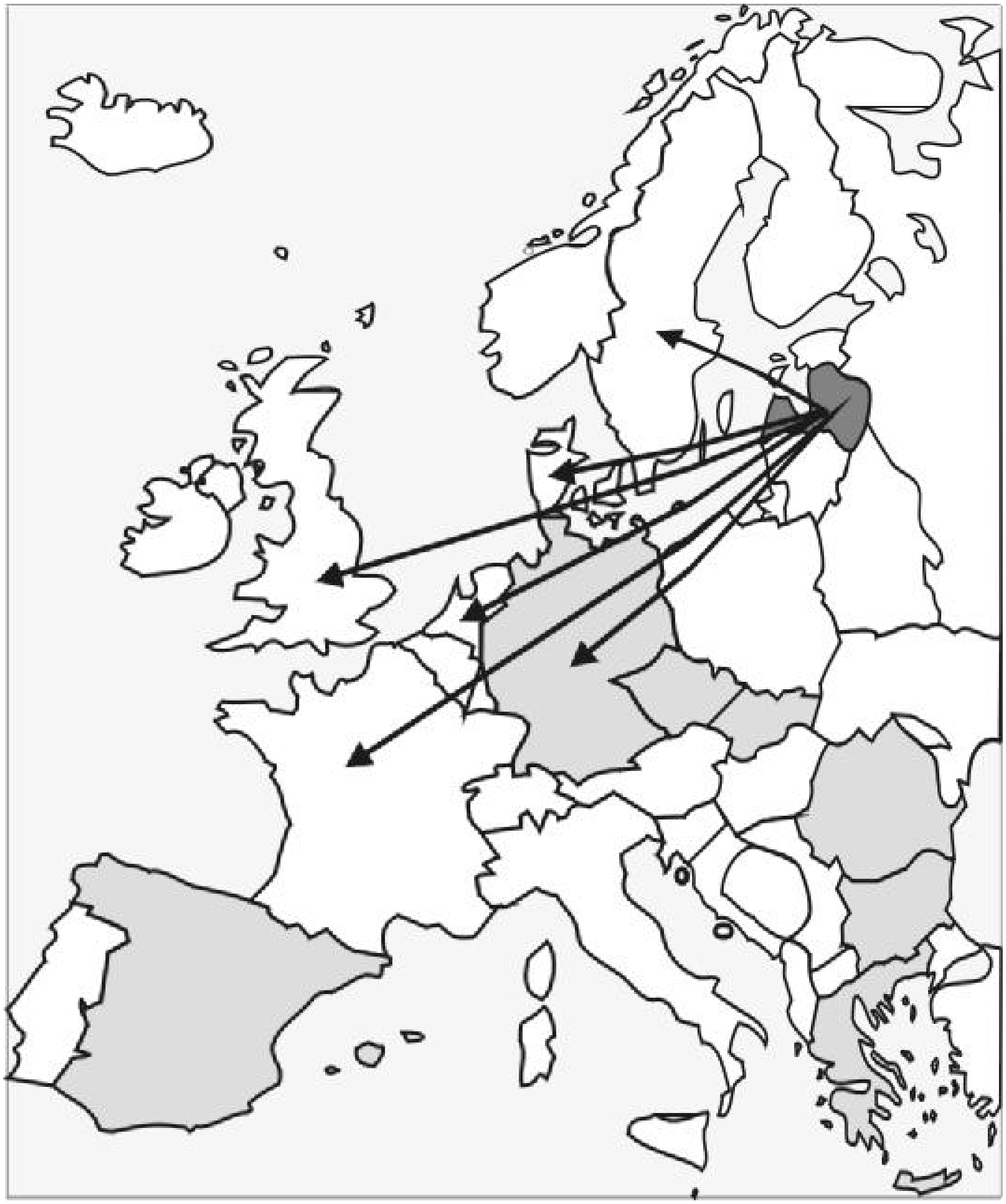
LATVIA



CONTENT:

1. MAIN DATA ABOUT COUNTRY AND ENERGY BALANCE

1.1 General description

Latvia is located in northeast Europe, boarded on the north by Estonia and the Gulf of Riga; on the east by Russia; on the south by Byelorussia and Lithuania; and on the west by the Baltic Sea. Riga, the capital and largest city, is also the country's chief port. About a third of the population resides here.

Latvia consists for the most part of a low-lying plain with some moderate elevations in the east, the tallest of which is 311 m. The principal river is the Daugava River serving the republic’s major hydroelectric power stations.

Latvia with total population of 2 366 131 (2001) covers a territory of 645900km^2. The 52% of the inhabitants are ethnic Latvians, Russians (34%) form the second major group. Latvia has population growth rate of –1,56% and 37 people per square kilometre density (2001).

The GDP is 7,60 bn Euro while the GDP per capita is of 3200 Euro (2000 data).

The clime in Latvia is dominated by marine influences, although more continental conditions, with greater climate variation, exist in the eastern portion of the republic. In the west, summers are cooler and winters milder. Snow covers the ground from two to more than four months of the year.

The main natural resources include amber, peat, limestone, dolomite, timber and hydroelectricity

The industry sector is diversified between agriculture, light engineering, food and beverage, textiles, wood products, and heavy engineering.

1.2 Land Use

Out of total area of 645900km^2, land makes 6.205 million ha in Latvia. At the beginning of the year 2001, 38.5% were agricultural lands, and 44.4% were forests.

1.2.1 Ownership Structure

In 2001, 44.5% of national land fund were with a registered ownership, but 52.7% were allocated for permanent use to private individuals, legal entities, as well as local governments and public institutions. In land ownership structure private individuals take up the main share, owning altogether about 2.7 million ha, which is about 94% of lands with registered ownership (see table 1). Meanwhile, public institutions are the leaders among land tenants [1].

	Hectares	Share of total land in ownership or under tenure, %	Share of total area of Latvia, %
Private individuals’ ownership	2 688 639	93.6	41.6
Legal entities’ ownership	75 923.0	2.7	1.2
Local governments’ ownership	83 781.8	2.9	1.3
Public administration institutions’ ownership	22 779.1	0.8	0.4
Mixed status joint ownership	1 073.8	X	X
Land in ownership, total	2 872 197	100.0	44.5
Private individuals’ tenure	1 097 505	32.3	17.0
Legal entities’ tenure	92 558.8	2.7	1.4
Local governments’ tenure	326 836	9.6	5.1
Public administration institutions’ tenure	1 887 864	55.4	29.2
Land tenure, total	3 404 765	100.0	52.7
Free state land	181 902	X	2.8
Total in Latvia	6 458 865	X	100.0

Table 1: Land ownership and use breakdown as of 01.01.2001, [Source: State Land Service]

According to State Land Service, at the beginning of 2001, out of all land under ownership or tenure about 4.1million ha have been allocated to private farms, enterprises and state farms, which have reported agriculture as core business. These areas, apart from agricultural land, include forests and other types of land use.

Type of farm	Thousands of ha					% of total		
	1990	1995	1999	2000	2001	1990	1995	2001
Family farms*	152	2159	3582	3606	3689	3.9%	78.9%	90.7%
State farms**	3545	52	14.4	11	9	91.3%	1.9%	0.2%
Other purposes	185	525.6	449	435	370	4.8%	19.2%	9.1%
Total	3882	2736.6	4045.4	4052	4068	100.0%	100.0%	100.0%
*) Including also household plots, subsidiary farms; **) specialised farms, subordinated to agricultural schools, experimental and testing stations								

[Source: State Land Service]

Table 2: Breakdown of land used for agriculture by type of user (as of 01.01.2001)

The number of family farms, defining agricultural production as land use purpose, has increased manifold between the land reform starting point and 1995. After 1995 the number of these farms has gradually started to shrink, however, the farmed areas are continuously increasing. Meanwhile, due to the privatisation, the number of state farms has notably decreased, and their area has decreased manifold. [1]

1.2.2 Agricultural Land Use

The trends in the use of agricultural land serve as an indicator of agricultural policy implementation. If the land is used to full extent, it is an evidence of the capacity of agricultural sector to generate stable and sufficiently high income, which encourages expanding business and a more complete use of the available natural resources. And vice versa, if a contrary trend is observed in land use, it means that traditional agriculture is not capable to generate an income, which would motivate the people employed in agriculture to expand their business.

Unfortunately, in Latvia during the recent years the non-farmed areas continue to grow, and this fact is closely related to the low-income level in the sector. Starting with 1998, when all pagasts (smallest administrative territorial unit) and rural territories of towns were included for supervision of agricultural land, the size of non-used agricultural lands has increased in average 2% per year.

As a result of supervision, in 2000 it was identified that the land areas overtaken by shrubs are increasing, i.e., 31743 ha or 1.4% of total agricultural land, including 10248 ha of meliorated lands – it is 0.65% of all meliorated agricultural land. The weeds have occupied 184835 of 7.9% of total agricultural land. (See details in table 3)

Indicators (thsd. ha)	1996	1997	1998	1999	2000
Land not used for agricultural production:	390.0	402.0	361.8	434.0	443.4
% of agricultural land	15.5	16.0	15.6	17.5	19.0
Areas overtaken by weeds:	196.0	191.0	144.0	175.7	184.8
% of agricultural land	7.8	7.1	6.2	7.5	7.9
Areas overtaken by shrubs:	20.0	15.1	21.5	26.5	31.7
% of agricultural land	0.84	0.63	0.93	1.10	1.40
Areas overtaken by bogs:	7.5	5.0	5.0	6.4	n.d.
% of agricultural land	0.28	0.21	0.21	0.26	n.d.

[Source: State Land Service]

Table3: Non-used agricultural lands between 1998 and 2000

Another problem very closely related to the failure of agriculture to generate a sufficiently high income is the inadequate maintenance of melioration systems; as a result the land is not any longer properly drained. About 60% or 1.6 million ha of agricultural land in Latvia are under melioration, out of this, in 350thsd.ha melioration systems do not function at the designed capacity. Practically no new systems have been built since 1993. The expected useful service life of the existing systems is up to 50 years, provided they are duly maintained. 20% of melioration systems are more than 20 years old. Over 220thsd ha of meliorated lands are overtaken by weeds, shrubs, or have turned into bogs [1].

1.2.3 Forest land

The landscape in Latvia is slightly undulating, without much altitude differences. Therefore, there are large territories of wet forest areas (about 40% in state-owned forests). Two nature zones meet in the territory of Latvia. From the South, broad-leaved forests growing in Western Europe comes in, and from the North elements of boreal forests come in – Scots pine, Norway spruce and birch forests. Also, from the climatic point of view, two zones can be singled out – maritime zone and the continental eastern part. This determines the diversity of soils and tree species. Latvian forest breakdown by type of soil is as follows:

- Upland (Dray mineral soil) forests 57%
- Wet forests (wet mineral and wet peat soils) 22%
- Drained forests (drained mineral and drained peat) 21%

The principal tree species in Latvia are Scots pine (38%), birch (29%), Norway spruce (20%), aspen (3%), alder (7.7%), ash, and oak (1.4%). The first four are right in the middle between the northern and southern borders of their distribution area, the trees are of the very top quality: straight and round trunks, fine branches, good branching, age-rings of medium width, straight fibre. (See figure 1)

The area of state owned forests has change very little over time; however, its share has decreased from 80% (in 1935) to 50% (in 2000). (See figure 2).

Out of this, 47% of forests are under tenure of state joint stock company “Latvian State Forests”, 1% is research forest, and the remaining 2% are under the authority of Ministry of Environment and Regional Development. It is forecasted that also in future about 50% of forests will continue to be privately owned, and the number of private holdings will exceed 150000; however, the average size of forest estate will not exceed 7-8 ha. [2]

The direct contribution of forestry and forest industry to gross domestic product (GDP) is assessed to be between 10 and 15%. According to statistics, 39.1 thsd people are employed in the sector (see table 4).

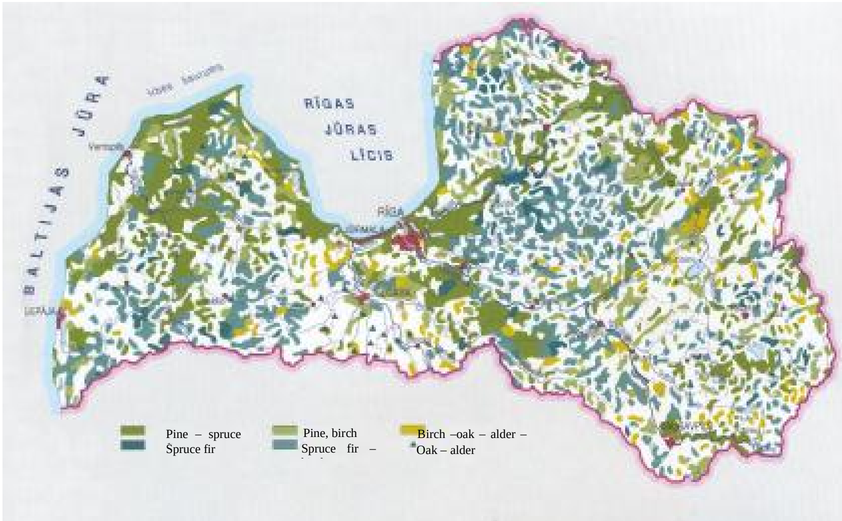
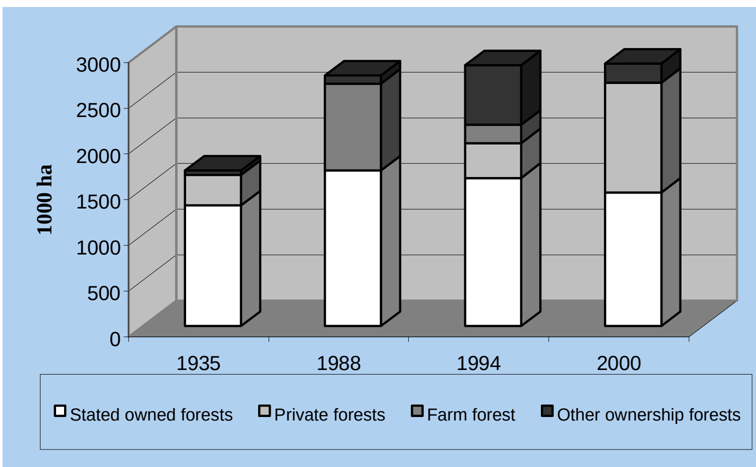


Figure 1: Forest map

In Latvia, forests (see figure 3) cover almost half of total land area.



