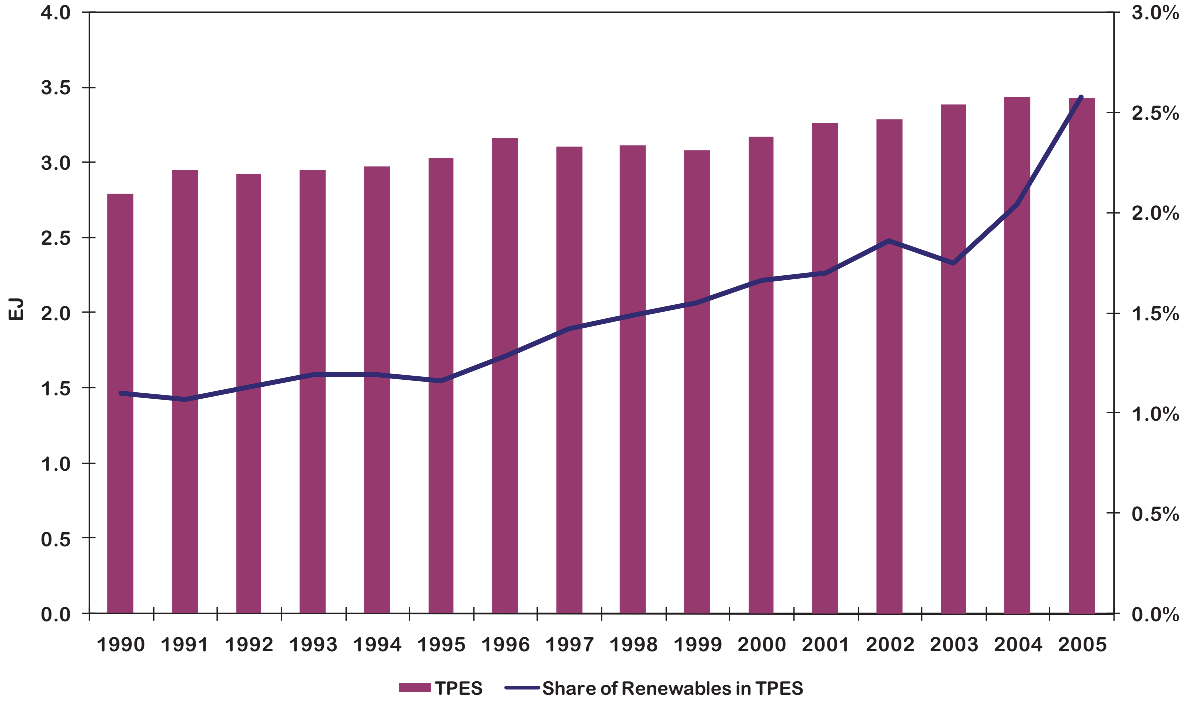
Figure 6. Renewable energy RD&D versus total government energy RD&D spending, 1990-2005



Source: IEA (2007b)

Renewables in Total Primary Energy Supply[4]

Figure 7. Share of Renewable Energy in Total Primary Energy Supply, 1990-2005



Source: IEA (2007a)

Renewable Energy Policy Information

For details on renewable energy support policies implemented in the Netherlands, readers may consult the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

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4 The official IEA statistics on TPES include, where applicable, traditional biomass but exclude pumped hydro.
Primary energy convention: The IEA uses the **physical energy content method** to calculate the primary energy equivalent of non-combustible energy sources, such as geothermal, hydro, solar and wind. As a consequence, there is an obvious link between the principles adopted in defining the primary energy forms of energy sources and the primary energy equivalent of these sources. For instance, in the case solar thermal and geothermal electricity production, as heat is the primary energy form selected by the IEA, the primary energy equivalent is the quantity of heat generated in the geothermal or solar thermal plant for electricity generation. In the case of hydro, wind, tide and solar PV, as electricity is the primary energy form selected, the primary energy equivalent is the physical energy content of the electricity generated in the plant, which amounts to assuming an efficiency of 100%. Readers may consult (IEA, 2007a) for more details.

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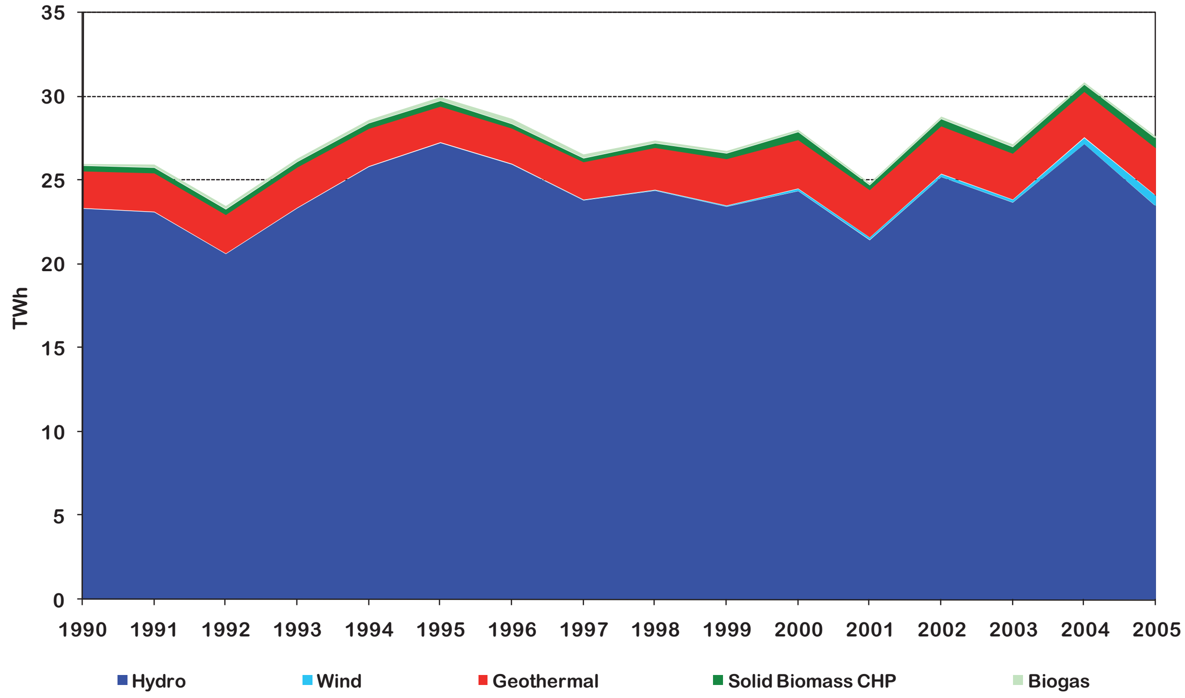
IEA (2008), "Global Renewable Energy Policies and Measures Database", www.iea.org/textbase/pm/grindex.aspx, International Energy Agency, accessed 15 March 2008.

NEW ZEALAND[1]

RENEWABLE ELECTRICITY (RES-E) MARKET

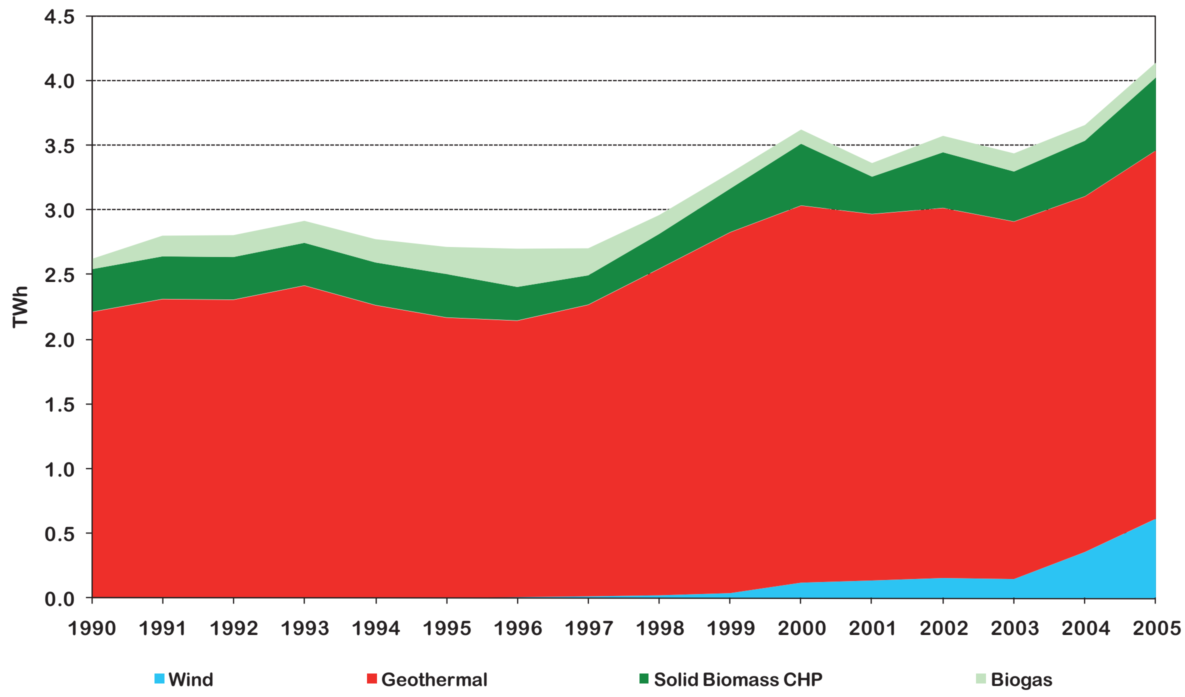
Figure 28. Total RES-E Production, 1990-2005



Source: IEA (2007a)

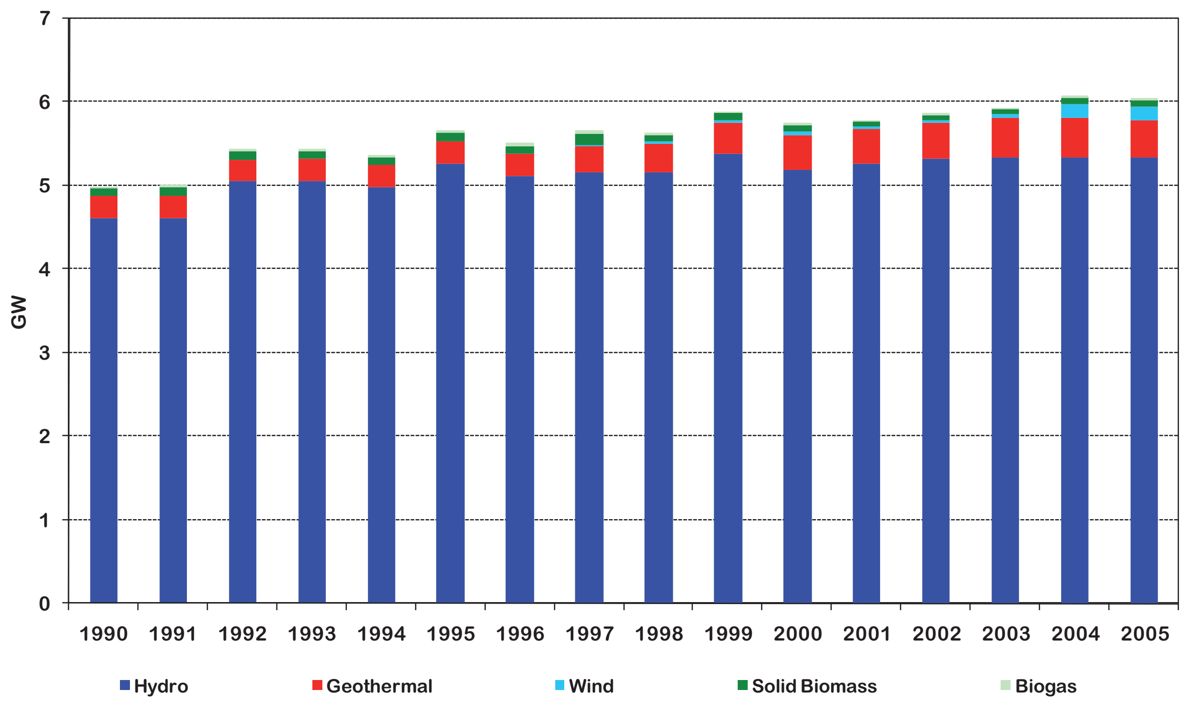
[1] A summary profile was prepared of New Zealand's renewable energy **market** developments from 1990 to 2005. Policy developments are available in the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

Figure 29. Total RES-E Production (excluding Hydropower), 1990-2005



Source: IEA (2007a)

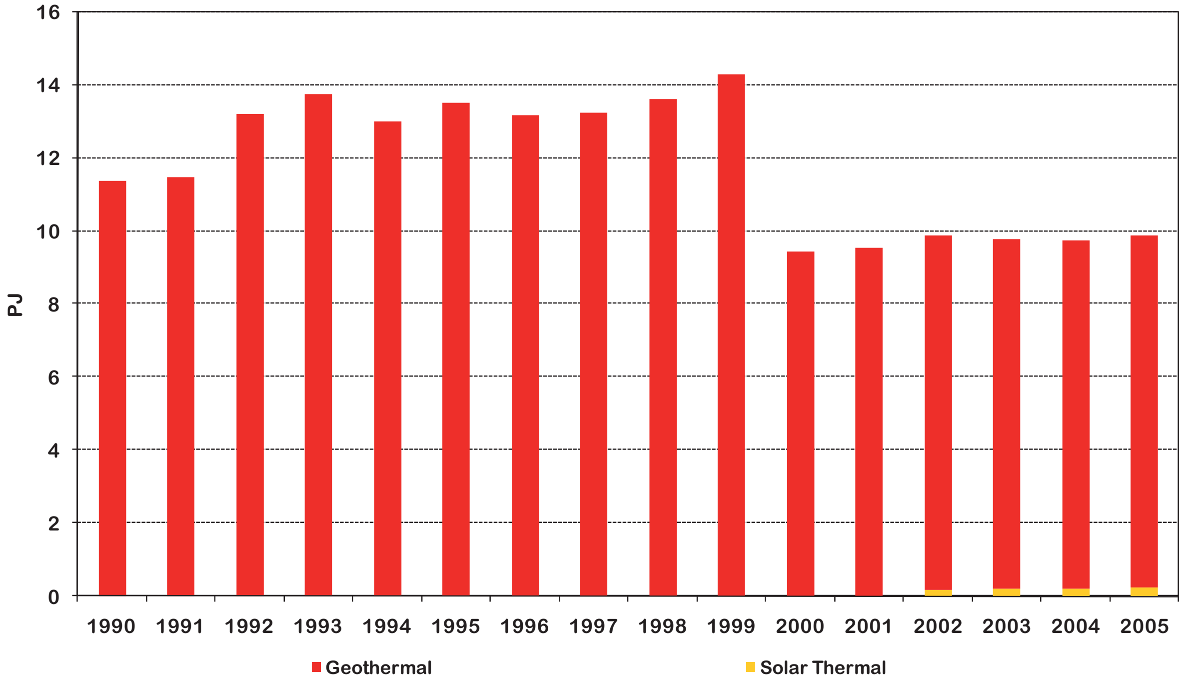
Figure 30. Net Generating Capacity of RES-E Plants, 1990-2005



Source: IEA (2007a)

RENEWABLE HEAT (RES-H) MARKET

Figure 4. Total RES-H Production, 1990-2005[2]



NB: Geothermal and solar thermal include direct final use.

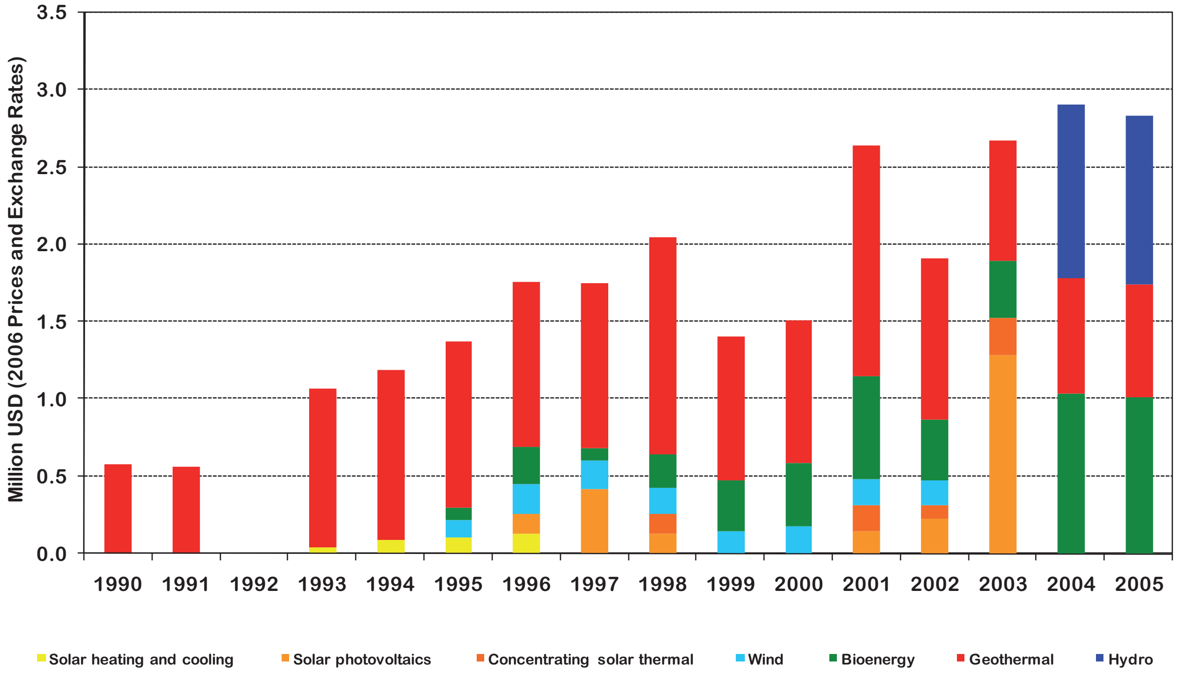
Source: IEA (2007a)

RENEWABLE TRANSPORT FUEL (RES-T) MARKET

Official IEA statistics do not report any biofuel production and consumption in New Zealand from 1990 to 2005.

[2] Official IEA statistics on heat generation from renewable energy sources relate to **commercial heat sold** with additional data on **direct use** of solar thermal and geothermal available for most OECD countries.

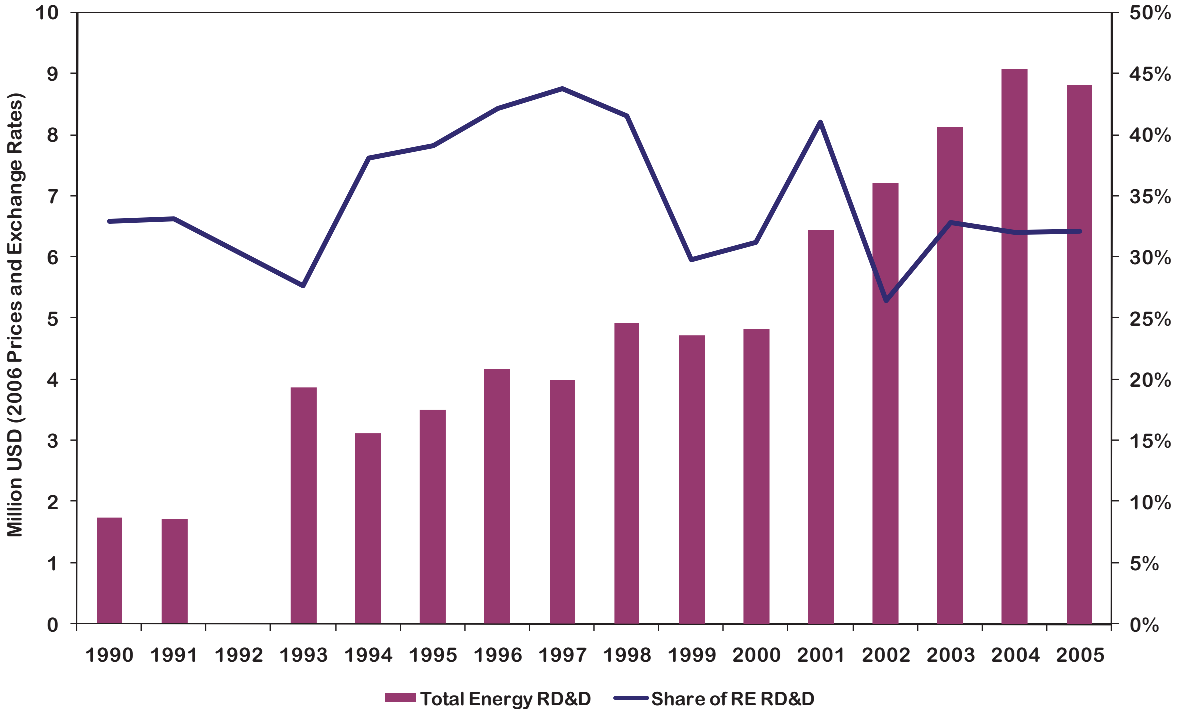
Figure 5. Annual Government RD&D Spending on Renewables, 1990-2005 (USD 2006 prices and exchange rates)[3]



Source: IEA (2007b)

[3] Official IEA data on energy RD&D budgets include only **government** funding and not **private** RD&D spending.

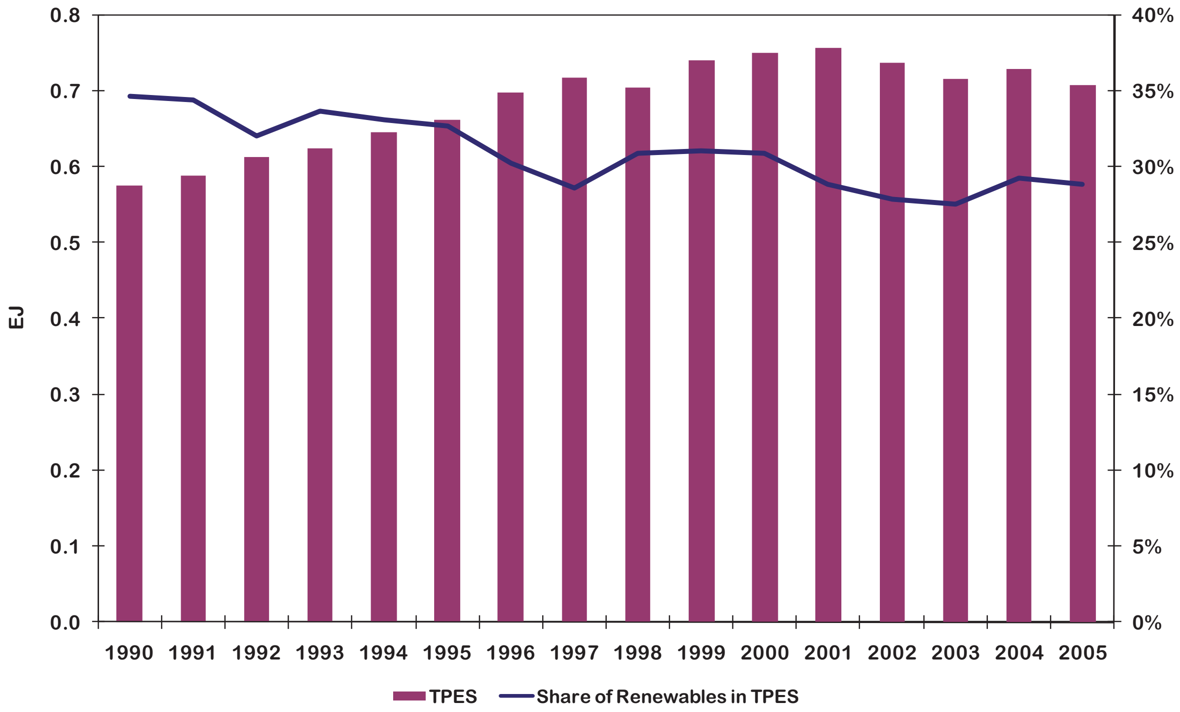
Figure 6. Renewable energy RD&D versus total government energy RD&D spending, 1990-2005



Source: IEA (2007b)

RENEWABLES IN TOTAL PRIMARY ENERGY SUPPLY[4]

Figure 7. Share of Renewable Energy in Total Primary Energy Supply, 1990-2005



Source: IEA (2007a)

RENEWABLE ENERGY POLICY INFORMATION

For details on renewable energy support policies implemented in New Zealand, readers may consult the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

[4] The official IEA statistics on TPES include, where applicable, traditional biomass but exclude pumped hydro.
Primary energy convention: The IEA uses the **physical energy content method** to calculate the primary energy equivalent of non-combustible energy sources, such as geothermal, hydro, solar and wind. As a consequence, there is an obvious link between the principles adopted in defining the primary energy forms of energy sources and the primary energy equivalent of these sources. For instance, in the case solar thermal and geothermal electricity production, as heat is the primary energy form selected by the IEA, the primary energy equivalent is the quantity of heat generated in the geothermal or solar thermal plant for electricity generation. In the case of hydro, wind, tide and solar PV, as electricity is the primary energy form selected, the primary energy equivalent is the physical energy content of the electricity generated in the plant, which amounts to assuming an efficiency of 100%. Please refer to (IEA, 2007a) for more details.

Glossary

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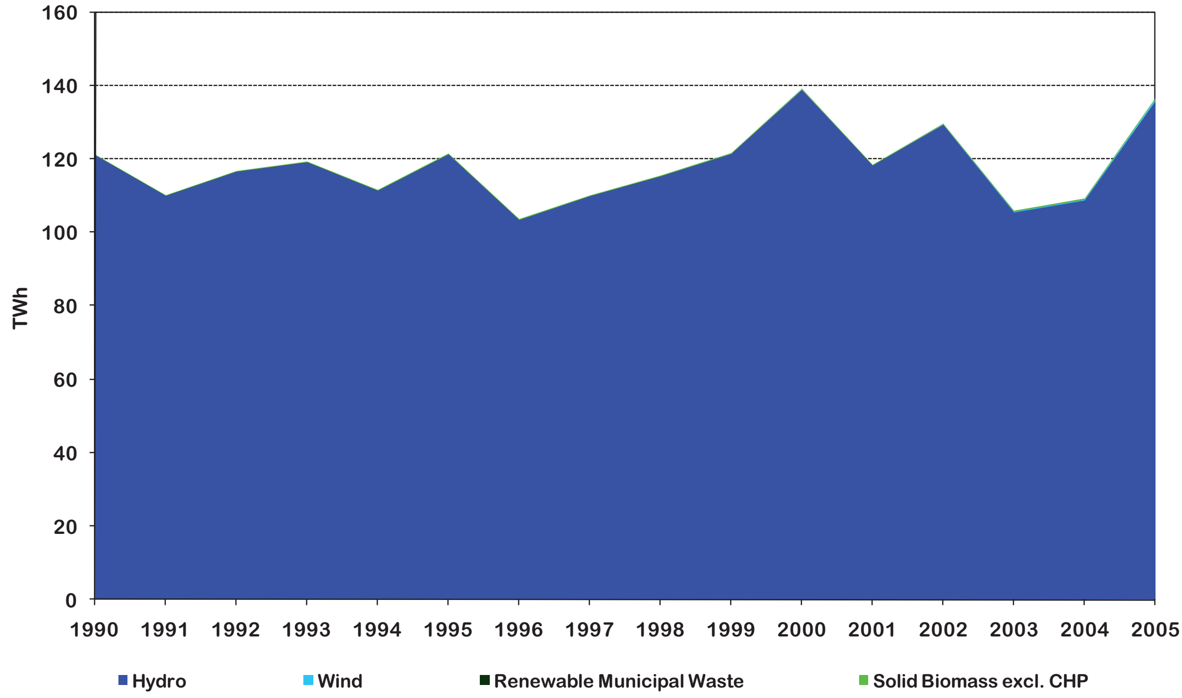
IEA (2007b), *IEA Energy Technology R&D Statistics,* IEA, Paris, *http://www.iea.org/Textbase/stats/rd.asp*, accessed 21 November 2007.

IEA (2008), "Global Renewable Energy Policies and Measures Database", www.iea.org/textbase/pm/grindex.aspx, International Energy Agency, accessed 15 March 2008.

NORWAY[1]

RENEWABLE ELECTRICITY (RES-E) MARKET

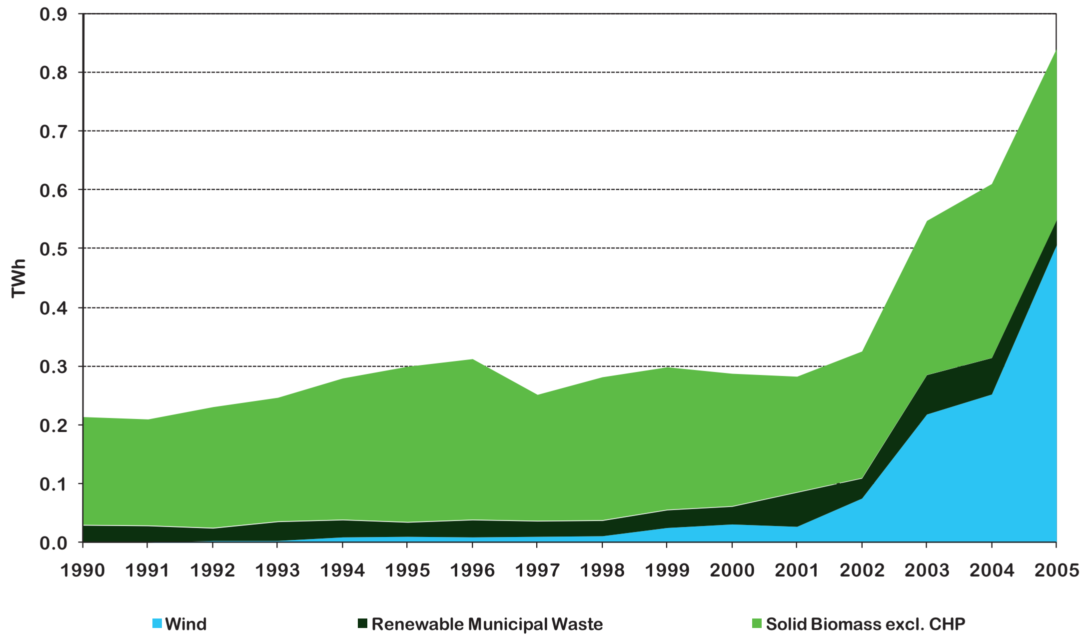
Figure 31. Total RES-E Production, 1990-2005



Source: IEA (2007a)

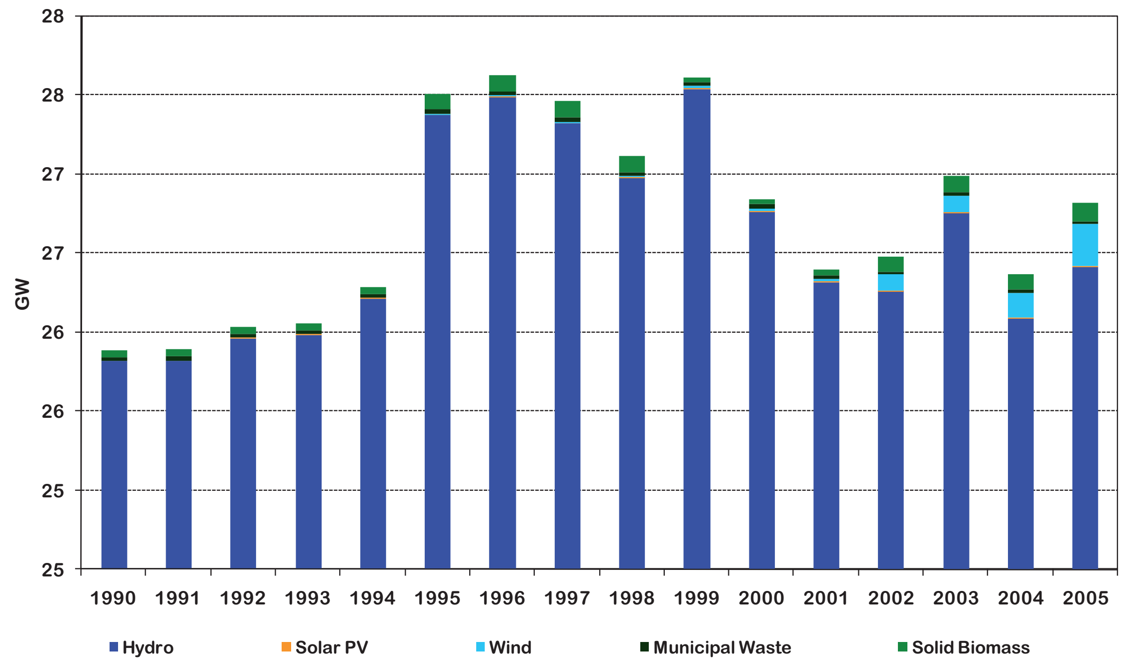
[1] A summary profile was prepared of Norway's renewable energy **market** developments from 1990 to 2005. Policy developments are available in the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

Figure 32. Total RES-E Production (excluding Hydropower), 1990-2005



Source: IEA (2007a)

Figure 3. Net Generating Capacity of RES-E Plants, 1990-2005

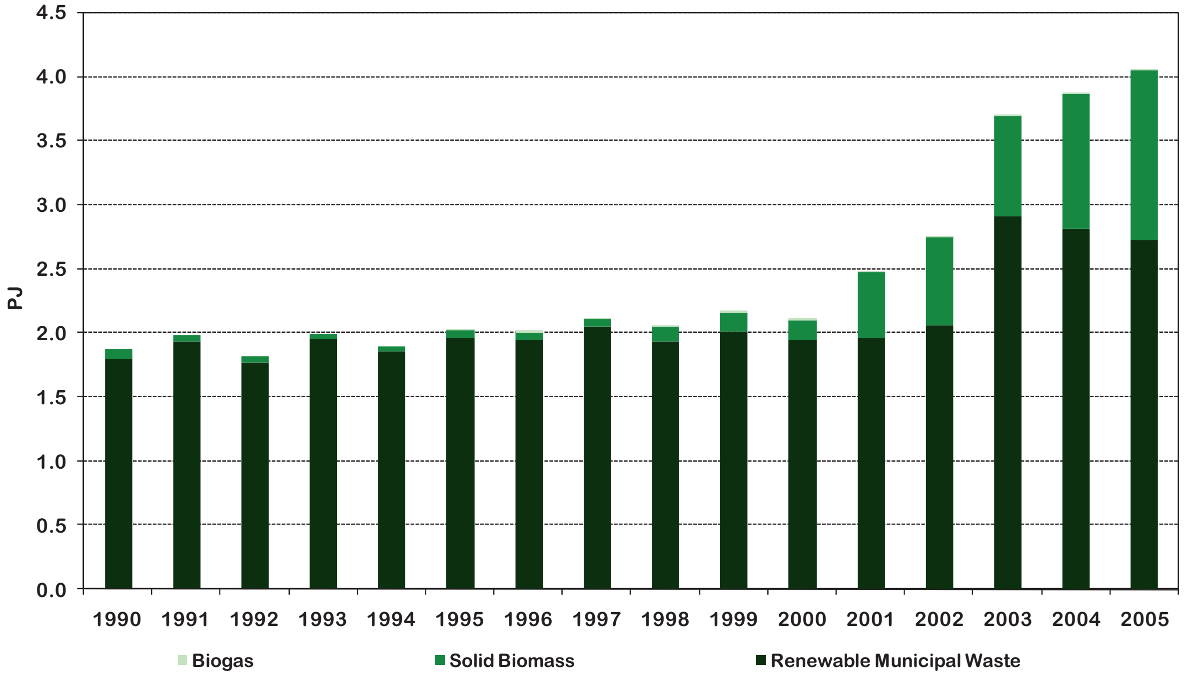


NB: Official IEA statistics on electricity generating capacity do not differentiate between *renewable* and *non-renewable* municipal waste.

Source: IEA (2007a)

RENEWABLE HEAT (RES-H) MARKET

Figure 4. Total RES-H Production, 1990-2005[2]



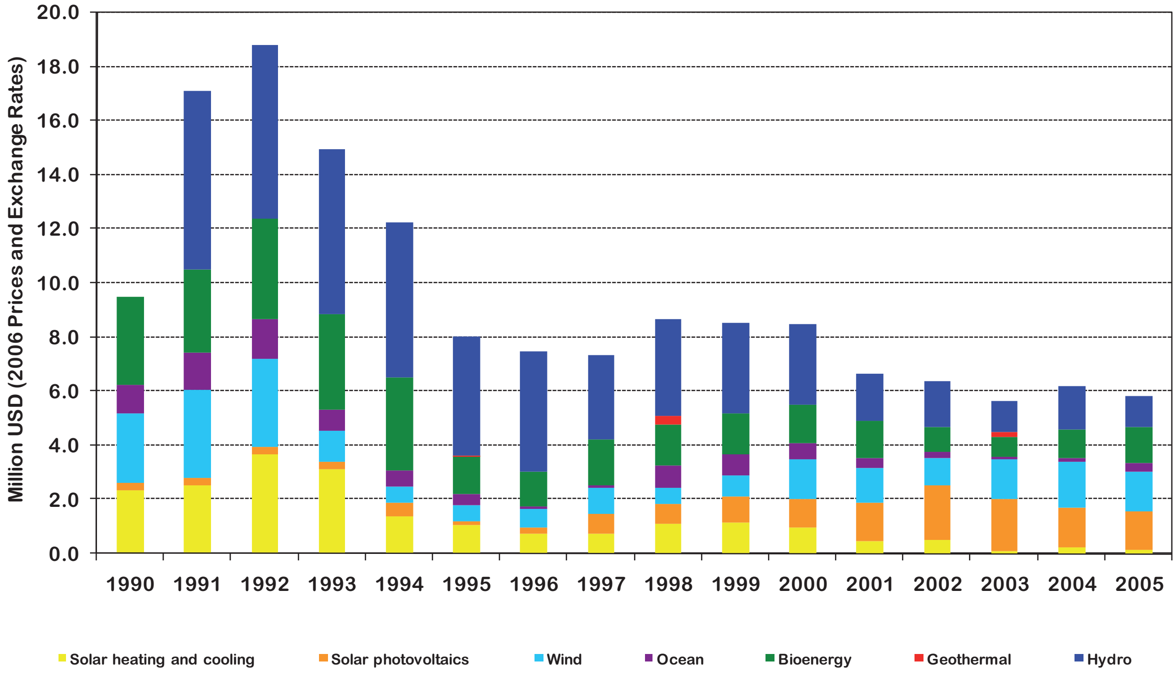
Source: IEA (2007a)

RENEWABLE TRANSPORT FUEL (RES-T) MARKET

Official IEA statistics do not show any biofuel production and consumption in Norway from 1990 to 2005.

[2] Official IEA statistics on heat generation from renewable energy sources relate to **commercial heat sold** with additional data on **direct use** of solar thermal and geothermal available for most OECD countries.

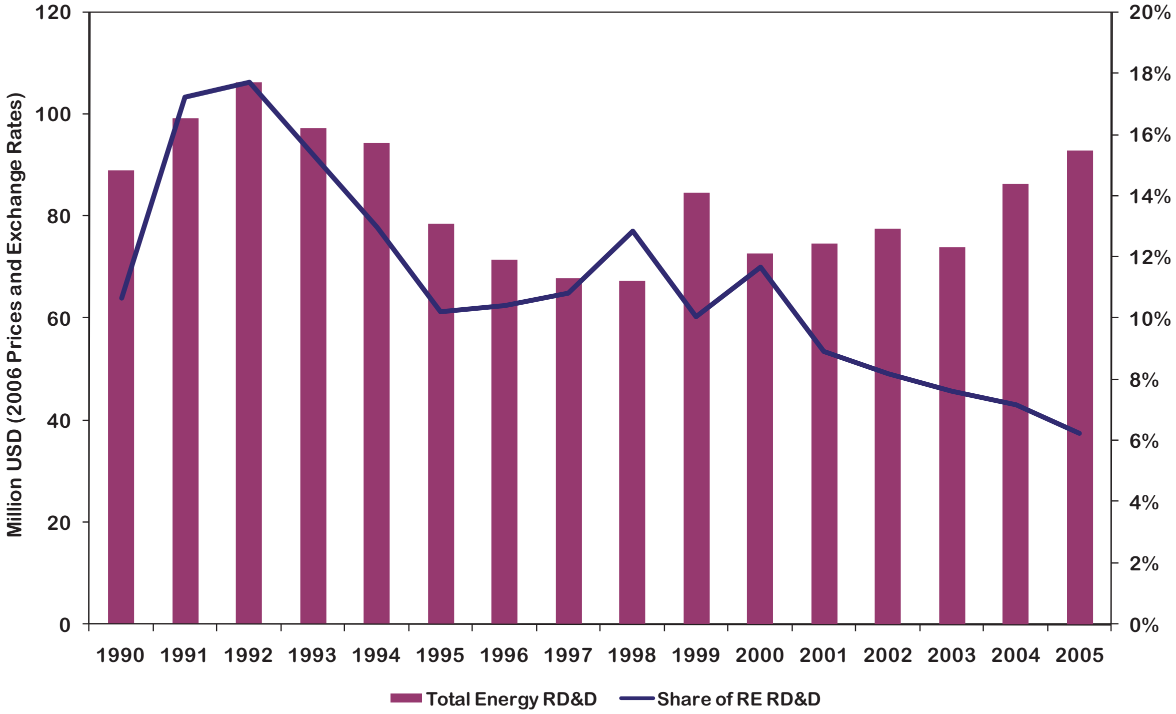
Figure 5. Annual Government RD&D Spending on Renewables, 1990-2005 (USD 2006 prices and exchange rates)[3]



Source: IEA (2007b)

[3] Official IEA data on energy RD&D budgets include only **government** funding and not **private** RD&D spending.

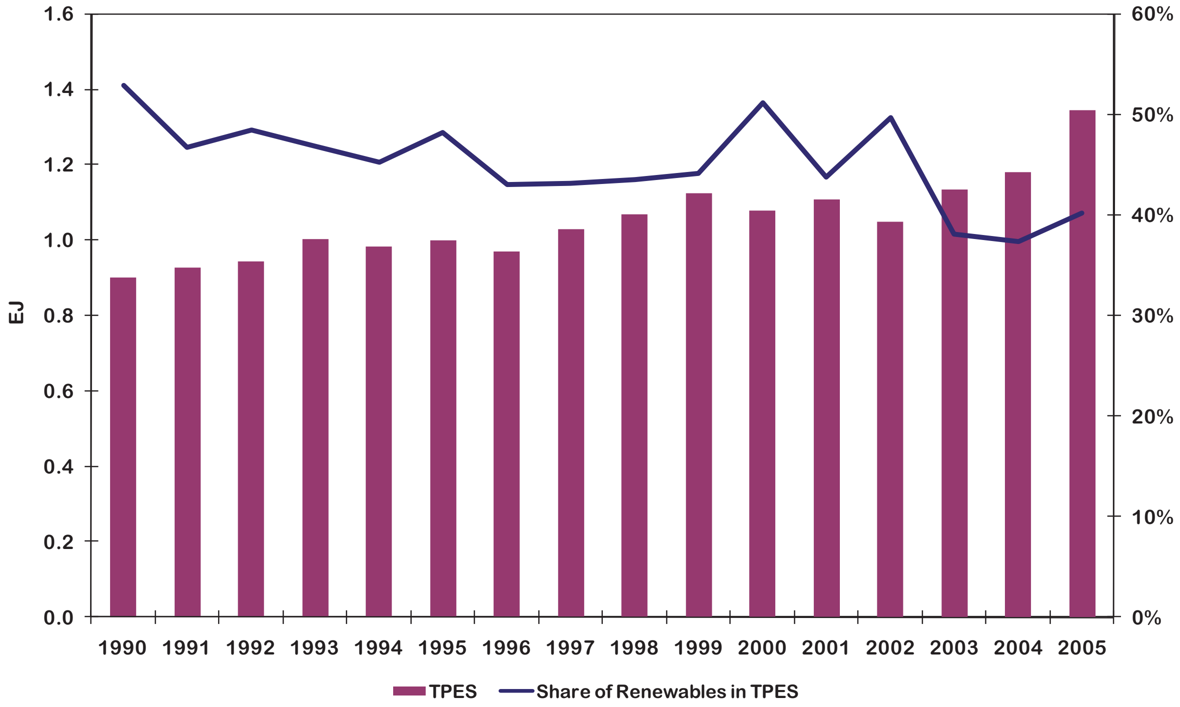
Figure 6. Renewable energy RD&D versus total government energy RD&D spending, 1990-2005



Source: IEA (2007b)

RENEWABLES IN TOTAL PRIMARY ENERGY SUPPLY[4]

Figure 7. Share of Renewable Energy in Total Primary Energy Supply, 1990-2005



Source: IEA (2007a)

RENEWABLE ENERGY POLICY INFORMATION

For details on renewable energy support policies implemented in Norway, readers may consult the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

[4] The official IEA statistics on TPES include, where applicable, traditional biomass but exclude pumped hydro.

