4. Future trends in energy, climate and woodfuel use

In this chapter the scope for future woodfuel use is placed in the context of expected trends in energy markets in the next 10 to 20 years. General global trends are reviewed in reference to past energy consumption and future projections developed by the International Energy Agency (IEA, 2009a). The IEA reference scenario provides a forecast of global energy use by fuel, region/country, sector and application; it assumes no fundamental changes in existing energy/climate policies and institutions and is based on an array of assumptions concerning the cost and availability of fuels, market structures, technologies and distribution/transport infrastructure.

HISTORICAL ENERGY TRENDS

Global primary energy demand increased by 37 percent between 1990 and 2007 (Table 19), while power generation increased by 52 percent (Table 20). The strong demand for electricity, particular in China, is the main reason for a significant increase in coal consumption; renewables increased at a higher rate but from a much lower base. The use of biomass and waste for power generation increased at a faster rate than the overall use of biomass as a source of primary energy, mainly because as the use of biomass for power generation has increased its use for traditional purposes has declined. The cost-effectiveness of biomass for heat and power generation in Europe and North America has been the main driver of increasing demand for biomass energy, along with the financial incentives available for renewable energy in the EU and several other regions.

TABLE 19
Global total primary energy demand

Energy type	Demand *(EJ)*		Share of total demand *(%)*		Annual average change *(%)*
	1990	2007	1990	2007	
Coal	93	133	25.4	26.5	2.43
Oil	135	171	36.7	34.1	1.61
Gas	70	105	19.1	20.9	2.75
Nuclear	22	30	6.0	5.9	2.01
Hydro	8	11	2.1	2.2	2.46
Biomass and waste	38	49	10.3	9.8	1.77
Other renewables	2	3	0.4	0.6	4.92
Total	**367**	**503**			**2.13**

Source: IEA, 2009b.

Trends in overall energy demand can also be assessed according to the status of countries as either Annex I or non-Annex I parties based on their obligations under the United Nations Framework Convention on Climate Change (UNFCCC). Energy demand in non-Annex I parties, led by China and India, nearly doubled between 1990 and 2007, resulting in a major shift in global energy-use patterns; non-Annex I parties now account for half of global energy use (Table 21). This transition in global energy demand has implications for woodfuels and other energy sources because the energy infrastructure in Annex I parties is older and suited for different fuels than the infrastructure in non-Annex I parties. For example, the co-firing of biomass in coal plants is more easily accommodated at the stage of boiler design and installation rather than in retrofitting (IEA, 2009a).

Energy consumption trends in Annex I and non-Annex I parties illustrate some of the sectoral dynamics of demand across end-use sectors at different phases of economic development (Table 22 and Table 23). The mature economies of Annex I parties have experienced greatest demand growth in service-oriented sectors ("other consumers" in the tables), where much of the demand is for electricity. Growth in non-Annex I demand has been greatest in industry and construction, where various fuels are used. Energy demand in the household

TABLE 20
Global primary energy demand for power generation

Energy type	Demand *(EJ)*		Share of total demand *(%)*		Average annual change *(%)*
	1990	2007	1990	2007	
Coal	51	91	41.2	47.6	3.86
Oil	16	12	12.6	6.2	-1.85
Gas	24	41	19.3	21.7	3.66
Nuclear	22	30	17.6	15.6	2.01
Hydro	8	11	6.2	5.8	2.46
Biomass and waste	2	4	2.0	1.8	2.38
Other renewables	1	3	1.1	1.3	4.28
Total	**125**	**191**			**2.87**

Source: IEA, 2009b.

TABLE 21
Global total primary energy demand by Annex I and non-Annex I parties

Group	Total primary energy demand *(EJ)*		Share of global demand *(%)*		Change *(%)*
	1990	2007	1990	2007	
Non-Annex I	128	250	35	50	4.6
Annex I	239	252	65	50	0.4
Total	**367**	**503**			**2.1**

Source: IEA, 2009b.

TABLE 22
Final (delivered) energy demand by sector, Annex I parties

Sector	Demand *(EJ)*		Share *(%)*		Average annual change *(%)*
	1990	2007	1990	2007	
Agriculture	1	1	1.6	0.9	1.10
Households	11	25	24.5	26.1	5.68
Industry and construction	11	27	25.6	28.0	5.86
Other consumers	3	16	5.7	16.3	12.92
Transportation industry	19	27	42.6	28.7	2.49
Total	**44**	**95**			**5.23**

Source: Calculated from IEA, 2010a.

