AN EVALUATION OF USING FUEL WOOD FOR DISTRICT HEATING PRODUCTION IN LATVIA

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Abstract
One can reasonably argue that issues related to the increased use of renewable energy resources in the energy production processes in Latvia, are at the forefront and will remain there in the future. This relates to the aspect that Latvia is not rich in non-renewable energy resources (around 70% of total primary energy consumption in Latvia is ensured by import, which can lead to undesired effects in many areas), but at the same time, there are available renewable energy resources in Latvia, with an untapped potential to be recognized. In particular this applies to fuel wood, which is already (year 2012) the most important domestic fuel in Latvia. In this context it is important to emphasize that, according to the particular study results, if unexpected socio-economic developments do not take place, raw wood material resources required for different types of fuel wood production in Latvia should be available in the same amount as it is now if not more. As for increasing the amount of fuel wood use in Latvia, an enormous 'potential' can be seen in general use boiler houses, where there are currently no technological limitations to utilize this 'potential'. General use cogeneration plants can be recognized as an even greater 'potential' for greater use of fuel wood in Latvia, but given the circumstances of energy supply in Latvia, the 'potential' is currently available on a very limited basis. At the same time it is important to note that both of these 'potentials' could be significantly reduced in the next few years.
Key words: fuel wood, district heating, power sector.

Introduction

By studying the current situation regarding the use of the energy resources in Latvia, the focus should be on two major issues. First, the power sector of Latvia is characterized by a relatively high dependence on the supplied energy resource import. For example, in 2010 the total primary energy consumption was 200.55 PJ (peta-joules) and only 33.21% (66.58 PJ) of it was provided by local energy resources, including a 32.79% share produced from utilizing renewable energy resources (hereinafter – RES). In these circumstances, Latvia may be subject to political, commercial and legal uncertainty, associated with the supply of imported energy resources and price. In addition, there is an outflow of funds from Latvia, due to payments for the imported energy resources, which results in contributing to the economic development of another country. Second, geographically Latvia is located in northern Europe, where thermal energy is needed not only to improve the quality of life, but also serves as a prerequisite for survival during winter. If we compare three main sectors, where the society utilizes energy, it is noticeable, that the largest portion of specific energy consumption in Latvia is for heating, but the least – for electricity, whereas transportation occupies the middle position. Therefore, heating is a particularly important power sector in Latvia. An additional nuance, which must be pointed out, is that the main RES sources in Latvia are agriculture and forestry, which are scattered throughout the country. The solid biomass obtained from these sources is suitable for the production of heat using widely tested technologies brought to the market, in contrast to the so-called production technologies of 'green' electricity (produced by the use of RES), Latvia is largely able to provide it by itself (Siltumapgāde Latvijā, 2009; Klāvs et al., 2010).

By understanding the importance of the aspects and cross-correlations mentioned above, it is possible to come to a conclusion, that the approach including heat production from agricultural and forestry biomass in Latvia, by looking at the situation in general, is already becoming stressed as a significant opportunity to promote the national economy and regional economic development, as well as new energy technology and product development, and also increase the independence of Latvian power sector. This clearly defines the actuality of the research topic.

In this particular study an assessment of using fuel wood of district heating in Latvia is selected as the ***research object***. The study is delimited by the ***research subject***, which anticipates the use of fuel wood in general use boiler houses and cogeneration plants.

Research aim: Evaluate the use of fuel wood for district heating in general use boiler houses and cogeneration plants in Latvia.

Research tasks:

1. to describe wood resources in Latvia.
2. to analyse the actual and perspective use of fuel wood for district heating in general use boiler houses and cogeneration plants in Latvia. In this particular study the words 'fuel wood consumption in perspective' are meant as an amount of fuel wood, which, due to a variety of circumstances, has in fact already been scheduled for energy production in the foreseeable future, by taking real actions, which ensure the predicted amount of fuel wood use.