Primary energy convention: The IEA uses the **physical energy content method** to calculate the primary energy equivalent of non-combustible energy sources, such as geothermal, hydro, solar and wind. As a consequence, there is an obvious link between the principles adopted in defining the primary energy forms of energy sources and the primary energy equivalent of these sources. For instance, in the case solar thermal and geothermal electricity production, as heat is the primary energy form selected by the IEA, the primary energy equivalent is the quantity of heat generated in the geothermal or solar thermal plant for electricity generation. In the case of hydro, wind, tide and solar PV, as electricity is the primary energy form selected, the primary energy equivalent is the physical energy content of the electricity generated in the plant, which amounts to assuming an efficiency of 100%. Please refer to (IEA, 2007a) for more details.

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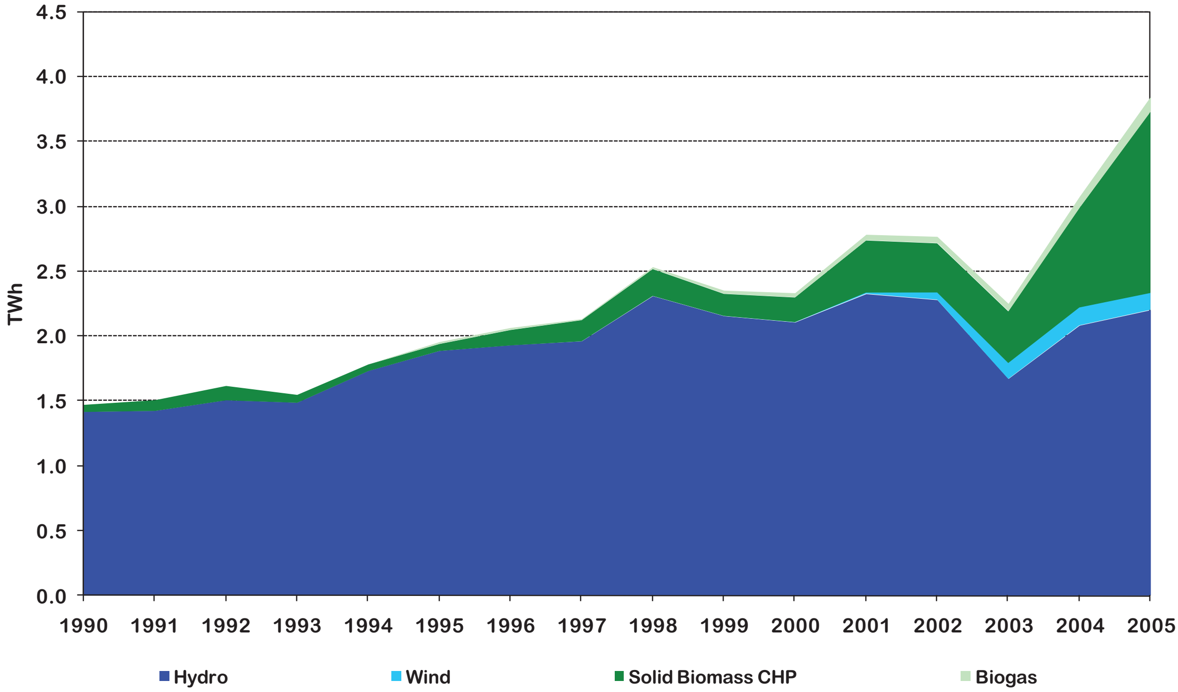
IEA (2008), "Global Renewable Energy Policies and Measures Database", www.iea.org/textbase/pm/grindex.aspx, International Energy Agency, accessed 15 March 2008.

POLAND[1]

RENEWABLE ELECTRICITY (RES-E) MARKET

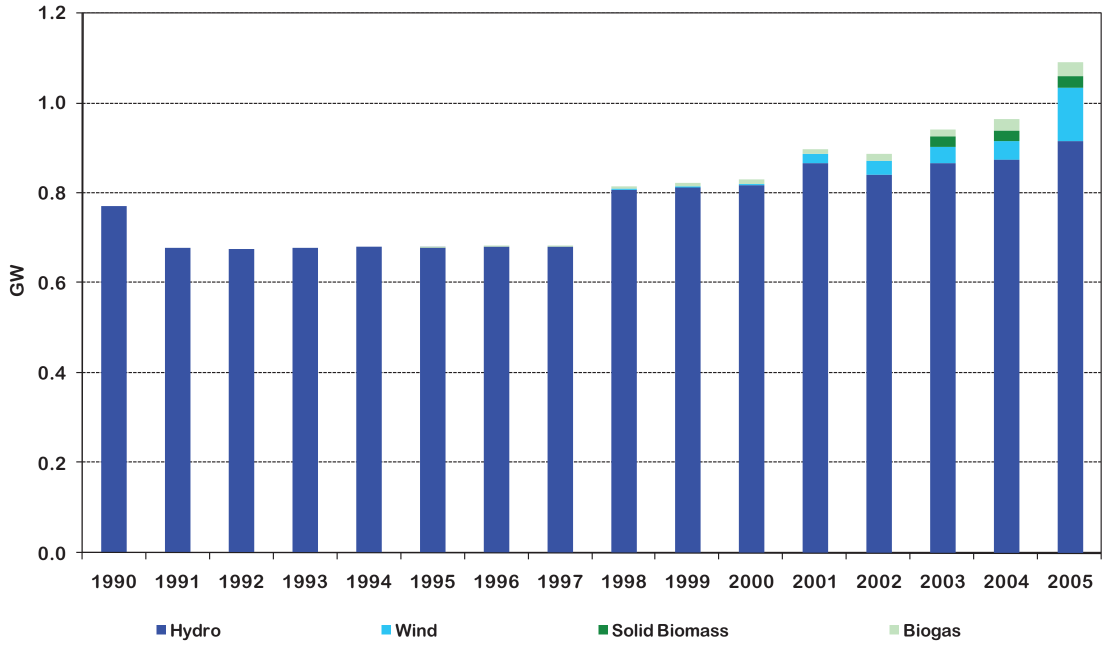
Figure 33. Total RES-E Production, 1990-2005



Source: IEA (2007a)

[1] A summary profile was prepared of Poland's renewable energy **market** developments from 1990 to 2005. Policy developments are available in the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

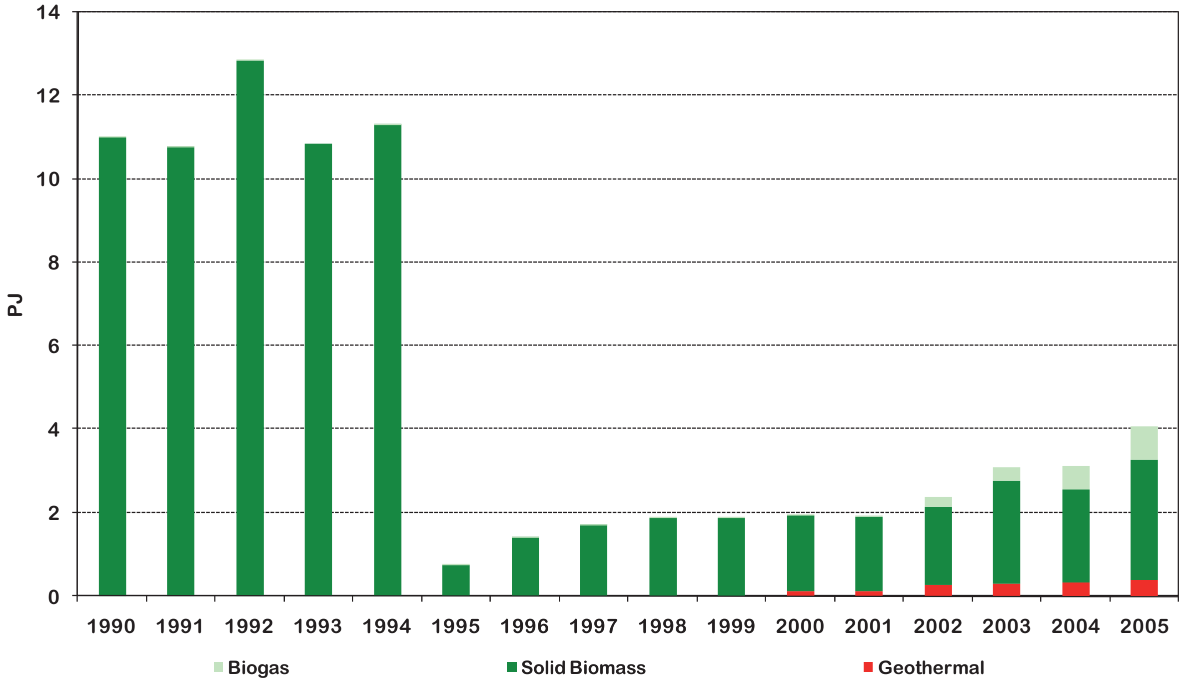
Figure 2. Net Generating Capacity of RES-E Plants, 1990-2005



Source: IEA (2007a)

RENEWABLE HEAT (RES-H) MARKET

Figure 3. Total RES-H Production, 1990-2005[2]



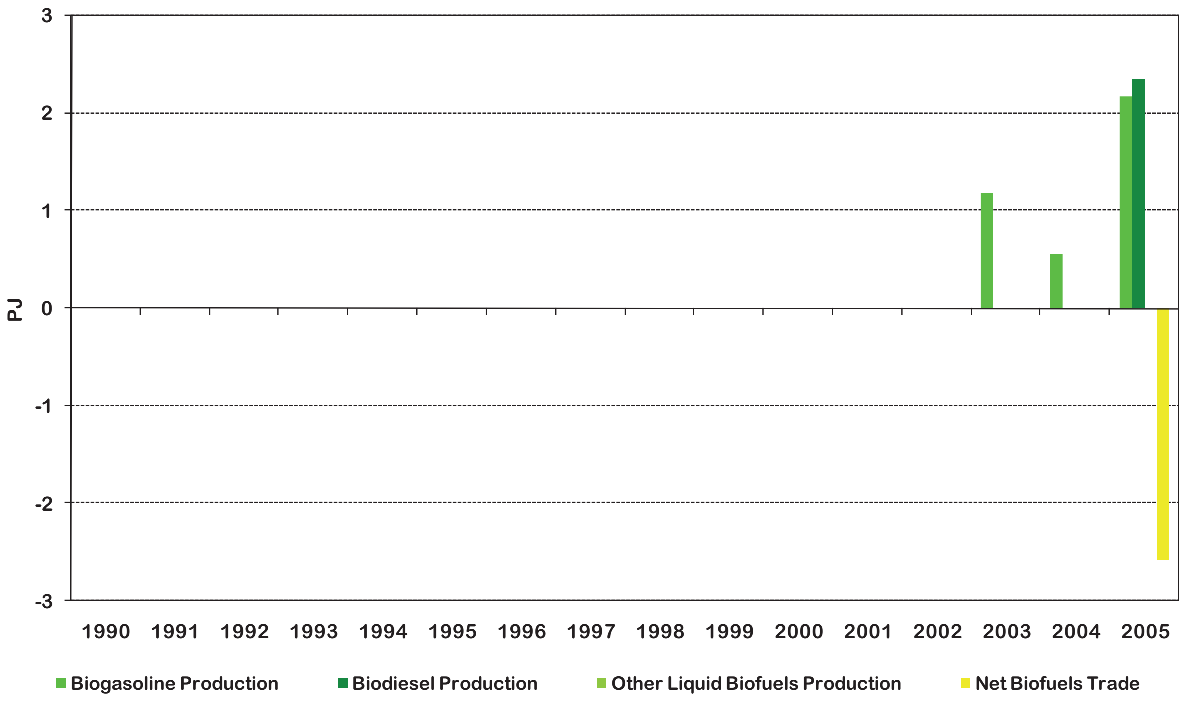
NB: Geothermal includes direct final use.

Source: IEA (2007a)

[2] Official IEA statistics on heat generation from renewable energy sources relate to **commercial heat sold** with additional data on **direct use** of solar thermal and geothermal available for most OECD countries.

Renewable Transport Fuel (RES-T) Market

Figure 4. Total RES-T Production, 1990-2005



NB: Net Biofuels Trade refers to the balance of domestic biofuel consumption, i.e. biofuel exports subtracted from imports.

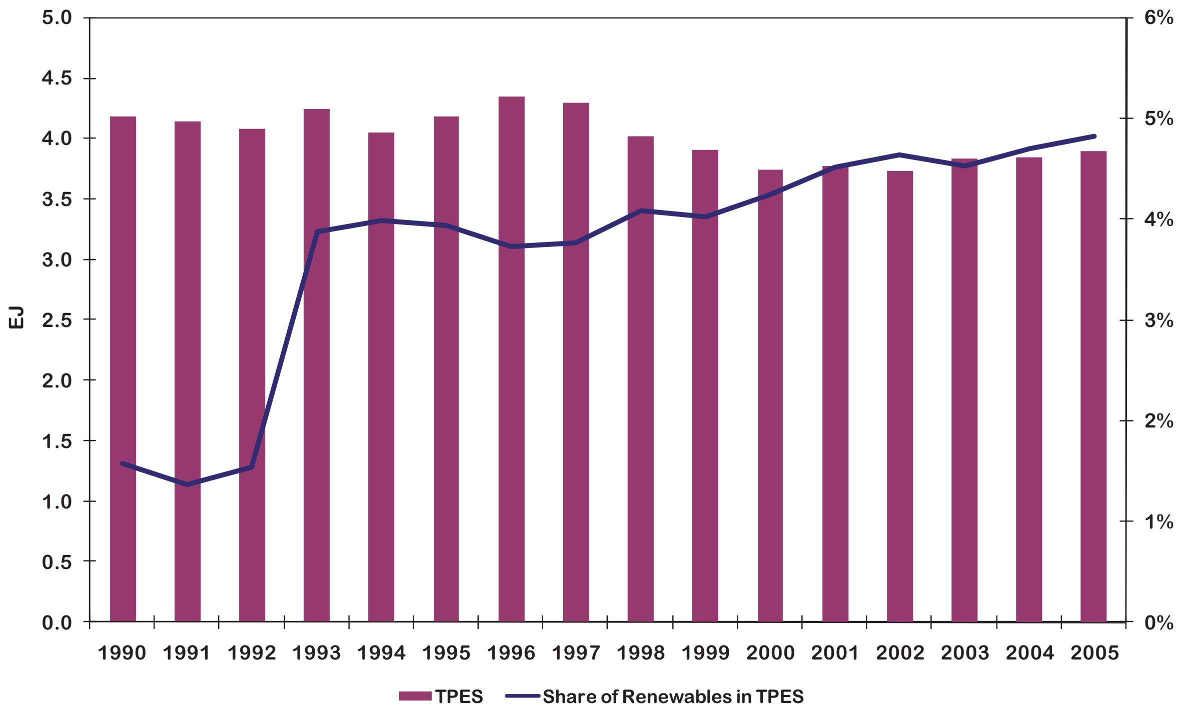
Source: IEA (2007a)

Research, Development and Demonstration Trends

Official IEA statistics do not report any government R&D funding for renewable energy technologies in Poland.

RENEWABLES IN TOTAL PRIMARY ENERGY SUPPLY[3]

Figure 5. Share of Renewable Energy in Total Primary Energy Supply, 1990-2005



Source: IEA (2007a)

RENEWABLE ENERGY POLICY INFORMATION

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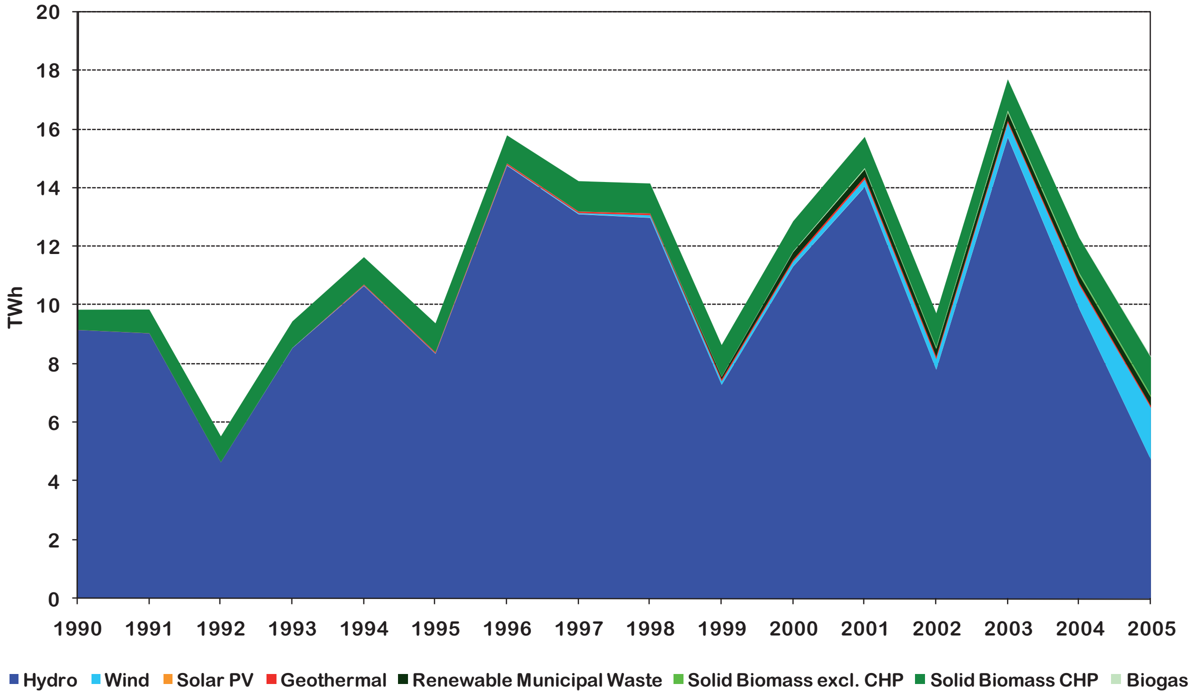
IEA (2007b), *IEA Energy Technology R&D Statistics,* IEA, Paris, *http://www.iea.org/Textbase/stats/rd.asp*, accessed 21 November 2007.

IEA (2008), "Global Renewable Energy Policies and Measures Database", www.iea.org/textbase/pm/grindex.aspx, International Energy Agency, accessed 15 March 2008.

PORTUGAL[1]

RENEWABLE ELECTRICITY (RES-E) MARKET

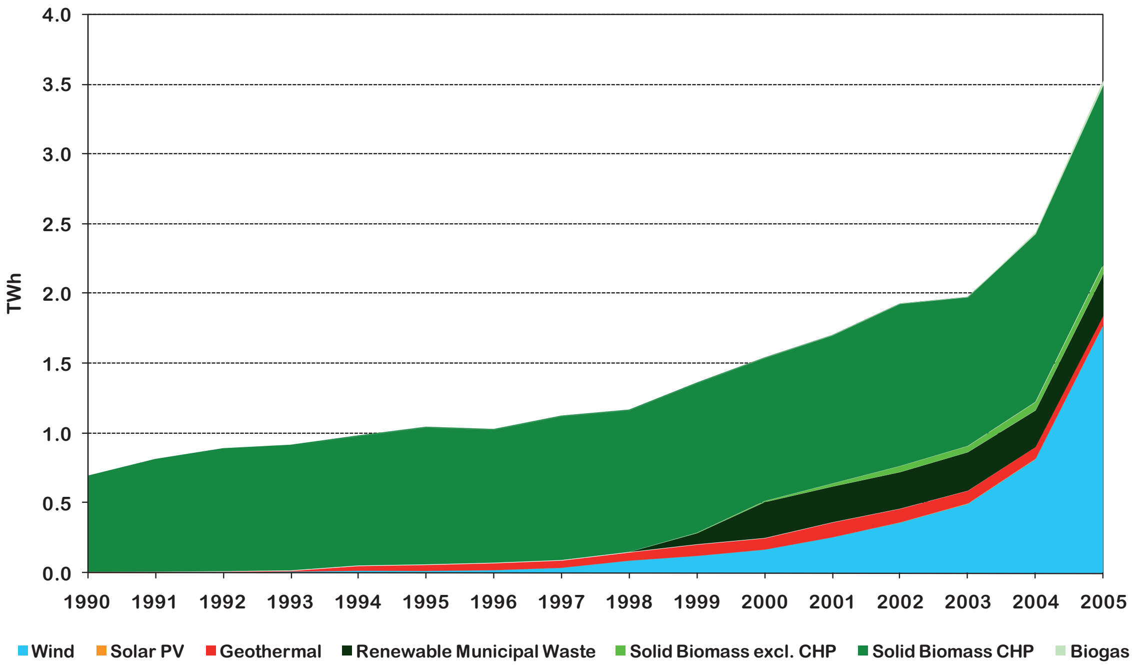
Figure 34. Total RES-E Production, 1990-2005



Source: IEA (2007a)

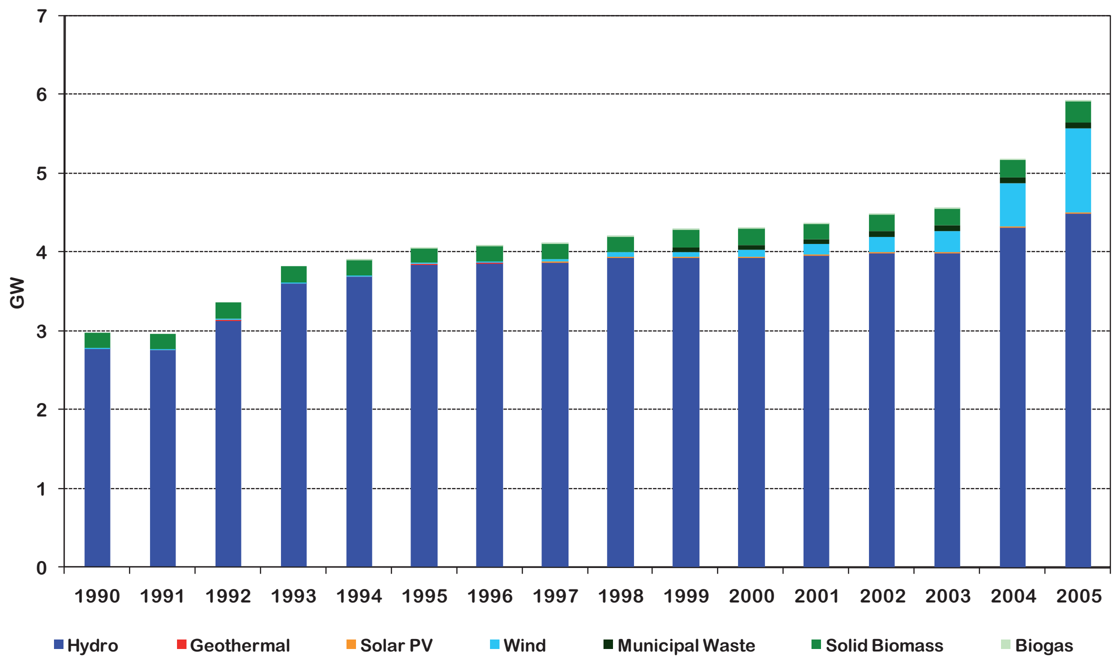
[1] A summary profile was prepared of Portugal's renewable energy **market** developments from 1990 to 2005. Policy developments are available in the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

Figure 35. Total RES-E Production (excluding Hydropower), 1990-2005



Source: IEA (2007a)

Figure 36. Net Generating Capacity of RES-E Plants, 1990-2005

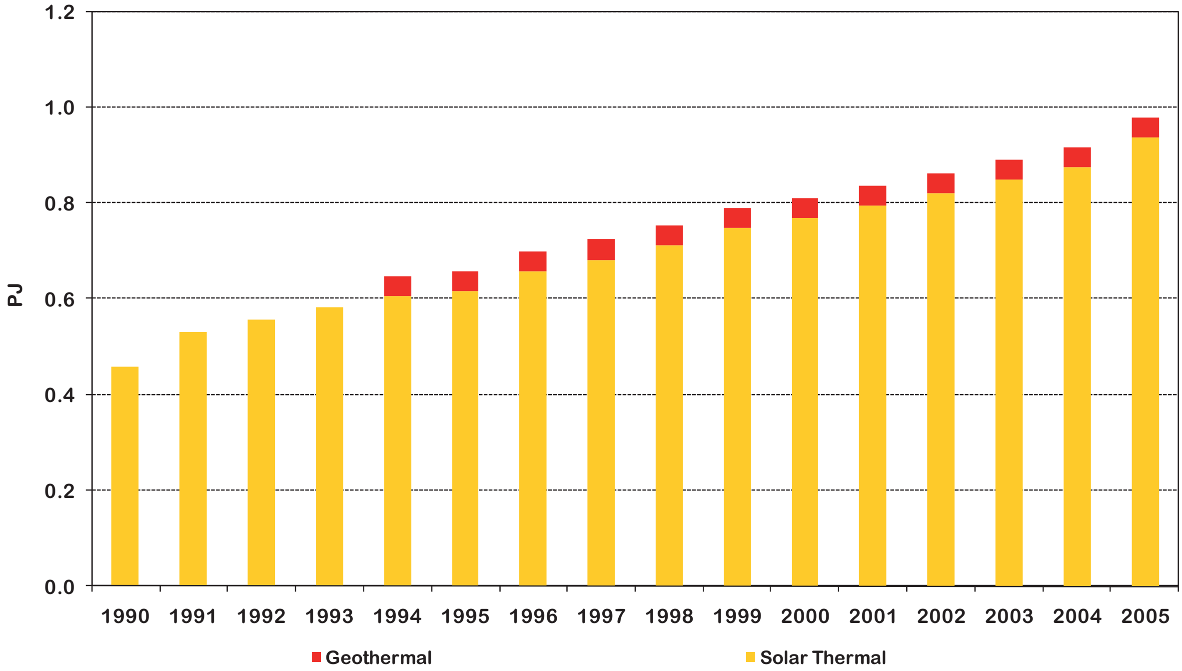


NB: Official IEA statistics on electricity generating capacity do not differentiate between *renewable* and *non-renewable* municipal waste.

Source: IEA (2007a)

Renewable heat (RES-H) Market

Figure 4. Total RES-H Production, 1990-2005[2]



NB: Geothermal and solar thermal include direct final use.

Source: IEA (2007a)

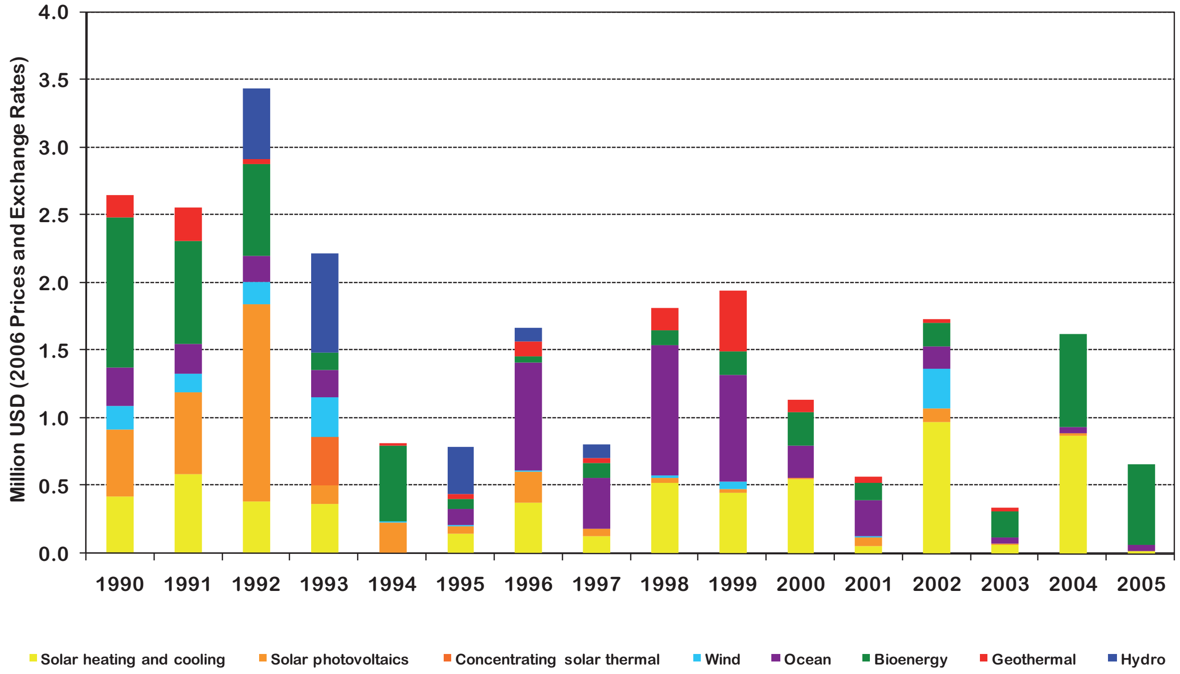
Renewable Transport Fuel (RES-T) Market

Official IEA statistics do not show any biofuel production and consumption in Portugal from 1990 to 2005.

[2] Official IEA statistics on heat generation from renewable energy sources relate to **commercial heat sold** with additional data on **direct use** of solar thermal and geothermal available for most OECD countries.

RESEARCH, DEVELOPMENT AND DEMONSTRATION TRENDS

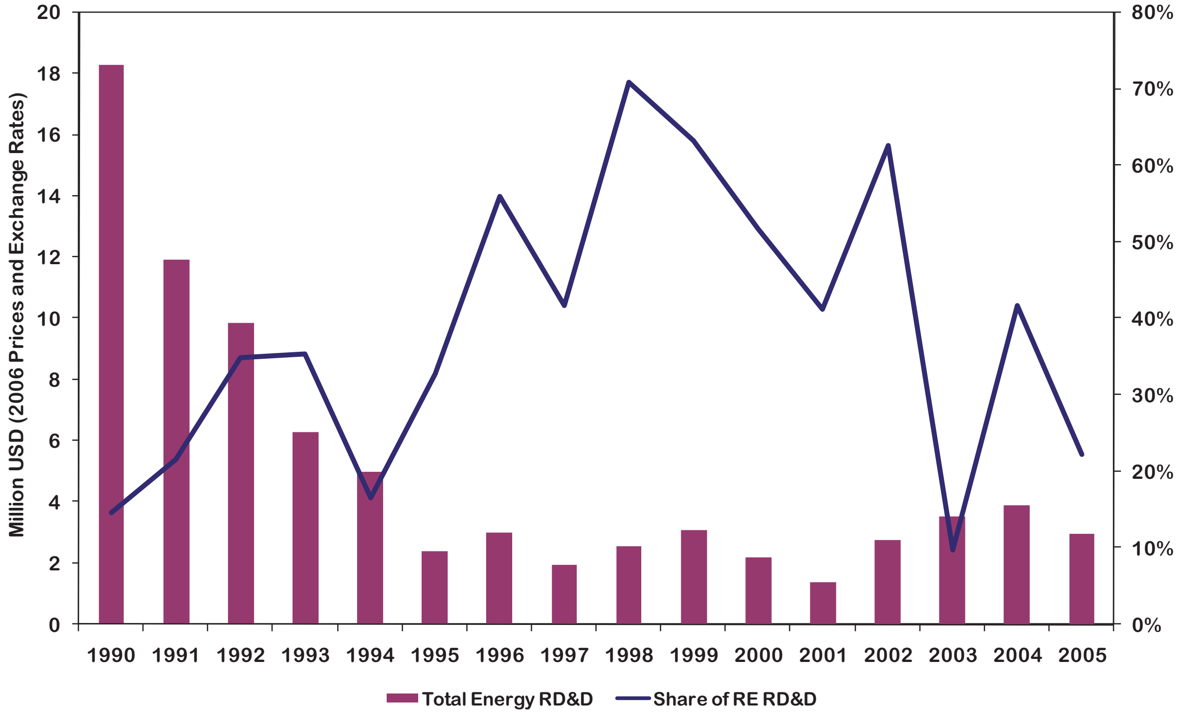
Figure 5. Annual Government RD&D Spending on Renewables, 1990-2005 (USD 2006 prices and exchange rates)[3]



Source: IEA (2007b)

[3] Official IEA data on energy RD&D budgets include only **government** funding and not **private** RD&D spending.

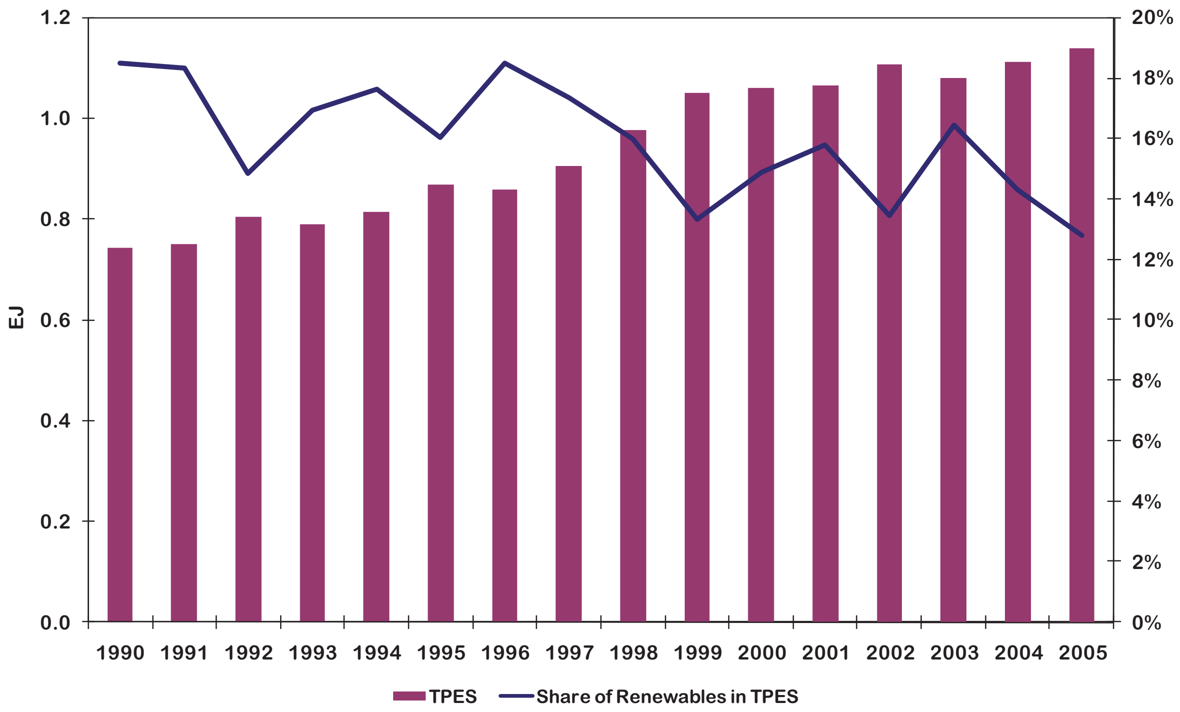
Figure 6. Renewable energy RD&D versus total government energy RD&D spending, 1990-2005



Source: IEA (2007b)

Renewables in Total Primary Energy Supply[4]

Figure 7. Share of Renewable Energy in Total Primary Energy Supply, 1990-2005



Source: IEA (2007a)

Renewable Energy Policy Information

For details on renewable energy support policies implemented in Portugal, readers may consult the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

[4] The official IEA statistics on TPES include, where applicable, traditional biomass but exclude pumped hydro.
Primary energy convention: The IEA uses the **physical energy content method** to calculate the primary energy equivalent of non-combustible energy sources, such as geothermal, hydro, solar and wind. As a consequence, there is an obvious link between the principles adopted in defining the primary energy forms of energy sources and the primary energy equivalent of these sources. For instance, in the case solar thermal and geothermal electricity production, as heat is the primary energy form selected by the IEA, the primary energy equivalent is the quantity of heat generated in the geothermal or solar thermal plant for electricity generation. In the case of hydro, wind, tide and solar PV, as electricity is the primary energy form selected, the primary energy equivalent is the physical energy content of the electricity generated in the plant, which amounts to assuming an efficiency of 100%. Please refer to (IEA, 2007a) for more details.

GLOSSARY

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REFERENCES

IEA (2007a), *Renewables Information 2007*, OECD/IEA, Paris.

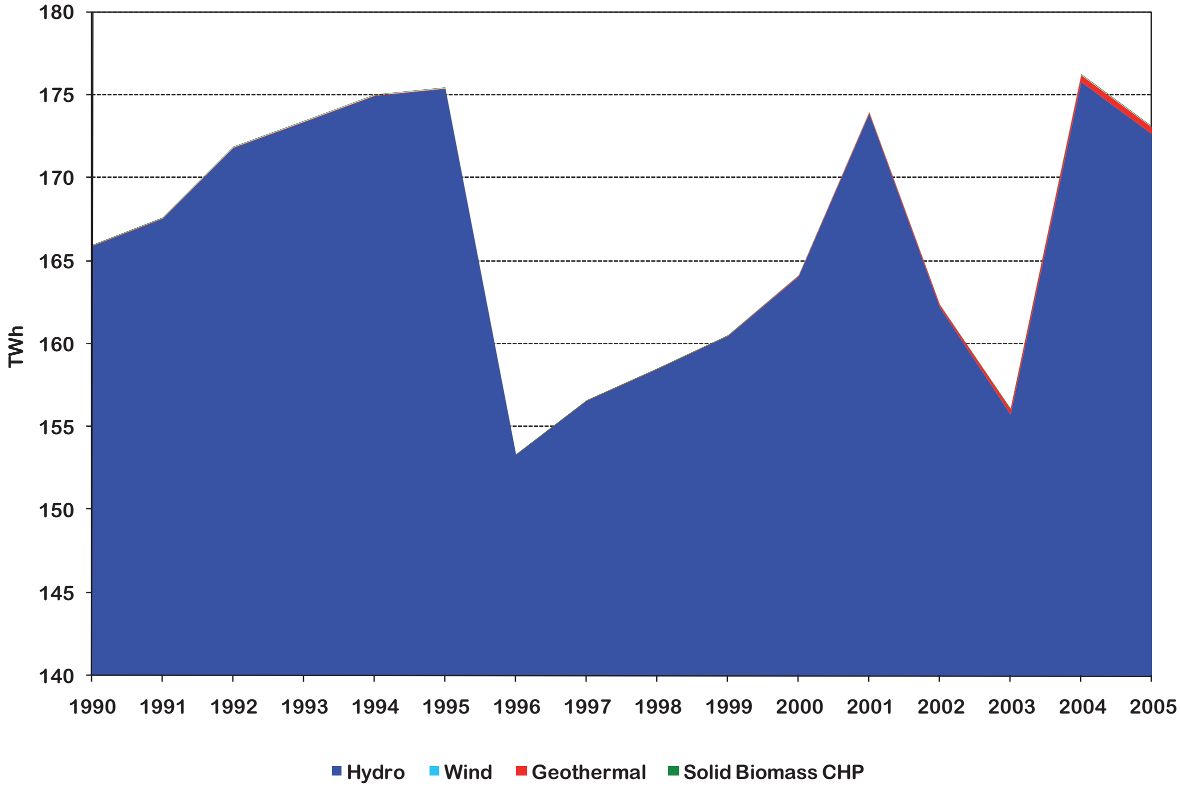
IEA (2007b), *IEA Energy Technology R&D Statistics,* IEA, Paris, *http://www.iea.org/Textbase/stats/rd.asp*, accessed 21 November 2007.

IEA (2008), "Global Renewable Energy Policies and Measures Database", www.iea.org/textbase/pm/grindex.aspx, International Energy Agency, accessed 15 March 2008.

RUSSIA[1]

RENEWABLE ELECTRICITY (RES-E) MARKET

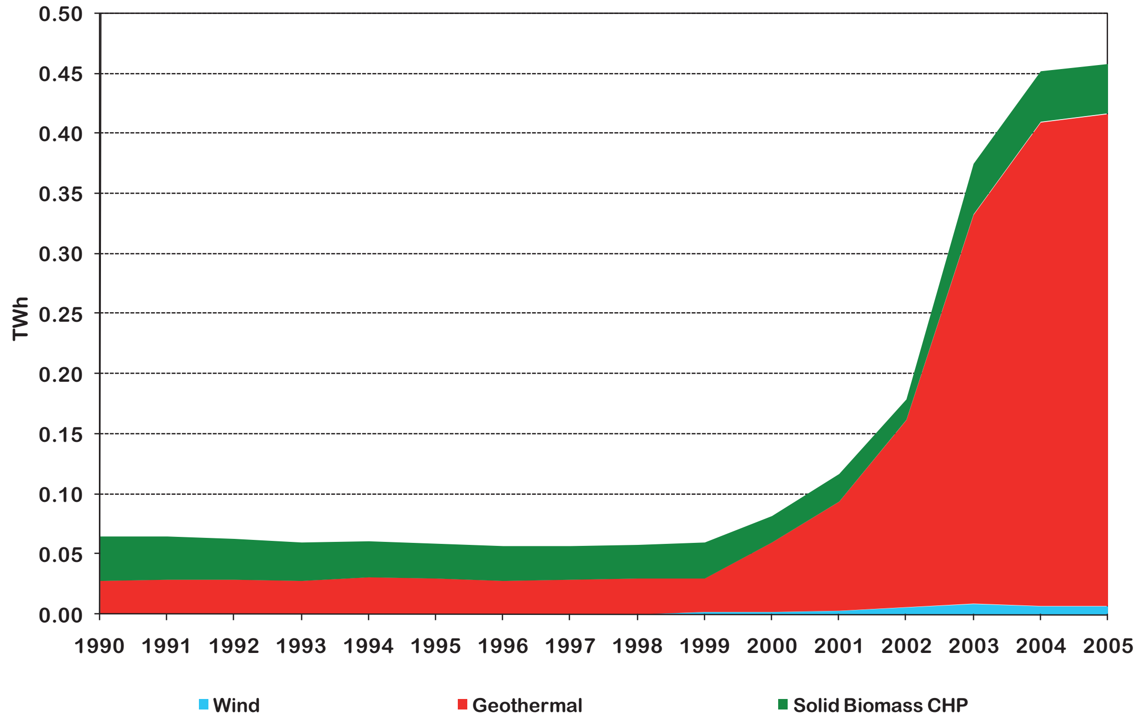
Figure 37. Total RES-E Production, 1990-2005



Source: IEA (2007)

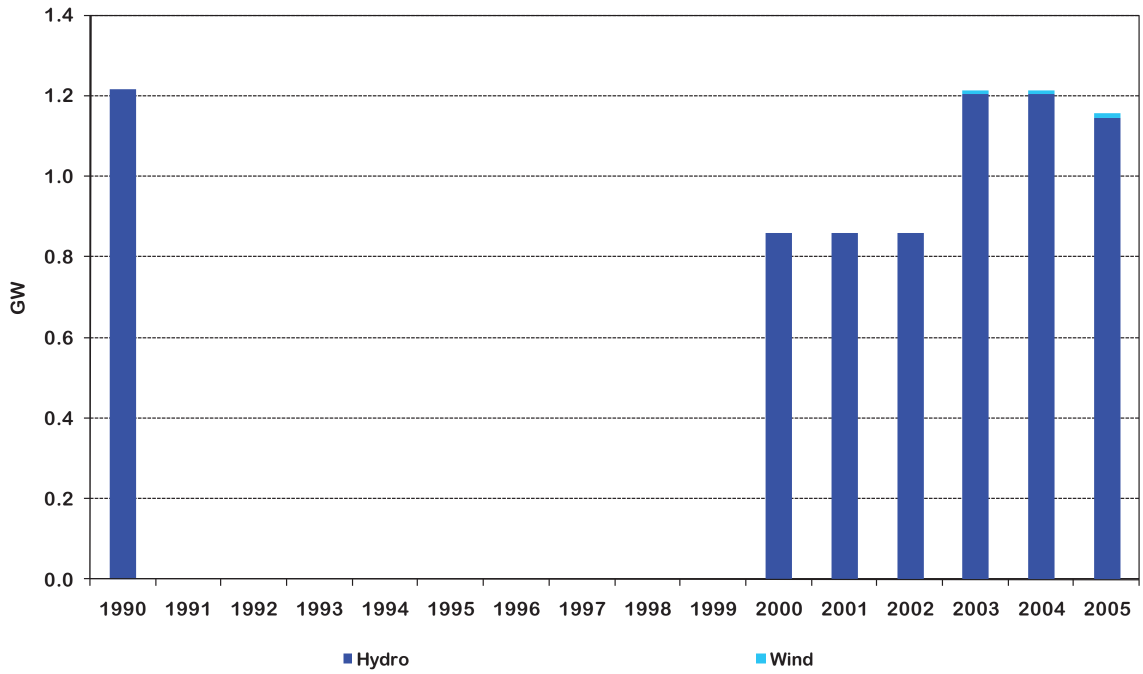
[1] No full profile was prepared of Russia's renewable energy market and policy developments since 1990.

