POTENTIAL CONTRIBUTION OF ENERGETIC USEFUL DOMESTIC WASTE TO THE ENERGY SUPPLY OF LITHUANIA

Saimniecisko atkritumu enerģētiskās izmantošanas potenciālais devums Lietuvas enerģijas apgādei

G. Denafas, I. Rimaitytė[1], H. Seeger[2], A. Urban[3]
Department for Environmental Engineering, Kaunas University of Technology,
LT-3028, Radvilenu 19, Kaunas, Lithuania
Tel. +370-37-351008, Fax. +370-37-451582,
E-mail: Gintaras.Denafas@ktu.lt , [1]ingrrima@yahoo.com
[2]Fachgebiet Abfalltechnik, Kassel University,
Mönchebergstraße 7, D-34125 Kassel, Germany
Tel.: +49-561-804-3744, Fax: +49-561-804-3744
E-mail: hseeger@uni-kassel.de, [3]urban@uni-kassel.de

Abstract
The energy potential of domestic waste in Lithuania is 1411 GWh annually. In the case of the introduction of an extensive material recycling of the domestic waste, this amount would be reduced to 727 GWh per annual.
Two variants of thermal waste treatment processes were taken into consideration: incineration by great furnaces and gasification followed by the incineration in gas power plants. The calculation of the necessary capacities for the thermal treatment of the domestic waste of every district is based on the annual availability of the plants of 75 %. Finally 4 scenarios arise, considering both the incineration on grate furnaces and the gasification in combination with the current energy potential of domestic waste and the potential after the introduction of extensive material recycling possible in the future.
Keywords: *domestic waste, energy supply.*

Introduction

With a territory of 65.301 km^2 and a population of 3.5 million, Lithuania is divided into 10 districts, which differ widely in their population density (Table 1). The main topic concerning European integration of Lithuania is its economical development. However environmental protection including waste management, which is related to the economical development, is also of importance.

Due to the rapidly economical development of the EU candidate nations in Middle- and East-Europe, it is likely that they will be confronted with similar problems of waste management as West-Europe. So the adoption of modern waste treatment technologies in Lithuania including thermal waste treatment is possible. Along with the safer waste disposal, thermal waste treatment usually also recovers and uses the energy content of the incinerated waste. Due to the future closing of the Ignalina Nuclear Power Plant, which now produces approximately 80% of the electricity in Lithuania, a restructuring of the energy economy is necessary. Since Lithuania has very small resources of fossil fuel, the energy recovering from waste could be of interest.

ISBN 9984 – 585 – 68 – 9

Table 1.

Number of inhabitants (thousands) in the Lithuanian districts [1]

District	In large cities	In small cities	In rural areas	Total
Vilnius	542	123	184	850
Kaunas	379	132	190	702
Klaipėda	193	90	103	386
Šiauliai	134	93	143	370
Panevėžys	120	59	121	300
Telšiai	-	106	73	180
Utena	-	101	85	186
Marijampolė	49	45	95	189
Alytus	71	39	77	188
Tauragė	-	55	80	134
In Lithuania total	1488	844	1152	3484

Waste in Lithuania

The amount of domestic waste, production waste and dangerous waste produced in Lithuania is registered from 1992 on. More of problem is data about the waste content. Only some researches have been made in the past. The two in Fig 1 presented compositions of domestic and similar waste were used as base data for the following considerations: the waste composition of Kaunas as model for large Lithuanian cities (> 50.000 inhabitants) and the waste composition of Visaginas as model for small Lithuanian cities [2].