Materials and Methods

The study is developed in the year 2012. To describe the object under study the monographic method is used frequently for both overall and between object parts, analysis and synthesis methods are also applied. The main source of information of the study is the publicly available database of the Central Statistics Bureau (hereinafter – CSB) of Latvian Republic (hereinafter – LR), as well as the forest inventory data of the State Forest Service (hereinafter – SFS). Similarly the study includes analytical information, acquired from research analysis carried out by academic and scientific staff (professional researchers), as well as some Internet sources.

Results and Discussion

1. Characteristics of Latvian wood resources

Forests in Latvia are clearly the national treasure. Based on the SFS (a public administration under the supervision of LR Ministry of Agriculture) forest inventory data for 2010, the total area of the forest land was 3264.64 thsd. ha (thousand hectares). By comparing this area to the total land area of Latvia (6459.8 thsd. ha), it is possible to attain a result, that in 2010 forest cover in Latvia was 50.5% (in comparison with the national average most of the forests in Latvia are located in the regions of Kurzeme and Vidzeme). By growing the trees form wood increment each year. The current estimates of SFS for recent years show that, at the moment it is about 16.5 mln. m^3 (million cubic meters) per year in Latvia. At the same time each year a certain amount of wood is felled (see Tab. 1). By associating these two figures together, a situation becomes distinct, where the total volume of forest growing stock in Latvian forests has increased, as forest growth is greater than the volume felled. In essence, this means, that the existing volume of tree felling in Latvia until now corresponds to the principles of sustainable forest management (Meža apsaimniekošana, 2012).

Table 1

Total forest growing stock and volume felled (million cubic meters) in Latvia from 2005 to 2010

Position	Report year, million cubic meters					
	2005	2006	2007	2008	2009	2010
Total forest growing stock	569	571	569	569	571	576
Volume felled in total*	11.29	9.81	10.12	8.96	10.73	12.98
state forests	4.80	4.41	4.69	5.54	7.73	7.64
other forests	6.49	5.40	5.43	3.42	3.00	5.34

* Volume felled, where it has been necessary for the SFS to issue a tree felling confirmation.
Source: made by the authors on the basis of SFS data.

Table 2

The distribution of the total dominant tree species growing stock (million cubic meters) and the total area (thousand hectares) in age classes in all Latvian forest for the year 2010

Age class, years	Total growing stock, million cubic meters			Total area, thousand hectares		
	Pine	Spruce	Birch	Pine	Spruce	Birch
to 10	0.68	1.13	1.66	50.48	80.71	80.25
from 11 to 20	1.14	2.05	4.23	39.70	54.94	87.60
from 21 to 30	1.38	5.75	4.18	20.91	63.13	43.60
from 31 to 40	3.55	11.95	7.65	26.95	74.49	53.20
from 41 to 50	7.44	17.33	16.62	40.47	74.25	89.84
from 51 to 60	17.63	7.91	33.01	76.99	28.94	147.52
from 61 to 70	32.82	7.97	41.81	126.35	26.36	165.51
from 71 to 80	38.14	9.02	24.33	139.78	27.80	93.09
from 81 to 90	38.51	9.03	13.56	134.01	27.46	51.09
from 91 to 100	34.37	8.20	8.65	115.97	25.26	31.86
from 101 to 110	25.73	5.19	3.64	84.77	15.88	13.46
from 111 to 120	15.45	2.74	1.01	51.61	8.54	3.91
over 120	30.16	3.34	0.31	105.29	11.02	1.29

Source: made by the authors on the basis of SFS data.

While analyzing the information on the total forest growing stock in Latvia (see Tab. 1), it is imperative to be aware that it marks a situation with wood resources in the country as a whole, but does not provide an insight in the actual availability of potential resources, because logging activities are planned, depending on tree species composition and the distribution of growing stock in age classes. By taking this into account, a summary of the most common Latvian tree species and their growing stock and area distribution in age classes was made (see Tab. 2). Latvian forest stands mainly consist of three dominant tree species: pine, spruce and birch. In accordance with information available on the LR CSB database, pine, spruce and birch forest stands together form 74% of total forest area in Latvia.

