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ENERGY DEMAND AND SUPPLY IN BULGARIA AND HASKOVO REGION

Technical Report for the Phare Project 'Energy Concept/Regional Energy Centre for the Pilot Region of Haskovo'

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Framework of the study

This study has been carried out in the framework of the Phare project BG9307-02-02 titled 'Regional Energy Concept/Regional Energy Centre for the Pilot Region of Haskovo', coordinated by COWI (Denmark). The project consisted of two phases, i.e. Phase I 'Development of a Regional Energy Concept' and Phase II 'Technical Assistance to the Regional Energy Centre'. Two tasks of the project Phase I, viz. 'Analysis of present energy supply' and 'Assessment of energy demand', were executed by ECN in strong cooperation with Energoproekt (Sofia, Bulgaria). This report is a technical report of the above mentioned two tasks of the project phase I, describing the approach designed and followed, and reports on analysis and results.

ECN project number 77044.

Abstract

The analysis of the collected data presented provides a characterization of the energy supply and energy demand in relation to socio-economic activities in the region of Haskovo in comparison with the national situation. Physical, economic, demographic or other indicators have been used to characterize energy consumption by service in consumer categories and to assess both regional and national energy balances.

The Haskovo region locates the Maritsa East mines which produce about 70% of national coal production and are considered to be profitable. The mines provide lignite to the main briquette factory in the country, in Galabovo, and to three thermal power plants which generate almost one third (40 PJ) of the national electricity production. The power plants are in unsatisfactory condition, but rehabilitation seems likely and profitable. The rehabilitation plans include flue gas desulphurisation measures, which are necessary: approximately half of the national SO_2 emissions and more than 90% of Haskovo SO_2 emissions originate in Maritsa East complex.

Regional energy demand and fuel mix are quite similar to those of the country as a whole and dropped 60% over the period 1990-1993 to a level of 36 PJ. The share of industry in final energy demand decreased from 77% to 68%. Haskovo industry can be characterised as about 20% less energy intense than the national industry. However, this is not due to a more energy efficient production but due to a different sectoral structure of industry. Industrial branches which are well developed in the region are food, textile, chemicals, and machinery. Due to low prices of heat and electricity and worsening economic conditions, final energy intensity is increasing again after having dropped substantially. In the industry in Haskovo, energy intensity increased alarmingly, due to a recovery and thus relative increase of energy intense chemical and basic metal industry.

Based on estimated energy saving potentials due to high volume of energy demand and relatively high specific energy consumption, municipalities have been prioritized as a background for the bottom-up assessment of municipal energy saving potentials. A socio-economic characterization of municipalities, made by the Regional Office in Haskovo, served as an economic context for prioritization.

CONTENTS

1. INTRODUCTION

Bulgaria, having a total population of more than 8 million inhabitants, is divided into nine regions with a population of 800,000 to 1,200,000 each. Haskovo is one of the four southern regions, having about 900,000 inhabitants. The objective of the Phare project 'Regional Energy Concept/Regional Energy Centre for the Pilot Region of Haskovo' is to develop a regional energy concept (REC) for Haskovo (Phase I) and to provide technical assistance to the Regional Energy Centre for the implementation of the REC and for the implementation of demonstration projects (Phase II).

Two tasks of the project Phase I, viz. 'Analysis of present energy supply' and 'Assessment of energy demand', focus on description and analysis of the developments of the regional energy situation to provide a background for the regional energy concept. This report finishing the two tasks is a technical report, describing the approach designed and followed, and reports on analysis and results.

Of course, the main focus of the data collection and analysis are regional energy related issues. However, the national energy situation has been taken as a benchmark or point of reference to understand and analyse the regional data. Furthermore, as much data as possible have been collected on a municipal level, in order to assess the regional energy pattern, which is important for understanding developments in the region as a whole and moreover, can serve as a background for the selection of demonstration projects. In addition, data of firms which have a large energy con-sumption have been collected for the same purpose.

The structure of the report is as follows. Section 2 and 3 clarify the objectives and approach for the two tasks which are dealt with. Also, a description of the database developed is given. Section 4 is a general introduction to the region of Haskovo. Section 5 will discuss the collected data and analysis on regional energy demand in comparison with national energy demand. Section 6 discusses regional energy supply in a similar way. Regional and national energy balances that resulted from the data collection are presented and analysed in Section 7. A preliminary assessment of regional SO_2 and CO_2 emissions is made in comparison with national emissions in Section 8. A municipal energy demand characterization as a background for prioritization of demonstration projects is made in Section 9. Finally, Section 10 summarizes the main findings and draws some intermediate conclusions on the region and more final conclusions on the execution of the project tasks.

2. OBJECTIVES

The two tasks 'Analysis of present energy supply' and 'Assessment of energy demand' are quite similar with respect to their structure; the first part consists of data collection, the second part of analysis and assessment. Moreover, data collected from energy suppliers form the basis for the assessment of energy demand. Therefore the two tasks are combined in one approach to assess the energy supply and consumption pattern in the region Haskovo.

The objective of the subtask Data Collection is threefold:

- To develop a consistent database as a basis for assessment of the regional energy supply and consumption pattern in order to develop a regional energy concept.
- This database will be provided to the Regional Energy Centre (REC) as a basis for further work.
- The database will be a background to select demonstration projects in the region of Haskovo.

The database will be continuously improved and updated during the project phase 2 and the REC staff will be trained in using, updating and improving the database.

Especially the future use of the database by the REC asks for a broad and general approach. The study Regional energy concept for Haskovo is one of the first in its kind in Bulgaria. Therefore data must also be collected at national level, in order to compare the regional energy situation with a national benchmark to characterize the region, but also as a back up in case regional data sources can not be found. National data collection also provides an opportunity for checking data reliability. Furthermore, a major part of energy policies is designed and implemented at national level. Therefore, comparability of national and regional data is essential.

Moreover, long term objective is to facilitate the implementation of regional energy concepts in all nine regions of Bulgaria. So, consistency with national level is important.

Furthermore, EU definitions and formats will be used in order to compare in the future with EU databases, standards etc.

The filled database will allow for analysing the regional energy situation in the second subtask Assessment, in order to fulfil the following objectives:

- Development of a method for establishment of regional energy balances in Bulgaria and illustration of this method by the actual example of Haskovo.
- Characterization of municipal energy consumption and supply.
- Assessment of the regional energy supply and consumption pattern of Haskovo.

The database has been designed in such a way that characterization and assessment is possible by combining energy data with physical, demographic or economic activity data into energy consumption indicators which characterize the municipal energy consumption over the region.

3. APPROACH

3.1 Conceptual framework

Objective of the approach is to assess the energy consumption pattern for the region of Haskovo. The pattern will distinguish energy consumption:

- geographically, viz. by municipality,
- by sector, viz. households, services, commercial, agriculture, and manufacturing, by energy carrier, viz. hard coal, brown coal (lignite), briquettes, heavy oil, light oil, natural gas, heat, electricity,
- by energy service, viz. heating, hot water, lighting, specific electricity use (households), specific production (by subsector of manufacturing and agricultural and commercial sector), and number of employees (public services).

A schematic overview of the approach followed to assess the regional energy supply and consumption pattern of Haskovo is given in figure 1.

Point sources

In order to characterize municipal energy supply region wide, energy production companies on a sub-regional level (between region and municipality) have been visited to collect data. It concerns coal mines, power plants and district heating plants. These energy production companies are categorized as 'point sources', being large energy production 'spots' on the Haskovo map.

Other point sources are large energy consumers (mainly large manufacturing companies). The structured selection of companies, based on a criteria such as energy consumption and/or energy consumption per unit of production etc., is very important. The first criterion is important for understanding the municipal energy consumption level, the second could be important for selection of demonstration projects.

Area sources

Energy consumption data by geographically spread small consumers such as households, public services etc. can not be collected directly. However, it is possible to derive energy consumption of these so called 'area sources' from total municipal energy consumption. Municipal fuel consumption data can be collected by sector at distribution companies for specific energy carrier types such as oil products (Petrol), solids (Toplivo), natural gas (Bulgargas), and electricity (distribution companies of National Electricity Company NEC).

Data on energy supply of energy carriers are available for most municipalities from the regional energy supply companies. Sometimes data are only available for a group of municipalities. These data distinguish roughly three main sectors, viz. households, industry (including agriculture), and others (public services and commercial sector).

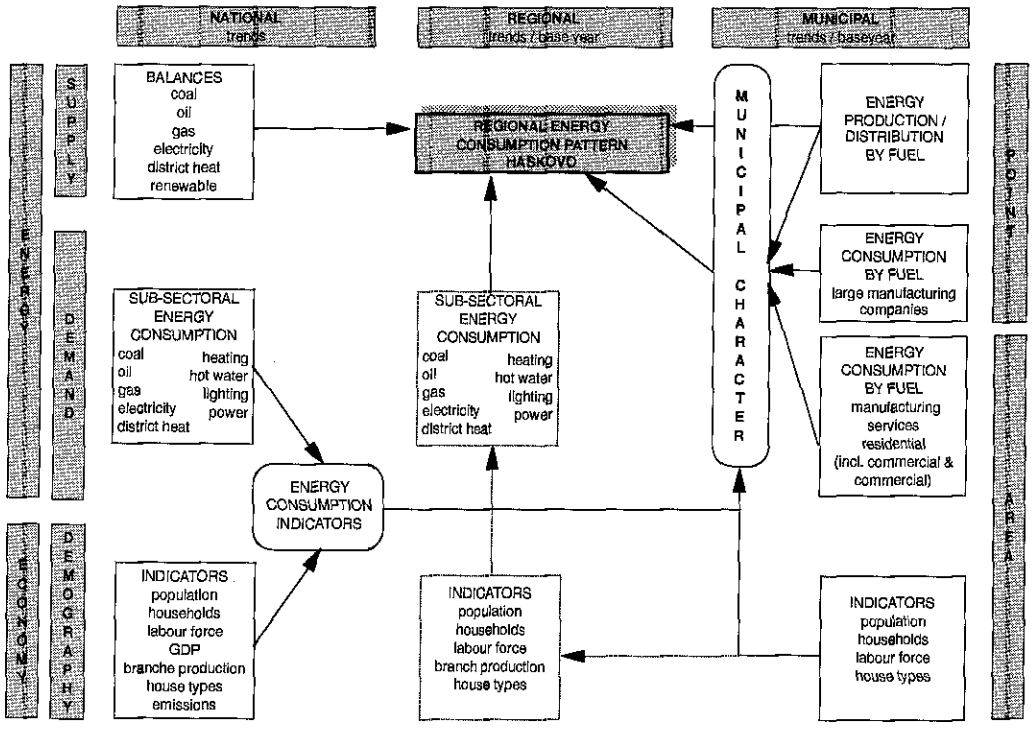


Figure 3.1 *Overview of approach for assessment of regional energy supply and demand*

Energy services

For development of a regional energy concept, it is necessary to know for what purpose energy is consumed and have indications on potentials and efficiency of energy consumption. It is not possible to collect these data directly from many small consumers. Two ways are possible:

- Bottom-up: estimate municipal consumption by service on the basis of a survey at a few typical consumer categories in the region of Haskovo.
- Top-down: estimate municipal consumption by service on the basis of national energy service data of a few typical consumer categories.

Advantages of the top-down approach are consistency with the national level and large scope coverage in a short time period. Advantages of bottom-up approach are accuracy and the direct relation to problems, options and instruments. Both approaches are complementary and both will be used in the project. In both cases, physical, economic, demographic or other indicators are needed to characterize energy consumption by service in a consumer category to scale it up to municipal energy consumption by service. The task Assessment of energy demand will focus on a first assessment of regional energy demand. Hence, the top-down approach is used in the analysis in this report.

Useful energy demand level will not be reached in the data collection; we strive for assessing final energy demand by energy service category, which is relevant for the type of technology in the particular end-use category and allows for assumptions on energy demand developments on the basis of growing activity levels and energy efficiency levels. Useful energy demand assessment will be made for typical consumer categories in other tasks of the project (bottom-up approach).

In summary, main structure of the task Regional energy supply and consumption pattern is:

1. Choose 'smart' (selective with respect to energy consumption) physical, demographical and/or economic indicators on national level.
2. Assess on a national level energy consumption and energy service levels *per indicator.*
3. Collect as much data as possible on regional and municipal level, but at least indicator data, so that regional and municipal energy consumption can be assessed in any case.

Municipality characterization

After data collection, energy consumption indicators have been calculated and used on the three distinguished levels (national, regional and municipal) for comparison and analysis. The approach resulted in a general characterization of municipalities with different characteristics with respect to economic activity and demographic structure on one hand, and their related demand for energy services on the other hand. Together with regional and national energy demand data, the approach resulted in a regional energy supply and consumption pattern by municipality for Haskovo. This consumption pattern forms the starting point for development of a regional energy concept, taking into account different aspects of municipalities in energy demand and supply.

3.2 Energy consumption indicators

For all sectors, a split into subsectors or energy services is made by energy indicators on the basis of subsectoral activity or energy service levels for which data or guestimates are available on national level.

Households

Energy is consumed in households for five purposes, viz. lighting, cooking, specific electricity use (household appliances), hot water, and heating (air conditioning). Transport is considered outside the scope of this project.

Guestimates are available on average energy consumption per service on national level. For the area analysis, it is assumed that the average ratio of energy consumption for energy services is similar for households in Haskovo and in the country, independent of the type of fuel. Given the fuel consumption for households in each municipality, an estimation can be made of the fuel consumption of households for a particular service. So, estimated Haskovo specific energy consumption for different services can be compared with national specific consumption.

Indications can be derived whether specific energy consumption for an energy service is more/less efficient or is demanded in larger/smaller quantities than on national level. By comparing local fuel mix and national fuel mix, an impression is given about possible reasons for differences in efficiency or demand. Of course, house types and average income also influence specific energy consumption. These issues will be discussed for each municipality for as far as data are available. In some cases, for instance the number of households using electricity for heating is known and can be used to check.

In Haskovo, only one district heating plant is present (in Kazanlak) and data are directly available from the district heating company. The number of households using heating and hot water from district heat is known as well in Kazanlak as on national level. These households are excluded from the area analysis in order to reach a more similar base for comparison.

Next stage is a more detailed analysis based on energy consumption in different house types.

Manufacturing & construction

Municipal energy consumption by energy carrier is available for the manufacturing and construction sector as a whole. On national level, the energy intensity (energy consumption per unit of production in Leva-1993) is available for each subsector. However, before calculating the energy intensity, energy consumption should be corrected for several factors.

First, fuel consumption for transportation, which is not directly related to the production process, is excluded. On municipal level, automotive fuels like gasoline etc. are also not included in energy consumption data. Second, fuels for steam generation by boilers in industry are excluded from final energy demand in national energy statistics (and included in the energy supply sector). However, fuel sales to industry in the statistics of regional energy suppliers include also fuels for conversion into steam and therefore the national energy intensity indicator has to include conversion losses of steam generation. Third, fuel consumption for non-energy purposes is included in the energy intensity of chemicals, which use natural gas for producing ammonia and fertilizer and use oil for producing plastics. This non-energy consumption is excluded from final demand by chemical industry in national statistics, but has to be included in order to be compatible with collected data on fuel consumption of chemical plants in the region.

The subsector energy intensity can be used for estimating the energy consumption of industrial branches in municipalities, since the industrial subsector or branch production in Leva is known for each municipality.

Commercial

The commercial sector can be treated in the same way as subsectors in manufacturing, viz. on the basis of energy intensity (energy consumption per unit of production in Leva-1993). However, no separate data on energy consumption is available for the commercial sector in Haskovo.

Agriculture

Two types of agricultural activities can be distinguished, viz. farming of cattle and growing of crops. Similar to industrial branches, the energy consumption per unit of production in Leva-1993 is a reasonable indicator of energy consumption. For growing of crops, energy consumption is corrected for greenhouses, which are treated separately being large consumers. However, no separate energy consumption data are available for the agricultural sector in Haskovo.

Public services

The number of inhabitants of a municipality will be used as indicator for the activity in the public service sector in relation to energy consumption. At the moment, m^2 of buildings, building types, and number of employees are not available yet for all municipalities.