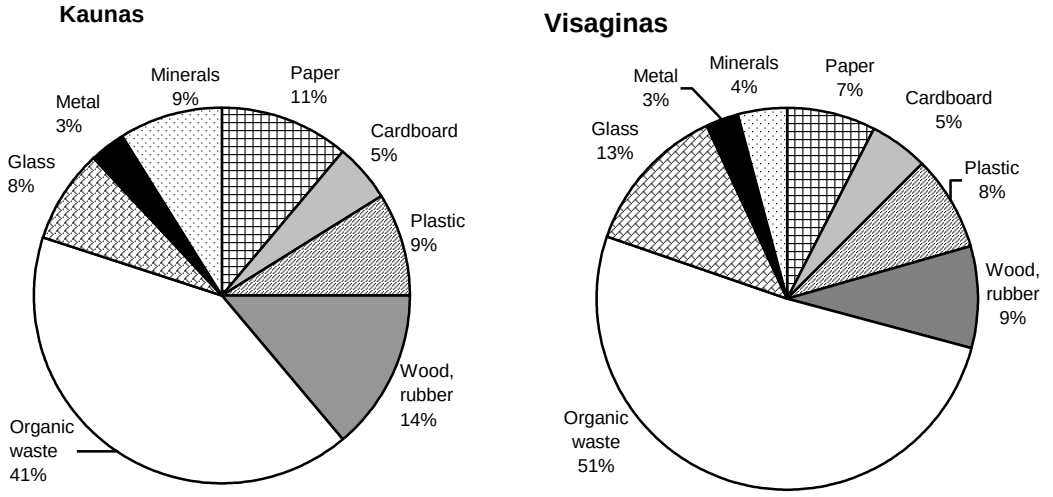

Fig. 1. Waste composition of Kaunas as model for Lithuanian large cities and waste composition of Visaginas as model for Lithuanian small cities

For calculation of waste energy potential two initial scenarios have been considered. For the first scenario, we assume that at the moment the recovering of material from waste has not countrywide reached a level that it has an significant impact on the composition of the disposed waste. This scenario will be marked as „current situation“. For the second scenario we assume that in the future a recycling of materials will countrywide reach a similar level to that in Germany, with the exception of the adoption of a system for the collection and composting of organic waste. The proposed recycling quotas for this scenario are presented in the table 2 [3].

ISBN 9984 – 585 – 68 – 9

Table 2.

Proposed future recycling quotas in Lithuania

Waste fraction	Glass	Paper	Organic waste	Metal	Plastic	Light waste	Other
Recycling quota, %	64	64	75	50	40	0	20

Energetic potential of domestic waste

The annual energetic potential of waste is calculated from the annual amount and the calorific value of the waste.

The data of the Lithuanian Environmental Ministry show that the produced annual amounts of domestic waste per capita are as follow: 300 kg in large cities, 220 kg in small cities, 70 kg in rural areas [4]. The high difference between the waste amounts in cities and in rural areas is explained by the use of organic waste as feedstuff for animals and of the burnable waste (paper, wood, plastics etc.) as fuel for the households in the rural areas. Therefore it can be concluded that the waste from the rural areas contain practically no burnable waste and because of that it is not considered in the sequent calculations.

The calorific values of separate waste fractions that were used for the calculation of the calorific value of the Lithuanian waste are presented in the table 3. The origins of these data are partly from Lithuanian investigations [5-7], and since calorific values of Lithuanian waste fractions are not significant different from German waste fractions and only the whole composition is different, also calorific values established in Germany both experimental and from literature [8] were used for the calculation of the energetic potential of the waste.

Table 3.

Calorific values of different waste fractions

Fraction	**Calorific value, kJ/kg**	**Water content %**	**Ash content %**	**Burnable, %**
Paper, cardboard	11.600	10	5	84
Plastic	24.900	2	10	88
Other burnable (wood, rubber, textile)	18.000	5	8	87
Organic waste	4.300	72	4	24

From the presented calorific values, waste content and the amount of produced waste presented above, the energetic potential of the domestic waste was established. The calculated values for every Lithuanian district regarding the current situation and regarding possible recycling quotas are presented in table 4.

Table 4.

