CHAPTER 18

Trends in the use of wood for energy, and the situation around 1980

18.1 INTRODUCTION

For over a quarter of a century, from shortly after the second world war until 1973, fuelwood was steadily replaced in Europe by other fuels: there seemed until then no reason to expect a change in this trend. The "energy crisis" of 1973-74 radically changed the situation and the general perception of the outlook for all forms of energy.

ETTS III, which was drafted shortly after the start of the "energy crisis", drew attention to these fundamental changes but did not have the statistical or analytical framework on which to base an analysis of the outlook for the use of wood for energy. In the absence of such a framework it assumed a continuation of pre-1973 trends but stressed the uncertainty on this point.

In the late 1970s and early 1980s, the Timber Committee undertook a number of activities to improve the understanding at the international level of the situation and prospects as regards the use of wood for energy. A seminar and a symposium[1] were held, and a team of experts was constituted, which helped to bring about major improvements in the international data base and arranged an intense exchange of information and experience on many aspects of wood and energy. As a result of the team's work, an *ad hoc* meeting was held in May 1983 on the impact of energy developments on the forestry and forest products sector. The objective of this meeting was to identify the main factors relating to wood/energy developments that needed to be taken into account in preparing ETTS IV.

The secretariat wishes to express its deep gratitude to the members of the team of specialists whose work provided the foundation for the analysis in chapters 18 and 19, as well as to the correspondents who prepared the replies to the enquiry which are presented below.

The work on chapters 18 and 19 was carried out with the valuable help of Mr G. A. Morin, generously put at the secretariat's disposal by the Government of France.

[1] Seminar on energy aspects of the forest industries, Udine (Italy), November 1978. Symposium on energy conservation and self-sufficiency in the sawmilling industry, Bonn (Federal Republic of Germany), September 1982.

18.2 OVERVIEW OF BROAD TRENDS IN ENERGY SUPPLY AND DEMAND

Until 1973, the price of oil had declined steadily in real terms for many years. This development, combined with the great convenience in use of oil and its products, had caused oil to reach a predominant place in the world energy market.

The political and economic events of 1973 led to a quadrupling of oil prices and temporary supply shortages. The shock which these events induced led all governments to develop new energy policies, aimed in most cases at reducing energy costs, encouraging conservation, diversifying energy sources, reducing energy imports and developing new and renewable sources of energy. Several major research and development programmes were initiated.

The global energy situation has in fact changed in many important ways since the early 1970s, partly because of national adjustment to changed economic circumstances and partly because of the energy policies mentioned above. Energy conservation measures have been very successful (the GDP elasticity of total energy consumption, which was over 1.0 in most countries, has fallen to well below 1.0 in many); new oil resources especially in non-OPEC countries have been developed and come on stream; oil imports, especially from the OPEC countries, have fallen; other sources of energy such as coal, gas, or in a few countries, nuclear power, have been developed. A strong impetus was given to these developments by the second oil price rise at the end of the 1970s, which was in fact greater than the first, in dollar terms at least.

As regards new and renewable sources of energy, although many large research programmes and pilot pro-

TABLE 18.1

Consumption of fuelwood, 1949-51 to 1979-81, as reported to ECE/FAO[a]

	1949-51 (million m^3)	1959-61 (million m^3)	1969-71 (million m^3)	1978 (million m^3)	1979-81 (million m^3)	Annual average percentage change 1950 to 1980
Nordic countries	26.4	19.8	11.8	5.6	6.1	−4.7
EEC(9)	34.8	23.4	11.5	10.1	11.8	−3.5
Central Europe	3.5	2.8	2.2	1.8	2.3	−1.4
Southern Europe	35.4	31.6	30.3	20.3	22.4	−1.5
Eastern Europe	21.6	15.9	13.4	11.2	11.1	−2.2
Europe	121.8	93.6	69.3	48.9	53.8	−2.7

[a] Real consumption is significantly higher (see text and table 18.2), but no consistent time series are available.

jects have been undertaken, most of these sources have not yet been applied to a significant degree. Exceptions to this include hydro-electricity, passive solar heating, and wood.

The situation on world energy markets changed dramatically, however, in 1985 and 1986, when oil production overcapacity, together with successful conservation measures brought about a collapse of the crude oil markets. The price of oil fell below $US 10/barrel in spring 1986, as compared to over $US 30/barrel a year earlier. If this low price were to be maintained in the medium to long term the outlook for the energy sector would be radically different from that foreseen in the early 1980s, which assumed in most cases an increase in energy prices in the long term or at least stabilization of prices at the then prevailing levels. In particular the economic incentive for energy conservation and development of non-oil fuels would be nearly destroyed. Are the very low oil prices of early 1986 a temporary phenomenon? Or will the situation persist in the medium to long term? It is not possible yet to answer these important questions. The analysis which follows was prepared before the sharp drop in oil prices, and it has not been possible to modify it substantially at the final stages of revision. The possibility of lower oil prices, and the resulting disincentive to develop the use of wood for energy cannot however be excluded.

The long-term decline in recorded fuelwood removals slowed down during the 1970s and, from 1978, recorded European fuelwood removals started to rise again (see figure 18.1), without, in most cases, any significant fiscal stimulus or the support of large-scale R and D programmes (which mostly concentrated on larger-scale projects, which have not yet been put into practice).

However, it became apparent during the 1970s that recorded fuelwood removals are only a partial and possibly misleading indicator of how much wood is used as a source of energy.

Much of the wood harvested for fuel is done so in rural areas for autoconsumption, i.e. the farmer, forester or other inhabitant of a rural area who harvests the wood burns it himself. Nor does all the wood burnt come from the forest: wood from hedgerows, isolated trees, or fruit orchards, is also burnt. For obvious reasons, these volumes are usually not recorded. In many countries they were not even estimated until recently.

Energy is also derived from other forms of wood, mostly residues of manufacturing or processing. Sawmills, panel mills, furniture and joinery plants, among others, in many cases derive energy from their residues of wood and bark. A special case is that of chemical pulping, which separates the cellulose part of the wood, (which will become chemical pulp) from the lignin and hemi-cellulose. These latter, which, along with the pulping chemicals are suspended in water, are burnt in special boilers to provide process heat and to recover the expensive chemicals, which are then re-used. In fact, in many cases, chemical pulping provides a surplus of energy which can be used elsewhere, for instance in a paper-making operation. In addition, much wood is burnt for energy after its original use: this is notably the case for wooden packaging, including pallets, and wood waste from demolished buildings.