3.3 Database

To operationalise this complex, structured approach, a database was developed to collect data consistently.

The data sheets have as much as possible the same format for the different subsectors at the different levels, viz. national, regional, and municipal level, in order to increase clearness and comparability. If requested data are not available, not relevant or inappropriate, the specific part of the sheet is not filled in. The database structure is similar to the structure of the approach as outlined in the scheme in figure 3.1. Examples of data sheets are presented in Appendix A.

1985 is the first relevant year to collect data for. Before this year, many organizational, structural and statistical changes have taken place which make data for an important part incomparable.

For 1994 data are available on National level, but not on Regional level. 1992 Is not a representative year since the Bulgarian economy reached at that time its lowest point. Data have been collected for the years 1985, 1990, 1992, 1993, and later for as far as available.

The database has a very simple structure and is implemented in Excel 5.0, a user-friendly spreadsheet software under Windows which is very flexible so that adjustments and extensions can be made very easy. Also graphs can be made within the database: the graphs in the report are directly from the database. The staff and experts involved in the project and at the REC will be provided with the database and trained to handle it.

Data formats

The designed database uses EU formats and definitions. Amounts of uranium are in PJ electricity production/0.375, the last being an average efficiency for fossil fuel combustion according to EU statistics. This coefficient does not apply for renewable energy (according to EU) and just the electricity production out of renewables is considered, in other words, an efficiency of 1 is used. However, biomass, biogas and wood are exceptions since they are combusted just as fossil fuels and therefore treated in the same way: input in TJ is given, not electricity and/or heat production.

The distinction between renewable wood and non-renewable wood is important but theoretic and therefore hard to assess. In Bulgaria, three categories of wood can be distinguished, viz. by source: energy suppliers/distributors, forest institutions, and 'uncontrolled', unregistered wood cutting of citizens (the forest institutions do not check on their permits). Wood from energy suppliers/distributors are included as renewable wood (chances are high that as many trees are planted as cut). For the

moment, wood from forest institutions are considered as non-renewable (chances are low that as many trees are planted as cut). Furthermore, the third category of national wood consumption will be estimated on the basis of heat demand and fuel consumption. This category will also be considered non-renewable.

Steam is included in Bulgarian final energy demand for industry, but will be given in fuel input needed for the steam generation. Fuels for non-energy use are known. Hot water and furnace heat are responsible for the rest of final fuel demand for industry.

Fuel consumption for transport is included in industrial and other final energy consumption in Bulgarian statistics. In order to be comparable with EU, it will be excluded from final energy consumption.

In general, the International Standard Industry Classification (ISIC) will be used for categorization of economic branches. The ISIC categorization is presented in Appendix B.

4. THE REGION OF HASKOVO

Haskovo region is located in the south-east part of Bulgaria. To the south, border countries are Turkey and Greece. It is one of nine Bulgarian regions, each with 800,000 to 1,200,000 inhabitants. Haskovo region has about 900,000 inhabitants. As a result of historical developments Haskovo is characterized by the presence of different ethnic groups.

The share of urban population is 59%, which is lower than the average for the country (67%). Nevertheless, Haskovo can not be called a rural region, since many municipalities have a strongly developed industrial sector. The region of Haskovo comprises 27 municipalities and covers a territory of 13,892 km^2. Haskovo is the regional centre and the second largest city with approximately 100 thousand inhabitants. It is located in the mid-west of Haskovo region. The largest city in the region and sixth city in the country is Stara Zagora, located in the north, with about 175 thousand people. Other major cities are Kazanlak (also north), Dimitrovgrad (in the mid-west part) and Kardgali (south-west).

Just as Bulgaria as a whole, the region was affected by the economic recession during the last years. The social conditions frustrated by the transition have led to low birth rates, rising death rates across all age groups, and considerable immigration and emigration. Did the population of Bulgaria decrease with 6% from 8.95 million in 1985 to 8.42 million people in 1993, Haskovo population decreased with 12% from 1.03 million people in 1985 to 0.90 million people in 1993. This is illustrated in figure 4.1. Although the decline in population differs from municipality to municipality, not one municipality has shown a growth. Populations of large cities such as Stara Zagora, Kazanlak, Dimitrovgrad, and Haskovo decreased only with a small share (Kardgali is an exception with a fall of 25%). Small municipalities such as Dgebel, Stambolovo, and Momtchilgrad faced large declines up to 50% of the population although many exceptions exist.

Both on a national level as on a regional level, the shares of different age categories changed. The share of people older than 60 years increased up to 24% nationally and 23% regionally and the share of people younger than 15 years decreased down to 18% on a national level and 22% on a regional level. The working age population share of total population remained more or less constant at 55-56% for the region and the country. So, Haskovo region is not a very exceptional region in that respect. Again, large differences exist on a municipality level. For instance, more than half of the population in Opan and Bratja Daskalovi is over sixty years. Also Topolovgrad, Ljubimetz and Galabovo have high shares of about 30% older people. Ardino, Dgebel, Kardgali, Kirkovo, Krumovgrad, Momtchilgrad, and Tchernootchene have large shares of almost 30% of people younger than 15 years.

Surprisingly, the share of the labour force in Haskovo decreased from over 50% of the population in 1985 to 26% of the population in 1993, while national labour force decreased from 50% of the population in 1985 to 45% of the population in 1993. Unemployment in Haskovo region was 12% in 1994, which was slightly lower than national unemployment. However, it should be noted that unemployment is expressed as a share of the labour force.

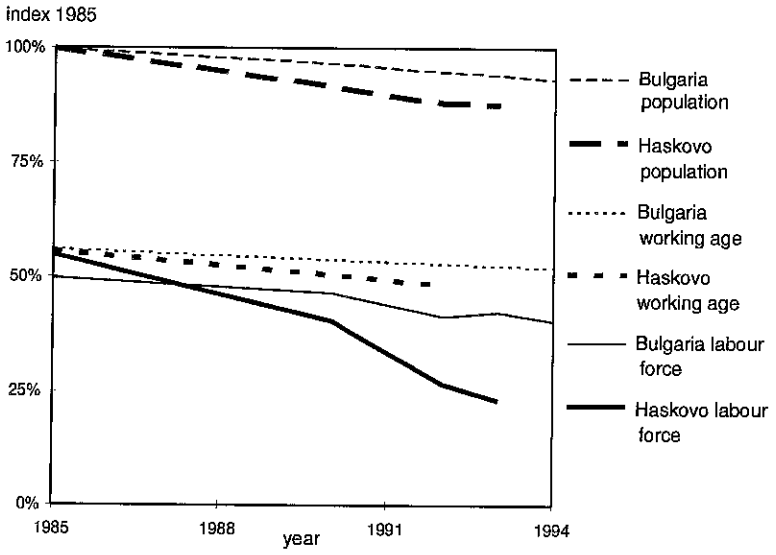


Figure 4.1 *Developments of total population, working age population and economic active population in Bulgaria and in Haskovo for the years 1985, 1990, 1992, 1993, 1994*

The production structure of the industry in the region of Haskovo is quite similar to the national industrial structure, which is shown in figure 4.2. One should have in mind that the structure of Haskovo is slightly distorted by the size of the production in the subsector 'others', which in fact in Haskovo statistics means that the production subsector is unknown. Textile and leather in Haskovo have high shares in industrial production compared with the country, and chemicals is relatively small.

The municipalities can be shortly characterized as follows:

- Southern municipalities with a prevailing economic activity in the fields of growing tobacco, wood processing, handicrafts (carpets) and mining [Dgebel, Ardino, Stambolovo, Madgarovo, Momtchilgrad, Tchernootchene, Kirkovo, Krumovgrad and Ivailovgrad].
- Central and northern municipalities which are characterized by agriculture, e.g. growing of cotton and rice, and some industry such as machine building, wood processing, food processing and other light industry in the municipality centres [Maglij, Bratja Daskalovi, Tchirpan, Opan, Simeonovgrad, Topolovgrad, Harmanli, Svilengrad and Ljubimetz].
- Recreation resort centres using geothermal springs [Pavel Banja and Mineralni Banji].
- Large municipalities with a well developed industrial sector [Stara Zagora, Haskovo, Kazanlak, Dimitrovgrad, Kardgali, Radnevo and Galabovo].

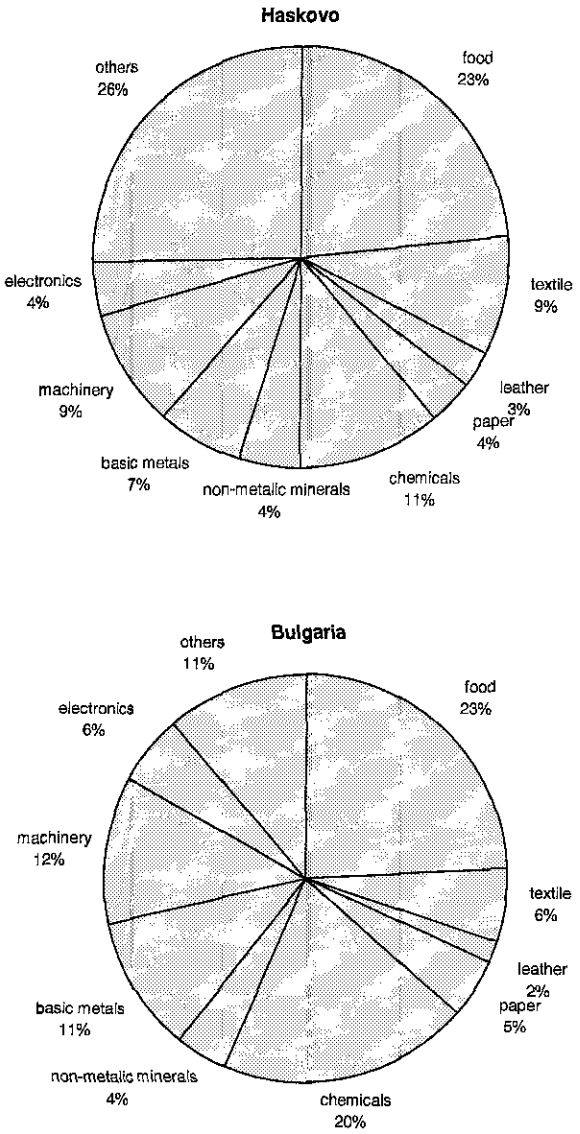


Figure 4.2 *Production structure of the manufacturing and construction sector of Haskovo region and of Bulgaria in the year 1993*

The latter, large municipalities cover about 62% of the regional population and produce 89% of regional industrial production. The large municipalities are producing mainly in the following branches:

- *Stara Zagora*
  machine building, electronics, food processing, grain processing, textile, beer production (Zagorka), chemicals (fertilizers by Agrobiochim);
- *Haskovo*
  tobacco processing, textile, beer (Astika) and wine production, machine building for the chemical industry, silk production;
- *Kazanlak*
  military plants, machine building, textile, light industry, rose oil production, food processing;
- *Dimitrovgrad*
  fertilizer production (Neochim), cement, machine building, food processing;

- *Kardgali*
  non-ferrous metal processing (lead zinc plant), machine building for the mining, chemical industry;
- *Radnevo*
  a balanced mix of all industrial branches and energy production;
- *Galabovo*
  machinery and energy production.

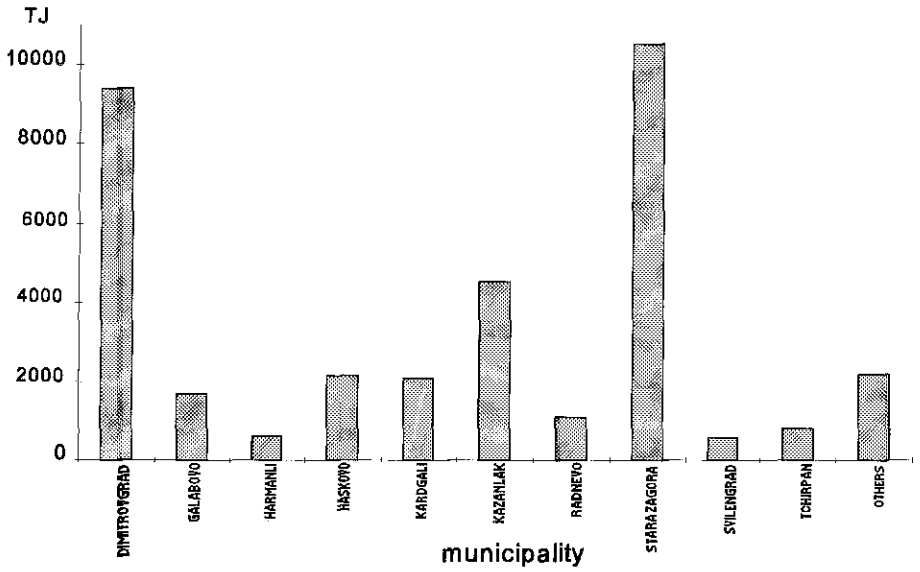


Figure 4.3 *Final energy consumption of municipalities with a relatively high energy consumption in the region of Haskovo in the year 1993*

The economic activities in the municipalities are, besides other issues such as population, reflected in the final energy demand of the municipalities, which is presented in figure 4.3. Only the municipalities with the highest energy consumption are explicitly mentioned, the others are included in the right bar labelled 'others'. Stara Zagora and Dimitrovgrad have the highest energy consumption, both around 10 PJ, totally about half the consumption of the total region. This can be explained for a large part by the presence of the large chemical plants in these cities. Furthermore, Kazanlak, Haskovo, Kardgali, Galabovo and Radnevo have a noticeable energy consumption. Consumption of the cities mentioned amounts to almost 90% of the regional final energy demand.

The final fuel mix in Haskovo is different from the national energy demand mix on two points. First, electricity consumption is relatively high due to considerable use of electricity for heating, in approximately one third of households. For Bulgaria as a whole, electricity is used for heating in less than 9% of the households. Instead, district heat has a high share in the national final fuel mix (about 17% of households is connected to a district heating system), while this is 1.7% in Haskovo (in Kazanlak). Haskovo gas consumption is limited to a few large industrial companies and power plants, but has a large share of about 40%, just as on the national level. Lignite consumption in the form of briquettes amounts to about 40% of energy demand of households which is similar to the country. Renewable energy is mainly used in the form of wood.

However, the fact that the economic structure and fuel mix of Haskovo are quite similar to those of Bulgaria is striking when considering the presence of a large energy producing industry in Haskovo region. One could expect a more energy intense industry because the largest energy complex of the country is located in Maritsa East, on the territory of Galabovo and Radnevo. There are three lignite mines (Troianovo 1-3), a briquette factory which produces briquettes for total Bulgaria from the lignite, and three thermal power plants which produce one third of national electricity, of course fired with lignite from the local mines. Unfortunately, the calorific value of the lignite is not high, while the sulphur and ash content is. This results in bad environmental consequences.

Besides Maritsa East, a smaller mining complex called Maritsa basin, sited at Dimitrovgrad, produces about 1 million ton of lignite annually. The production costs of these mines are higher, and the quality of the coal is lower than in Maritsa East. A Combined Heat and Power plant (CHP), Maritsa 3, is located close to the mines. Furthermore, Agrobiochim, a large chemical fertilizer plant in Stara Zagora is using the coal in an industrial CHP plant.

There is only one district heating plant in the region, located in Kazanlak, which is heavy oil fired and providing heat to households (1.7% of the households in the region), public buildings and industry and delivers electricity to the public network.

5. NATIONAL AND REGIONAL ENERGY DEMAND

5.1 Introduction

A brief introduction to the Bulgarian national energy system and energy policies is considered necessary for two main reasons. First, national policies set the framework and conditions for regional policies, instruments and implementation of options. Second, since the national energy system is documented and researched very well, national average indicators of energy consumption, performances of technology, economic production standards etc. can function as a benchmark for characterization of regional and municipal energy related activities.

From 1989, the economic development of Bulgaria was marked by crisis processes, changes of macroeconomic structure and developments towards a market oriented economy. An overall impression of the Bulgarian economic development during this period is given by the development of Gross Domestic Product (GDP) in figure 5.1.