Source: Latvian MoA

Figure 2: Distribution of forestland following the ownership categories (1000 ha)

	1996	1997	1998	1999	2000
Forestry, forest harvesting and related services	14000	15000	14000	15000	15900
Wood processing	16451	17604	19742	20787	23189
Total	30451	32604	33742	35787	39089

Table 4: Dynamics of the number of people employed in forestry [Source: CSB]

Since 1930 forest covered areas in Latvia have nearly doubled – from 24% in 1930 to 45% in 2000 with a covered area of 285 million ha. The trend is expected to continue, mainly due to the lands with low agricultural efficiency or non-efficient lands. The distribution various by administrative district from 25 – 30% of the land in Dobele, Jelgava, Bauska, Preili, Rezekne and 50 – 60% in Ventspils, Talsi and Aizkraukle. There are 1.9ha of forests per capita in Latvia, which is nearly four times the average in the EU countries and twice as much as the average figure in the world [1]

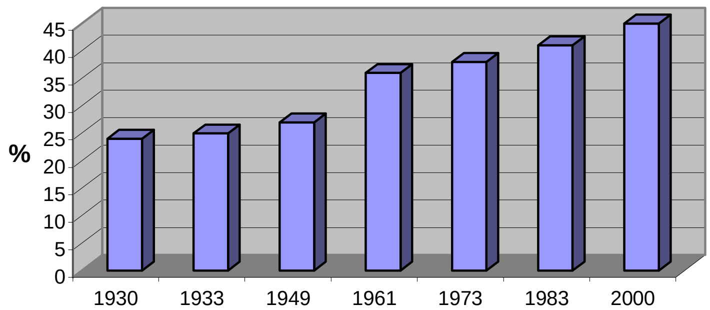


Figure 3: Dynamics of the forest cover (%) 1930-2000 - Source: Latvian MoA

2. INTRODUCTION TO THE ENERGY SECTOR

During the last years the Latvian government's policy has centred on the promotion of both energy efficiency and conservation measures. Accordingly in Latvia, has been encouraged a better utilization of the existing potential for combined heat and power production, a greater usage of indigenous energy resources and the liberalization of the energy market.

In accordance with this policy, the utilisation of the indigenous energy resources is an important priority, even because Latvia has substantial resources of hydro, peat and woody biomass

The present urgent problems for the development of the energy sector are the following [3]:

§ Streamlining of energy legislation
§ Reliability of energy deliveries
§ Privatisation and restructuring of energy companies
§ Increase of energy efficiency

Drafting on energy legislation continues, basically in two directions:

§ Harmonization of laws and regulatory documents with the regulations of EU
§ Drafting of new laws and regulations in compliance with requirements of external and domestic markets to develop power delivery service in the state

Both public and commercial project are implemented in the energy sector and several new project should be worked out. The main projects, in line with the government's policy, are:

§ Construction of new, environmentally friendly power plants
§ Increase the energy efficiency and energy saving
§ Installation of co-generation equipments
§ Use of local energy resources

2.1 Energy supply

Both the imported (natural and liquefied gas, oil products, coal) and local fuels (wood and peat) are used in Latvia to provide energy (power, electricity and heat) to sectors of national economy, commercial users and residents.

The structure of the supplied energy resources in 2000 (see figure 4) consisted of: oil products (light fuel, heavy fuel other oil products) – 29%, natural and liquefied gas – 33%, wood fuel – 22%, electricity of hydro plants – 6%, import of electricity – 4%, peat and other – 6%.

Significant changes in the balance of energy resources in the nearest five years are not predicted in view of the existing heat and electricity supply capacities, large industrial, commercial and household energy consumers.

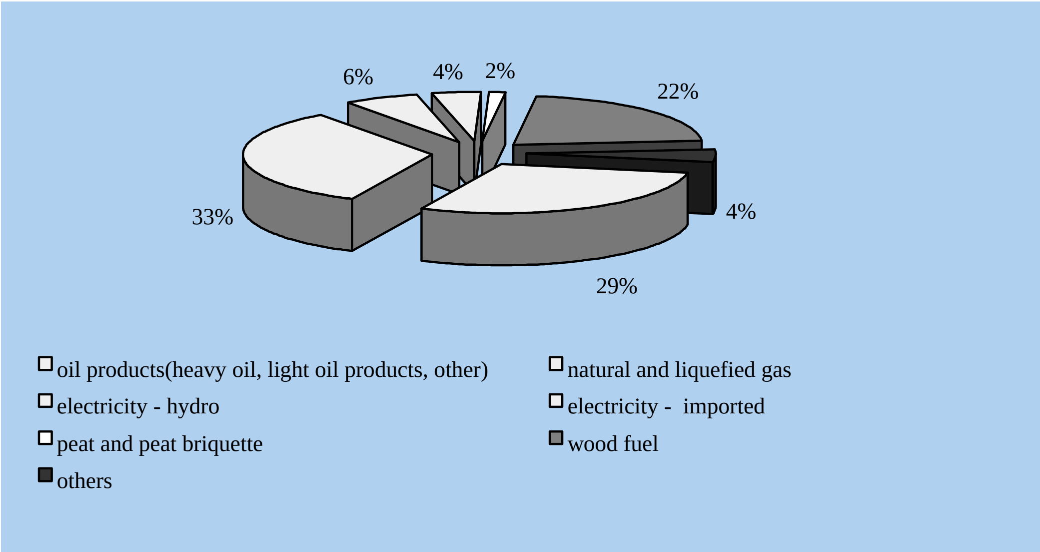


Figure 4: structure supplied energy resources – year 2000

In table 5 are provided information about consumption of energy resources in Latvia, while in table 6 are shown the average prices, for enterprises, of energy resources. Renewable energy resources are separately dealt in Chapter 3.

Consumption of energy resources		1999	2000
Gross energy consumption		172853	159145
of which:	oil products(heavy oil, light oil products, other)	61597	46325
	natural and liquefied gas	47821	52847
	electricity - hydro	9936	10162
	electricity - imported	7038	6430
	peat and peat briquette	1459	2483
	wood fuel	38244	34250
	others	6758	6648

[Source: Central Statistical Bureau and Ministry of Economy]
Table 5: Consumption of Energy Resources in Latvia (terajule)

Energy	Price [LVL]	Price [Euro]
Gasoline (t)	365	650.6
Diesel oil (t)	280	499.1
Mazut[1] (t)	72	128.3
Jet fuel (t)	281	500.9
Natural gas (thsd Nm^3)	67	119.4
LPG (t)	245	436.7
Coal (t)	31	55.3
Shale oil (t)	26	46.4

[Modified from: Central Statistical Bureau of Latvia, Energy Balance 2000, Riga 2001]
[1Euro=0,561LVL; 1Euro=0,8857UD$]

Table 6: average prices of purchased energy resources (year 2000)

[1] Mazut: heavy fuel oil deriving from crack reaction of crude oil. It is rather popular in Latvia, although in a lot of projects it is replaced by natural gas and local fuels.

Electrical power in Latvia is mainly generated in hydroelectric power station (HES) and CHPs, and then part is generated in small HES, windmill and SSCHP. Imports play an important role and electricity is purchased from Russia, Estonia and Lithuania.

2.2 Share of renewable on primary energy sources

Wood is the most significant local fuel and renewable energy resource in Latvia with a 22% share of the gross energy consumption. It is quite sustainable to increase further wood fuel production, but the growth cannot be only toward felled wood and firewood log but also by more efficient use of wood waste after processing and better forest management. It is estimated that about 40% of potential wood energy is still left in forests and at the processing phase as low quality fuel [4].

For the Latvian environmentalist experts, wood will retain its important position in the fuel balance of Latvia; however, if the amount of primary firewood is not reduced and the amount of less effective wood, wood-waste and chips, is not increased together with the use of more efficient boiler equipment– all this will cause the reduction of the overall wood resources. [5]

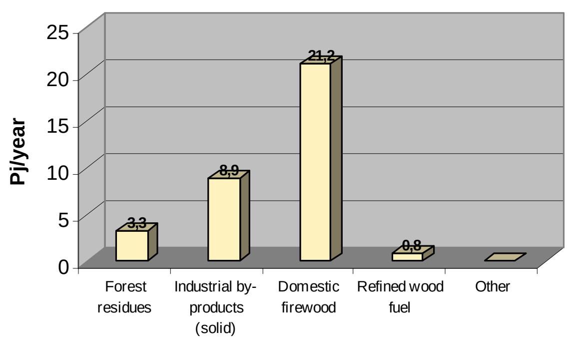


Figure 5: Current energy use of biomass in Latvia (total 34,2PJ/year)

Other renewable energy resources in Latvia are Agricultural biomass, Biodiesel and Biogas, but are not mentioned in the national energy program as primary energy sources.

The current energy use of different biomass type in Latvia is presented in figure 5, where under other with a share close to zero are gathered agricultural biomass (straw) biodiesel and biogas.

3. BIOMASS SOURCES

The most important biomass resource in Latvia is firewood; the utilization rate of forest residues is around 20%. About half of the refined wood fuel resources are used in Latvia while the rest is exported. Also part of the industrial by-products (mainly wood chips) are exported, the utilisation rate in Latvia ranges between 36%. [4]

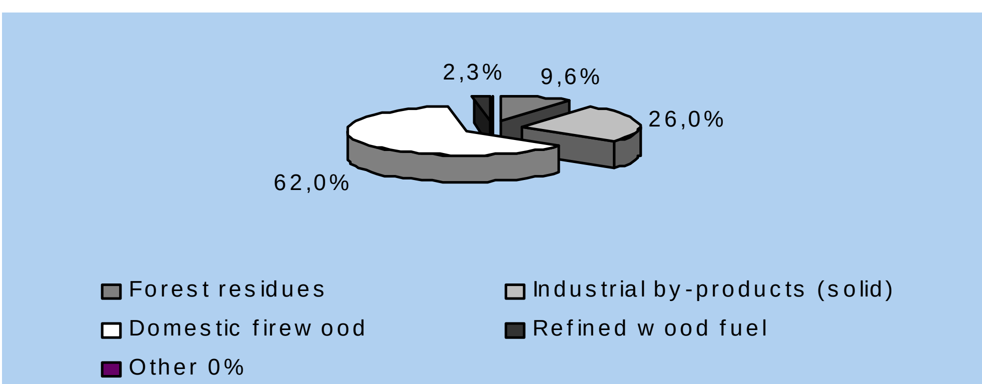


Figure 6: Different fuels in Latvian biomass utilisation

The shares of the different biomass fuels in the total biomass use are presented in figure 6; firewood has a share of 62%, following industrial by-products and forest residues.

3.1 Wood biomass

Wood is the most essential resource of forest; therefore, wood harvesting and processing are the main ways of forest use. The total standing volume of wood in Latvia forests is estimated at some 489 million cubic meters, which equals to an average volume of 160 cubic meters. Average annual increment is estimated at 6.30 cubic meters per ha, which in total yields 16.5 million cubic meters per year. [6] Annual harvesting volumes in Latvia for year 2000 have been 11 million m^3 (see figure 7).

3.1.1 Wood harvesting

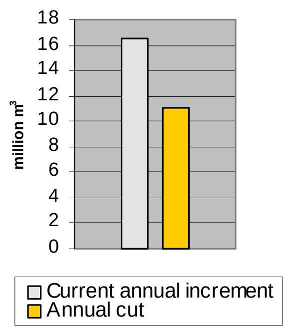


Figure 7: increment and

Use of wood resources starts with harvesting. In Latvia, during the recent years wood harvesting has undergone essential structural changes. Previously about 30 rather large state-owned forestry companies, partly involved also in wood processing and reforestation, were working in state forests. Today these companies are privately owned, or have partly split up, or have set up joint ventures with foreign partners. In the course of privatisation, small private logging companies and firms have developed rapidly, partly operating also in the wood processing and trade [7].

Annual harvesting volumes in the Republic of Latvia between 1991 and 2000 have increased from 4 to 11 million m^3 (see figure 8).

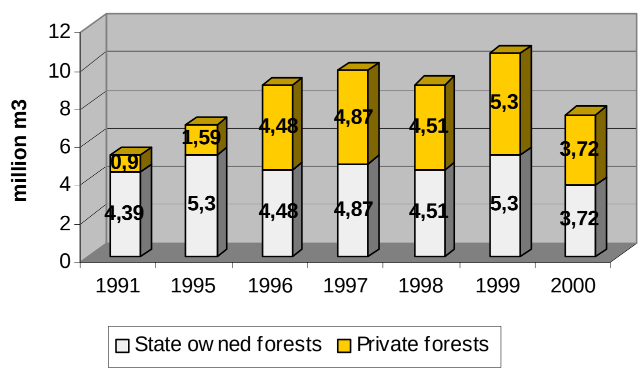


Figure 8: Dynamics of the volume of wood harvesting, million m^3 (1999 – felling volumes in 15 months), Source: Latvian MoA

The rapid increase is the result of involvement private forests in the business as well as the growth of logging and, especially saw-milling capacities. Harvesting volume in state-owned forests is relatively stable – about 4.5 million per m^3 year. Wood obtained as a result of logging is subject to further processing both for meeting the demand in domestic as well as in export markets.

3.1.2 Wood sawing

In the period following the restoration of independence wood processing, mainly sawing, has developed rapidly. The value added in wood processing was increasing annually. The main wood processing sectors in Latvia are sawing and production of plywood, fibreboard and furniture.

Figure 9 and figure 10 demonstrate the increase of the value of sawn wood and furniture output during the recent years. Production of sawn wood is the main processing activity in Latvia, since it requires comparatively little labour and energy input. Yet, furniture manufacturing has grown notably, too. Currently furniture manufacturing has good opportunity to make a success, since all the prerequisites are in place [1]:

- § High quality timber, which can be bought at a competitive price;
- § There are good furniture manufacturing traditions in Latvia;
- § The labour force in the industry is skilled and with high qualifications;
- § Good woodworking and furniture manufacturing training traditions;
- § Production capacities with a development potential.