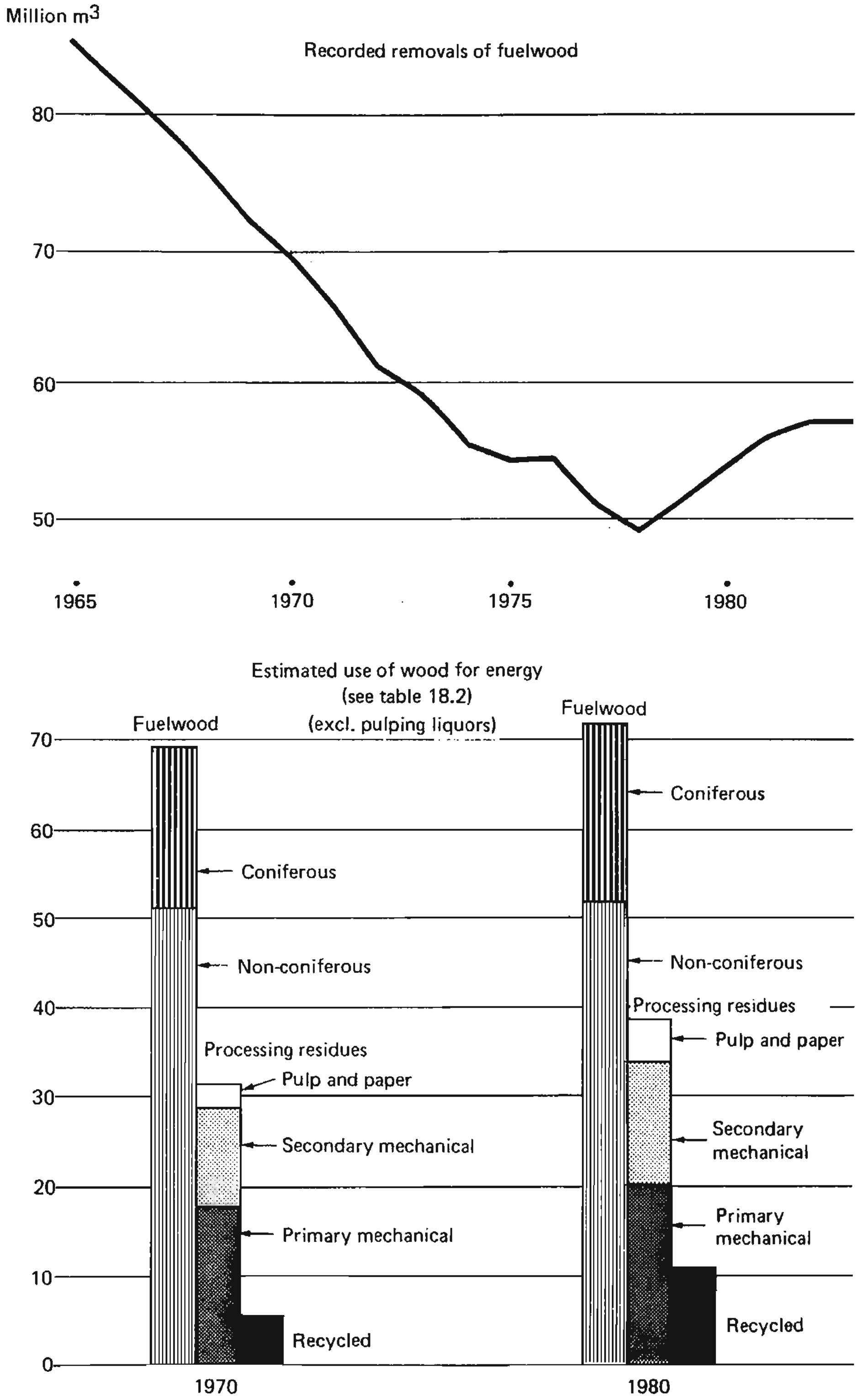
The ETTS IV correspondents were asked, in 1984, to provide estimates of the volumes of wood used as a source of energy in 1970 and 1980, as well as to estimate the outlook to the year 2000. Almost all correspondents were able to reply. Their estimates for 1980 are presented in table 18.2 (estimates of future trends are presented and discussed in chapter 19) and for all years (i.e. 1970, 1980, 1990 and 2000) in the annex tables to chapter 19. Due to the nature of the estimates, these data cannot be considered very precise but it is likely that the general picture is correct.

On the basis of the partial data available, which are summarized in tables 18.2 and 18.3, it is possible to make estimates for Europe as a whole and for individual country groups, in 1970 and 1980. These estimates are presented in table 18.4. Despite the need for estimation, these tables seem to represent a fairly realistic picture of developments in the 1970s.

It is estimated that 123 million m^3 of wood was used as a source of energy in 1980. Of this estimated total less than 60% was accounted for by fuelwood removals, most of which were from non-coniferous species. Over 20 million m^3 of residues from sawmilling and the manufacture of wood-based panels were used as a source of energy, as well as significant amounts of residues of secondary wood processing and pulp and paper manufacture, and recycled wood.

FIGURE 18.1

Europe: use of wood for energy



There are significant differences between developments for the different assortments. Growth in European consumption was slowest for the most important wood energy assortment – non-coniferous fuelwood, which was only marginally higher at the end of the decade than at the beginning, after the long-term downward trend was reversed around 1978. Consumption for energy of processing residues grew by over 20% over the decade. The use of wood and bark as fuel by the pulp and paper industry grew particularly fast – by over 70% in the decade. The use of recycled wood for energy is estimated to have grown by 67% over the decade, admittedly from a low base.

The generation of energy was, with the provision of shelter, the earliest use of wood. It is not often realised that it remains one of its most important uses even in the developed countries. Taking the estimates of table 18.4 as a starting point, the following calculation is possible for Europe as a whole in 1980:

Wood (including bark) used directly for energy ...	123 million m³
of which:	
Fuelwood ...	72 million m³
Industrial residues (wood and bark) ...	40 million m³
Recycled wood ...	11 million m³
Total removals, underbark (adjusted to take account of unrecorded fuelwood removals) ...	360 million m³
Total removals, overbark (estimate) ...	410 million m³
Percentage of removals used directly for energy ..	30
Estimated wood equivalent of pulping liquors	44 million m³
Total wood for energy (direct use plus liquors) ...	165 million m³
Percentage of removals used as a source of energy	41

If over 40% of the volume of wood removed is used as a source of energy, then the provision of energy remains the single most important use of wood, in volume terms.

This fact is probably not fully appreciated by many concerned with the forest sector. It bears out the opinion that there is very little real wastage of wood as almost all the wood (and, probably, bark) which is harvested either forms part of a final product or is used as an energy source. The importance of energy as an end-use for wood also justifies the attention now being paid, by ETTS IV and other studies, to demand for energy wood and to energy/raw material interactions.

Where is this wood used? It is clear from the above-mentioned enquiry that most of the wood used as a source of energy (around 60%) is burnt in households, presumably mostly rural. The second most important wood burners are the forest industries (under 30% of the wood used for energy). Data for the 17 countries (from all parts of Europe) which provided information on the breakdown of consumption of wood-derived energy are shown in table 18.5.

Table 18.2

Estimated use of wood for energy, 1980

	Fuel-wood (million m³)	Residues of industry (wood and bark) (million m³): Primary mechanical	Secondary mechanical	Pulp and paper	Recycled wood (million m³)	Total wood and bark (million m³)	Pulping liquors [a] (1000 TJ)
Finland	3.7	1.6	0.4	1.2	–	6.9	50
Norway	1.8	0.6	0.1	0.2	0.2	2.8	3
Sweden	4.5	2.2	0.5	2.0	1.5	10.7	97
Denmark	0.2	0.3	0.4	–	–	1.0	..
France	10.0	1.5	0.8	0.6	3.0	15.9	14
Germany, Federal Republic of	3.6	2.0	5.0	0.4	0.5	11.4	11
Ireland	0.2	–	–	–	–	0.3	..
United Kingdom	0.2	0.5	0.1	–	–	0.8	..
Switzerland	0.8	0.2	0.2	–	1.0	2.2	1
Portugal	5.4	0.7	–	0.3	–	6.5	8
Spain	2.0	1.8	0.2	0.4	0.1	4.5	10
Bulgaria	1.9	0.3	0.1	–	–	2.4	1
Poland	1.9	1.5	0.8	0.1	0.3	4.6	7
13 countries with complete data	36.3	13.3	8.7	5.2	6.7	70.1	205*
7 countries with data for fuelwood[b]	29.7	3.9*	2.6*	0.4*	2.4*	39.0*	22*
8 countries which did not supply data[c]	6.0	3.3*	2.1*	0.5*	1.7*	13.6*	28*
Europe	72.0	20.5*	13.4*	6.1*	10.8*	122.8*	255*

[a] The questionnaire did not specify whether gross energy content of liquors or net (delivered) energy, taking account of boiler efficiencies, was required. Comparison of replies indicated that countries had interpreted the question differently. The data here have been adjusted by the secretariat to give estimated net values. The original data are reproduced in annex table 19.12.

[b] Czechoslovakia, Greece, Hungary, Israel, Italy, Turkey, Yugoslavia. Some of these also have data for some other types of wood energy (see annex tables).

[c] Austria, Belgium-Luxembourg, Cyprus, German Democratic Republic, Iceland, Malta, Netherlands, Romania.

Definitions: See note to table 18.3.

TABLE 18.3

Share of different types of energy from wood and bark, 1980
(Percentage of total, excluding liquors)

	Fuelwood	Residues of industry (wood and bark): Primary mechanical	Secondary mechanical	Pulp and paper	Recycled wood
Finland	54	23	8	17	–
Norway	62	20	4	6	8
Sweden	42	21	5	19	14
Denmark	25	30	40	–	5
France	63	9	5	4	19
Germany, Federal Republic of	32	18	44	3	4
Ireland	75	23	–	–	1
United Kingdom	19	66	12	1	1
Switzerland	36	9	9	–	44
Portugal	84	11	–	5	–
Spain	44	40	4	9	2
Bulgaria	79	14	6	1	1
Poland	42	33	17	2	6
13 countries	52	19	12	7	10
Europe (estimate)	59	17	11	5	9

Source: Table 18.2.

