INFO SYSTEM FOR ANALYSIS OF TECHNICAL AND ECONOMIC DEVELOPMENT OF THE USE OF WOOD FUEL
Kokgāzes izmantošanas tehniski ekonomiskās attīstības analīzes info sistēma

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Abstract
EU Integration raises new requirements to energy sector, including municipal energy sector and improvement of local planning. Important role is assigned to development of energy infrastructure, use of renewable energy sources and energy efficiency. In order to use financial support from EU Structural funds for regional energy development, qualified applications will have to be developed in adequacy with the requirements for the use and control of EU Structural funds. The latter should be developed in the context of regional development programs (including energy sector development), which should be based on info systems.

The Laboratory of Regional Energy Development at LEI is developing integrated info system "TAUSA" for this purpose. This info system is formed as server of data bases with respective bases and additional analysis modules. Information for the consumers of info systems could be available at Internet website. Besides indicators on district heating, "TAUSA" will accumulate data on distribution and end use of renewable energy sources at regional level, which permits to assess main macroeconomic indicators in the development of this economic activity. Matrix model for economic activity of preparing local fuel will enable to evaluate inter-branch links for district heating sector and the role of local fuel production in Gross Domestic Product (GDP) creating process.

The macroeconomic model under development will help to assess economic benefit from the use of renewable energy sources in the region, including the facts that it improves employment, increases the flow of taxes to municipal budget, paid by the companies employed in this sector, give new business development opportunities.

Keywords: *information systems, renewable energy sources, wood fuel, local planning.*

Introduction

EU Integration raise new requirements for energy sector, including development of municipal energy sector and improvement of local planning. Important role is assigned to development of energy infrastructure, use of renewable energy sources and energy efficiency.

With regard to use financial support from EU Structural funds for regional energy development, qualified applications will have to be developed in adequacy with the requirements for the use and control of EU Structural funds. The latter should be developed in the context of regional development programs (including energy sector development), which should be based on info systems.

The use of Information system IS "TAUSA"

The Laboratory of Regional Energy Development at LEI is developing integrated info system "TAUSA" for this purpose [1]. It is foreseen that this system will be used and developed for a long time by supplementing is with new opportunities, including such ones, which can't be forecasted today. The purpose of IS TAUSA is:

Monitoring and analysis of modernization and efficiency of district heating sector,

Formation of analytical basis for development of state energy development policy in district heating sector.

While the use of renewable fuel is growing in district heating sector, the need for establishment of data basis (DB) on the use of wood fuel and including this data into information system of district heating development appeared. As the amount of accumulated data in IS TAUSA and the number of its' consumers are growing, management system for the IS will be improved with the aim of better use of Internet opportunities for data introduction as well as its delivery to potential customers. This is integrated IS, consisting of already created and now being created modules (NETWORK, CONSUMER, DH SECTOR,

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MACROECONOMICS, MUNICIPAL) and respective Data Bases. For the needs of regional planning data on resources, production and consumption of wood fuel are accumulated in module MUNICIPAL.

Application areas for IIS include:

- Activity management and planning for companies,
- Information transfer for higher authorities.

After full implementing of this system it could become one of the main tools for municipal info center for energy sector.

IIS TAUSA is open text program, which can be easily integrated with other Info Systems or Data Bases with respective interface. This IS is formed as server for data bases, including respective Data Bases and additional Analytical modules. It could be available for consumers on Internet Website.

The info unit in DB is DATA, which can be characterised by it's Code, area or any other Dependence code, Measure unit and Date:

$$DATA = f\,(Data\ code,\ Dependence\ code,\ Measure\ unit,\ Date)$$

Every DATA is linked to Data, Area dependence and Measures Units Vocabularies (Figure 1)