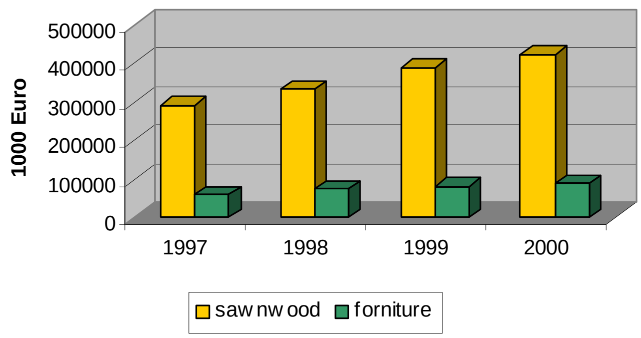


Figure 9: Output of the sawn wood production and the furniture in terms of value (thousands LVL) - Source: Latvian MoA

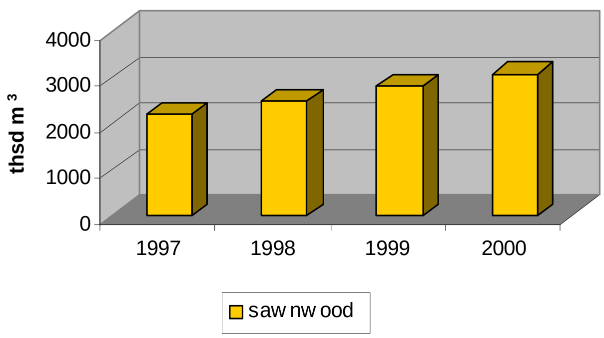


Figure 10: Output of the sawn wood production - Source: Latvian MoA

Latvian forest and wood processing industry produces mainly for export – about 85 to 90% of output is exported. Domestic demand for wood products is low – the annual consumption in Latvia is about 0.1 to 0.15 m^3 of sawn wood per capita, while the average in Europe is over 0.25 m^3. The difference is mainly due to the low-income level in Latvia and correspondingly - low long-term investment levels by population (for example, in building). [8]

3.1.3 Firewood

Figure 11: firewood piled

Firewood is the most important biomass fuel type in Latvia, with a share of 62% of the available biomass energy resources and a share of 13% on the Latvian energy balance. The level of use of firewood resources in Latvia in 2000 has been 21.2PJ (around 3200thsd m^3) [4]

All woods, regardless of species, available in Latvia are used as firewood. Traditionally the wood is harvested, split and stack in the early spring and then used after the end of the summer. Usually firewood is piled in a place where sun can warm it and wind can blow through it; as the sun heats and evaporates the water from the woodpile the wind whisks it away. In Latvian conditions wood well stack should dry, and be ready, in 4-5 months, unless for regions close to the shore, where the clime is more humid, or for very dense wood like oak, in these case 6-8 months are needed.

Wood is split to the proper size for burning, from 15cm to up to 18 or 20cm cross sectional dimension. Wood of sizes from 8 to 15cm in diameter is as well as good for firewood. (See figure 11)

3.1.4 Chips, particles, waste wood and other wood residues

In Latvia wood waste are primary produced at the cutting areas and during the transport to the temporally storehouse.

Figure 13: transport of wood biomass

At the moment, due to unfavourable economic conditions for wood suppliers, it is not possible to ensure the complete utilisation of wood-waste for the purposes of heat production [9] and the bulk of the wood wastes are left on site. It is estimated that 35% of potential wood fuel is lost between cutting areas and storehouse .

According to the thickness, wood logs are classified waste when their diameter is less than 8-10cm. Mainly these wastes are branches, brushwood and bark The main problem, beside the unfavourable economic conditions for wood suppliers, with the collection of biomass from forests is the low compression ratio (see figure 13). Therefore for a remunerative extraction of wood wastes from forest there is need of specific bundler machinery enable to collect, compress and pack slash and logging residuals for an effective transport. Consequently, very often in Latvia these wastes are burnt on site.

In processing wood materials in saw frame and furniture factories different sort of wastes are produced and often used for energy purposes. In this case an additional economical input rise from the dumping problem for sawmill, particles and other wood residues that otherwise would occur.

In table 7 are provided the main types of industrial production using wood sources from 1998 to year 2000.

Products	1998		1999		2000	
	1000 (unit)		1000 (unit)		1000 (unit)	
Round wood:	2759,9	m^3	2953,6	m^3	4189,8	m^3
Coniferous	1298,7	m^3	1477,4	m^3	1968,6	m^3
- diameter to 14 cm	1151,9	m^3	1045,6	m^3	1595,4	m^3
- diameter more 14 cm	146,7	m^3	431,8	m^3	373,1	m^3
Non-coniferous	1461,3	m^3	1476,2	m^3	2221,3	m^3
- diameter to 16 cm	1186,5	m^3	1154,4	m^3	1921,4	m^3
- diameter more 16 cm	274,7	m^3	321,8	m^3	299,9	m^3
Sleepers	26,7	m^3	7,4	m^3	13,0	m^3
Sawn wood:	2482,6	m^3	2818,8	m^3	3082,2	m^3
Coniferous	2177,9	m^3	2447,3	m^3	2635,2	m^3
Non-coniferous	304,7	m^3	371,5	m^3	447,0	m^3
Veneer sheets	6,8	m^3	6,9	m^3	7,6	m^3
Particle board	123,7	m^3	108,5	m^3	78,7	m^3
Fibreboard	6858,1	m^2	7066,0	m^2	5725,1	m^2
Plywood	137,8	m^3	132,7	m^3	128,0	m^3
Wooden packaging	38,3	t	58,7	t	89,4	t
Joinery and carpentry	7,2	t	28,6	t	56,3	t

Table 7 Main type wood products

3.2 Agricultural biomass

The efficient use of domestic energy resources has high priority in the Latvian energy policy. Domestic energy resources such as wood and peat cover approximately 2 and 22 % of the primary energy supply respectively. In contrast, straw from agriculture and agricultural biomass has not been considered as a potential energy resource until now, and are not mentioned in the national energy program. However, experience from Denmark and from neighbouring Lithuania has propagated an interest in investigating the possibilities of utilizing straw as a source of fuel within the Latvian energy sector [10].

Agricultural output in 2000 has been more than 20% smaller in comparison with 1995. Looking at the role of agriculture in the composition of GDP, in 2000 this sector has clearly stepped on a path of successful development. The gross agriculture product has increased by 3.3%, which is the highest growth rate of the past decade. However, even such a fast growth rate has not set off the consequences of the sharp drop of the two previous years, and the share of agriculture declined by another 0.1% while the share of forestry and related services have grown. [1]

In 2000, compared to 1999, the value of agricultural production in real prices has grown by approximately Euro 27,7mln or 5.8%. However, the volume is still at 37% of the level in 1990. The value of crop production has grown by 1%. As a result of the aforementioned, the share of livestock production grew by 2.2%, making it again the main component of agriculture produce (51.5%).

The increase in the value of agriculture produce in 2000 has been facilitated both by the increase in production volume as well as by the increase in the price level of livestock products.

3.2.1 Crop production

Although the total area of grain in 2000 continued to decrease, the total value of crop production has increased. During year 2000, calculated as the value of crop production per 1ha of sown area, it has increased by 4.6% or 5.9% respectively (see table 8).

	1995	1996	1997	1998	1999	2000	2000 / 1999, %
Area sown, thousands of ha							
Total, incl.	930.2	986.1	1002.8	983.4	912.3	881.1	96.6
- grain	411.4	449.8	487.5	466.	415.6	420.0	101.1
- sugar-beets	9.5	10.0	10.9	16.3	15.5	12.7	81.9
- potatoes	75.3	78.7	69.6	58.8	50.1	51.3	102.4
Total yield, thousands of tons							
- grain	693.7	968.6	1043.5	958.9	783.4	923.6	117.9
- sugar-beets	250.0	257.8	387.5	597.0	451.5	407.7	90.3
- potatoes	863.7	1081.9	946.2	694.1	795.5	747.1	93.9

[Source: LSIAE according to CSB data and EAA calculations (1995-1997 crops + legumes)]
Table 8: The development of crop production, 1995-2000

Compared to the previous year, in 2000 the productivity of main crops has increased. The productivity of grains has on average gone up by 20.9%, for sugar beets – by 10.3%, while the productivity of open-field vegetables has dropped by 15.1% (see table 9).

Along with a slight increase of area under grains (by 4.4thousand ha), there has also been an increase of productivity – in total by 3.8 t/ha. Grain production in Latvia practically insures self-sufficiency for food grain, excluding rise.

The production quotas introduced in the sugar-beet production sector slowed down the previously observed annual growth of the area sown and production volume. In 2000 there was even a decrease (see table 8). In 2000 there were altogether over 650 commercial sugar-beet farms with the average area sown of 20ha.

Crop	1990	1995	1996	1997	1998	1999	2000	2000/1999, (+ / -) %
Wheat	26.3	22.2	24.0	25.1	25.5	24.1	27.0	12.0
Rye	24.8	17.6	20.0	21.3	18.2	18.8	20.2	7.4
Barley	22.6	14.0	20.8	18.7	18.6	15.8	19.4	22.8
Oats	21.4	16.1	18.9	19.7	17.4	14.0	17.5	25.0
Grain on average	23.6	16.9	21.5	21.2	19.8	18.2	22.0	20.9
Sugar-beets	299	263	258	356	366	291	321	10.3
Potatoes	127	115	144	121	118	159	146	8.2
Open-field vegetables	156.9	127.8	114.3	120.4	103.1	126	107	-15.1
Fruits and garden berries	9.4	34.4	24.4	66.4	22.2	37.0	39.4	6.5

Table 9: Productivity of the main crop, 1990-2000, t/ha [Source: LSIAE according to CSB data]

The decrease of area under sugar beet can be explained by the increasing production efficiency and stronger specialization, which has resulted in the increase of average productivity by 29 t/ha, reaching 321 t/ha (see table 9). Meanwhile, the decrease of the total harvest is mainly linked with harvesting difficulties due to climate problems. There is still a significant risk factor in this sector, especially with regard to the very different policies in the Baltic countries regarding sugar production.

Rapeseed yield in 2000 (10000tons) shows that the production results of 1999 (11700tons compared to 1600tons in the previous year) have not been a mere coincidence, but rather a purposeful, coordinated activity that has a very positive impact on the development of the sector.

Due to the adverse weather conditions in 2000 (frosts, rain), potato productivity has been lower than previously – by 8.2%. The potato production has dropped by 6%, and mainly on account of the decreased productivity, because the planted area has actually even increased. Nevertheless, the volume of produced potatoes still exceeds the annual consumption in Latvia

The planted area of open-field vegetables has decreased by 1%, which could be due to the normal annual fluctuations, traditionally ranging from 1-2%. The consecutive drop in the total harvest of open-field vegetables influences this factor. The drop in productivity of open-field vegetables may be caused by the adverse weather conditions.

After the decrease of the planted area of vegetables under covered areas in 1998, in 1999 it was again increased by 11%. The data for 2000 also shows an increase (27%). The productivity of vegetables has, however, gone down by 7.9%. Some trends in this sector show that in the future it will maintain its importance. Although the production requests large investments (both human and financial), vegetable growing in under covered areas takes less space and the productivity is significantly higher than for the open-field vegetables.

3.2.2 Agricultural wastes

The use of biomass for energy purposes is not too developed in Latvia. Farmers return crop residues to the fields or for livestock production. Then, common practice is to burn agricultural land in springtime for cleaning and fertilize the earth.

Approximately 1 million cereals straw and 150 thousands tons of potatoes stalks are produced per year in Latvia. Typical calorific value for cereal straw is estimated between 11-14 GJ/t (mainly function of the moisture content), therefore the potential energy is around 13 000 000 GJ.

Straw is used in Saulane region for heat energy production. Annually are used between 600 and 800 tons of straw producing around 2000 MWh_{th}.

3.2.3 Bio diesel

Production and use of bio fuel in Latvia until 2010 is prescribed in the National Program on Production and Use of Bio fuel in Latvia. One of the key priorities in this program is to organise bio diesel fuel production for diesel engine application, which should equal to 40% of total diesel fuel used in agriculture.

The forecasted fuel consumption in Latvia [11] is showed in table 10.

Fuel type/ years	Fuel consumption		
	1000 toe	1000 t.	$1000m^3$ or 10^6 l.
Gasoline			
2000	594,0	564,3	723,5
2002	629,6	598,1	766,8
2005	657,0	624,2	800,0
2010	690,0	655,5	840,0
Diesel			
2000	739.0	804.0	962.9
2005	887.0	965.1	1155.8
2010	1020.0	1109.8	1329.1

Table 10: The forecasted fuel consumption in natural expression

Using data from the table 10 has been calculated the demand for ethanol Latol-005 production. In table 11 is shown the forecasted quantity of ethanol required for production of Latol-005, in accordance with European regulations.

Years	Latol required, 1000m^3	Gasoline required		Ethanol required	
		1000m^3	1000 t.	1000m^3	1000 t
2000	-	-	-	-	-
2003	560.0	532.0	415.0	28.0	22.1
2005	800.0	760.0	592.8	40.0	31.6
2010	840.0	798.0	622.4	42.0	33.1

a – in 2000production of "latol-005" is not forecasted

b – in 2003 production level of fuel ethanol will not give the opportunity to add oxygen to gasoline that is required for transport, - 766,82 milj.l.

Table 11: Forecasted quantities of ethanol required for production of Latol-005

In table 12 are shown the quantities of raw material required for production of biodiesel.

Raw materials in the process				Obtained production			
Rape seed oil	Ethyl alcohol	Catalyst (KOH or NaOH)	Total	Biodiesel	Glycerine	Total	Losses
950.5	149.3	5.3	1105.1	1000	99.5	1099.5	5.6

* - by reesterificating rapeseed oil fatty acid with ethanol, it can possible to extract biodiesel that consists of fatty acid ethyl-esters (or **REE**), unlike **RME** that are extracted by reesterificating them with methanol.

Table 12: Prescription of biodiesel for extraction of 1 tonne biofuel, kg [11].