DEFINITIONS:

Fuelwood: Wood in the rough, from the forest or elsewhere, used for energy.

Residues of industry: Wood and bark used as source of energy, arising from the operations of the following industries:

- Primary mechanical processing, defined as manufacture of sawnwood and wood-based panels;
- Secondary mechanical processing, defined as further processing of sawnwood or panels or manufacture of products from them, e.g. furniture or joinery;
- Pulp and paper industry, defined as the manufacture of all types of pulp and paper (pulping liquors are treated separately from wood and bark residues of the pulp and paper industry);

Recycled wood: Forest products used for energy after their original use, e.g. used pallets, wood from the demolition of buildings.

Pulping liquors: Lignin and hemi-cellulose separated from cellulose in chemical pulping and used for energy.

TABLE 18.4

Europe: estimated use of wood and bark for energy, 1970 and 1980 (excluding liquors)

	1970 (million m^3)	1980 (million m^3)	Change 1970 to 1980: Volume (million m^3)	Percentage
Fuelwood	69.1	72.0	+ 2.9	+ 4
of which:				
Coniferous	17.8	20.0	+ 2.2	+12
Non-coniferous	51.3	52.0	+ 0.7	+ 1
Processing residues (wood and bark).	32.7	40.0	+ 7.3	+22
of which:				
Primary mechanical	17.8	20.5	+ 2.7	+15
Secondary mechanical	11.1	13.4	+ 2.3	+21
Pulp and paper	3.8	6.1	+ 2.3	+61
Recycled wood	5.8	10.8	+ 5.0	+86
Total	107.6	122.8	+15.2	+14

TABLE 18.5

Reported uses of energy from wood, 1970 and 1980

	Volume (million m^3): 1970	1980	Percentage of total: 1970	1980	Percentage change 1970 to 1980
Households	34.9	35.3	61.9	58.7	+ 1.1
Forest industries	15.2	17.8	26.9	29.6	+17.1
Other	6.3	7.0	11.2	11.6	+11.1
Total (17 countries with data)	56.5	60.0	100.0	100.0	+ 6.2

Source: Replies to enquiry.

Most of the "other" uses were accounted for by combustion in intermediate or large-scale units outside the forest industries (e.g. in schools, hospitals, barracks, or district heating plants), with minor volumes going to the production of charcoal. Very small volumes were used in a few European countries to generate electricity or to manufacture solid fuels (e.g. briquettes). No wood is used at present in the region to make synthetic liquid or gaseous fuels. Use of energy wood by the forest industries and "other" users has grown faster than use by households.

How important is energy from wood in national energy balances? The ECE/FAO medium-term survey of trends in the markets for pulpwood, wood for energy and miscellaneous roundwood[2] estimated (based on national replies) the contribution of energy from wood to final energy consumption, at the end of the 1970s (table 18.6).

In most countries, wood is a marginal source of energy, especially in those urbanized, industrialized economies which are heavy users of conventional forms of energy. In only a few countries does wood play a significant role; notably Turkey (23.3% of final energy consumption derived from wood, including pulping liquors); Finland (16.6%); Yugoslavia (8.3%); Sweden (7.2%); and Portugal (6.5%). There are major differences in the geographical and economic situation of these countries, but they mostly have major forest resources and no major domestic sources of energy. In the two Nordic countries mentioned (Finland and Sweden), use of wood residues for energy by the forest industries is very much more important than in the three southern European countries (Portugal, Turkey, Yugoslavia), where use of fuelwood by rural populations predominates.

This chapter has outlined the situation and trends for wood-derived energy, notably the volumes concerned, the importance of energy as an end-use for wood, and the contribution of wood to national energy balances. The outlook for the future is discussed in chapter 19.

TABLE 18.6

Share of wood-derived energy in final energy consumption, late 1970s

	Fuelwood and processing residues	*Pulping liquors*	*Fuelwood, processing residues and pulping liquors*
Nordic countries .	4.6	4.2	8.8
EEC(9)	0.7	0.1	0.8
Central Europe . .	1.2	1.2	2.4
Southern Europe	6.7	0.9	7.6
Eastern Europe . .	1.0	0.3	1.3
Europe	1.5	0.6	2.1

[2] Supplement 15 to volume XXXIV of the *Timber Bulletin for Europe*, Geneva, 1982. See especially table 14. Because of the different source and the different period, these data are not fully comparable with those used elsewhere in this chapter.

CHAPTER 19

Outlook for the use of wood for energy

19.1 INTRODUCTION

It is clear from the account in the preceding chapter that:

- Developments in the use of wood for energy will affect the outlook for the forest products sector as a whole; and
- It is no longer possible to make simple assumptions for the future course of events, as circumstances have changed fundamentally over the past decade. Indeed, fundamental factors such as the price of oil, are in constant evolution.

How should the necessary analysis of the outlook for wood-derived energy be carried out? Despite the multiplicity of energy-linked studies which have been produced since 1974, no consensus has emerged on likely future developments for global energy supply and demand. Even if such a consensus on the broad outlook did exist, it is far from certain how this would affect the forest and forest products sector. Views expressed on the future for wood-derived energy in the past five years range from a conviction that the use of wood for energy will expand until the whole forest sector is changed beyond recognition, to the belief that fuelwood use will soon resume its long-term decline towards insignificance.

The methodology and the data base were not considered sufficiently advanced to enable a modelling approach to be attempted, especially as many of the determining factors are highly local and could not therefore be integrated into a regional study.

The approach adopted is the following:

- To present the major factors which will determine future developments, and their likely evolution, while drawing attention to the high degree of uncertainty connected with some of them. The demand from conventional uses (combustion by rural households, forest industries, etc.) will be treated separately from demand for new types of wood-derived energy (e.g. methanol) and new sources of wood for energy, notably "energy plantations";
- To request national experts to evaluate the outlook for each country and to make estimates for future developments. The estimates made are presented below (section 19.4).

19.2 FACTORS AFFECTING THE OUTLOOK FOR CONVENTIONAL USES OF WOOD FOR ENERGY

For the purposes of this chapter, "conventional" uses of wood for energy are defined as those uses which account for significant volumes of wood-derived energy at present i.e. the combustion, for heat, of roundwood from forests or from trees outside the forest, of industrial wood residues and of recycled wood, in houses, forest industries and intermediate-scale (non-forest industry) units. For ease of combustion, the wood is usually either cut in short lengths and split or chipped. Compression into briquettes or pellets, which is a fairly simple mechanical process, may also be considered "conventional" although not at present widespread.

Wood energy use shows marked differences between regions due to the wide variations in forest resources and population density, and the fact that fuelwood is usually neither convenient nor economic to transport over long distances. There is a strong contrast between wood, whose resources (the forest) are dispersed and of more concentrated energy sources, such as oil, gas or coal, which are usually obtained in large quantities from relatively few places, often transported very long distances and frequently burnt in large units such as electric power stations or heavy industry.

Perhaps the most important factor which will determine the future use of wood for energy is the development of the *overall balance between supply and demand of energy*. It was above all the easy availability and falling real prices of other forms of energy, notably oil, which caused fuelwood consumption to decline from 1950 to the mid-1970s, and the subsequent rise in energy prices which reversed this trend thereafter. For several years after the first energy crisis, most analysts foresaw a future characterized by increasingly scarce and expensive energy, due to the exhaustion of reserves of fossil fuels, especially oil and gas, and monopolistic behaviour by oil exporters. This view, however, underestimated a number of factors, notably the potential to conserve energy and to develop new sources of energy in a context of higher energy prices. Reserves of oil, gas or coal which had not been economic when the oil price was US$4 a barrel became very attractive when this price was US$30 a barrel or more, even if there was a need for enormous investments in the technology to extract oil in arctic conditions or from offshore wells. In addition, several countries which were heavily dependent on energy imports were prepared to pay a premium on their energy prices to develop domestic sources and to diversify sources of imported energy.

Conservation, the development of new energy sources and the slowdown in economic growth (attributed in part to the rise in energy prices) have led to a situation where the price of oil, still the world reference price for energy, has been dropping, in dollar terms at least, and the share of OPEC countries in world production and trade of oil has fallen sharply. In 1985 and 1986, the world oil price fell dramatically. In general, the world energy economy has proved more resilient and flexible than many expected.