Figure 38. Total RES-E Production (excluding Hydropower), 1990-2005



Source: IEA (2007)

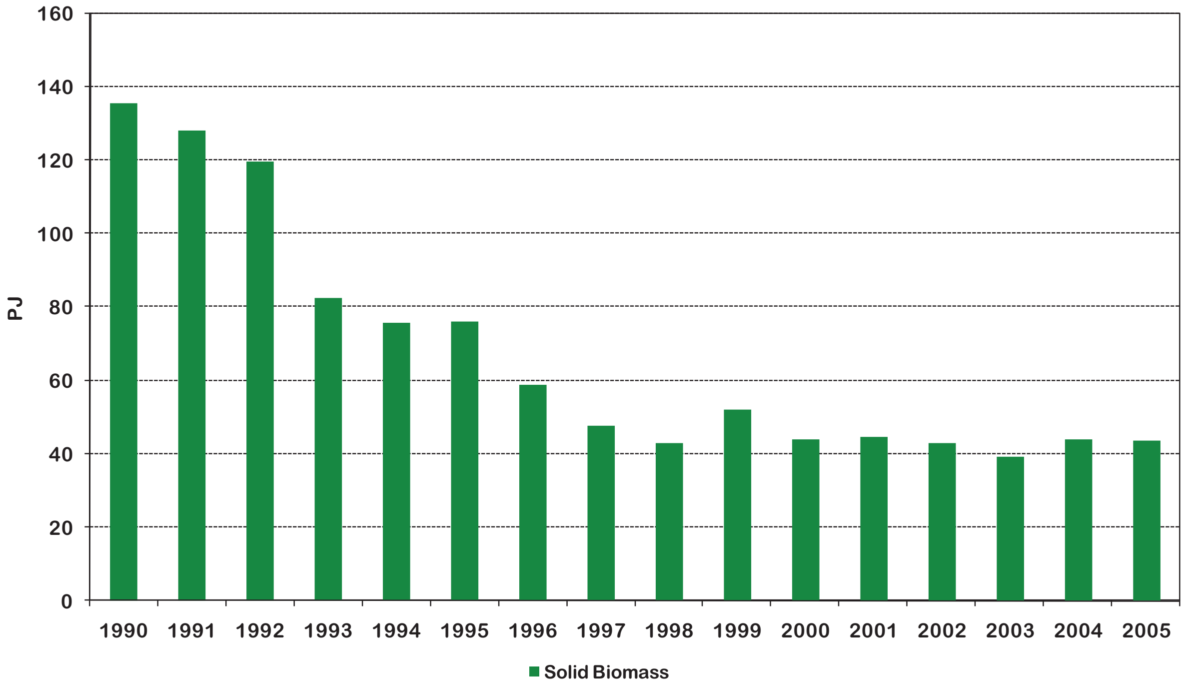
Figure 3. Net Generating Capacity of RES-E Plants, 1990-2005



Source: IEA (2007)

RENEWABLE HEAT (RES-H) MARKET

Figure 4. Total RES-H Production, 1990-2005[2]



Source: IEA (2007)

RENEWABLE TRANSPORT FUEL (RES-T) MARKET

Official IEA statistics do not report any biofuel production and consumption in Russia from 1990 to 2005.

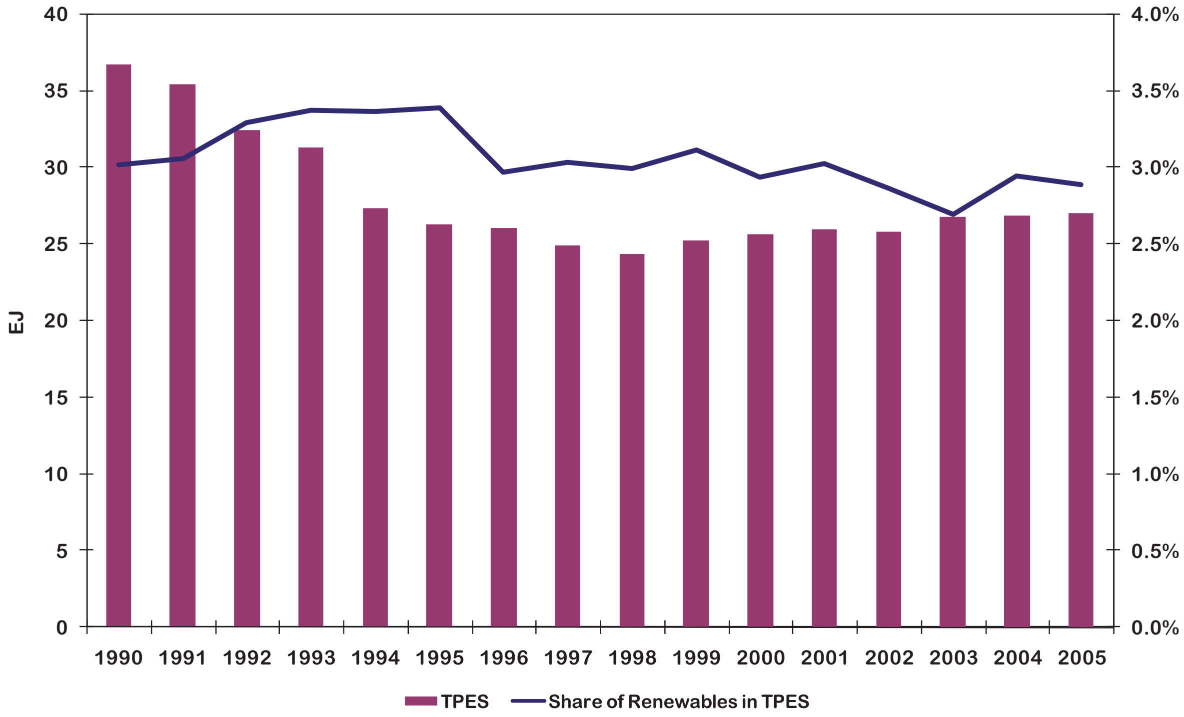
RESEARCH, DEVELOPMENT AND DEMONSTRATION TRENDS

No data was available on Russia's public R&D funding for energy technologies. The IEA does not collect such data for Russia.

[2] Official IEA statistics on heat generation from renewable energy sources relate to **commercial heat sold** with additional data on **direct use** of solar thermal and geothermal available for most OECD countries.

RENEWABLES IN TOTAL PRIMARY ENERGY SUPPLY[3]

Figure 5. Share of Renewable Energy in Total Primary Energy Supply, 1990-2005



Source: IEA (2007)

RENEWABLE ENERGY POLICY INFORMATION

For details on renewable energy support policies implemented in Russia, readers may consult the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

[3] The official IEA statistics on TPES include, where applicable, traditional biomass but exclude pumped hydro.
Primary energy convention: The IEA uses the **physical energy content method** to calculate the primary energy equivalent of non-combustible energy sources, such as geothermal, hydro, solar and wind. As a consequence, there is an obvious link between the principles adopted in defining the primary energy forms of energy sources and the primary energy equivalent of these sources. For instance, in the case solar thermal and geothermal electricity production, as heat is the primary energy form selected by the IEA, the primary energy equivalent is the quantity of heat generated in the geothermal or solar thermal plant for electricity generation. In the case of hydro, wind, tide and solar PV, as electricity is the primary energy form selected, the primary energy equivalent is the physical energy content of the electricity generated in the plant, which amounts to assuming an efficiency of 100%. Readers may consult (IEA, 2007) for more details.

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REFERENCES

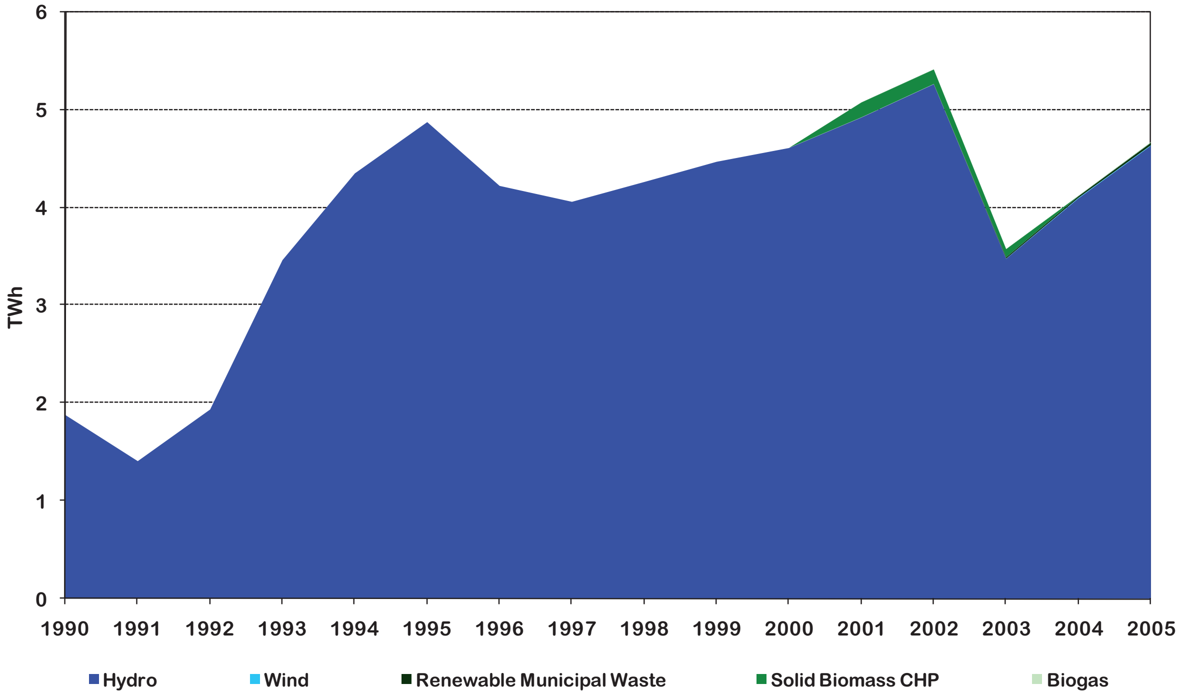
IEA (2007), *Renewables Information 2007*, OECD/IEA, Paris.

IEA (2008), "Global Renewable Energy Policies and Measures Database", www.iea.org/textbase/pm/grindex.aspx, International Energy Agency, accessed 15 March 2008.

SLOVAK REPUBLIC[1]

RENEWABLE ELECTRICITY (RES-E) MARKET

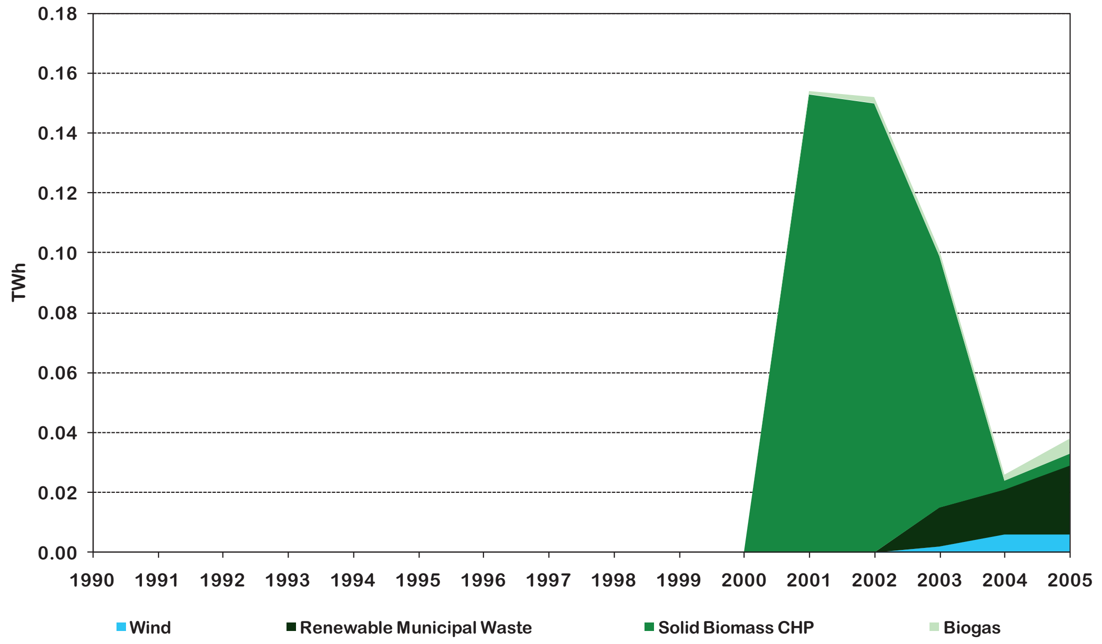
Figure 1. Total RES-E Production, 1990-2005



Source: IEA (2007a)

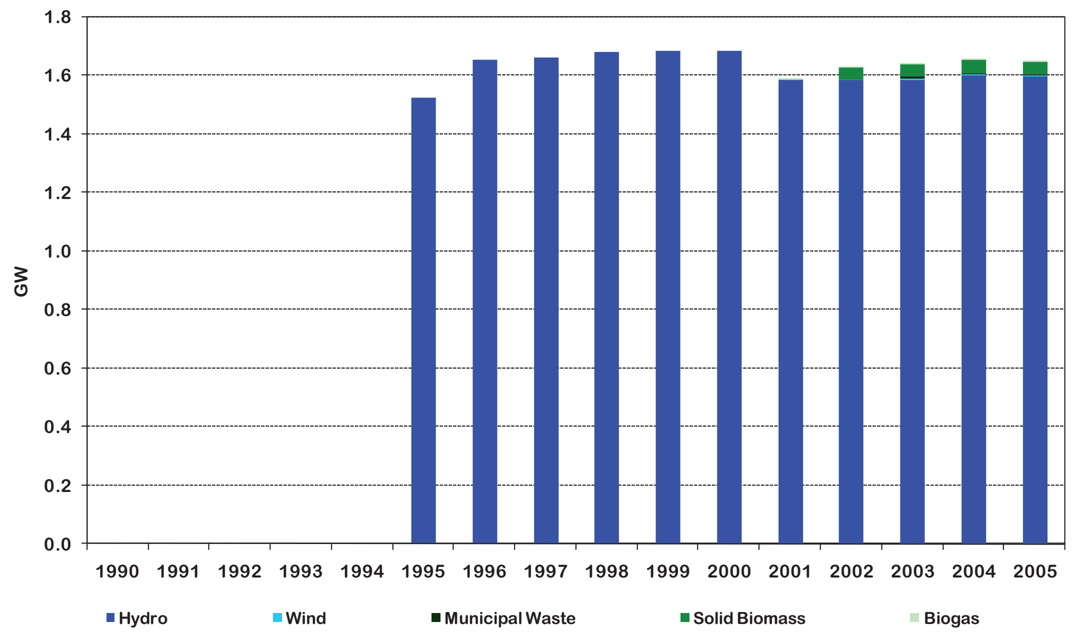
[1] A summary profile was prepared of the Slovak Republic's renewable energy **market** developments from 1990 to 2005. Policy developments are available in the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

Figure 39. Total RES-E Production (excluding Hydropower), 1990-2005



Source: IEA (2007a)

Figure 3. Net Generating Capacity of RES-E Plants, 1990-2005

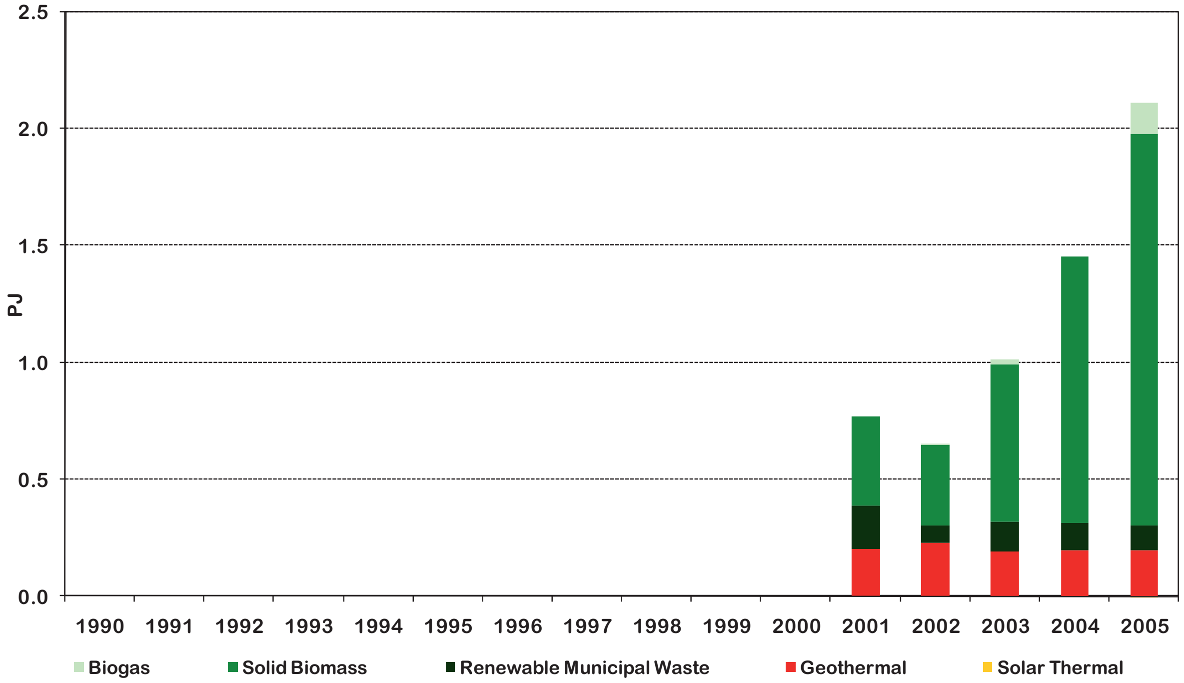


NB: Official IEA statistics on electricity generating capacity do not differentiate between *renewable* and *non-renewable* municipal waste.

Source: IEA (2007a)

Renewable heat (RES-H) Market

Figure 4. Total RES-H Production, 1990-2005[2]



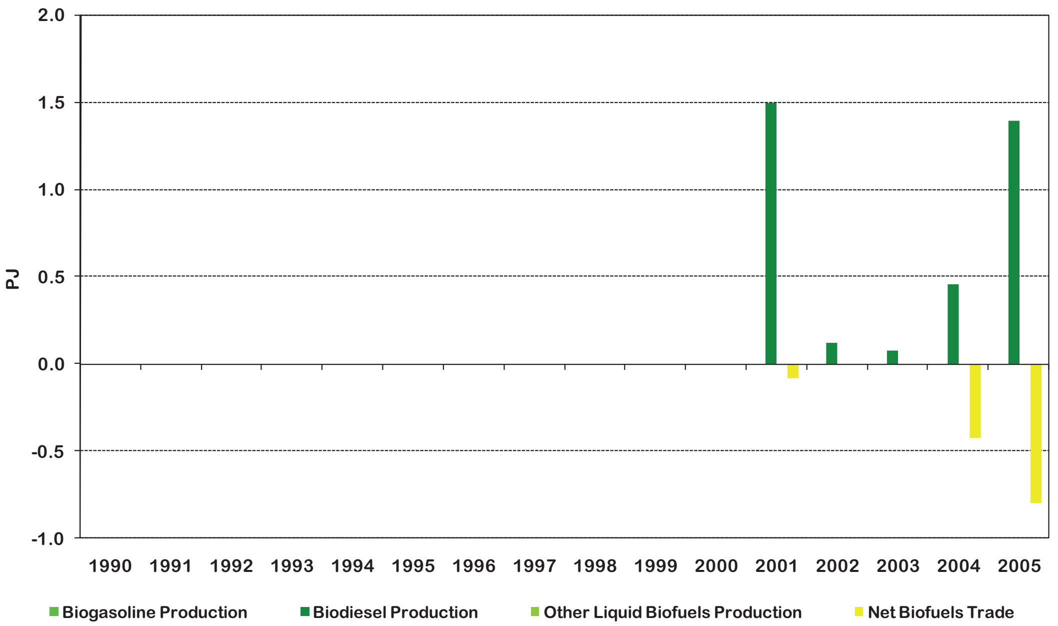
NB: Geothermal and solar thermal include direct final use.

Source: IEA (2007a)

[2] Official IEA statistics on heat generation from renewable energy sources relate to **commercial heat sold** with additional data on **direct use** of solar thermal and geothermal available for most OECD countries.

RENEWABLE TRANSPORT FUEL (RES-T) MARKET

Figure 5. Total RES-T Production, 1990-2005

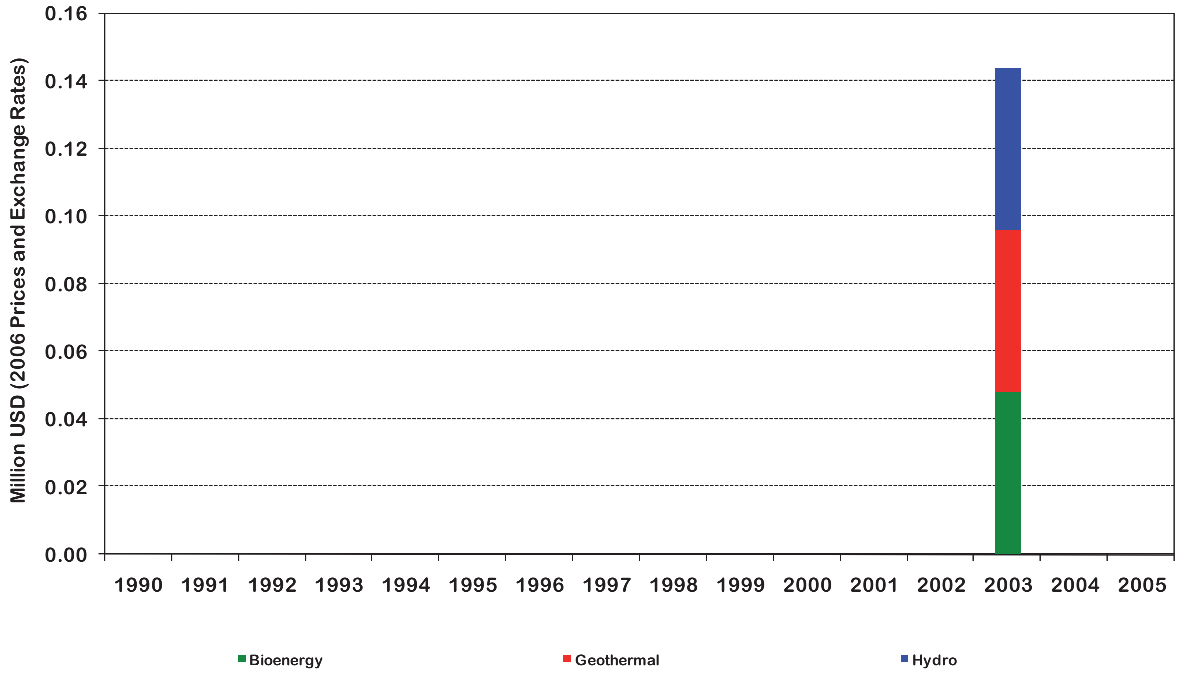


NB: Net Biofuels Trade refers to the balance of domestic biofuel consumption, i.e. biofuel exports subtracted from imports.

Source: IEA (2007a)

RESEARCH, DEVELOPMENT AND DEMONSTRATION TRENDS

Figure 6. Annual Government RD&D Spending on Renewables, 1990-2005 (USD 2006 prices and exchange rates)[3]

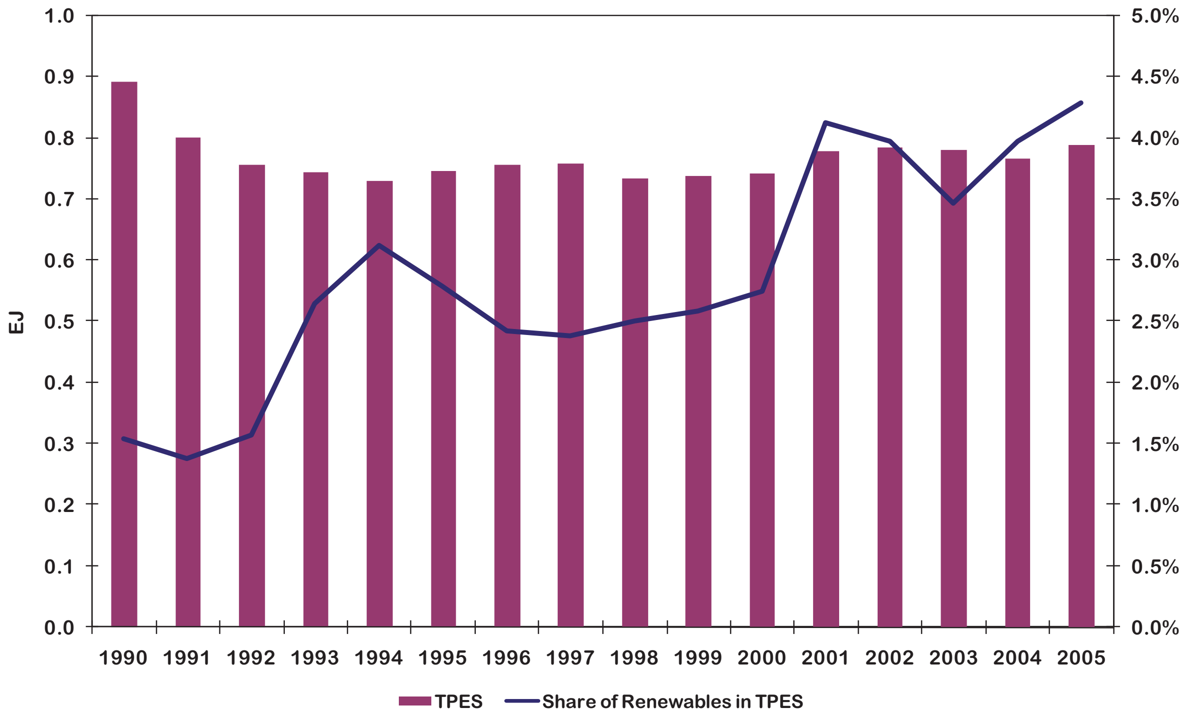


Source: IEA (2007b)

[3] Official IEA data on energy RD&D budgets include only **government** funding and not **private** RD&D spending.

Renewables in Total Primary Energy Supply[4]

Figure 7. Share of Renewable Energy in Total Primary Energy Supply, 1990-2005



Source: IEA (2007a)

Renewable Energy Policy Information

For details on renewable energy support policies implemented in the Slovak Republic, readers may consult the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

Glossary

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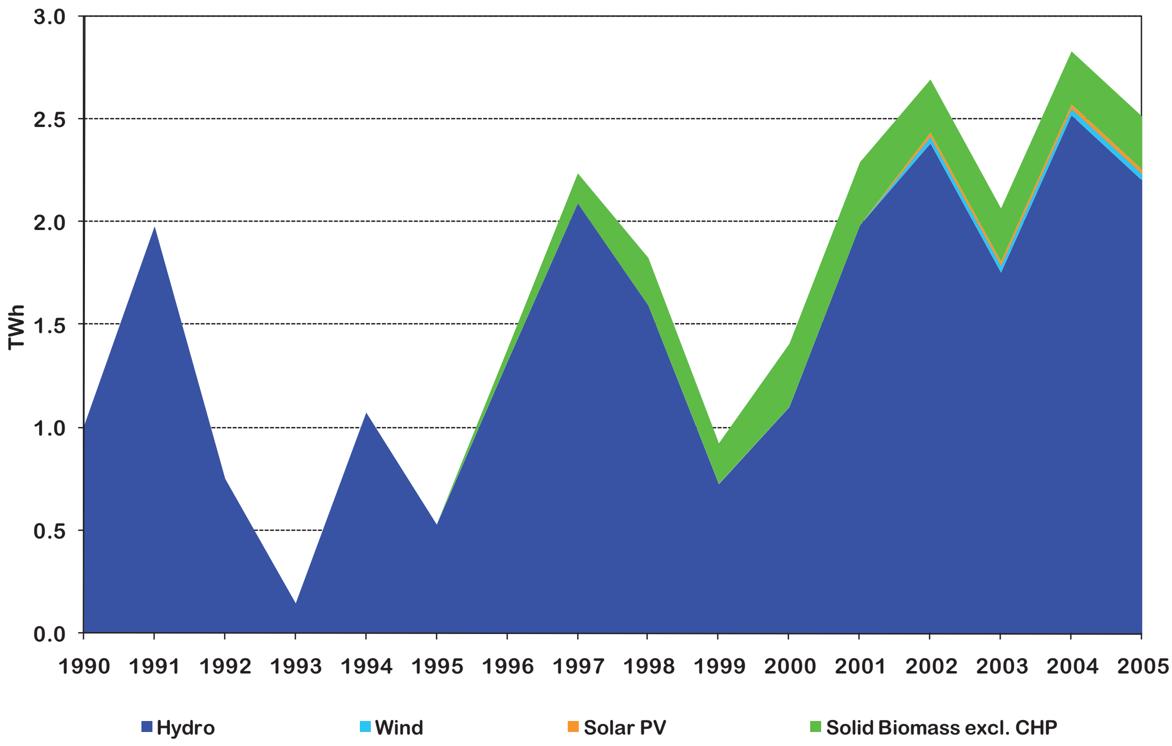
IEA (2007b), *IEA Energy Technology R&D Statistics,* IEA, Paris, http://www.iea.org/Textbase/stats/rd.asp, accessed 21 November 2007.

IEA (2008), "Global Renewable Energy Policies and Measures Database", www.iea.org/textbase/pm/grindex.aspx, International Energy Agency, accessed 15 March 2008.

SOUTH AFRICA[1]

RENEWABLE ELECTRICITY (RES-E) MARKET

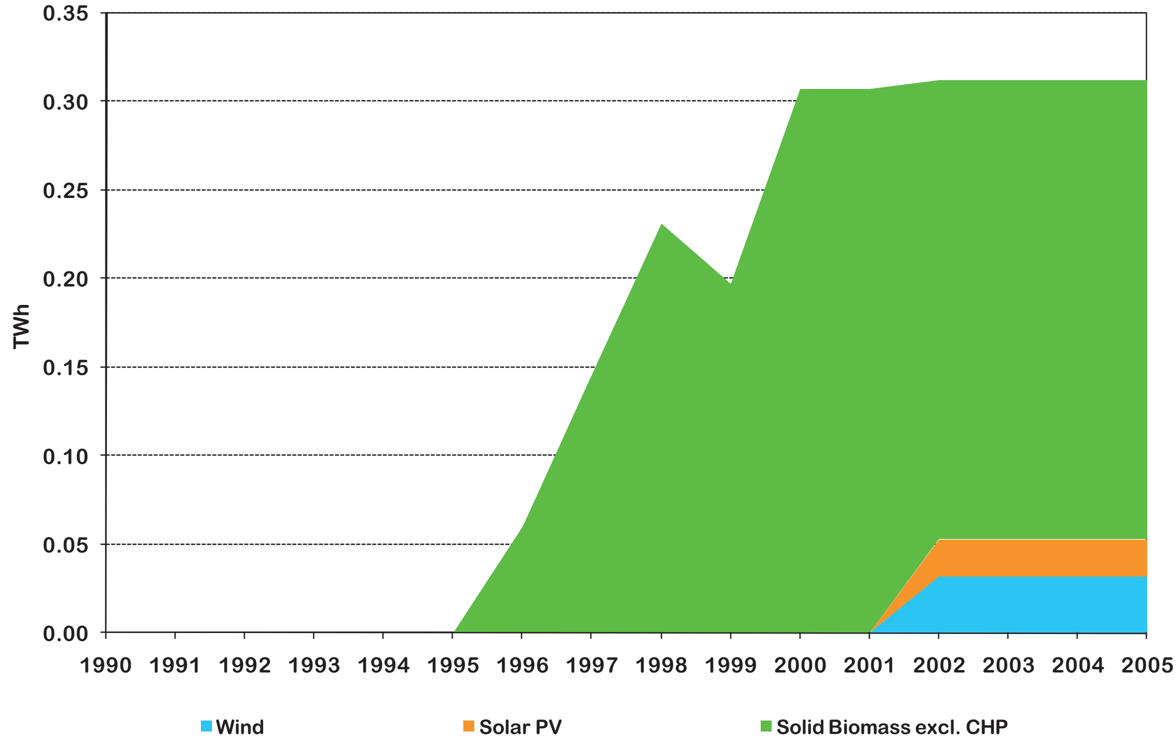
Figure 40. Total RES-E Production, 1990-2005



Source: IEA (2007)

Figure 41. Total RES-E Production (excluding Hydropower), 1990-2005

[1] No full profile was prepared of South Africa's renewable energy market and policy developments since 1990.



Source: IEA (2007)

Net Generating Capacity of RES-E Plants, 1990-2005

The IEA does not collect data on the generating capacity of renewable electricity plants in South Africa.

Renewable heat (RES-H) Market

Official IEA statistics do not report any renewable heat production and consumption in South Africa from 1990 to 2005.

Renewable Transport Fuel (RES-T) Market

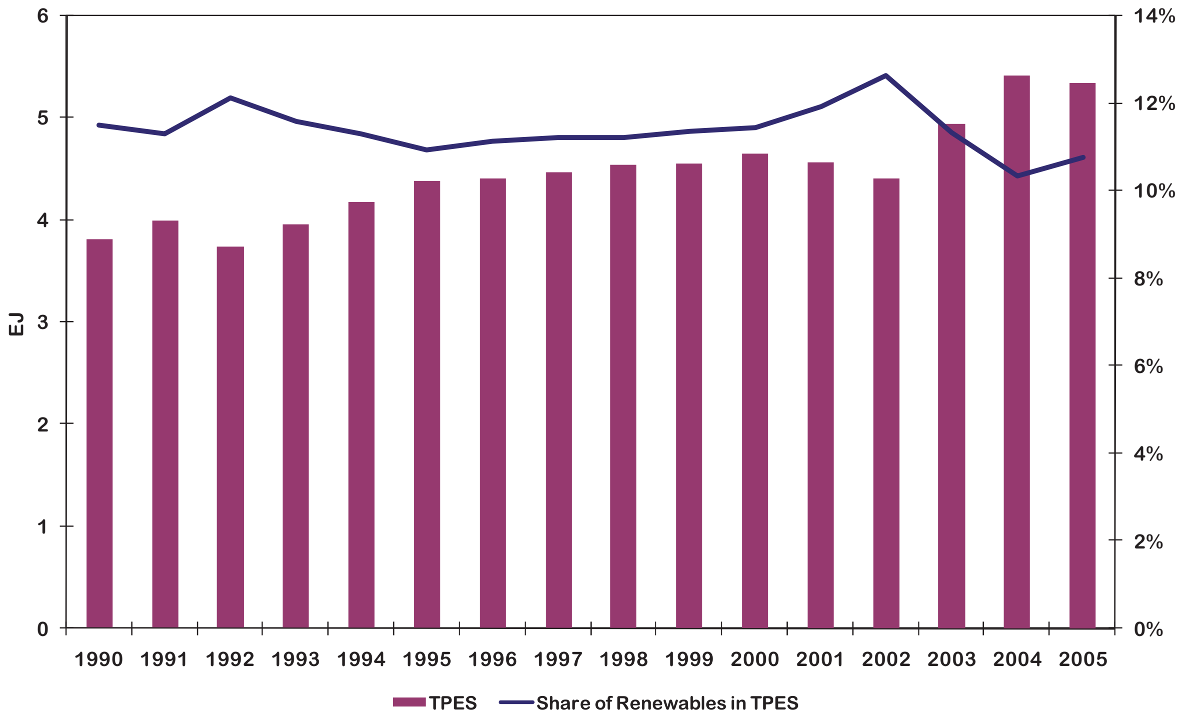
Official IEA statistics do not report any biofuel production and consumption in South Africa from 1990 to 2005.

Research, Development and Demonstration Trends

No data was available on South Africa's public R&D funding for energy technologies. The IEA does not collect such data for South Africa.

Renewables in Total Primary Energy Supply[2]

Figure 4. Share of Renewable Energy in Total Primary Energy Supply, 1990-2005



Source: IEA (2007)

Renewable Energy Policy Information

For details on renewable energy support policies implemented in South Africa, readers may consult the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

[2] The official IEA statistics on TPES include, where applicable, traditional biomass but exclude pumped hydro.
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IEA (2007), *Renewables Information 2007*, OECD/IEA, Paris.

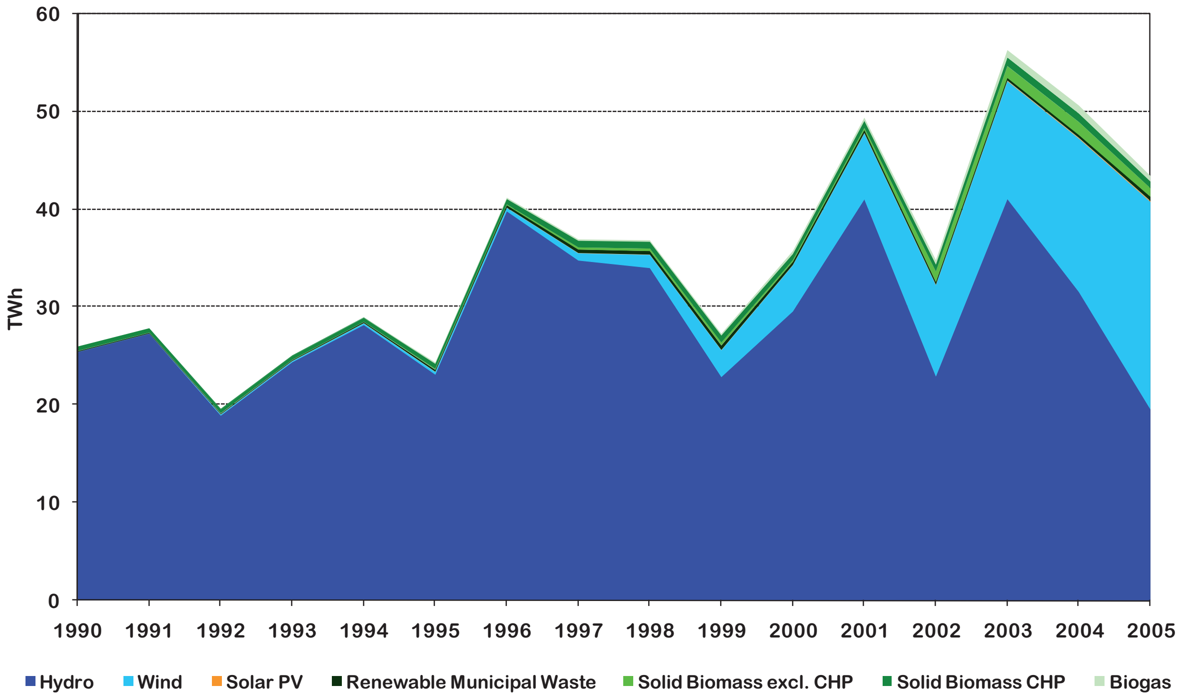
IEA (2008), "Global Renewable Energy Policies and Measures Database", www.iea.org/textbase/pm/grindex.aspx, International Energy Agency, accessed 15 March 2008.