Energetic potential of domestic waste in Lithuanian districts, GWh

District	**Large cities**		**Small cities**		**Total**	
	Current situation	**After recycling**	**Current situation**	**After recycling**	**Current situation**	**After recycling**
Vilnius district	379,00	202,14	54,35	26,74	433,35	228,88
Kaunas district	264,84	141,25	58,22	18,16	323,06	159,41
Klaipėda district	134,85	71,92	39,48	19,42	174,33	91,35
Šiauliai district	93,57	49,91	41,11	20,22	134,68	70,13
Panevežys district	83,69	44,64	26,11	12,85	109,80	57,48
Telšiai district	0,00	0,00	46,87	23,06	46,87	23,06
Utena district	0,00	0,00	44,40	21,84	44,40	21,84
Marijampolė district	34,02	18,14	19,59	9,64	53,61	27,78
Alytus district	49,96	26,65	17,35	8,54	67,32	35,18
Tauragė district	0,00	0,00	24,08	11,85	24,08	11,85
Lithuania total:	**1039,94**	**554,66**	**371,55**	**172,30**	**1411,49**	**726,96**

ISBN 9984 – 585 – 68 – 9

Scenarios for the energetic use of domestic waste in Lithuania

Two main criteria influenced the selection of potential sites for the plants. Because the production of heat is favorable to the production of electricity, it was looked after sites where a potential heat demand could be expected. The second criterion was the infrastructure. It was particularly looked after sites connected to the railway routes.

Two technologies for waste-to-energy conversion have been proposed. At first incineration on the fire-grate is worldwide prevalent technology. However municipal and industrial power plants in Lithuania have mostly gas/oil boilers and this will mostly also be used in the future. Therefore the alternative possibility would be to use a waste gasification connected to gas/oil boiler where the produced gas can be co-incinerated of together with natural gas/oil. For this second technology an additional criteria for the selection of a plant site was the existence of a power plant.

It is necessary to point out that the Lithuanian network of power plants is not evenly distributed. The 3000 MW capacities of the Ignalina Nuclear power plant located in Northeast Lithuania, Utena district and producing 80 % of all electricity in Lithuania will be fully replaced in the future by capacities of the other Lithuanian power plant. The largest thermal power plant of 1800 MW capacity is located in Elektrėnai between the Lithuanian capital Vilnius and the second largest city Kaunas. Both of these cities also have their thermal power plants of 384 and 178 MW capacities. So the largest thermal power plants capacities are situated in the Middle-South part of Lithuania. Only Mažeikiai CHP of 194 MW capacity is situated in the North-West Lithuania beside an oil processing enterprise. Its capacities are the highest in North and West Lithuania. The small industrial CHP are situated mostly near Vilnius and Kaunas. All Lithuanian thermal power plants have been adapted for gas/oil burning but no for burning of solid fuel on the fire grate or fluidized-bed furnace.

The sizes of necessary incinerators for every district have been established by recalculation of waste energetic potential to incineration capacities by assuming that all not-recovered waste will receive thermal treatment and that the plant operation availability would be 75%. If the necessary treatment capacities would be to small for a single plant in some districts, these districts waste would be transported to treatment plants in neighbouring districts.

Finally we received 4 scenarios:

- incineration on the fire grate based on the current situation of waste production (Fig.2);
- incineration on the fire grate based on the future waste recycling quotas (Fig.3);
- application of gasification technology based on the current situation of waste production (Fig.4);
- application of gasification technology based on the future waste recycling quotas (Fig.5).

During the selection of the plant sites both for fire grate and for gasification we considered that fire grate should only be used in modernized or new built thermal power plants. To these belong the current Vilnius and Kaunas CHP, future Klaipėda, Šiauliai and Panevėžys CHP and industrial CHP in Jonava and Kėdainiai cities near Kaunas. Unfortunately no fire grate incineration will be implemented in the Lithuanian PP because the current incineration capacities are already to large.