What is the outlook for the future? There can, of course, be no certainty on this question; it has been the subject of numerous studies which have foreseen a wide range of different energy futures from a return to the cheap energy of the 1960s to a picture of dwindling resources, shortages and very expensive energy. However, the fact that fossil fuel resources are finite would seem to argue against the first of these extremes (notwithstanding the fact that the price of crude oil was between $10 and $15 a barrel as ETTS IV went to press) and the fact that the energy economy has proved itself very adaptable (in the medium term) against the second. Many analysts in recent years have foreseen a future of slowly rising energy prices after the decreases of the first half of the 1980s.

In particular it seems likely that there will be continuing advances in energy conservation which is immediately economically attractive to all energy consumers. The gains from conservation may however not be as rapid as in recent years, as the "easy" conservation measures have already been carried out.

In addition, demand will develop differently for different types of energy. Whereas there are many existing and potential sources of heat energy ranging from coal to solar, potential sources of energy for transport (especially road transport) are more limited. Much of the R & D effort has been devoted to developing transport fuels from sources other than oil e.g. by liquifying solid fuels such as coal but also wood. If economic or physical scarcity did occur, oil-based fuels would be increasingly reserved for these "premium" uses (as well as for petro-chemicals).

Most governments radically reviewed and revised their energy policies in the 1970s in the light of the changed situation. In most cases, they concluded that wood was for them a marginal source of energy and took no special measures to encourage or direct the generation of energy from wood, which was treated in the same way as other types of energy. A few countries, however, with a relatively high ratio of forest resources to energy needs, considered that wood was, in their particular circumstances, an important source of energy: the governments of these countries took specific measures concerning wood energy, such as the funding of significant R & D programmes. In several of these countries, a significant factor was the desire to reduce energy imports by encouraging a domestic energy source (even if this source was slightly more expensive than imported energy).

The overall energy situation, notably its price, is probably the major factor determining future demand for wood-derived energy, but there are a number of factors which affect specifically this sector. The future *availability* of wood for energy will be analysed together with the availability of wood for other uses, elsewhere in this study, but it should be borne in mind that, just as the consumption of fuelwood is often not recorded, so this material comes from sources which are not included in traditional forest inventories – parts of the tree other than the stem, trees outside the forest, hedgerows, woody agricultural residues (from fruit trees, vines, etc.). The results of the inventory of woody biomass (but not biomass from agricultural sources, such as fruit trees), have been summarized in chapter 3. Although there are no detailed data for future availability, estimates could be made by assuming a constant relationship between the total biomass growing stock and the inventoried growing stock. Such estimates would, however, be of limited validity for the following reasons:

(*a*) It is not known what proportion of fuelwood consumption comes from inventoried growing stock, from other forest biomass or from agricultural sources. Correspondents were requested to estimate these percentages but many were unable to do so and there was such a wide variation between those answers which were received that it is not possible to make even tentative global estimates;

(*b*) While national biomass inventories are a necessary part of energy resource planning, especially in the context of evaluating major biomass-based projects, conventional fuelwood availability is determined above all by local factors such as ownership régimes (communal or private), silvicultural practices, local practices, or seasonal employment patterns.

It is therefore proposed to compare changes in fuelwood demand with forecast changes in removals of small wood, while bearing in mind that part of the increased fuelwood demand could be satisfied by increased use of non-inventoried sources. Interpretation of the consistency analysis to be presented in chapter 20 will take this factor into account.

Although much of the fuelwood removed is for auto-consumption, a part is distributed through *commercial channels*. New fuelwood users are, in most cases, dependent on these for a supply of fuelwood, even in rural areas.

Certainly, no significant expansion of fuelwood use is possible, in European conditions, without a corresponding increase in harvesting and distribution services. However, the experience of the 1970s would seem to indicate that these services develop spontaneously, on a decentralized basis, if there is a demand. A technical aspect to which some governments have devoted attention is that of measurement of fuelwood and its calorific content (volume or mass, moisture content, degree of preparation, species) as uniform and rational measurement methods encourage effective and fair distribution networks. Whereas very small enterprises are usually sufficient to provide fuelwood for household use, the "intermediate" users require larger quantities on a continuous and reliable basis. Enterprises already active in a similar capacity in the forest products sector have in many cases undertaken this task, in some cases integrating it with their other harvesting activities e.g. by sorting out for energy use lower qualities or forest residues from harvesting operations for pulpwood or sawlogs.

The direct comparison of *fuel costs* between auto-consumed fuelwood and other fuels is complex because of the difficulty of evaluating the cost of harvesting and preparing the fuelwood, especially if this is done in a season when there are few other tasks for the farmer. In addition no taxes are paid on auto-consumed fuelwood, unlike other fuels (including fuelwood bought through commercial channels).

Another possible constraint on development of conventional wood energy applications is the availability of *wood-burning equipment*. The investment in appropriate equipment is often the major obstacle for households who wish to change their source of energy. In the initial stages of the recovery in fuelwood use, many users turned to old systems which had not been completely abandoned in the period of decline in fuelwood use. These, however, often proved inconvenient and inefficient from an energy conservation point of view. There was an enormous increase in the sale of modern, energy-efficient, wood-burning stoves during the 1970s. In most cases, however, these stoves (at least the smaller versions), still require hand stoking, which many users, accustomed to the convenience of modern oil- or gas-burning installations, are unwilling to accept. There has been progress in this field, however, and now completely automatic, chip-burning installations, which used to be restricted to larger units, are available for requirements as small as those of a medium-sized farm.

A related aspect is the emission of pollutants during combustion. From this point of view, wood is considered preferable to many other fuels, notably because of lower sulphur emissions. However, if combustion of wood takes place in unsatisfactory conditions (e.g. in older equipment which does not achieve full combustion) emission problems can also arise for wood-burning equipment, notably as regards particulates. Work is in hand in several countries in drawing up standards on emissions by wood-burning installations.

The development of commercial channels and of more convenient and effective wood-burning installations was a necessary condition for the expansion of fuelwood use, so that wood could compete with other fuels on its technical and economic merits. Developments over the last decade, in reaction to the "energy crisis" seem to indicate that the fuelwood sector is flexible enough to overcome this type of constraint, if the fundamental economic and resource situation is favourable to expansion in fuelwood use.

It should, however, be borne in mind that equipment constraints do impose a time lag in responding to relative price changes between fuels, as a change of fuel often implies a change of equipment. In some countries, there is a trend towards installing flexible equipment which can be rapidly converted from burning oil to burning solid fuels (wood or coal) and *vice versa*.

An important factor determining the economic accessibility of conventional fuelwood resources is the *cost of harvesting and transport* (except for auto-consumption, where economic criteria do not play a major role). These costs are higher, relative to the volume harvested, for small wood, such as fuelwood, than for logs, and even higher for the collection of logging residues. If wood is to remain competitive with other sources of energy, harvesting and transport costs (which are strongly influenced by the price of the oil-based fuels used for harvesting equipment) must not be allowed to rise excessively. In recent years, however, a number of systems have been developed to harvest small-sized wood economically – often systems which integrate fuelwood harvesting with the harvesting of other assortments.

In conclusion, consumption of conventional fuelwood could continue to rise, if the energy price also rises; harvesting, distribution and combustion are not expected to pose major problems. However, the rise is unlikely to be of such a magnitude as to transform completely the pattern of wood removals: wood is suitable as a fuel in rural areas, in decentralised systems. Larger systems imply longer transport distances and much higher costs, not to mention the problems of competition for raw material with the forest industries, which will be discussed below. Furthermore, in most countries, the wood resource is simply too small to provide more than a small part of total energy consumption. (For Europe, the entire tree biomass growing stock is equivalent to only four years' energy consumption: in the Nordic countries, it is equivalent to over 17 years, but in the EEC to only about 1.5 years.)

Most *forest industries* are now very conscious of their energy costs[1] and of the energy content of the residues of wood processing, and are therefore increasingly unwilling to allow any of their residues to be wasted – especially as the disposal of unused residues represents an additional cost. Some of the residues produced have no other rational use than as a source of energy – most bark, sander dust, material contaminated with glue or overlays, etc. The in-

[1] In Sweden, in 1980, purchased fuels and electricity accounted for 2.5% of the sales value for sawmills, 10.7% for pulp mills and 13.4% for the paper and paperboard industry.

dustries may, therefore, be expected to continue to review their energy balances and options and install wood-burning equipment as appropriate to the quantity and type of residues available and the specific energy needs of the industry.