SPAIN

RENEWABLE ELECTRICITY (RES-E) MARKET

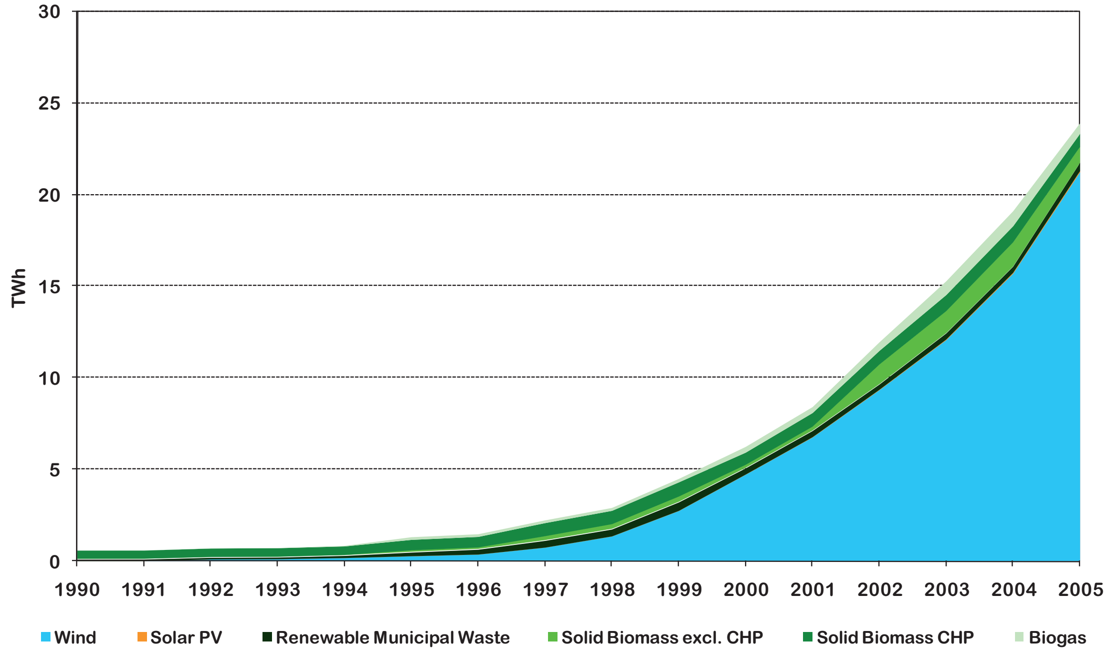
RES-E Market Developments

Figure 1. Total RES-E Production, 1990-2005



Source: IEA (2007a)

Figure 2. Total RES-E Production (excluding Hydropower), 1990-2005



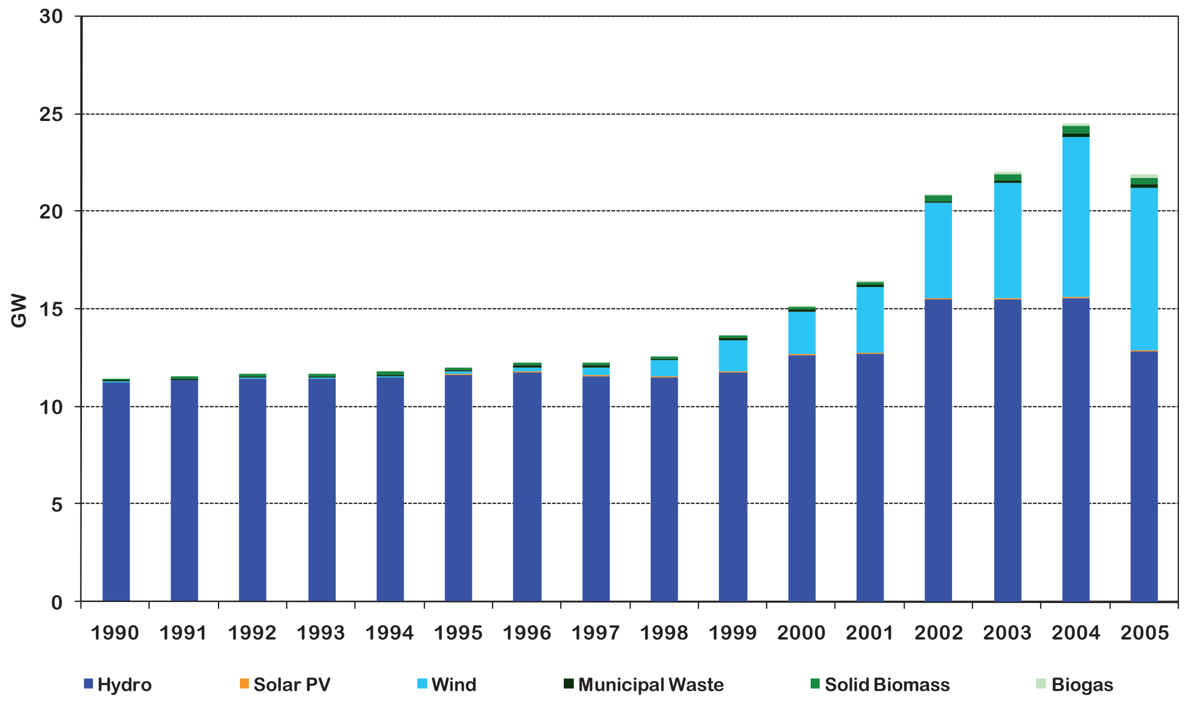
Source: IEA (2007a)

Spain's total renewable electricity supply was 43.5 TWh in 2005, representing 15% of total electricity production. Wind power production was for the first time higher than hydropower generation in 2005, accounting for 49% and 45% of RES-E, respectively. The remaining 6% stemmed from renewable combustibles. Solar PV production was 78 GWh in 2005 – a share of 0.2% of renewable electricity generation.

In 1990, renewable electricity production was 26.0 TWh and almost entirely based on hydropower, which accounted for 98%. The remaining 2% were supplied by solid biomass combustion. While hydropower capacity increased only marginally and production levels fluctuated heavily, wind power production increased by an average of 63% per annum (p.a.) since 1990 showing the strongest and continued growth among renewable energy technologies.

Other renewable electricity sources also grew considerably over the period from 1990 to 2005. Electricity production from biogas grew by 36% p.a. on average since 1992, non-CHP solid biomass increased on average by 30% p.a. since 1990, solar PV by 19% and renewable municipal waste by 12% over the same period. Despite the lower increase of total electricity generation, which was 5% on annual average, the share of most renewable energy sources remained at a relatively low level.

Figure 3. Net Generating Capacity of RES-E Plants, 1990-2005



NB: Official IEA statistics on electricity generating capacity do not differentiate between *renewable* and *non-renewable* municipal waste.

Source: IEA (2007a)

Development of Renewable Electricity Policies

Under the European Union (EU) directive 2001/77/EC[1], Spain has an indicative RES-E target of 29.4% of gross electricity consumption. However, as of 2005, Spain was lagging far behind its RES-E target (see previous section).

The first significant deployment policies for renewable energy sources (RES) in Spain were implemented in 1980, applying to small hydropower and other renewables. Policies were developed towards guaranteed network connection, purchase contracts with utilities and minimum guaranteed prices for renewable electricity, which culminated in a feed-in tariff system. However, early laws lacked a clear definition of renewable energy sources.

In 1997, the "General Electricity Law" (54/1997) was enforced further liberalising the electricity sector and guaranteeing electricity supply at lowest possible costs. It promoted renewable energy and the plan for achieving the indicative goal of 12% of primary energy consumption from renewable sources by 2010. It was implemented through royal decrees, most notably "Royal Decree 2818/1998", which specified feed-in tariffs (FITs) ranging from EUR 0.03/kWh for biowaste electricity to EUR0.39/kWh for solar PV (below 5 kW capacity).

[1] (European Commission, 2001)

Further amendments specifying eligibility of individual renewable energy technologies (RETs) followed in “Royal Decree 1663/2000”. In 2002, RES-E producers were required through “Royal Decree 841/2002” to disclose production forecasts and other information. Installations with a generating capacity greater than 50 MW using renewable energy sources were obliged to submit offers for the sale of electricity via the market operator. Generators covered by the system were guaranteed a price equal to that offered by the market plus EUR 0.009/kWh as a power guarantee, in addition to the premium due under the legislation.

Until 2004, all RES-E generation was supported in Spain under a so-called “Special Regime” with a fixed FIT which was adjusted on an annual basis. In 2004, the support system changed with the passing of “Royal Decree 436/2004”. Under the revised scheme RES-E generators – with the exception of solar PV which continued to benefit only from a FIT - could choose on an annual basis between the fixed FIT system and a feed-in premium (FIP) system based on electricity pool prices and technology-specific premiums.

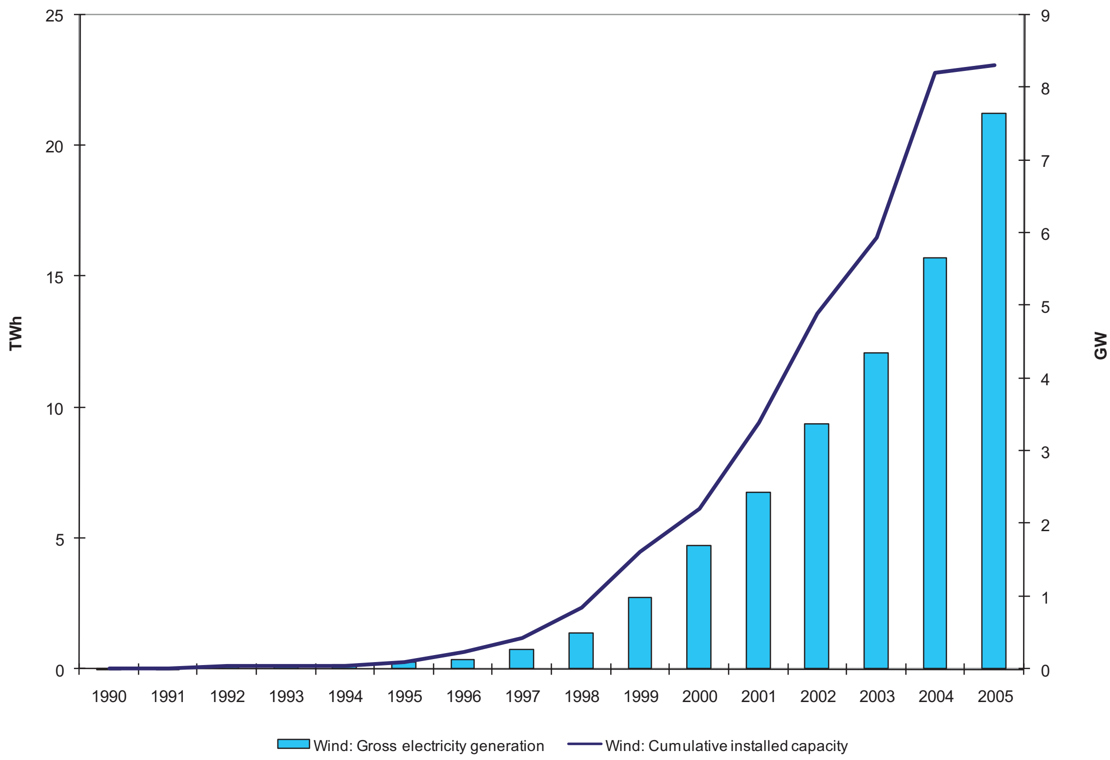
Due to increasing electricity prices in Spain, remuneration for wind operators in the FIP system was remarkably high in 2005 and 2006 - averaging EUR 91/MWh (Lascorz, 2007). Moreover, no element of degression had been incorporated in the FIT structure, thus providing little incentive for cost reductions.

In 2007, “Royal Decree 661/2007” introduced yet another approach, setting an upper and lower cap for the remuneration paid to wind energy producers to limit their benefits and risks. The upper limit was set at EUR 84.94/MWh. Floor and ceiling prices as well as premiums will be adjusted for inflation and reviewed in 2010. Other benefits in the form of deferrals of tax payments were granted (IEA, 2008). RES-E installations governed by the previous regulations (Royal Decree 436/2004) have until January 2009 to decide whether they will continue to follow the previous incentive regime or the new one (Royal Decree 661/2007).

Furthermore, low-interest loans that cover up to 80% of the reference costs are available for RET installations.

Focus: Wind Power Market and Policy Developments

Figure 4. Wind Power Market Development, 1990-2005



Source: IEA (2007a)

Spain has become one of the world leaders in electricity production from wind. Average annual growth in electricity production of 63% over 15 years resulted in 21 233 TWh of electricity produced from wind in 2005. Annual capacity additions were particularly high in 2004 amounting to 2 275 MW. In 2005, however, official IEA data suggested a substantial deceleration of new wind power capacity going online with capacity additions of less than 100 MW. Although market growth slowed down in 2005 and did not meet expectations, other suggest that capacity additions were actually been above 1 600 MW in 2005 (IEA Wind, 2006; Lascorz, 2007). Thus, Spain ranked third in terms of annual installations in 2005 behind the United States and Germany. More recent data from these sources indicated that growth in 2006 was similar to the previous year resulting in a total of 11 615 MW by 1 January 2007 and around 12 800 MW by mid 2007.

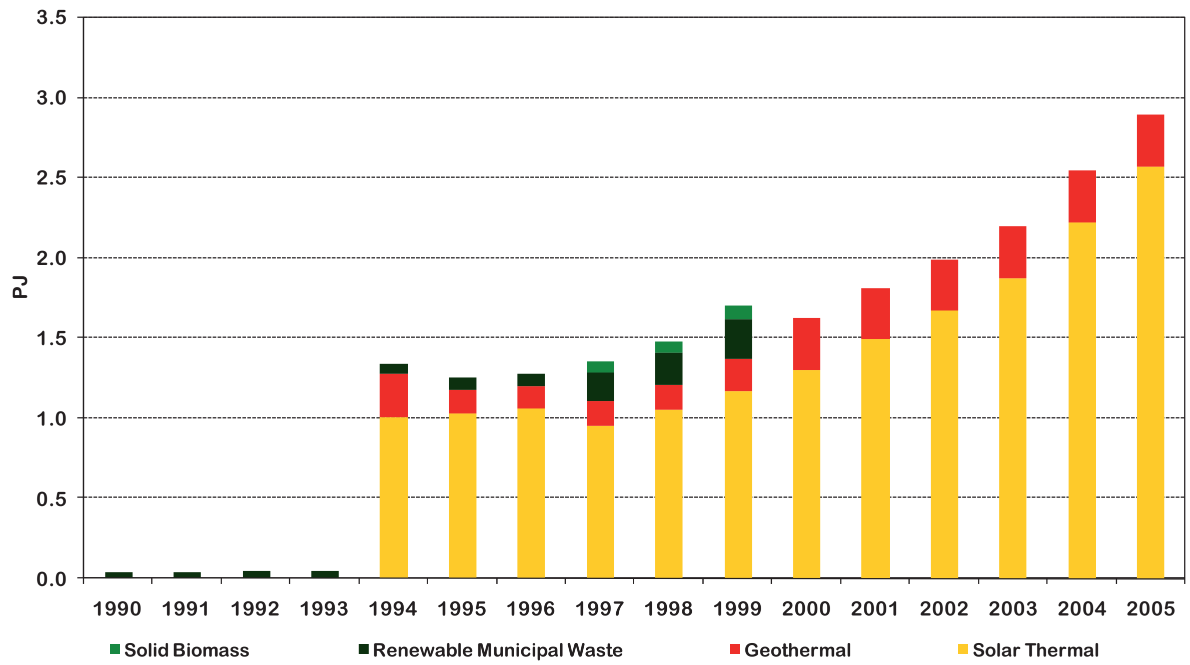
Despite high profits in the wind power sector (as outlined in the previous section on RES-E policies), mid-term targets for wind set out in the "Renewable Energy Plan 2005-2010" were not fully met. However, sector analysts are optimistic that the 2010 target for wind energy (20 155 MW by 2010) will be met – in contrast to other RET-specific targets. One frequently mentioned reason for not fully fulfilling the targets is delays in construction of necessary electricity infrastructure, such as transport lines and high voltage sub-stations. In 2007, a new grid code "P.O.12.3" took effect – and will become mandatory in 2008 - which facilitates the grid integration of wind energy by regulating technical considerations, such as reactive power and voltage drops.

The use of local content requirements likely contributed to the development of a strong, international competitive wind industry in Spain. Due to the fact that many companies in Spain are both wind turbine manufacturers and wind farm developers, Spain had not – by early 2007 – felt the full impact of the bottleneck of a lack of major components which began to curb, at least temporarily, wind power development at the global level. At the same time, exports of wind turbine equipment are increasing in Spain with more than 1 200 MW of turbine capacity exported in 2006 (Lascorz, 2007).

Policy support to promote offshore wind power development was first mentioned in the revised incentive scheme implemented in 2007, whereby offshore wind farms are only eligible for the feed-in premium option. Royal Decree 1028/2007 was implemented which establishes the administrative procedures for processing permit applications for electricity generation facilities in Spain's territorial waters. For offshore wind farms, this rule requires a minimum installed capacity of over 50 MW and establishes a system of competing bids. Several off-shore wind farm projects are at the initial design and basic engineering stage off the South and East coasts of Spain. They add up to a total of 2 000 MW.

RENEWABLE HEAT (RES-H) MARKET

Figure 5. Total RES-H Production, 1990-2005[2]



NB: Geothermal and solar thermal include direct final use.

Source: IEA (2007a)

Renewable heat supply in Spain was based on solar thermal (89%) and geothermal heat (11%) amounting to a total of 2.9 PJ. While solar thermal heat grew constantly since 1997 at an average annual rate of 13.2%, geothermal heat supply remained constant at 321 TJ since 2000.

According to IEA statistics, use of heat from non-traditional biomass and renewable municipal waste stopped in 2000, although both had contributed a total of 331 TJ in 1999. However, the European Renewable Energy Council (2004) reports that Spain's cogeneration facilities, almost all of which are run by auto-producers, have increased from 369 MWe in 1990 to 5.52 GWe in 2001. Incentives for these installations were provided through third party finance (6.7% of installation costs) and premium prices made available for CHP energy generation. Biomass heat (including traditional biomass) amounted to 172.6 PJ in 2005 (IEA and RETD, 2007).

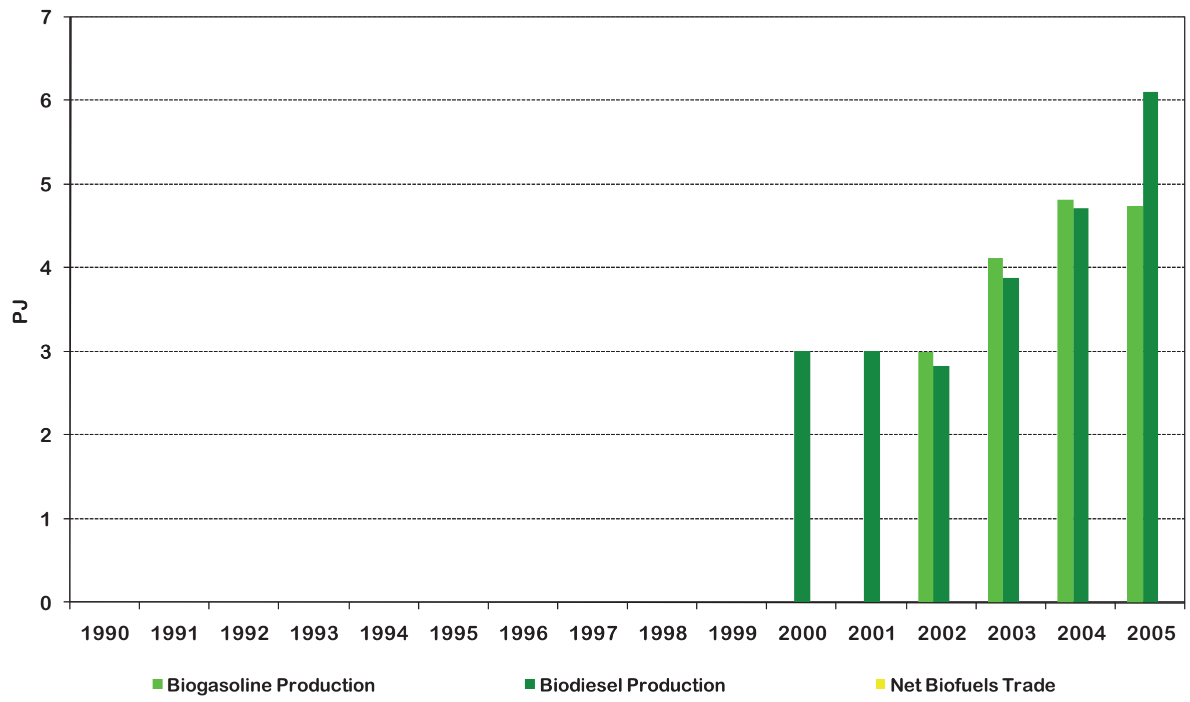
[2] Official IEA statistics on heat generation from renewable energy sources relate to **commercial heat sold** with additional data on **direct use** of solar thermal and geothermal available for most OECD countries.

Increasing the utilisation of RES-H has been targeted in the 1991 “Energy Saving and Efficiency Plan” and in the 1999 “Plan for the Promotion of Renewable Energy”. The latter offered various support programmes providing subsidies for solar thermal projects that were initiated in 2002 and completed before October 2003.

The “Renewable Energy Plan 2005-2010” increased the targets for 2010 to 4.9 million m^2 of solar thermal collector area – an increase of 4.2 million m^2 within 5 years – and an annual increase of 24.4 PJ in biomass heat until 2010. It included an Aid Programme for Solar Thermal (EUR 348 million), an Aid Programme for Biomass (EUR 283 million) as well as a Technical Building Code. The aid programmes are offering financial support of 30% up to 50% of installation costs. The new Technical Building Code includes an obligation to cover 30-70% of the domestic hot water demand from solar thermal energy and it applies to all new buildings and renovations. The assumed volume of hot water demand and the geographical location of the building determine the exact percentage that applies. This policy instrument is considered a milestone in the political support for renewable heating, which is expected to have considerable impact on the deployment of solar thermal heating devices in the coming years.

RENEWABLE TRANSPORT FUEL (RES-T) MARKET

Figure 6. Total RES-T Production, 1990-2005



NB: Net Biofuels Trade refers to the balance of domestic biofuel consumption, i.e. biofuel exports subtracted from imports.

Source: IEA (2007a)

Total biofuel production in Spain amounted to 10.8 PJ in 2005, 56% of which is biodiesel. From 2000 to 2005, biodiesel production doubled from 3 PJ to 6.1 PJ. Ethanol production rose from 3 PJ in 2002 to 4.8 PJ in 2004 and remained almost constant in 2005.

In 2002, Spain introduced tax relief for the promotion of biofuels, notably a zero hydrocarbon tax level for biofuels until 2012. Other transport-oriented policies focused instead on changing mobility patterns and means of transportation than on enforcing substitution of conventional fuels by biofuels.

In the Spanish government's 2005 report[3] to the European Commission on the implementation of EC Directive 2003/30/EC[4], the national target for the marketing of biofuels and other renewable fuels was set at 0.4-0.5% of energy content by 31 December 2005. Although this share was achieved (0.44%)[5], it has to be noted that it is considerably lower

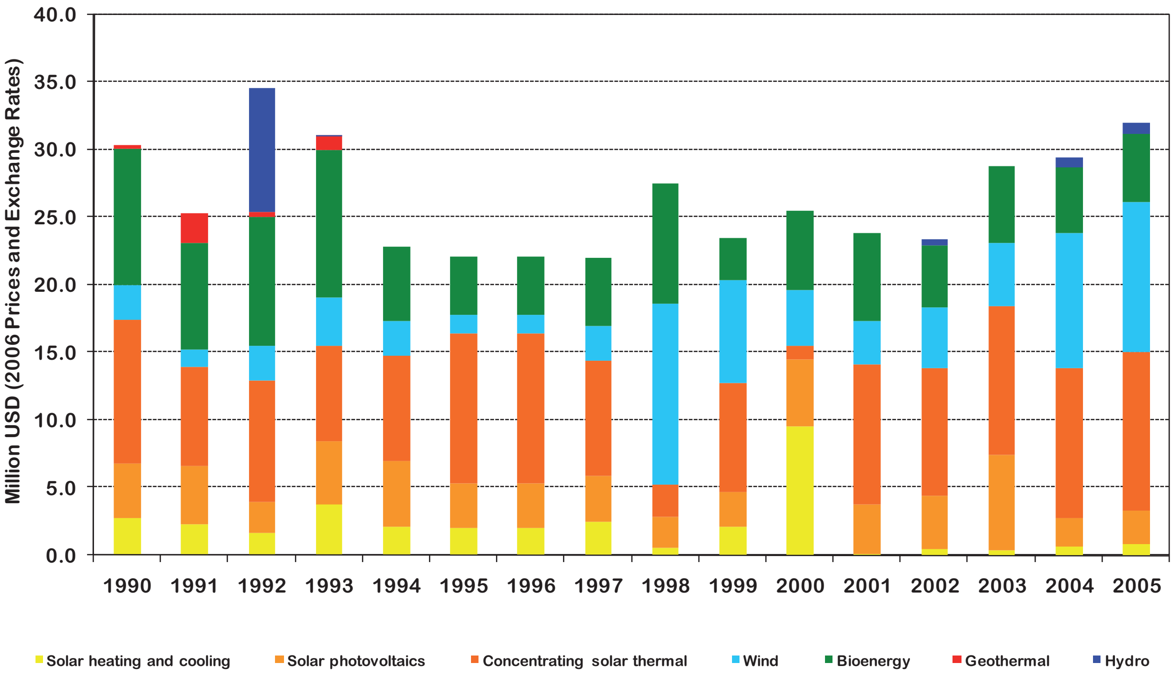
[3] (Spanish Directorate-General for Energy Policy and Mines, 2005)
[4] (European Commission, 2003)
[5] (European Commission, 2007)

than the 2005 target of 2% in terms of energy content proposed in the Directive. The 2010 indicative target was set at 5.75%.

Within the context of the 2005 National Plan for Renewable Energy, which set a 2010 target for biofuel share in transport of 5.83%, Spain established mandatory biofuels blending requirements in 2007. A compulsory intermediate target was set for 2009 of 3.4% of biofuel consumption in transport with an indicative target of 1.9% for 2008 (IEA, 2008).

RESEARCH, DEVELOPMENT AND DEMONSTRATION TRENDS

Figure 7. Annual Government RD&D Spending on Renewables, 1990-2005 (USD 2006 prices and exchange rates)[6]



Source: IEA (2007b)

In 2005, total government spending on RE RD&D in Spain was USD 32.0 million[7]. This was slightly higher than Spain's average annual spending of USD 28.3 million. For the early 1990s, RE RD&D budgets tended to be slightly higher than the overall average. In the mid 1990s until 2002, spending ranged around USD 23.6 million – with the exception of 1998 – and increased again in 2003 to pre-1994 levels.

Solar thermal power and high temperature appliances received the largest share of total expenditures between 1990 and 2005. 32% of the total periodical budget was spent on this

[6] Official IEA data on energy RD&D budgets include only **government** funding and not **private** RD&D spending.
[7] Conversion from national currency to USD is in USD (2006) prices and exchange rates.

technology. In the mid 1990s this share peaked at 50% of the total RE RD&D budget. In 2005 solar thermal technologies received more than USD 11 million representing 36% of the total annual budget. 24% of cumulative investments from 1990 to 2005 went into bioenergy RD&D. in 2005, however, only USD 5 million were spent on bioenergy – 16% of the annual expenditure on renewables. The second largest share was instead spent on wind energy amounting USD 11.2 million.

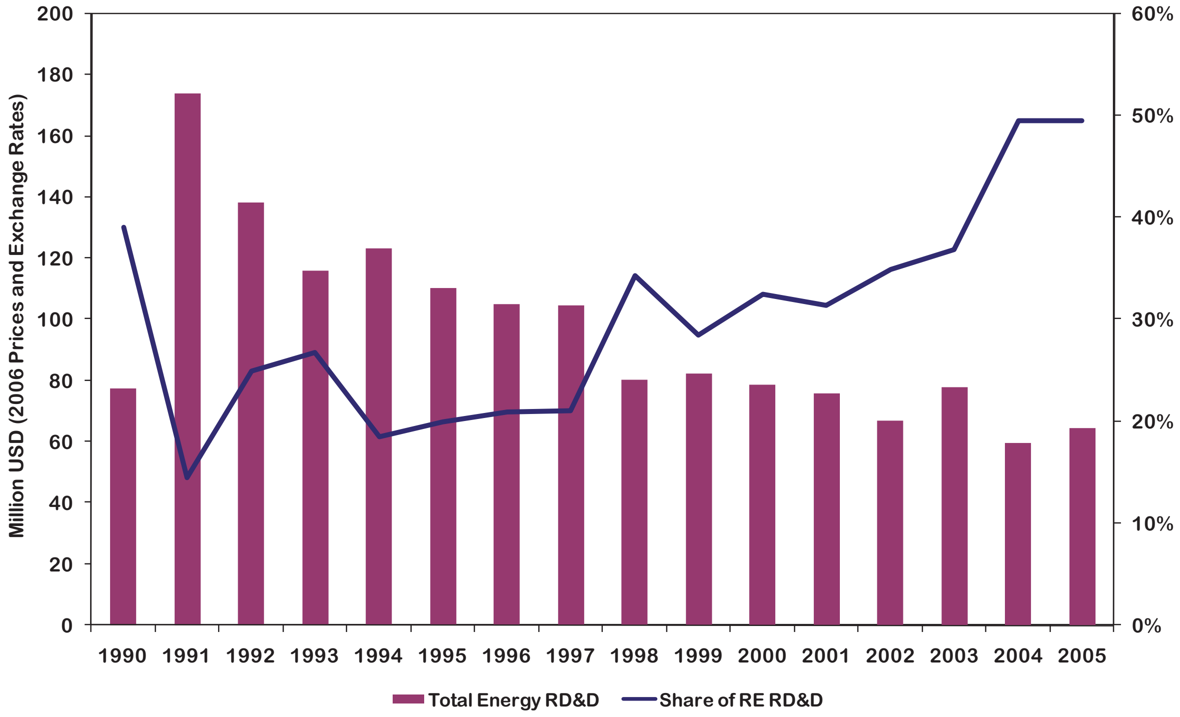
In 1998 funds for wind energy RD&D increased more than five-fold to USD 13.4 million, which was 49% of the total annual budget. Though spending decreased again thereafter, it remained at a higher level than previously.

Spending on solar PV accounted for 14% of the cumulative 1990 – 2005 budget, equal to an average annual spending of USD 4.0 million. Solar heating and cooling attracted 8% of the total and hydropower as well as geothermal power did only receive discontinuous RD&D support.

Spending on solar heating and cooling technologies peaked in 2000, similarly as wind, at almost 5 times its previous levels, notably USD 9.5 million, but fell to lower levels thereafter.

Despite a downwards trend of total energy RD&D spending, expenditures fell from USD 174.0 million in 1991 to USD 64.7 million in 2005, just slightly more than one third of 1991 levels. Therefore, the share of renewables as percentage of the total RD&D budget rose to 50% in 2005, comparing to 15% in 1991. However, as indicated by figure 7, the absolute amount of RE RD&D remained fairly constant.

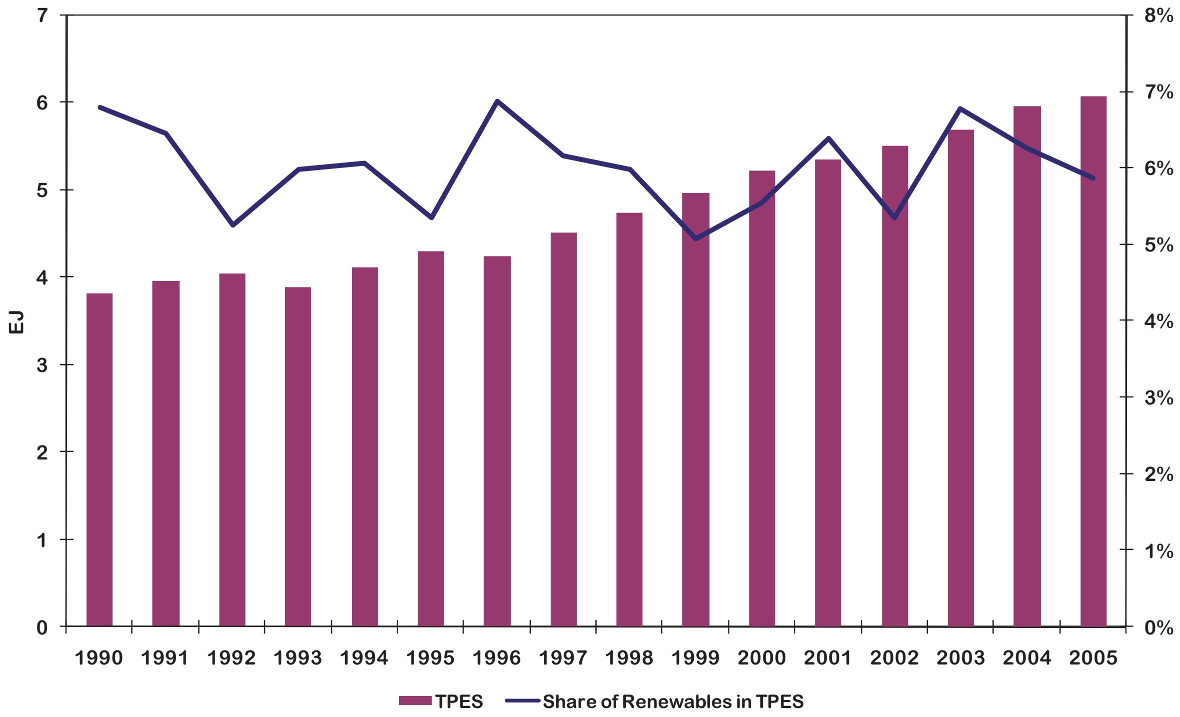
Figure 8. Renewable energy RD&D versus total government energy RD&D spending, 1990-2005



Source: IEA (2007b)

RENEWABLES IN TOTAL PRIMARY ENERGY SUPPLY[8]

Figure 9. Share of Renewable Energy in Total Primary Energy Supply, 1990-2005



Source: IEA (2007a)

Spanish TPES rose almost 60% since 1990 to 6.079 EJ in 2005. This represents an average annual increase of 3.2%. Renewable primary energy supply, in contrast, increased on annual average by only 2.2%, thus showing a slight downwards trend. Strong fluctuations can be attributed to changing hydropower production. In 2005, these developments culminated in a 5.9% share of renewables in TPES, compared to 6.8% in 1990.

[8] The official IEA statistics on TPES include, where applicable, traditional biomass but exclude pumped hydro.

Primary energy convention: The IEA uses the **physical energy content method** to calculate the primary energy equivalent of non-combustible energy sources, such as geothermal, hydro, solar and wind. As a consequence, there is an obvious link between the principles adopted in defining the primary energy forms of energy sources and the primary energy equivalent of these sources. For instance, in the case solar thermal and geothermal electricity production, as heat is the primary energy form selected by the IEA, the primary energy equivalent is the quantity of heat generated in the geothermal or solar thermal plant for electricity generation. In the case of hydro, wind, tide and solar PV, as electricity is the primary energy form selected, the primary energy equivalent is the physical energy content of the electricity generated in the plant, which amounts to assuming an efficiency of 100%. Readers may consult (IEA, 2007a) for more details.

Renewable Energy Policy Information

For further details on renewable energy support policies implemented in Spain, readers may consult the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

Glossary

Definitions, abbreviations, acronyms and units are explained in the Glossary which can be found after the country profiles.

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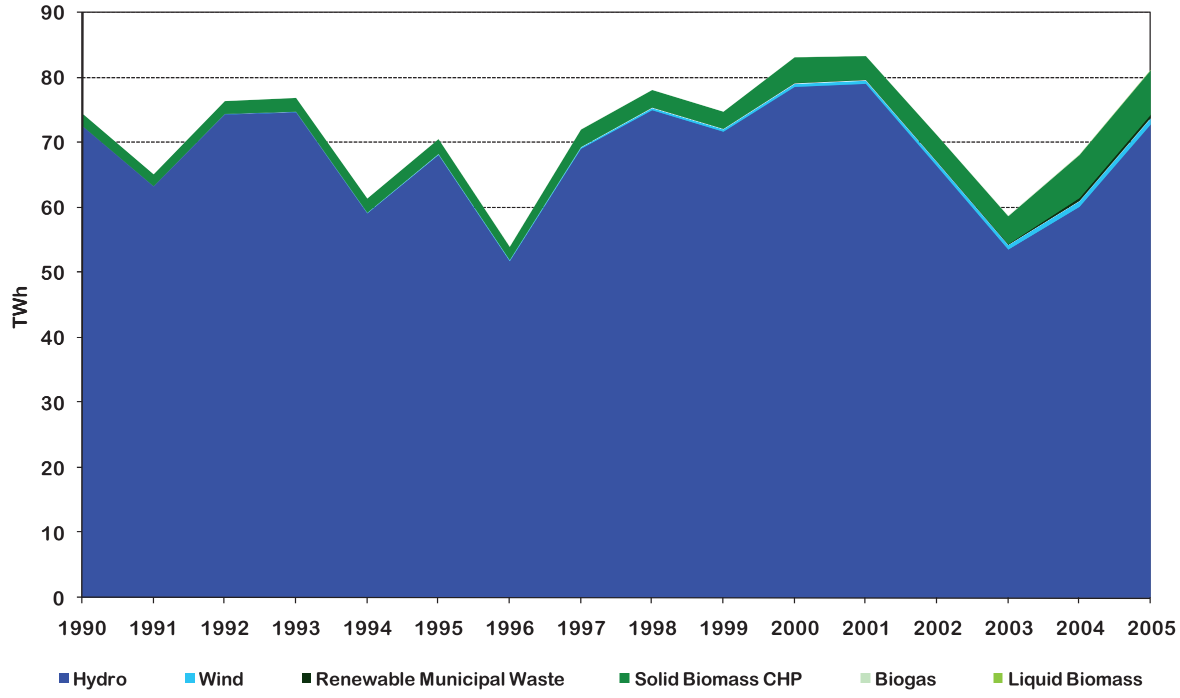
SWEDEN

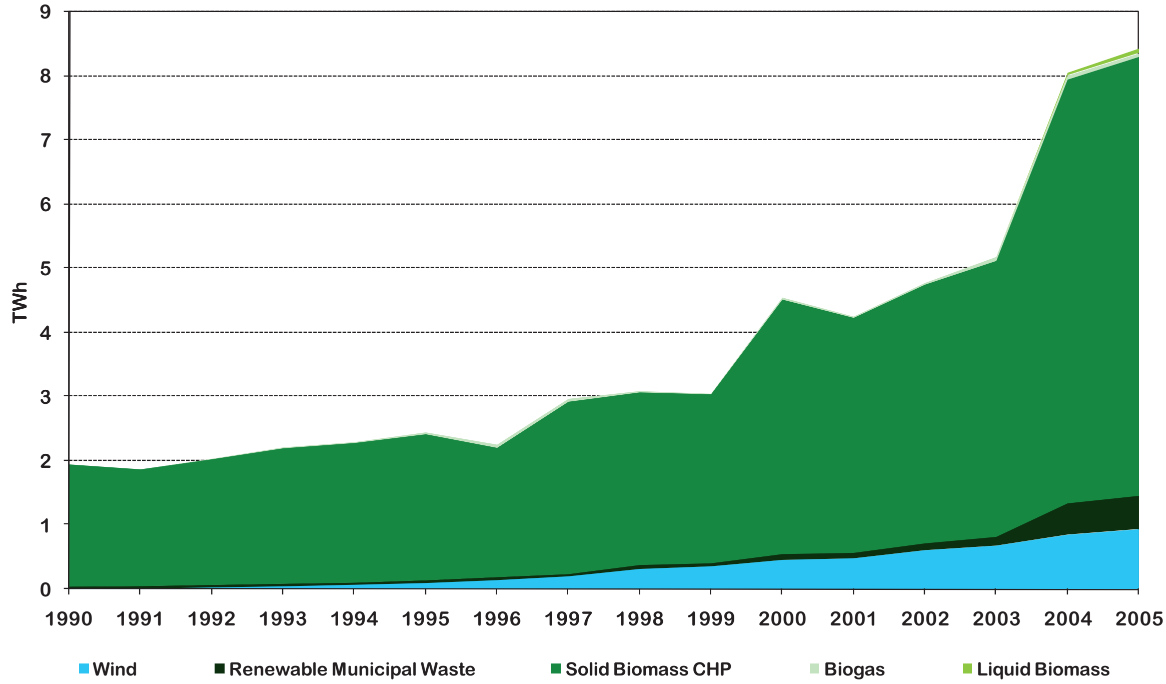
RENEWABLE ELECTRICITY (RES-E) MARKET

Figure 1. Total RES-E Production, 1990-2005



Source: IEA (2007a)

Figure 42. Total RES-E Production (excluding Hydropower), 1990-2005



Source: IEA (2007a)

48% of Swedish gross electricity generation from 1990 to 2005, which averaged 158.7 TWh on an annual basis, was provided by renewable energy sources, 95% of which from hydropower plants. Despite the fact that hydropower production was above average in 2005, its total share in the renewables mix was only 90%. Hydropower capacity remained almost stable over the 15-year period, ranging between 15.7 GW and 16.5 GW.

In 2005, total renewable electricity (RES-E) production was 81.2 TWh, of which hydropower accounted for almost 90%, solid biomass CHP plants for 8.4%, wind for 1.2%, renewable municipal waste incineration for 0.6% and biogas as well as liquid biomass for 0.1%, each.

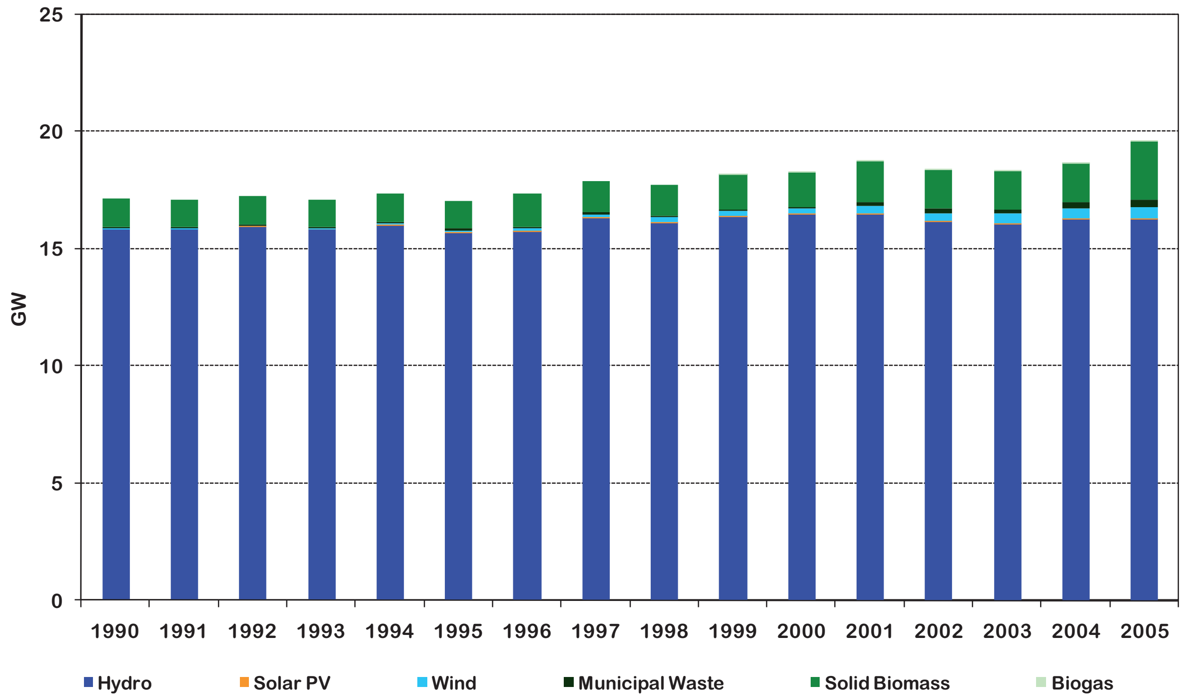
Renewable electricity generation grew by 0.58% on annual average over the 15-year period, slightly faster than total electricity generation (0.52%). In total RES-E in 2005 was 6.8 TWh above the 1990 level. This growth figure is, however, heavily influenced by the large share of hydropower. Non-hydro electricity production grew at a much faster pace, notably 10.3% on annual average. This led to 6.5 TWh of additional non-hydro RES-E in 2005 compared to 1990 – 96% of the total increase in RES-E.

However, the share of RES-E in power production has not increased significantly. In 2005, it was 51.3% – 0.5% above the 1990-level. In between this period, the share ranged from 42.9% in 1994 to 57.2% in 2000 very much depending on the level of precipitation.

Wind power generation was the strongest growing source of new renewable power production over the 15-year period – 40.0% on annual average, but starting from a level of only 6 GWh in 1990. Growth in annual electricity production slowed down to 15% on annual average from 2000 to 2005. However, the average increase in annual production for the period from 2001 to 2005 was 96 GWh – thus, more than double the figure for the prior 10-year period, in which production increased on average by 45 GWh annually. In total 14% of the increase in RES-E from non-hydro sources (2005 compared to 1990) stemmed from wind power production.

According to the Swedish Energy Agency (SEA), 53 MW of additional capacity have been installed during 2006. The IEA Wind Energy Implementing Agreement reported 62 MW of additional wind power capacity during 2006. Both of these figures are consistent with the average annual installations for the period 2001 to 2005 (57 MW), thus not showing any significant increase in annual capacity additions. However, the SEA expected the major share of RES-E additions in 2007 to come from wind power. A 110 MW Vattenfall project in Lillgrund started to produce electricity in late 2007 with an expected annual production of 330 GWh (though the actual 2007 production will be much lower due to the late-year start up). A couple of large-scale projects are planned to commence operation in the next few years. Among those is an additional offshore wind-farm in Vänern (90 MW) as well as two upland wind parks, Havsnäs (96 MW) and Uljabuoda (approximately 36 MW). Another offshore project (so-called Utgrunden II), which was supposed to be constructed during 2007, was eventually postponed by developer E.ON, since calculated revenues were considered to be too low.