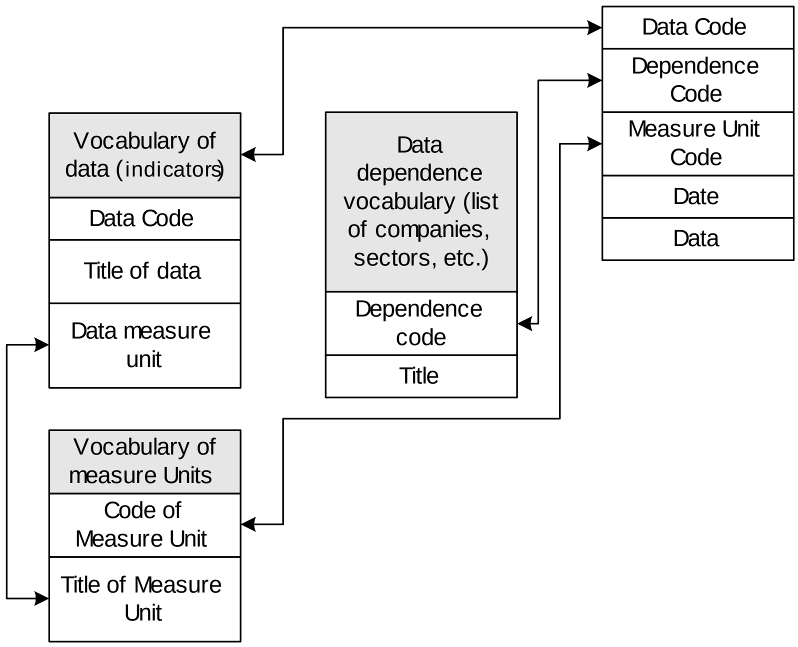

Fig.1. Data (indicators) coding system

On the basis of separate data info lines (vectors), matrixes of lines (matrix) and meta-tables are formed.

Regional distribution of Wood Fuel Sources

Besides indicators on district heating, data was accumulated on distribution and end use of renewable energy sources at regional level, which permits to assess main macroeconomic indicators in the development of the use of wood fuel. According to administrational constitution, Lithuania is divided into 60 municipalities, of which 6 are big cities, several smaller towns of state importance and 44 regions. The following data on wood energy sources is contained in IIS "TAUSA" on Municipal basis:

- The area of the municipality;

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- The forests area of the municipality;
- Total felling.

Actually total felling can be characterised by felling structure and wood use structure (Figure 2). In first case main and intermediate felling could be selected. The latter consist of:

 - Current felling,
 - Sanitary felling,
 - Thinning,
 - Cleaning.

<table>
<tr><td rowspan="4">Final wood consumption, $c_1 = d_1$</td><td colspan="13">Final Fuel consumption</td><td rowspan="8"></td></tr>
<tr><td colspan="2">Firewood, d_2</td><td colspan="4">Saw-dust and cuttings for sales, d_3</td><td colspan="3">Wood chips, d_4</td><td colspan="4">Residuals, d_5</td></tr>
<tr><td colspan="13">Raw material for production of wood fuel</td></tr>
<tr><td>Saw-dust, c_2</td><td colspan="4">Cuttings, c_3</td><td colspan="2">Firewood, c_4</td><td colspan="3">Stems, c_5</td><td colspan="3">Branches, c_6</td></tr>
<tr><td colspan="8">Liquidated wood</td><td colspan="6" rowspan="2">Unliquidated wood, b_3</td></tr>
<tr><td colspan="4">Industrial wood, b_1</td><td colspan="4">Firewood, b_2</td></tr>
<tr><td colspan="5" rowspan="2">Main felling (a_1)</td><td colspan="9">Intermediate felling</td></tr>
<tr><td colspan="4">Sanitary felling a_2</td><td colspan="3">Current felling, a_3</td><td>Thinning a_4</td><td>Cleaning, a_5</td></tr>
<tr><td colspan="14">Relative annual rate of felling SMKN (t)</td><td>Not used MMTP – SMKN (t)</td></tr>
<tr><td colspan="15">Annual growth of wood volume (MMTP)</td></tr>
</table>

Fig.2. The use structure for wood volume growth, m^3/ha

Following the structure of end use, total felling can be divided into liquidated and unliquidated or firewood. Liquidated wood can be divided into industrial and firewood. Only part of Liquidated wood is used by end-user. The rest parts are: saw-dust, cuttings. All this together with unliquidated wood (stems and branches from main and intermediate felling) is main raw material for wood fuel. The following scheme does not evaluate wood export-import. Using guidelines from Lithuanian forestry Institute Annual Growth of Wood Volume (*MMTP*) is assumed as the main indicator for planning of felling volumes [2]. In this case depending upon the goals of forests management policy Relative Annual Rate of Felling (*SMKN*) could be expressed as follows:

$$SMKN = MMTP - NMP. \qquad (1)$$

Here:

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NMP – Growth of not used wood, m^3/ha. In certain cases NMP can be negative (in case of the need to reduce accumulated growth rate, need for sanitary felling, etc.).

However, *SMKN* is one of the main indicators to define the volume of raw material for production of wood fuel, For formation of balance we assume that *MMTP* is constant of 6,1 m^3/ha, and *SMKT(t)* is known time function per past period.

Then structural scheme, shown in Figure 2 can be expressed in the following equation:

$$\sum_{i=1}^{N_a} a_i(t) = \sum_{i=1}^{N_b} b_i(t) = \sum_{i=1}^{N_c} c_i(t) = \sum_{i=1}^{N_d} d_i(t). \qquad (2)$$

Here:

a – Structural shares of felling (N_a = 5),
b – Structural shares of wood use (N_b = 3),
c – Distribution of end-use by raw material (N_c = 6),
d – Distribution of end-use by purpose (N_d = 5),
t – Year.