The installation of waste gasification technologies is a less difficult case because gasification products can be co-incinerated together with natural gas or heavy fuel oil. So the in the farther future to be modernized Mažeikiai CHP can also be equipped with a waste gasification.

ISBN 9984 – 585 – 68 – 9

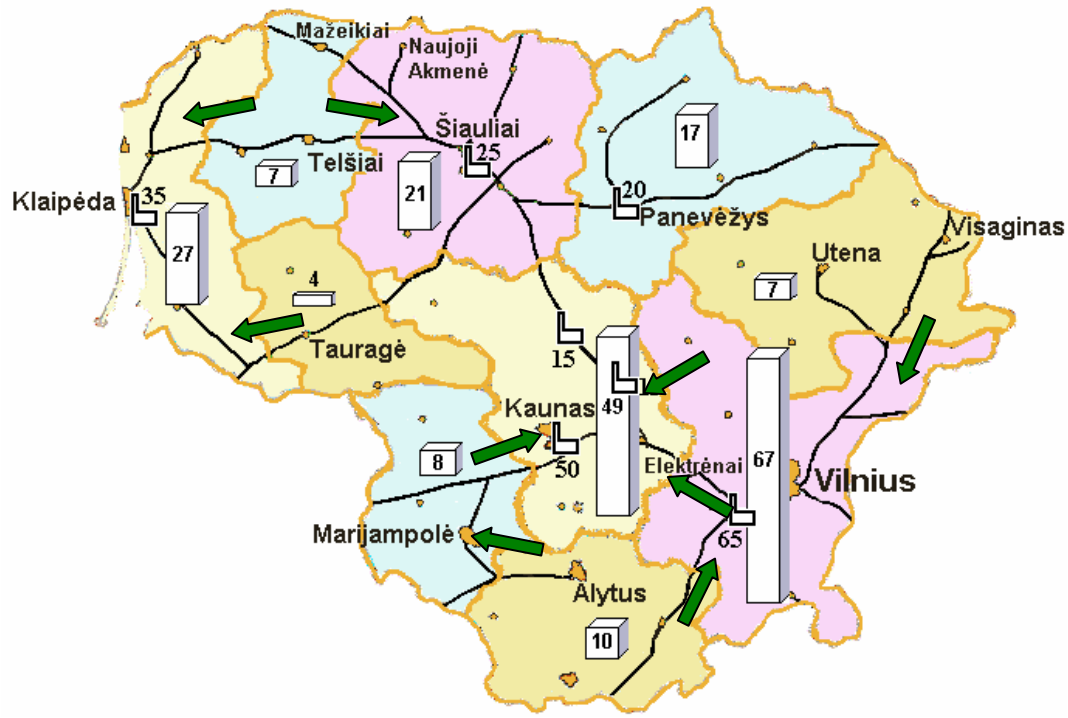

Fig 2. Scenario **a** – potential domestic waste thermal treatment capacities for all districts and proposed fire grate capacities (MW) based on the current domestic waste production