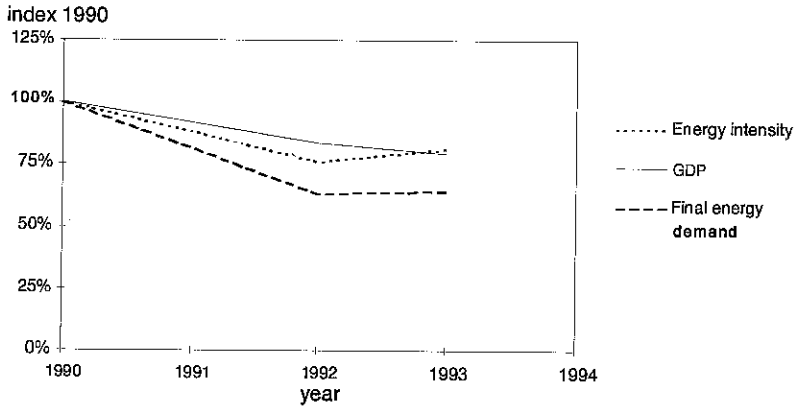


Figure 5.1 *Development of GDP corrected for inflation, in relation to final energy demand and overall energy intensity, all indexed to 1990 values, Bulgaria*

The Bulgarian GDP drop amounts to 21% from 1990 to 1993. Industry suffered the largest decrease in production which resulted in a decrease of the GDP share of the industrial sector from 59% in 1989 to 49% in 1993. Final energy demand declined faster than GDP as a result of structural changes and energy savings in the economy, resulting in a declining energy intensity. Final energy demand in 1993 is about 64 percent of that in 1990. However, in the year 1993 energy intensity has risen, probably as a result of stagnating structural changes and increasing inefficiencies due to low utility rates of equipment. The economic situation in the Haskovo region seems also to be problematic, as can be seen in figure 5.2, wherein the development of the industrial economic output of the Haskovo region is given. Because of a lack of economic output data of other sectors, it is not possible to present figures of the development of GDP for the Haskovo region.

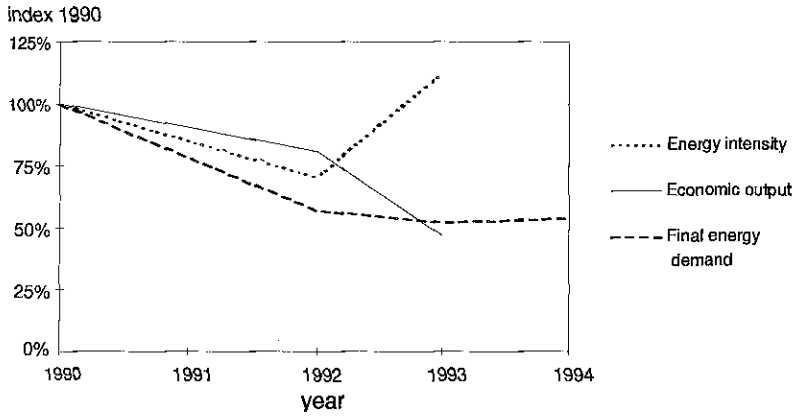


Figure 5.2 *Development of economic output corrected for inflation, in relation to final energy demand and energy intensity, all for the manufacturing & construction sector, indexed to 1990 values, Haskovo region*

The decrease of industrial economic output in the Haskovo region amounts to 53% from 1990 to 1993. The development of the energy intensity is quite dramatically affected by the drop of industrial economic output in the year 1993. This is due to energy intense production growth of the chemical industry and relative growth of basic metals. Industrial final energy demand declined to 54% of the 1990 level, comparable with the decline of the industrial final energy demand for Bulgaria (i.e. 56% of 1990 level).

For the Haskovo region energy demand data is available for the period 1990-1994. Unfortunately, sectoral energy demand data is quite difficult to compare with national sectoral energy demand data. The allocation of regional energy demand data to the different sectors is not consistent. Electricity demand can be distinguished for three different sectors: manufacturing and construction, public services and the residential sector. Electricity demand of agricultural and commercial enterprises are included in public services. For regional fuel demand, the existing allocation is dissimilar: fuel demand of public, large and small consumers is distinguished. Agriculture and commercial demand is then largy accounted for in the category small consumers, i.e. residential. As a result of this, regional energy demand of agriculture and the commercial sector are not available.

Here it is mentioned that the following figures of regional energy demand do not include energy demand for transport activities. Regional transport activities are more connected to national than to regional developments and therefore not included in the assessment of regional energy demand. Furthermore, transport on national level is not included in the different sectors but separately accounted for in the sector transport (EU method), which makes comparison with the regional data easier.

It is clear that the economic stagnation of the last years has strongly affected the structure of energy demand. National sectoral final energy demand developments are presented in figure 5.3. Final energy demand fell down to 469 PJ in the year 1993, i.e 64% of the 1990 level. In the year 1993 industrial energy demand accounts for 198 PJ, i.e. 56% of the 1990 level. The share of industry in final energy demand has dropped from 48% in 1990 to 42% in 1993. Also public services and agricultural energy demand has decreased enormously. Besides other reasons such as energy price increases, a major reason for these declines is the fall in production or activity. In

contrast, energy demand of residential and commercial sector decreased not as much as the energy demand of the other sectors. Services in households such as heating and lighting are needed in any case, and not directly dependent on economic growth or stagnation.

The development of regional final energy demand by sector is presented in figure 5.4. Regional final energy demand fell down to 36 PJ in the year 1993, i.e 60% of the 1990 level. In the year 1993 industrial energy demand accounts for 24 PJ, i.e. 54% of the 1990 level. The share of industry in final energy demand has dropped from 77% in 1990 to 68% in 1993. These figures are comparable with national energy demand developments, if a correction is made for non-energy use and conversion losses for steam generation.

The same holds for the specific energy consumption per capita, based on final energy demand (transport demand excluded). The specific energy consumption per capita for Haskovo and for Bulgaria comes to about 40 GJ/capita in the year 1993. However, for Bulgaria the decline of energy demand of public services was 20% larger than the decline of public energy demand in the Haskovo region. Also the development of the regional energy demand for the residential sector differs from the national development: during the period 1992-1993 the regional energy demand increases up to 110% of the 1992 level, in contrast with the Bulgarian residential energy demand, which decreases down to 97% of the 1992 level.

In the following sections, a description of sectoral energy demands is given.

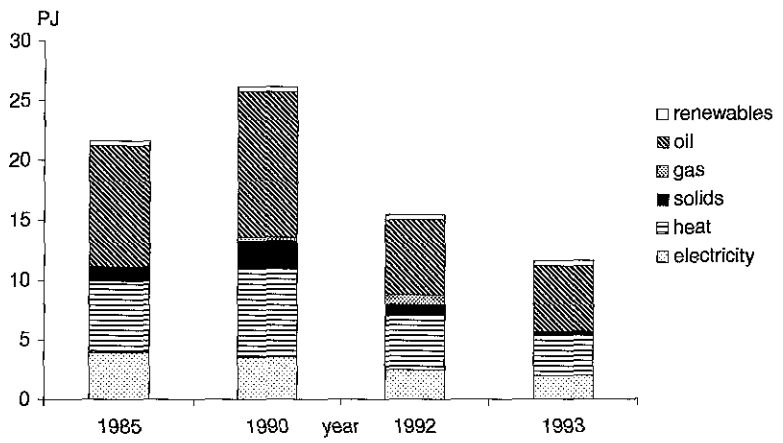


Figure 5.3 *Development of final energy demand by sector, Bulgaria*

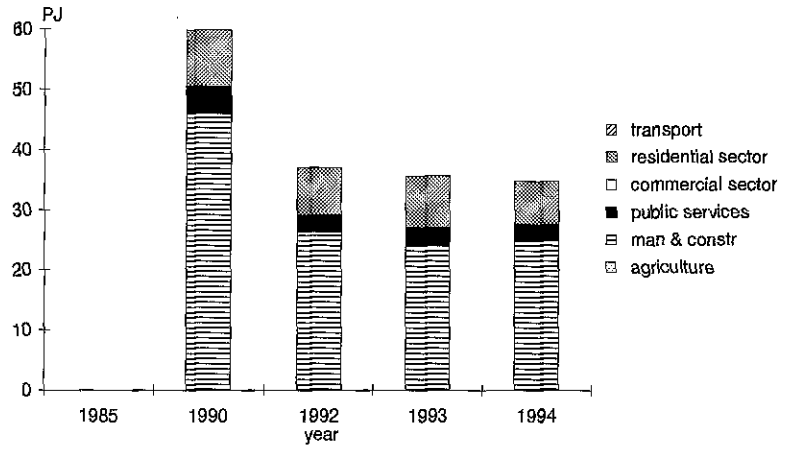


Figure 5.4 *Development of final energy demand by sector, Haskovo region*

5.2 Agriculture

As has been mentioned before, energy data for the agriculture in Haskovo are not present explicitly, but are included mainly in residential. To give an impression of energy consumption in agriculture, the national situation is discussed.

After an increase of final energy demand in the period 1885-1990, the agricultural final energy demand for Bulgaria declined to 12 PJ in the year 1993 (figure 5.5), i.e. 54 percent of the 1985 level. Dividing agricultural activities in the subsectors growing of crops, farming of cattle and combined farming, the energy demand of the subsector growing of crops increased up to a share of 98 percent of agricultural final energy demand (figure 5.6). Combined farming is not cultivated in Bulgaria.

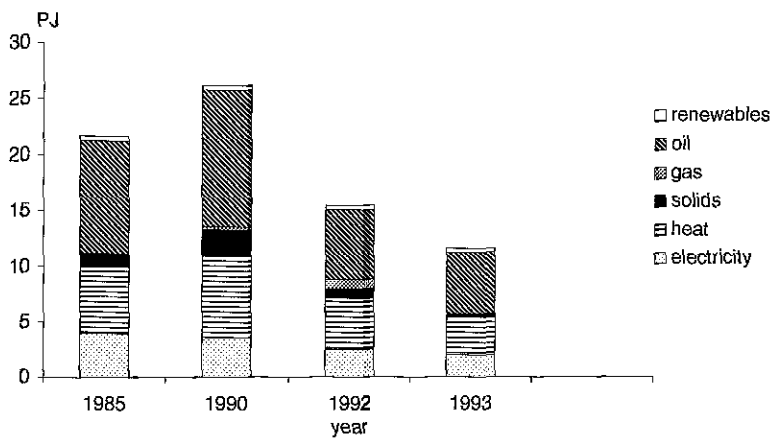


Figure 5.5 *Development of final energy demand of agriculture by fuel, Bulgaria*

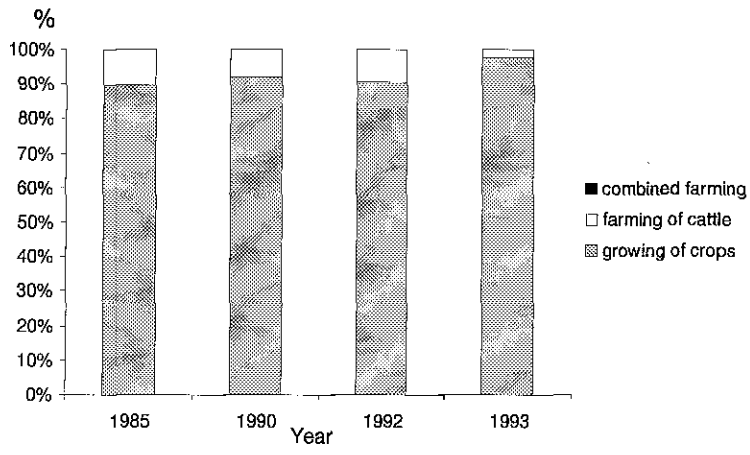


Figure 5.6 *Development final energy demand of agriculture by subsector, Bulgaria*

The share of oil is quite large, especially when taking into account that the fuel demand for transport (10 PJ, tractor on gasoil) is excluded from these figures. Heavy oil contributes to about 50 percent of final energy demand, mainly used for heating of greenhouses.

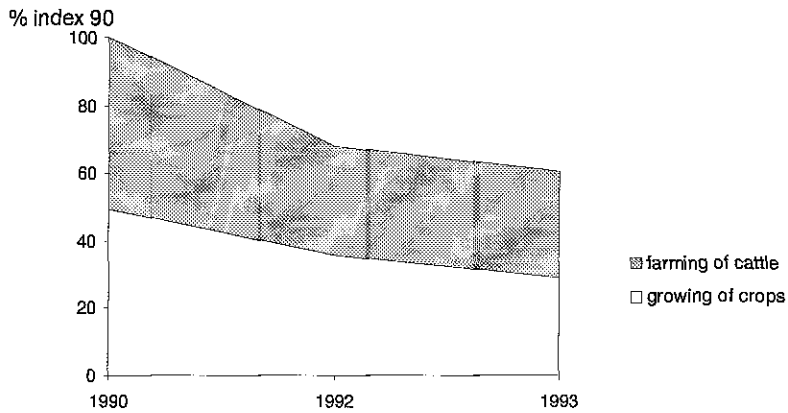


Figure 5.7 *Development gross domestic product agriculture, Bulgaria*

The gross domestic product declined from 13.0 billion Leva-1990 in 1990 to 7.9 billion Leva-1990 in 1993 (figure 5.7). The contribution of the subsectors growing of crops and farming of cattle to the gross domestic product of agriculture remained at a constant level of about 50 percent.

Figures of for example gross domestic product and yields per square metre are indispensable to analyse the agricultural final energy demand in more detail. Moreover, the analysis results in the determination of agricultural energy consumption indicators, which are to be used for the regional assessment of the agricultural energy demand. Because of the lack of appropriate data, a detailed analysis of the final energy demand of the agricultural sector can not be carried out yet.

5.3 Manufacturing & construction

The sector manufacturing and construction (industry) accounted for 65 percent of overall decrease of final energy demand in Bulgaria over the period 1985-1993. Total industrial final energy demand fell down to 56 percent of the 1990 level. The fuel mix remained quite constant over the period 1985-1993, as can be seen in figure 5.8. Apparently, the economic crisis in industry initially resulted in a decrease of the share of the demand for solids and natural gas.

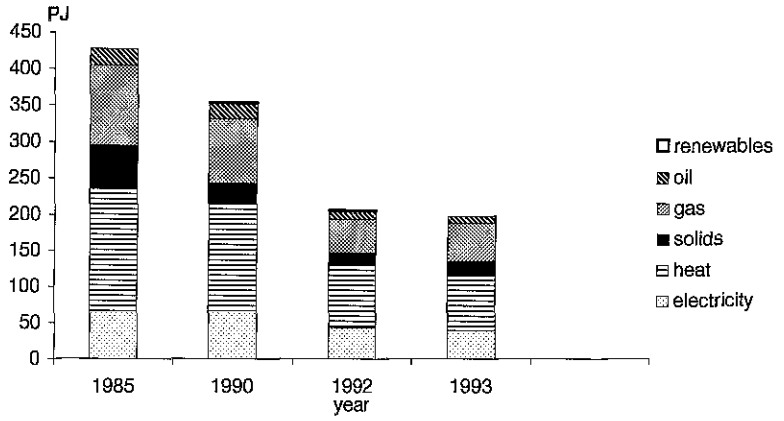


Figure 5.8. *Development of final energy demand of manufacturing & construction by fuel, Bulgaria (fuel demand for non-energy products and corrected fuel demand for steam production not included)*

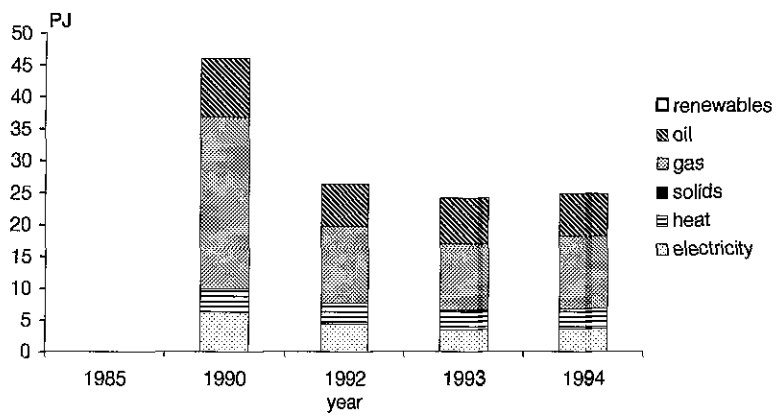


Figure 5.9 *Development of final energy demand of manufacturing & construction by fuel, Haskovo region (fuel demand for non-energy products and corrected fuel demand for steam production included)*

The share of natural gas in final energy demand is relatively large, i.e. 26 percent in the year 1993. Actually, gas demand in industry is even higher due to the gas consumption of industrial CHP-plants which are used for steam production. As already mentioned before, the Bulgarian fuel consumption for industrial steam production is assigned to the energy supply table. A similar definition is applicable for the energy consumption of non-energy products, which is also not assigned to the national final energy demand table. However, within the region of Haskovo, only total fuel consumption data for the industry is available. After correction, the gas share in national industrial final energy demand would be 40%. The amount of solids used in the industrial

sector is quite low. Solid fuels are mainly used for iron and steel production (cokes) in the subsector Basic metals.