Rapeseeds contain 42-45% of oil. By using cold mechanical pressing technology, 30-33% of oil is pressed out of the seeds while the remaining 12-15% rest in the pulp. Taking into account that rape is becoming a popular crop in the country, it can be forecasted that in 2010 its sowing areas will reach 87 000 ha and this mean a potential of 58 000 t of oil.

The quantity of ethanol required for the reesterification of this oil in ethyl-esters (for extraction of biodiesel) is 9110t.

The forecast of the total ethanol consumption in Latvian national economy in 2010 is showed in table 13.

Nr. p. k.	Consumers	Quantity		
		t	**m^3**	**10^6 l**
1.	Total biofuel production, including:	42210	53500	53.0
	production of "Latol-005"	33100	42000	42.00
	production of biodiesel	9110	11500	11.50
2.	The other branches, including:	14207	18000	18.00
	production of strong drinks	10260	13000	13.00
	perfumery industry	2368	3000	3.00
	pharmaceutical industry	592	750	0.75
	medicine	592	750	0.75
	chemical industry, a.o.	395	500	0.50
	Total	56417	71500	71.50

Table 13: The quantity of ethanol forecasted for 2010

Rape is grown and rapeseed oil is produced successfully in Latvia already now. There are not unutilised by-products in rapeseed oil industry:

- Oil is available for food, extraction of biofuel, other industry and gastronomy;
- Pulp– for production of feed for cattle;
- Phosphates.

Rape is becoming a popular crop in Latvia and it is forecasted that in 2010 its sowing areas will reach 87 000 ha and will give a potential of 58 000 t of oil. From this 58 000 t oil and 9110 t ethanol is possible to obtain 60 700 t of biodiesel. This quantity could cover 40% of total amount of diesel used in agriculture. Taking into account the aspects of fuel ethanol production and the forecast that rape-sowing areas will extend in the nearest future, it can be expected that rates of development of biodiesel production will be the following:

- 2002 – 20,9 thousand t.
- 2005 – 31,4 thousand t.
- 2010 – 60,7 thousand t.

3.3 Biogas

3.3.1 Extraction of biogas

One of the possibilities to process organically degradable waste is the production of biogas. Biogas may be used as a source of energy – directly (for generation of heat and electricity) or it may be sold to other users. The presently obtained quantity of biogas in Latvia is approximately 1.770 million m^3 per year, potential production capacity – 170 million m^3 per year [12].

The major biogas volume in Latvia might be generated from agricultural waste, sewage waters from food processing industry and from other waste. However, the decentralisation of agricultural production has largely reduced the potential basis for raw materials.

Latvia has an experience in methane zymurgy of pig's sludge liquid droppings. In 1983 pigsty Papardes (with 2500 pigs), in Ogres district, had processed 20-30 m^3 of liquid droppings with 2-4 % dry substances daily. Two horizontal cylindrical bioreactors have been installed, each with a volume of 75 m^3. One year later a reactor of Finn firm Embon, with volume 120 m^3, was installed. As a result were obtained 20-30 m^3 of biogas with 60-70 % methane content, from each cubic meter of liquid treated.

At present slime of Riga sewage aerobic treatment plant are re-gasified in vertical bioreactors in Bolderāja. The obtained biogas can be combusted in boiler for warm technological water. Earlier biogas was obtained from plant remains. It gave a possibility to use biogas in heating of greenhouses and obtaining carbon dioxide after combustion of biogas in order to stimulate photosynthesis and increase tomatoes crop yield [11].

3.3.2 Perspectives of extraction of biogas

In Latvia the largest amount of biogas can be obtained by:

- Processing sludge of domestic animals – about 100mil m3 per year (see table 14);
- Sewage of food industry – about 10mil m3 (see table 15);
- Household/municipal waste – 20.8mil m^3 (see table 16).

Name	Number 1000	Sludge 1000/year		Possibilities of obtaining biogas 10^6 m^3	
		Theoretical	In practice	Theoretical	Realizable
Cattle	378.4	5525.0	1211.0	247.3	39.7
Pigs	404.9	664.8	464.8	34.7	18.7
Sheep	27.0	13.5	4.7	0.9	0.2
Horses	19.0	85.0	25.3	4.7	1.1
Poultry	3236.9	236.0	212.1	23.5	17.1
	Total:	6524.3	1917.9	311.1	***76.8***

Table 14: The possibilities of obtaining of biogas from sludge of livestock in Latvia

Type of production	Sewage, per year 10^6 m^3	Biogas, per year 10^6 m^3	Perspective: sewage, per year 10^6 m^3	Perspective: biogas, per year 10^6 m^3
Dairy produce	1.931	2.317	6.191	7.430
Meat products	0.900	0.720	3.932	3.146
Fruit and vegetable preserves	1.680	0.672	5.000	2.000
Production of yeast	0.077	0.092	0.230	0.280
Production of sugar	0.192	0.154	0.576	0.460
Production of alcohol	0.080	0.144	0.180	0.324
Total:	4.86	4.099	16.109	***13.640***

Table 15: The amount of sewage of food industry and the result of biogas

Resources of biogas	Biogas with 65% of methane		Natural gas Equivalent amount	
	1000 m^3/day	10^6 m^3/year	1000 m^3/day	10^6 m^3/year
	Slime and liquid waste:			
1. Regional equipments, 25	7.5	2.7	4.8	1.7
2. Riga - BAS Daugavgrīva reconstruction	15.0	5.4	9.9	3.6
	Household/municipal waste in landfills:			
1. Riga - Getliņi - 2	25.0	9.1	16.2	5.9
2. Regional equipments, 3	10.0	3.6	6.5	2.3
Total:	57.5	**20.8**	37.4	**13.5**

Table 16: The real resources of biogas from municipal waste

In future also waste from fruit trees can be used for obtaining biogas, because generally in Latvia only a small part of the tree is used for humans and animals needs. Beets, leaves, stalks, roots etc. are considered waste and, after fruits harvesting, are ploughed in the soil. It is desirable to add fruit trees waste (straw, leaves, tops, etc.) in biogas equipment in order to improve C : N ratio. It is desirable to process the whole fruit trees production that is rotten and no longer utilized, for example, potatoes, silage, beets, straw. Approximately 1 million cereals straw and 150 thousands tons of potatoes stalks are produced per year in Latvia. If it would be possible to gather the 20% of this amount and process it in biogas equipment, then about 53.6 million m^3 and additional 5 million m^3 could be produced reaching a total amount of 58.6 million m^3. The total amount of biogas obtained in Latvia would be approximately 170 million m^3 that corresponds to 100 million m^3 natural gas (table 17). [11]

Resource of extraction	Amount of biogas (10^6 m^3 / year)
Agricultural waste	135,4
Household/municipal sewage and waste	20,8
Food industry sewage	13,6
Total:	169,8
That is equivalent to natural gas	103,1

Table 17 Total amount of resources of biogas.

3.3.3 The possible location of biogas factories

Biogas equipment should be installed where are the larger concentration of waste as feed complexes and larger farms. Then 20-25 equipments should be installed in every district. It would be perfect if both storage of organic waste and biogas equipment (total about 600) would be as near as possible to large boiler house in each rural municipality.

At first it would be useful to develop:

1. Biogas extraction systems in large landfills.
2. Biogas equipment in landfills of district centers and villages and near the sewage treatment equipment of food enterprises.
3. Pre-project documentation and biogas factory project for swine-breeding complex in Mikelani.
4. Standard module design for biogas equipment and develop technical documentation of the main equipment for fermentation of droppings in pigsties.

5. Install biogas equipment near the largest swine breeding and feed complexes.

A project for the landfill of Getliņi (Riga Municipality) foresees generation of biogas from waste and its further use for energy generation. It is planned to install five generators, each with the capacity of 1 MW. The first generator could start operating in March 2002. Table 18 presents the planned biogas outputs from 2001 to 2027 [13].

Year	Landfill, Nm^3	Energy cells, Nm^3	Total gas generation, Nm^3
2001	20880000	0	208780000
2005	12990000	24245000	37235000
2010	7696000	26448000	34144000
2015	4860000	26448000	31308000
2020	3225000	26448000	29673000
2025	0	26448000	26448000
2027	0	26448000	26448000

Table 18: The projected biogas generation outputs in 2001-2026

In Liepāja municipality a waste management project is aimed at the creation of a modern waste management system, which meets the requirements of the day, with the focus on the maximal use of the generated biogas, groundwater protection, waste sorting and other problems. The biogas produced from waste will be used for energy generation. It is planned to install two generators with a total capacity of 1.3 MW [14].

4. CHARACTERISTICS OF BIOMASS

Biomass feedstocks and fuels exhibit a wide range of physical, chemical, and agricultural process engineering properties. Despite their wide range of possible sources, biomass feedstocks are remarkably uniform in many of their fuel properties, compared with competing feedstocks such as coal or petroleum. For example, there are many kinds of coals whose gross heating value ranges from 20 to 30 GJ/t. However, nearly all kinds of biomass feedstocks destined for combustion fall in the range 11-17 GJ/t. For most agricultural residues, the heating values are even more uniform, about 11-14 GJ/t; the values for most woody materials are 14-15 GJ/t. Moisture content is probably the most important determinant of heating value. Air-dried biomass typically has about 15-20% moisture, whereas the moisture content for oven-dried biomass is around 0,5%. Moisture content is also an important characteristic of coals, varying in the range 2-30%. However, the bulk density (and hence energy density) of most biomass feedstocks is generally low, even after densification – between about 10 and 40% of the bulk density of most fossil fuels, although liquid biofuels have comparable bulk densities

4.1 Wood biomass

4.1.1 Firewood

The quality of firewood is mainly affected by:

§ Moisture content

§ Tree species

§ Piece size

Traditionally, the favoured trees in Latvia are oaks and ashes because are very dense and produce long-lasting coal bed. But these are valuable trees and in many areas are not plentiful enough to burn. So, all the woods are used as firewood, even more because they have about the same energy content per kg.

Although the energy content of dry wood per kg is almost the same, regardless the species, softwood and hardwoods burn differently because of different in density. Softwoods, such as pine, spruce and aspen are less dense than hardwoods like oak and ash.

In table 19 are shown density and energy content values, at 20% moisture, for the main trees species in Latvia.

Wood type	Density, kg/m^3	Energy content, GJ/m^3	Energy content, GJ/t	Hard
Oak	760	11,5	15,1	
Ash	660	9,8	14,8	
Birch	560	8,2	14,6	
Aspen	550	7,6	13,8	
Alder	530	7,5	14,2	
Pine	510	7,3	14,3	
Spruce	480	7	14,6	Soft

Table 19: bulk density and energy content of main wood type in Latvia

The size of firewood pieces affects the rate of combustion. Larger pieces ignite and release their energy slower than small pieces. Smaller pieces are better for short, hot fires and larger are preferable for extended firing cycles. The largest piece size for high efficiency appliances in Latvia usually is around 15cm across the largest dimension. In general, Latvian commercial firewood dealers produce firewood in larger pieces, and often are necessary to split some of the wood again before using it.

4.1.2 Chips, particles, waste wood and other wood residues

Quality of fuels is determined by the calorific value and for solid fuels as well as by ash content. The calorific value of different kind of fuels and wood fuels is provided in table 20.

Generally dry wood fuels are preferable for energy transformation purposes. Even better is the utilization of pallets, but in this case are necessary specific processing plants.

Biomass from wood processing industry often has high moisture content, in particular when it is produced from sawmill plants. Often in this case for the utilization of these wastes are necessary drying equipments.

Fuel type	Calorific value, MJ/kg
Dry wood 20%	14,4
Wet wood 40%	10,2
Dry wood chips 25%	13,3
Wet wood chips 40%	10,2
Wood residues 50%	8,0
Wood pallets 7-11%	17,6
Coal	21,8
Natural gas	33,9
Liquid fuel	32,4

Table 20: calorific value for different fuel types

In table 21 are given different type of wood wastes and their moisture content and density.

Processing waste	Moisture content	Density (kg/m^3)
Saw dust	10 50	100 300
Spitted bark	10 50	100 280
Pieces-sliver <3cm main cross section	10 20	150 190
Shavings 3-8mm	10 20	70 95
Shavings 8-15mm	10 20	45 60

Table 21: Moisture content and density of typical waste product from wood processing plant

Wastes with moisture content greater then 20% need additional treatments before utilization.

4.1.3 Briquettes

In Latvia briquettes are very densely pressed wood chips. That is one of the most cheapest fuel materials, which is as well very ecologically clean. Briquettes are produced from conifer (pine and spruce) that unfortunately are resinous trees. In some cases, resin from trees sediments on the boiler walls and therefore, specialists advice from time to time to use briquettes from aspen that are ideally clean fuel material but as well as more expensive. Latvian producers have been trying to produce briquettes from birch but that was rather unsuccessful because these briquettes are more fluffy and pulverulent and therefore not qualitative. Latvian producers are making different tests at the Institute of Chemistry to determine calorific value and often a cheaper briquette achieve better results. The calorific value of briquette from wood chip varies from 11MJ/kg to 16MJ/kg [15].

Usually Briquettes are recognizable only by production site or appearance, but they are not named or labelled.

The main advantages of briquettes are:

- Easy storage, briquettes are compact (1 ton of briquettes need approximately 1 m2 floor area and 1-2 m height);
- Always dray and ready to burn;
- Greater calorific value than wood;
- Homogeneous physical and chemical properties;
- Can be transported in small quantities (packed 10-25 kg);
- Comparably cheap fuel;
- Ecologically clean fuel.

Anyway it is important to remind as briquettes may very rapidly absorb moisture and after they appear as wood chips and this process is irreversible.

The use of the briquettes depends from their size and form. There are 2 different types of briquettes, figure 14: one of them is bigger and usually round; these briquettes are typically used in ovens, furnaces and boilers because they burn faster but after the coal bed generates long term heat. The other type of briquettes is smaller, very hard and the form of them reminds a brick – very dense, burning slower. These briquettes are used for heat non-accumulating ovens with small doors [15].