Most of the uncontaminated wood residues, however, are used for the manufacture of pulp, particle board and fibreboard and form a major and increasing part of these industries' raw material input (see chapter 15). Whether any of the residues suitable as raw material are burnt by the producing industry will depend on a number of local factors, including the price offered by the potential raw material consumer, the cost and availability of other fuels, and the energy needs of the residue-producing industry. Moreover, decisions on these questions are often taken on a medium-term basis, e.g. when installing new energy equipment or drawing up raw material supply contracts; residue producers are normally not able or willing to let their decisions be influenced by short-term variations in price differentials, but will undoubtedly take these into account for their medium- and long-term planning. There is thus often an element of time lag between changes in differentials between prices for energy and raw material and changes in the distribution of the residues.

At present there has certainly been no major shift from using residues as raw material to using them for energy, although it is likely that energy prices have indirectly influenced the prices offered by buyers of residues as raw material. It seems likely that this situation will continue, unless there are very steep rises in energy prices: only marginal volumes of residues suitable for raw material (in areas where there are buyers) would actually be "diverted" for use as a source of energy, but there might well be a price effect with the "energy equivalent" price effectively setting a minimum price for wood residues.

It is also likely that, in the future, as at present, those who buy or sell wood raw material, whether from the forest or the forest industries, will take fully into account, in their economic calculations and negotiations, not only the physical product which can be derived from the material but also the energy which can be generated.

It has also been suggested that governments take measures to ensure that wood suitable for use as raw material is not used for energy, thus introducing an element of raw material allocation which is not normally found in market economies. No such measures have been taken, however, both because the problem has not been as acute as was feared and because governments in market-economy countries have preferred not to distort market forces. In some countries (e.g. Sweden) the legal framework has been modified to ensure that medium- to large-scale wood-burning enterprises are subject to the same planning regulations as all other wood-using plants over a certain capacity.

19.3 FACTORS AFFECTING THE OUTLOOK FOR NEW USES OF WOOD FOR ENERGY

The developments in conventional wood-derived energy described above may be considered normal reactions of the forest and energy economies to a higher price for energy. In most cases, it was not government subsidy or governmental directives which were the cause of increased wood energy use, and little was required in the way of large-scale R & D projects. Most technical developments were improvements on existing technology, not radical new departures.

However, in the ferment of new ideas which followed the first "energy crisis", and was sustained by the second, a number of proposals were made for radically new systems for deriving energy from wood or other biomass, (alongside proposals concerning other new and renewable sources of energy). Major programmes were set up by many governments to review and assess these ideas and to undertake the necessary research and development. At present, very few of the proposals in the field of energy from wood biomass have passed the pilot plant stage, but this is not surprising in view of the long lead times always associated with such ambitious projects. The object of this section is to review these proposals and some of the factors which will determine whether or not they are widely applied, and thereby result in radical changes in the demand for wood.

As mentioned above, much R & D work on energy is concentrated on finding replacement for a few fuels with special characteristics, notably liquid fuels for transport. Most of the new systems proposed for wood energy have in common that wood is not simply burnt to provide heat but processed, for instance into methanol, ethanol, gas, or electricity, to replace other forms of energy which, it is feared, will become in future scarce and/or expensive. There is a loss in energy content as well as extra costs, sometimes substantial, due to this processing, which, it is claimed, will be compensated by the desirable qualities of the new type of energy produced (and the premium price which is thereby made possible).

In almost all cases, the process being investigated, if carried out on a commercial scale, would require, for technical and economic reasons, that units be rather large. This implies a correspondingly large area from which wood must be transported to the processing plant, with a corresponding increase in the costs of wood delivered to the plant. Some of the units proposed would require similar volumes of wood to those used by a pulpmill and the same care would have to be taken as for a pulpmill to identify at an early planning stage a raw material resource which was technically and economically suitable, taking into account also the requirements of existing users.

The quality requirements for raw material of some of the processes are different from those of the existing forest industries (e.g. as regards moisture content, species, bark content). Indeed, in several cases wood is only one potential raw material alongside other types of biomass including special crops and agricultural residues.

Estimations of the economic viability of all these projects are, of course, strongly affected by the assumptions about future energy prices. In all cases the processing causes costs and energy losses to increase, so that to become economic these more ambitious proposals require higher energy prices than does direct combustion of wood (which is widely carried out at the present energy price). At the energy prices of the early 1980s, few, if any, of the processes proposed for the transformation of wood biomass into other types of fuel appear to be economically viable. This situation may be radically changed, either by technical progress (e.g. to lower processing costs) or by a rise in energy prices. Furthermore significant demand for wood for energy would probably stimulate a rise in the price for wood as other wood consumers defended their raw material supply. This would have negative consequences for the economies of the wood energy enterprises.

At present, governmental attitudes towards R & D projects in the "fuels from wood biomass" field appear to fall into two groups. The first, adopted by a majority of countries, considers that these projects are unlikely to be economically viable in the near future; furthermore, national forest resources are not large enough for wood-based fuels to make a significant contribution to national energy supply. These governments consider that the most effective way of deriving energy from wood is by simple combustion and have slowed down or abandoned R & D projects in the field of wood-derived energy. A few governments, however, in countries with a large forest resource, especially where they are without other domestic sources of energy, are continuing their programmes. This decision appears to be based partly on the expectation of an eventual energy price rise but also on a desire to dispose of a national "insurance policy" if energy supplies were interrupted. In these circumstances, a replacement for premium fuels, notably oil-based, would be available relatively quickly. Furthermore, it might be possible, if there was a demand for new wood-based fuels, to market to other countries the know-how obtained from these programmes.

Another major proposal concerned with wood energy, on the supply rather than the processing side, is for specially managed short rotation plantations of wood for energy (*energy plantations*). These are plantations of fast growing species, usually genetically improved, often of hardwoods such as willow, poplar or alder, but also of softwoods. These plantations are often coppiced, with major inputs of fertilizer and in general are treated more like agricultural crops than normal forest stands. Rotations are usually short – under ten years, sometimes only two to four years. Very high yields have been achieved on experimental plots – for instance about 20 m.t. dry matter/ha/year in Sweden. It is unlikely that such high yields would be achieved on average in Europe if energy plantations were widely introduced, in part because some of them were established on good quality agricultural land, which would not be widely available for forestry. The availability of wood from energy plantations would improve the economics of the large-scale, fuels-from-wood plants mentioned above, as the higher rate of biological production would make it possible to reduce transport distances, so that a constant supply of wood would be possible from a smaller area.

Like the fuels-from-wood projects, the future economic viability of energy plantations will be determined by the price of energy and by technical progress in increasing yields, reducing costs and integrating energy plantations into broader energy systems. For these plantations, however, there is another major factor – the availability of land. Even with the very high yields achieved on experimental plots, very large areas of land would be required to make a significant contribution to energy supply. It has been estimated[2] that to provide 1% of Europe's energy consumption in 1980, 1.4 million ha of land would be required for energy plantations (assuming the high yield of 20 m.t. dry matter/ha/year). This is 0.25% of Europe's land area. If more conservative yield estimates were made, the area required would of course be greater. For instance, if 10 m.t./ha/year is assumed, 0.5% of Europe's land area would be needed to provide 1% of Europe's 1980 energy consumption. The situation is different in areas with a more favourable ratio between forest area and energy requirements, such as the Nordic countries and Southern Europe, where to provide 1% of their energy needs, only 0.07% of the land area would be required (assuming 20 m.t./ha/year).