In figure 5.9 the development of the industrial final energy demand by fuel is presented for the region of Haskovo. In the year 1993 industrial energy demand accounts for 24 PJ, i.e. 54% of the 1990 level. The share of natural gas in final energy demand in the year 1993 (i.e. 50%) is higher than the gas share for Bulgarian industry (i.e. 40%, fuel demand for non-energy products and corrected fuel demand for steam or heat production included). The share of oil consumption for the Haskovo region is similar to the national share, viz. 29% of industrial energy consumption. The demand for heat in the region of Haskovo is 12%, quite small compared to the industrial heat demand in Bulgaria (i.e. 29%, fuel demand for non-energy products and corrected fuel demand for steam or heat production included).

For the regional energy assessment, applicable national energy consumption indicators have to be determined. Therefore, national energy consumption indicators should be based on fuel demand data wherein the demand for steam and non-energy products are included. This is carried out for the comparison of subsectoral energy demand data of the Bulgarian and regional industrial sector Subsectoral energy demand data is not available for the region of Haskovo, but economic output data is. Therefore, sub- ctoral economic output data is combined with national subsectoral energy intensities in order to estimate the subsectoral final energy demand for the industrial sector of the region of Haskovo.

The subsector Food contributes to the largest extend to the industrial economic output of Bulgaria and the Haskovo region (figure 5.10). The economic output of the subsector Others is relatively high in the Haskovo region, which can be ascribed to a lack of data. In general it can be stated that the structure of subsectoral economic output of the industrial sector in the Haskovo region is quite comparable with the related Bulgarian structure.

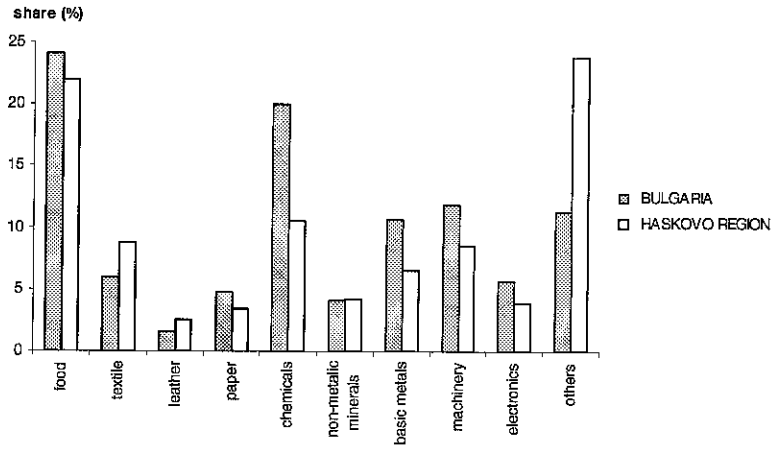


Figure 5.10 *Subsectoral economic output of manufacturing & construction by subsector, as a share of the total economic output of manufacturing & construction for Bulgaria and Haskovo region, year 1993*

In figure 5.11 national subsectoral energy intensities of the industrial sector are presented. The non-energy consumption of the subsector Chemicals (24 PJ natural gas, 30 PJ oil products) is included in this figure. The fuel demand for steam production is calculated by using an overall energy conversion efficiency of 80 percent. The economic output of the subsector Non-metallic minerals is quite low, resulting in a high energy intensity of the production of non-metallic mineral products. The average energy intensity of the industrial sector comes to about 1.2 MJ/Leva-1993.

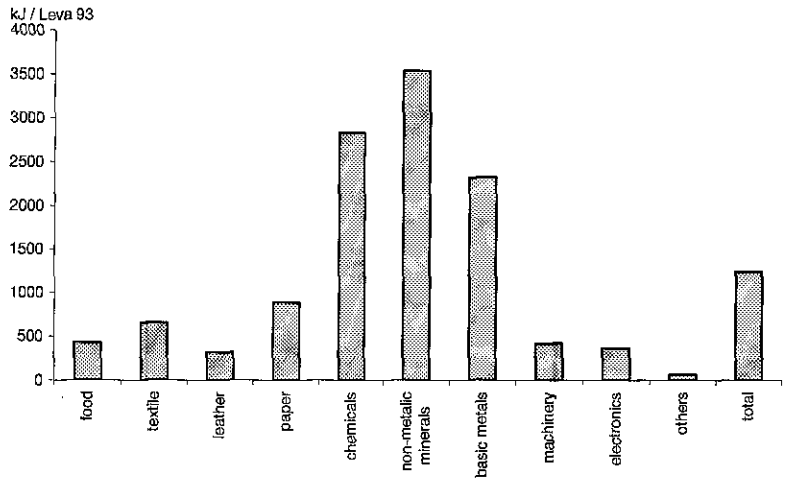


Figure 5.11 *Energy intensity of manufacturing & construction by subsector, year 1993, Bulgaria*

In figure 5.12 the estimated subsectoral final energy demand for the industrial sector of the region of Haskovo are presented, based on the subsectoral economic output data as given in figure 5.10 and the national subsectoral energy intensities as given in figure 5.11. For Bulgaria, the subsectors Chemicals and Basic metals (e.g. iron&steel) account for about 66 percent of national industrial energy demand. The energy consumption in the subsectors Non-metallic minerals (e.g. cement) and Food is also quite substantial (20 percent).

The estimated regional energy demand is lower than the actual regional energy demand (i.e. 10 percent). This is illustrated by figure 5.13, wherein the actual and estimated energy intensity of the industrial sector of the Haskovo region are given, together with the actual energy intensity of the Bulgarian industry. The actual overall energy intensity of Haskovo industry is based on collected data on economic output and final energy demand. The difference between the actual and estimated energy intensity of Haskovo industry is mainly a result of the relatively high regional economic output of the subsector 'Others' and the corresponding low national energy intensity of this subsector. The estimated overall energy intensity is quite sensitive for the assumed energy intensity of 'Others' due to the high economic output share of 'Others' in the region.

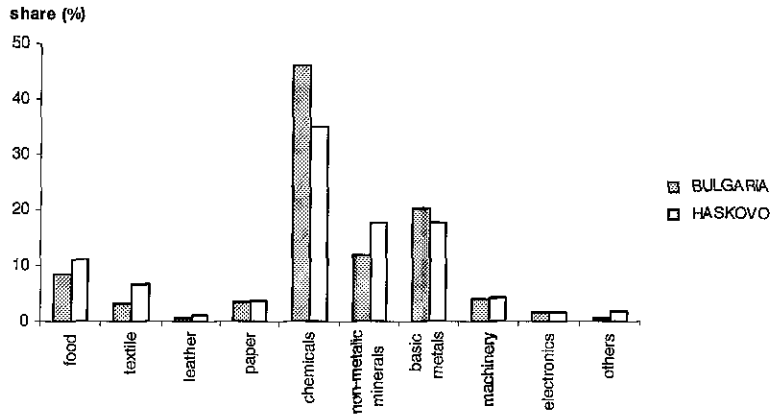


Figure 5.12 *Actual final energy demand of manufacturing & construction by subsector for Bulgaria, and estimated final energy demand for the Haskovo region, year 1993*

The actual energy intensity of the industrial sector in the Haskovo region comes to about 1.0 MJ/Leva-1993, i.e. 20% lower than the energy intensity of the Bulgarian industry. Since this difference can be explained by differences in industry structure, it is concluded that Haskovo average energy efficiency of production is comparable with the national average values, while a less energy intense industrial structure leads to a lower average energy intensity of industry in Haskovo than in the country as a whole.

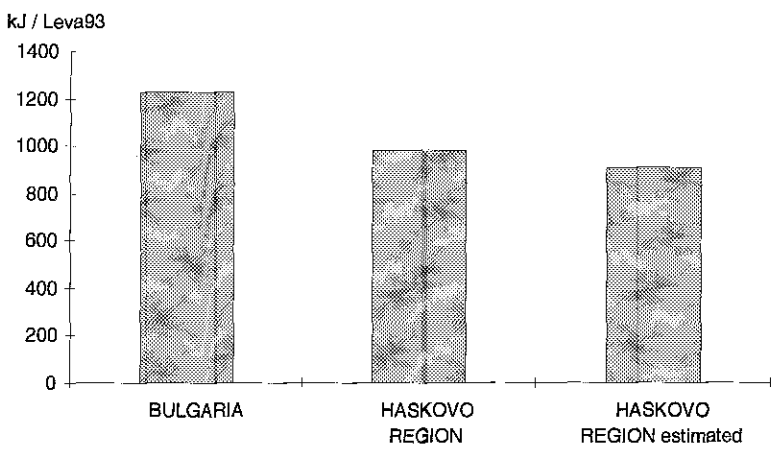


Figure 5.13 *Actual energy intensity manufacturing & construction for Bulgaria and Haskovo region, and estimated energy intensity manufacturing & construction for Haskovo region, year 1993*

5.4 Public services and commercial sector

In the following figures the development of final energy demand for public services and the commercial sector is presented. Final energy demand figures for energy services (i.e. cooking heating, hot water, lighting and specific electricity) are based on expert estimation (Energoproekt, NEC).

The economic crisis is dramatically reflected by the decline of final energy demand in public services over the period 1985-1993. In the year 1993 the final energy demand accounted for only 53% of the 1990 level (36% of the 1985 level), as illustrated by figure 5.14. The decrease is mainly represented by a diminishing demand for naphtha, used for heating purposes. This trend also occurred in the residential sector, simply because of a considerable growth of naphtha prices. Furthermore, in public services district heating decreased down to 36 percent of the 1990 level.

In the year 1993 the regional energy demand of public services accounted for 65% of the 1990 level (figure 5.15). As a matter of fact, in the year 1993 the regional energy demand of public services per capita accounted for 3.2 GJ/cap, about 45% higher than the related national level (2.2 GJ/cap). Comparing the national and regional energy demand figures, it can be stated that the high share of electricity demand (78%) is a result of a low contribution of district heating in the Haskovo region.

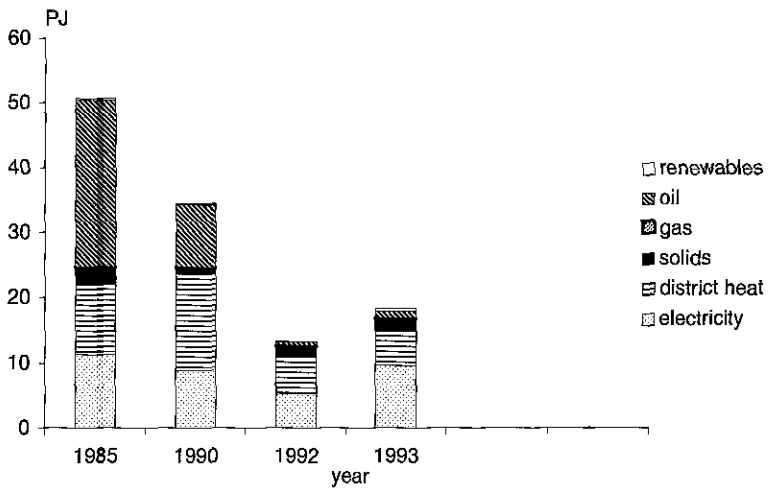


Figure 5.14 *Development of final energy demand of public services by fuel, Bulgaria*

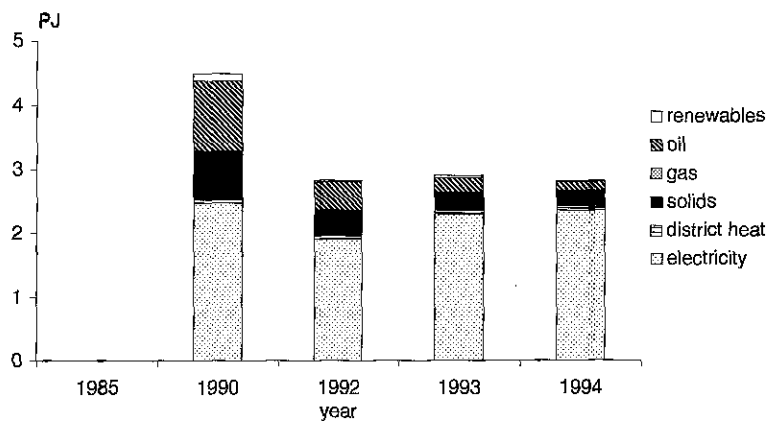


Figure 5.15 *Development of final energy demand of public services by fuel, Haskovo region*

Final energy demand of the commercial sector is quite small in Bulgaria. The decline of final energy demand in the commercial sector is only 19 percent of the 1990 level (figure 5.17). Remarkably, the demand for naphtha, used for heating and hot water, did not diminish over the considered period, as it is the case for natural gas, which is also used for both purposes.

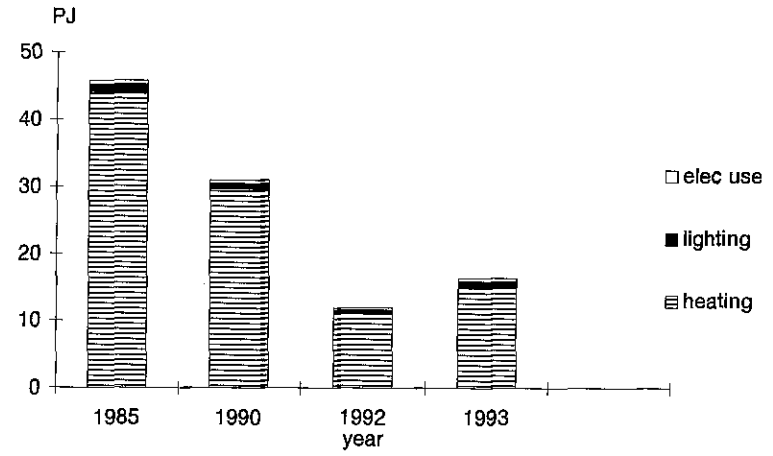


Figure 5.16 *Development of final energy demand of public services by energy service, Bulgaria*

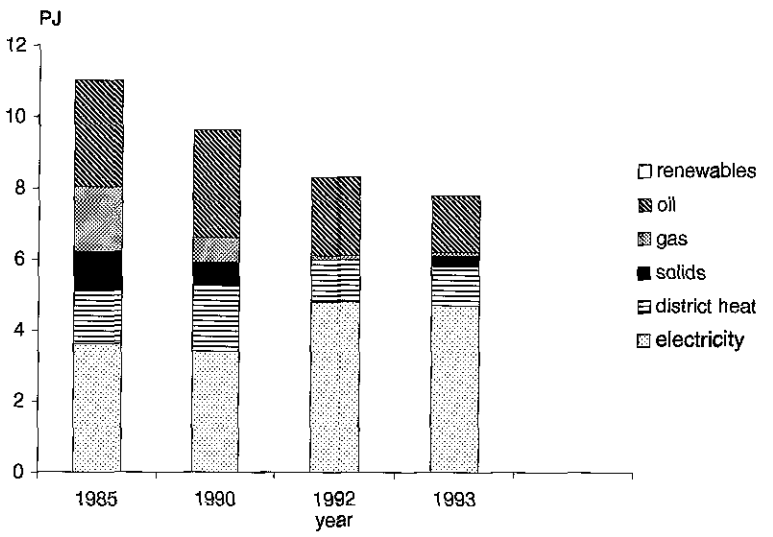


Figure 5.17 *Development of final energy demand of commercial sector by fuel, Bulgaria*

Despite of the declining final energy demand, electricity demand remained at a constant level in public services in Bulgaria and increased slightly in the commercial sector. As a result of this, the share of electricity in final energy demand increased considerably: in public services from 22 percent in 1985 to 52 percent in 1993, in the commercial sector from 33 percent in 1985 to 60 percent in 1993. This is reflected by the growth of the share of electricity for heating purposes: in public services from 18 percent in 1985 to 47 percent in 1993, in the commercial sector from 16 percent in 1985 to 36 percent in 1993. Electrical heating became, compared to other fuels, economically more attractive over the period considered. The demand for electricity is relatively little affected by the economic crisis. Applying the expert estimates of final energy demand figures for energy services on the regional energy demand data, the share of electricity demand for heating purposes in the Haskovo region comes to about 77% in the year 1993.