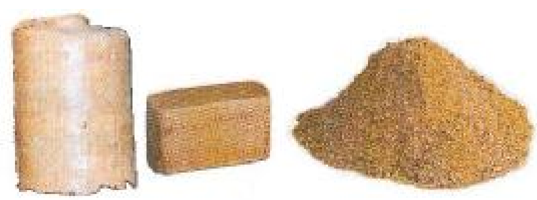


Figure 14: two forms of wood briquettes from wood

With briquettes it is possible to heat all kind of ovens, hearths, boilers or furnaces that are planned for wood fuel.

4.1.4 Pellets

Wood pellets, figure 15, are cylindrical pieces of extruded wood particles with a diameter of approximately 8-10mm and a length between 1 and 2cm. They have the advantages of wood briquettes:

- High density and therefore high heat value related to the storage volume;
- Low water content (less then 10%) and therefore high combustion efficiency
- Homogeneous physical and chemical properties

Figure 15: wood pallets for use in small-scale furnaces

However, the most important additional property of wood pellets is that they can be fed by screw feeder and even by pneumatic equipment. Thus, the transportation of wood pellets is similar to the transportation of a liquid fuel:

- § Wood pellets can be sucked in by a special tank lorry and, after transportation can be blow into a storage room at the location of the user without any manual help.
- § From the storage room, they can be easily transported to and into the combustion chamber by screw feeders or by pneumatic transportation system

Thus wood pallets furnaces may be operated in a manner almost comparable to oil furnaces [16, 17].

4.2 Agriculture biomass

In Table 22 are shown typical chemical and physical properties for selected common bioenergy feedstocks and biofuels, compared with wood, coal and oil.

COMPOSITION				
		Cellulose (%)	Hemi-cellulose (%)	Lignin (%)
Bioenergy Feedstock	Corn stover	35	28	16-21
	Sunflower	32-48	19-24	23-32
	Hardwood	45	30	20
	Softwood	42	21	26
Liquid Biofuels	Bioethanol	N/A	N/A	N/A
	Biodiesel	N/A	N/A	N/A
Fossil Fuels	Coal (low rank; lignite/subbituminous)	N/A	N/A	N/A
	Coal (high rank; ituminous/anthracite)	N/A	N/A	N/A
	Oil (typical distillate)	N/A	N/A	N/A

CHEMICAL CHARACTERISTICS					
		Heating value (GJ/t)	Ash (%)	Sulfur (%)	Potassium (%)
Bioenergy Feedstock	Straw	14,6			
	Corn stover	16,2	5.6		
	Sunflower	15,8	7,5-8,2	0,10-0,15	0,73-0,97
	Hardwood	20.5	0.45	0.009	0.04
	Softwood	19.6	0.3	0.01	
Liquid Biofuels	Bioethanol	28		<0.01	
	Biodiesel	40	<0.02	<0.05	<0.0001
Fossil Fuels	Coal (low rank; lignite/subbituminous)	15-19	5-20	1.0-3.0	0.02-0.3
	Coal (high rank; ituminous/anthracite)	27-30	1-10	0.5-1.5	0.06-0.15
	Oil (typical distillate)	42-45	0.5-1.5	0.2-1.2	

PHYSICAL CHARACTERISTICS				
		Cellulose fibre length (mm)	Chopped density at harvest (kg/m^3)	Baled density (kg/m^3)
Bioenergy Feedstock	Corn stover	1.5		
	Sunflower	1,7	50-75	
	Hardwood	1.2		
	Softwood			
Liquid Biofuels	Bioethanol	N/A	N/A	790
	Biodiesel	N/A	N/A	875
Fossil Fuels	Coal (low rank; lignite/sub-bitum.)	N/A	N/A	700
	Coal (high rank; bitum/anthracite)	N/A	N/A	850
	Oil (typical distillate)	N/A	N/A	700-900

N/A = not applicable

Table 22 Main chemical and physical characteristics for corn stover and sunflower

5. BIOFUEL PRODUCTION AND PACKING

5.1 Wood biofuels

In Latvia at the present there is a production of both briquettes and pellets. The technology for production of this refined biomass consists of a pressing process of fragmented biomass material in order to obtain briquettes, of different shapes, and pallets. The process of pressing into briquettes or pellets is performed without using additional chemical substances.

Briquettes and pallets packing

Mainly the operations for production of briquettes and pellets are diversify depending from the biomass source; thus it is possible to identify the two following operational chains:

§ Biomass from wood-processing site, sawmill and wood industry in general

§ Biomass from cutting site

In figure 16 below is provided a graphical view of the two possible paths in Latvia.

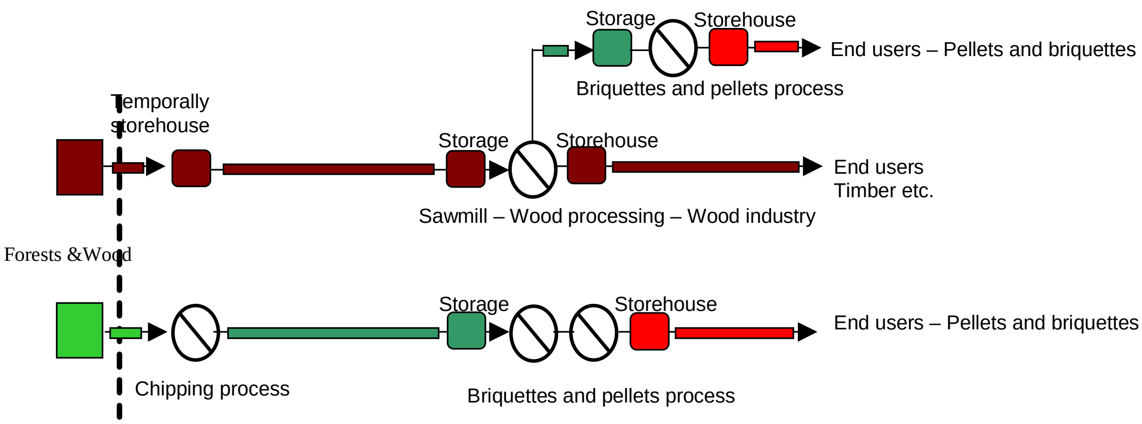


Figure16: Operational chain for briquettes and pallets production in Latvia

In the first case, when using waste biomass from wood-processing site, sawmill and wood industry in general (hereinafter wood-industry) as a source, briquettes and pellets production comprise of the following operations: (a) starting from the wood industry raw material is transported to the briquetting/palletizing workshop, often this is carried out by typical belt conveyors; (b) unloading the raw material and if necessary chipping operation to an appropriate size for briquetting/palletizing; (c) sorting out the received material and removal of the inappropriate size particles; (d) drying the raw material, in general using direct contact rotary drum dryers; (e) pressing operation and cooling phase; (f) cutting the briquettes with certain length; (g) packing of briquettes with certain length in polythene folio bags or cardboard boxes (see figure 17); (g) parking of pallets in nylon bag; (h) storing in storehouse and transporting to end users.

In the second case, when using waste biomass from cutting site, briquetting and pelletising comprise of the following operations: (a) gathering of waste branches, residues, brushwood, irregular logs etc.; (b) chipping on site of wastes with mobile woodcutting tractor into slivers; (c) loading and transporting the slivers to the briquette/pallets workshop; (d) unloading the raw material and if necessary chipping operation to an appropriate size for briquetting / pelletising; (e) sorting out the obtained material and removal of the inappropriate in size particles; (f) drying the raw material, in general using direct contact rotary drum dryers; (g) pressing operation and cooling; (h) packing the briquettes with certain length in polythene folio bags or cardboard boxes (see figure 17); (h) parking of pallets in nylon bag (i) storing in storehouse and transporting to end users.

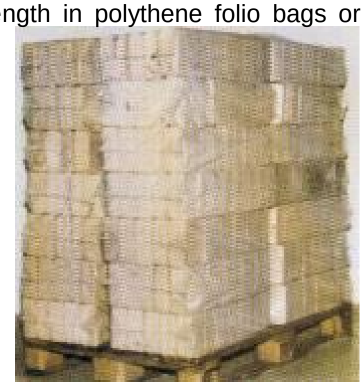


Figure 17: briquettes packed in polythene folio

During the whole process the drying operation is the most expensive. The method of drying wood chips and sliver is by direct contact in rotary drum dryers using oil or gas. It is then quite important to have already a raw material with moisture content less than 50%. In general raw material with moisture content grater then 15% is subject to drying.

In Latvian Briquette market has started 4-5 years ago. In former Soviet time, in Riga was possible to buy briquettes produced in Riga Carriage Plant (in a very limited amount) but however most of the users were not satisfy and the price was not competitive with firewood. Nevertheless, briquettes with its economical efficiency have gain popularity and nowadays in Latvia there are approximately 30 companies. In the middle of 90-ties the briquettes were not packed; for example to Adazi production site briquettes were directly transported by truck or for small amount users were going with their own bags. Afterwards briquettes were packed in potato bags and then in polythene bags (approximately 10 kg) [17].

Then, in Chapter 7 is possible to find more information about transport segments that connect each previously mentioned operations.

5.1.1 Briquette press

In Latvia typically are used hydraulic presses for briquettes, unless in some sporadic case when for small production as well as mechanical presses are employed.

In Latvia briquette presses are imported mainly from west Europe, where companies design, build and supply standard briquette presses for continuous and intermittent usage. The machines have capacities of between 50 and 3,000 kg/h;

Figure 18: hydraulic press for rectangular briquettes

In table 23 are provided the main technical data for the presses provided by RUF® company to different Latvian wood briquette industries (see figure 18).

Technical data	RB 110	RB 220	RB 330	RB 440	RB 880	RB 30
Capacity*, kg/h	110	220	330	440	880	600
Moisture content	<15%					
Motor output, kW	5,5	11	18,5	30	45	30
Specific pressing power	14 200	14 200	14 200	14 200	14 200	14 200
Briquette size l x w x h, mm	150 x 60 x 40-100					240 x 70 x 40-110
Machine weight, kg	2100	2300	2700	3000	4500	4900

*Capacity depends on the attribute of the material, in this case is considered wood chips

Table 23: Briquette press, technical data

5.1.2 Pelletising equipment

The first production of pellets in Latvia started in the beginning of nineties in Tukums where the first pellets were realized using OGM grass flour press produced in Lithuania. With one grass flour matrix it was possible to produce approximately 30 tons finished products but after that was consumed and usually broken. According these technologies as well later in different regions of Latvia, producers tried to use them but all of that stayed in the experimental level. [17]

The main components of pelletising equipment:

1 Feed screw, 1 Mixer, 1 Pelleting press, 1 Motor
Roller shells: Die ∅ 8 mm or ∅ 10 mm
1 Cooler, 1 Cyclone – pipe, 1 Rotary sifter 1.5 kW

5.2 Agriculture biofuels

Agricultural biofuel, in form of straw, for heat energy production in Latvia are used in Saulaine region. In general, the straw is sufficient dry, and the average moisture content in the bales does not exceed the acceptable level of 22%. The corners of a few of the pressed bales may have moisture content of 25-30% in case of extreme weather conditions during the summer. The average weight of the bales is 550kg (min/max: 350/750 kg). The costs for baling are shown in table 25.

Baling	Costs, Euro/tons
Salaries	0,63
Fuel	5,3
Lubrication	0,07
Strings	2,7
Tractor cost	2,5
Total	11,2

Table 24: cost for bailing straw in Saulaine

Bales are produced with specific baling machinery and tied with canapé strings as it is shown in figure 19.

Figure19: bailing procedures in Saulaine region

5.3 Biodiesel

Rapeseed oil large-scale manufacture can be developed in the factory of oil extraction in Liepaja, which is undertaken, this production from rapeseeds grown in Latvia already now. The factory is developing its basis of the local raw materials, concluding bilateral advantageous agreements with Latvian peasants about rapeseed supply. The price of supply (according to the agreements) is 210 – 250 Euro/t. The prices are in the world level or even exceeding it. For example, the world price of rapeseeds (yield in 1999) was 160-180 Euro/t. It is useful to locate smaller factories nearer rape breeders/planters [11].

Share company “Naukseni” are going to organize biodiesel production. But due to financial lack this enterprise has not succeed in. Nevertheless, in the beginning of 2000 an agreement with NordReina-Westfalene state government is concluded. This government (through Vidzeme agri-economical cooperative society (Valmiera) will sponsor the development of biodiesel factory in Naukseni rural municipality with capacity/power of 1000 t rapeseed oil per year. This factory is oriented to supply with diesel biofuel Naukseni rural municipality and its neighbour farmsteads. [12, 18]

In 2001 the Company SIA “Delta – Rīga” in Valmiera region Naukšēni municipality has started the production of bio diesel fuel from rapeseed oil and alcohol. The first year of operation has produced 2500 tons of fuel by processing 7500 tons of rapeseed.

Also farm Zalkalni, in Alsunga rural municipality in Kuldīgas district, is going to develop production of biodiesel.

Latvian Small Energy Fond in association with Riga Council has examined the possibility for the utilization of biodiesel in city public transport. In this case it is useful to locate biodiesel factories in the industrial estate, creating a united infrastructure (common roads, storehouses, water and energy supply, drainage, fire prevention measures, etc.).

Taking into account the cautious forecast of the development of rape sowing areas (87 000 ha), two quite high-powered biodiesel factories could start working in the end of 2010 in Latvia: one in Liepaja on the basis of oil extraction factory (20 000 t per year) and also in other cities of Latvia, for example, in Ventspils (40 000 t per year). A larger amount of smaller factories could start working as well.

The suggested location of biodiesel factories is showed in figure 20. The development of the industry of biodiesel production, according to estimation of experts, should require 13-16 million Euro investments [11].