In order to assess the information, provided by Table 2, in detail, there is a further need to identify the distribution of dominant tree species by the site index. Site index is a man-made classification unit for the description of the productivity of a forest stand, which is determined on the basis of tree height at a certain age. To put it in simple terms, the site index indicates the rotation age (see Tab. 3) of the dominant tree species to be felled in the final felling. According to the information of LR Ministry of Agriculture, spruce and birch mostly make up I and II forest stand site index in Latvia, while pines generally constitute I, II and III forest stand site index (Meža platība, 2010).

By taking into consideration the contents of Table 2 and 3, it is clear that the accumulation of grown and overgrown pine forest stands has taken place in Latvia. There has also been the accumulation of spruce and birch forest stands, though not in quantities as large as pine forest stands. In addition, with the exception of spruce stands, where forest stands being in the minority will have reached the existing final felling age within the next 30 years, in birch and pine stands the majority of the forest stands is where the final felling age will be reached in 10 to 20 years. This in turn means that in the foreseeable future, the available wood resources for felling will not decrease from what it is today in Latvia. And, given the fact, that leaving grown and overgrown forests by themselves, the wood loses its quality and its value decreases. It is possible to assume, that the logging activities in Latvia in the foreseeable future will not decrease. On the contrary, they will increase. It follows that, the raw wood material resources required for the production of various types of fuel wood (logs, pellets, wood briquettes, wood chips, etc.), in the foreseeable future should be available in the same amount as it is

Table 3

Final felling age (in years) depending on the site index in Latvia under 'Law on Forests'

Dominant tree species	Final felling age (in years) depending on the site index		
	I and higher	II-III	IV and lower
Oak	101	121	121
Pine and larch	101	101	121
Spruce, ash and lime-tree	81	81	81
Birch	71	71	51
Common alder	71	71	71
Aspen	41	41	41

Source: Meža likums, 2000.

Table 4

Latvian-produced fuel wood export (thousand solid cubic meters) in a division by type from year 2005 to year 2010

Type of fuel wood	Report year, thousand solid cubic meters					
	2005	2006	2007	2008	2009	2010
Firewood	372	418	450	495	740	805
Wood pellets	407	597	607	544	680	843
Woodchips	845	674	536	484	444	635
Wood briquettes	36	26	21	24	34	43
Wood residues	123	83	90	60	51	52
In total:	1782	1798	1705	1608	1949	2378

Source: made by the authors on the basis of LR CSB data.

today. This is undeniably dependant on the condition that in the foreseeable future there wouldn't be any unforeseen socio-economic developments, which significantly reduces the demand for wood products in export markets, which in turn could reduce the volume felled in Latvia.

Not of less importance, in the context of energy production is that large amounts of fuel wood are currently exported from Latvia (see Tab. 4). On the one hand, these amounts improve the Latvian foreign trading balance. On the other hand, they point to the potential of local fuel that could be used in Latvia.

Relating the total amount of fuel wood export (excluding transit) (see Tab. 4) to the total amount of fuel wood production in Latvia, a situation is indicated, where during the period from 2005 to 2009 the export share was 20% on average. But in 2010 it significantly increased, reaching 24.90%, which in principle means, that a quarter of fuel wood produced in Latvia during 2010 was being exported rather than used for domestic purposes.

2. An evaluation of the actual and future fuel wood use in district heating general use boiler houses and cogeneration plants in Latvia

Initially, it should be noted that, in accordance with the data compiled by LR CSB, in recent years in the total primary energy consumption structure of Latvia three types of energy resources dominate, taking about an equal share – oil products (year 2010 – 32.20% or 64.58 PJ), natural gas (year 2010 – 30.57% or 61.31 PJ) and fuel wood (year 2010 – 25.61% or 51.14 PJ). With this in mind, it is possible to argue that fuel wood is now a major domestic fuel in Latvia, while dominating the largest consumer is households, which, for example, in 2010 consumed a total of 4540 thsd. solid m^3 (thousand solid cubic meters) fuel wood, making up 61.95% of the total fuel wood consumption in 2010 in Latvia.