As already mentioned in section 5.1, regional energy demand data of the commercial sector is not available. Moreover, because of the lack of appropriate data, an analysis of the final energy demand of the public services and commercial sector by using energy consumption indicators (per employee, per m^2) can not be carried out yet.

5.5 Residential sector

Final energy demand of residential sector in Bulgaria accounted for 83% in the year 1993, compared to the 1990 level (84% of the 1985 level). Looking at figure 5.18, the decline can be ascribed to a decrease of the demand for heating (25 percent compared to the 1990 level), reflected by an almost completely diminishing demand for naphtha (93 percent decline), slightly replaced by a surprisingly considerable growth of demand for district heating (68 percent increase).

In figure 5.19 the development of final energy demand of the residential sector in Haskovo is presented. Final energy demand decreased down to 91% in the year 1993, compared to the 1990 level. The regional development of demand for electricity and naphtha is quite similar to the national outline. The share of district heating in the Haskovo region is low compared to the national level (i.e. 4% vs. 25%) and is partly replaced by electricity (43% vs. 34%). The demand for solids was quite unstable and increased up to a share of 41% in 1993, comparable with the national share (38% in 1993). The share of the demand for wood (i.e. officially registered) remained quite constant (about 10% of final energy demand). The specific energy consumption of wood per capita comes to 0.94 GJ/capita for Haskovo, which is about 13% higher than the specific wood consumption for Bulgaria (0.83 GJ/capita). This seems logical, considering the on average somewhat higher degree of urbanisation of the country as a whole.

The specific energy consumption based on the final energy demand of the residential sector in Haskovo is about 25% lower than the Bulgarian consumption (i.e. 9.5 GJ/capita or 24.4 GJ/dwelling vs. 12.5 GJ/capita or 30.8 GJ/dwelling).

The share of electricity for heating purposes did only increase little (to 8.6% in 1993), in contrast with the related demand in public services and the commercial sector. The demand for other services remained quite constant: cooking decreased to 86 percent of the 1985 level, hot water increased to 112 percent of the 1985 level (figure 5.20). In Bulgaria the demand for natural gas of the residential sector is negligible.

For the region of Haskovo data on the current state of dwellings, such as type of construction, floor space of dwellings and also number of inhabitants per dwelling and climate conditions are available in order to analyse the final energy demand in the residential sector. Regional energy consumption indicators can be compared with national energy consumption indicators. Here an example of the analysis is presented, namely a comparison of the specific energy consumption per service per dwelling, district heating included and district heating excluded.

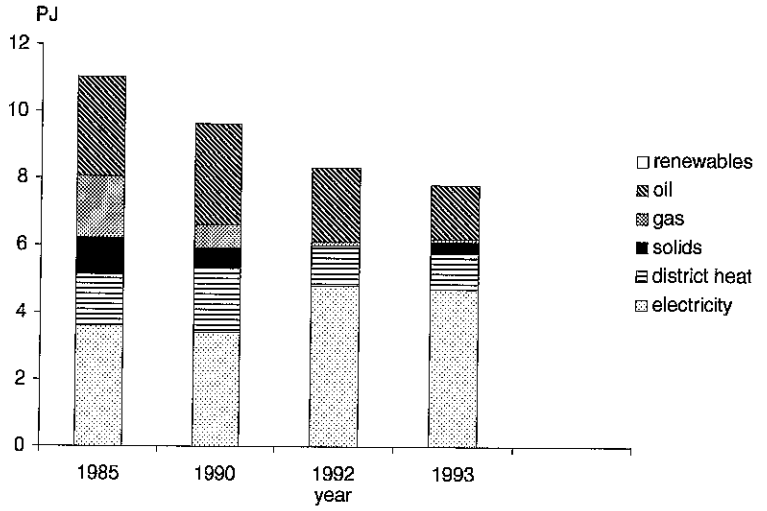


Figure 5.18 *Development of final energy demand of residential sector by fuel, Bulgaria*

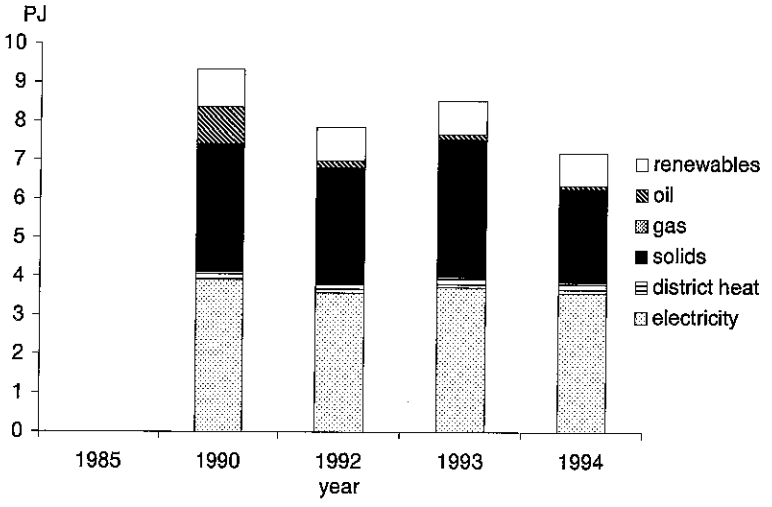


Figure 5.19 *Development of final energy demand of residential sector by fuel, Haskovo region*

As for public services and the commercial sector, the residential final energy demand figures for energy services are based on expert estimation. This firstly has been carried out for national energy demand data. The out coming energy demand shares of the distinguished energy services are applied on regional energy demand data. The resulting figures of regional energy services must be seen as guestimates, but are useful for providing more insight in the regional energy demand profile of the residential sector. Table 5.1 and 5.2 give an overview of the specific energy consumption of dwellings in Bulgaria and Haskovo, distinguished by energy service. The total specific The total specific energy consumption data located in the grey areas are based on national and regional energy demand statistics. energy consumption data located in the grey areas are based on national and regional energy demand statistics.

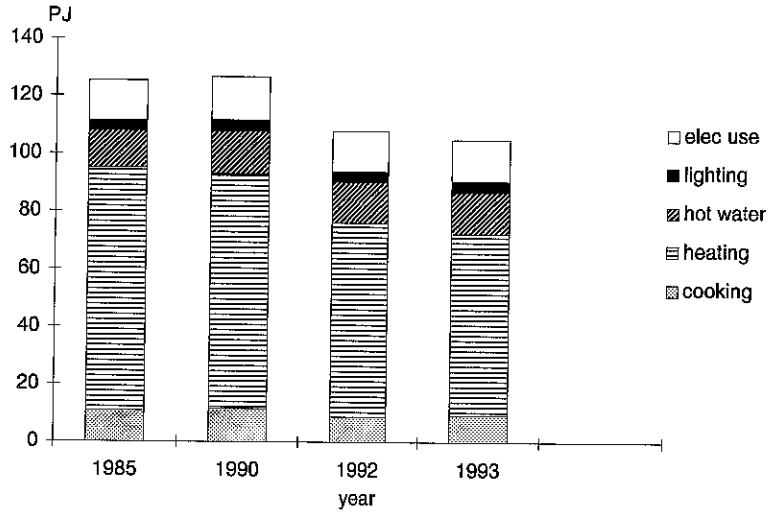


Figure 5.20 *Development of final energy demand of residential sector by energy service, Bulgaria*

In Bulgaria about 17 percent of the dwellings (i.e. 580556) are connected to a district heating network. Knowing this figure, the specific energy consumption for dwellings which are not connected to a district heating network can be calculated. The shares of energy services are determined under the assumption that in district heated dwellings fuels are only used for cooking. For Haskovo the amount of district heated dwellings accounts for 1.7%.

Looking at the figures of the total specific energy consumption, it can be seen that in Bulgaria the total specific energy consumption of district heated dwellings is 2.1 times higher than the total specific energy consumption for non-district heated dwellings. It is noticed that energy losses of the district heating network are not included in the energy demand figures. The large difference in specific energy consumption for heating for district heated dwellings and non-district heated dwellings is probably mainly a result of a high level of heating demand for district heated dwellings and a low level of heating demand for non-district heated dwellings, due to the fixed heat tariff structure for district heat and variable price structure of the latter, which induces demand responses.

Table 5.1 *Specific energy consumption of average non-district heated dwelling and district heated dwelling residential sector, year 1993, Bulgaria*

Energy consumption [GJ/dwelling]	Cooking	Heating	Hot water	Lighting	Electric use	*Total*
Dwelling without district heating (83%)						
Fuels	1.4	12.8	0.4			*14.6*
Public district heat						
Public electricity	1.3	1.9	2.8	1.1	4.2	*11.4*
Total	2.7	14.7	3.2	1.1	4.2	*26.0*
District heated dwelling (17%)						
Fuels	1.4					*1.4*
Public district heat		36.9	9.2			*46.1*
Public electricity	1.3			1.1	4.2	*6.7*
Total	2.7	36.9	9.2	1.1	4.2	*54.2*

Table 5.2 *Specific energy consumption of average non-district heated dwelling and district heated dwelling residential sector, year 1993, Haskovo region*

Energy consumption [GJ/dwelling]	Cooking	Heating	Hot water	Lighting	Electric use	*Total*
Dwelling without district heating (98.3%)						
Fuels	1.4	9.5	2.2			*13.0*
Public district heat						
Public electricity	0.7	4.7	1.1	0.8	3.4	*10.6*
Total	2.1	14.2	3.3	0.8	3.4	*23.7*
District heated dwelling (1.7%)						
Fuels	1.4					*1.4*
Public district heat		49.0	11.3			*60.3*
Public electricity	0.7			0.8	3.4	*4.9*
Total	2.1	49.0	11.3	0.8	3.4	*66.6*

Furthermore, the specific energy consumption of non-district heated dwellings in Haskovo is about 10% lower than the national figure. A large difference can be seen in the demand for electricity used for heating purposes, as a share of the total demand for heating of non-district heated dwellings in Haskovo (33%) and Bulgaria (13%).This in itself could explain the 10% lower specific energy consumption in Haskovo, since conversion losses of non-electrical heating are higher in the dwelling. Also, the number of degree days in Haskovo region is about 10% lower than on average in the

country. On the other hand, the share of primitive and brick houses is about 10% higher than in the country.

Furthermore, the specific energy consumption of district heated dwellings is in Haskovo 23% higher than the national specific energy consumption of district heated dwellings.

5.6 Transport sector

Statistics on transport demand are quite difficult to assess. Especially in Central and Eastern European countries, transport demand databases are not yet very elaborated. Amounts of vehicles and fuel demand are well known, but end-use figures on vehicle kilometres or passenger kilometres are lacking. Transport activities are ascribed to the specific sector. Therefore, fuel demand for transport purposes is often hidden in sectoral energy demand tables. This is also the case for Bulgaria, where the energy demand of the transport sector only consists of fuel demand of transport companies for freight transport by truck (mainly diesel) and demand for freight and passenger transport by airplane (kerosene). Consequently, final energy demand for other transport activities must be subtracted from the considered sectors by ascribing demand for gasoline, diesel and kerosene to the transport sector. In figure 5.21 and figure 5.22 the development of final energy demand is presented. In these figures the demand for energy services for public transport buildings and the electricity demand for trains, trams etc. are not included.

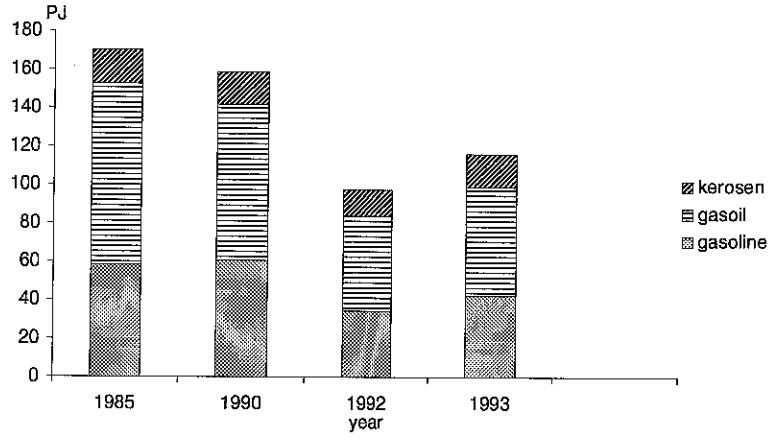


Figure 5.21 *Development of final energy demand of transport sector by fuel, Bulgaria*

Final energy demand of the transport sector declined to 69 percent of the 1985 level. The share of demand for diesel is quite large, i.e. 49 percent in the year 1993, especially when taking into account that in Bulgaria only an insignificant amount of the vehicle stock for passenger cars are equipped with a diesel-engine. The large share of diesel is partly a result of ascribing too much diesel which is used in households to transport activities (about 15 PJ).

In Bulgarian energy demand statistics, the demand for gasoline for passenger cars is assigned to the residential sector. Figure 5.22 shows that the share of residential demand for transport activities is growing considerably (about 90 percent), a result of

an equivalent growth of demand for gasoline and demand for diesel, of which the latter should not be assigned to transport activities. Furthermore, the demand for transport activities assigned to public services decreased (about 80 percent), partly reflected by a decline of the stock of busses for public transport (down to 42 percent of the 1985 level). The energy demand of transport companies, incorporated in the transport sector, fell down to 62 percent of the 1985 level, completely a result of a declining demand for diesel.

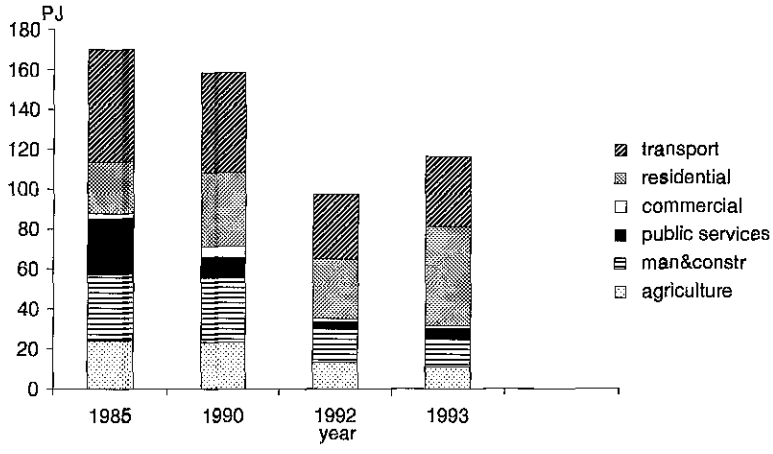


Figure 5.22 *Development of final energy demand of transport sector by sector, Bulgaria*

Commonly used indicators for the analysis of the transport sector are for example annual mileage (vehicle kilometre per year or per capita), amount of passenger cars per capita (cars/capita), annual demand (passenger or tonnes kilometres per year) or gross domestic product per truck (GDP/truck). For Bulgaria, the amount of passenger cars per capita accounts for about 15 percent, which is more or less equivalent with Poland (14 percent), evidently lower than the Czech Republic (23 percent) and substantial lower than Denmark (31 percent). The annual mileage of passenger cars comes to about 1750 kilometres per year (Denmark 5100 km/capita). Obviously, in the coming years transport demand by passenger car will grow in Bulgaria, as it is the case for other CEEC-countries, where the ratio between amount of cars and GDP is expected to decline.