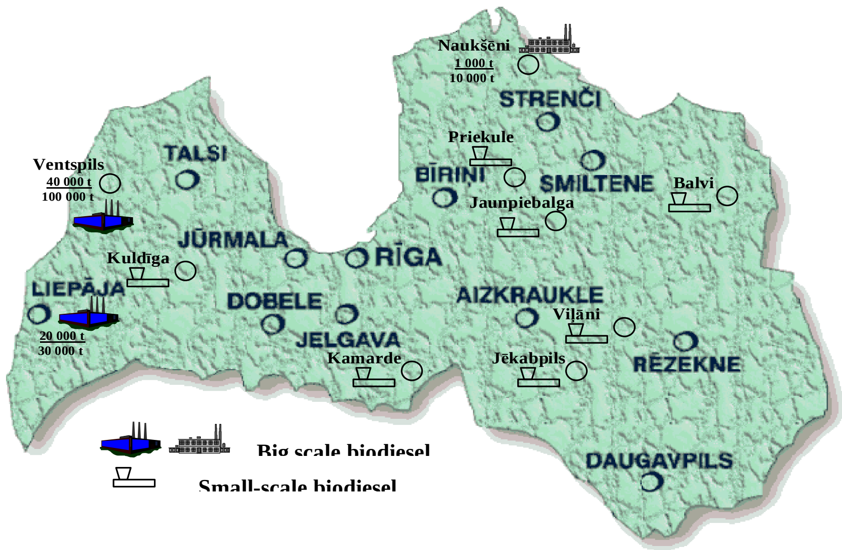


Figure: Suggested biodiesel production sites – source

6. PRICES OF BIOFUELS

6.1 Wood biofuels

The seasonal costs for heating a base flat of $100m^2$ and heated volume of $250m^3$ are provided in table 26. For Latvian weather conditions and buildings is assumed that 190kWh are needed for heating $1m^2$ ($2{,}5m^3$ volume) during seven-month period (heating season). These are merely assumption in order to compare conventional fuels and energy sources with wood based fuels for heating reasons. As a result, in Latvia wood based fuels are competitive.

Fuel type	Calorific value, MJ/kg	Boiler efficiency coefficient, %	Price, Ls	Seasonal consumption $1m^2$ (*)			Seasonal consumption $100m^2$		
				kg	**m^3**	**€**	**t**	**m^3**	**€**
Dry wood 20%	14,4	75	11,6 €/m^3	60	0,085	0,99	6	8,5	99
Wet wood 40%	10,2	75	11,6 €/m^3	84	0,14	1,62	8,4	14	162
Dry wood chips 25%	13,3	80	2,98 €/m^3	62	0,25	0,75	6,2	25	75
Wet wood chips 40%	10,2	80	7,72 €/m^3	80	0,32	2,47	8	32	247
Wood residues 50%	8,0	80			2,7			270	0
Wood pallets 7-11%	17,6	85	77,2 €/t	40	0,034	2,62	4	3,4	262
Coal	21,8	75	96,5 €/t	41		3,96	4,1		396
Natural gas	33,9	85	117 €/1000m^3		24	2,74		2400	274
Liquid fuel	32,4	85	0,193 €/l	24		4,63	2,4		463
Electricity			56,1€/MWh			7,56			756

*Assumption: $1m^2$ in a seven-month season consume 190kWh heat energy

Table 25: Heating cost with different fuels

6.2 Agricultural biofuels

The only agricultural biofuel used in Latvia is straw. Price in Saulaine region is 19,8 Euro/t.

6.3 Economical aspects of biodiesel production

6.3.1 Rapeseed oil production costs

It is presumed in calculations that 0.39 t oil and 600 kg of pulp are extracted in the process of hot pressing of one ton of rapeseed and further process of oil extraction. Rapeseed cost price is 210 Euro/t. On these conditions oil first cost is 0.298 Euro/l. Plus amortization of equipment (12% per year), the obtained first cost is as follows – 0,333 Euro/t or 0.361 Euro/kg [11].

6.3.2 Costs for production of biodiesel

In table 27 are shown production cost for biodiesel; it is presumed that when extracting 1 t REE, 149,3 kg fuel ethanol and 5.3 kg KOH are added to 950.5 kg rapeseed oil. Cost price of ethanol is 0.53 Euro/l or 667 Euro/t and price for KOH is 790 Euro/t.

Indicators	Unity of measure	Value
Costs of rapeseed oil	Euro/t	343.52
Ethanol costs	Euro/t	98.53
KOH costs	Euro/t	4.18
Total costs of raw materials	Euro	447.23
Costs of oil reesterification (50 Ls/t)	Euro	83.27
Total costs of production	Euro	530.61
Costs of production of 1 t biodiesel (REE)	Euro	530.61
Costs of production of 1 l REE (0,302 . 0,88) 0,88 - REE compactness	Euro	0,46

Table 26: Cost for biodiesel production

The production costs shown in table 27 are calculated talking into account that biofuel is produced in the same factory where rapeseed oil is extracted. If biodiesel production takes place in some other place, then the costs will be higher due to additional transportation expenses.

7. BIOFUELS TRANSPORT

The analysis of biofuels and biomass transport is connected with the identification of the feed points and then with the consequences on the transmission system, or in other words: the identification of the biomass energy supply value chain.

The general simplified framework used for biofuel transportation analysis in Latvia, which includes biological fuels and waste in its wider meaning, is shown in figure 21.

Starting from the raw source is possible to identify a chain that is made by different phases connected each other by transport segments. The steps are mainly of four types:

1. Resources
2. Storage and/or pre-processing
3. Processing and/or Storage
4. Transformation

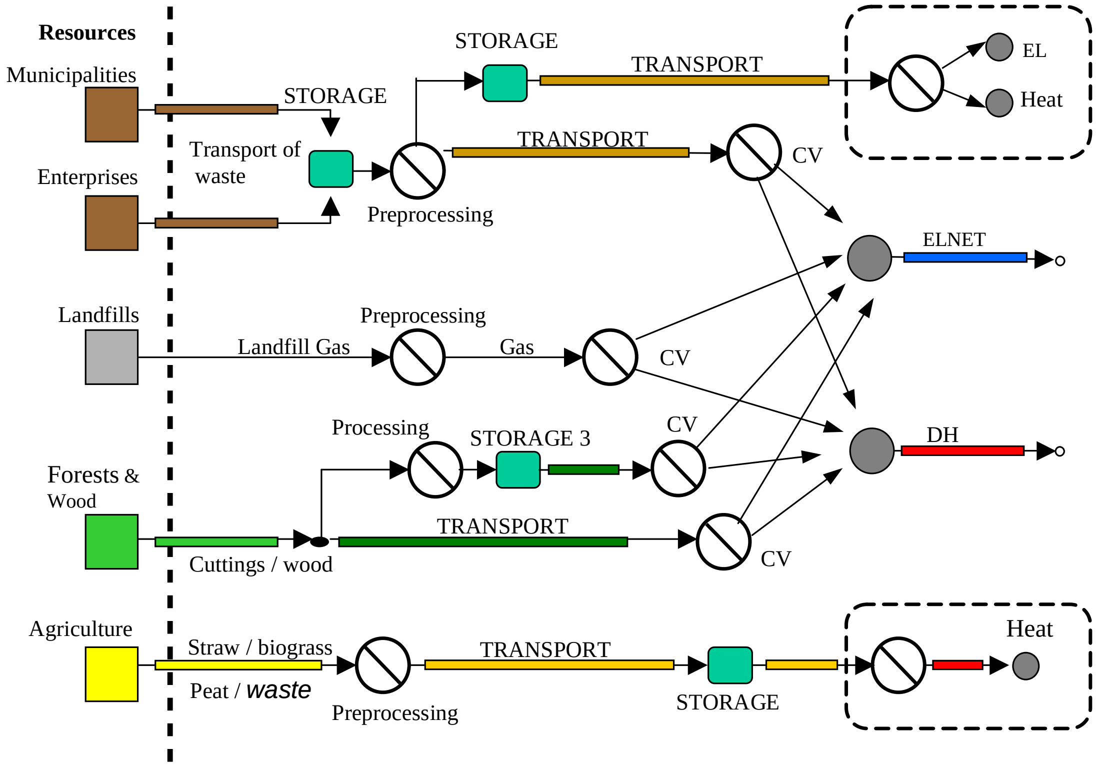


Figure 21: distributed energy from biomass and waste

Each chain, depending from case to case, is then divided in subsystems. In relation to figure 21 only the chain starting from forest and wood is well developed in Latvia, while the others are more connected to single projects. In the following paragraphs are described in more details aspects concerning transportation of wood-based fuels and straw.

7.1 Transportation of wood-based fuels

The chain for wood-based fuels in principle begins from forests, and then following, before the final transformation in energy, there are different phases each one characterized by a transport operation.

A more detailed framework for wood based fuels is shown in figure 22. While, in figure 23 is provided a further detailed chains for production of pellets and briquettes.

Taking a closer look to the general chain that starts from *Forests and Wood* is possible to divide the scheme into at least three subsystems or sub chains (see figure 22), which start from the same source – i.e. forests. The first chain is connected with sawmill and in general wood industries, where wood represents the raw material. The second chain is composed by production of firewood, while the last chain includes the utilization of waste, branches and residues from cutting areas. A more graphic view is provided in figure 24.

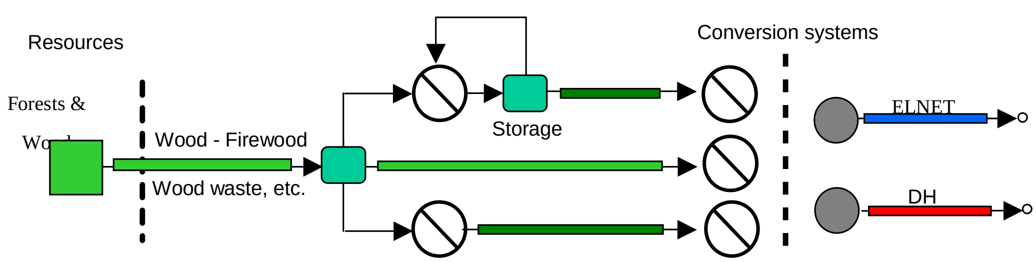


Figure22: distributed energy from wood – based fuels

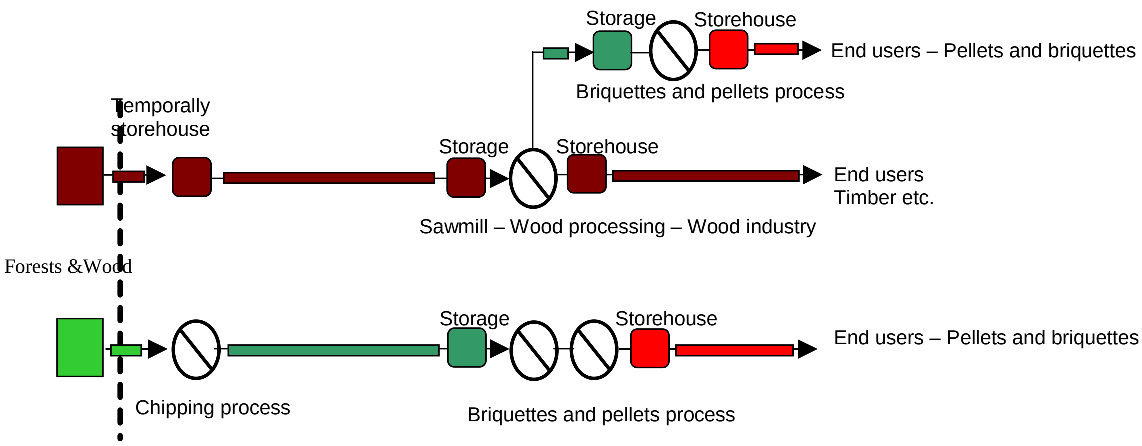


Figure 23: detail on distributed energy from wood – based fuels

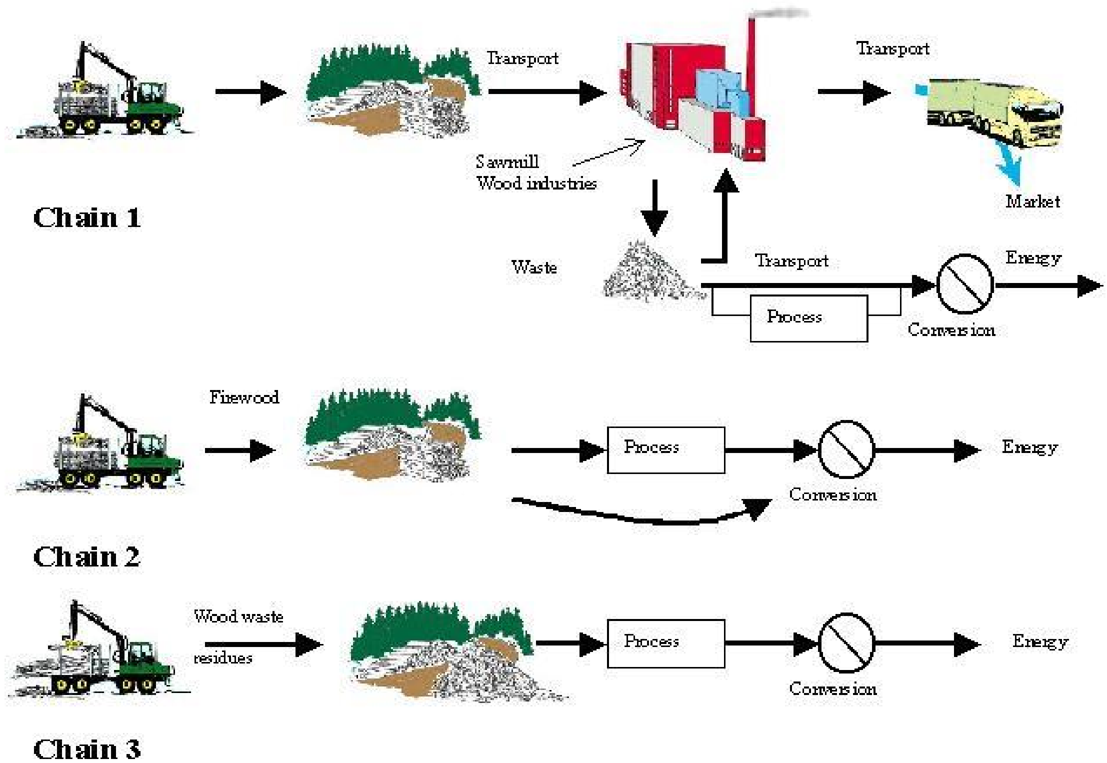


Figure 24: energy value chains for wood based fuels in Latvia

In Latvia transportation of wood recourses is possible either by road, railway or interlard water way and for exportation as well as by sea.