TABLE 23
Final (delivered) energy demand by sector, non-Annex I parties

Sector	Demand *(EJ)*		Share *(%)*		Average annual change *(%)*
	1990	2007	1990	2007	
Agriculture	1	2	2.5	1.7	3.1
Households	23	33	56.0	34.5	2.6
Industry and construction	7	38	18.5	39.8	11.5
Other consumers	5	12	13.0	12.9	6.2
Transportation industry	4	11	10.0	11.1	6.6
Total	**40**	**97**			**6**

Source: Calculated from IEA, 2010a.

sector has grown fastest in Annex I parties, largely because households there mainly use electricity; households in non-Annex I parties are using mainly traditional forms of biomass energy, which are less versatile and therefore less given to rapid consumption increases.

PROJECTIONS OF ENERGY SUPPLY AND DEMAND TO 2030

The IEA reference scenario provides "a baseline picture of how global energy markets would evolve if governments make no changes to their existing policies and measures" (IEA, 2009a). It shows an annual growth in energy demand through 2030 of 1.5 percent (Table 24), with coal consumption growing at an annual rate of 1.9 percent annually. It is projected that oil consumption will rise by 0.9 percent annually, mainly in non-OECD countries. Natural gas use will expand by 1.5 percent annually, with the Near East, China and India as major consumers along with North America, the Russian Federation and Europe. Coal consumption will grow at 1.9 percent annually, mainly due to rising consumption in China (IEA, 2009a).

Electricity consumption is expected to increase by 1.9 percent annually to 2030, with over 80 percent of the growth in non-OECD countries. Nuclear power capacity will be added in all OECD regions except Europe, and also in China and India. Biomass for power generation grows at 5 percent in the reference scenario, which is lower than the "other renewables" category, which grows at 7.4 percent (Table 25) (IEA, 2009a). However, since these figures are for primary energy and only electricity (i.e. they do not include heat), it is important to note the difference in measurement for thermal power compared to other renewables. The high share of coal for electricity production illustrates a potential role for biomass co-firing. For new power plants, climate change mitigation options include biomass cogeneration (heat and power) plants where scale and resources can be matched to demand.

TABLE 24
IEA reference scenario: total world primary energy consumption

Energy type	Primary energy consumption *(EJ)*			Share of total *(%)*		Average annual change, 2007–2030 *(%)*
	2007	2020	2030	2007	2030	
Coal	133	173	205	27	29	1.9
Oil	171	186	210	34	30	0.9
Gas	105	127	149	21	21	1.5
Nuclear	30	36	40	6	6	1.3
Hydro	11	14	17	2	2	1.8
Biomass and waste	49	60	67	10	10	1.4
Other renewables	3	9	15	1	2	7.2
Total	**503**	**605**	**703**			**1.5**

Source: IEA, 2009b.

TABLE 25
IEA reference scenario: world primary energy for power generation

Energy type	Primary energy consumption *(EJ)*			Share of total *(%)*		Annual average change to gross consumption, 2007–2030 *(%)*
	2007	2020	2030	2007	2030	
Coal	91	120	146	48	49	2.1
Oil	12	8	7	6	2	-2.3
Gas	41	50	61	22	21	1.7
Nuclear	30	36	40	16	14	1.3
Hydro	11	15	17	6	6	1.8
Biomass and waste	4	7	11	2	4	5.0
Other renewables	3	8	13	1	4	7.5
Total	**191**	**244**	**295**			**1.9**

Source: IEA, 2009b.

GLOBAL CO_2 EMISSIONS

According to the IEA reference scenario, global energy related CO_2 emissions are expected to increase from 29 gigatonnes of carbon (GtC) per year to 40 GtC per year between 2007 and 2030 (Table 26). Under the IEA reference scenario, energy-related CO_2 emissions are dominated by power generation and transport, with increases of 50 percent and 40 percent, respectively, between 2007 and 2030. Transport-sector emissions are overwhelmingly from road transport. One difficulty in relating the IEA projections to substitution potential lies in the incomplete nature of data on heat consumption and heat demand. Since cogeneration has the most cost-effective substitution potential, it is difficult to estimate the real achievable potential.