By assessing the state of primary energy resource use in district heating production in general use boiler houses and cogeneration plants in Latvia, a special emphasis should be on fact that at the moment they are practically dominated by natural gas (see Tab. 5). In general use cogeneration plants this dominance is absolute, but in general use boiler houses – very high.

It is important to emphasize, that in Latvia the active use of fuel wood in general use boiler houses for district heating began around 1993, when in conditions of absence of large primary resources, growing costs of fossil fuels, and decreasing consumer ability to pay, heating companies focused on the possibility of using fuel wood as cheap fuel. At that time, the transition to wider use of fuel wood was also contributed by the gradual development of the forest industry in Latvia, which generated substantial non-liquid residues. For instance, in 1990 only 436 TJ of fuel wood was consumed in general use boiler houses, ten years later (in 2000) it was 3191 TJ, while another ten years later (in 2010) – 4357 TJ (see Tab. 5). These changes have taken place mainly by replacing oil products and use of coal with wider use of fuel wood (mostly in the form of woodchips) (Meža īpašnieku iespējas..., 2011).

Evaluating the information shown in Table 5, it is possible to come to an evident conclusion, that there is still a great 'potential' for fuel wood (or other local fuel) use for district heating production in general use boiler houses in Latvia. And what is particularly essential, there are no technological limits at the moment for the transition from natural gas use in general use boiler houses to the use of a different energy resource. The main restrictive factor

Table 5

The primary energy resources (TJ (tera-joules)) used in district heating production in general use boiler houses and cogeneration plants in Latvia from 2005 to 2010

Position	Report year, TJ (tera-joules)					
	2005	2006	2007	2008	2009	2010
Boiler houses						
Natural gas	10565	8049	7333	7610	7105	6970
Fuel wood	3509	4081	4078	3901	3741	4357
Other energy resources	1838	862	776	572	776	567
In total:	15912	12992	12187	12083	11622	11894
Cogeneration plants						
Natural gas	21869	26193	24710	24236	23634	30842
Fuel wood	623	660	597	655	649	727
Other energy resources	663	655	896	679	881	801
In total:	23155	27508	26203	25570	25164	32370

Source: made by the authors on the basis of LR CSB data.

is the large amount of investments needed for such a transition, the limited capacity of local government to take on financial obligations, as well as the slow capital turnover rate in district heating companies (Siltumapgāde Latvijā, 2009).

Compared with general use boiler houses, the 'potential' of fuel wood (or other local fuel) use in cogeneration plants is even greater. But at this point hasty decisions should not be made. In essence, the very word 'cogeneration', which means the combined production of heat and electricity, indicates, that in order to completely understand the concept in Table 5, it is important not only to understand the situation in district heating, but also in the context of electric power supply. And it is the securing of national electric power supply that has been one of the main reasons for the establishment of natural gas as the main energy resource in general use cogeneration plants in Latvia. In particular, this applies to the first thermoelectric central in Riga (hereinafter – TEC-1) and Riga's second thermoelectric central (hereinafter – TEC-2), which belong to JSC 'Latvenergo', and is the most distinct example of why in the current condition of power supply of Latvia there is a need to preserve the highly effective cogeneration, which is provided by the use of natural gas as a fuel in the foreseeable future (Riga TEC-1 and TEC-2 (combined) consumed roughly 70% (therefore the dominating share) of the total natural gas consumption in general use cogeneration plants in Latvia in 2010). Just as important is to maintain a highly efficient cogeneration, provided by the use of natural gas as a fuel in other general use cogeneration plants, built in significant LR cities and provide cogeneration electric power production in large quantities.