Figure 3. Net Generating Capacity of RES-E Plants, 1990-2005



NB: Official IEA statistics on electricity generating capacity do not differentiate between *renewable* and *non-renewable* municipal waste.

Source: IEA (2007a)

The major increase in RES-E generation, however, stemmed from additional production of solid biomass CHP. 76% of the increase in non-hydro RES-E can be attributed to solid biomass CHP. Many formerly fossil-fuelled CHP-plants as well as district heating plants have been converted in to bio-fuelled CHP units, which can be achieved relatively quickly through an exchange of the boiler unit. A well-developed forest industry providing high quantities of biomass feedstock, good road systems to transport the high volume of biomass and wide use of district heating systems make this a very cost-efficient option to increase the share of RES-E. Besides, around half of the Swedish biomass resource is used by industry in pulp and saw mills providing electricity and heat for their own use.

7% of the non-hydro RES-E additions over the considered period can be attributed to increased use of municipal renewable waste. RES-E from this resource was 524 GWh in 2005 – 483 TWh more than in 1990. Average annual growth of this technology's electricity generation was 18.5% since 1990. However, almost all of the growth occurred in one year (2004), when production increased 3.5-fold compared to the previous year to a total of 493 GWh.

Other RES-E sources comprise biogas and liquid biomass. However, their overall contribution is marginal, despite the existence of future potential.

Development of Renewable Electricity Policies

Sweden applies a couple of different support measures to foster the development of renewable electricity generation technologies. Historically, the CO_2 tax introduced in 1990 has long been a key instrument, though only providing indirect support.

Under EU Directive 2001/77/EC, Sweden's indicative, non-binding target for the share of renewable electricity has been set at 60% of its total electricity consumption by 2010 (European Commission, 2001).

Since May 2003, a quota obligation system with tradable green certificates has become one of the main mechanisms to directly support renewable electricity generation. Generators that use eligible technologies[1] receive certificates for each MWh of electricity that they produce within a specified period. These certificates can be traded to achieve additional income from RES-E generation. Under the scheme, utilities are obliged to hold by the end of each obligation period an amount of certificates that equals the required percentage of their total electricity production. The obligation applies as well to auto-producers of electricity, while electricity-intensive industries are excluded (IEA, 2008a).

Initially, quotas were set only until 2010 aiming at 10 TWh of new renewable electricity generation compared to 2002. But in 2006, the scheme was extended until 2030 to provide long-term stability with the goal to achieve 17 TWh of RES-E by the end of 2016[2]. The

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[1] Eligible technologies include solar, wind, small hydro (up to 1.5 MW), bioenergy as well as peat in CHP plants, wave energy, and geothermal energy.

[2] The timeframe is extended until 2030 in order to provide a stable framework for investments in the later phase of the quota obligation system. For instance, a plant commencing operation in 2016 is entitled to receive certificates until 2030 (15 years). In order to have a positive price and thus additional income, there has to be certain quota for the years after 2016.

allocation period for certificates has been set to a maximum of 15 years. Plants commissioned before the initial introduction of the scheme on 1 May 2003 will be phased out of the system at the end of 2012 or 2014 depending on the type of plant and its date of construction. In addition, special restrictions apply to small-scale hydropower. A sub-sector target has been set for wind energy to generate 10 TWh of electricity annually by 2015.

The penalty for non-compliance, which in effect makes the scheme obligatory rather than voluntary, has been fixed at SEK[3] 175 in 2003 and SEK 240 in 2004. With effect from 2005, the penalty was set at 150% of the weighted average price of the previous year. Compliance with the scheme during 2005 and 2006 was 99.9% with average prices SEK 216 and SEK 191, respectively. Before the opening of the market price expectations based on the cost of renewable electricity generation were said to be around SEK 100.

Wind power production receives additional support, the so-called environmental bonus, in the form of an energy tax reduction. This tax reduction amounted to approximately 65 SEK/MWh for onshore generation and 150 SEK/MWh for offshore installations. The subsidy for onshore wind power will be gradually phased out until 2009. The bonus for offshore generation will be reduced to 120 SEK/MWh by that date. In order to tackle non-economic barriers for wind energy deployment, Sweden's municipalities are obliged to include suitable sites for wind energy generation in their spatial planning decisions. In December 2006, Sweden decided to raise the threshold for projects that can be permitted by municipal authorities from 1 to 25 MW. Financial support for the necessary planning can be obtained from the national government since 2007. In addition, ways to improve the incentives for better grid connection of small-scale wind power are elaborated by the Swedish government.

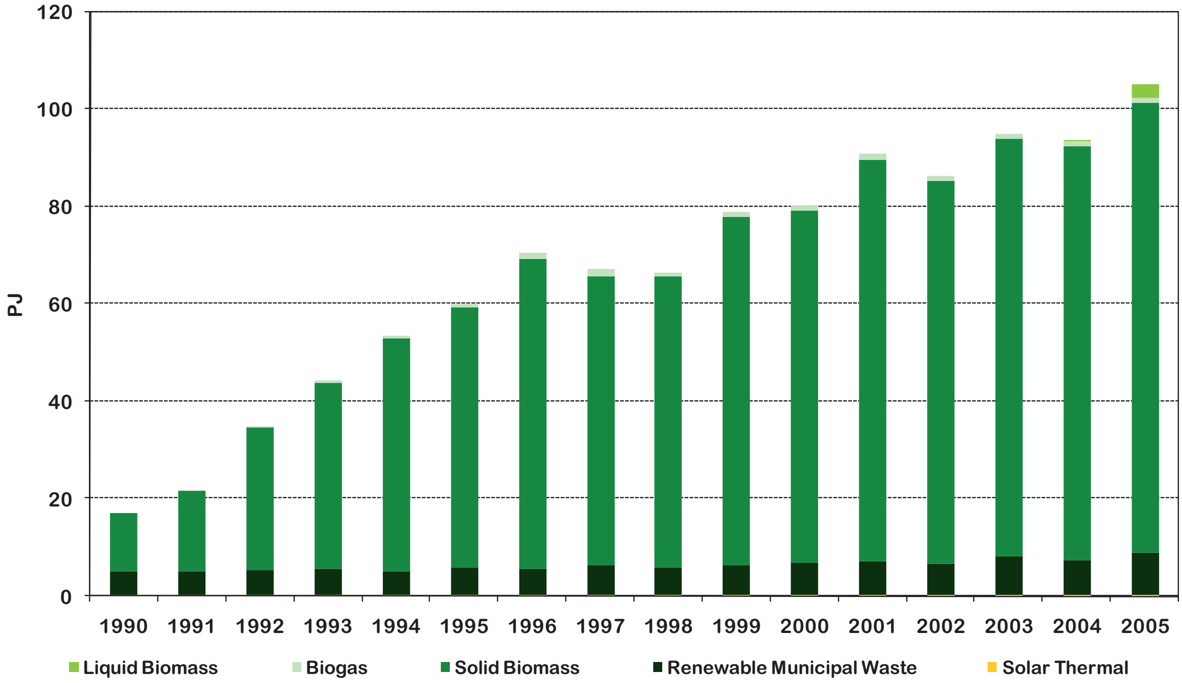
CHP plants have also received additional support irrespective of the fuel used for power and heat production[4]. Since 2004, a reduction of the CO_2 tax to 21% of the initial percentage has been applied.

Furthermore, around SEK 150 million are allocated in the form of investment grants to building integrated solar PV. This programme started in 2005 and continues until the end of 2008.

[3] SEK is short for "Swedish Krona". In 2006, 1 SEK equalled about USD 0.14 and EUR 0.11.
[4] However, biomass accounted for 30% of the total fuel used in CHP plants at present.

RENEWABLE HEAT (RES-H) MARKET

Figure 4. Total RES-H Production, 1990-2005[5]



NB: Geothermal and solar thermal include direct final use.

Source: IEA (2007a)

In 2005, Swedish total renewable heat supply was 105.1 PJ – roughly one third of total demand for space heating and domestic hot water, which is estimated at 306.0 PJ for 2006 (Renewables for Heating and Cooling, 2007). Since 1990 renewable heat supply has increased more than six-fold.

80.7 PJ (92%) of the total additions in RES-H over the period from 1990 to 2005 stemmed from increased solid biomass combustion. Despite a high share in RES-H in 1990 (70% of renewable fuels for heat supply), growth in solid biomass use for heating purposes was on average 15% annually until 2005 providing 88% of total RES-H in that year.

3.6 PJ (4%) of the additions over the whole period stemmed from increased use of renewable municipal waste. Biogas use increased two-fold from 1992 to 2005 to 866 TJ[6]. However, biogas use did not show continuous growth patterns peaking at 1.4 PJ in 1997 and decreasing again afterwards. Liquid biomass use for heating purposes jumped to 2.7 PJ in 2005 within two years capturing a share of roughly 3% in total RES-H. Solar thermal heat supply is no more than 0.2% of total RES-H, though showing some growth in recent years.

[5] Official IEA statistics on heat generation from renewable energy sources relate to **commercial heat sold** with additional data on **direct use** of solar thermal and geothermal available for most OECD countries.
[6] Separate collection of data on biogas started in 1992. Before 1992, it was included in solid biomass.

Sweden has the largest capacity of geothermal heat pumps (GHP) in Europe with approximately 30% of all Swedish single-family houses using GHPs. Besides these most common small-scale systems (around 12 kW) a limited number of larger-scale installations exist feeding into district heating networks. However, data on GHPs for non-commercial use is not collected in official IEA statistics[7]. Other sources state an installed capacity of 47 MW in 1994, which rose to 377 MW in 2000 and increased more than ten-fold over the following five-year period to 3 840 MW by the end of 2005, contributing approximately 36 PJ to total heat supply – a significant increase in total renewable heat supply of more than 30% compared to the figure stated above (IEA and RETD, 2007).

Development of Policies for Renewable Heat

Roughly half of Sweden's heat demand is supplied by district heating networks. In 2006, almost two thirds of the fuel used in district heating was renewable – a considerable change from the 100% oil-based heat supply in 1980, which has been to a large extent due to favourable CO_2 and energy taxation. Substantial energy taxes, a carbon dioxide (CO_2) tax and a sulphur tax have been imposed in Sweden since 1991. The use of biomass in district heating was exempt from these taxes, thus making biomass the least cost options for heat supply in many instances[8]. However, in sectors that were not subject to the full CO_2 tax, biomass use was not competitive to heat from coal and gas.

In addition to favourable taxation, investment subsidies of approximately 4000 SEK/kW were granted from 1991 to 1996 to CHP plants using at least 85% of biomass for a period of five years. Retrofitting of existing plants was also supported with 25% of investment costs up to a maximum of the equivalent for new investments. After funds for these subsidies were exhausted as soon as by 1994, an additional SEK 450 million were provided in 1998. Applications for more than three times the amount available for funding were filed within the first month of the programme.

More recently, a total of SEK 250 million of investment grants was made available for small-scale biomass-fired heating systems and energy efficient windows as of January 2004 for a period of three years. In addition, 30% of installation costs of biomass heating systems are tax deductible since that date.

A ban of the disposal of organic combustible waste in landfills passed in 2005 is expected to further increase the amount of renewable municipal waste used for heating purposes, particularly in district heating plants.

A technology-neutral scheme supporting conversions from oil-, gas- and electricity-based heating systems to district heating, biomass-fired heating systems, geothermal heat pumps and/or solar heating has been enacted in January 2006. The total budget for this programme amounts to SEK 2.0 billion to be allocated in the form of 30% rebate on installation costs. This programme will be active through 2010.

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[7] Furthermore, GHPs need some electricity input that need not necessarily be renewable. Thus, only net energy gains from GHPs can be considered renewable. See (IEA, 2007a) for further details on data coverage in official IEA statistics.

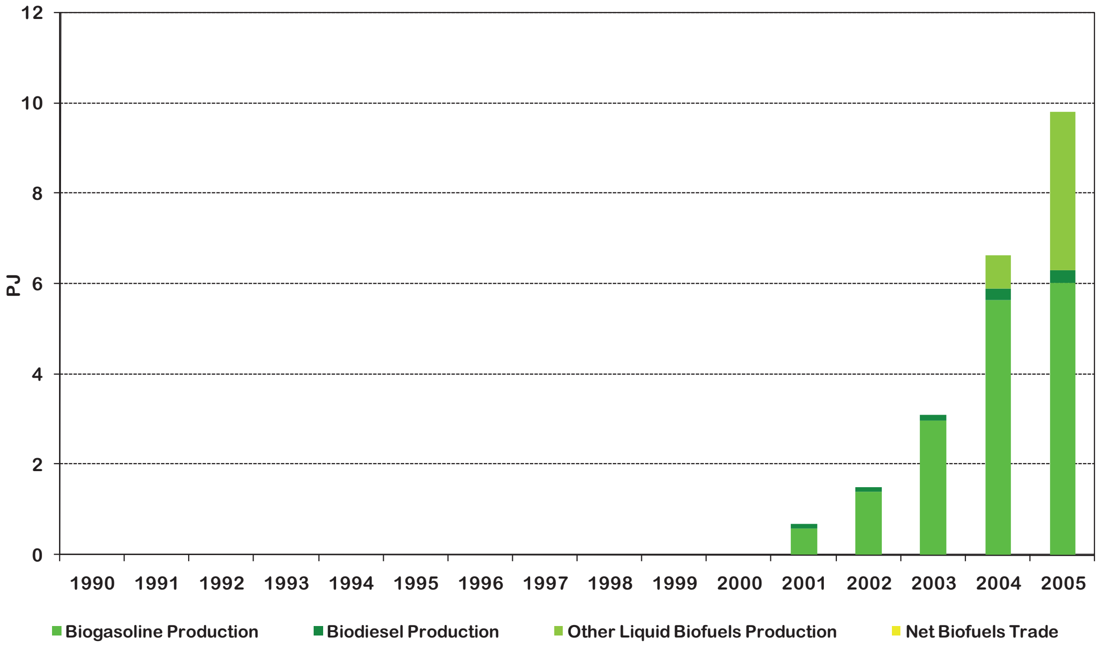
[8] In 2007, the CO_2 tax was SEK 930/t CO_2 (or EUR 101//t CO_2), having been continuously raised since their introduction in 1991 at an initial level of SEK 250/t CO_2 (IEA, 2008b).

Solar heating equipment in buildings is eligible for subsidies of SEK 2.5/kWh. Subsidies are capped to a maximum of SEK 7 500 for single-family houses and SEK 5 000 for other residential properties[9]. Commercial buildings, which entered the scheme in July 2006, are entitled to a maximum of 30% of total investment costs repaid in form of a tax refund. This scheme is in force until 2010 with a total budget of SEK 150 million (IEA, 2008b).

The significant growth in the use of geothermal heat pumps is supposed to derive from a governmental procurement scheme initiated in 1994. A grant for the successful, most efficient technologies with guaranteed sales of 2000 units was offered in a tender procedure with information campaigns implemented as follow-up. This led to the dissemination of a technological break-through in geothermal heat pump development decreasing costs significantly and paving the way for mass-market deployment in Sweden (Olerup, 2001).

Renewable Transport Fuel (RES-T) Market

Figure 5. Total RES-T Production, 1990-2005



NB: Net Biofuels Trade refers to the balance of domestic biofuel consumption, i.e. biofuel exports subtracted from imports.

Source: IEA (2007a)

Biofuels data for the Swedish transport sector is available since 2001. By the end of 2005, biofuels production and consumption reached 9.8 PJ, 62% of which were biogasoline, 36%

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[9] These include individual apartments in multi-family dwellings and housing related facilities. The maximum grant per property is limited to SEK 250,000.

other liquid biofuels and 3% biodiesel. This represents a 14.5-fold increase in production and consumption compared to 2001 or an average annual growth of 95%.

No trade in biofuels is reported in official IEA statistics, while other data sources indicate a very different picture. The Global Agriculture Information Network [10]reports domestic ethanol production in 2005 of only 1.4 PJ (52 000 t) with net ethanol imports of around 6.8 PJ (254 000 t), which represent the lion's share of Sweden's total ethanol consumption. Indeed, these latter data are supported by the IEA Energy Policy Review 2008[11] reporting that Sweden currently has two bioethanol plants with cumulative production estimated at approximately 1.5 PJ (73 million litres[12]) and by a comprehensive report of the Global Bioenergy Partnership[13] stating similar import figures.

These data inconsistencies may be due to the specific trade regime for biofuels. In fact, Swedish ethanol imports have been classified as "other chemicals" under the European Union (EU) import tariff regime in order to take advantage of significantly reduced import tariffs compared to the official tariff line for ethanol. This classification could be obtained by mixing the ethanol with a certain percentage of gasoline before it was imported. Custom duties imposed on ethanol imports were about EUR 0.192[14]/litre, while tariffs on "other chemicals" were only about 0.0025 EUR/litre (6.5% of import price). Ethanol imported under the preferential tariff line nevertheless benefited from full tax relief for biofuels[15] (GAIN, 2006).

A large share of biofuel imports was sourced in Brazil. Brazilian ethanol from sugarcane is not only cheaper than domestic production, which is mainly based on grain, but also considered to be more environmentally friendly and thus benefiting both the consumer and the climate. However, such a judgement should be based on complete and thorough life-cycle assessment including, for instance, emissions arising from transport of fuels over long distances. Nevertheless, the Swedish government favours the import of ethanol and announced in September 2007 that it is working on the termination of high European import tariffs. For the time being, Sweden achieved consent from the EU Customs Code Committee in February 2008 that it was allowed to continue applying lower tariffs to ethanol dedicated to flex-fuel vehicles as high ethanol blend (E85/E95)[16].

In fact, about 89 000 so-called ethanol cars are being driven in Sweden using such high ethanol-content blends. Flex-fuel vehicles as well as other "clean" cars[17] are being promoted by Swedish government policies. In 2005, sales of these vehicles have risen to 22 618 compared to 5,386 in 2004. Sweden is also the world leader in terms of automotive biogas production with about 4 500 vehicles running on gaseous fuel, 45% of which is biogas. "Clean" cars benefit from lower vehicle taxes and soft measures, such as free parking and

[10] (GAIN, 2006)
[11] (IEA, 2008b)
[12] For the applied biofuel conversion factors, refer to the Glossary which can be found after the country profiles.
[13] (GBEP, 2007)
[14] The conversion to EUR was done at an approximate exchange rate of: 1 SEK = 0.11 EUR
[15] Taxes represent about 30% of the total price for gasoline and 40% of the price for biodiesel.
[16] "E85" and "E95" are ethanol-gasoline blends with 85% and 95% ethanol content, respectively.
[17] The definition of clean cars, as announced by the Swedish Road Administration, includes not only fuel-efficient biofuel-based cars, but also certain other diesel and gasoline vehicles with low consumption and low emissions of nitrogen and particulate matter.

exemption from the congestion charge in Stockholm. In addition, companies can receive investment subsidies of 30% if they buy "clean" vehicles for their fleet.

Like all EU member states, Sweden has a non-binding target of 5.75% biofuel share in total transport fuel consumption by 2010. This has been directly translated into a national biofuels target with an interim target for 2005 being set to 3% compared to the 2% proposed by the European Commission. This interim target, however, has not been reached with biofuels only accounting for 2.23% of total transport fuels in 2005. Since 2005, a minimum quota of 3% biofuel content applies to all transport fuels.

From August 2006, diesel may be blended with a maximum of 5% biodiesel, instead of 2%, which is expected to increase the previously low biodiesel penetration. Taking into account announcements for new biodiesel plants, domestic production capacity was expected to rise from 151.2 TJ (4 000 t) in 2005 to 11.3 PJ (300 000 t) in 2007. In 2005, imports of biodiesel were roughly at the same level as domestic production, but are expected to increase as well.

In order to ensure the availability of biofuels at filling stations, Sweden imposed a regulation in December 2005 which requires larger gas stations to sell at least one type of biofuel. This requirement was supported by public funds of SEK 50 million in 2006 and SEK 100 million in 2007. Small filling stations will be subject to the same requirement as of 2009.

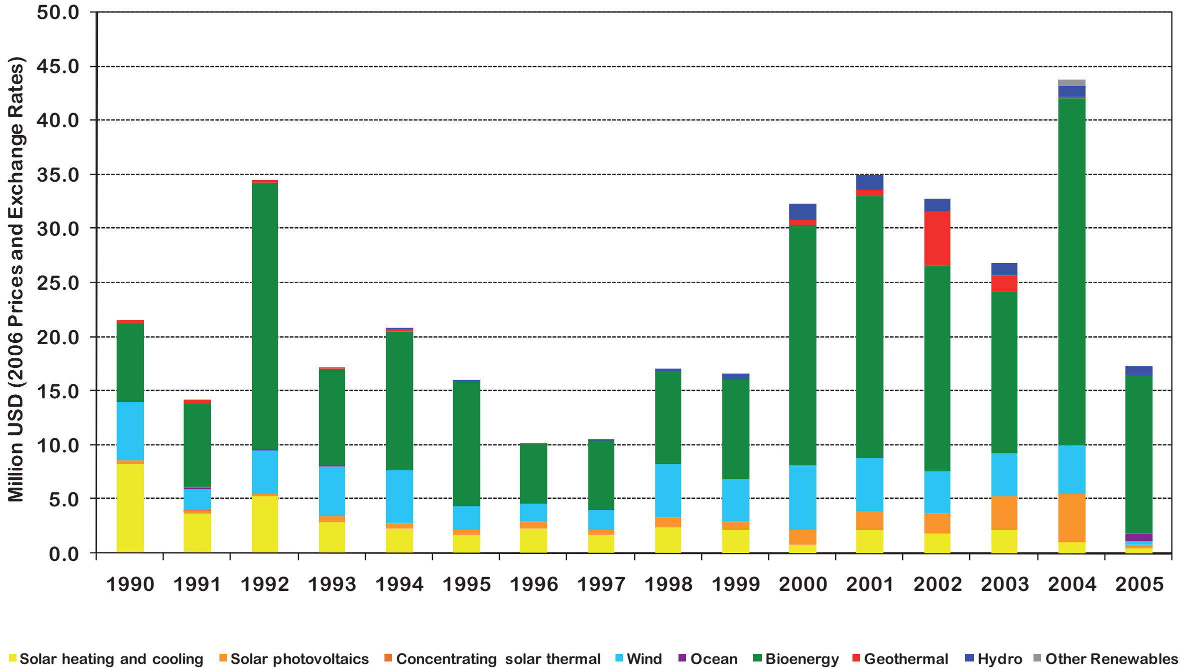
In effect, 2 400 of 3 700 stations will be required to supply at least one renewable fuel by that date. Biogas methane was available at some 30 filling stations.

In addition, EU subsidies for the cultivation of energy crops are available for Swedish farmers if certain criteria are fulfilled.

RESEARCH, DEVELOPMENT AND DEMONSTRATION TRENDS

Figure 6. Annual Government RD&D Spending on Renewables, 1990-2005 (USD 2006 prices and exchange rates)[18]

[18] Official IEA data on energy RD&D budgets include only **government** funding and not **private** RD&D spending.



Source: IEA (2007b)

The large potential for biomass is reflected in Sweden's strong RD&D focus on bioenergy. Over the period from 1990 to 2005, 63% (USD 230 million[19]) of the total RE RD&D budget (USD 367 million) was been spent on bioenergy.

The second largest fraction of the total cumulative budget was invested in wind energy RD&D, notably USD 59 million. This represents 16% of the total.

Solar heating and cooling technologies received 11% of the total cumulative budget (USD 41 million). However, the share of the total RE RD&D budget was among the highest in the early 1990s, but received increasingly less funding in later years ending up with 3% of the total in 2005.

Solar PV RD&D has received funding throughout the period 1990-2005, despite its marginal overall share of 5% of the cumulative spending. Funding increased considerably in total and relative terms since 2000, reaching a high of 12% (USD 3.1 million) in 2003 and USD 4.5 million in 2004 (10%). However, its share and total funding decreased considerably in 2005 similarly to all other technologies except bioenergy.

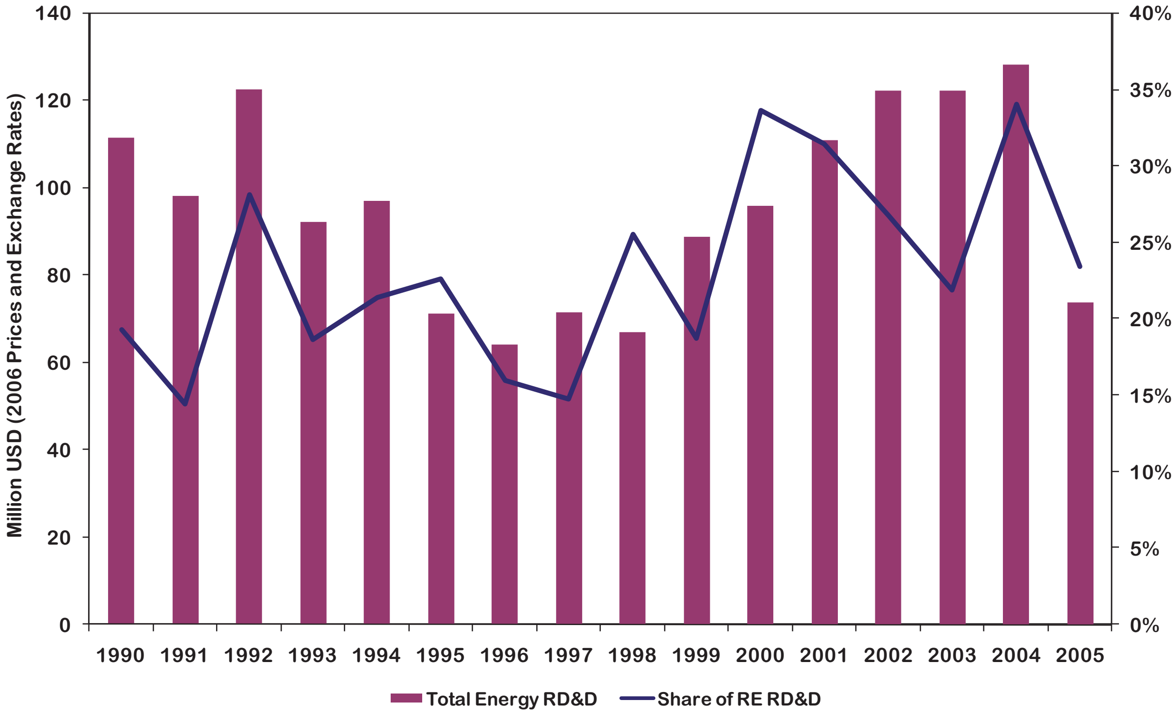
Hydropower as well as geothermal energy technologies saw little RD&D support, despite periodical peaks in the early 2000s.

The overall RE RD&D budget varied quite strongly over the whole period. Despite a peak in 1992, it was at the level of RE RD&D spending was half of that in the early 2000s. On average, annual RE RD&D budgets were USD 18 million for the period from 1990 to 1999 and USD 34 million for the years from 2000 to 2004. In 2005, the budget was cut back to USD 17 million.

[19] Conversion from national currency to USD is in USD (2006) prices and exchange rates.

The share of RE RD&D in total energy RD&D varied from 14% to 34% over the considered period, though not showing an explicit up- or downwards trend. In 2005, the share was 23% of total energy RD&D.

Figure 7. Renewable energy RD&D versus total government energy RD&D spending, 1990-2005



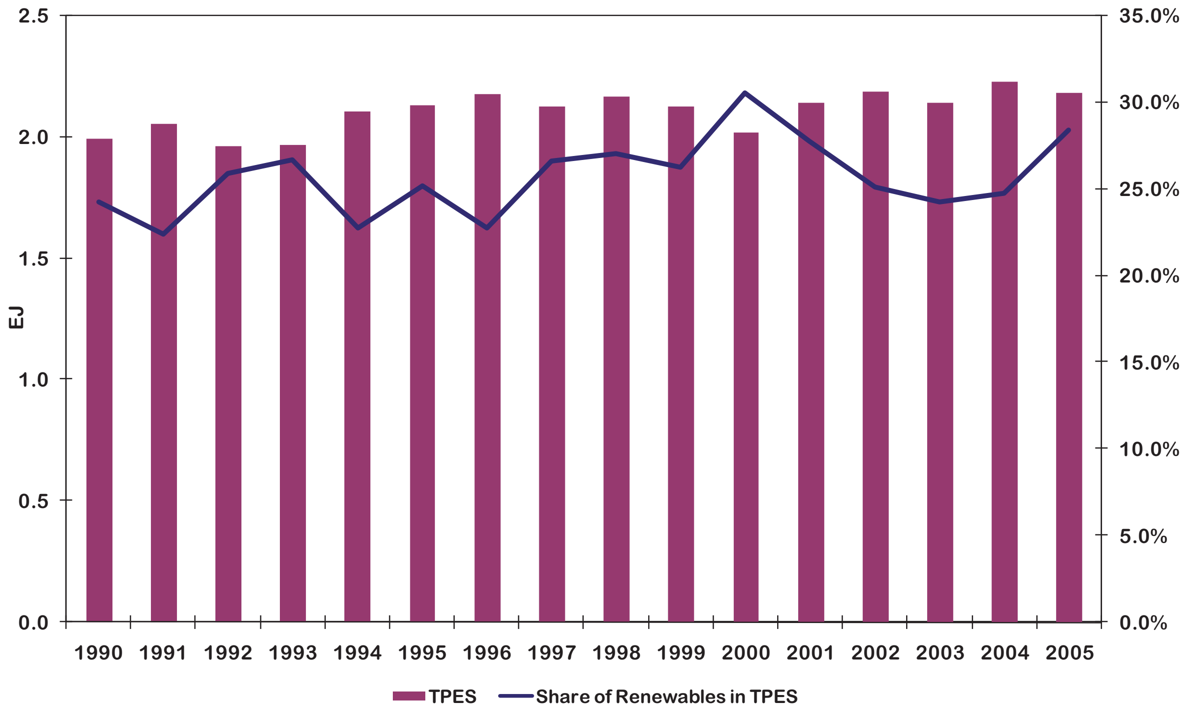
Source: IEA (2007b)

Bioenergy research is supported in six major areas as identified by the Swedish Energy Agency including energy crop production, sustainable management of production systems, related biotechnology, genomic markers for water and fungal resistance and characteristics of the biomass, supply chains, forest soil carbon and soil organisms, stump harvesting, and advanced conversion technologies including CHP, pellet production and ethanol plants.

Biofuel research projects are the major recipient of RE RD&D investments. From 1993 to 1997, the ethanol R&D programme received funds amounting to USD 6.2 million. From 1998 to 2004, the “Ethanol from Wood R&D” programme was financed by more than USD 27 million. One of the results of these research efforts is the pilot ethanol plant in Örnsköldsvik, which has been operating since May 2004 and looks at more efficient biofuel production processes for lingo-cellulosic feedstock. Two other pilot plants focus on solid biomass gasification for biofuel production and on black liquor gasification.

RENEWABLES IN TOTAL PRIMARY ENERGY SUPPLY[20]

Figure 8. Share of Renewable Energy in Total Primary Energy Supply, 1990-2005



Source: IEA (2007a)

From 1990 to 2005, Sweden's total primary energy supply (TPES) was relatively stable, increasing at an annual average of only 0.62% over the period. Thus, primary energy supply grew at a lower speed than the Swedish GDP. In 2005, Swedish TPES was 2.18 EJ - 9.7% above the 1990 level. Renewable energy supply (including traditional biomass, but excluding pumped storage), however, increased at almost double that rate, reaching 17.3% above the 1990 level in 2005. The share of renewables in TPES fluctuates with precipitation levels due to the large share of hydropower in electricity generation. In 2005, the share of renewables was 28.4% of TPES – the third-highest share among IEA countries.

[20] The official IEA statistics on TPES include, where applicable, traditional biomass but exclude pumped hydro.

Primary energy convention: The IEA uses the **physical energy content method** to calculate the primary energy equivalent of non-combustible energy sources, such as geothermal, hydro, solar and wind. As a consequence, there is an obvious link between the principles adopted in defining the primary energy forms of energy sources and the primary energy equivalent of these sources. For instance, in the case solar thermal and geothermal electricity production, as heat is the primary energy form selected by the IEA, the primary energy equivalent is the quantity of heat generated in the geothermal or solar thermal plant for electricity generation. In the case of hydro, wind, tide and solar PV, as electricity is the primary energy form selected, the primary energy equivalent is the physical energy content of the electricity generated in the plant, which amounts to assuming an efficiency of 100%. Readers may consult (IEA, 2007a) for more details.

Renewable Energy Policy Information

For further details on renewable energy support policies implemented in Sweden, readers may consult the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

Glossary

Definitions, abbreviations, acronyms and units are explained in the Glossary which can be found after the country profiles.

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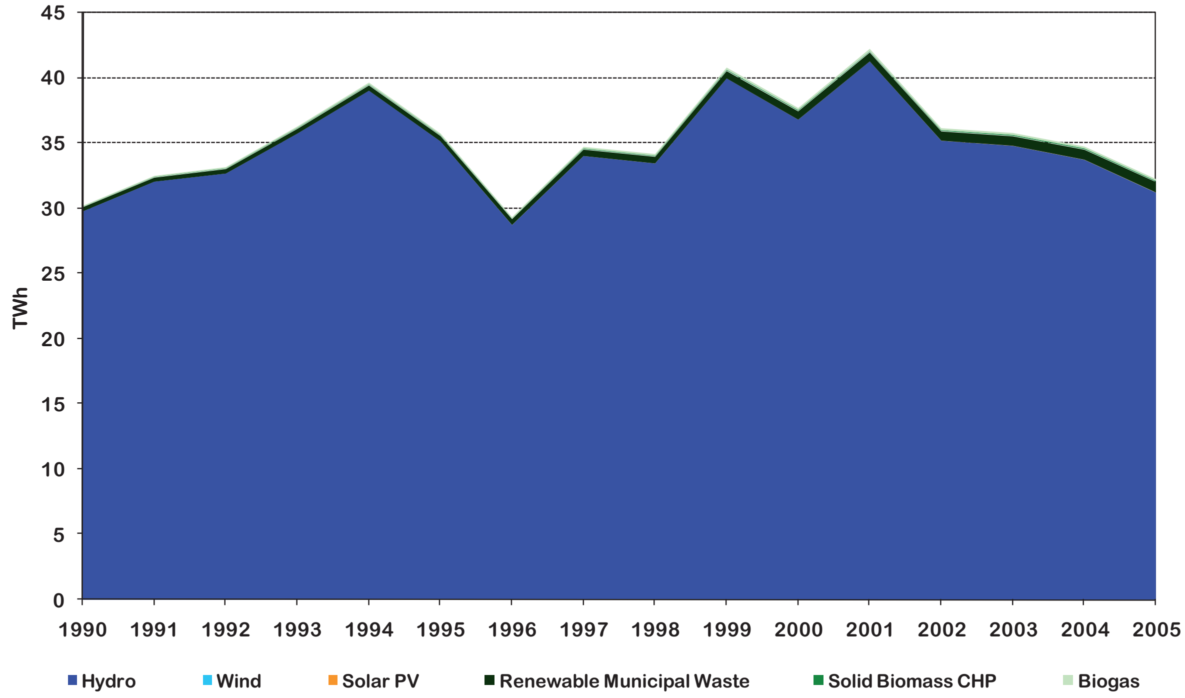
SWITZERLAND[1]

RENEWABLE ELECTRICITY (RES-E) MARKET

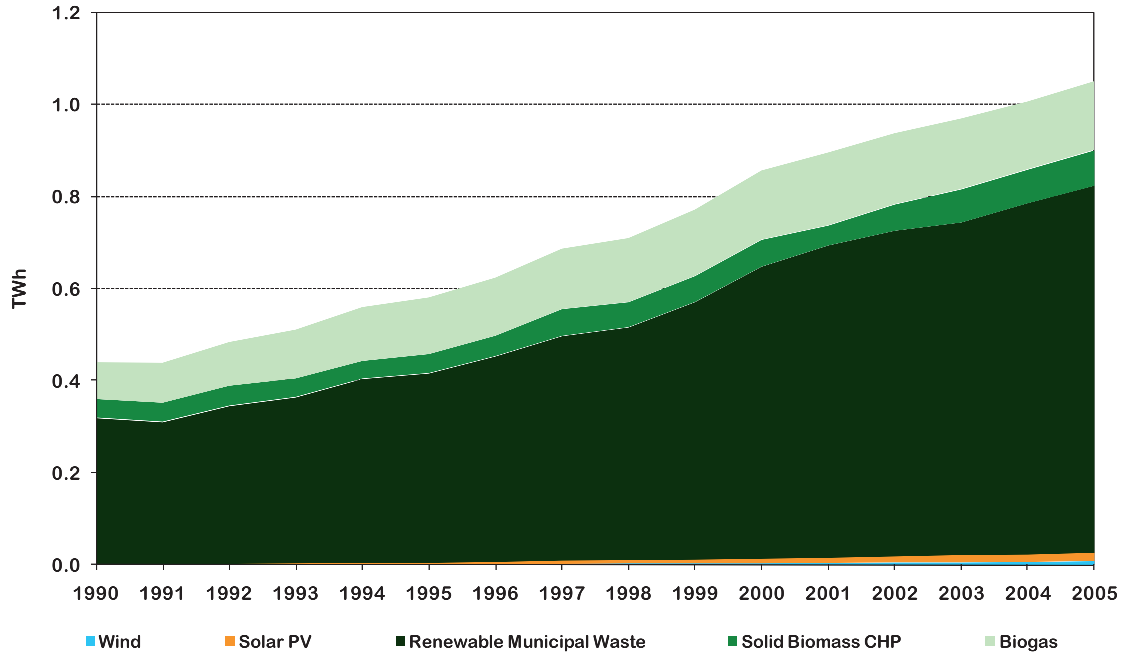
Figure 1. Total RES-E Production, 1990-2005



Source: IEA (2007a)

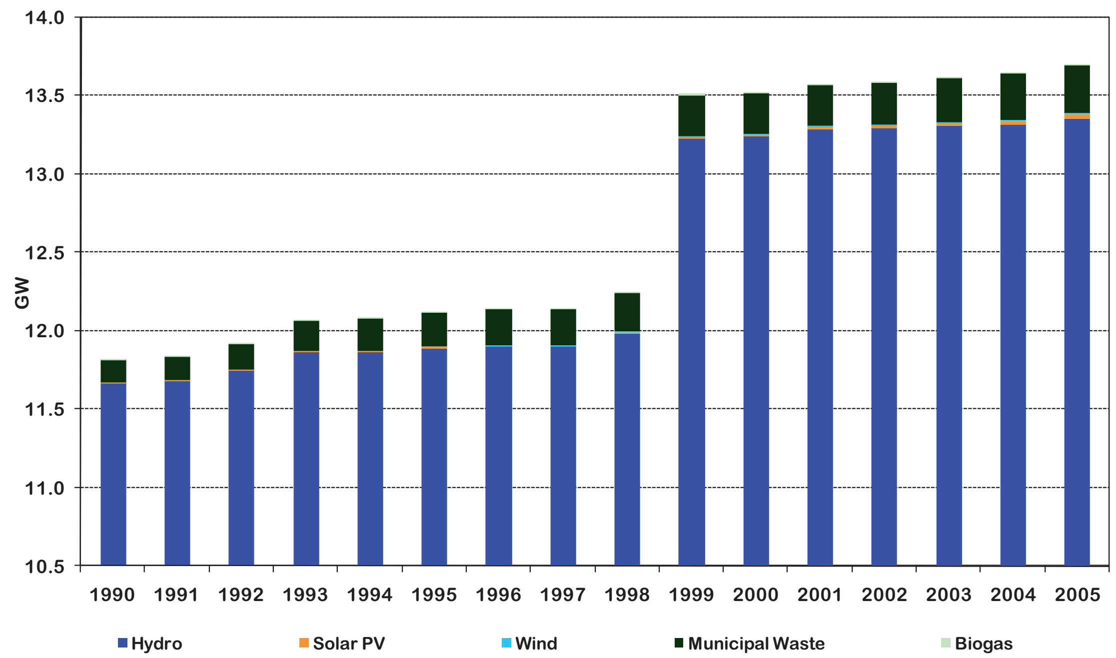
[1] A summary profile was prepared of Switzerland's renewable energy **market** developments from 1990 to 2005. Policy developments are available in the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

Figure 43. Total RES-E Production (excluding Hydropower), 1990-2005



Source: IEA (2007a)

Figure 3. Net Generating Capacity of RES-E Plants, 1990-2005

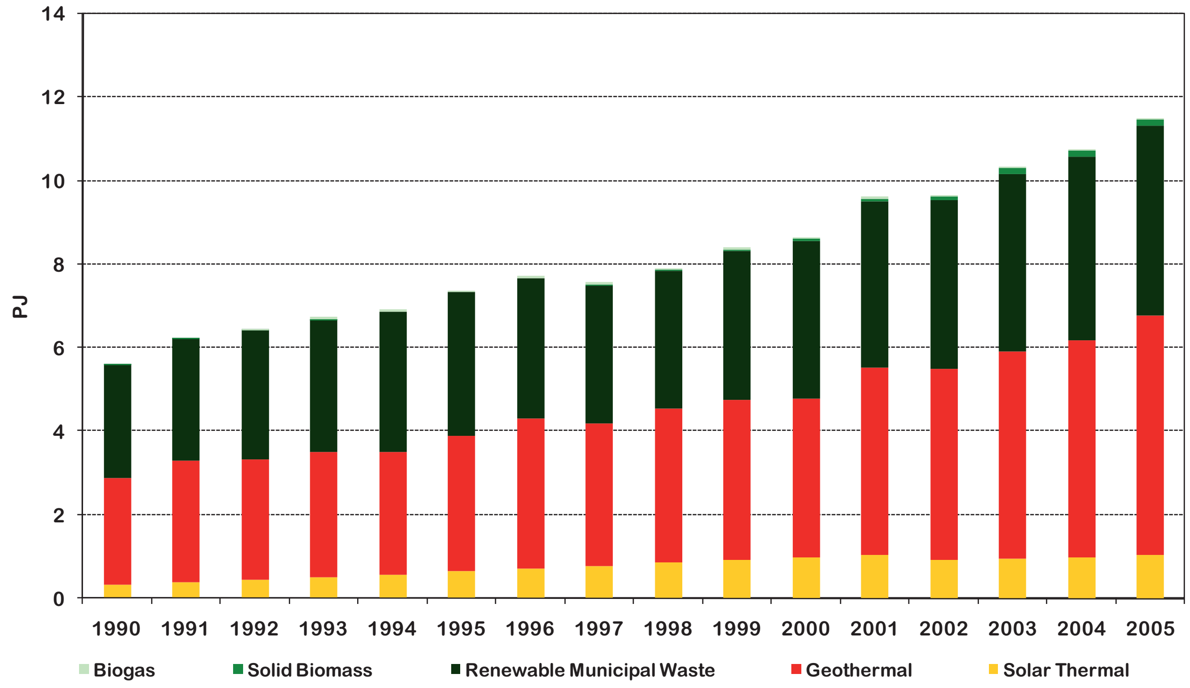


NB: Official IEA statistics on electricity generating capacity do not differentiate between *renewable* and *non-renewable* municipal waste.