There are no full statistical data on the dynamics of mentioned indicators, thus for modelling of wood fuel preparing process we need to use existing data, though not full one.

Rather detailed data structure of wood felling and use by forestry for the period of 1990-1995 was widely used for assessment of wood fuel potential [4]. These data were regrouped for present administrational distribution in Lithuania, and were introduced into DB and used for analysis of wood fuel preparing structure in 52 municipalities. The results of simulation for coefficients a_i and b_i are given in Table 1. Other coefficients were assessed by expert methodology.

There are no more detailed investigations on the use of industrial wood. Data from MEC shows, that timber makes only 30% of total industrial wood volume. Nearly 10% of industrial wood is used for production of panels and other industrial needs. It is assumed that nearly 12% of industrial wood is transformed into sawdust, and 48% of it are various types of cuttings, which could become potential raw material for firewood or chips. It is assumed that 40% of unliquidated wood are stems, and the rest are branches.

Table 1.

Assessment of structural coefficients for the end-use of wood, based on the data from 1990-1995

Indicator	**Coeffi-cient**	**1**	**2**	**3**	**4**	**5**	**6**
Felling structure	a_i	0,569	0,232	0,111	0,080	0,008	-
Wood purveyance distribution structure	b_i	0,495	0,247	0,258	-	-	-
Wood End Use Structure	c_i	$0{,}4 \cdot b_1$	$0{,}12 \cdot b_1$	$0{,}48 \cdot b_1$	0,258	$0{,}4 \cdot b_3$	$0{,}6 \cdot b_3$
End Use of Wood Fuel Consumption Structure	d_i	$0{,}4 \cdot b_1$	$0{,}12 \cdot b_1 + 0{,}5 \cdot b_3$	$0{,}258 + 0{,}48 \cdot b_1 + 0{,}5 \cdot b_3$	$0{,}5 \cdot b_3$	-	-

It was notified that relative wood purveyance volumes or metric felling rate is separate municipalities, based on mentioned data, were changing in rather wide range. Statistical analysis showed that *SMKN* was distributed following Normal distribution law in most municipalities.

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$$\frac{S_r}{\sum_{r=1}^{r=N_r} S_r} = \frac{1}{\sigma \cdot \sqrt{2\pi}} \exp(-U)^2 \qquad (3)$$

Here:

$\sigma = 1,5883$

S_r Number of municipalities with deviation U from average relative felling rate.

$U = (SMKN_{m,r} - \overline{SMKN_m}) / \sigma$,

$SMKN_{m,r}$ Average relative felling rate during year *m* in municipality *r*.

$\overline{SMKN_m}$ Average relative felling rate during year *m* all over the country.

Without more precise available information mathematical wood fuel production model assumes that relative annual felling rate for municipality *r* during year *m* is as follows:

$$SMKN_{r,m} = \overline{SMKN_m} * (2 \cdot \delta - 1), \qquad (4)$$

Here:

0<=δ<=1 – random number.

The Centre of Forests Economics (MEC) under Ministry of Environment gives systematic information on Lithuanian wood market, volumes of felling and production [3]. On the basis of this data it is possible to elaborate assessment of wood end-use structure in Counties level (Figure 3).