Are these quantities of land available? Could or should they be transferred to energy plantations? Several possibilities have been suggested – worked-over peat bogs, drained marshlands, and the millions of hectares of marginal agricultural land which exist in Europe, where agriculture has been abandoned (in some cases to be succeeded by the natural extension of unmanaged forest) or is maintained artificially by subsidies. It has even been suggested that these subsidies, which have led in many cases to enormous, expensive and economically irrational agricultural surpluses, should be partly redirected to support energy production on the same land which would thus enable energy imports to the countries concerned to be reduced. This is certainly a possible course of action if governments attach sufficient importance to energy self-sufficiency and reducing agricultural surpluses while maintaining rural employment. There are, however, several obstacles to such a course, notably the fact that experience

[2] This estimate, and others presented in this chapter, are taken from a paper prepared by a member of the secretariat entitled "How much biomass is available for energy in Europe?" and included in the proceedings of the Fifth Canadian Bioenergy R & D Seminar, edited by S. Hasnain., Elsevier Applied Science Publishers, London and New York, 1984.

with agricultural subsidy schemes has led many governments to be unwilling to subsidise projects which are not economic (at least in the long term) without subsidies. Great concern has been expressed about rising public expenditure and persistent budget deficits. Many governments are seeking ways to reduce expenditure and subsidies, not to find new recipients for them. Furthermore, most of the marginal agricultural land is so classified because of its low fertility, which would also reduce yields of wood biomass, and thereby the economic viability of plantations intended solely or primarily for energy wood production.

Another factor to be taken into account when assessing the outlook for energy plantations is the opposition from many people, including city dwellers who visit the countryside for recreation, to any changes – permanent or semi-permanent – in land use. The experience of the United Kingdom with afforestation of bare uplands and of France with conversion of hardwood coppice to coniferous high forest (*"enrésinement"*) has proved the strength of this type of opposition, which curiously totally ignores major changes in agricultural practice such as changes from arable land to pasture or *vice versa*. The establishment of millions of hectares of energy plantations, which are not very attractive from a landscape point of view, could be expected to encounter vigorous opposition on these grounds in many countries (even though some members of the same groups are advocates of renewable energy, including that from wood).

These questions of allocation of rural land, and policy for rural areas, are of great importance for the forest sector as a whole and will be discussed further in the conclusions of the study.

19.4 NATIONAL ESTIMATES OF OUTLOOK FOR USE OF WOOD FOR ENERGY

In view of the obstacles to modelling future demand for energy wood, notably the weakness of the statistical base and the importance of local factors, it was decided to rely on the judgement of those in contact with the situation at the national level. A rather elaborate enquiry was therefore circulated to ETTS IV correspondents requesting estimates for the present situation and the outlook to 2000 for the consumption and supply of wood-derived energy. For supply, estimates were requested on fuelwood (coniferous and non-coniferous), residues from primary and secondary mechanical wood processing, residues of the pulp and paper industries (pulping liquors, wood and bark) and recycled wood products. For consumption, estimates were requested for use by households, forest industries, intermediate-size users, and for electricity generation, solid wood-based fuels, and liquid and gaseous fuels. Correspondents were requested to check the coherence of their replies (notably that total supply was equal to total consumption) and to provide the reasoning on which their estimates were based. Replies were received from 22 European countries, as well as Canada and the USA. Most of the replies were very complete (national data are presented in annex tables 19.1 to 19.12). The secretariat wishes to express again its deep gratitude to the correspondents who undertook this difficult task.

Correspondents were requested to provide estimates for supply and consumption of wood-derived energy under two hypotheses for the general development in the energy sphere, which were defined as follows:

Hypothesis A (high demand scenario)

This scenario is based on an economic environment conducive to buoyant energy demand growth. Its basic assumption is that energy prices would maintain their real value in the long run, i.e. increase at the rate of inflation, between the mid-1980s and the end of the century. Until 1985, however, real oil prices are assumed to decline. Economic growth would be relatively high (an average of about 3.2% in OECD countries from 1985 to 2000).

Hypothesis B (low demand scenario)

In this scenario energy demand growth would be dampened by gradually rising oil prices and subdued economic growth. The scenario assumes a 3% annual increase in the real energy price after 1985. For the immediate future, a price decline is assumed. Growth rates would be lower than in hypothesis A (an average of about 2.7% between 1985 and 2000 for OECD countries).

It is interesting to note that correspondents drew different conclusions as to the effect of these general circumstances on wood-derived energy. Whereas many expected consumption of wood-derived energy to be higher under hypothesis B, a significant minority foresaw an opposite development; other correspondents provided only one scenario. There were also differences of interpretation by product, frequently justified by detailed arguments.

It is unfortunately not possible to examine in detail in ETTS IV, for reasons of space, the reasoning behind the different scenarios, in different countries, although such a discussion would be of great interest. The existence of such a diversity of interpretations is further proof (if such proof were needed) that there is no consensus at present as to how general energy developments will affect wood-derived energy. In this chapter, no attempt has been made to impose a uniformity of approach and the data presented are as the correspondents supplied them.

The summary of these estimates in table 19.1 (including only those countries that provided complete forecasts)

TABLE 19.1

National forecasts for use of wood and bark as a source of energy in 13 selected countries

	1980 (million m³)	2000 [a] (million m³) Hypothesis A	Hypothesis B	Change 1980 to 2000 Volume (million m³) A	B	Annual average (percentage) A	B
Finland	6.9	7.9	9.3	+ 1.0	+ 2.4	+0.7	+1.5
Norway	2.8	3.5	3.7	+ 0.7	+ 1.0	+1.1	+1.5
Sweden	10.7	16.1	20.0	+ 5.4	+ 9.3	+2.1	+3.2
Denmark	1.0	0.8	1.5	− 0.2	+ 0.5	−0.8	+2.1
France	15.9	20.3	29.0	+ 4.4	+13.1	+1.2	+3.0
Germany, Federal Republic of	11.4	20.7	21.7	+ 9.3	+10.3	+3.0	+3.3
Ireland	0.3	0.6	0.7	+ 0.3	+ 0.4	+3.0	+4.0
United Kingdom	0.8	1.6	1.1	+ 0.8	+ 0.3	+3.7	+1.6
Switzerland	2.2	4.7	2.7	+ 2.5	+ 0.4	+3.8	+0.9
Portugal	6.5	11.2	10.7	+ 4.7	+ 4.3	+2.8	+2.6
Spain	4.5	8.6	7.5	+ 4.1	+ 3.0	+3.3	+2.6
Bulgaria	2.4	2.1	2.1	− 0.3	− 0.3	−0.7	−0.7
Poland	4.6	5.9	5.2	+ 1.4	+ 0.7	+1.3	+0.7
Total (13 countries)	70.1	104.1	115.3	+34.0	+45.2	+2.0	+2.5
of which:							
Fuelwood	36.3	50.9	60.8	+14.6	+24.5	+1.7	+2.6
Primary processing residues	13.3	18.1	18.2	+ 4.8	+ 4.9	+1.5	+1.6
Secondary processing residues	8.7	12.8	13.6	+ 4.1	+ 4.9	+2.0	+2.3
Pulp and paper residues[b]	5.2	8.7	8.8	+ 3.5	+ 3.6	+2.6	+2.7
Recycled wood	6.7	13.7	14.0	+ 7.0	+ 7.3	+3.6	+3.8

[a] For explanation of hypotheses A and B see text.

[b] Excludes pulping liquors, but includes wood and bark used for energy by pulp and paper industry.

shows that sustained, but not explosive, growth in the use of wood for energy is expected by most countries, for most types of energy wood. The 13 countries, which between them accounted for about two-thirds of total European removals, expected the use of wood for energy (excluding pulping liquors) to be 30-45 million m^3 higher in 2000 than in 1980, an annual average rate of growth of about 2.0 to 2.5%. This rate is, in fact, in the same range as the growth rates projected for consumption of other forest products (chapter 12), in contrast to earlier periods when fuelwood consumption was expected to decline while that of industrial forest products rose. For the 13 countries together, slightly lower growth rates were expected for residues of primary processing of wood than for other wood types, no doubt because it was considered that raw material uses for these residues would continue to prove more attractive than energy uses for residues which were technically suitable. Higher rates of growth were foreseen for burning of wood and bark by the pulp and paper industry and for burning of recycled wood products. The latter increase is essentially due to two countries: France foresaw a rise from 3.0 million m^3 to 4.0-5.2 million m^3 over the 20 year period and the Federal Republic of Germany from 0.5 to 5.0 million m^3.

In volume terms, the largest increases are forecast by France (4.4-13.1 million m^3), the Federal Republic of Germany (9.3-10.3 million m^3), and Sweden (5.4-9.3 million m^3). There are, however, interesting differences between these countries in the type of growth foreseen, as shown in table 19.2.