Without going into details (such as fuel property evaluation, after which, by the way, biomass also is significantly 'behind' natural gas and fossil fuel as such), the approach described above is mainly related to the ratio between the produced electricity and thermal energy. Namely, to produce a part of electricity depending on the type of biomass, power plant capacity and technology, 3 to 5 parts of heat have to be produced, while using the well-proven and available technologies, intended for the use of biomass for energy production on an industrial scale. While using natural gas as a fuel in combined cycle gas turbine units (such technologies (combined cycle gas turbines (CCGT)) in Latvia have been installed in TEC-1 and TEC-2), the produced electricity ratio to heat can be a lot closer to '1 to 1' outcome and even achieve a reversed ratio. To put it simple, if natural gas as a fuel for the general use cogeneration plants would be replaced with biomass, then only taking into account the produced amount of energy (as opposed to price et al. nuances), with the existing heat loads (in case of cogeneration, electricity is generated according to the provided heat load), the produced quantity of electric power in Latvia would decrease considerably. A situation such as this would subject the national energy supply to particularly high risks. Because the 'base' capacity of electric power is already at a deficit, and it is predicted that in the foreseeable future electricity consumption in Latvia will strongly increase. Thus, based on accurate technically economic calculations (rather than a 'belief' in the additional economic benefits of RES use), there is a need to maintain highly efficient cogeneration in Latvia, which is provided by the use of natural gas as a fuel in general use in cogeneration plants. It is possible to familiarize with a detailed justification of this approach, for example, at the Institute of Physical Energetics, as well as in studies carried out by JSC 'Latvenergo'. At the same time we have to keep in mind that the electricity market in Latvia is open. Consequently, it is possible to argue that even from an elementary logic point of view, JSC 'Latvenergo' is interested in producing electricity, what can compete in the market of today (Meža nozares ieguldījums..., 2008; Energo Forums, 2011).

To evaluate the perspective (see the context of this word in the introduction of the study) use of fuel wood in district heating production in general use boiler houses and cogeneration plants in Latvia, it is necessary to identify projects predicting a wider use of fuel wood in substantial volumes (there is no considerable abandonment of fuel wood use in Latvia). The so-called 'serious projects', related to the development of new capacity for the fuel wood consumption in Latvia, are based on the engagement of co-financing from the European Union (hereinafter – EU) in structural funds, because without it theses projects would cost too much (the ratio of investment and projected benefit). In particular, we have to advert here to the EU support programs that existed / still exist in Latvia, such as: the activity 'Measures of increase the efficiency of district heat supply systems' (hereinafter – '3.5.2.1. activity') and the activity 'Development of cogeneration power plants using renewable energy resources' (hereinafter – '3.5.2.2. activity') financed by the EU Cohesion fund.

Based on the publicly available information the agreements signed between the Investment and Development Agency of Latvia and EU structural fund beneficiaries, a summary of the projects, which are approved in the planning period of 2007 to 2013 within '3.5.2.1. activity' and '3.5.2.2. activity' was made. From the perspective of a new fuel wood consumption quantity development, this information is a focused representation of the major projects (planned heat load is 7 MW (megawatts) or greater) and is shown in Table 6.

Table 6

The largest development projects for fuel wood consumption capacities with or in progress of receiving co-financing from the European Union's structural fund in Latvia for 25 January 2012

Project applicant	Project site	Planned project closure	Target capacity, MW		
			Heating	Electric	Total
JSC 'Rīgas siltums'	Tīraines street 5a, Rīga	03.2013.	22	4	26
JSC 'Rīgas siltums'	Kandavas street 16, Rīga	05.2013.	20	0	20
Ltd. 'Salaspils siltums'	Miera street 31a, Salaspils	05.1012.	7	0	7
Ltd. 'Tukuma siltums'	Asteru street 6, Tukums	11.2011.	10	0	10
Ltd. 'Fortum Jelgava'	Rūpniecības street 73, Jelgava	03.2013.	45	23	68
Ltd. 'Ventspils siltums'	Talsu street 69, Ventspils	07.2013.	20	0	20
Ltd. 'Enefit Power & Heat Valka'	Rūjienas street 5, Valka	01.2013.	9	2	11
Ltd. 'Cēsu siltumtīkli'	Rūpniecības street 12, Cēsis	06.2013.	7*	0	7*
Ltd. 'Liepājas enerģija'	Kaiju street 33, Liepāja	07.2013.	7.85	1.8	9.65
Ltd. 'Liepājas enerģija'	Kaiju street 33, Liepāja	06.2013.	30	0	30

* Plus an economizer with 1 MW capacity.