Source: IEA (2007a)

RENEWABLE HEAT (RES-H) MARKET

Figure 4. Total RES-H Production, 1990-2005[2]



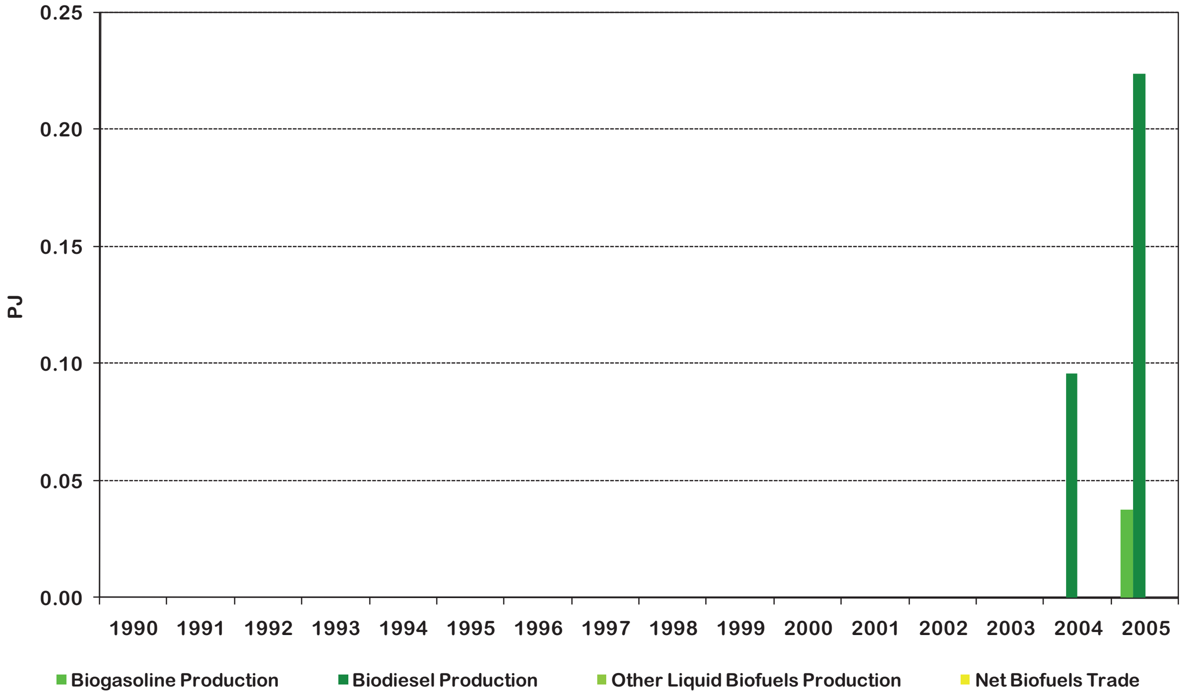
NB: Geothermal and solar thermal include direct final use.

Source: IEA (2007a)

[2] Official IEA statistics on heat generation from renewable energy sources relate to **commercial heat sold** with additional data on **direct use** of solar thermal and geothermal available for most OECD countries.

RENEWABLE TRANSPORT FUEL (RES-T) MARKET

Figure 5. Total RES-T Production, 1990-2005

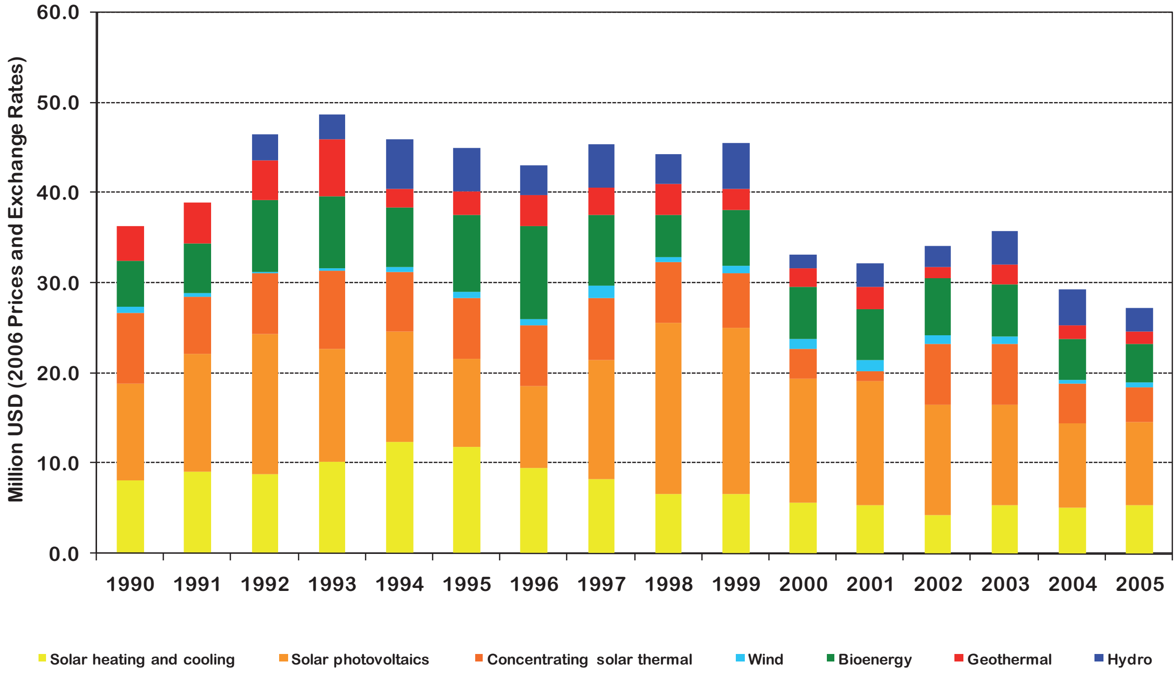


NB: Net Biofuels Trade refers to the balance of domestic biofuel consumption, i.e. biofuel exports subtracted from imports.

Source: IEA (2007a)

RESEARCH, DEVELOPMENT AND DEMONSTRATION TRENDS

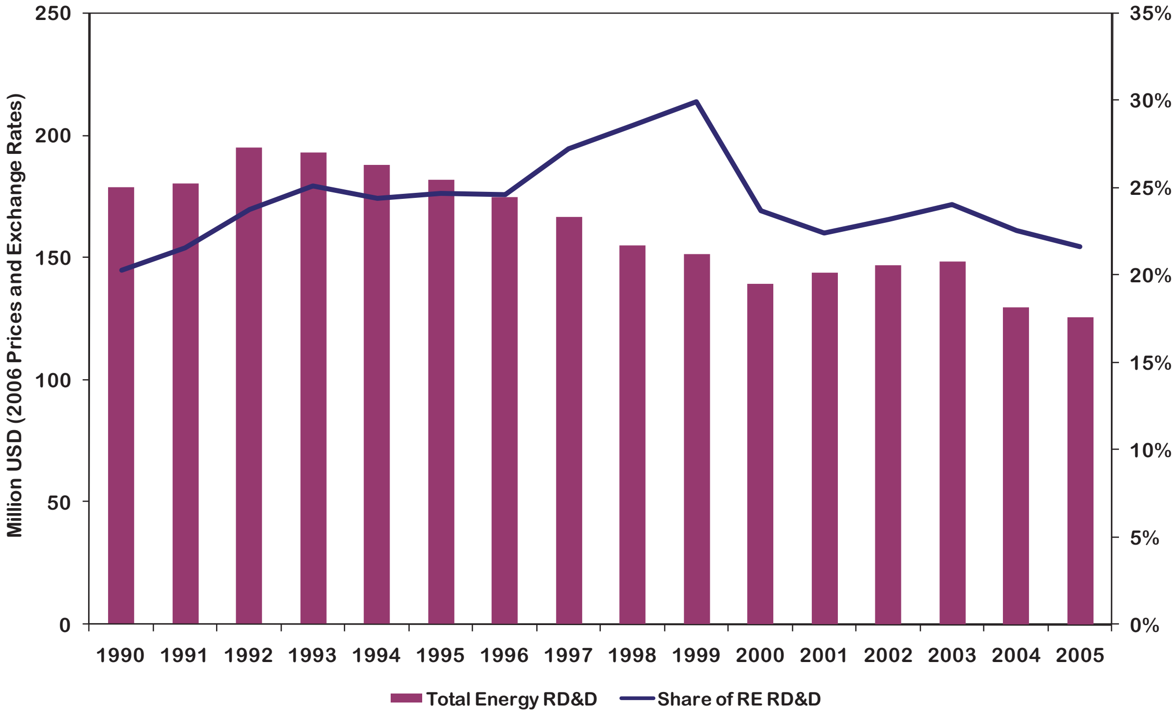
Figure 6. Annual Government RD&D Spending on Renewables, 1990-2005 (USD 2006 prices and exchange rates)[3]



Source: IEA (2007b)

[3] Official IEA data on energy RD&D budgets include only **government** funding and not **private** RD&D spending.

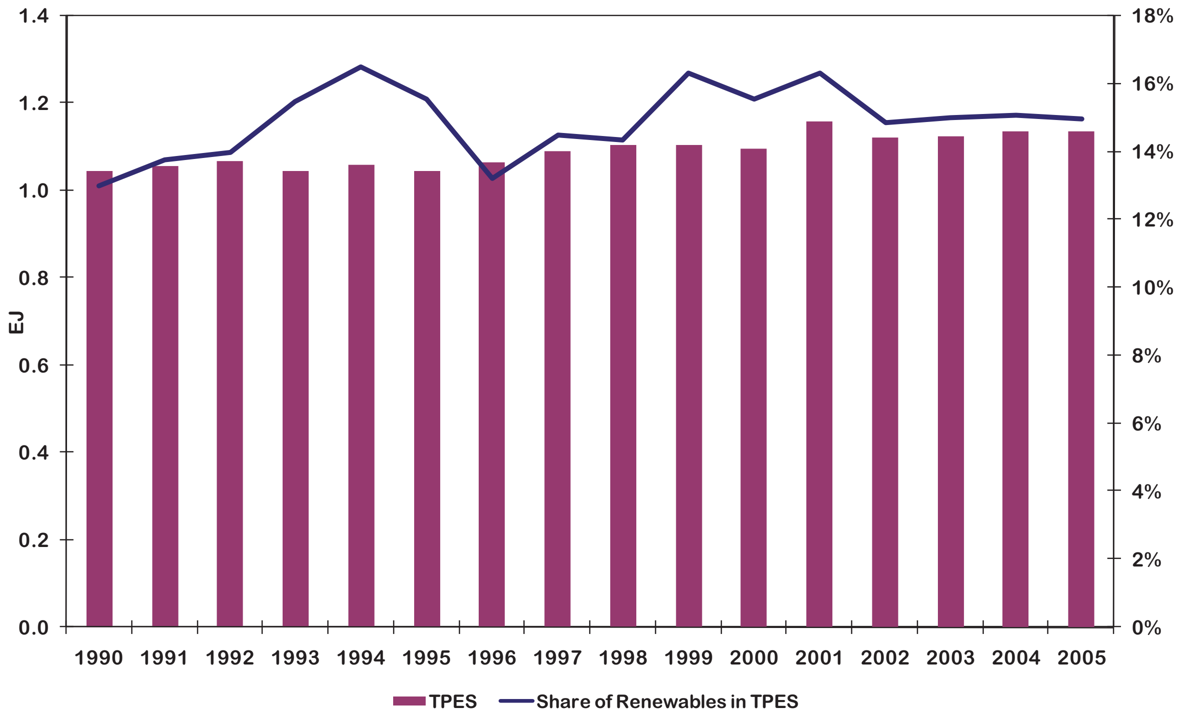
Figure 7. Renewable energy RD&D versus total government energy RD&D spending, 1990-2005



Source: IEA (2007b)

RENEWABLES IN TOTAL PRIMARY ENERGY SUPPLY[4]

Figure 8. Share of Renewable Energy in Total Primary Energy Supply, 1990-2005



Source: IEA (2007a)

RENEWABLE ENERGY POLICY INFORMATION

For details on renewable energy support policies implemented in Switzerland, readers may consult the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

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[4] The official IEA statistics on TPES include, where applicable, traditional biomass but exclude pumped hydro.

Primary energy convention: The IEA uses the **physical energy content method** to calculate the primary energy equivalent of non-combustible energy sources, such as geothermal, hydro, solar and wind. As a consequence, there is an obvious link between the principles adopted in defining the primary energy forms of energy sources and the primary energy equivalent of these sources. For instance, in the case solar thermal and geothermal electricity production, as heat is the primary energy form selected by the IEA, the primary energy equivalent is the quantity of heat generated in the geothermal or solar thermal plant for electricity generation. In the case of hydro, wind, tide and solar PV, as electricity is the primary energy form selected, the primary energy equivalent is the physical energy content of the electricity generated in the plant, which amounts to assuming an efficiency of 100%. Please refer to (IEA, 2007a) for more details.

GLOSSARY

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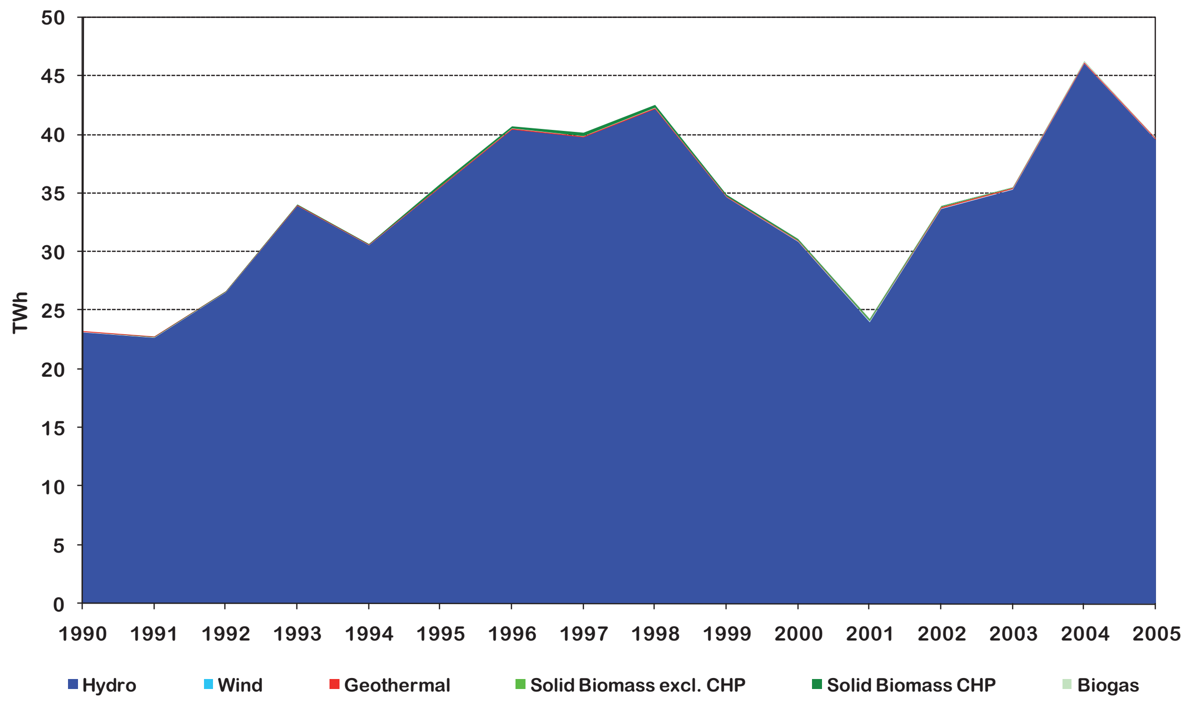
TURKEY[1]

RENEWABLE ELECTRICITY (RES-E) MARKET

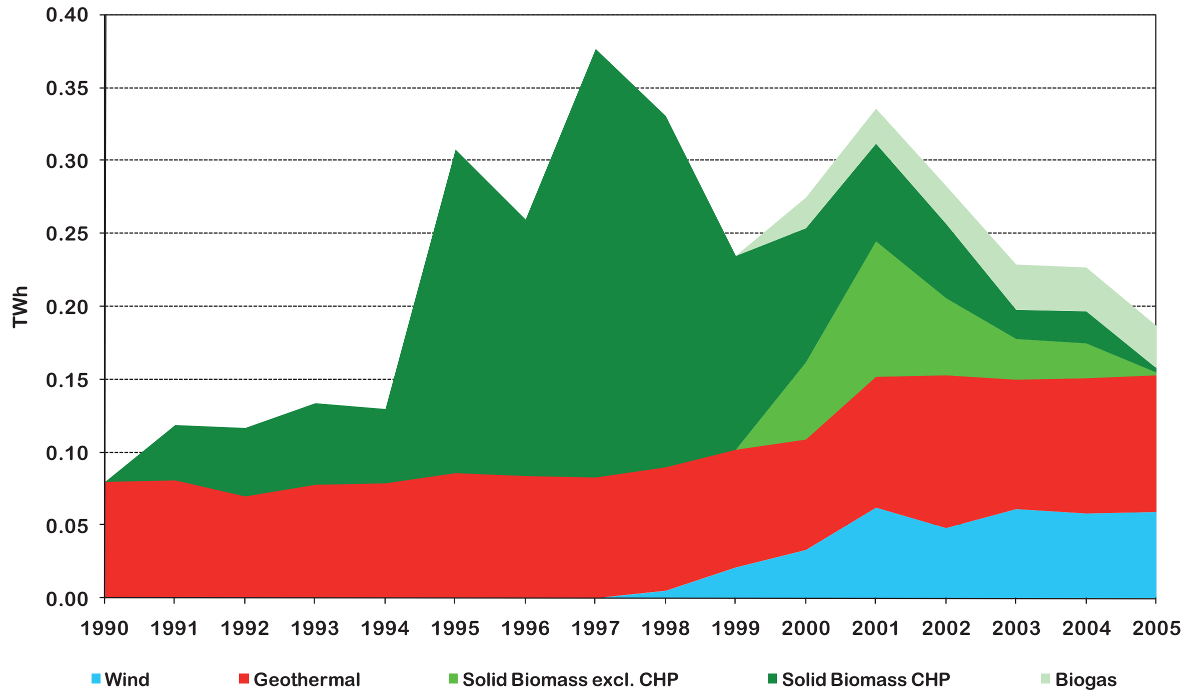
Figure 1. Total RES-E Production, 1990-2005



Source: IEA (2007a)

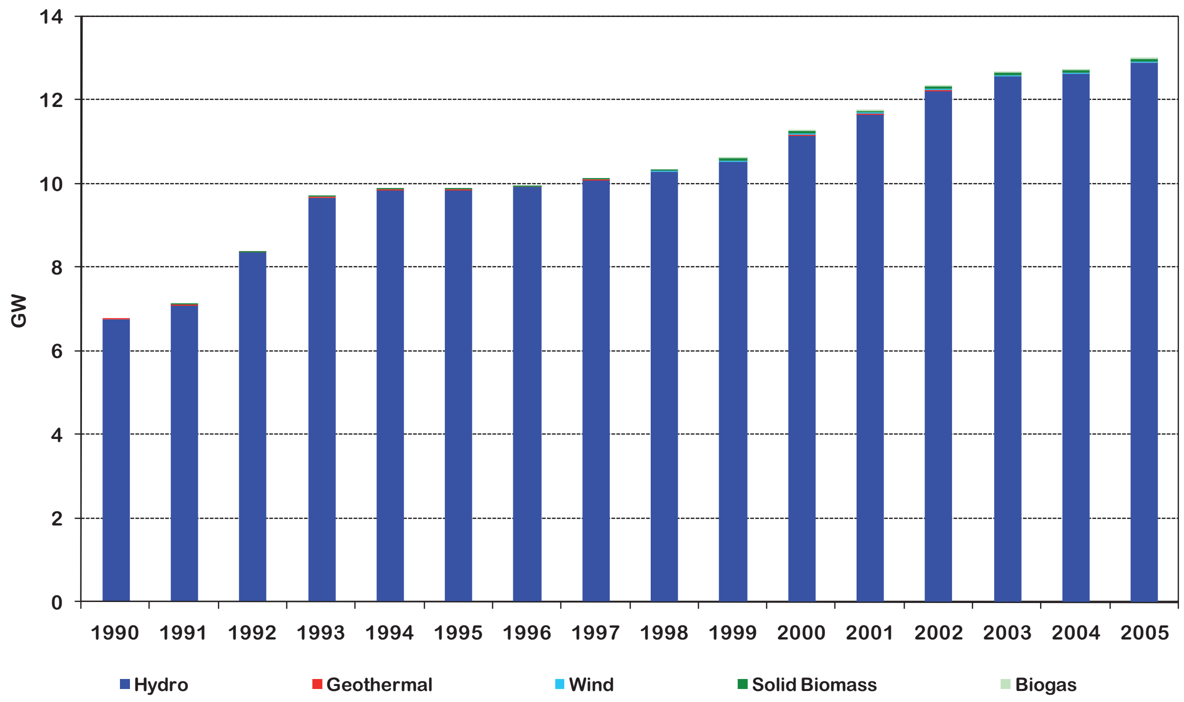
[1] A summary profile was prepared of Turkey's renewable energy **market** developments from 1990 to 2005. Policy developments are available in the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

Figure 44. Total RES-E Production (excluding Hydropower), 1990-2005



Source: IEA (2007a)

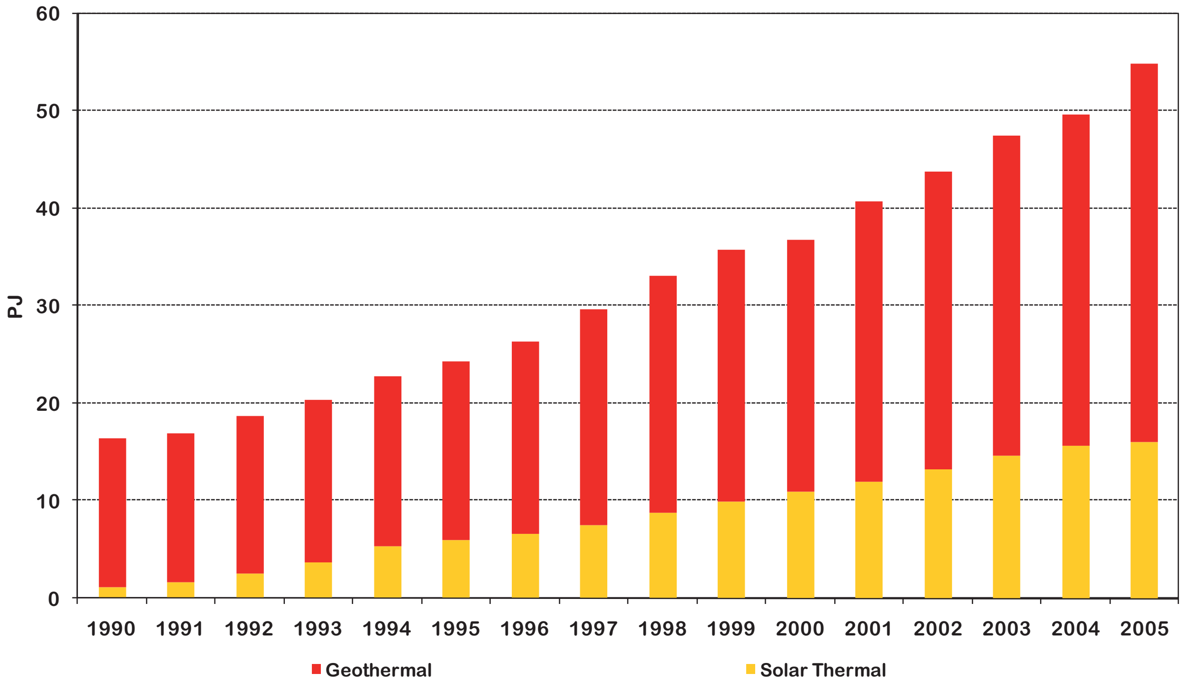
Figure 3. Net Generating Capacity of RES-E Plants, 1990-2005



Source: IEA (2007a)

Renewable heat (RES-H) Market

Figure 4. Total RES-H Production, 1990-2005[2]



NB: Geothermal and solar thermal include direct final use.

Source: IEA (2007a)

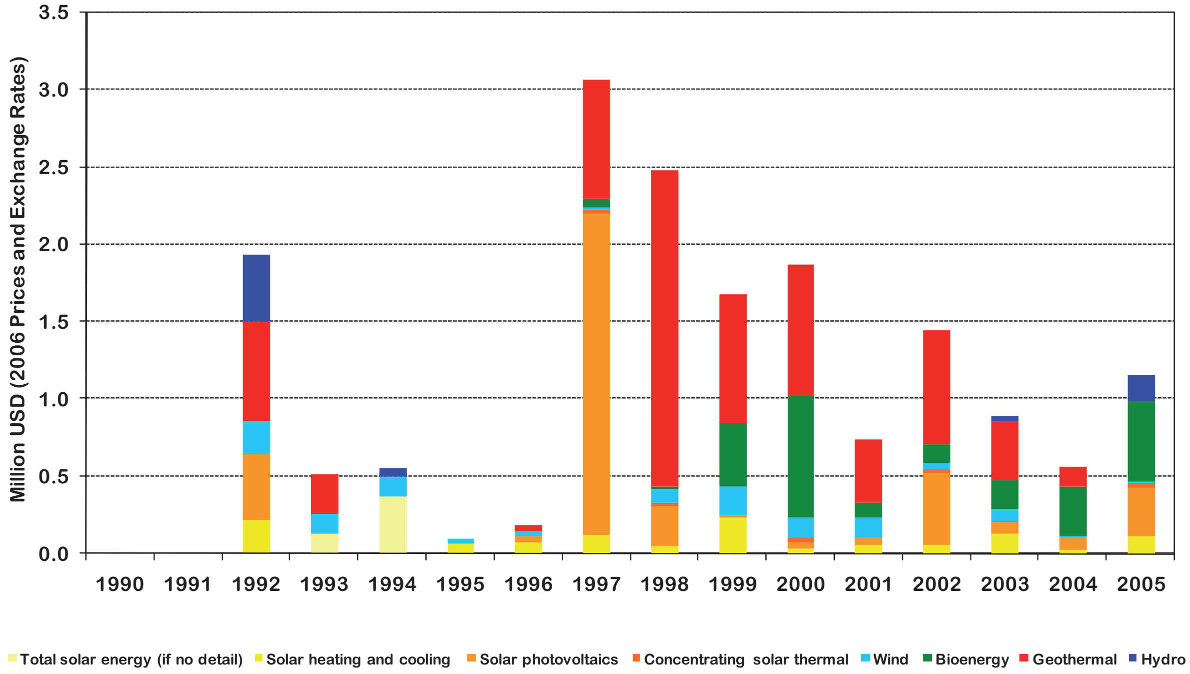
Renewable Transport Fuel (RES-T) Market

Official IEA statistics do not report any biofuel production and consumption in Turkey from 1990 to 2005.

[2] Official IEA statistics on heat generation from renewable energy sources relate to **commercial heat sold** with additional data on **direct use** of solar thermal and geothermal available for most OECD countries.

RESEARCH, DEVELOPMENT AND DEMONSTRATION TRENDS

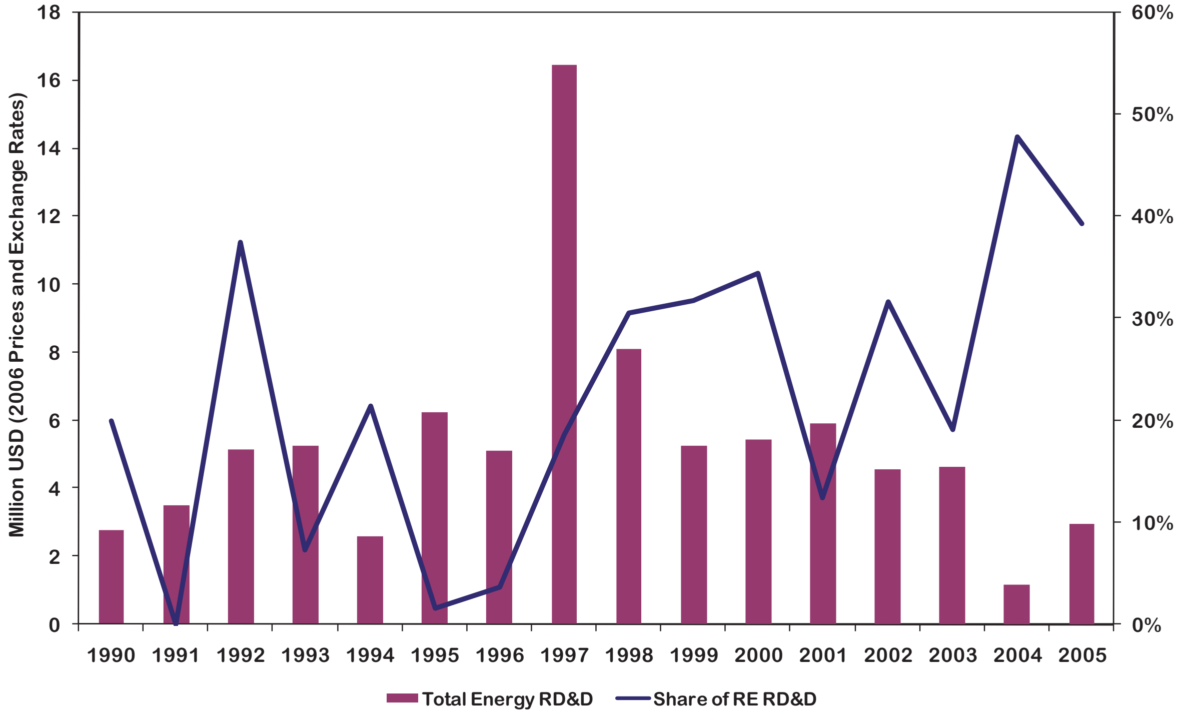
Figure 5. Annual Government RD&D Spending on Renewables, 1990-2005 (USD 2006 prices and exchange rates)[3]



Source: IEA (2007b)

[3] Official IEA data on energy RD&D budgets include only **government** funding and not **private** RD&D spending.

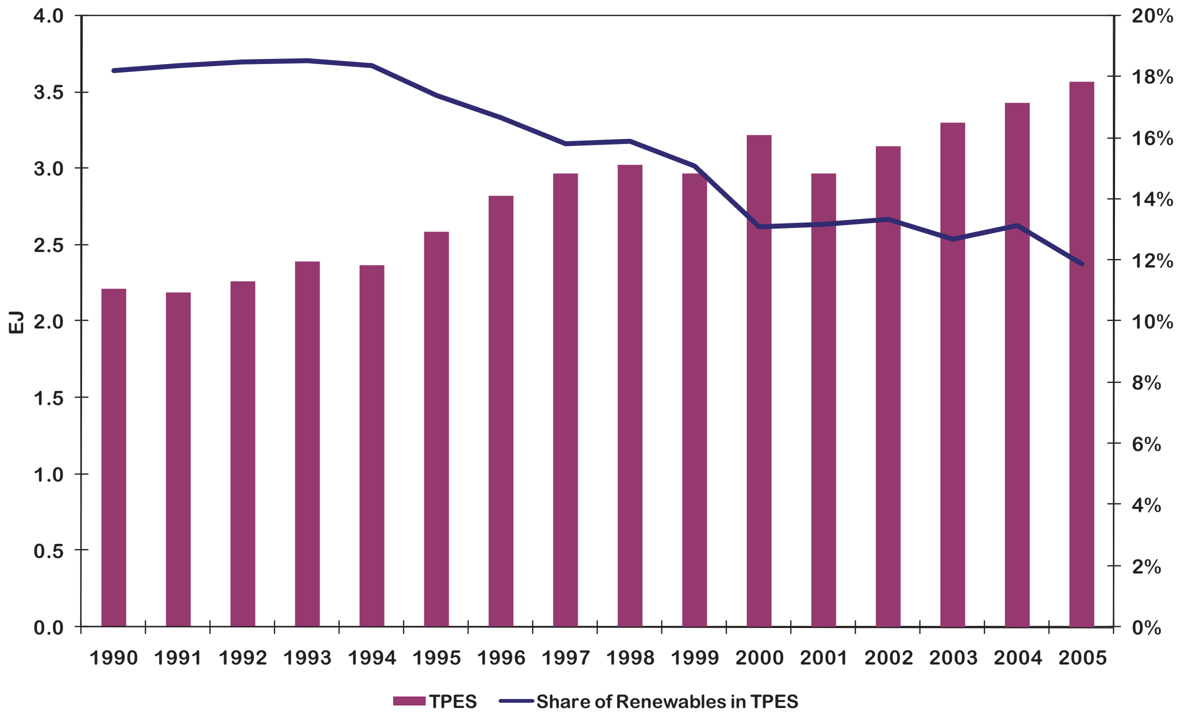
Figure 6. Renewable energy RD&D versus total government energy RD&D spending, 1990-2005



Source: IEA (2007b)

RENEWABLES IN TOTAL PRIMARY ENERGY SUPPLY[4]

Figure 7. Share of Renewable Energy in Total Primary Energy Supply, 1990-2005



Source: IEA (2007a)

RENEWABLE ENERGY POLICY INFORMATION

For details on renewable energy support policies implemented in Turkey, readers may consult the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

[4] The official IEA statistics on TPES include, where applicable, traditional biomass but exclude pumped hydro.
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IEA (2007b), *IEA Energy Technology R&D Statistics,* IEA, Paris, *http://www.iea.org/Textbase/stats/rd.asp*, accessed 21 November 2007.

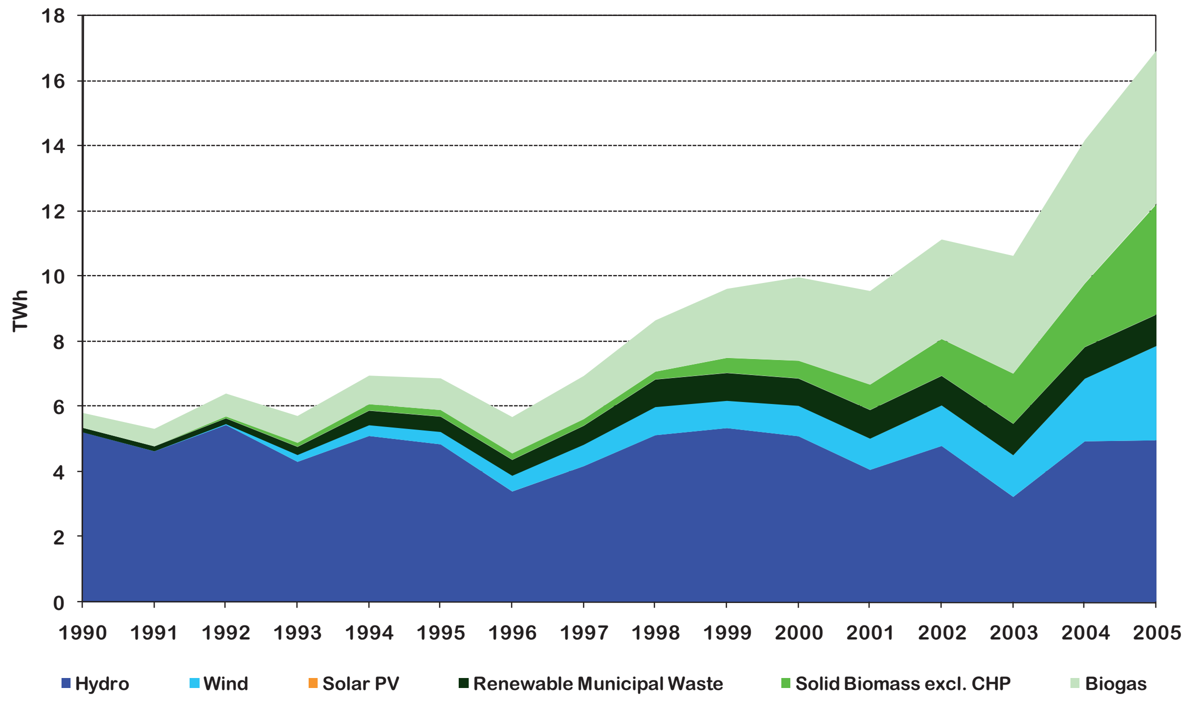
IEA (2008), "Global Renewable Energy Policies and Measures Database", www.iea.org/textbase/pm/grindex.aspx, International Energy Agency, accessed 15 March 2008.

UNITED KINGDOM

RENEWABLE ELECTRICITY (RES-E) MARKET

RES-E Market Developments

Figure 1. Total RES-E Production, 1990-2005



Source: IEA (2007a)

Electricity supply from renewable energy sources (RES-E) totalled 16.9 TWh in 2005, representing 4.2% of total electricity generation. In 1990, the share of renewables in total electricity supply was only 1.8%.

29% (5.0 TWh) of renewable electricity in 2005 were generated by hydropower, 28% by biogas, 20% by solid biomass (excl. CHP), 17% by wind and 6% by renewable municipal waste. Electricity production from solar PV amounted to a total of 8 GWh representing only 0.05% of renewable electricity.

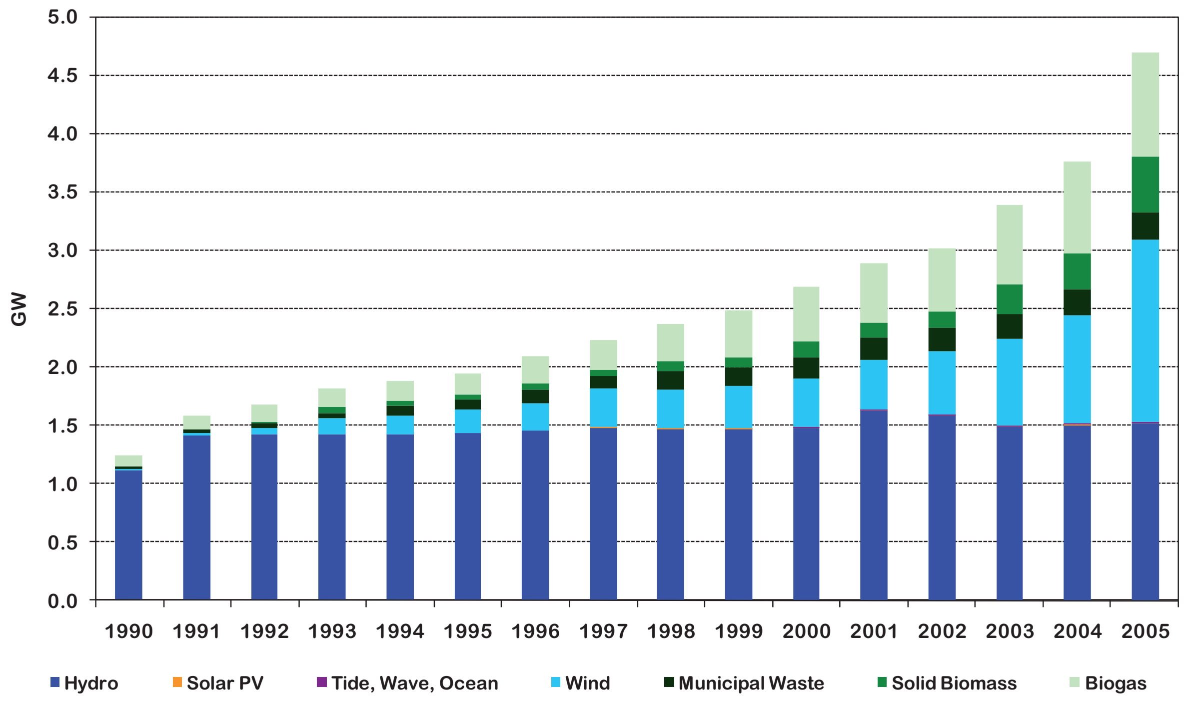
In 1990 hydropower accounted for 90% (5.2 TWh) of the total 5.8 TWh of renewable electricity, another 8% were coming from biogas plants and the remainder from renewable municipal waste. By the end of 2005, hydropower production had decreased at an annual average rate of 0.3% (hydropower capacity remained relatively stable since 1991), whereas total renewable electricity increased by 7.4% on average over the same period.

Wind power production has increased considerably in the United Kingdom. In 2005, the United Kingdom ranked sixth among IEA countries in terms of annually installed wind power capacity compared to 1990 when annual power generation from wind was only 9 GWh representing a marginal fraction of the total. However, it grew at an average annual rate of 47% over the considered period, thereby, gaining significant market share in recent years with 2.9 TWh of power output in 2005. Although growth in power production slowed down after an initial take-off, it averaged 25.2% from 2000 to 2005 and reached 50.3% in 2005. Additional information is presented in the focus section on wind energy market development below.

Biomass electricity generation was first reported in 1991 and amounted to 52 GWh in 1992. Since then it grew until 2005 at an average rate of 37.9% p.a. with a recent peak of 73.8% growth in 2005.

Growth of solar PV power production averaged 41.4% p.a. since 1999 when solar PV generated 1 GWh of electricity.

Figure 2. Net Generating Capacity of RES-E Plants, 1990-2005



NB: Official IEA statistics on electricity generating capacity do not differentiate between *renewable* and *non-renewable* municipal waste.

Source: IEA (2007a)

Development of Policies for Renewable Electricity

In accordance with EU Directive 2001/77/EC[1] on renewable electricity, the United Kingdom government set a RES-E target of 10% of gross electricity consumption by 2010. It also set an indicative target of 20% by 2020.

One of the main policy support instruments for renewable energy technologies in the United Kingdom is the "Renewables Obligation Order", a quota obligation system with tradable green certificates (TGCs) that was enacted in 2002 to replace the previous Non-Fossil Fuel Obligation (a tender system introduced in 1990)[2]. The Renewables Obligation is imposed on electricity supply companies which are required to source a percentage of their electricity sales (increasing each year) from eligible renewable sources. The obligation started at 3% in 2002/3, increased in annual steps to 7.9% for 2007/8 (time of writing) and is mandated to rise to a minimum of 15.4% by 2015/6. From 2016, the obligation level will increase up to 20% on a guaranteed headroom basis. It will remain in place until 2027 (Figure 3). Electricity suppliers Electricity supply companies. The obligation for 2007/8 is 7.9% rising to a minimum of 15.4% by 2015/6. From 2016, the obligation level will increase up to 20% on a guaranteed headroom basis. It will remain in place until 2027. Companies can meet their obligation either by (i) presenting Renewable Obligation Certificates (ROCs); (ii) by paying a "buy-out fund" contribution; or (iii) a combination of the two. Buy-out prices are determined by the government and adjusted annually in line with the retail price index. In 2007/2008 the buy-out price was GBP 34.3/kWh (USD 68.1/kWh)[3].

However, the actual market value of ROCs is determined by the buy-out price as well as the final share of the "buy-out fund", which is reimbursed to the suppliers *pro rata* to the number of ROCs presented. The larger the difference between the Renewables Obligation and the number of ROCs presented, the larger is the "buy-out fund" and, consequently, the higher the ROC price. This

Despite some success in bringing forward relatively mature energy technologies like onshore wind, landfill gas and co-firing of biomass, the technology neutrality of the support scheme has not managed to develop less mature, higher cost-gap technologies. As a result, the United Kingdom government commissioned several studies to investigate the possibility of adopting a "technology banding" approach in order to encourage emerging technologies through the TGC system.

In its current form, the Renewables Obligation is not expected to deliver the targeted level of RES-E deployment.

Considerable difficulties have arisen from non-economic barriers, such as securing planning consent for RES-E deployment, in particular onshore wind. Administrative barriers contributed to a sizable amount of planned RES-E capacity waiting for approval in 2007.