Regional transport activities are more connected to national than to regional developments. Therefore, the transport sector is excluded from the assessment of regional energy demand.

5.7 Large energy consumers in Haskovo

The large energy consumers in manufacturing and construction, being point sources, are very important for understanding the regional energy consumption pattern. Energy demand data have been collected from the regional electricity offices of NEC, the refinery of Burgas and the regional office of Bulgargas in Stara Zagora.

Table 5.3 *Overview of large energy consumers in the region of Haskovo and their electricity and fuel consumption for the years 1990 and 1994, including mining but excluding electricity generation*

Municipality/subsector	Company	Consumption [TJ]				Fuel type
		Electricity		Fuel		
		1990	1994	1990	1994	
Ardino						
Basic metals & metal products	Gorubso	40	25			
Dimitrovgrad						
Lignite mining	Marbas	133	101			
Chemicals & plastics	Neochim	1072	512	18324	15977	gas '95
Non-metallic mineral products	Vulkan	196	123	2784	2072	gas '95
Textile and ready made clothing	Trikon	60	11			
Galabovo						
Lignite mining	Troianovo 3	814	798			
Briquettes production	Briquette ent.	256	241			
Harmanli						
Textile and ready made clothing	Hatex	13	7			
Non-metallic mineral products	Keramika	21	14			
Haskovo						
Food, beverages & tobacco	Haskovo- BT	30	25			
Food, beverages & tobacco	Astika	25	27			
Food, beverages & tobacco	Mesokombinat	18	6			
Textile and ready made clothing	Manuela	67	42	574	457	oil
Basic metals & metal products	Trakia- RM	63	3	224	167	oil
Machinery and equipment	ZMM	4	2			
Machinery and equipment	Chimmash	30	10	365	165	gas/oil
Machinery and equipment	Mlada gvardia	12	4	218	155	oil
Kardgali						
Food, beverages & tobacco	Bulgartabac	7	9	68	48	oil
Food, beverages & tobacco	Monijak	0	1	30	18	oil
Textile and ready made clothing	Orfei	18	9			
Non-metallic mineral products	Bentonit	26	11	97	107	oil
Basic metals & metal products	Gorubso	60	37			
Basic metals & metal products	OTZK	455	449	281	252	oil
Machinery and equipment	Cap. P.Voivoda	6	2	170	70	oil
Machinery and equipment	Pnevmatika	20	7			
Machinery and equipment	Monek-jug	16	7			
Machinery and equipment	Arda instrument	17	7			
Machinery and equipment	Formoplast	20	8			
Kazanlak						
Food, beverages & tobacco	Hleb	13	7			
Textile and ready made clothing	Katex	64	51			
Textile and ready made clothing	Runo	14	3			
Textile and ready made clothing	Filtex	7	7			
Textile and ready made clothing	Bulgaria -K			130	131	oil
Wood, paper & pulp	Gabrovnitza	9	4			
Chemicals & plastics	Bulgarian rose	6	4	51	56	oil
Machinery and equipment	Kaproni	58	18	43	27	oil

Table 5.3 *(continuation)*

Municipality/Subsector	Company	Consumption [TJ]				Fuel type
		Electricity		Fuel		
		1990	1994	1990	1994	
Madgarovo						
Basic metals & metal products	Madgarovo	99	68			
Momtchilgrad						
Non-metallic mineral products	Bentonit	10	7			
Basic metals & metal products	Gorubso	23	16			
Radnevo						
Lignite mining	Troianovo1	1322	407			
Lignite mining	Troianovo north	473	691			
Public supply of electricity	Remotex	30	49			
Stara Zagora						
Food, beverages & tobacco	Mesokombinat	20	14	2	2	oil
Food, beverages & tobacco	Smesler	11	6			
Food, beverages & tobacco	Zagorka	34	41	315	398	oil
Food, beverages & tobacco	Vegedora	5	0			
Food, beverages & tobacco	Bulgartabak	26	17			
Food, beverages & tobacco	Serdika	13	11			
Food, beverages & tobacco	Galia Zagoretz	24	23			
Food, beverages & tobacco	Bisser Oliva	32	37	307	236	oil
Food, beverages & tobacco	DF P.Enev	8	8	481	803	oil
Textile and ready made clothing	Natalia	6	6	54	43	oil
Wood, paper & pulp	Mebel	15	9			
Wood, paper & pulp	Sredna gora	8	5			
Wood, paper & pulp	Prizon	7	6			
Chemicals & plastics	Agrobiochim	2488	1265	9039	7247	gas (lignite) '95
Chemicals & plastics	ZKU G.Botevo	11	3			
Chemicals & plastics	Neochim	4	4			
Non-metallic mineral products	Borue	15	5	326	41	gas
Non-metallic mineral products	Domostroitel	7	4			
Basic metals & metal products	Progres	75	27			
Basic metals & metal products	Tcherveno zname	16	11			
Machinery and equipment	Preskov	65	32			
Machinery and equipment	Beroe	25	17			
Electronics & elect. equipment	DZU RTO	119	50	146	19	oil
Electronics & elect. equipment	Svetlina	10	15			
Svilengrad						
Textile and ready made clothing	Koprina	29	32			
Machinery and equipment	Sakar	14	11			
Machinery and equipment	Unimet	13	3			
Tchernootchene						
Machinery and equipment	Pnevmatika	3	0			
Tchirpan						
Machinery and equipment	Budushtnost	34	11			
Total large consumers		8832	5548	36148	29587	

Mining companies are included for as far as it concerns electricity consumption. Public power production is not considered. Table 5.3 gives an overview of large energy consumption by firm for electricity and several types of fuel in different municipalities in the region of Haskovo.

The largest energy consumers are easy to identify. Agrobiochim, Neochim, and Vulkan (chemicals), Manuela (textile), Troianovo-1, -3, and -North (mining), OTZK (basic metals), Arsenal (machinery), Zagorka, DF P. Enev and Bisser Oliva (food) are examples of very big consumers of electricity and/or fuels.

Energy demand of the large consumers in the table is larger than regional final energy demand of industry because some energy supply companies are included. When energy supply companies are excluded, electricity consumption of large consumers in 1994 is about as large as total industrial electricity demand in 1993. Fuel demand of large consumers in 1994/1995 is even larger than total industrial fuel demand in 1993. This is due to a large growth in gas consumption in the period 1993-1995. In other words, the list seems to cover the largest part of electricity and fuel demand in industry.

6. NATIONAL AND REGIONAL ENERGY SUPPLY

6.1 Introduction

The energy supply system is run by a few national energy supply companies, which are not only guided by national policies, but also act on a national level. Therefore, energy supply has to be studied in a national context.

The economic recession is reflected by the development of total primary energy requirements (TPER) of the country (figure 6.1). Unfortunately, drop in GDP and drop in TPER are similar. So, in contrast with FED energy intensity, TPER energy intensity remained constant over the years. In other words, structural changes, energy conservation and efficiency improvements in end-use have been counterbalanced by relative increases of production with corresponding low conversion efficiency of the energy supply sector.

The mix of fuels has changed since 1985. Nuclear power delivered a more or less constant contribution, determined by the current generation capacity (about 150 PJ) and baseload demand for electricity, resulting in a growing share of 11% in 1985 to 16% in 1993. Consumption of oil, which is almost totally imported from Russia, has decreased in absolute and relative terms from 40% (523 PJ) in 1985 to 29% (270 PJ). In 1993, natural gas, also imported from Russia, was required less than in 1985 but increased its share from 14% to 17% of TPER. Demand for hard coal, which is mainly imported from Ukraine has decreased from more than 200 PJ to 100 PJ in 1993. Locally extracted brown coal and lignite decreased from 240 PJ to 220 PJ. Total coal share in TPER increased from 33% in 1985 to 36% in 1993. The primary balance of electricity (import minus export) decreased from 16 PJ in 1985 to 0 PJ in 1993.

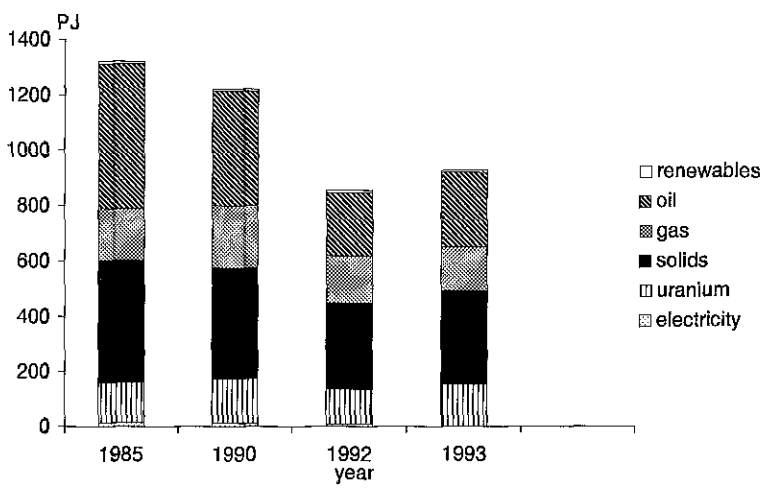


Figure 6.1 *Development of total primary energy requirements by fuel*

6.2 Coal sector

As has been discussed before, the coal sector is very important for Bulgaria: brown coal and lignite are the only substantial Bulgarian energy reserves, but these sources are the lowest quality and most polluting energy source in the primary energy mix. In general, sulphur and ash content are very high while the calorific value is very low.

The coal share in TPER is 36%, the domestic coal accounts for a quarter of TPER. About 100 PJ of high quality anthracite is imported from Ukraine. The production of the different types of coal in Bulgaria for the period 1990-1993 are shown in table 6.1.

Table 6.1 *Production of types of coal in Bulgaria and in Haskovo for the years 1990-1993*

Coal type	Production [kton]			
	1990	1991	1992	1993
Inland production				
Lignite	27827	25231	26734	25350
Brown coal	4879	4113	4402	4554
Black coal	304	265	237	233
Anthracite	50	46	51	46
Total coal extraction	33059	29656	31423	30183
Haskovo production				
Lignite	26165	23745	24988	23690

The lignite production of Haskovo region accounts for almost 70% of national coal production (in terms of energy content, in tonnes it is more).

Maritsa East in the region of Haskovo has the largest coal production in Bulgaria. This large complex includes three coal mines (Troianovo 1 to 3) with a yearly production of around 25 million tonnes and a potential of 35 million tonnes per year. The parameters of coal production in Maritsa East and other mines are given in table 6.2. The Maritsa East complex is located on the territory of the municipalities Galabovo and Radnevo.

Three TPPs are also sited there and use coal from the mines. Furthermore, the largest briquette factory in the country is located in Galabovo. It is 35 years old and processes about four million tonnes of raw coal and produces 1.5 million tonnes of briquettes annually. The latter have low technical and environmental properties and are subsidized by the state budget. Energy consumption and production of the briquette factory are depicted in table 6.3. and it appears that gross efficiency of the production has improved the last years. Production increased during the economic crisis, probably due to an increase in demand because of a comparably low price, but decreased sharply in 1994. A separate Phare project has investigated options for improvement of the quality of briquettes.

Table 6.2 *Parameters of coal mines and their produced coal in Bulgaria*

Coal mine	Purpose	LHV	S-dry	Ash	Dry production [kton]			Production costs	
		[KJ]	[%]	[%]	1990	1992	1993	[Leva/GJ]	
Maritza East		1557	5.40	32.70	25134	24120	22758	33	Haskovo
Lignite	energy production	1525	5.40	35.27					
	briquettes	1723	5.40	19.60					
Maritza basin		1669	6.30	50.43	1031	867	932	113	Haskovo
Lignite	energy production	1689	6.30	50.27					
	other consumption	1636	6.30	50.70					
Sofia Basin		1868	1.85	33.45	1585	1584	1500	35	
	energy production	1805	1.88	34.59				35	
	domestic	2524	1.58	21.64				37	
	briquettes	1908	2.00	28.64				38	
Bobov dol		2979	2.65	46.31	1876	1756	1867	91	
Brown coal	energy production	2717	2.65	49.90					
	domestic	4832	2.65	20.94					
Pernik		2461	1.00	53.37	2313	2074	2180	84	
Brown coal	energy production	2118	1.00	58.00					
	domestic	4115	1.00	31.05					
Balk, basiblack		4176	2.09	43.28	304	237	233	134	
Coal	energy production	4154	2.09	43.48					
	other consumption	4273	2.09	42.40					
Pirin		3079	2.02	31.97	37	83	75	145	
Lignin	energy production	2615	2.02	40.36					
	other consumption	3797	2.02	18.98					
Cherno More		2973	4.30	41.86	242	243	215	95	
Brown coal	energy production	2900	4.30	42.83					
	other consumption	3199	4.30	38.86					
Bistritza		2055	3.60	45.16	40	80	85	122	
Lignite	energy production	1650	3.60	53.18					
	other consumption	2752	3.60	31.35					
Antrazit		4672	0.90	34.46	50	51	46	123	
Anthracite	energy production	4672	0.90	34.46					
	other consumption	4672	0.90	34.46					
Import Ukraine		5723	1.90	19.35	6094	3590	4216		
Anthracite	energy production	5723	1.90	19.35					

Note: Sofia basin: lignite by Bely breg, Staniantzy & Chukurovo. LHV values concern wet coal which especially influences the LHV values of brown coal and lignite, which can have water contents of more than 50%.

Table 6.3 *Energy consumption and production of the briquettes factory in Galabovo in the years 1990-1993*

Energy carrier	1985	1990	1992	1993	1994
Input					
Lignite	26.9	28.1	26.8	26.9	
Electricity	0.3	0.4	0.3	0.3	0.3
Heat	6.5	7.3	7.1	6.8	4.8
Gross efficiency	70.4%	74.7%	75.7%	77.6%	
Output					
Briquettes	23.7	26.7	25.9	26.4	19.1

The coal mining complex Maritsa basin is located in Dimitrovgrad. Its annual lignite production is about one million tonnes but its potential is much larger. The recently constructed mine Zdravetz can produce about two million tonnes annually. This potential is not utilised for the following reasons:

- Production costs are relatively high because the coal production is underground, which made subsidies necessary (e.g. in 1993 production costs were 670 Leva/ton while the sale price was 162 Leva/ton).
- The sulphur content of the lignite is very high, 4.1% in raw mass or 6.3% of dry coal, especially having in mind the low calorific value of the coal, 1669 kCal/kg.

One has to bear in mind that LHV values are of wet coal. Especially the LHV values of brown coal and lignite can be higher if the water content, which can be over 50%, is lowered.

Currently, studies are being carried out to explore the possibility of using the coal in Fluidized Bed Combustion boilers in order to avoid negative environmental effects.

Main consumers of the Maritsa basin coal are the CHP of Agrobiochim (a fertilizer producer in Stara Zagora), which consumes 300000 ton annually, and CHP Maritsa 3 in Dimitrovgrad, which consumes 650000 ton per year. CHP Maritsa 3 was built to cover the needs of Neochim, a chemical plant in Dimitrovgrad, but recently it became self-sufficient (using natural gas for feedstocks and process heat).

Based on a thorough analysis, Quantitative Energy Scenarios for Bulgaria distinguish three coal supply scenarios, viz. Maximum scenario (technical potential), Optimistic scenario (based upon a forecast of the Coal Holding Company), and Realistic scenario. The Realistic scenario takes into account the overall fuel and energy balance, demand for local coal, independence of the energy sector, as well as the social problems resulting from the structural changes in the coal mining sector, and compliance with the environmental protection norms and international agreements Bulgaria has signed.

Although the Realistic scenario projects the lowest national coal production and demand of the three scenarios, national coal production is projected to increase with almost a quarter up to the year 2015. Almost all coal mines are projected to continue to produce in the next century, although additional investments are needed. Only Anthracite will close. The expected production costs of coal of different mines after investments are listed in the last column of table 6.2.

