AUSTRIA

1. Situation of Renewable Energy

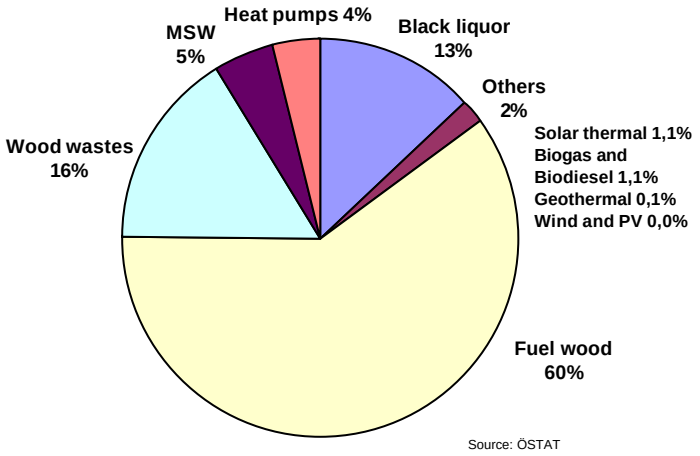
Austria's energy supply is based on a balanced mixture of energy sources which is characterised by the prominent role of renewables. Their share in the overall energy system has been rising continuously since the mid-seventies and reached 26.4% (statistical convention of Austria; Eurostat-convention: 24.3%) of total energy supply in 1996. This rate is one of the highest in the European Union.

Table: Primary Energy from RES (according to IDAE's graph)

Year	1990	1991	1992	1993	1994	1995	1996	2010
RES Primary Energy Production (ktoe)	5775	5616	5872	6433	6196	6614	6208	n.a.
RES contribution to the total inland consumption (%)	25,7	27,0	25,5	25,6	26,3	26,7	27,6	n.a.

The most important renewable sources of energy are hydropower with a share of 13.4%, and the so-called "other energy sources" (especially biomass) with about 13%.

"Other sources of energy " in Austria (1996)



The high proportion of biomass used is mainly due to the great significance of wood for domestic heating. But for the near future it is very likely that the share of renewable energy sources will decline. On the one hand only a few more hydro-power plants will be built because of cost reasons (Internal Market for Electricity), on the other hand biomass is loosing ground in the domestic heating sector.

The high level of renewables-based energy, such as the two-thirds of electricity production, has helped keep Austria's per capita emissions of CO_2 at 7.5 tonnes in 1995, as opposed to an EU average of 8.6 tonnes.

1.1. Renewable energy technologies

Small hydro

Austria's tradition of utilising hydropower as a clean and emission-free way of generating electricity dates back several decades. Of the total 17.5 GW installed in 1996 in Austria's energy utilities as well as in installations operated by the Austrian Railways and by industrial enterprises, 11.4 GW was hydropower (this includes 5.0 GW from run-of-river power stations and 6.4 GW from storage power stations). Overall, hydropower accounts for about 70% of domestic power production. Its share of total energy supply is 13.4% (statistical convention of Austria).

In addition to the large hydropower stations of the major energy utilities, Austria has a great number of small and very small power plants. According to a survey of all small plants which are connected to the grid of regional utilities, there were 1,690 small hydropower stations with a total capacity of about 600 MW and an annual generating capacity of 2,300 GWh, in 1994. This represents about 9% of total hydropower capacity. There are probably another 4,000 to 5,000 small stations in Austria which are not covered by the statistics as they are not connected to the public grid, increasing the overall power output by roughly 10 to 15%. These figures are based on estimates of the turbine industry as well as on extrapolations from detailed examinations of a number of running waters.

Typically, Austria's small-scale hydropower stations are characterised by their decentralised location, often by immediate energy utilisation by private or industrial users, by the investment of private capital, and by the resulting effect on the regional and local economy.

Even though the maximum capacity of "small hydropower plants" in Austria's definition is 5 MW, about 70% of all stations for which there are statistical data have a capacity less than 250 kW. Over 90% of all installations are below 1,000 kW. Taking into account the estimated number of stations which are not covered by statistics, the proportion of plants smaller than 100 kW rises to about 90%, and the share of those with less than 1,000 kW, to 97%. It is thus safe to assume that the capacity of the typical Austrian small-scale power station is between 100 and 300 kW.