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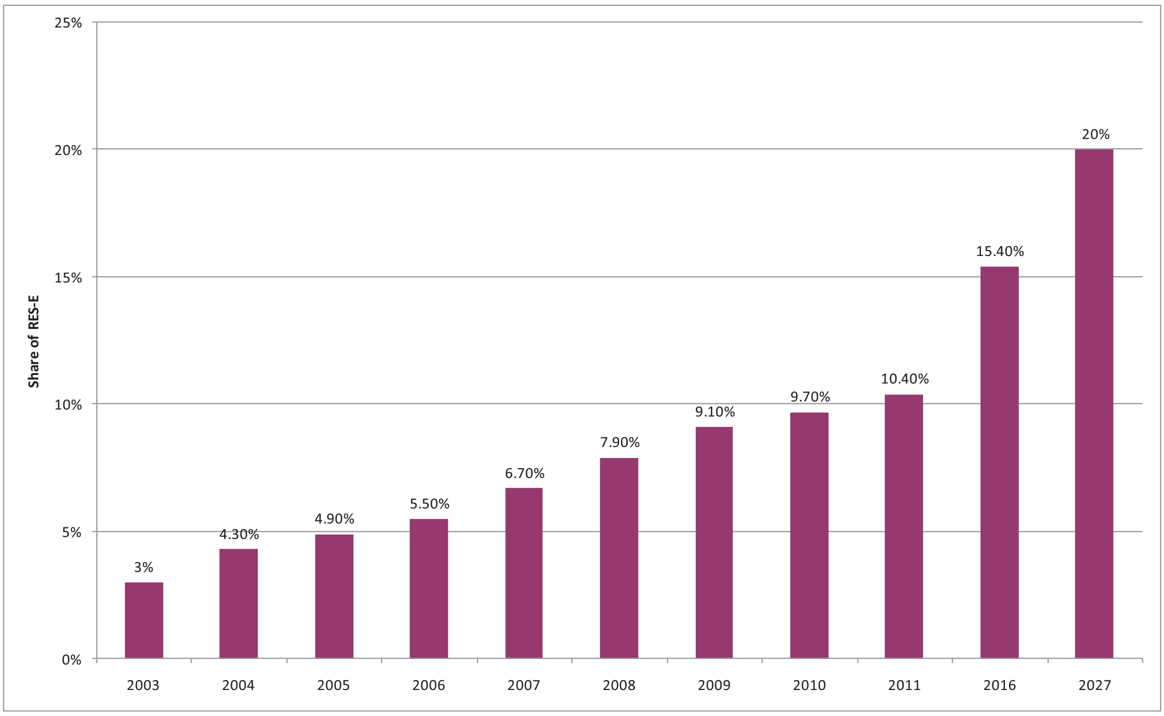
[1] (European Commission, 2001)

[2] Although the Renewables Obligation is now the Government's main mechanism for expanding the renewables sector, the last of the existing orders will continue in effect until it expires in 2018.

[3] In 2007, the average exchange rate was GBP 1 = USD 1.984.

Figure 3. Renewables Obligation Targets in the United Kingdom



Source: DTI (2007)

Other support measures that have been used so far include an exemption from the climate change levy that is imposed on electricity producers, VAT tax reductions and capital grants for solar PV installations, for the cultivation of energy crops, biomass power plants and for offshore wind projects.

In 2006, the government passed the "Climate Change and Sustainable Energy Act", which allows homeowners and others who produce electricity with small-scale wind turbines or solar panels to sell energy back to the electricity grid. The "Low Carbon Buildings Programme", which also entered into force in 2006, offers up to 50% funding for new PV projects, subject to maximum levels per kW and the fulfilment of certain energy efficiency standards.

In May 2007, the Energy White Paper was published addressing several issues related to renewables. Key questions laid out in the report concern possibilities to strengthen and modify the Renewables Obligation so as to reduce policy uncertainty and shorten overall timescales in the planning process for renewables, and to improve grid access conditions both onshore and offshore.

Banding of the Renewables Obligation is foreseen to be introduced on 1 April 2009. According to this approach, different technologies will be pooled in technology bands with respect to their maturity status. Eligible technologies will then receive less or more than one ROC/MWh depending on their respective technology bands[4]. A transitory treatment of

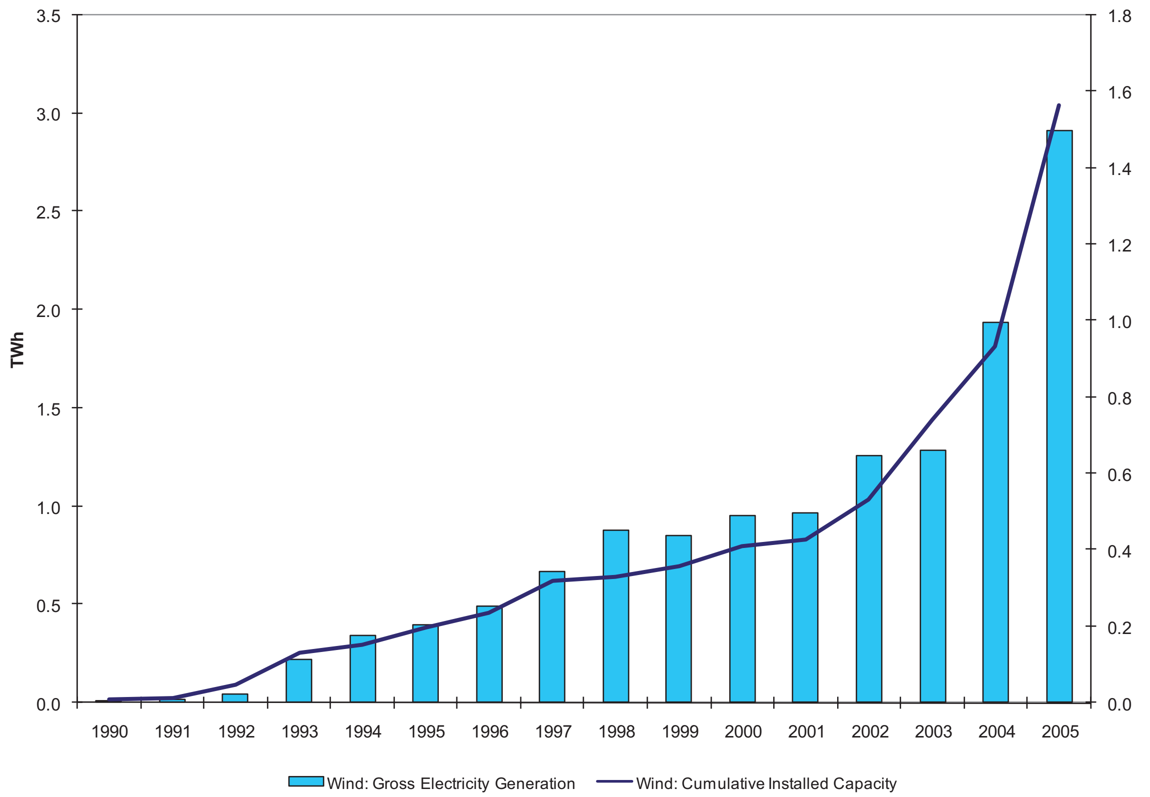
[4] Four bands will be introduced - Band 1: established technologies, 0.25 ROCs/MWh; Band 2: reference technologies, 1 ROC/MWh; Band 3: post-demonstration technologies, 1.5 ROCs/MWh;

existing and currently planned/constructed projects is intended to provide certainty for investors. Besides, limits on the support of co-firing through ROCs will be lifted. The overall target of the scheme will be raised to the aspired 20% of renewables on a "guaranteed headroom" basis, i.e. it will only be raised if market growth justifies it.

Details on streamlining planning and grid access guidelines for renewables can be found in the Energy White Paper 2007 (DTI, 2007).

Focus: Wind Energy Market and Policy Developments

Figure 4. Wind Power Market Development, 1990-2005



Source: IEA (2007a)

The United Kingdom has some of the best wind resources in Europe with significant potential for both onshore and offshore wind. According to the British Wind Energy Association (BWEA), the development of new wind power installations has constantly increased in recent years – 241 MW in 2004, 447 MW in 2005 and 630 MW in 2006[5]. Thus, the United Kingdom was the sixth largest market among IEA member states in 2006. 22 new projects were scheduled to come on-stream in 2006, including the 90 MW "Barrow Offshore

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Band 4: emerging technologies, 2 ROCs/MWh. Detailed information on the proposed technology banding can be found in the Energy White Paper 2007 (DTI, 2007).

[5] IEA data for recent years suggest that in 2005 new installations already totalled 632 MW. However, 2006 data were not yet available at the time of writing.

Wind Farm", the fifth offshore project entering into operation. Total offshore capacity reached 304 MW by 2006. Two other offshore projects were under construction in 2006. One of them, the 90 MW "Burbo Bank" wind farm, was inaugurated in October 2007. The other, the "Robin Rigg" project, consists of two 90 MW wind farms and is expected to be commissioned by spring 2009.

Total installed capacity came close to 2 GW in 2006 according to BWEA figures, making the United Kingdom also rank sixth in terms of total wind power capacity (eighth if IEA non-member countries such as China and India are taken into account).

In addition, a total of 3 176 MW of wind power projects had obtained the necessary approval by planning authorities at the end of 2006, but had not yet started construction[6]. Among those that received approval in 2006 was the GBP 300 million (approximately USD 595.2 million[2]) "Whitelee" wind farm project, which comprises 140 turbines totalling 322 MW. Once completed (construction began in 2007) Whitelee is expected to be the largest onshore wind farm in Europe.

In a second offshore wind energy development round, another 15 sites were offered to project developers for a total of 7 200 MW new offshore capacity. Two applications have already been granted consent in December 2006 – the 1 GW "London Array" project, which will be the world's largest wind farm, and the 300 MW "Thanet" project. Three more projects totalling 1 265 MW have submitted their planning applications during 2006.

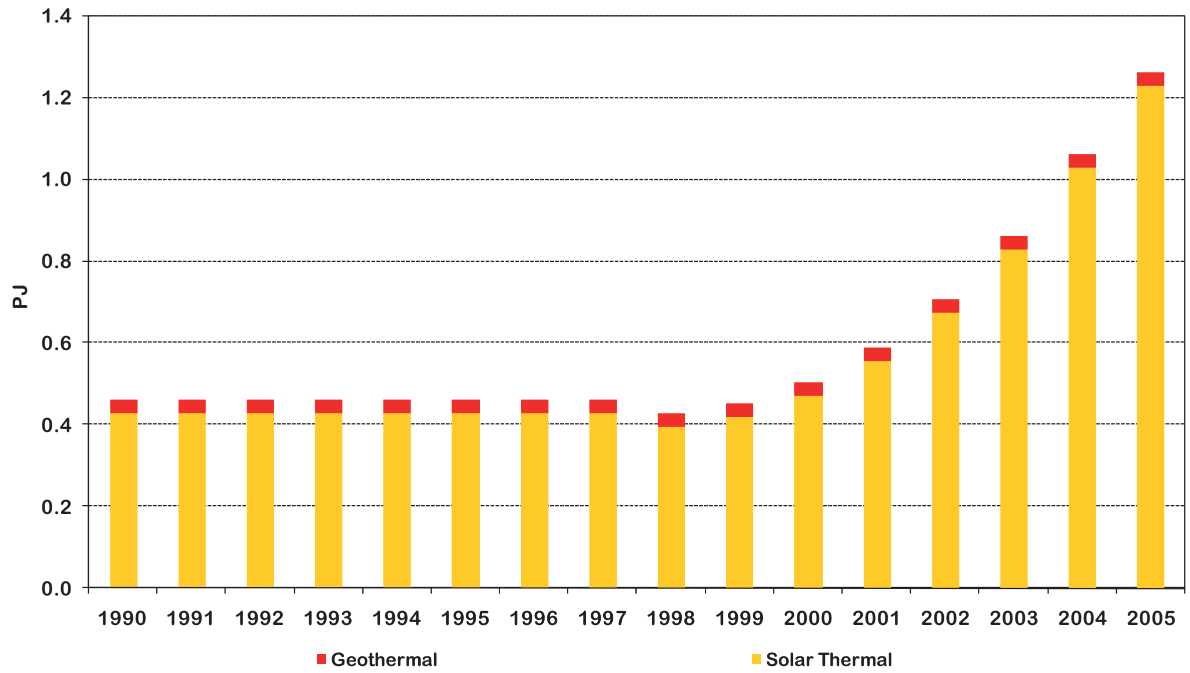
However, of the 18 sites in total awarded to offshore wind power projects in the first offshore wind energy round only six had been developed by the end of 2007 (including "Burbo Bank", but not "Robin Rigg"). A number of planning constraints have led to the deteriorating economics of the proposed projects, despite the availability of investment grants for twelve of these projects amounting to approximately GBP 10 million per project (USD 19.8 million[2]) via the Offshore Wind Capital Grant Programme launched in early 2002. Bottlenecks in the upstream supply stream have been considered as major reason for price increases that led to the postponement of offshore projects. In addition, the division of responsibilities for offshore transmission systems has still been a matter of discussion. Comments on two possible solutions for offshore connections have been requested by the government.

Besides a number of upstream supply bottlenecks, onshore wind power development has been hampered by long delays in project approval. According to industry statistics, an average of 21 months is needed to obtain planning consent compared to a target of determining 60% of all "major applications" within 13 weeks.

RENEWABLE HEAT (RES-H) MARKET

Figure 4. Total RES-H Production, 1990-2005[7]

[6] 1 789.55 MW out of the total received their approval in 2006.
[7] Official IEA statistics on heat generation from renewable energy sources relate to **commercial heat sold** with additional data on **direct use** of solar thermal and geothermal available for most OECD countries.



NB: Geothermal and solar thermal include direct final use.

Source: IEA (2007a)

Solar thermal heat production has historically only been used in the United Kingdom to a limited extent with most installations being used for swimming pool heating. Output was estimated to remain constant from 1990 to 1997 at 428 TJ. After a short drop in 1998, solar thermal heat increased at an annual average rate of 17.6% until 2005 amounting to 1229 TJ – a tripling compared to 1990 levels.

While official IEA statistics indicate that geothermal heat stayed constant at 33 TJ over the whole period, other sources show increasing geothermal heat production in recent years with a spike in 2006. Low-temperature, shallow geothermal heat capacity (primarily ground-source heat pumps - GHPs) increased from 2.3-2.9 MWth in 2000 to 10.2 MWth by 2004, producing an estimated 45.6 TJ of heat per year. However, data on GHPs for non-commercial use is not collected in official IEA statistics[8]. The only larger-scale geothermal heat plant is a 2 MWth geothermal district heating plant in Southampton.

No biomass heat output has been reported to the IEA and electricity statistics indicate only non-CHP biomass plants. Other sources, however, state biomass heat production more than 30 PJ in the mid 1990s dropping until recently to half of that level. Tightened environmental legislation and emission controls in the late 1990 are being regarded as the main drivers for the switch to fossil fuel heating systems by industry rather than upgrading existing wood heat combustion systems.

[8] Furthermore, GHPs need some electricity input that need not necessarily be renewable. Thus, only net energy gains from GHPs can be considered renewable. See (IEA, 2007a) for further details on data coverage in official IEA statistics.

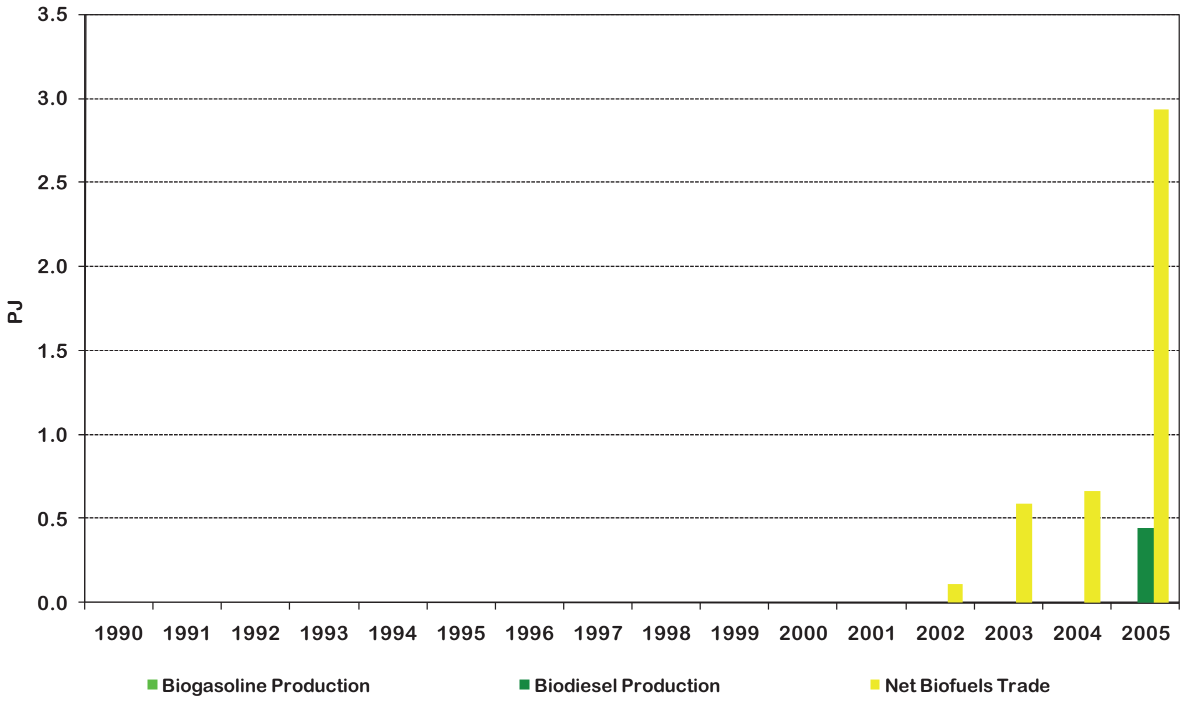
Political support for renewable heat production has been negligible in the 1990s. However, since 2000 a number of programmes started to encourage the production and use of renewable heat. All of them offered financial support, mainly in the form of capital grants, for the upfront costs of renewable heating installations. The Renewable Obligation Order additionally sets incentives for the use of biomass in CHP, thus it also has an indirect impact on the renewable heat sector. In April 2007, an assessment of a Renewable Heat Obligation was published. This would be an innovative step in terms of renewable heat support.

Capital grants for biomass-based heat supply were provided by the 2001 Community Energy Programme, the 2002 Bio-Energy Capital Grants Scheme, the 2003 Clear Skies Initiative, the 2005 Bio-Energy Infrastructure Scheme, the 2006 Low Carbon Buildings Programme, and the grant scheme included in the 2006 Climate Change Programme Review. Support for training and information campaigns have also been included in some of the programmes mentioned above. Despite financial support for biomass heat installations, deployment is supposed to be primarily hampered by a lack of a well established supply chain that can assure reliable quality of biomass supply within a reasonable transport distance. Only part of the supply chain has been addressed by the 2000 Energy Crops Scheme offering grants for biomass supply.

Support for solar and geothermal heat basically started with the 2003 Clear Skies Initiative offering grants and information for solar thermal heat and some financial support for geothermal demonstration projects. The 2006 Low Carbon Buildings Programme offers financing of up to 30% of solar thermal installation costs and also grants for geothermal heat pumps. Despite financial support being ramped up, lack of information and awareness of the availability of technologies as well as a shortage of skilled installers can pose barriers to increased deployment.

RENEWABLE TRANSPORT FUEL (RES-T) MARKET

Figure 5. Total RES-T Production, 1990-2005



Source: IEA (2007a)

Biofuel utilisation started in the United Kingdom in 2002 after the announcement of duty reductions under the umbrella of the Green Fuels Challenge policy. Initial consumption levels were 111 TJ in 2002, all of which was imported. In 2003 consumption was already more than five times higher than in the previous year, in 2004 it was six times the 2002 level amounting to 663 TJ.

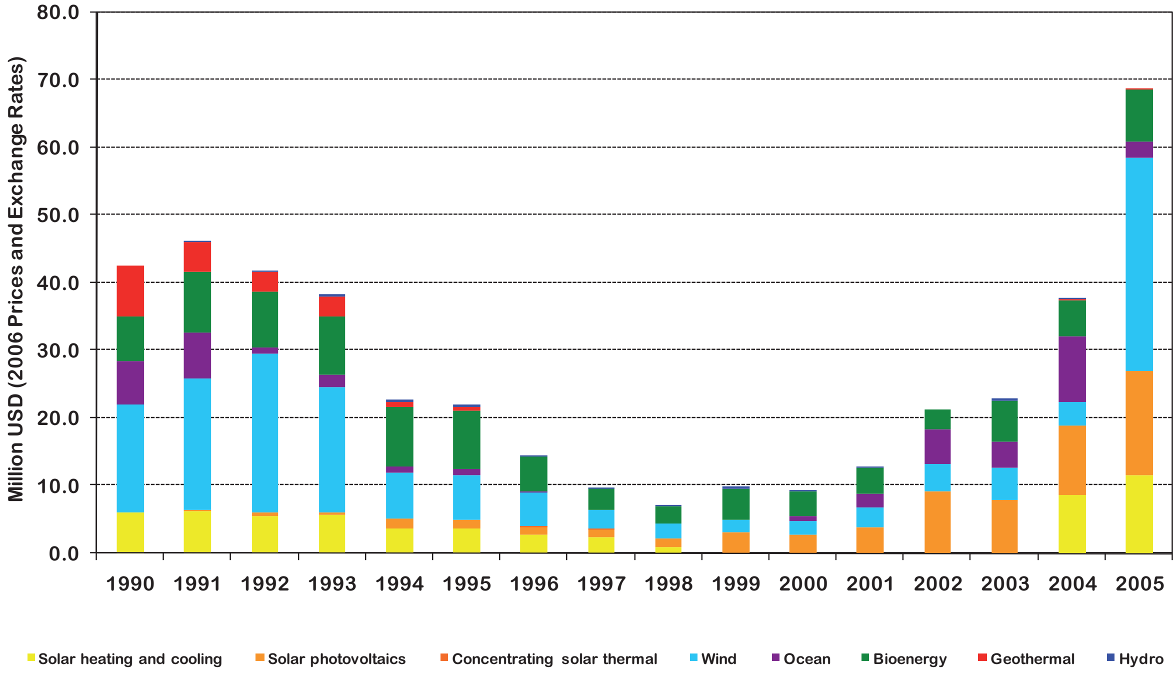
The start of biofuels consumption in the United Kingdom coincides with the entering into force of the "Biofuels Duty Incentive" (BFDI) in 2002, which reduced the duty rate for biodiesel by GBP 0.2/ litre (USD 0.4/ litre[2]) compared to ultra-low sulphur diesel. This tax reduction was first supposed to be maintained until at least 2007. However, it was extended until 2008/2009, i.e. it will cease with the introduction of the Renewable Transport Fuel Obligation (RTFO).

In 2005, reported domestic production of biodiesel started at 442 TJ. This amount, however, did not satisfy the more than five times increase in consumption of biofuels compared to 2004. Thus, imports of biofuels continued to grow to 2934 TJ overtaking the market for renewable heat within one year in terms of energy content.

The introduction of the RTFO in 2005 obliges transport fuel suppliers to ensure that a certain percentage of their fuels sales are from a renewable source, thus, adding a "stick" to the "carrot"-based BFDI. However, the RTFO offers a buy-out option as well with the buy-out price set at GBP 0.15/ litre (USD 0.3/ litre). The level of obligation will start in 2008/2009 with 2.5% and increase to 3.75% and 5% in 2009/2010 and 2010/2011 respectively. Quotas beyond 2011 will be announced in due course.

RESEARCH, DEVELOPMENT AND DEMONSTRATION TRENDS

Figure 6. Annual Government RD&D Spending on Renewables, 1990-2005 (USD 2006 prices and exchange rates)[9]



Source: IEA (2007b)

RD&D budgets for renewable energy technologies decreased until the middle of the period and then increased sharply up to 2005 (Figure 6). Overall energy RD&D budgets decreased heavily in the early 1990s from USD 481 million[10] in 1990 to USD 127 million in 1994. Average annual spending for the period from 1994 until 2005 was only USD 98 million.

From 1990-1993, RD&D budgets for renewable energy technologies averaged USD 42.3 million per year. In the subsequent two years, total renewable energy RD&D spending declined to about USD 22.4 million p.a. and decreased further towards the end of the 1990s.

[9] Official IEA data on energy RD&D budgets include only **government** funding and not **private** RD&D spending.

[10] Conversion from national currency to USD is in USD (2006) prices and exchange rates.

During the early 1990s governmental investments in ocean energy and geothermal technologies came to a halt. The main focus from 1990 to 1994 was on wind technologies, which accounted for 46% of cumulative investments of this period. 19% of RD&D expenditures went into bioenergy technologies, 14% to solar thermal heating over this period.

In 1994 spending on wind decreased by two thirds to USD 6.8 million, while investments in bioenergy technologies remained relatively constant at 6.7 million Euro.

For the period from 1996 to 2001 annual government spending on renewable energy RD&D was USD 10.6 million on average with an all time low in 1998 of only USD 7.2 million. During this period not only total governmental energy RD&D expenditures were relatively low, but also the share of the total that was invested in RE RD&D was as low as 7% in 1998.

Bioenergy received 36% of total investments within 1996 to 2001, 27% of that period's investments went into wind RD&D and 21% to solar PV, a new energy RD&D focus in the United Kingdom. Besides generally high fluctuations in terms of technology-specific public RD&D expenditures in the United Kingdom, solar PV spending has almost continuously grown from 0 in 1990 to USD 15.4 million in 2005.

After 1998 government RD&D spending on renewables started to increase again, reaching mid-1990s levels in 2002/2003 with solar PV spending having more than doubled to USD 9.2 million in 2002.

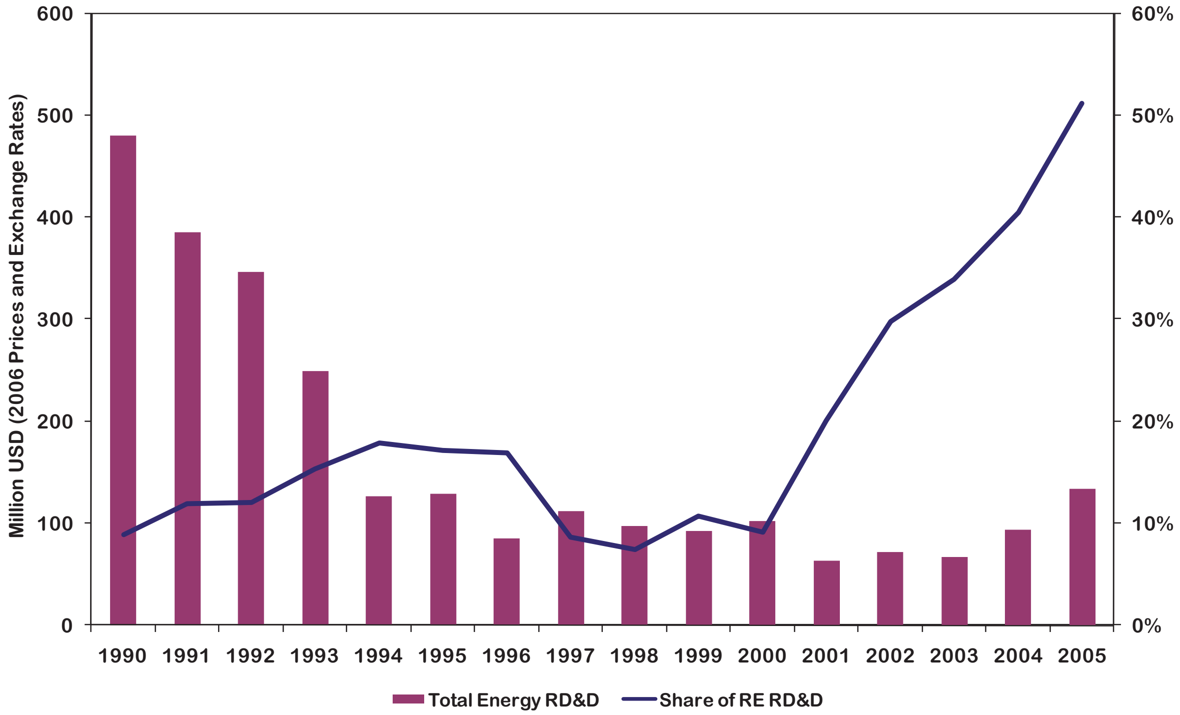
In 2002 the United Kingdom government launched the "Energy Technology Programme" designed to support industry-led R&D projects with GBP 18 million (USD 35.7 million[2]) annually in the area of biofuels, fuel cells, solar PV, wind energy (primarily offshore), distributed generation (including energy storage), wave and tidal energy, and small-scale hydro.

In 2005, government expenditures on RE RD&D had tripled compared to 2003, despite the fact that total governmental energy spending did only slightly increase. The share of RE RD&D in terms of total public energy RD&D expenditures, however, increased steadily from 9% in 2000 to an all time high of 51% in 2005.

The increase in 2004 was mainly due to a renewed interest in solar thermal as well as ocean energy RD&D. Wave and tidal stream technologies received special funding from a corresponding RD&D scheme that started in 2000.

The 2005 increase can be attributed to RD&D expenditures on wind that were almost nine times as high as in the previous year. This implies that 46% of the 2005 expenditures on renewable energy RD&D were spent on wind technology.

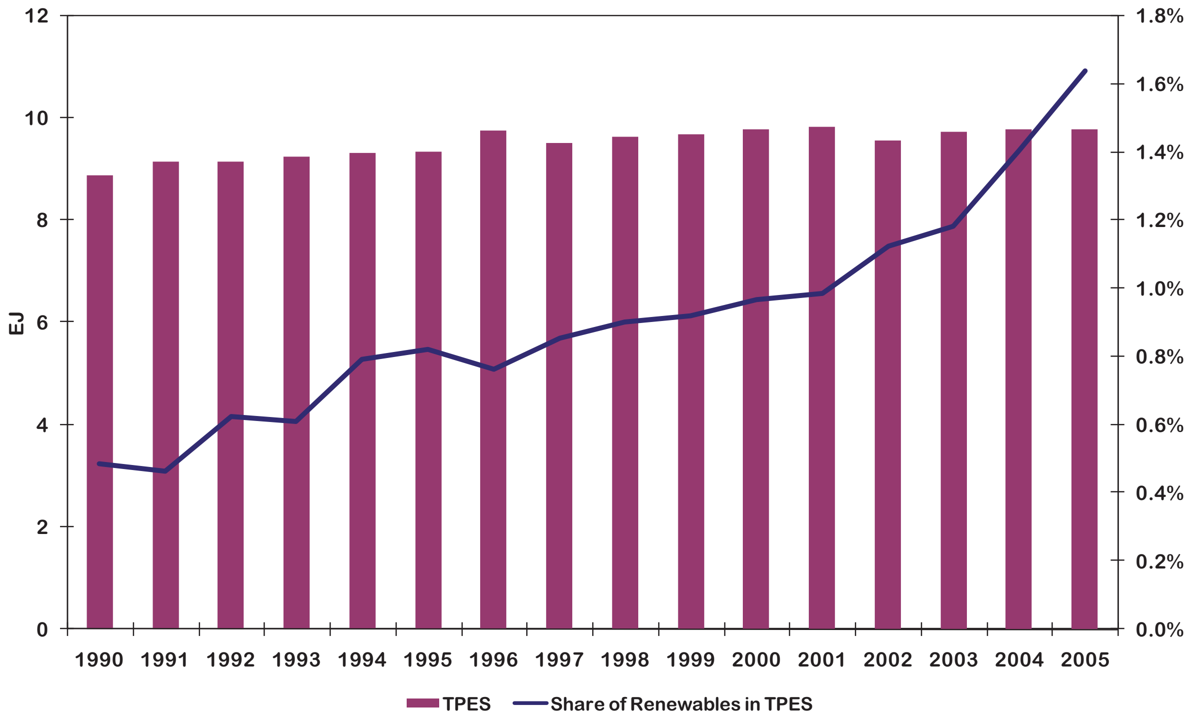
Figure 7. Renewable energy RD&D versus total government energy RD&D spending, 1990-2005



Source: IEA (2007b)

RENEWABLES IN TOTAL PRIMARY ENERGY SUPPLY[11]

Figure 8. Share of Renewable Energy in Total Primary Energy Supply, 1990-2005



Source: IEA (2007a)

TPES in the United Kingdom increased on average by 0.6% annually since 1990 to 9.8 EJ in 2005. The 10-year average of TPES since 1996 lying slightly above this amount indicates that TPES has more or less stabilized in the United Kingdom.

The contribution of renewables in TPES, however, constantly increased at an average annual rate of 9.3% to 160 PJ in 2005. This represents a share of renewables in TPES of 1.64%, more than a tripling compared to 1990 levels, when renewables contributed 43 PJ to TPES. However, compared to the average level in EU-27 countries of 6.7% renewables in TPES, this amount is fairly low.

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[11] The official IEA statistics on TPES include, where applicable, traditional biomass but exclude pumped hydro.

Primary energy convention: The IEA uses the **physical energy content method** to calculate the primary energy equivalent of non-combustible energy sources, such as geothermal, hydro, solar and wind. As a consequence, there is an obvious link between the principles adopted in defining the primary energy forms of energy sources and the primary energy equivalent of these sources. For instance, in the case solar thermal and geothermal electricity production, as heat is the primary energy form selected by the IEA, the primary energy equivalent is the quantity of heat generated in the geothermal or solar thermal plant for electricity generation. In the case of hydro, wind, tide and solar PV, as electricity is the primary energy form selected, the primary energy equivalent is the physical energy content of the electricity generated in the plant, which amounts to assuming an efficiency of 100%. Readers may consult (IEA, 2007a) for more details.

Renewable Energy Policy Information

For further details on renewable energy support policies implemented in the United Kingdom, readers may consult the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

Glossary

Definitions, abbreviations, acronyms and units are explained in the Glossary which can be found after the country profiles.

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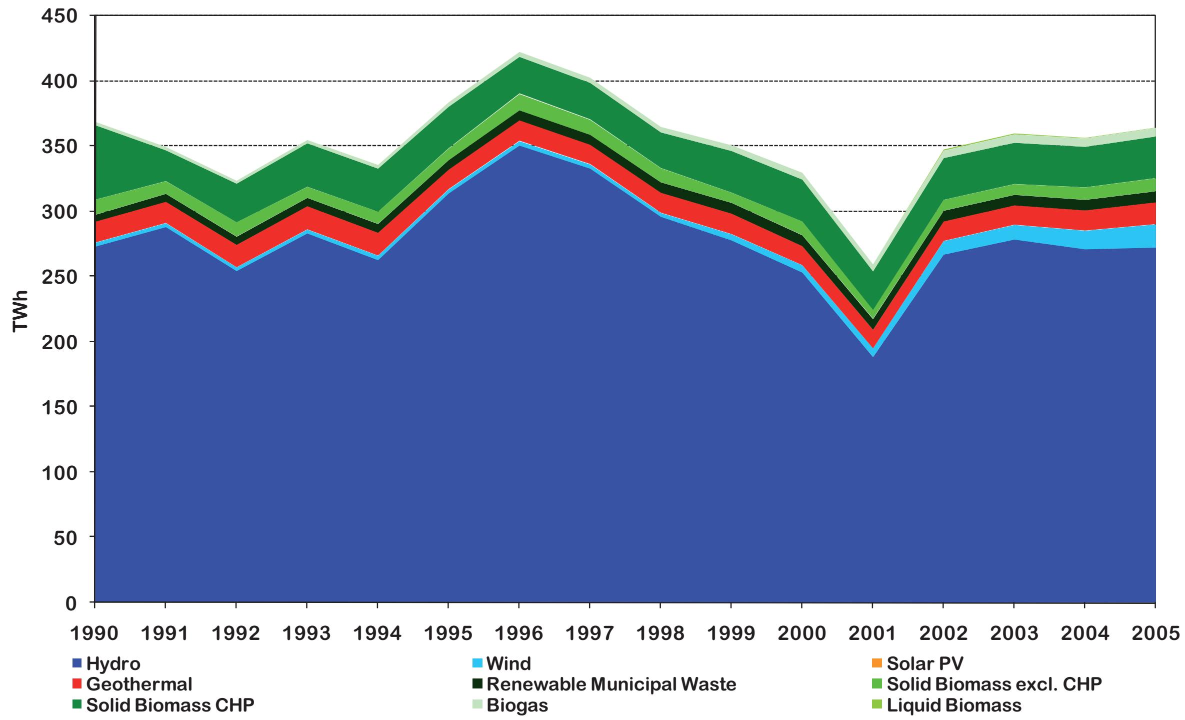
UNITED STATES

RENEWABLE ELECTRICITY (RES-E) MARKET

RES-E Market Developments

Figure 1. Total RES-E Production, 1990-2005



Source: IEA (2007a)

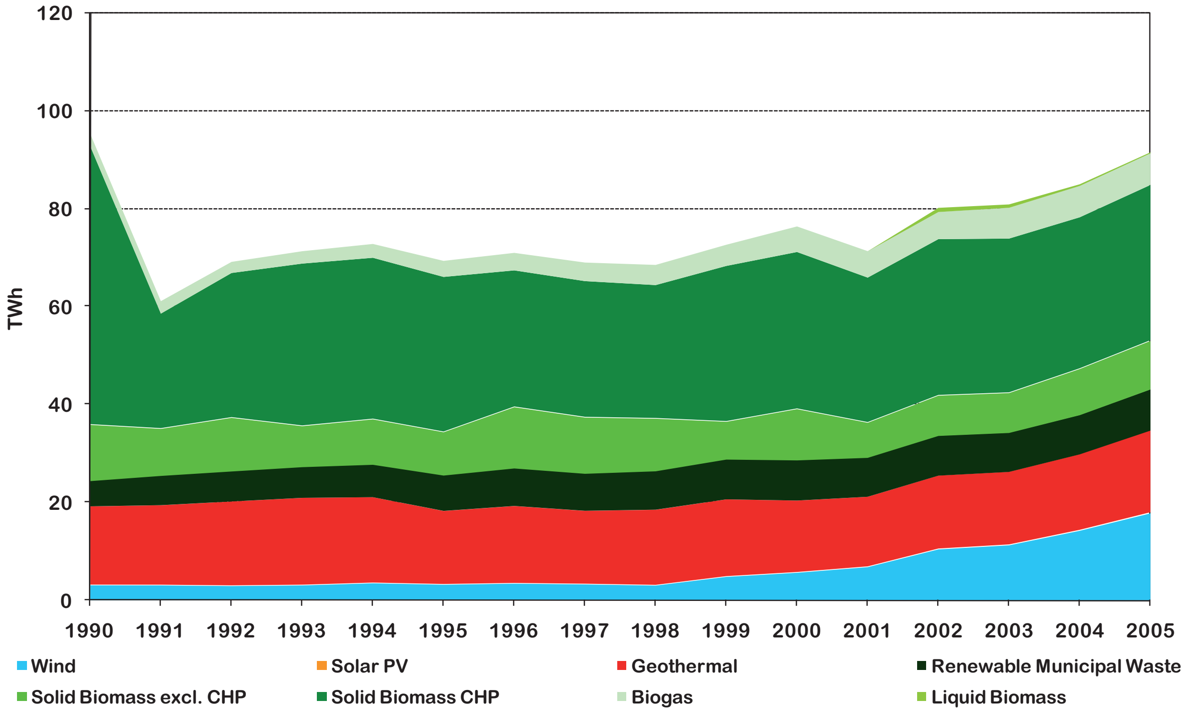
The renewable electricity (RES-E) portfolio in the United States has been dominated by hydropower, mainly large-scale plant. The share of RES-E in total electricity production decreased from 11.5% in 1990 to 8.5% in 2005, since total RES-E remained fairly constant, whereas total electricity production increased by one third, *i.e.* 1 068 TWh, over the 15-year period to 4,286 TWh. However, there have been considerable changes in the composition of renewable electricity portfolio in this period. In 2005, total RES-E generation amounted to 364 TWh.

In 2005 hydropower supplied 272.4 TWh of renewable electricity representing 75% of total renewable electricity production. Hydropower capacities have been more or less stable since 1991 (in 1990 more than 17 GW of hydro power capacity have been retired), since no new large hydro facilities have been built over several decades, nor are major new facilities contemplated for the future. Electricity production from hydropower has varied with precipitation levels ranging from 188 TWh in 2001 to 351 TWh in 1996.

The second largest share of RES-E stemmed from solid biomass CHP amounting to 32 TWh in 2005. However, in 1990 solid biomass CHP plants produced 57 TWh – almost double of the 2005 level.

Wind power supplied approximately 18 TWh of electricity in 2005 – almost 5% of total RES-E. Wind power has seen significant growth in the period 1990 – 2005, clearly being the success story of renewable energy deployment in the US. Almost all of this growth has actually occurred since the late 1990s adding 6.8 GW of capacity with the total amounting to 8.7 GW. According to the IEA Wind Energy Implementing Agreement (2007), the United States have seen the world's largest annual net increase in wind power installations in 2005 as well as in 2006 with almost 11.6 GW of total installed capacities at the close of 2006. In terms of cumulative installed capacity the US ranked third behind Spain (slightly above 11.6 GW) and Germany with more than 20 GW of wind power capacity.

Figure 45. Total RES-E Production (excluding Hydropower), 1990-2005



Source: IEA (2007a)

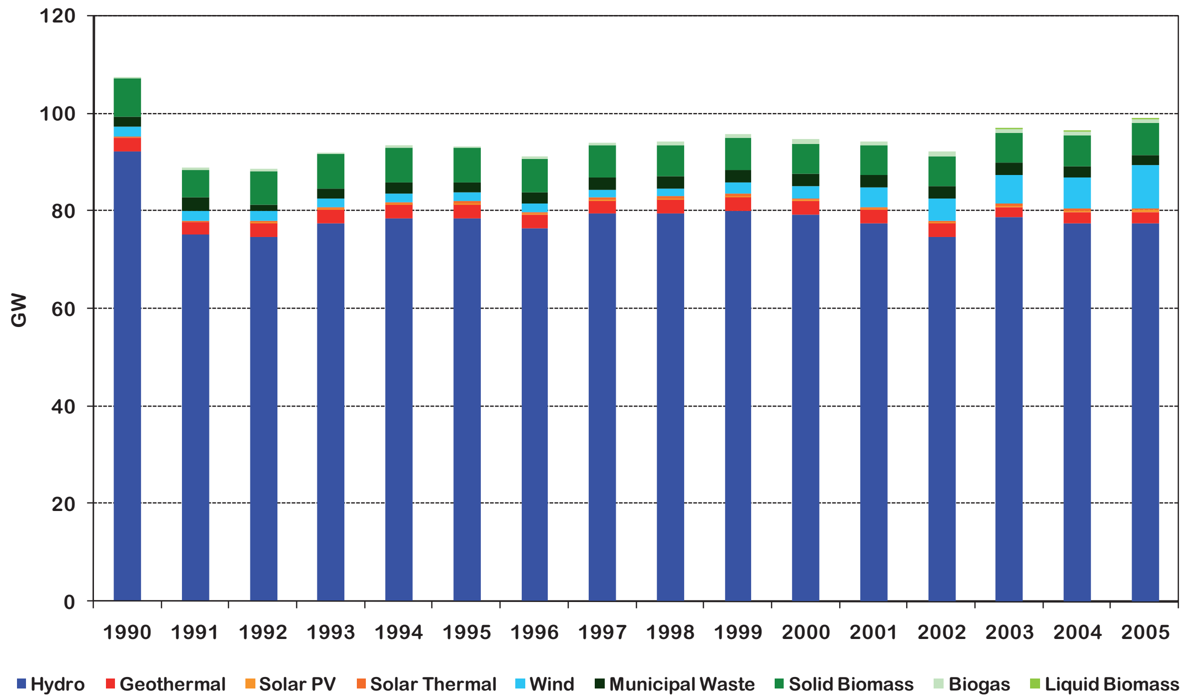
Geothermal electricity contributed 4.6% to the overall RES-E, non-CHP solid biomass 2.7% and renewable municipal waste 2.3%. While Geothermal electricity has seen a 2.8% annual average growth from 2000 – 2005, electricity from renewable municipal waste remained almost constant and RES-E from non-CHP solid biomass even declined.

Despite its lower share in total RES-E of 1.8%, electricity generation from biogas grew constantly over the 15-year period – on annual average by 6.5% – thus adding almost 4 TWh of annual electricity production in 2005 compared to 1990.

Electricity generated from solar PV added only 13 GWh in absolute terms to the RES-E portfolio between 1990 and 2005. However, installed solar PV capacities have grown on average by 19% annually from 1990 – 2005 and even by 28% for the period 2000-2005.

Concentrating solar power, which has not seen growth of any kind so far, is now expected to grow considerably, since new agreements were signed that are expected to result in 1-2 GW of new CSP plants.