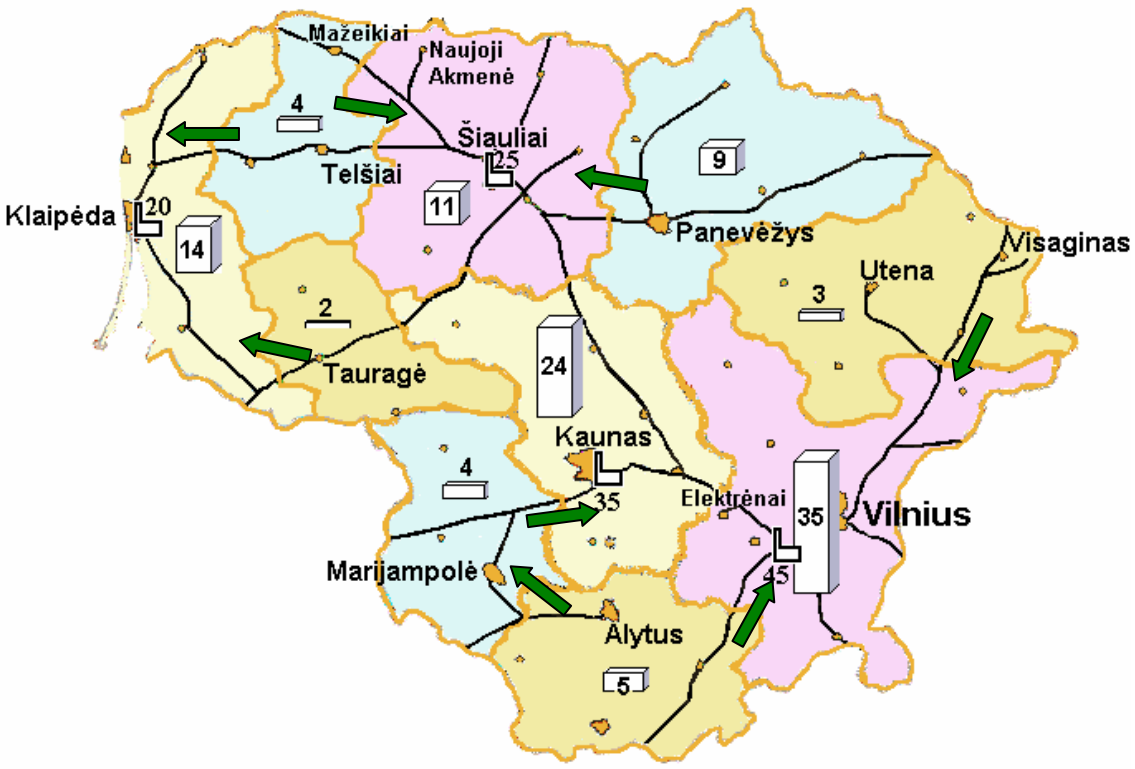

Fig 3. Scenario **b** – potential domestic waste thermal treatment capacities for all districts and proposed fire grate capacities (MW) based on the possible domestic waste recycling quotas