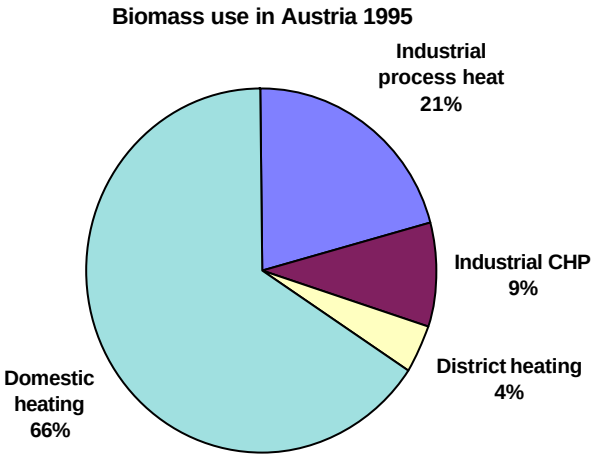
According to an estimate of the Austrian Association for the Promotion of Small Power Stations, about 40 to 45% of the potential for small hydropower plants has been exploited to date, leaving approximately 800 MW or 4,000 GWh/y still to be developed.

Biomass

With forest making up about 46 % of the landscape, Austria is among the most densely wooded countries in Europe, which is why the heating of buildings with biomass (wood) has a very long tradition. In large urban areas biogenous fuels have largely been replaced by fossil fuels (natural gas and oil) and district heating. However, biogenous energy is still very important in rural areas where "local energy" is utilised, increasingly by means of the latest technique, in single heaters, central heating systems and biomass district heating plants with several MW thermal power. The contribution of biomass to total energy supply is about 13%.

Austria (draft)

Total biomass supply is about 150 PJ annually. Over 70 % of the biomass is utilised in low-temperature applications, i.e. the combustion of wood or wood chips in single heaters or central heating boilers in the case of small-scale users, or of various biogenous fuels (bark, sawmill residue, wood chips, or straw) in biomass-fired district heating systems.



Biomass for Space Heating

More than 570,000 domiciles are currently heated by wood-fired systems. Most of the biomass is used in traditional fuelwood-furnaces, but many of which are already equipped with modern combustion technology. Between 1983 and 1997 22,577 heating systems based on wood chips (small, medium and large scale furnaces) with an installed heat power of 2,207 MW were installed. Only since 1997 furnaces based on biomass pellets have begun a promising boom. Nevertheless the share of households with biomass heating systems is decreasing for some years.

New systems entering the market are subject to a strict licensing procedure by authorised testing institutions. As a result of strict regulation since the eighties, considerable progress has been made in the combustion and control technology of small log-fired systems, which has positively affected the utilisation and sale of such systems. Thus emissions of carbons in organic compounds and of carbon monoxide could be reduced to one-tenth to one-hundredth for both hand-charged and automatically charged systems, while their efficiency has increased from an average of 60% to 80 or 90% in the last ten years. Significant progress has also been made in terms of design and user-friendliness as well as suitability for serial production of Austrian systems. In the interest of enhanced user-friendliness, attempts are currently being made to stimulate the market for pellets.

Biomass-fired district heating networks have been developed and built in rural areas since the mid-eighties; this market has meanwhile seen a considerable upturn. The construction of such plants has been subsidised by both the Federal Government and the Federal States with great success: approximately 50 new plants per year have been built in the last few years; by the end of 1997 as many as 359 plants with a total capacity of 483 MW were operating.

Continuous development work is also being done in the sector of district heating networks. Current research projects deal with issues such as efficiency upgrading, further reduction of pollutant emissions, flue gas condensation, and ash processing.

Biomass utilisation in Industry

Almost one-third of the annual overall biomass supply of about 150 PJ is used for process heat and in industrial CHP plants. The industries mainly utilising biomass (which is usually a by-product of their own activities) include the sawmill industry, the paper and wood pulp industry and the wood working industry.

There are approximately 1,700 sawmills in Austria, processing about two-thirds of the country's timber. This amounts to more than 10 millions of cubic metres of solid timber. Approximately two thirds of the timber (without bark) which is processed in sawmills is converted to sawn timber; the remaining as well as the bark are residues which are partly suitable for further processing, and partly utilised for energy production. As most sawmills are equipped with bark peeling machines, wood residues tend to be bark-free. This makes them suitable for further processing in the paper and wood pulp industry, where they fetch a higher price. What remains for energy production is therefore mostly the bark, amounting to about 600,000 m^3 of solid timber annually.