The production costs differ substantially, also per GJ. Sale prices differ also substantially, depending on the quality of the coal. Comparison of production costs and sale price gives a first impression of cost-effectiveness of a mine. Based on these figures, a few mines, Maritsa basin, Balkanski basin, Pirin, and Bistritza seem to have higher production costs than sale price.

For Haskovo, its seems that Maritsa basin (Dimitrovgrad) has problems producing cost-effectively, while the Maritsa East complex can produce cost-effectively, even if wet coal LHV values are used in the calculation.

6.3 Oil sector

Consumption of oil, which is almost totally imported from Russia, has decreased in absolute and relative terms from 40% (523 PJ) in 1985 to 29% (270 PJ). At current world market prices, oil is relatively polluting and expensive. Therefore, it is used more and more for the purpose where no good alternative fuel is available: transportation.

Oil prices are practically on world market level in Bulgaria. Prices for automotive fuels without tax are comparable with those of Western Europe; Prices including tax are much lower than in Western Europe.

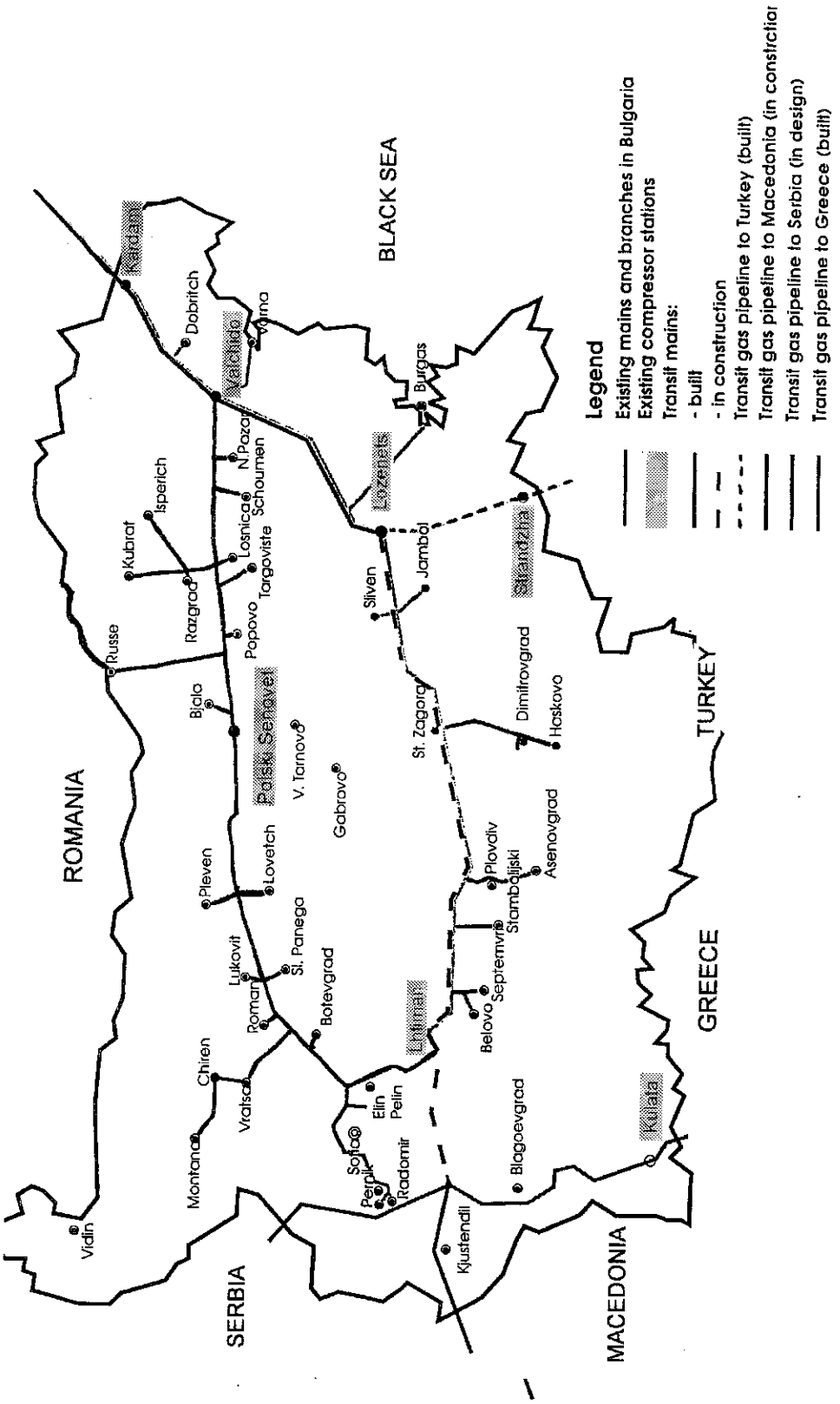
Bulgarian demand for oil products is projected to be double current demand in the year 2005. In that case, current oil refining capacity of Nephtochim in Burgas (12 million tonnes per annum) and of Plama in Pleven (3 million tonnes per annum) will still not be used at their full capacity. Their total capacity is more than three times current production. An option for using this free capacity is transportation of oil products from Burgas by pipeline to Alexandropolis (Greece) or building a ferry line to Russia. This would be related to 5 million tons per annum.

Main point is to study desulfurization of heavy fuel oil in Nephtochim. For oil, desulfurization in refineries has lower costs than using flue gas desulfurization in oil combustion plants.

6.4 Gas sector

Natural gas to Bulgaria is imported from Russia. The pipeline from Russia is crossing Ukraine, Moldava, and Romania before it gets to Bulgaria to the receiving unit, the Kardam compressor station. Figure 6.2. presents a schematic overview of the natural gas network in Bulgaria.

Figure 6.2 *Schematic map of the natural gas network in Bulgaria*



There are two gas transmission systems in Bulgaria which can operate independently and commonly via 'looping' transferring. One of the systems is built to supply local consumers, the other one is a transit system to supply the neighbouring countries.

The local gas supply system has a capacity of 10 billion m_n^3. The main branches are:
- gas main from Kardam CS to Valchy dol CS,
- Northern gas main from Valchy dol CS to Sofia,
- Southern gas main from Valchy dol CS via Lozenets CS and Ihtiman CS to Sofia where the northern and southern branches connect,
- main gas pipes high pressure for the towns which are incorporated in the system,
- gas pipeline to the underground storage (capacity of 1 billion m_n^3) in the village of Chiren (near Vratsa),
- automatic gas distribution stations (AGDS) and gas distribution stations (GDS) for individual consumers,
- gas pipes middle pressure (0.6-1.2 MPa) from AGDS and GDS to industrial consumers,
- gas distribution units (GDU) for industrial consumers.

The gas supply system is to be said of high quality and overall losses of gas are 1.8% (bear in mind that hardly a distribution, small-scale network exists).

The transit gas supply system has a capacity of 11 billion m_n^3 and covers:
- gas main from Kardam CS via Valchy dol CS to Lozenets CS,
- gas main to Turkey with a capacity of 6 billion m_n^3 from Lozenets CS via Strandja CS,
- gas main with a capacity of 5 billion m_n^3 from Lozenets to Ihtiman CS (under construction),
- gas main with a capacity of 2.4 billion m_n^3 from Ihtiman CS to Kulata CS,
- gas main to Serbia and Macedonia with a capacity of 2.6 billion m_n^3 from Ihtiman CS to Dupnitsa,
- gas main to Macedonia with a capacity of 1.2 billion m_n^3 from Dupnitsa to Gyueshevo (under construction),
- gas main to Serbia with a capacity of 1.4 billion m_n^3 from Dupnitsa to Tsaribrod (under design).

Bulgaria considers itself to be 'The Balkan Gas Centre', i.e. the central dispatch centre between the Russian imports and the supply to Turkey, Greece, Macedonia and Serbia. The gas sector is therefore very important to the national energy policy of Bulgaria. The other way around, it is also important for Bulgaria to diversify natural gas supply. Many hypothetical options are discussed, ranging from Iran, Nigeria, and CIS countries other than Russia etc.

Presently, natural gas is used in industry, electricity and heat generation but not used directly in households. The natural gas consumption of the different types of consumers in Bulgaria is depicted in table 6.4. National gas consumption was in 1993 4.6 billion m_n^3 or 159 PJ and decreased in the last two years. Up to now, capacity problems have not occurred, since the local gas supply main has a capacity of 10 billion m_n^3. However, during winter peak period, especially when gas supply has stagnated temporarily, shortages of natural gas have occurred. Therefore, enlargement of the underground storage capacity of Chiren of 1 billion m_n^3 with 3 billion m_n^3 is an option to be considered.

Table 6.4 *Natural gas consumption by type of consumer in Bulgaria [million m_n^3]*

Consumer	1985	1989	1990	1991	1992	1993
Electricity & heat generation	1120	1550	1810	1905	1803	1365
Oil refineries & chemical plants	2440	2880	2910	2532	2164	2017
Metal industry (ferrous & non-ferrous)	790	880	800	580	468	463
Construction materials	780	820	780	390	312	388
Glass & porcelain	280	310	310	222	183	208
Others	90	140	170	123	127	144
Total gas demand	5500	6580	6780	5752	5057	4585

For the future, a considerable growth of natural gas is expected. First, subsidies on other fuels will decrease. Second, natural gas is environmentally friendly. Especially dust and sulphur dioxide emissions will be reduced.

Substitution to natural gas of (mainly heavy oil combusting) district heating plants is foreseen (Sofia, Plovdiv, Pleven, Shoumen and others). A cynical argument for switching to natural gas is the fact that gas supply to most firms can not be shut down, for instance if payment has been delayed for months, because no closing valves exist on the pipelines. So, in contrast with coal and oil, natural gas does not have to be paid (immediately).

Gas supply to households is a seriously considered option. Energoproekt and NITI Promishlena developed a national programme for household gas supply. Gas supply can be considered for towns located near AGDS or gas mains, especially if district heating is not available. When the fuel to be replaced is electricity, the advantage would be the decreasing annual electricity demand and the peak hour load. Moreover, national imports of fuels used for electricity production could be decreased considerably due to the fact that average electricity generation efficiency is about 30%.

Bulgargas provides investments for the high pressure gas network and supplies natural gas to large consumers. Investments in middle and low pressure (0.4 Mpa and 0.05 Mpa) town gas networks and GDUs to supply small consumers such as households and small companies with natural gas has to be done by private firms such as Overgas, eventually in combination with municipality participation.

Stara Zagora is one of five natural gas centres in Bulgaria and lies on the Southern gas main from Valchy dol CS to Sofia between Lozenets CS and Ihtiman CS. In Stara Zagora starts a branch to the south to Dimitrovgrad and Haskovo. Table 6.5 shows the natural gas consumption in the region of Haskovo. It concerns only a few consumers such as chemical plants, building material factories and TPP Maritsa 3. Total Haskovo gas consumption accounts for about half of Stara Zagora gas supply to its distribution region and 8% of 1993 national gas consumption. In 1988, Haskovo gas consumption accounted for 15% of the countries gas consumption. Industrial demand in Haskovo has decreased since, while in the rest of Bulgaria a substantial part of natural gas is used for electricity generation and district heating which had a less decreasing demand than industry.

The national programme for household gas supply selected a list of towns which fulfill the first requirements for household gas supply. From the region, Stara Zagora and

Haskovo are in this list for consideration of natural gas: the towns are connected to the natural gas grid, the towns are big enough (economy of scales), and pollution is very high (briquettes in Haskovo) or electricity is used for heating (Stara Zagora).

Table 6.5 *Natural gas consumption in Haskovo region [million m_n^3]*

Consumer	Municipality	Sector	1986	1987	1988	1989	1990	1991	1992	1993	1995
Neochim	Dimitrovgrad	chemicals	185.8	226.1	558.0	555.0	551.3	396.0	226.1	188.1	480.6
Agrobiochim	Stara Zagora	chemicals	301.4	313.6	269.8	242.6	230.4	206.1	164.7	143.9	175.8
Chimmas	Haskovo	chemicals	0.6	6.8	5.5	4.0	4.6	2.4	2.2	0.0	0.2
TPP Maritsa3	Dimitrovgrad	energy	0.0	0.0	0.0	0.0	0.0	5.5	3.8	1.6	0.7
Vulkan	Dimitrovgrad	building	94.1	123.1	119.2	89.4	83.8	31.8	27.8	42.9	62.3
Borue	Stara Zagora	building	2.8	4.5	6.9	4.3	9.8	4.8	2.5	1.2	
Total Haskovo region			584.7	674.0	959.4	895.2	879.8	646.5	427.0	377.7	719.6
Share national gas consumption [%]			10.6	11.5	15.2	13.8	13.1	11.2	8.4	8.2	0.0

6.5 Electricity sector

The electricity sector is a very important sector, especially bearing in mind that the share of electricity is one fifth of final energy consumption. The balance of electricity production and demand gives a good overview of the electricity sector during the last decade (table 6.6).

In the years after 1989, electricity consumption has declined with about one quarter. However, in the years 1992-1994 consumption stabilized in contrast with the GDP. Distribution losses as a share of total resources increased from 8.4% in 1985 to 11.9% in 1993, after a peak in 1992 of almost 13%. Self consumption increased from 9.5% of total resources in 1985 to 10.8% in 1993.

In the year 1994, import of electricity has diminished down to 1.2 TWh or 3% of total electricity resources. Thermal Power Plants (TPP) and the Nuclear Power Plant (NPP) in Kozloduy produce each about 40% of national electricity production. The rest is produced by Combined Heat and Power plants (CHP) under the COE or in industry and by Hydro Power Plants (HPP).

Table 6.6 *Balance of electricity production and consumption of Bulgaria [TWh]*

	1985	1989	1990	1991	1992	1993	1994
Gross production	41.6	44.3	42.1	38.8	35.6	37.9	38.1
Thermal PP [NEC]	19.5	20.6	19.9	17.9	17.3	17.3	16.8
CHP [COE]	2.1	2.0	2.0	1.8	1.6	1.7	1.8
Industrial CHP	4.7	4.4	3.8	3.5	3.0	3.1	2.7
Nuclear PP [NEC]	13.1	14.6	14.8	13.2	11.6	13.9	15.3
Hydro PP [NEC]	2.2	2.7	1.8	2.5	2.1	1.9	1.5
Import	6.0	4.9	5.4	3.1	3.3	1.6	1.2
Total resources	47.6	49.2	47.5	41.9	38.9	39.5	39.3
Export	1.7	0.5	1.6	1.0	0.6	1.5	1.2
Self consumption	4.5	4.7	4.6	4.2	4.1	4.2	4.2
Distribution loss	4.0	4.7	4.4	5.2	5.0	4.8	4.7
Net consumption	37.4	39.3	36.9	31.6	29.3	29.0	29.1

It is clear from table 6.6 that from 1985, no large shifts have occurred between the types of electricity generation. Industrial CHP has declined due to the fall of industrial production. CHP of the COE has declined less than industrial CHP because part of the produced heat is supplied to households which had a fairly stable heating demand. HPP production has declined mainly due to hydrological conditions (see renewables). NPP Kozloduy produces full load in the electricity base load.

The fuel consumption for electricity generation is illustrated in figure 6.3. Uranium is expressed in fossil fuel equivalents (according to EU conventions with an efficiency of 0.375). Solids have a very high share, firing most of the TPPs. Again, large shifts have not occurred. Oil consumption decreased from 25 PJ in 1985 to 14 PJ in 1993. Imported hard coal decreased from 95 PJ in 1985 to about 50 PJ in 1993, consumption of brown coal and lignite was stabile at about 160 PJ.

However, the growth of total fuel consumption in the period 1992-1993 is remarkable compared to the modest growth of electricity production during the same period.

The electricity sector has been studied in detail by many institutions and consultants such as the COE, NEC, Energoproekt, Techenergo, Bechtel (USA), Powergen (UK) and others. The main conclusions of the studies are that a major part of the installed TPPs are in poor technical conditions. The recommended measures for improvement of the generation capacity are:

- rehabilitation and renovation of existing plants targeting at extension of their period of operation and improvement of their performance,
- decommissioning of some worn out plants,
- building of new TPPs taking into account the decommissioning programme, electricity demand growth and the relative share of TPPs in the overall electricity balance.