ISBN 9984 – 585 – 68 – 9

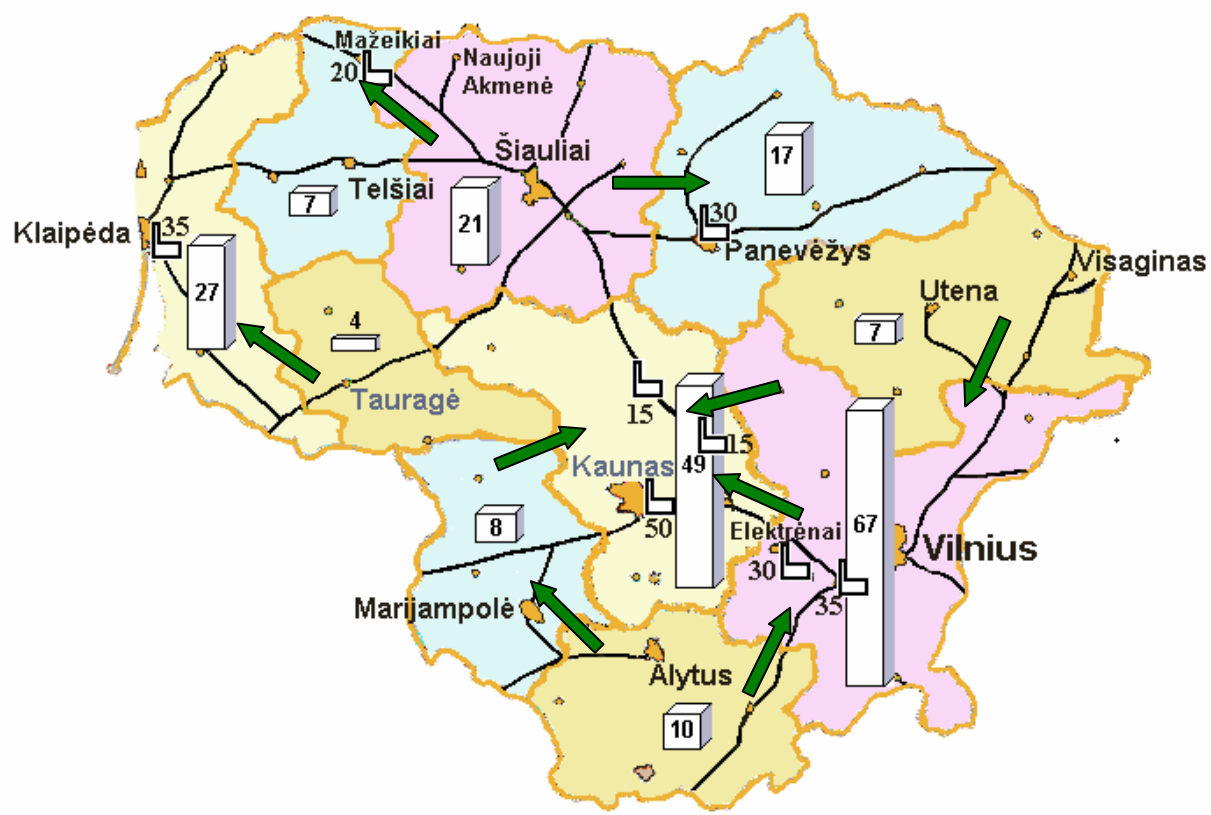

Fig 4. Scenario **c** – potential domestic waste thermal treatment capacities for all districts and proposed gasification capacities (MW) based on the current domestic waste production