The residues of the paper and wood pulp industry which are utilised for energy generation include bark and black liquor from pulp production, which mostly consists of dissolved lignin, a constituent of wood. They are mainly used in black liquor boilers and fluidised bed boilers to supply the industry's own electricity and heat demand. Of the total fuel of about 62 PJ consumed by the roughly 30 enterprises of the paper and wood pulp industry in 1997, 34% was black liquor, 1% sludge, 5% bark, 47% natural gas, and 13% coal and oil. In other words, 40% of the energy required in this sector was produced from environmentally benign biomass. Bark and black liquor utilisation for energy production has gone up over the last few years, along with the industry's rising overall energy consumption and the increasing production of paper and wood pulp. The use of coal and oil, on the other hand, is steadily decreasing.

The various branches of Austria's wood working industry (construction, furniture and ski manufacture, joiners' and carpenters' workshops) produce a considerable quantity of waste wood, most of which is used as fuel. On average, this amounts to approximately 1.5 million m^3 of solid timber, of which about 70% is used for thermal energy production. 350,000 m^3 is passed on to other enterprises or to private households; most of the remaining 30% of the total quantity is processed further, mainly in paper and board production.

Electricity from Biomass

If an adequate energy supply is to be ensured for the future, increased use will have to be made of biomass for power production. Several projects for the development of the required technologies have therefore been launched in Austria.

In co-operation with an industrial enterprise, a new fluid bed process for the gasification of biomass has been developed which will allow the production of high-grade product gas. Through the use of steam as a gasification agent it has been possible to achieve a marked reduction in the tar content of the product gas compared to using conventional

techniques. This technology constitutes an interesting option for combined heat and power generation from biomass, mainly in larger installations of about 5 MW or more. Possible applications in fuel cells are to be explored within the framework of an JOULE-THERMIE project.

In order to provide a suitable technology for the low and medium power range (200 kW to 1 MW), researchers at Graz Technical University are developing a solid bed gasifier. Specifically, this process could be implemented in biomass-fired district heating networks to supply their own power demand.

Austria's biggest electricity utility (Verbundgesellschaft) has been exploring the application of biomass for co-firing in coal-fired power stations and has realised two major projects so far: In the 110 MW coal power station at St. Andrä a biomass incineration grate was installed in the course of a major overhaul, so that about 30 tons of coal a day can now be substituted with biomass if the plant is operating at capacity. In the 137 MW coal power station at Zeltweg, biomass is crushed and partially gasified in a circulating fluidised bed gasifier so that the resulting product gas can be burned (10 MW_{th}).

Biogas

It has been established that methane (CH_4) is accountable for 13% of the greenhouse effect caused by human activity. In view of world-wide efforts to reduce anthropogenic greenhouse gas emissions, the recovery of biogas, a significant part of which is methane, for energy production gains special importance.

After a series of setbacks in the early seventies there have been several successful applications in Austria in recent years which have contributed to the increased importance which biogas technology enjoys today.

Total number of biogas installations in Austria (1996)

installations	**number**
agricultural installations	58
anaerobic digesters	3
industrial installations	6
municipal sludge digesters	118
landfill gas recovery	11
total number of installations	**196**

Currently there are about 200 installations of different sizes and types in operation. Additional ones are being planned, especially in the field of landfill gas recovery.

Even though the existing potential is far from being exhaustively utilised, landfill gas is continually gaining in importance. Besides several smaller installations, the gas from Vienna's largest landfill at Rautenweg has been recovered for energy production since 1991. This plant with an electric power capacity of 8 MW and an annual electricity production of about 40 GWh is currently the largest in Europe.

The advantages of biogas utilisation in agriculture are numerous: it represents a renewable energy source, an environmentally sound way of organic waste disposal and organic fertiliser production, and significantly reduces bad smell. Biogas is typically util-

ised in combined heat and power installations, whose excess power is fed into the grid. Occasionally substances such as vegetable and other food residues or oil are added. In order to encourage the further development of this potential a fund has been set up to subsidise the installation of biogas systems by agricultural operators.