In Sweden, most of the increase is expected to be for fuelwood, in line with national policy to encourage the development of domestic fuels. In the Federal Republic of Germany, however, significant increases were expected from most sources, especially recycled wood products. France, too, foresaw fairly widespread increases, and indicated a particularly wide range between the "low" and the "high" hypotheses for fuelwood consumption with increases between 1.2 and 8.5 million m^3. The high growth in fuelwood consumption under hypothesis B (low demand scenario) is assumed to result from a situation of high energy prices when strong Governmental action is taken to encourage the use of wood for energy. It is worth pointing out that in these circumstances growth in demand for forest products is considered unlikely to be high (due to low GDP growth as specified in hypothesis B). As a consequence high fuelwood consumption is unlikely to coincide, in France at least, with high consumption of forest products. The consequences of this line of reasoning for the overall material balance are discussed further in chapter 20. None of the three countries foresaw a significant increase in the burning of wood and bark residues by the pulp and paper industries, presumably as these residues are fully used at present. Indeed, at the European level, the increase for this category is due essentially to one country, Portugal, which expects an increase from 0.3 to 2.2 million m^3, possibly due to an expansion of that country's pulp and paper industry, as well as to a more intense use for energy of available wood and bark residues.

TABLE 19.2

Changes in volume of wood used for energy, by source, in France, the Federal Republic of Germany and Sweden, between 1980 and 2000

(Million m³)

	France		Federal Republic of Germany		Sweden	
	A	B	A	B	A	B
Fuelwood	+1.2	+ 8.5	+1.4	+ 1.4	+4.4	+8.5
Primary processing (mechanical)	+1.0	+ 1.0	+1.4	+ 1.4	+0.5	+0.3
Secondary processing (mechanical)	+0.9	+ 0.9	+2.0	+ 3.0	b	b
Pulp and paper industry[a]	+0.3	+ 0.3	–	–	+0.5	+0.5
Recycled wood	+1.0	+ 2.2	+4.5	+ 4.5	b	b
Total	+4.4	+13.1	+9.3	+10.3	+5.4	+9.3

[a] Excluding pulping liquors. [b] No national forecast.

TABLE 19.3

Summary of national forecasts for consumption of wood for energy in conventional uses, 1980 to 2000, in 17 selected countries[a]

	1970 (million m³)	1980 (million m³)	2000 (million m³)		Change 1980 to 2000: Volume (million m³)		Change 1980 to 2000: Average annual percentage	
			A	B	A	B	A	B
Households	34.9	35.3	43.1	44.8	+ 7.8	+ 9.5	+1.0	+1.2
Forest industries	15.2	17.8	28.9	29.4	+11.1	+11.6	+2.5	+2.6
Intermediate and large-scale units[b]	7.0	7.6	17.4	17.9	+ 9.7	+12.0	+4.2	+4.4
Charcoal manufacture[c]	1.6	1.9	2.8	2.6	+ 0.9	+ 0.7	+2.0	+1.6
Total (17 countries)	58.7	62.6	92.2	94.7	+29.6	+32.1	+2.0	+2.1

[a] Bulgaria; Cyprus; Czechoslovakia; Denmark; Finland; the Federal Republic of Germany; Greece; Hungary; Ireland; Norway; Poland; Portugal; Spain; Sweden; Switzerland; the United Kingdom; Yugoslavia.

[b] Outside the forest industry.

[c] Where correspondents did not mention charcoal manufacture, it has been assumed that the volumes concerned are insignificant.

The estimates presented in this chapter have been used as the basis for the "ETTS IV consumption scenario" for *fuelwood*[3] in chapter 12 (see, in particular, annex table 12.23). Secretariat estimates were made for those countries which did not reply to the enquiry. For Austria, Belgium-Luxembourg, the German Democratic Republic, the Netherlands and Romania, it was assumed that fuelwood consumption would grow at the average rate of the other members of the respective country group. This procedure was not possible for Turkey, which is Europe's largest fuelwood user (over 20% of the total) and has a quite different social and economic situation from other countries covered by ETTS IV. In Turkey, there appear to be two conflicting trends in the fuelwood field. On the one hand, the forecast above-average rate of population growth could increase fuelwood demand; on the other, a modernization of economic structures and energy use patterns could reduce it. A rather wide range of estimates is therefore presented: from 15.7 million m³ in 1980, a fall to 13 million m³ or a rise to 18 million m³.

What are countries' forecasts for the consumption patterns of wood-derived energy? The replies are presented in full in annex tables 19.7 to 19.11. A summary of the replies for conventional uses (as defined in chapter 18) is in table 19.3.

Consumption of wood for energy in all conventional uses, notably by direct combustion to produce heat, is expected to rise by around 2% a year between 1980 and 2000, rather more slowly in households; the potential for further expansion in wood-burning by rural families seems to be considered limited, and penetration of the urban household market, in competition with other fuels, unlikely. Consumption growth is expected to be stronger in the forest industries: unrecovered waste of wood and bark is expected to be steadily reduced as wood-burning equipment is installed. The fastest growth is expected in the area of intermediate and large-scale users outside the forest industries, which include schools, barracks, hospitals and residential complexes, as well as district heating units. When situated in rural areas, this type of heating installation is often well suited to wood-based heating, as they are not so large as to require inordinately high transport costs, but are large enough to justify long-term supply contracts, investments in handling and storage facilities, etc. In many cases the owners of the installations are also forest owners, making the whole system more attractive economically. Wood consumption by this type of unit is expected to grow by over 4% a year until 2000 with particularly large rises in Sweden (+1.6 to 2.9 million m³).

[3] For chapter 12, and the consistency analysis in chapter 20, only scenarios for fuelwood were needed, as scenarios for residues etc. would cause double counting. The effect of energy wood demand on availability of residues for raw material is discussed below.

The outlook is less clear for the "new" types of wood-derived energy, not included in table 19.3 These are defined as generation of electricity for the public grid (cogeneration of electricity by the forest industries is included with other wood-energy use by those industries), solid fuels (briquettes, pellets, etc.) and liquid or gaseous fuels (often seen as substitutes or additives to traditional fuels). National replies, reproduced in annex table 19.11, seem to indicate that very little expansion is expected. Nevertheless, in their comments, many correspondents drew attention to the very high degree of uncertainty about the future for these fuels, arising from possible technical progress.

Some of the correspondents' comments on the outlook for these new fuels are reproduced in annex 19.13 (along with replies from Canada and the USA, for comparison).

It is clear from these remarks that although most countries do not expect any growth in these "new" uses and all countries are extremely prudent, a significant increase cannot be entirely ruled out, in the right circumstances (technological progress, satisfactory wood supply, high prices for conventional energy sources). Most correspondents, however, expect little or no growth.

Only a few correspondents were able to provide estimates for future use of pulping liquors as a source of energy but these replies do come from countries which accounted for the great majority of European chemical pulp production. (These replies are presented in annex table 19.12). The slow growth rates foreseen (around 1% p.a.) reflect the expected growth in production of chemical pulp. However the absence of estimates for many countries does not have a significant effect on the wood balance which ETTS IV will draw up, as these liquors arise only in the process of chemical pulping and are in almost all cases entirely consumed in the same process. The quantity of energy produced is therefore entirely determined by the level and techniques of production of chemical pulp and does not affect other parts of the forest and forest products sector. It does however effect the calculation of the share of wood ultimately used as a source of energy (see estimate of over 40% for 1980 in chapter 18).

19.5 EFFECTS OF DEMAND FOR ENERGY WOOD ON SUPPLY OF WOOD RAW MATERIAL

In the period after the first "oil shock", considerable concern was expressed in many quarters that strong demand for energy wood would deprive the forest industries of part of their raw material supply. As mentioned above, this did not occur, although some price effects were noted. Would the increase in consumption of energy wood foreseen in the previous section have any negative effect on raw material availability? As the situation is different for each type of energy wood, they will be treated separately.

The effect of demand for *fuelwood* must be treated in the global context of wood supply, in chapter 20, as all wood can be burnt and it is necessary to compare total demand for wood with the total potential of the forest to supply it. There is one aspect, however, of particular relevance to fuelwood supply: a large part of fuelwood removals are taken from sources not covered in the inventory data on growing stock and increment – notably tops and branches, trees outside the forest, hedgerows, ligneous agricultural residues, etc. Although the forecasts for total removals (chapter 5) do include wood from outside the forest, it is difficult to make precise forecasts for wood arising in such a wide variety of places. This fact introduces an unavoidable element of uncertainty into the final balance calculation.