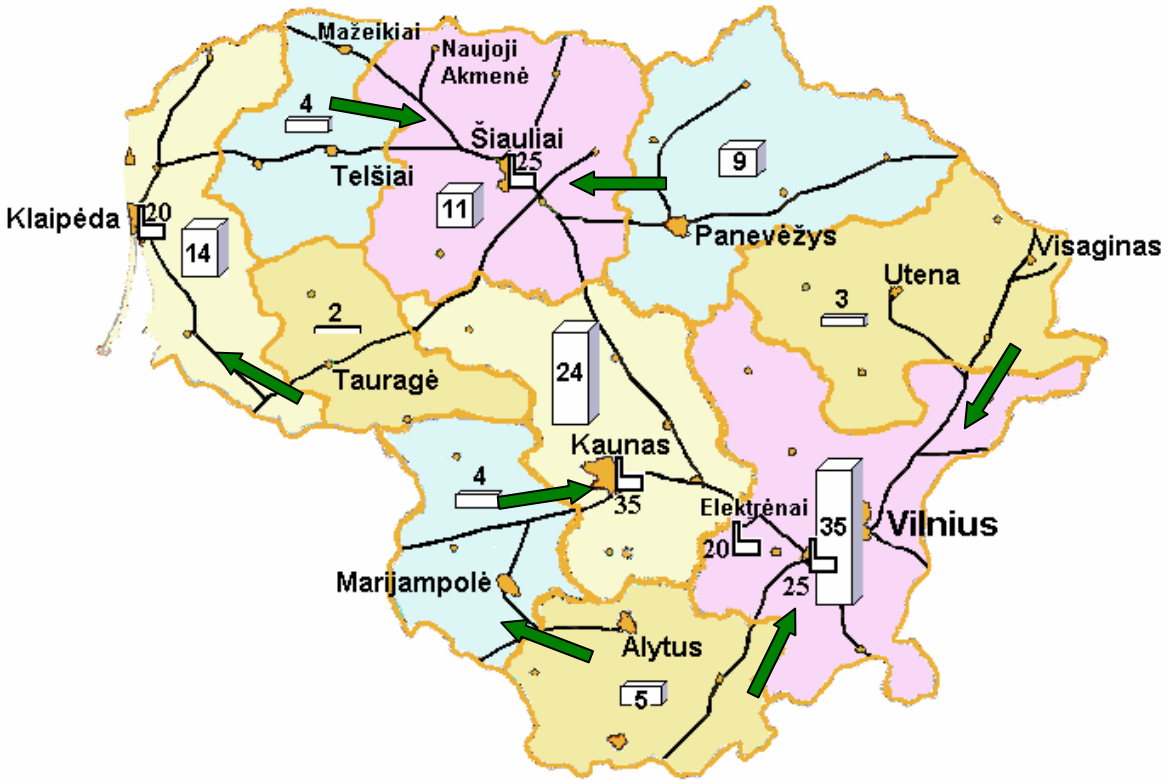

Fig. 5. Scenario **d** – potential domestic waste thermal treatment capacities for all districts and proposed gasification capacities (MW) based on the possible domestic waste recycling quotas

ISBN 9984 – 585 – 68 – 9

Conclusions

The energy potential of domestic waste in Lithuania is 1411 GWh annually. In the case of the introduction of an extensive material recycling of the domestic waste, this amount would be reduced to 727 GWh per anno.

For the selection of potential locations for the thermal waste treatment plants, 2 criteria have been used. Because the heat production from thermal waste treatment is much more favorable to the generation of electricity by thermal waste treatment, the plants should be located near to areas of high demand of heat. At second it was looked after the situation of the infrastructure. In particular, a good connection by railway was seen as important.

Two variants of thermal waste treatment processes were taken into consideration: incineration by great furnaces and gasification followed by the incineration in gas power plants. The calculation of the necessary capacities for the thermal treatment of the domestic waste of every district is based on the annual availability of the plants of 75 %. Finally 4 scenarios arise, considering both the incineration on grate furnaces and the gasification in combination with the current energy potential of domestic waste and the potential after the introduction of extensive material recycling possible in the future.

References

1. http://www.statistika.lt
2. Visagino miesto komunalinių atliekų surinkimo ir tvarkymo programa. – UAB “Baltijos ekostudija”, Vilnius, 1999
3. Friedel, M.; Urban, A.: Ökologische Aspekte beim Einsatz aufbereiteter Abfälle in thermischen Anlagen in Faulstich, M.; Bilitewski, B.; Urban, A. [Hrsg.]: 3.Fachtagung Thermische Abfallbehandlung, Berichte aus Wassergüte- und Abfallwirtschaft Nr. 137, Technische Universität München, München 1998
4. Lithuanian Environmental ministry information
5. Research Support Scheme. Report of co-operative project RSS 1631/2000” The Environmental Consequences of Use of Biomass and incinerable Wastes in the Baltic Region – Baltic States and Kaliningrad” – Kaunas, Riga, Tartu, Kaliningrad – 2000 – 2001.
6. Denafas, G.; Žaliauskienė, A.; Revoldas, V. Atliekų ir biomasės panaudojimo energetikos ir transporto reikmėms ekologiškumas // Aplinkos tyrimai, inžinerija ir vadyba Nr. 4(18), 2001. P.30-39.
7. Denafas, G.; Revoldas, V.; Žaliauskienė, A., Bendere, R.; Kudrenickis, I.; Mander, U.; Oja, T.; Sergeeva, L.’ Esipenko, A. Environmental consequenses of the use of biomass and combustible waste in the Baltic region. // Latvian Journal of Physics and Technical Sciences, 2002, Nr. 2, Riga, P.24-45
8. Kost, T. Brennstofftechnische Charakterisierung von Abfällen. Promotion an der Technischen Universität Dresden; Schriftenreihe des Institutes für Abfallwirtschaft und Altlasten Band 16; Dresden, 2001

ISBN 9984 – 585 – 68 – 9