7.1.1 Chain 1 – To and from wood industries

Starting from the beginning of the chain 1(see figure 24) is possible to follow the wood-fuel path:

§ Segment 1: usually, tractors carry out the first transportation segment, from the cutting sites to the pre-processing site or storehouse; this segment is in the range between 1 and 10 km.

- Segment 2: transportation from the pre-processing site or storehouse to the processing plant is carried out by truck, which often is provided with a specific tail crane for easy self-loading. Here the range of distances made is much wider and it varies from few kilometres up to 100 kilometres. Sometimes this segment is divided into two parts, the first one by truck from the pre-processing site or storehouse to a railway station and then by train to the processing plant.
- Segment 3: transportation from the processing plant to the users is carried out essentially by truck in case of local demand. Distances are function of the user location. In case of exportation transportation is carried out as well as with railway or boat.
- Segment 4: from the processing plant wood waste as sawdust, sliver or wood and bark chips are produced. These wastes very often are partly used for heat purposes on the processing site itself. In some case this are transformed in chips, pellets or briquettes and then transport to the end users (mainly Boiler houses) essentially by truck. In case of local use the segment in never greater than 30 kilometres. In case of exportation then the distance depend from country to country.

7.1.2 Chain 2 - Firewood

This chain is usually the shorter in Latvia. From the cutting site, which often is as well as a processing site where wood is chopped, firewood is transported by truck to boiler houses or local users. The total transportation distance is habitually less than 30 km.

7.1.3 Chain 3 – Waste wood

This last chain concerns the recovery of wood waste and residues from the cutting sites for energy purposes. In Latvia typically the residues are pre-processed in wood chips either on cutting site or after a short transportation phase by tractors. Then the alternatives are the palletizing of alternatively the direct use as wood chips. The total distance, as for chain 2, is usually less than 30km.

7.2 Transportation of biofuels from agricultural land

In Latvia the transportation of biomass, in the form of straw, from agricultural land is practiced only in Saulaine region. The biomass chain is shown in figure 25.

Figure 25: distributed energy from straw biomass

The straw is packed on site in bales; from here is then load on a trailer of 8 tons capacity, for and average distance of 4-5km to the long-term storage. The trailers used have a dumping feature for fast unloading. Modern loading equipment with a telescope leader crane is used to put the bales into place.

The total time spent for loading and transporting is estimated at approximately 14 minutes per tons, assuming 8 tons per load.

More detailed information are provided in Chapter 11, Case Sites.

8. ENERGY UTILIZATION OF BIOMASS

8.1 Wood biofuels

The number and total capacity of current biomass user in Latvia are resented in table 28. The biomass fuels are used in small district heating plans (average installed capacity 2,3Mw_{th}) and sawmills (average capacity 2,2 MW_{th}). The first Latvian biomass fuelled CHP plant (stream turbines) has been finished in 2001.

Biomass user	Amount	Unit
Boiler houses (>1MW) Installed capacity	750 1700	Unit MW_{th}
CHP plants Installed capacity	1 10 30	Unit MW_e MW_{th}
Plants in sawmills Installed capacity	280 620	Unit MW_{th}

Table 27: Current biomass users in Latvia

In table 29 are shown, divided by region, the use of wood fuel in district heating systems.

Within the near future boiler plants in the range of 1,0 -4,0 MW are considered being most suitable for wood chip applications as investments in lower capacities are much higher than in alternative options, while larger capacities require well developed market infrastructure which ensures stability of fuel supplies [19]. Projections indicate that in short and middle term woodworking industry will generate sufficient volumes of wood residues to cover the main part of wood chip consumption.

It is anticipated that the number of modern boiler plants fuelled by wood chips will grow in future as present fuel conversion trend when imported fuels are replaced by locally produced wood-fuel will transform in extensive application of chips as they are much more technological, less labor consuming and, ultimately yield higher efficiency and lower costs.

Due to large number of small boiler plants in rural towns and villages firewood will still maintain its principal position in these areas. Chip production from firewood is more expensive and district heating companies that use wood chips at present mainly cover their needs either by chips supplied by woodworking plants or by covering to chips almost free woodworking industry' residues. Chipping of such residues as tops, branches and brush wood will only be competitive in distant future with application of advance forestry technologies.

First projects of modern technology, wood chip fuelled boiler installation in Latvia have been implemented in 1993 in Mālpils (gift of the Danish government) and in Balvi (within the EAES program of the Swedish government) [14].

Region	Firewood	Wood chips		Other wood waste	
	MWh	m^3	MWh	m^3	MWh
Rīga	16599,3	155099,0	96021,8	419672,1	257837
Daugavpils,	1753,4	0,0	0,0	0,0	0,0
Jelgava	5267,1	0,0	0,0	0,0	0,0
Jūrmala	2440,3	80412,0	49859,0	0,0	0,0
Liepāja	368,2	0,0	0,0	0,0	0,0
Rēzekne	0,0	0,0	0,0	0,0	0,0
Ventspils	0,0	6448,0	4669,0	6506,0	4693,0
Aizkraukles region	48145,9	14807,0	9180,3	1676,7	3118,7
Alūksnes region	13150,2	36596,0	22689,5	1490,0	923,8
Balvu region	20967,4	4226,0	4310,5	8114,0	5030,7
Bauskas region	9106,9	355,0	220,0	825,4	511,7
Cēsu region	45501,5	42083,6	26443,1	61373,0	37299,0
Daugavpils	36815,8	3575,0	2139,0	797,0	485,2
region	30838,3	0,0	0,0	1553,0	1002,0
Dobeles region	21701,5	16141,0	10007,0	14312,4	8873,4
Gulbenes region	7677,5	1879,0	1165,0	19338,0	11989,0
Jelgavas region	27980,8	20526,0	12726,0	16351,3	10137,8
Jēkabpils region	9307,8	0,0	0,0	10906,0	6761,1
Krāslavas region	32350,5	0,0	0,0	1011,0	626,6
Kuldīgas region	31979,4	4524,0	2904,6	17074,0	10446,1
Liepājas region	24158,6	33395,7	20705,4	4706,1	2917,8
Limbažu region	18736,5	3537,0	2192,9	5622,6	3486,1
Ludzas region	48525,4	49917,2	32708,6	25544,3	18812,9
Madonas region	34421,0	7039,6	4937,2	12009,8	7446,1
Ogres region	2718,9	4578,6	2838,7	11624,9	7207,4
Preiļu region	19699,5	3353,7	2079,3	6322,8	5079,9
Rēzeknes region	10367,4	121981,9	71043,8	38046,6	23994,6
Rīgas region	39620,0	22596,0	15909,0	9478,0	6425,8
Saldus region	29665,3	78399,0	55731,5	11878,0	7464,0
Talsu region	34034,9	8098,0	9202,3	9626,1	14876,9
Tukuma region	56183,0	25455,2	15781,8	10358,6	6409,3
Valkas region	47238,1	11220,0	7255,4	16313,0	9731,4
Valmieras region	13843,8	5080,0	3149,6	2153,0	1334,8
Ventspils region					
Total	**741164,2**	**761323,5**	**408085,9**	**744683,7**	**474922,7**

Table 28 Use of wood based fuel for DH systems

8.2 Agriculture biofuels

Straw, as energy source, in Latvia is used in a small-scale straw fired boiler plant at the State Agricultural School in Saulaine.

More detailed information are provided in Chapter 11, Case Sites

9. BIOFUELS MARKET

9.1 Wood-based fuels

Nowadays the market for wood-based fuels is fast developing. Latvia from its side in the period 1999-2000 has exported 658 100 tons of firewood for a value of 21,2million Euro and 360 000 tons of Chips, particles and other wood residues for a value of 10million Euro. The export market for pellets and briquettes is still in its infancy but probably will be developed in the future years. [8]

In Figure 26 are shown wood products exports, by export destinations in 1999-2000

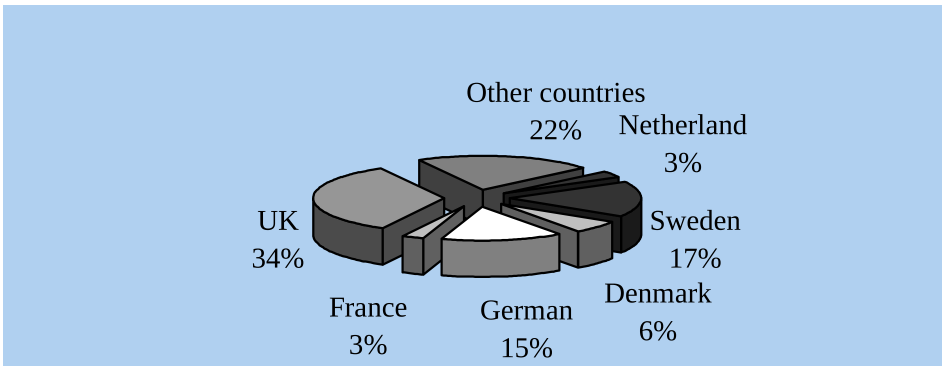


Figure 26: Wood products export, by export destinations in 2000 [Source: Latvian MoA]

9.2 Agricultural biomass

The market if agricultural biomass in Latvia is restricted to the region of Saulaine, where is located the only straw fuelled plant. The region is able to satisfy the annual demand of straw so that the market is just limited to the region.

Exportation and/or import of agricultural biomass is not existing at the moment in Latvia.

9.3 General description of biodiesel market

For the time being biodiesel has not become an extend export article. Export-import is observed just in scattered instances and small scale. The main obstacle for more extended penetration in market is biodiesel price. The help of political decisions usually overcomes this obstacle: tax reduction (mainly excise tax), subsidies/endowments, guaranties, etc. Also Latvia should follow this way [11].

9.4 Barriers of market development

The capital costs of wood fuel fired boiler plants are much higher than those of gas and oil fired and that is a significant barrier to a more extensive energy use from biomass. As the plant size increases, the economy of wood fuel plants becomes more attractive, however it may conflict with the rather low availability of fuel at a given place. Quite important obstacle to development and wider use of wood is lack of capital for investments in new and efficient technologies.

10. LEGISLATIVE AND FINANCIAL INSTRUMENTS

In the past, Latvia has had a long time experience in wood fuel use, with rather low combustion efficiency. In Latvia after the independence in 1991, the high potential of renewable energy has created a good foundation for the firsts pilot projects, which proposed “know-how” technologies.

Efficient energy technologies requires high investments, accordingly the success of the projects is based upon the conditions for loans or subsidies. Ten years of experience have shown advantages and shortages of different financial and organizational schemes.

Different types of economic supports for biomass projects have been and are provided [5]:

1. The support measures are addressed to particular demonstration projects, from different international programs. For example, Wood chips boiler house in Malpils and straw boiler house in Saulaine donated by Danish Energy Agency.
2. Swedish governmental Programme “Environmentally Adapted Energy Systems in Baltic States and Eastern Europe”, which includes 14 fuel conversion projects (from Coal or heavy fuel oil to wood chips) in Latvia.
3. Energy Efficiency Foundation (EEF), which has started to operate in 1998 and provides loans for small projects. Mainly the projects concern the replacement of the existing equipment, by a more efficient one, during the reconstruction of the heat supply systems. Loans are provided as well as for reconstruction and construction of small hydro power plants. Loans, for projects financing, range from 9 000 to 360 000 Euro.
4. Third party financing project, finished with the establishment of the Dutch-Latvian company, Ludza Bioenergy, in 2000. A 7MW wood chips boiler covers the basic load of Ludza District Heating System.
5. Latvian Environmental Investment Foundation, which has provided loans for fuel conversion projects. The Financial conditions were similar to the EEF ones.
6. Self-governmental Crediting Foundation (SCF), which has been established for providing loans for fuel conversion projects by using the Nordic Investment Bank credits. SCF has last to operate in summer 2001.
7. Nordic Investment Bank is still continuing its work, started by SCF.
8. Latvian Public Investment programme, which supports biofuel conversion projects.

In Latvia there is a wide range of possibilities for using energy derived by wood waste. This has both created a market for the involved technologies and formed awareness on biofuel possibilities. The economical analyses carried out on projects regarding wood chips boiler houses in Latvia have demonstrated that money savings, in case of fuel conversion (HFO to wood), cover the investments and loans in 5–7 years (payback period).

10.1 Research and development plans

At the moment in Latvia research programmes, on biomass energy use, proceed within two different frameworks. The first one is the Latvian National research programme, while the second gathers different international cooperation activities. In table 1 are shown the main areas and activities of the mentioned frameworks.

Latvian National research program
Investigation of energy technologies for wood fuel in Latvia, implemented by professors and scientists in Riga Technical University
Biofuel from vegetable oil and perspectives in Latvia, investigated by professors and scientists from Latvian University.
International Cooperation activities
EC Programmes OPET network, ALTENER, THERMIE B
Swedish National Energy Administration (STEM), structure for the development of small boiler production by local manufacturers
Danish - Latvian co-operation agreement - improvement of energy efficiency, including projects of reconstruction of boiler houses and heat networks, regional planning, use of renewable resources, etc.
Dutch – Latvian PSO Programme, oriented to the development of sawdust use for energy production

Table 29: research programmes on biomass energy

International cooperation activities play an important role for facilitating the development of the national economy. Indeed, beside they provide additional external funds they also introduce advanced technologies and new equipments. Co-operation with international financial institutions and direct foreign investments brings a substantial enhancement to the national economy in addition to national sources.

10.2 State strategy and energy plans

The Kyoto Protocol (1997) introduced quantified reductions targets for different countries, individually and jointly for the period of 2008 - 2012 in reference to the base year. The individual commitments vary from 8% reduction to 10% increase. Latvia is amongst those countries, which should reduce greenhouse gases emissions by 8%.

The Kyoto Protocol establishes three "flexible mechanisms" to reduce GHGs - Joint Implementation (JI), Clean Development Mechanism (CDM) and Emissions Trading (ET).