Biofuels

Research and development activities in the biofuel sector have been under way for many years now; the first projects were started in 1973. In 1987 a large-scale pilot project on biodiesel was launched at the Federal Institute of Agricultural Engineering at Wieselburg, with the aim of developing a diesel fuel from rape oil to the marketable stage. In 1990 producers released the first tractors running on biodiesel.

In 1991 one of the world's first industrial biodiesel production plants started operation at Aschach (Federal State of Upper Austria). Today up to 28,000 tons of biodiesel a year can be produced in two industrial plants. In addition there are several small plants in Austria owned by agricultural co-operative societies with annual production capacities of 1,000 to 3,000 tons.

Most of the fuel produced is RME; sunflower methyl ester and used-oil methyl ester are only produced in small quantities.

In small co-operative plants the raw material and the finished product remain the property of the farmer, who receives the fuel against payment of a processing fee. A distribution infrastructure has had to be set up for fuel from commercial plants, which is sold partly to farmers and partly to haulage contractors. At present there are more than 50 "ECOdiesel stations".

A few emergency power generating units running on vegetable oil are used to supply alpine refuges which are located in ground water preserves.

Municipal Solid Waste

Three MSW-incineration plants are in operation in Austria. Two of them are located in Vienna. Their annual capacity is about 438,000 tons of MSW. About half of the MWS's heat value derives from various biogenous materials. The Spittelau-plant, which was designed by the famous artist Hundertwasser, produced 35 GWh of electricity and 442 GWh of heat in 1997. The heat produced in these plants covers about one fourth of Vienna's district heating demand.

Wind power

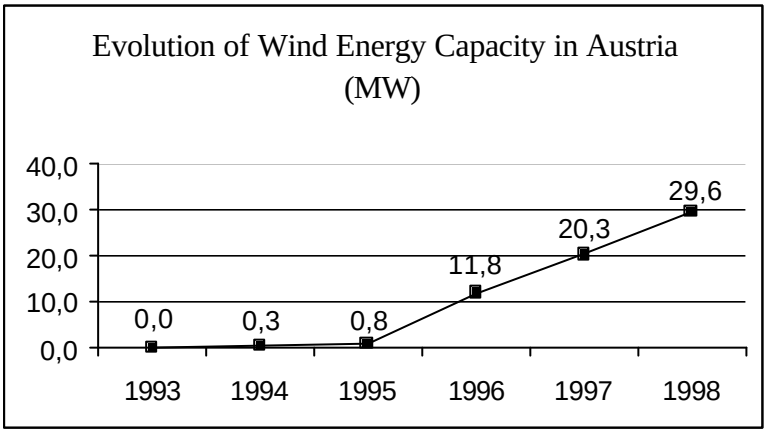
Despite being a landlocked country with distinct topographic features, Austria meets the meteorological requirements for the utilisation of wind energy. In the early eighties preliminary calculations on the basis of the anemometric data provided by meteorological stations surprisingly showed a technically utilisable wind energy potential of 6,600 to 10,000 GWh annually. Even though only part of this potential is also economically viable and desirable from the point of view of landscape protection, there have been promising developments in this sector.

Until a few years ago only small installations were built; in 1994 the first major grid-connected wind power station came on line. By the end of 1998 66 wind turbines with an installed capacity of 28.1 MW were in operation. Almost all of them were installed

in 1996 or later. These pioneer projects have inspired plans for another 100 installations totalling more than 50 MW.

Particularly in Austria with its high degree of hydropower utilisation, wind power is considered a practicable supplementary form of alternative energy production. Two-thirds of the wind occurs during the winter, the time when water availability is at its lowest and power demand is at its highest. It is particularly during this time that wind power stations could replace thermal power stations, thus helping to reduce electricity imports.

Conditions are particularly favourable in the agricultural areas in the foothills of the Alps in the Federal States of Lower Austria and Upper Austria, as well as in the east of Vienna in the northern part of the Federal State of Burgenland.



Solar Thermal

After the original boom in the late seventies and a slump in the market in the eighties, the last few years saw the installation of more than twice as much collector capacity as in the fifteen years before. In the years from 1987 to 1997 alone about 100,000 installations went into operation. The majority of these installations are used for water heating and for partially solar space heating; a smaller proportion are used to heat swimming pools. While the share of solar thermal energy in total energy supply is still below 0.2%, the annual increase rates are remarkable. Today Austria is the country with the second highest per capita rate of solar collectors in Europe.