The calculation of CO_2 emissions and greenhouse gas impacts associated with bioenergy is plagued by a number of uncertainties, most of which are poorly addressed in current accounting methods. First, land-use change due to bioenergy production is not necessarily included; in some cases it may be accounted for within the applicable land-use sectors, although there are considerable uncertainties associated with above-ground versus below-ground biomass. Second, the uncertainty in data on traditional biomass use results in corresponding uncertainties in emissions, even if conversion assumptions are reasonably accurate. Third, the use of traditional forms of biomass energy gives rise to black carbon or soot, which is not a global greenhouse gas but which does increase radiative forcing. Since the Intergovernmental Panel on Climate Change

TABLE 26
Energy-related CO_2 emissions for IEA reference scenario (Gt C)

Sector	1990	2007	2020	2030
Power generation	7 471	11 896	14 953	17 824
Other energy sector	1 016	1 437	1 755	1 993
Industry	3 937	4 781	5 571	6 152
Iron and steel	938	1 470	1 702	1 796
Non-metallic minerals	505	818	822	810
Other industry	2 493	2 493	3 047	3 546
Transport	4 574	6 623	7 733	9 332
Road	3 291	4 835	5 646	6 920
Aviation	538	742	884	1 067
International shipping	358	613	685	780
Other transport	387	433	518	564
Residential	1 891	1 877	2 031	2 198
Services	1 066	878	972	1 096
Agriculture	405	433	423	437
Non-energy use	581	900	1 087	1 195
Total	**20 941**	**28 826**	**34 526**	**40 226**

Source: IEA, 2009b.

(IPCC) does not yet include "short-lived" climate forcers such as black carbon, these impacts are not reflected in accounts (Bond and Sun, 2005).

ENERGY AND ELECTRICITY ACCESS

Also of importance for future emissions and the scope of woodfuel use is the projection of the number of people without access to electricity in the reference scenario, since this determines the number of people reliant on traditional biomass use. The total number of people reliant on traditional biomass use globally is expected to decrease by 175 million between 2008 and 2030 (Table 27). In some countries and regions, particularly in sub-Saharan Africa, however, the absolute number will increase. Moreover, these figures represent only those people who will have no access to electricity, nearly all of whom will be in rural areas. There is an additional number of people, almost as great, who will have limited or unreliable access to electricity and this group also uses traditional biomass in significant quantities. Sub-Saharan Africa is expected be the only major world region where electricity access will remain below 50 percent in 2030.

WOODFUEL CONSUMPTION

Mead (2005) analysed the role of planted forests in providing woodfuels and used regional statistics of current woodfuel use to project woodfuel use to 2030 (Table 28). Consumption is expected to decrease in Asia, mainly due to shifts in China and India. Total woodfuel consumption in 2030 is projected to be 1 502 million m^3, which equates to 15 to 18 EJ. The projections for Europe appear to be too low, since EU legislation is stimulating greater wood energy use (European Commission, 2006, 2009).

TABLE 27
Access to electricity, IEA/WEO reference case

Region	2008				Projections			
	Population without access *(millions of people)*	Electrification rate *(%)*			Population without access *(millions of people)*		Electrification rate *(%)*	
		Overall	Urban	Rural	2015	2030	2015	2030
Africa	589	40	67	23	627	700	45	54
North Africa	2	99	100	98	2	2	99	99
Sub-Saharan Africa	587	29	57	12	625	698	36	47
Non-OECD Asia	809	77	94	67	764	561	80	87
China	8	99	100	99	5	0	100	100
India	405	65	93	53	385	294	69	79
Other	396	63	85	48	374	267	68	81
Latin America	34	93	99	70	18	13	96	98
Near East	21	89	98	71	11	5	95	98
World	**1 456**	**78**	**93**	**63**	**1 422**	**1 281**	**80**	**84**

Source: IEA, 2009b.

TABLE 28
Actual and projected woodfuel consumption, by region (million m^3 per year)

Region	Actual		Projected	
	1990	2005	2020	2030
Asia	852	740	630	550
South Asia	336	369	362	339
East Asia	283	205	155	127
Africa	365	463	526	545
South America	96	104	115	122
North and Central America	170	167	142	162
Europe	127	122	104	96
World	**1 612**	**1 605**	**1 558**	**1 502**

Source: Mead, 2005.

Future woodfuel use will also be determined by the quantity of woody biomass that can be sustainably supplied for modern bioenergy use. One set of estimates for 2050 shows a supply range of up to 100 EJ, based on various combinations of residues and surplus forest growth, after accounting for future demand for industrial roundwood and fuelwood (Smeets and Faaiij, 2007). The imposition of stringent ecological and economic criteria reduces this potential to as low as zero; nevertheless there is considerable scope for increasing the sustainable use of forest resources for woodfuels by improving forest and wood product management (Smeets and Faaij, 2007).

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