Latvia has participated in international climate change negotiations since the signing of the United Nations Framework Convention on Climate Change (UNFCCC) and has fulfilled all of its official requirements, but domestic climate change policy is not the highest priority environmental issue for the government. To a great extent it can be explained by the fact that it is not foreseen that Latvia will have any problems to fulfil its international commitments. Also, other questions, like EU accession have a much higher political priority at this moment. Therefore it is crucial at this moment to explain benefits from JI projects realisation to policy makers as well as potential project beneficiaries like municipalities in order to ensure their support in the whole project development cycle. [20]

Although Latvia's total emissions have decreased over the last decade and it is likely that Latvia will have no problems meeting its Kyoto commitments, it still has high-energy inefficiency and higher emissions per capita than most OECD countries. World development patterns indicate that emissions reduction measures taken after economic growth has induced environmental side effects and are more expensive than slowing emissions earlier on by investing in cleaner technology. For these reasons, it is important that Latvia participate in energy efficiency and GHG reduction activities along with other countries.

It is important to implement policies and measures across all policy sectors. Today, Latvia Climate Change Policy issues indirectly are integrated into strategic plans of the following specific branches of the national economy, which have a great impact on GHG emissions:

- Energy sector;
- Transport sector;
- Industry sector;
- Agriculture;
- Forestry;
- Waste management.

Nowadays in Latvia there are several governmental plans, programmes and strategies in connection with use of biomass:

- Latvian Energy Policy, 2000
- Latvian Energy Efficiency strategy, 2000
- Latvian State strategy for GHG reduction, 2001 (draft)
- Latvian National Renewable Energy Programme, 2000.
- Efficient use of biofuel. Proposal for changes in legislation in Latvia – under discussions in Latvian Bioenergy Association

Considering that the amount of potential projects in Latvia is comparatively small, biomass projects will play a significant role towards JI and emission trading.

11. CASE SITES

11.1 Woodchips and sawdust for energy in Ludza, Latvia

11.1.1 Project background

The construction design of the new boiler house in Ludza (city in eastern part of Latvia, 275 km from Riga) was worked out with the support of the Netherlands governmental agency – *Senter International* within the framework of the PSO program. A new boiler house, basically fuelled with wood waste was built instead of the old heavy fuel oil boiler house. Construction of the boiler houses was started in 2000 and exploitation was started in autumn 2001. The building of "Ludza Bio-Energija" (LBE) boiler house consists of 3 sections:

- § Office (office room, locker room, workroom, WC, shower);
- § Boiler section;
- § Wood fuel roofed storage.

Heat production system of the boiler house consists of:

- § Woodchip hot water boiler (capacity 8 MW, efficiency 80% with wood chips moisture content 60% on wet basis, maximum water temperature 110ºC, working pressure 2 bar, maximum pressure 3 bar) including furnace with moving grates, combustion air preheating, air fans and ducts, wood supply system (sieving machine, walking floor and transport system), flue gas filter, flue gas fan, ash transport system, chimney, as well as diesel oil burner, for reason of emergency.
- § Diesel oil hot water boiler (capacity 7 MW, efficiency 90%, maximum water temperature 110ºC, working pressure 2 bar, maximum pressure 3 bar) including oil burner and burner control cabinet, oil meter, oil pumps, oil tank, oil pipelines, chimney.
- § Water circulation system: supply and return pipes of both boilers, manifold, circulation pumps, flow meters, expansion vessels, 2 heat exchangers.
- § Heat dissipater for safety of wood boiler, as well for heating of boiler house;
- § Emergency power diesel generator;
- § Electrical and control cabinet incl. wood boiler and total heat meters, PRIVA control and monitoring system.

The woodchip boiler is in use up to its maximum capacity. Oil fired boiler is operated only for covering of maximum loads.

LBE heat production system is connected to heat distribution network of the Municipality of Ludza. The border between two systems is outlet of the heat exchangers at the side of Ludza heating network.

11.1.2 Fuel supply and long term sustainability

As a fuel for wood boiler are used woodchips and sawdusts. The agreement on wood fuel supply is made between LBE and the company LINDEKS. The duration of the agreement is 15 year. LINDEKS is responsible for regular and sufficient delivery of wood fuel to the LBE boiler house wood storage, in accordance with the planned heat load duration curve. Wood fuel is produced in the local wood processing companies.

11.1.3 Fuel characteristics

The moisture content of wood fuel delivered to LBE is from 10 till 60 %, depending on fuel type and season.

Moisture content (% wet basis)	Caloric value MWh/t	Density t/m^3
10	4,3	0,17
40	2,9	0,24
50	2,2	0,28
55	2,0	0,33

According to the agreement on wood fuel supply wood fuel price is set to 4 LVL (excluding VAT) per produced MWh of heat by the wood boiler.

11.2 Straw for Energy in Saulaine, Latvia

11.2.1 Project background

As part of the Danish Environmental-related Energy Sector Programme, an assistance project has been carried out to estimate the potential for the utilization of straw as an energy source in Latvia. Part of this project has included the implementation of a small- scale straw-fired boiler plant at the State Agricultural School in Saulaine, which is serving as a demonstration plant.

The efficient use of domestic energy resources has been given high priority in the Latvian energy policy. Domestic energy resources such as peat and wood cover approximately 2 and 22 % of the primary energy supply respectively. In contrast, straw from agriculture has not been considered as a potential energy resource until now, and straw is not mentioned in the national energy programme. However, experience from Denmark and from neighbouring Lithuania has propagated an interest in investigating the possibilities of utilizing straw as a source of fuel within the Latvian energy sector.

The project is divided into two phases:

Phase 1 of the assistance project was carried out in the period May 1998 -November 1999, and comprised:

- A Fuel Study aiming at analysing the present and future straw surplus potential in Latvia.
- A Feasibility Study, including an overall assessment of the possibilities for utilizing straw within the Latvian energy sector on the basis of the estimated straw surplus.
- Preparation of the straw-fired boiler demonstration plant at Saulaine State Agricultural School in Latvia. This includes:
    - The technical feasibility of the district heating system supplying the school.
    - A technical proposal for the straw-fired boiler plant.
    - A straw supply contract.

Phase 2 of the assistance project was carried out from April -December 1999, and dealt with the actual implementation of the above-mentioned straw-fired demonstration boiler plant, including:

- Tendering
- Supervision of Installations
- Commissioning, Guarantee Testing and Service Contract
- Training and Dissemination

The plant started operation on 3rd November 1999. A performance test was carried out and indicated good operational results.

The plant is installed with a capacity of 1.2 MW (4 boilers of 300 kW each). The plant has been delivered by the Danish-Lithuanian joint venture Alcon / Umega.

Three requirements were imposed on the recipient organization regarding the implementation of Phase 2 and the donation of the grant for the straw-fired boiler:

1. The school should finance the erection of a straw barn next to the heating plant, to be used as a buffer storage, and other necessary building works (foundation, rehabilitation, etc.)
2. An agreement should be reached between Saulaine State Agricultural School and the Latvian Ministry of Agriculture to establish a revolving fund, to ensure that any cost savings from the installation of the straw-fired boiler plant are spent on other energy- related investments at the school.
3. 3. A 5-year supply agreement should be entered into with the straw supplier.

11.2.2 Milestones

The project estimates indicate that there would be sufficient amounts of straw to utilize straw as a source of energy in the Latvian energy sector, and that the straw can be col- lected at reasonable costs.

However, the general economic feasibility of straw-fired boilers would depend on the development of environmental and policy-based support measures, which create economic incentives for investing in straw-fired boilers. Such measures would be reasonable from the point of view that the utilization of straw would reduce the consumption of imported fuels, and the environmental emissions from the energy sector.

Bearing in mind the relatively limited straw surplus and the uncertainties related to the availability of the straw, it is recommended that the straw initially be used primarily in the agricultural sector, and in connection with small-scale heating plants close to where the straw is produced. Significant interest has been expressed by Latvian agricultural organizations with regards to the possible use of straw as a fuel in the agricultural sector.

Once more experience has been gained, both with regards to the use of the technology and to the organization of straw supplies, it may be feasible to use straw on a larger scale. This should also be seen in light of the fact that the amounts of straw surplus available may increase in step with the modernization of agriculture, and the introduction of more productive grain varieties. Moreover, the local production of boilers may reduce investment costs.

11.2.3 Fuel supply and long term sustainability

The straw supplier, LIDUMSI company has been able to prepare and deliver straw of the required quality for both the heating seasons 1999/2000 and 2000/2001. There have been a number of minor problems in connection with the collection of straw for the heating season 2000/20011, which are related to the extremely wet summer, but finally approximately 800 tons were collected, which is assessed to be sufficient.

Presented accounts (and calculations) of the straw preparation costs indicate a cost level, which is far in excess of the agreed 5 years contract price. In this connection LIDUMS has been recommended to organize the preparation and collection of straw more efficiently and in particular to transport more than 3 tons of straw at a time (minimum 8tons). This will decrease the straw preparation costs significantly.

The straw supplier, LIDUMS, is converting from a joint stock company into a limited company. The organization and management of the company has thus changed since the project started. The company's grain area for wheat and barley has been reduced from l 786 hectares in 1997 to approximately 1040 hectares in 2000. The company has thus a potential of delivering approximately 3,000 tons of straw annually (approximately 3 tons/ha).

There is a problem connected with the transportation of straw, as just 3 tons have been transported in one load. The calculation of the cost of the straw fuel in the first phase of the project was based on 8 tons being transported per load.

LIDUMS has transport trailers to transport 8 tons or more, but the loading equipment required is not used (or available) when the straw is loaded. The older Russian equipment being used can only load the smaller transport trailers. Modern loading equipment (Volvo telescope loader) is only used to put the bales into place in the long-term storage.

As a result, the total amount of transport is greater than that originally foreseen, whilst there may actually be less loading work, as the transport trailers being used have a dumping feature, so no time or equipment is required to unload the wagons.

The total time spent loading and transporting was originally estimated at approximately 14 minutes per ton, assuming 8 tones per load. If only 3 tones are transported in one load, the time spent is estimated at approximately 30 minutes per ton. Danish experience suggests 12 minutes per ton.

11.2.4 Fuel characteristics

In general, the straw is sufficiently dry, and the average moisture content in the bales does not exceed the acceptable level of 22%. The corners of a few of the pressed bales have moisture content of 25-30%, due to the extreme weather conditions in the summer of 2000. The average weight of the bales was 490 kg (min/max: 350/700 kg) for the heating sea- son 1999-2000 and 540 kg for the heating season 2000-2001.

The price for the supply of straw was fixed contractually at L VL 5.7 per ton of straw for a 5-year period (1999 price level plus 10% profit), on the basis of calculations assuming that 8 tons would be transported per load. Assuming that there are 3 tons per load, and that 15 minutes are saved in unloading the transport trailers, the same calculation would indicate a cost level of L VL 9.73 per ton (excluding the depreciation of the straw bale presser, which was donated via a grant). This is illustrated in the figure 27 below.

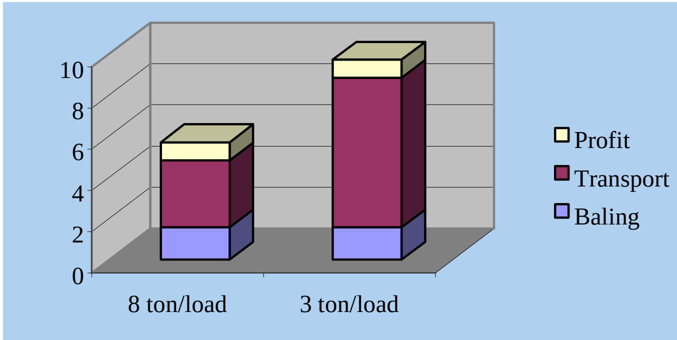


Figure 27: calculated cost of straw preparation depending on transport capacity (excluding depreciation of straw bale presser)

11.2.5 Production and consumption figures

Key figures for the past five heating seasons are shown in Table 33 below. The figures for' L 1996/97 and 1997/98 are based on fuel consumption data, whilst those for 1998/99, 1999/2000 and 2000/2001 are based on the energy data measured.

Heating season October-March	Estimate 1996-97	Estimate 1997-98	Actual 1998-99	Predicted 1999-00	Actual 1999-00	Actual 2000-01
Fuel consumption, MWh	6 667	4 100	3 834	2 875	3 118	2 958
Boiler production, MWh	2 780	2 460	2 300	2 300	2 290	2 056
Boiler efficiency, %	42	60	60	80	74	69,5
Consumers heat demand, MWh	2 140	1 820	2 140	2 140	2 150	1 856
Heat loss in network, MWh	640	640	160	160	141	195
System efficiency, %	32	44	56	74	69	63

Table 30:Energy production and consumption 1996-2001

Energy in MWh	Nov. 00	Dec. 00	Jan. 01	Feb. 01	Mar. 01	Apr 01	Total
Boiler house production	124	282	375	439	421	423	2055
Fuel consumption							
Straw in tons	46	98	139	158	145	151	737
Wood briquettes in tons		0,25			0,8		
Peat in tons		0,52			1,6		
Coal in tons							
Fuel consumption (MWh)	184	395	555,2	632	589,7	605,2	2958

Table 31. energy production and consumption in the heating season 2000-2001

Data for monthly outdoor temperatures indicate that the heat need for the heating season 2000-2001 should be a little less than for the heating season 1999-2000.

It can be seen that the actual production and heat demand in 1999/2000 and 2001/2001 corresponds with the predicted level. However, the boiler efficiency has been approximately 5-10% lower than expected, which has resulted in the fuel input being higher than expected.

The heat loss in the DH network in 1999/2000 is lower than expected. The increased heat loss in the DH network in 2000/2001 was due to renovation and water loss on one of the old installations.

The new system has enabled hot tap water to be consumed in the summer period in the dwellings and the school buildings, which are connected. The hot tap water consumption amounted to 22.95MWh in the summer of 1999 and increased to 70.67MWh in the summer of 2000, due to an increase in the number of consumers who are connected to the hot tap water. The hot tap water consumed in the heating season 1999/2000 amounted to 54.68MWh and increased to 67.93MWh in 2000/2001.

These figures suggest that the total annual production (heating season + summer period) will be as indicated in Table 34.

Straw consumption	701tons
	2 875MWh
Production (80%boiler efficiency)	2 299MWh
Heat loss in pipe network (7%)	161MWh
- Space heat consumption	1 999 MWh
- Hot tap water consumption	139 MWh
Total end user consumption	2 138 MWh

Table 32 Expected annual energy production and consumption

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