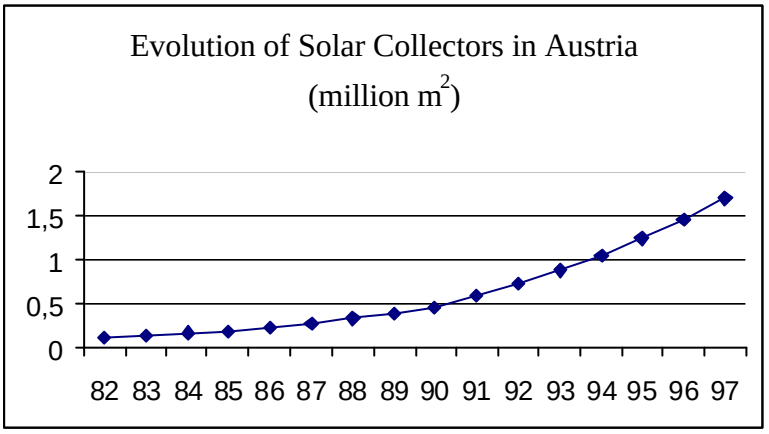
By the end of 1997 1.7 million m^2 of solar collectors had been installed in Austria, of which 68% was standard-type collectors, 31% synthetic collectors (absorbers), and 1%, vacuum collectors. The annual heat output of about 566 GWh corresponds to a (fictitious) fuel oil equivalent of about 870,600 tons, which means that pollutant emissions are reduced accordingly.

The rise of solar energy began in 1983, when the first self-assembly group for solar water heaters, was organised in Styria. This idea has since developed into a movement ("Arbeitsgemeinschaft ERNEUERBARE ENERGIE"), active in the whole of Austria. The self-assembly systems have been continually developed and with public support the organisation of a consultation service for the whole of Austria has been worked out. Self

assembling also has initiated great demand for commercially built solar water heaters, which has brought up numerous companies now working in this field. Since 1993 commercially built solar systems hold by far the biggest share in the solar market.

Apart from the solar hot-water and the partial solar room heating units, also several larger solar plants for heating purposes (combined with biomass district heating plants) have been carried out.

This positive development is partly due to many years of continuous and intensive R&D work. On the other hand, subsidy schemes have been set up by the Federal States as well as by local authorities to promote the use of solar energy. In addition, tax cuts are available for end users who install solar collectors, provided that they meet certain requirements.



Solar Photovoltaic

At the end of 1997 photovoltaic systems with 2.2 MWp were installed in Austria. A capacity of 1.2 MWp was connected to the grid. During the last years the annual growth rate was constantly around 30%.

An analysis of the development of system-costs showed a decrease from 10.5 ECU/Wp in 1993 to 6.7 ECU/Wp in 1997.

Geothermal

The launch of geothermal energy utilisation in Austria was actually the result of a failure: in 1978, while drilling for petroleum near Bad Waltersdorf in eastern Styria, the prospectors struck a hot spring. Today the spring heats hotels with a total capacity of 1,000 beds, two schools and a thermal spa including a therapy centre. The remaining water temperature of 55°C is utilised for the spa's service water heating and ventilation systems. Only then is the medicinal water used for bathing in. Before being re-injected into the geological strata from which was extracted, as provided by Austrian law, the thermal spring water is used to heat the municipal gardening establishment.

Under current economic and geological conditions Austria's total geothermal potential amounts to 2,000 MW thermal energy and about 7 MW electricity. The construction of 20 to 40 plants is considered realistic. Geologically suitable areas include the so-called

Styrian thermal spring region, the Upper and Lower Austrian molasse basin, and the Vienna basin. Some of these regions, however, are rather sparsely populated, which makes such operations less economical.

Six geothermal installations have been built to date, the best-known of which is the 10 MW plant at Altheim (Upper Austria). Several more projects are in the planning stage, some of them supported by the THERMIE programme due to their innovative character.