Source: made by the authors on the basis of Noslēgtie līgumi, 2012.

After an evaluation of information in Table 6 even without additional comments, it is clear that the demand for fuel wood in the domestic market (mostly woodchips) in the next few years will increase significantly, as new (both large and not so large) consumers of fuel wood will be active. For example:

- Ltd. 'Fortum Jelgava' estimate, that the necessary amount of woodchips will be around 450 thsd. solid m^3 to ensure the operation of the biofuel cogeneration plant in Rūpniecības street 73 (Jelgava). In the context of Latvia this is a very high quantity;
- JSC 'Rīgas siltums' estimate that the necessary amount of woodchips will be around 151719 solid m^3 to ensure the operation of 'Ziepniekkalns' (Rīga, Tīraines street 5a) biofuel cogeneration power unit. Likewise, this quantity is viewed as large in the context of Latvia (Noslēgtie līgumi, 2012).

Since there will be an additional volume of the fuel wood already consumed in Latvia, the provision of this amount could only be accomplished in three different ways or as a result of combining them:

- by increasing the production volumes of fuel wood in Latvia. The determining factor for such an eventuality to be truly realized, will be the increase of logging, because the raw materials of fuel wood are obtained at all stages of logging and woodworking as a by-product, rather than primary production;
- by shifting the fuel wood volumes meant for export to local markets. To truly realize such a possibility, local consumers in terms of discipline of solvency have to be able to compete with consumers outside Latvian borders. Or there is a need to create a more strict approach in the regulatory laws, promoting the use of the produced fuel wood for domestic purposes rather than export;
- by increasing the volume of imported fuel wood (in very small quantities, but a variety of fuel wood products are already being imported in Latvia, such as wood pellets from Belarus).

Given that:

- parallel to the projects included in Table 6 within the '3.5.2.1. activity' and '3.5.2.2. activity', there is a development of other similar projects in Latvia, with the only exception that the installed heat loads will not be so large;
- except for the projects developing within '3.5.2.1. activity' and '3.5.2.2. activity', there are other similar projects developing in Latvia (these are funded from company's assets and/or the use of Climate change financial instrument financing, and/or other provided financial instruments);
- Latvia is not the only country in Europe with large developing new projects for increasing used capacity of fuel wood.

It is possible to argue with a high probability that in the next few years in Latvia, rather than accomplishing one of the options mentioned above, but the combination of all options will occur.

Conclusions

1. If unexpected socio-economic developments do realize, raw wood material resources, required for the production of various types of fuel wood, in the foreseeable future in Latvia should be available at a quantity no less than they are today.

2. In the structure of primary energy resources used for district heating production in Latvia in general use:
   - boiler houses fuel wood have achieved a stable share – more than 30%;
   - cogeneration plants fuel wood is used in very small amounts – less than 3%.
3. There is a great 'potential' for fuel wood use in both general use boiler houses and cogeneration plants in Latvia, with one difference, under the existing conditions in Latvia's energy supply, this 'potential' in principle is only exploitable in general use boiler houses.
4. The consumption of fuel wood for district heating production in general use boiler houses and cogeneration plants in Latvia will increase significantly in the next few years; this increase will be especially 'felt' with the start of the 2013/14 heating season.

Acknowledgement

The publication has been supported by the European Social Fund (ESF) within the Project 'Support for the Doctoral Studies Programme of Latvia University of Agriculture' (2009/0180/1DP/1.1.2.1.2./09/IPIA/VIAA/017) //No.04.4-08/EF2.D2.20'

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