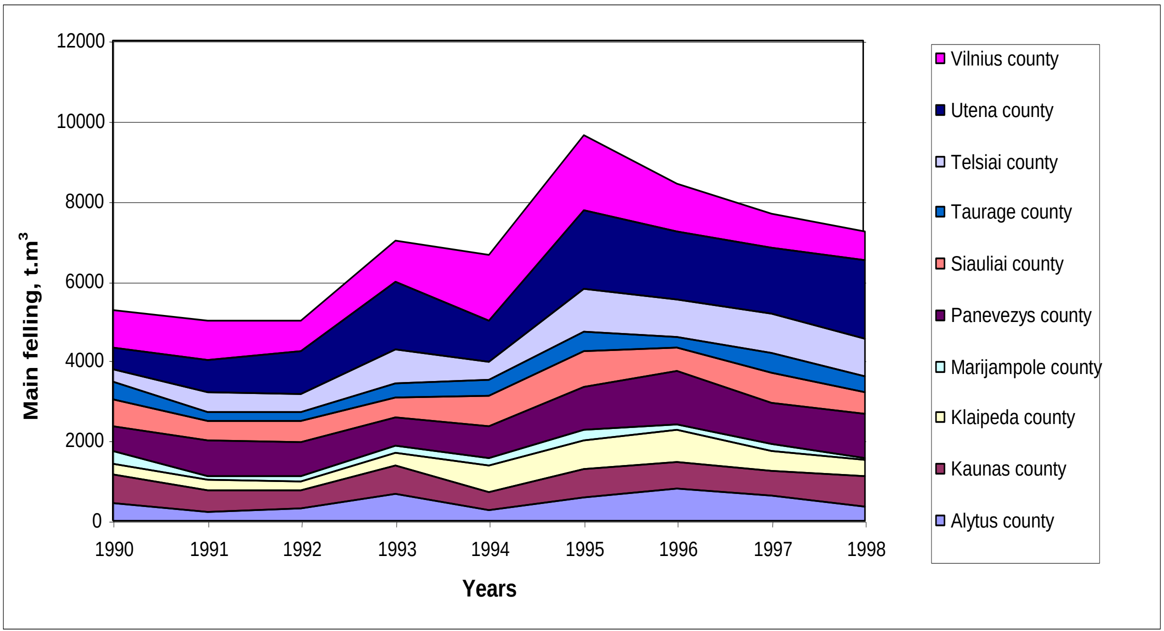

Fig.3. Distribution of annual felling volumes by counties

Development analysis of wood fuel production and use

Bearing in mind rather significant indeterminacies concerning initial information, it is difficult to expect that such model would be adequate to actual wood fuel consumption volumes. On the other hand we should assume also the fact that data of fuel-energy balance during period of 1990-1999 are not very precise, and only this data could enable comparison of simulation results.

Comparison of data from fuel-energy balance with volumes of raw material for wood fuel shows, that at the beginning of investigated period only minor share of possible resources was consumed (Figure 4).

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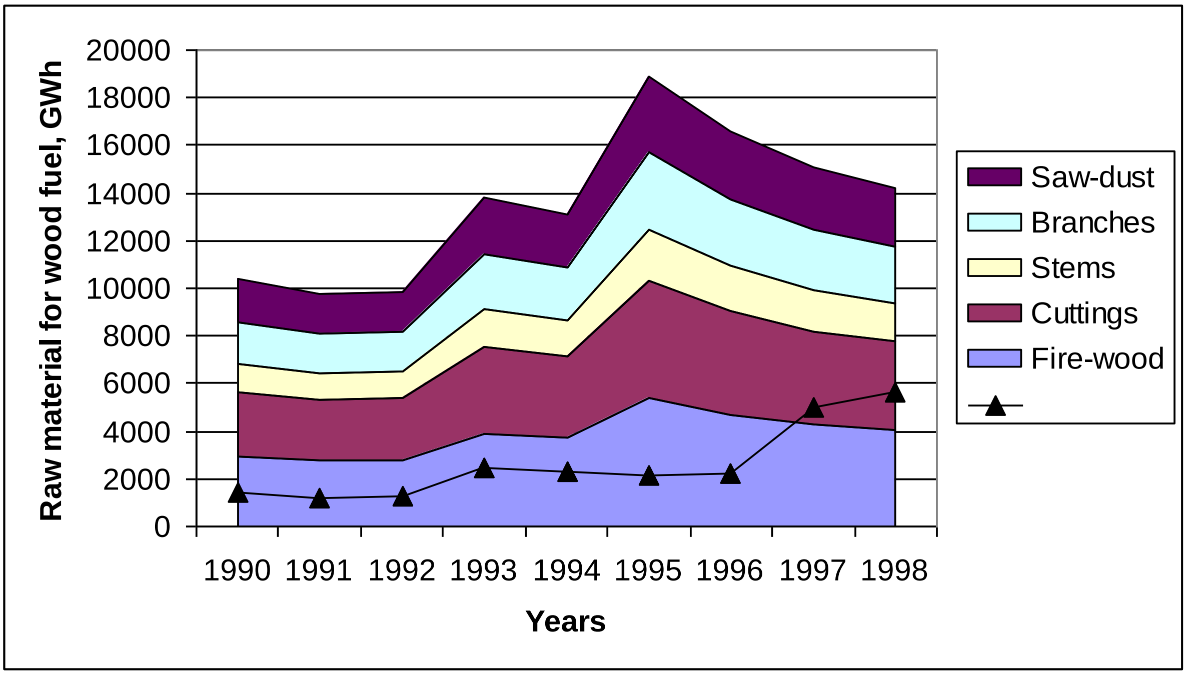

Fig.4. Comparison of raw material volumes for wood fuel vs. the end-use of wood fuel

Clear jump in wood fuel consumption can be partly related to the fact, that fuel-energy balance was revised during this year. While comparing fuel purveyance and raw material structural indicators, one can see that for production of wood chips stems and branches from felling will be used, as the resources of cuttings and firewood are reducing.

Suggested comparison of the results of mathematical simulation with actual wood fuel end-use structure could currently be evaluated as preliminary results. Suggested model is rather flexible and can be adapted for real situation after revising data in fuel-energy balance, as well as data on wood felling and other indicators concerning wood consumption.

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