Ambient Energy

Since the mid-seventies, when heat pump technology began to take off in the market place, this environmentally sound, low-emission form of energy production has seen a considerable up-swing in Austria. Whereas there were only 10 plants operating in 1975, their number had increased to 139,273 by 1997. By far the majority of heat pumps in Austria are used for domestic water heating (approximately 109,000), a far smaller number (about 29,200) are used for space heating, and the remainder (about 1,400), for the dehumidification of indoor swimming pools.

The total heating capacity of the heat pumps installed in Austria by the end of 1997 is roughly 670 MW. The annual heat output is about 1,632 GWh, of which 980 GWh per year is generated by ambient energy, a renewable energy source.

The annual heat output from heat pump technology corresponds to a (fictitious) fuel oil equivalent of about 220,300 tons, which means that pollutant emissions are reduced accordingly.

In an effort to promote the use of heat pumps, most Federal States grant financial assistance, either within the framework of housing construction or housing rehabilitation promotion schemes or by way of direct subsidies. In addition, tax reductions are available for private individuals who install heat pumps.

2. Policy affecting RES

The reasons for the positive development in the past lies in the fact that renewable energy sources have been a long-term priority of Austria's energy, subsidy and research policies on the one hand, and in the traditionally high level of environmental consciousness of the Austrian people, who have supported the idea of utilising renewable energy sources from the beginning, on the other. In order to ensure a sustainable energy supply which is as environmentally sound as possible, but also to counteract the foreseeable exhaustion of the country's energy resources in good time, Austria started to promote the development of renewable energy sources early on.

The Federal Energy Concepts state the following principles:

- The energy policy is basically market oriented. Therefore, government interference is mainly limited to cases where market forces do not work.
- Long-term sustainable development, including environmental compatibility, is a predominant goal in energy policy strategies.

2.1 Institutional Framework

Renewable energy policy is implemented by both the Federal and the nine Bundesländer (Federal States) Governments.

The guidelines of energy policy at Federal level are developed by the Energy Department of the Federal Ministry for Economic Affairs. Other ministries cover certain other energy-relevant aspects: the Federal Chancellery has a central co-ordinating function, the Ministry of Environment is responsible for environmental regulation of the energy sector, the Ministry of Agriculture and Forestry is active in supporting bioenergy projects, and the Ministry of Finance is responsible for issues such as energy-relevant taxes.

At the Provincial level the energy agenda is managed by different departments of the Provincial governments. The Austrian Constitution reserves the 9 Federal States important competencies over legislation and implementation on energy-related issues.

Both at the Federal and at the Provincial level energy agencies have been created which support energy policy through expert advice, research and specific initiatives supporting the targets set out by energy policy and relevant laws. In view of the information deficit regarding the use of renewable energy sources which is still widespread among energy users, some Federal States have set up a dense network of energy and environmental counselling centres advising end users, largely at no cost, on efficient and environment-friendly energy use and on the utilisation of renewable energy sources. Special importance is placed on optimal and continuous training for the counsellors.

2.2. Incentives

There is a wide variety of instruments to facilitate the placing of renewable energy sources in the market, ranging from tax policy to subsidies in sectors such as housing construction, agriculture and industry. The main instrument for promoting renewable energy sources are subsidies. Federal and provincial governments are subsidising almost all technologies based on these sources. E.V.A.'s website provides a complete overview on all the existing subsidies (http://www.eva.wsr.ac.at/esf/index.htm - information only in German). No data about the sum of all these financial subsidies is available.

As a step in the direction of internalising external cost, an energy tax on gas (ATS 0.60/m^3 + ATS 0.12 VAT) and electricity (ATS 0.10/kWh + ATS 0.02 VAT) was introduced as of 1 June 1996. This tax applies to small-scale as well as industrial users. Approximately 12% of the tax revenue is made available to the Federal Provinces for the implementation of energy saving and environmental protection measures, including measures for the promotion of renewable energy sources.

2.2.1. Electricity Market

Feed-in tariffs are fixed by the federal provinces (*"Bundesländer"*) or the regional electricity utilities. All feed-in tariffs have seasonal (winter/summer) and time-of-day differentiations (day/night & weekend).

In accordance with the current regulations regarding feed-in tariffs, independent producers of electricity from wind and photovoltaic systems receive between ATS 0.40 (minimum tariff at night and weekends) and ATS 0.55 (maximum tariff during the day)

per kWh (ECU 0.029 to 0.040/kWh) in the summer for the electricity they feed into the grid. In winter the tariffs vary over a range of ATS 0.61 and 1.08 per kWh (ECU 0.044 to 0.078/kWh). The annual average feed-in tariffs vary between ATS 0.56 and 0.68 per kWh (ECU 0.040 to 0.049/kWh).