In fact the relationship between fuelwood demand and the level of supply of industrial wood is quite complex. On the one hand, increased demand for fuelwood may encourage thinning, bringing extra supplies of industrial wood onto the market and improving the quality of the forest resource and its ability to supply wood in the future. On the other, there can be competition between uses for available supplies of small wood, so that an increase in fuelwood demand reduces supplies of industrial wood. It appears that there are two types of fuelwood demand: the first, for auto-consumption, has little effect on supplies of industrial wood; the second, for fuelwood entering commercial channels, especially for the larger consumers (e.g. district heating) does interact with the industrial wood market. It is not possible to examine these questions in greater detail here, notably because of the importance of local factors.

Most concern has been expressed about competition for *primary processing residues*, especially the solid wood residues from sawmills, plywood mills and veneer mills, which represent a major and increasingly important source of raw material for the pulp and panel industries (see chapter 15, which also shows that an increasing share of these residues has in fact been transferred for use as raw material). This competition concerns essentially the solid wood portion of these residues, as bark is not usually attractive as a raw material for pulp or panels.[4]

It would be desirable to compare:

(*a*) The volume of solid wood primary processing residues generated;

(*b*) The volume of these residues required for the manufacture of pulp, particle board and fibreboard; and;

(*c*) The volume of these residues required as a source of energy.

[4] Bark does have several other uses, notably in horticulture, but these are of relatively local importance. In any case, most of these uses would be able to pay sufficiently high prices to prevent the bark being used for energy.

TABLE 19.4

Outlook for availability of solid wood residues of primary processing and demand for these residues for raw material and energy, 1980 and 2000

(Million m^3)

	Residues generated			*Not used for raw material*		
	1980 [a]	*2000 low*	*2000 high*	*1980* [a]	*2000 low*	*2000 high*
Finland	9.0	9.4	9.9	1.2	1.0	0.3
Norway	2.1	2.1	2.3	0.2	0.2	–
Sweden	11.0	10.8	11.3	1.1	0.8	–
Denmark	0.9	1.1	1.2	0.7	0.5	0.5
Germany, Federal Republic of[a]	4.8	5.3	6.2	–0.2	–0.2	–0.3
Ireland	0.1	0.1	0.2	0.1	–	–
United Kingdom	1.1	1.3	1.5	0.6	0.4	0.3
Switzerland	0.8	0.8	1.0	0.2	0.1	0.1
Greece	0.4	0.7	0.9	0.2	0.3	0.2
Spain	2.0	2.6	3.1	1.8	1.8	1.2
Bulgaria	1.0	1.1	1.3	0.7	0.5	0.2
Hungary	1.2	1.2	1.3	1.0	0.8	0.5
Poland	3.6	4.2	4.4	2.0	1.4	1.1
	Use for energy			*Surplus (+) or deficit (–)*		
	1980	*2000 low*	*2000 high*	*1980*	*2000 low*	*2000 high*
Finland	0.4	0.5	0.7	+0.8	+0.5	–0.4
Norway	–	–	–	+0.2	+0.2	–
Sweden	0.7	0.8	0.9	+0.4	–	–0.9
Denmark	0.3	0.2	0.5	+0.4	+0.5	–
Germany, Federal Republic of[a]	0.6	0.6	0.6	–0.8	–0.8	–0.9
Ireland	0.1	0.2	0.3	–	–0.1	–0.2
United Kingdom	0.5	0.5	0.6	+0.1	–0.1	–0.3
Switzerland	0.1	0.1	0.1	+0.1	–	–
Greece	0.1	0.1	0.1	+0.1	+0.2	+0.1
Spain	1.1	2.0	2.1	+0.7	–0.2	–0.9
Bulgaria	0.1	0.1	0.1	+0.6	+0.4	+0.1
Hungary	0.4	0.5	0.6	+0.6	+0.3	–
Poland	0.6	0.7	0.7	+1.4	+0.7	+0.4

Sources: "Residues generated" and "residues not used for raw material", from consistency analysis model, assuming imports retain a constant share of consumption. See chapter 20. For "residue use for energy", see section 19.4.

[a] 1979-81 average, from consistency analysis model.

[b] Secondary processing residues also included on raw material consumption side (leading to negative figures for "not used for raw material"). See text.

The sum of (*b*) and (*c*) should not exceed (*a*). Estimates for (*c*) were presented in the previous section. (For country detail, see annex table 19.3, for solid wood only). It has been possible also to prepare estimates for (*a*) and (*b*) in the context of the "consistency analysis" which will be presented in chapter 20. This comparison is therefore presented in table 19.4, although it must be borne in mind that, because of the low quality of the basic statistics on residue availability and use, and the large number of assumptions made, this comparison should only be considered a very rough indicator of the situation. Nevertheless, a few facts are apparent:

(*a*) For 1980, in all cases except one (the Federal Republic of Germany, which will be discussed below), the figure for residues "not used for raw material" is higher, sometimes considerably higher, than the estimate of the use of these residues for energy. This indicates that it is likely that the comparisons undertaken are not too distorted;

(*b*) In 2000, with "low" consumption (of pulp, panels and sawnwood), and "low" use of primary processing residues for energy, there is usually a surplus. In this scenario, few, if any, problems of residue availability for energy or for raw material seem likely;

(*c*) In 2000, with the "high" scenario both for consumption and for energy use, many countries show a "deficit" or volumes of residues "not used for raw material" equivalent to the estimate for "residues for energy". This is an indication that in the "high" scenario, competition problems could well occur. Probably there would be no "deficit" in physical terms: it is more likely that the resulting tensions would cause prices of primary processing residues to rise;

(*d*) In the Federal Republic of Germany there is a "deficit" even in 1980 (also discussed in chapter 15). This indicates that part of the domestic supply of residues comes from the secondary wood processing sector (e.g. the sizeable planing industry) not taken into account in the consistency analysis (only the primary processing industries are taken into account when estimating "residues generated"). This artificial "deficit" does not increase significantly in the estimates for 2000. It is, of course, possible that the pulp and panels industries of other countries could also find a source of raw material in the residues of the secondary processing industries.

The situation for the other sources of wood-derived energy – *secondary processing residues, pulp and paper industry residues, recycled wood products* – is rather different. With a very few exceptions, this material is not at present used as raw material for pulp or panels: indeed, in many cases, it is technically not suitable for such use, as it has been contaminated with paint, glue, lacquer, nails, etc. Few reliable estimates have been prepared of the availability of this material and even fewer of the volumes in fact used as raw material by the pulp and panel industries. The consumption of this material for uses other than energy must, in most countries, be considered negligible at present. Furthermore, for reasons of expense and organization of collection circuits, it is unlikely that use for raw material will increase significantly, unless there arose a major raw material shortage for the pulp and panel industries. For these residues, therefore, few, if any, problems of competition between "raw material" and "energy" uses are foreseen.

19.6 OVERVIEW AND CONCLUSIONS

Chapter 18 established that wood is used as a source of energy in a number of forms: wood in the rough (fuelwood), residues of primary and secondary mechanical processing, and of the pulp and paper industries (wood and bark, as well as pulping liquors and recycled wood). It is estimated that 40% of the volume of wood removed in Europe is used as a source of energy. The decline in the consumption of fuelwood was reversed in the late 1970s, under the influence of the two "energy crises".

Chapter 19 examined the outlook for the use of wood for energy on the basis, among other things, of the replies to an enquiry. "Conventional" uses (i.e. combustion, usually by rural households or in the forest industries) were seen as being economically attractive when the study was drafted and were expected to continue to grow at a moderate speed (about 2-3% a year). "New" uses (e.g. the production of liquid or gaseous fuels from wood, electricity generation), were not expected to increase, but there was great uncertainty, notably about future technical developments and energy prices. Even with the most optimistic assumptions, wood could only provide a relatively small part of national energy demand (except in a few forest-rich countries).

Demand for energy uses was not expected to affect availability of wood residues for use as raw material, in a "low" demand scenario. In a high "demand" scenario, energy/raw material competition for these residues might occur.

How would the forecast increased demand for fuelwood affect the overall supply/demand balance? To answer this question, it is necessary to bring together, on a comparable basis, the various forecasts for consumption and supply of wood and forest products made in ETTS IV. This exercise is carried out in chapter 20.