Figure 3. Net Generating Capacity of RES-E Plants, 1990-2005



NB: Official IEA statistics on electricity generating capacity do not differentiate between *renewable* and *non-renewable* municipal waste.

Source: IEA (2007a)

Development of Renewable Electricity Policies

The support framework for the deployment of renewable energy is currently based on several federal incentives, but in fact nearly all renewable energy policy is state-driven. One of the most important federal schemes is the renewable electricity production tax credit (PTC), currently worth USD 20 per MWh, accompanied by "clean renewable energy bonds", which enable preferential financing of renewable energy projects for non-taxed entities, as well as other tax incentives and rebates especially for solar and geothermal installations. The Energy Policy Act (EPAct) of 2005 called for an increase of the renewable share in electricity production to 10% by 2010.

The most important state level policies are Renewable Portfolio Standards (RPS) that have so far been enacted in 25 states, the "Public Benefit Funds" (PBF) and state tax incentives for renewables.

The first RPS was enacted in 1996 and adoption of new state systems continued through 2007. They specify a quota of electricity that has to be supplied by renewable energy sources that ranges from a low 2% to 30%, but are frequently in the range of 20%. 12 of these states have specific set-asides in order to support the less mature, more expensive technologies like solar PV. Nevertheless, approximately 90% of the new renewable energy development that resulted from the introduction of RPS systems has come from wind power (Wiser *et al.*, 2007).

A 20% RPS has also been considered by the U.S. Congress on the national level, but – at the time of writing - no decisive action has been taken in this respect.

PBFs have been enacted in 17 states plus the District of Columbia providing additional support to renewable energy technologies in various ways. In general, funds are raised by utilities collecting a small fee from their customer's, *e.g.* USD 0.001 per kWh, and either administered by the state of by the utilities themselves. These funds range from a few million dollar per year to several hundred, accumulating to USD 6.8 billion by 2017.

Furthermore, states have also made increased use of, amongst others, net-metering laws, voluntary renewable electricity programmes, governmental purchases, preferential loans or rebate programmes for distributed generation. In most cases, federal and state incentives are cumulative. State tax incentives, however, are supposed not to be a strong driver for utility-scale large renewable projects, since tax liabilities of utilities may not be extensive in certain states and "state tax incentives are not incremental to the federal PTC, which tends to be much more valuable. This means that the developer can take advantage if the PTC or the state tax credit, but not both" (CEC, 2007).

The first political support instruments for the wider deployment of renewables have been introduced under the umbrella of the "Public Utilities Regulatory Act (PURPA)". It required electric utilities to buy the electrical output of small renewable energy generators at the utilities' avoided cost. PURPA also encouraged cogeneration plants. Avoided cost is the price that a utility would otherwise have to pay for power if it were to generate the power on its own. State regulatory commissions determined the details of the regulations governing PURPA contracts. In California and some other states the policy took the form of feed-in tariffs (FITs) based upon standard long-term purchase contracts and a mandatory fixed priced for all or some of the contract period.

During the 1980s tax credits and preferential depreciation rules set additional incentives for the deployment of solar, wind and geothermal equipment.

The "Energy Policy Act 1992" introduced a production tax credit (PTC) for wind and biomass projects, which was initially set at 1.5 cents per kWh for the first ten years of production and adjusted for inflation afterwards. Critical state policies were the Public Benefit Fund (PBF) and the Renewable Portfolio Standards.

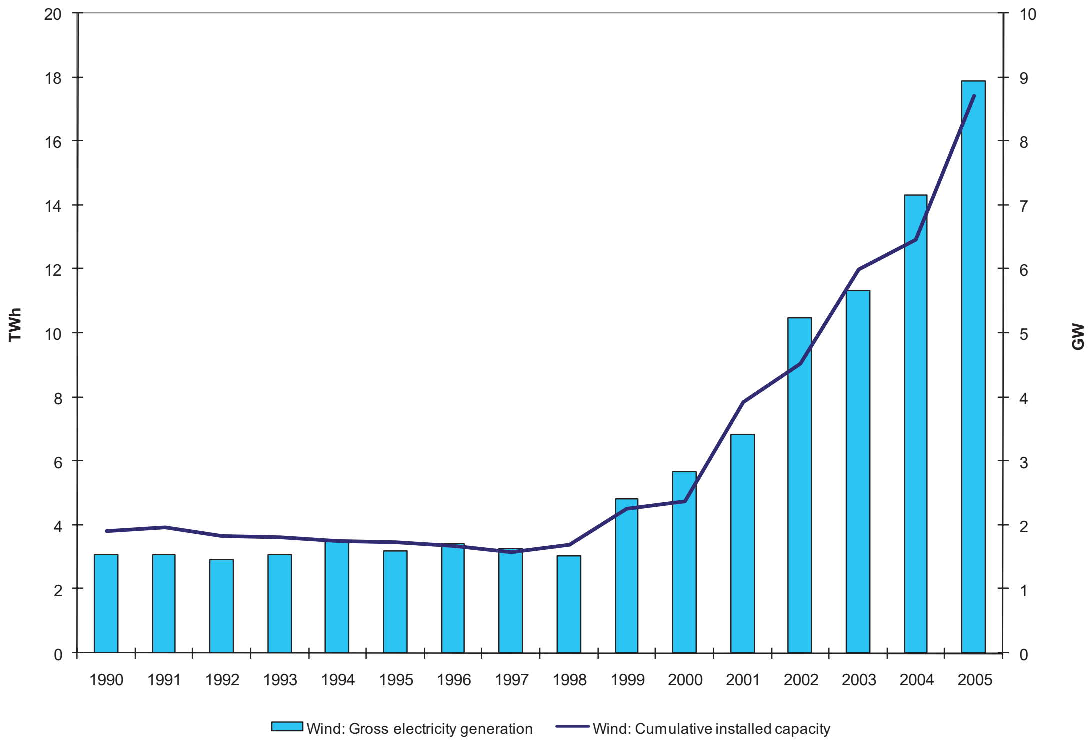
Nevertheless, the early 1990s were a period of increased uncertainty for the renewable energy industry with utility-based R&D programmes being drastically reduced. Besides, the PURPA-based support structure for renewables was largely dismantled, since mistakes in the design of purchase contracts have led to increasing prices for renewables, while wholesale electricity prices declined.

In the "Energy Policy Act 2005" (EPAct) the PTC was extended to geothermal energy, landfill gas, and certain hydro facilities. In effect, the PTC has made many wind and some other renewable electricity projects competitive to new coal power plants. However, the PTC was subject to many expirations and extensions, typically two-year periods (1999, 2001, and 2003), leading to boom and bust cycles in the installation of new wind power facilities (Figure 4).

In December 2006, the PTC was extended for another two years.

Focus: Wind Power Market and Policy Developments

Figure 4. Wind Power Market Development, 1990-2005



Source: IEA (2007a)

Since the beginning of the considered period (1990), wind power market development stagnated until the late 1990s with an overall trend of declining installed capacity until 1997. Since then development has picked up speed growing on annual average by 24%. This led to total capacity additions of more than 7 GW amounting to a total installed capacity of 8.7 GW in 2005 - more than five times 1997 levels. The United States have seen the world's largest annual net increase in wind power installations in 2005 as well as in 2006 (2 431 GW and 2 454 GW, respectively) with almost 11.6 GW of total installed capacities at the close of 2006 (IEA Wind, 2007). In terms of total installed capacity the US rates third behind Spain (slightly above 11.6 GW) and Germany with more than 20 GW of wind power capacity. However, growth in the US was not continuous since 1997 arguably due to the expiration cycles of PTC policies mentioned above.

Wind energy was one of the largest sources of new power generation capacities in 2006, second only to gas power plants (approximately 9 GW). According to the "Advanced Energy Initiative" launched by President Bush in 2006, 20% of the nation's electricity consumption could be provided by wind power (0.4% share in 2005) requiring an estimated 350 GW of total capacity.

By the end of 2006, five states accounted for two-thirds of the country's total wind power capacity:

- Texas with 2 739 MW;
- California with 2 376 MW;
- Iowa with 931 MW;
- Minnesota with 895 MW; and
- Washington with 818 MW.

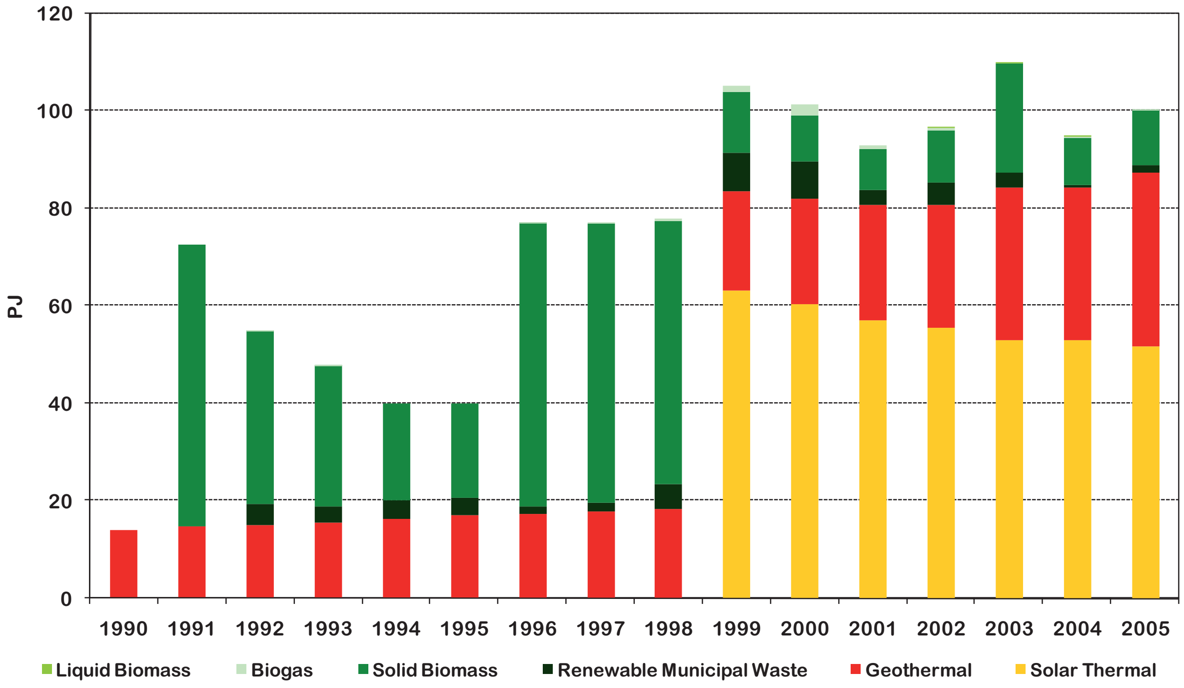
In addition, 11 other states have more than 100 MW of installed wind power capacities and five states have more than 50 MW.

Estimates indicate that over 50% of wind power capacity additions between 2001 and 2006 were motivated in part by quota requirements arising from state RPS schemes (Wiser *et al*, 2007). Federal tax incentives, mainly the PTC that – in 2007 - stood at 0.020 USD/kWh for a period of 10 years, helped to cover some of the additional costs of wind power generation.

Moreover, there are a number of additional federal as well as state level programmes offering loans, grants and other financial incentives. However, these are limited in terms of available funding and thus impact on wind power and other renewable energy technologies' development

Renewable heat (RES-H) Market

Figure 5. Total RES-H Production, 1990-2005[1]



NB: Geothermal and solar thermal include direct final use.

Source: IEA (2007a)

The quality of data on renewable heat is limited. According to IEA statistics, 100.4 PJ of renewable heat production has been reported for 2005. Slightly more than half of the total renewable heat stemmed from solar thermal applications, 36% was geothermal heat and the remaining 13% were supplied by biomass.

No data on solar thermal heat was available prior to 1999. Since then, solar thermal heat has declined on average 3% annually. In contrast, geothermal heat supply has grown continuously since 1990 – on average by 6% per annum. Data on heat from biomass shows considerable variations over time, probably due to data availability. However, its total and relative contribution to renewable heat has decreased.

Many states have policies to encourage production of renewable heat. These programmes often focus on solar heat, although some also offer incentives for biomass or geothermal heat as well. Such policy support exists in at least 43 out of the 50 states. These incentives have typically come in the form of income, sales and property tax exemptions and loans to

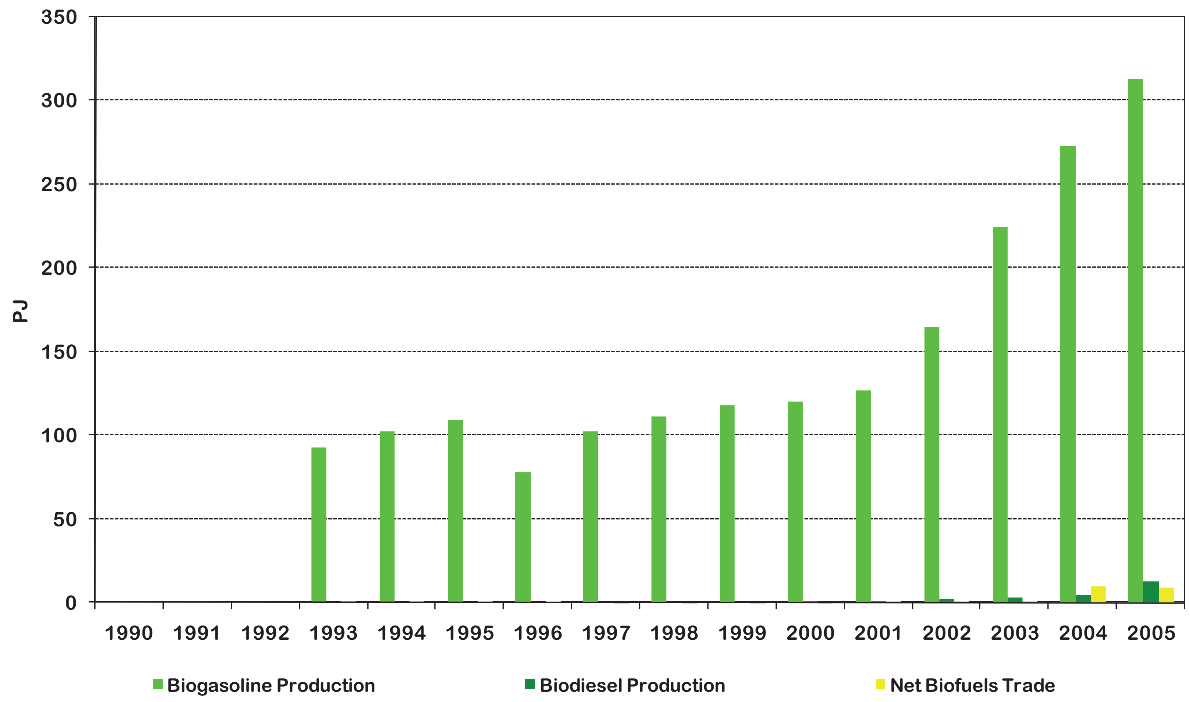
[1] Official IEA statistics on heat generation from renewable energy sources relate to **commercial heat sold** with additional data on **direct use** of solar thermal and geothermal available for most OECD countries.

businesses or homeowners. In the case of solar energy, many states specifically authorize individuals to engage in contracts to guarantee solar access – also referred to as solar easements.

RENEWABLE TRANSPORT FUEL (RES-T) MARKET

RES-T Market Developments

Figure 6. Total RES-T Production, 1990-2005



Source: IEA (2007a)

The United States are the world's second largest producer of bioethanol with 313 PJ in 2005, which is slightly below Brazil's 2005 level of production. In terms of consumption of total biofuels the United States leave Brazil behind due to its high biofuel exports.

No data has been made available to the IEA for biofuel production in the United States prior to 1993. In general, ethanol growth was limited in the 1990s and biodiesel production did only start in 2000. From 2001 until 2005, however, ethanol production grew by 250% - on average 25% per year – reaching 313 PJ in 2005. Biodiesel production grew even stronger – almost doubling production every year since 2001, despite its lower starting base.

In 2005 ethanol made up 90% of all biofuel consumption. Biodiesel accounted for only 4% of the total renewable transport fuels. Other liquid biofuels have an equally high share and the remaining 3% of total biofuel consumption is imported.

97 percent of ethanol in the United States comes from corn, and about 26 percent of the total corn produced went to ethanol production. Almost all biodiesel uses soybean as a feedstock in the United States and biodiesel will use about 10 percent of the total soybean crop production by the end of 2007 for total production of 500 million gallons[2] (1.89 billion litres). According to the USDA, the corn crop will soon face constraints on its ability to meet increasing demand for bioethanol. As a consequence, the United States is focusing heavily on the development of the second-generation biofuel cellulosic ethanol.

Development of Renewable Transport Fuel Policies

Biofuels production is driven by a combination of state and federal policies. 26 states have enacted legislations to support biofuels, among other measures using blending quotas.

On the federal level, the EPAct 2005 included a renewable fuel standard (RFS) for liquid fuels that mandated the stepwise increase of alternative fuel production to 7.5 billion gallons (28.4 billion litres) by 2012. After targets have been exceeded in 2006 by 13%, the President announced in his “20 in 10” plan[3] in January 2007 to increase the RFS to 35 billion gallons (132.5 billion litres) of biofuel production by 2017, which represents 15% of gasoline demand in a business-as-usual scenario. In December 2007, the United States President signed into law an energy bill expanding the horizon of the biofuels mandate to 36 billion gallons (136.3 billion litres) in 2022.

Further goals that are referred to as the Biofuels Initiative of the Department of Energy (DOE) are to make cellulosic ethanol cost competitive by 2012 and achieve a long-term goal of displacing 30% of the 2004 gasoline demand with biofuels by 2030.

The implementation of the RFS programme is governed by the Environmental Protection Agency (EPA) and translates into obligatory blending quotas for regulated entities, such as refiners, importers and certain blenders of gasoline. In February 2008, the blending quota for 2008 has been revised from 4.66% to 7.76%. Compliance for regulated bodies is facilitated by trading provisions enabling obligated parties to purchase so-called renewable identification numbers (RIN) that represent a certain amount of biofuels if they cannot or do not wish to blend renewable fuels into gasoline.

Besides the RFS, the EPAct included tax incentives for E85[4] refuelling stations, tax and performance incentives, authorizations for loan guarantees, a bioenergy research and development programme, and biorefinery demonstration projects. The blender’s tax credit of USD 0.51 per gallon (USD 1.93 per litre) was extended through 2010, but in effect applies only to domestic ethanol production[5]. For imported ethanol the tax credit is almost

[2] This refers to US (liquid) gallons. 1 US gallon equals 3.785 litres.
[3] The “20 in 10”plan envisages a reduction in gasoline consumption by 20% within 10 years.
[4] E85 is a gasoline-ethanol blend that includes up to 85% ethanol.
[5] The blender’s tax credit was first introduced in the “American Jobs Creation Act of 2004”.

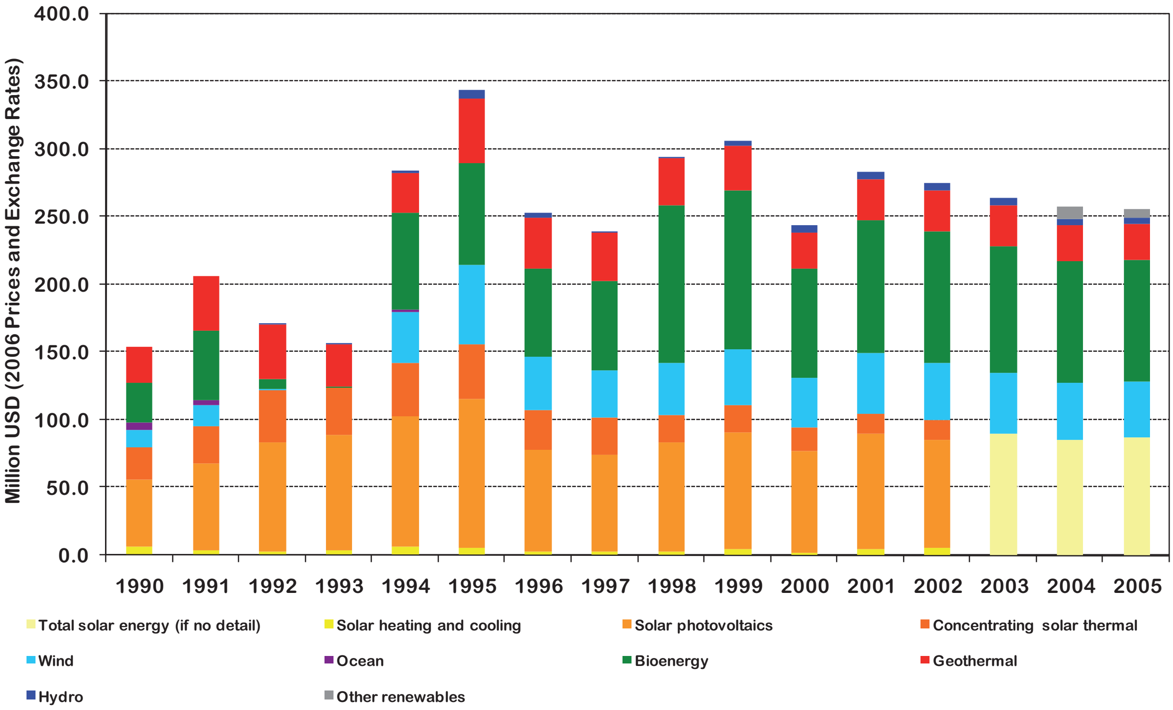
completely neutralised by a special tariff of USD 0.54 as well as a 2.5% import duty[6]. The tax credit was also extended in scope to biodiesel products and ranges from USD 0.50 – 1.00 depending on the feedstock.

The government also encouraged vehicle manufacturers to produce E85 flex-fuel vehicles[4]. In 2004 such flex-fuel vehicles accounted for 4.7% of all vehicles sales. The ethanol distribution infrastructure is being expanded by the private sector, but it is still limited to approximately 1,200 fuelling stations, mainly in the so-called Corn Belt, representing only 0.7% of all fuelling stations.

Biofuel policies started with the 1978 Energy Tax Act that provided an excise-tax exemption of 100% of the gasoline tax for alcohol fuel blends equal to USD 0.04 at that time. The 1990 Clean Air Act Amendments introduced a requirement on fuel additives that were increasingly met by ethanol due to the phasing out of methyl tertiary butyl ether (MTBE), which was completed in 2006. The new five-year Farm Bill for 2007 is expected to contain significant biofuel incentives.

[6] Some countries are exempt from the tariff, including but not limited to those from the Caribbean basin.

Figure 7. Annual Government RD&D Spending on Renewables, 1990-2005 (USD 2006 prices and exchange rates)[7]



Source: IEA (2007b)

Governmental RD&D expenditures on renewable energy amounted to USD 255.7 million in 2005. Bioenergy accounted for 35% of the total RE RD&D budget, followed by solar technologies (including solar heating and cooling, solar PV and solar thermal power) with 34% of the total. 16% were invested in wind energy RD&D, 10% in geothermal technologies and roughly 2% in hydropower and other renewables, each.

Considering cumulative expenditures for the period from 1990 to 2005, solar technologies received the largest share of public RE RD&D investments – 43% of the total USD 3,993 million. Expenditures on solar technologies rose continuously in the early 1990s until 1995 and were relatively stable, although on a lower level, since 1996. Solar PV accounted for the largest share among solar technologies (approximately 26% of the total), followed by solar thermal power (approximately 9% of the total) and solar heating and cooling with roughly 1%. On average annual spending on solar technologies amounted to US 114 million.

Bioenergy made up 29% of total cumulative investments. Despite strong fluctuations in the bioenergy spending, this is the second largest share of the budget. The annual average

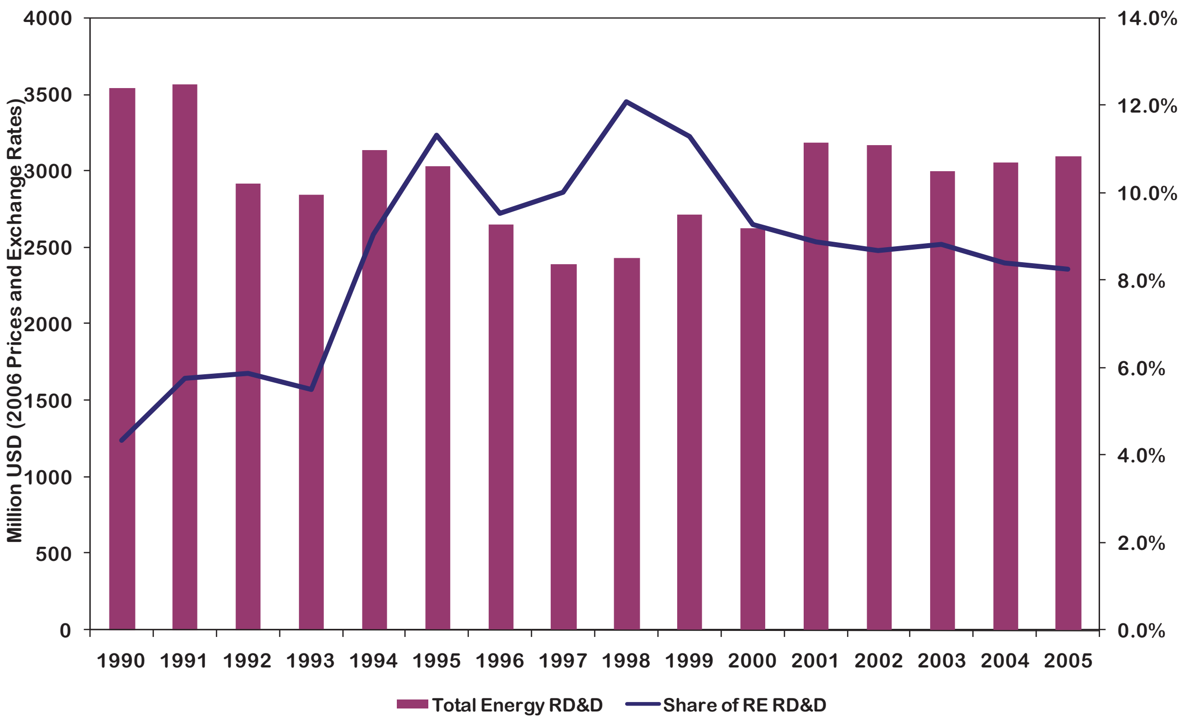
[7] Official IEA data on energy RD&D budgets include only **government** funding and not **private** RD&D spending.

budget was USD 77 million, but ranging from USD 1 million in 1993 to USD 118 million in 1999.

Spending on wind energy and geothermal energy accounts for 13% of the total cumulative budget from 1990 to 2005, each – on average USD 36 million per year. However, wind energy expenditures have been constantly higher since the mid 1990s, in contrast to the early 1990s, when wind RD&D was negligible. The budget for hydropower RD&D ranged from zero to USD 6 million in the considered time period.

The share of total RE RD&D in total energy RD&D expenditures was 8.3% in 2005, compared to 4.4% in 1990. It increased during the mid to late 1990s and was as high as 12.1% in 1998. Afterwards the share dropped again significantly. For the whole period 8.4% of the cumulative energy RD&D budget was spent on RETs.

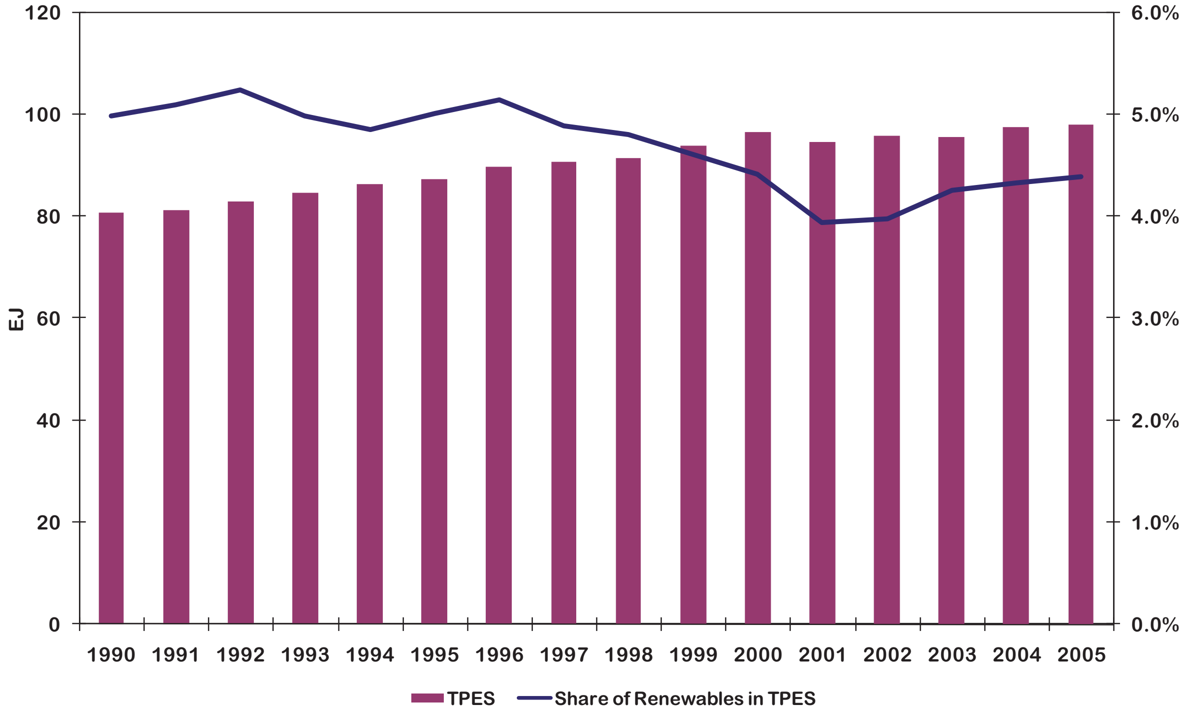
Figure 8. Renewable energy RD&D versus total government energy RD&D spending, 1990-2005



Source: IEA (2007b)

RENEWABLES IN TOTAL PRIMARY ENERGY SUPPLY[8]

Figure 9. Share of Renewable Energy in Total Primary Energy Supply, 1990-2005



Source: IEA (2007a)

TPES was 80.7 EJ in 1990 and rose to 98.0 EJ in 2005. The United States have seen strong economic growth in recent years. In contrast, renewable primary energy supply grew only by 0.5% on annual average.

The share of renewable primary energy supply in TPES was 5.0% in 1990, peaked in 1992 at 5.2% and declined significantly afterwards to 3.9% in 2001. The downturn from the mid to late 1990s can in part be attributed to low precipitation levels and, thus, lower hydro power generation. Until 2005 the share of renewables in TPES rose again to 4.4%. However, due to steadily increasing TPES this was still considerably lower than in the early 1990s, despite average hydro capacity factors.

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[8] The official IEA statistics on TPES include, where applicable, traditional biomass but exclude pumped hydro.

Primary energy convention: The IEA uses the **physical energy content method** to calculate the primary energy equivalent of non-combustible energy sources, such as geothermal, hydro, solar and wind. As a consequence, there is an obvious link between the principles adopted in defining the primary energy forms of energy sources and the primary energy equivalent of these sources. For instance, in the case solar thermal and geothermal electricity production, as heat is the primary energy form selected by the IEA, the primary energy equivalent is the quantity of heat generated in the geothermal or solar thermal plant for electricity generation. In the case of hydro, wind, tide and solar PV, as electricity is the primary energy form selected, the primary energy equivalent is the physical energy content of the electricity generated in the plant, which amounts to assuming an efficiency of 100%. Readers may consult (IEA, 2007a) for more details.

Renewable Energy Policy Information

For further details on renewable energy support policies implemented in the United States, readers may consult the regularly updated IEA/JREC Global Renewable Energy Policies and Measures online database (http://renewables.iea.org).

Glossary

Definitions, abbreviations, acronyms and units are explained in the Glossary which can be found after the country profiles.

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DEFINITIONS, ABBREVIATIONS, ACRONYMS AND UNITS

TECHNOLOGY DEFINITIONS[1]

Biofuels/Liquid biomass

Biofuels/liquid biomass includes the following fuels and bioadditives: such as biogasoline (includes bioethanol, biomethanol, bioETBE and bioMTBE), biodiesel and other liquid biofuels.

- *Bioethanol*: ethanol produced from biomass and/or biodegradable fraction of organic waste.
- *Biomethanol*: methanol produced from biomass and/or the biodegradable fraction of organic waste.
- *Biodiesel*: diesel quality liquid fuel including biodiesel, biodimethylether, Fischer Tropsch, cold pressed bio-oil and all other liquid biofuels which are added to, blended with or used straight as transport diesel.
- *Other liquid biofuels*: includes liquid biofuels, used directly as fuel, not included in biogasoline or biodiesels.

Biogas

Biogas is a gas composed principally of methane and carbon dioxide, derived principally from the anaerobic fermentation of biomass and solid waste and is combusted to produce heat and/or power. It comprises:

- *Landfill gas*, formed by the digestion of organic landfilled wastes;
- *Sewage sludge gas*, produced from the anaerobic fermentation of sewage sludge;
- *Other biogas*, such as biogas produced from the anaerobic fermentation of animal slurries and of wastes in abattoirs, breweries and other agro-food industries.

Biomass

Biomass is defined in this context as any plant matter used directly as fuel or converted into other forms before combustion. Due to its varied forms and uses, biomass is a highly challenging resource on which to compile statistics.

Biomass co-firing

Combustion of small shares of biomass in coal-fired power plants

[1] More detailed information can be obtained by consulting the annual IEA publications *Renewables Information*, *Electricity Information*, *Energy Balances of OECD Countries* and *Energy Balances of Non-OECD Countries*. Detailed descriptions and appraisals of the status of individual renewable energy technologies are available from the IEA publications *Renewable Energy RD&D Priorities: Insights from IEA Technology Programmes* and *Energy Technology Perspectives 2008*.

Combined heat and power (CHP)

Co-generation of usable heat and power

Geothermal energy

Energy available as heat emitted from the earth's crust, usually in the form of hot water or steam. It is exploited at suitable sites:

- for electricity generation using dry steam or high enthalpy brine after flashing; or
- directly as heat for district heating, agriculture, etc.

Hydropower

Kinetic energy of falling water converted into electricity in hydroelectric plants. Pumped storage information is included in the data collection, but in a separate category as it is mostly derived from non-renewable sources. Detailed plant sizes are reported net of pumped storage. **Only hydro generation net of pumped storage** is included in "Total Renewable Energy Supply".

Ocean energy

Mechanical energy derived from ocean currents, tidal movement or wave motion and exploited for electricity generation.

Renewable municipal waste

Renewable municipal waste consists of the biodegradable part of municipal waste products that are combusted directly to produce heat and/or power. It comprises waste produced by the residential, commercial and public services sectors that is collected by local authorities for disposal in a central location, including biodegradable hospital waste.

Solid biomass

Included are:

- *Charcoal:* the solid residue of the distillation and pyrolysis of wood and other vegetal material; and
- *Wood, wood wastes, other solid wastes:* purpose-grown energy crops (poplar, willow etc.), a multitude of woody materials generated by an industrial process (wood/paper industry in particular) or provided directly by forestry and agriculture (firewood, wood chips, bark, sawdust, shavings, chips, black liquor, etc.) as well as wastes such as straw, rice husks, nut shells, poultry litter, crushed grape dregs, etc. Combustion is the preferred technology for these solid wastes. The quantity of fuel used is reported on a **net** calorific value basis.

Solar energy

Solar radiation exploited for hot water production, space heating and/or electricity generation[2], separately defined as:

- *Solar photovoltaics (PV)*: This is solar radiation exploited for electricity generation by photovoltaic cells.
- *Solar thermal*: This is solar radiation exploited for
  - i) for hot water production or for seasonal heating by flat plate collectors; and/or
  - ii) electricity generation by solar thermal-electric plants.

There are three main *solar thermal-electric* technologies:

- *Parabolic trough plant:* Large cylindrical parabolic mirrors concentrate the sunlight on a line of focus. Several of these collectors in a row form a solar field. Molten salt is then used to transport the heat to a (conventional) gas or steam turbine.
- *Solar power tower plant:* The solar field of a central receiver system, *i.e.* the power tower, is made up of several hundred mirrors which concentrate the sun light to the central receiver. Similar to above, air or molten salt is used to transport the heat to a conventional gas or steam turbine.
- *Dish/Stirling Technology:* Parabolic dish concentrators are rather small units – in the range of kilowatts – in contrast to the above technology concepts.

Trough and power tower plant are usually equipped either with a thermal storage block or a hybrid fossil burner in order to guarantee a non-fluctuating power supply.

Total final consumption

Total final consumption is the sum of consumption by the different end use-sectors. TFC is broken down into energy demand in the following sectors: industry, transport, other (includes agriculture, residential, commercial and public services) and non-energy uses. Industry includes manufacturing, construction and mining industries. In final consumption, petrochemical feedstocks appear under industry use. Other non-energy uses are shown under non-energy use.

Total primary energy supply

Total primary energy supply is equivalent to total primary energy demand. This represents inland demand only and, except for world energy demand, excludes international marine bunkers.

Traditional biomass

Traditional biomass refers mainly to non-commercial biomass use.

[2] Passive solar energy for direct heating, cooling or lighting of dwellings or other buildings is not included.

Transformation sector

The transformation sector comprises the conversion of primary forms of energy to secondary forms as well as further transformation processes.

Wind energy

Kinetic energy of wind exploited for electricity generation in wind turbines.

Note: The kinetic wind energy that is harvested as mechanical force for such applications as water pumps is not included.

DEFINITIONS USED FOR IEA ENERGY TECHNOLOGY RESEARCH, DEVELOPMENT AND DEMONSTRATION (RD&D) STATISTICS[3]

Renewable energy sources

Renewable energy sources encompass: bioenergy, geothermal energy, hydropower, ocean energy, solar energy, wind energy, and other renewables.

Bioenergy

Bioenergy encompasses:

- *Production from transport biofuels including from wastes*: conventional biofuels; cellulosic conversion to alcohol; and biomass gas-to-liquids
- *Production of other biomass-derived fuels including wastes*: bio-solids, bio-liquids; biogas thermal; and biogas biological.
- *Applications for heat and electricity*: bio-heat excluding multi-firing with fossil fuels; bio-electricity excluding multi-firing with fossil fuels; CHP (combined heat and power) excluding multi-firing with fossil fuels; and recycling and uses of urban, industrial and agricultural wastes not covered elsewhere.
- *Other bio-energy*: improvements of energy crops; and research on bio-energy production potential and associated land-use effects; and other.

Geothermal energy

Geothermal energy includes *hydro-thermal, Enhanced geothermal systems (EGS or hot dry rock), geothermal heat applications, including agriculture*.

[3] The IEA RD&D statistics data can be accessed at: http://www.iea.org/Textbase/stats/rd.asp . More detailed information on the RD&D technology categories used can be obtained by consulting the documentation on the IEA energy technology RD&D budget statistics: http://wds.iea.org/WDS/tableviewer/document.aspx?FileId=1092 .

Hydropower

Hydropower encompasses:

- *Large hydropower*: hydropower plants with capacity of 10MW and above; and
- *Small hydropower*: hydropower plants with capacity of below 10MW.

Ocean energy

Ocean energy includes: *tidal power; wave energy; ocean current power*; and *ocean thermal power*.

Solar energy

Solar energy encompasses:

Solar heating and cooling (including daylighting): collector development; hot water preparation; combined-space heating; active solar heating and cooling; passive solar heating and cooling; daylighting; solar architecture; solar drying; solar-assisted ventilation; swimming pool heating; and low-temperature process heating;

Solar photovoltaics (PV): solar cell development; PV module development; PV inverter development; building-integrated PV-modules; and PV system development; and

Concentrating solar thermal[4] *and high temperature applications*: concentrating collector development; solar thermal power plants (design, construction and testing); solar high-temperature applications for process heat; and solar chemistry.

Wind energy

Wind energy encompasses: *converter development; system integration; on-shore applications;* and *off-shore applications*.

Other renewables

The technology category encompasses: studies of renewable energy potentials not covered elsewhere; and other.

[4] **Concentrating solar thermal:** Concentrating solar thermal is an alternative denotation for concentrated solar power (CSP) or solar thermal electricity (see entry for **solar energy**).

Bioenergy conversion factors

The bioenergy conversion factors applied in the country profiles are taken from a quick-reference list used by the Bioenergy Feedstock Development Programmes at Oak Ridge National Laboratory (ORNL), Oak Ridge, United States[5].

Ethanol:

Metric tonne ethanol = 7.94 petroleum barrels = 1262 litres

Ethanol energy content (lower heating value, LHV) = 75,700 Btu/(US liquid) gallon[6] = 26.7 GJ/tonne = 21.1 MJ/litre

Higher heating value (HHV) for ethanol = 84,000 Btu/gallon = 89 MJ/(US liquid) gallon = 23.4 MJ/litre

Ethanol density (average) = 0.79 g/ml (= metric tonnes/m^3)

Biodiesel:

Metric tonne biodiesel = 37.8 GJ (33.3-35.7 MJ/litre)

biodiesel density (average) = 0.88 g/ml (= metric tonnes/m^3)

Abbreviations and acronyms

Btu	British thermal unit
CHP	combined heat and power
CO_2	carbon dioxide
CSP	concentrating solar power
FIT	feed-in tariff
FIP	feed-in premium
GHP	ground-source heat pump
HHV	higher heating value
IEA	International Energy Agency
LHV	lower heating value
LPG	liquefied petroleum gas
NB	*Nota Bene* (note well)
p.a.	per annum
PTC	production tax credit
PV	photovoltaics
R&D	research and development
RD&D	research, development and demonstration

[5] http://bioenergy.ornl.gov/papers/misc/energy_conv.html
[6] 1 US (liquid) gallon equals 3.785 litres.

RE	renewable energy
RES	renewable energy sources
RES-E	electricity generated from renewable energy sources
RES-H	heat produced from renewable energy sources
RES-T	transport fuels produced from renewable energy sources
RET	renewable energy technology
ROC	Renewable Obligation Certificate
TGC	tradable green certificate
TPES	total primary energy supply
UNFCCC	United Nations Framework Convention on Climate Change

CURRENCY CODES

AUD	Australian dollar
BRL	Brazilian real
CAD	Canadian dollar
CNY	Yuan renminbi
EUR	Euro[7]
INR	Indian rupee
KRW	Korean won
JPY	Japanese yen
MXN	Mexican peso
NOK	Norwegian krone
SEK	Swedish krona
USD	United States dollar

UNITS

EJ	exajoule, 1 exajoule equals 10^{18} joules
g	gramme
Gwe	gigawatt electric
GWh	gigawatt-hour, 1 kilowatt-hour equals 10^{9} watt-hours
h/a	hours per year
ha	hectare
hl	hectolitre, 1 hectolitre equals 100 litres
J	joule

[7] The Euro became the legal tender in 12 OECD-EU countries on 1 January 1999: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal and Spain. The cash changeover occurred on 1 January 2002.

kb	kilobarrel
kl	kilolitre, 1 kilolitre equals 1 000 litres
km^2	square kilometre
ktoe	kilo tonne of oil equivalent
kV	kilovolt, 1 kilovolt equals 1 000 volts
kWh	kilowatt-hour, 1 kilowatt-hour equals 10^3 watt-hours
kWp	kilowatt-peak
kWth	kilowatt thermal
l	litre
m^2	square metre
m^3	cubic metre
ml	millilitre
Mtoe	million tonnes of oil equivalent
Mwe	megawatt electric
MWh	megawatt hour, 1 megawatt-hour equals 10^6 watt-hours
MWp	megawatt-peak
PJ	petajoule, 1 petajoule equals 10^{15} joules
t	(metric) tonne
TJ	terajoule, 1 terajoule equals 10^{12} joules
toe	tonne of oil equivalent
TWh	terawatt-hour, 1 terawatt-hour equals 10^{12} watt-hours
W	watt