Feed-in tariffs for electricity from power plants based on biomass range from ATS 0.38 to 0.55 per kWh (ECU 0.028 to 0.04/kWh) in summer and from ATS 0.59 to 0.90 per kWh (ECU 0.043 to 0.065/kWh) in winter.

An important measure to step up the production of "green" electricity, especially from wind power, has been the so-called "three-year agreement": in a voluntary act between the Minister of Economic Affairs (Energy Minister) and the energy utilities it has been agreed that the utilities, in addition to the regular feed-in tariffs (like the ones mentioned above), pay a bonus to independent producers for a period of three years after the construction of a given plant. The additional bonus for electricity from wind turbines and photovoltaic systems has been 100%, and for electricity from biomass (biogas) 20%. The bonus has been paid to all new power plants constructed before 31 December 1996. It is important to mention that this subsidisation scheme was extended for several projects until early 1998 by some energy utilities. In addition to the subsidisation of feed-in tariffs, investment subsidy programmes have been – and still are – in place in Austria.

The Ministry of the Environment has established subsidisation programmes for wind, hydropower, landfill gas, biomass and biogas energy systems. In May 1998, a new market-orientated scheme for wind energy was implemented. Potential investors in wind turbines were invited to submit their offers. The contracts were awarded to the most cost-effective projects, in accordance with the best-bidder principle. Previously, 30% investment subsidies were paid.

In July 1998, the Austrian Parliament adopted a new electricity law (*Elektrizitätswirtschafts- und Organisationsgesetz*, ElWOG for short), reflecting the EC directive for developing the internal market for electricity. The law lays down that by 2005 renewable energy sources (RES, not including hydropower and waste lye) should make up 3% of the electricity sold by the distribution enterprises/utilities to end users. The governors of the Bundesländer have to fix minimum feed-in tariffs for this "green" electricity. This may bring about a change in the aforementioned existing regulations. Extra costs incurred by the distribution companies will be compensated for by an additional tariff in the distribution area. Furthermore, the law provides for the possibility of selling green electricity directly to customers, i.e. enterprises producing electricity from RES may conclude delivery contracts not only with eligible customers, but with any customer.

Since 1997 investment grants of 25% have been available for the reactivation of defunct small scale hydro power stations and the extension of operating ones, and in some cases also for the construction of new installations with a capacity of up to 500 kW. The idea is to stimulate the mobilisation of existing potential as a further contribution to the reduction of CO_2 emissions.

2.2.2. Heat Market

The heat market is not as regulated as the electricity sector, and therefore the subsidies to the investment costs constitute the major incentive.

E.V.A.'s website provides a complete overview on all the existing subsidies (http://www.eva.wsr.ac.at/esf/index.htm - information only in German).

2.2.3. Transport

In order to facilitate the use of biodiesel, a 95% relief from mineral oil tax is granted on this fuel. Biodiesel which is used exclusively for agricultural purposes is totally exempt.

2.3. Research and Development Policy

On the basis of the 1980 Austrian Energy Research Plan, renewable energy sources have been the main focus of targeted research activities besides the improvement of energy efficiency. Tapping new or insufficiently exploited sources such as biomass, solar and geothermal energy is one of the main objectives of this research plan. Following this principle, the lion's share of the Austrian energy research budget, about 60%, is spent on biomass projects. Further important fields of research are solar heating, photovoltaics, wind energy and geothermal energy.

Governmental expenditure for (renewable) energy research activities in Austria include grants and allotments from the Federal ministries, the Federal States, the Austrian Science Foundation (FWF), the Austrian Industrial Promotion Fund (FFF), the Austrian Innovation and Technology Fund (ITF) and the Austrian National Bank Jubilee Fund as well as Federal and/or Provincial sponsorship of independent research by university departments and other institutions. Furthermore, the union of all Austrian utilities (VEÖ) has set up a research association ("Energieforschungsgemeinschaft"- EFG), which carries out extensive research projects.

The total funding available for energy research on renewable energy has been rising continually over the last few years reaching 7.4 MECU in 1997.