In general, rehabilitation of TPPs is cost-effective compared to investing in new TPPs if capital is scarce (high real interest and discount rates) and if low cost fuels are used (efficiency not so important).

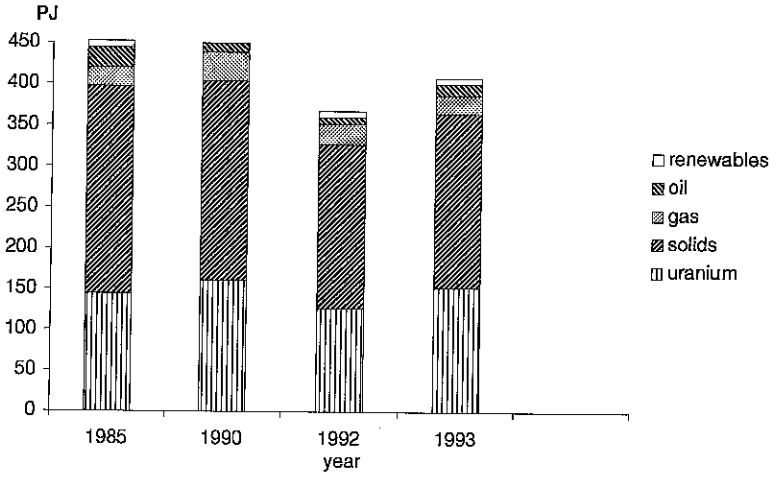


Figure 6.3 *Fuel consumption of the Bulgarian electricity sector for different years*

For a more detailed review of options and plans for TPPs and NPP, the reader is referred to Quantitative Energy Scenarios for Bulgaria. An overview of plants will be given for the region of Haskovo.

Haskovo region is an important producer of electricity for Bulgaria. This is illustrated in table 6.7 where electricity and heat generation of TPPs and CHPs is given for different years. Haskovo region produces almost one third of Bulgarian electricity. Clearly, TPPs Maritsa East-2 and -3 have the largest contribution.

Table 6.7 *Development of electricity and heat production by CHPs and TPPs in Haskovo region [TJ]*

Plant	1989	1990	1991	1992	1993	1994
Power						
Agrobiochim	229	201	185	160	158	265
Kazanlak	155	114	71	62	72	85
Maritsa East-1	3901	3982	3528	3971	3852	3528
Maritsa East-2	17999	18590	16851	19617	17496	21928
Maritsa East-3	17900	15890	14743	15515	16776	15973
Maritsa-3	1030	1025	553	381	1080	835
Total power	41214	39802	35932	39707	39434	42614
Heat						
Agrobiochim	3305	2875	3495	3006	2930	2947
Kazanlak	1660	1310	1093	926	858	980
Maritsa East-1	6793	6991	6127	7053	6153	4613
Maritsa East-2	0	0	0	0	0	0
Maritsa East-3	0	0	0	0	0	0
Maritsa-3	888	864	805	558	569	297
Total heat	12646	12040	11519	11542	10511	8838

Table 6.8 *Technical and other parameters of CHP and TPP in Haskovo region*

Designation	Municipality	Owner	Fuel type	Capacity		Boilers				Turbines	
							Production	Pressure	Temperature	capacity	
				[MWe]	[MWth]	Nr.	[ton/hr]	[MPa]	[Celcius]	Nr.	[MWe]
Agrobiochim	Stara Zagora	Industry	lignite			3	75	3.9	450	4	6
			gas	48	349	2	75	3.9	450	2	6
Kazanlak	Kazanlak	COE	heavy oil	12	87	3	75	3.9	450	2	6
Maritsa East-1	Galabovo	NEC	lignite	200	872	6	210	14	540	4	50
Maritsa East-2	Radnevo	NEC	lignite			8	250	14	540	4	150
			lignite			2	670	14	540	2	210
			lignite			1	670	14	540	1	215
			lignite	1450	-	1	670	14	540	1	215
Maritsa East-3	Galabovo	NEC	lignite	840	-	4	670	14	540	4	210
Maritsa-3	Dimitrovgrad	NEC	lignite		80	2	170	10	510	2	25
			gas	170	-	1	380	14	540	1	120
Vulkan	Dimitrovgrad	Industry	gas	8.5						1	5.5
			gas							1	3

Technical and other parameters of power plants in Haskovo are depicted in table 6.8. Obviously, most generation capacity uses lignite from Maritsa East mines.

To get an impression of the performance of plants, table 6.9 shows a few indicators. The share of electricity in total electricity and heat production of a plant is given in the first column, gross efficiency of total heat and electricity generation in the second column and the full load utility of the turbines in the last column. In general, all plants have a low turbine utility. Especially the CHPs suffer from a lack of heat demand. Utilities of Maritsa East-2 and Maritsa East-3 are also low. Maritsa East-1 and Maritsa-3 are already quite old and have also a low efficiency. This is probably due to the decrease in electricity demand.

The future of these plants is studied intensively. In table 6.10 a summary is given of probable years for decommissioning or rehabilitation as currently is being considered by NEC, COE etc. The content of the table does not concern plans, just consi-de-rations. Worth while mentioning is that schemes for rehabilitation of plants include investments for flue gas desulfurization (FGD), in order to reduce SO_2 emissions. Investments for rehabilitation are generally more cost-effective than investments for the construction of new plants.

One should bear in mind that Maritsa-3 is located next to the coal mine Maritsa basin. The conglomerate was originally built to provide steam and feedstocks to the chemi-cal fertilizer factory Neochim. However, in the eighties Neochim has switched to natural gas. Furthermore, Maritsa basin has problems to produce lignite cost-effectively.

The district heating plant in Kazanlak has lost in the last couple of years a few large industrial consumers of steam. Recently, heavy fuel oil has become quite expensive and heat tariffs are such that production costs are not covered. Switching to natural gas, as is considered for several oil fired district heating plants, is an option which will be investigated in another part of the study. In fact, the distance from the national gasgrid of the district heating plant of Kazanlak is less than 20 km, which is not a prohibitive distance.

Table 6.9 *Performance indicators of CHP and TPP in Haskovo region*

Plant	Fuel	Capacity	Electricity share	Gross efficiency	Turbine utility
		[MWe]	[%]	[%]	[%]
Agrobiochim	gas/lignite	48	8	88	17
Kazanlak	heavy oil	12	8	79	22
Maritsa East-1	lignite	200	43	49	56
Maritsa East-2	lignite	1450	100	30	48
Maritsa East-3	lignite	840	100	31	60
Maritsa-3	lignite	170	74	28	16

Table 6.10 *Overview of possible rehabilitation or decommissioning of CHP and TPP in Haskovo region as currently is being considered*

Designation	Fuel type	Turbines capacity		Commissioned	Decommissioning	Rehabilitation	Commissioning	Investment incl. FGD
		Nr.	[MWe]	[year]	[year]	[year]	[year]	[mln USD]
Agrobiochim	lignite	4	6	?	?			
	natural gas	2	6	?	2015			
Kazanlak	heavy oil	2	6	1974-1975	?			
Maritsa East-1	lignite	4	50	1958-1961	1999			
Maritsa East-2	lignite	4	150	1966-1969	2002-2003	1997	2000	211.2
	lignite	2	210	1985	2015	1999-2000	2000-2001	142
	lignite	1	215	1990	2020			
	lignite	1	215	1995	2025			
Maritsa East-3	lignite	4	210	1977-1980	2011-2014	1995-1998	1996-1999	284
Maritsa-3	lignite	2	25	1951-1954	?			
	natural gas	1	120	1972	2000			
Vulkan	natural gas	1	5.5	?	2000			
		1	3	?	2000			

6.6 District heating sector

The district heating sector is an important sector on a national level. About 17% of households in Bulgaria are supplied with district heating, while public buildings and industries are delivered heat too. However, in Haskovo only one district heating is present, in Kazanlak, which supplies about 1,7% of the households of the region. This subject was treated in the section on energy demand. The performance of this heavy oil fired plant was discussed in the section on electricity generation, since it is a CHP.

Table 6.11 and table 6.12 give an overview which makes it possible to compare the Kazanlak district heated buildings with other district heated buildings in the country, in the residential and public sector. The tables are from the Phare study on Energy Efficiency executed by Kantor, although the specific energy consumption figures have been corrected.

Obviously, specific energy consumption per square metre living space in residential buildings in Kazanlak is one of the highest in the country. In the public sector, the difference with other district heating plants is even larger. This could not be due to the climate, since the number of degree days in Haskovo is about 10% lower than the average number for the country. After degree day correction, Kazanlak has the highest

specific energy consumption. This could be due to house types, the state of the buildings, the state of the pipes, and many other factors. The specific situation of Kazanlak is analysed in another part of the study, based on updated data from Kazanlak.

The reader is referred to the Phare report Quantitative Energy Scenarios for Bulgaria for information on the role and conditions for district heating in the national energy strategy.

Table 6.11 *Dwellings heated by district heating in Bulgaria in 1992*

Region	Number of dwellings	Towns with DH	Dwellings with DH	Living space	Share of total dwellings	Supplied thermal energy	Final energy consumption	Specific energy consumption	
				[1000 m^2]	[%]	[PJ]	[PJ]	[MJ/ sq.m]	[kJ/sq.m. degree day]
Bourgas	297892	3	38169	2805	12.8	2.6	2.2	774	220
Haskovo	327238	1	6013	442	1.8	0.4	0.4	820	234
Lovetch	377249	5	37967	2791	10.1	2.6	2.2	805	198
Montana	235056	1	13528	994	5.8	0.9	0.8	793	184
Plovdiv	411975	1	38319	2817	9.3	2.8	2.4	850	232
Rousse	273904	3	15463	1137	5.6	1.0	0.9	772	187
Sofia	353666	4	19077	1402	5.4	1.3	1.1	814	204
Sofiacity	459367	1	343990	25283	74.9	25.3	20.2	800	181
Varna	325006	2	21474	1556	6.6	1.4	1.3	811	221
Total	3061353	21	534000	39227	17.4	38.3	31.5	802	204

Table 6.12 *District heating in the public service sector in Bulgaria in 1992*

Region	Converted dwellings with DH	Floor space	Supplied thermal energy	Final energy	Specific energy consumption	
		[1000 m^2]	[PJ]	[PJ]	[MJ/ sq.m.]	[kJ/sq.m. degree day]
Bourgas	9064	666	0.6	0.5	800	227
Haskovo	1047	77	0.1	0.1	1046	298
Lovetch	15100	1110	1.1	0.9	851	206
Montana	4761	350	0.4	0.3	895	209
Plovdiv	21503	1580	1.7	1.4	912	239
Rousse	10276	755	0.7	0.6	806	196
Sofia	10337	760	0.8	0.7	883	231
Sofiacity	142593	10480	11.2	9.0	854	200
Varna	6824	502	0.5	0.4	865	236
Total	221505	16280	17.0	14.0	859	219

The term Converted dwellings is used to indicate the number of average dwellings (floor space 73.5 m^2) which corresponds to the floor space of the public buildings, heated by DH.

6.7 Renewables

Up to now, not much attention was paid to the utilization of renewable energy sources in Bulgaria. One reason for this were the low prices of primary energy sources and final energy carriers.

In energy production, hydropower contributed 7 PJ in 1993. Solar energy contributed 0.2 PJ, geothermal energy 0.8 PJ. Wood consumption in energy statistics account for 8 PJ. It concerns wood consumption which is accounted to manufacturing and construction and agriculture. Residential wood consumption is not considered in national statistics.

Besides hydro power plants, connection of renewable electricity generation to the national grid is considered in Bulgaria as being difficult, since capacity utilisation can not be planned as for instance TPP. In the next few years, several pilot projects are expected to take place to investigate this topic. Furthermore, an adequate legal framework is necessary to facilitate for instance delivery to the national grid. The legal framework should also take into account additional economic measures which can translate typical national benefits of renewable energy into incentives for local investors. These national benefits are for instance:

- reduction of fuel import payments in hard currency,
- reduction of polluting emissions of CO_2, SO_2 and dust.

Wood

In Bulgaria, three categories of wood can be distinguished, viz. by source: energy suppliers/distributors, forest institutions, and 'uncontrolled', unregistered wood cutting of citizens (the forest institutions do not check on their permits).

An estimate of the third category of wood consumption on the basis of heat demand and fuel consumption could be made by experts from Energoproekt.

Waste wood from wood processing factories could be seen as a fourth source of wood. The wastes are estimated to be about 200 to 250 kton/annum, obtained from about 40 factories. At a calorific value of 1100 kCal/kg or 4.6 GJ/ton this represents about one PJ. Promishlena energetika has designed a range of boilers burning wood wastes, and some are currently in operation in wood factories.

In Haskovo region, wood factories can be found in most municipalities. Their production is not known but probably available at the regional forestry office.

It is unclear what part of wood consumption is renewable, in other words: is replaced by new trees. As a first estimate it is assumed that unregistered wood cutting can be considered as non-renewable, while other sources are renewable.

Waste

The potential of agricultural waste is estimated to be small, about 10 TJ. NIMESS developed prototypes for combustion systems with capacities of 150 and 230 kW suitable for farms, greenhouses and public buildings. For small farms, NIMESS developed stoves which combust different types of fuel such as wood, agricultural waste and coal.

The potential of biogas (manure) is estimated to be small partly because the Bulgarian cattle stock has decreased severely the last couple of years. There are a few experimental biogas installations. The only reactor which proved to operate efficiently was designed by Agropromproekt and is situated in Podgumer. The obtained biogas has a calorific value of 5500 kCal/m_n^3 or 23 MJ/m_n^3 (natural gas LHV is 33 MJ/m_n^3).

Up to now, municipal solid waste is only stored on waste disposals. Municipal solid waste could be treated by combustion (heat and/or power generation) or anaerobe decomposition resulting in biogas production. In 1992, municipal solid waste per capita was 230 kg. At an average calorific value of 1350 kCal/kg or 5.65 GJ/ton, the potential for Bulgaria appears to be around 10 PJ maximal. This implies that the potential of municipal solid waste for the region of Haskovo is about 1 PJ.

Precipitation obtained from precipitation installations from sewage systems can be converted into biogas. In Sofia, the biogas from the precipitation station has a calorific value of 5000 kCal/m_n^3 or 21 MJ/m_n^3 and is combusted in a local boiler for auxiliary consumption.

Wind

Wind power potential in Bulgaria is very limited. A study of the University Meteorological Institute reports that regions suitable for wind turbines are those near the Black Sea and in the mountains. In these areas, average wind velocity exceeds 6 to 7 m/sec. with an energy flow of 6 MWh per annum per m^2. Six wind turbines with a capacity of 5, 55 and 125 kW have been built and tested the last six years by the Technical University of Varna.

Haskovo wind velocity is below national average and not high enough for cost-effective wind energy production.

Solar

Solar boilers for hot water and heating are presently used in Bulgaria in the public services (0.1 PJ) and manufacturing (0.1 PJ) sector. Some solar boilers are locally produced but more are imported from Greece. Compared to Greece, penetration of solar boilers is low. Return on investment (compared with oil fired boilers) is approximately 8 years.

In Bulgaria little experience exists with electricity from photovoltaics, which seems expensive. In Western Europe, where solar radiation has a lower level, photovoltaics are relatively expensive, but cost-effective application is possible in remote areas, where avoided network costs are substantial.

Geothermal

In Bulgaria, the potential of geothermal energy in the form of hot water is estimated to be 175000 ton coal equivalent or 5 PJ and is up to now used mostly for baths. Phare project BG 9307-03 'Technical and economic assessment of renewable energy sources in Bulgaria' will provide more information.

In Haskovo, some municipalities are famous for their geothermal springs, for instance Mineralni Banji.

Hydro

Existing hydro power plants (HPP) are operating under NEC and have an installed capacity of 1996 MW. The planned utilisation was 2255 hours, but only 1038 hours utilisation was realized in 1993. During summer, water has to be provided for irrigation and water supply which reduced utilisation substantially. Therefore, HPPs function as peak load capacities comparable with gas power plants. Besides hydrological conditions, technical conditions hamper electricity production. Improved performance of a number of HPPs up to increases of 8% could be reached by replacement of the turbine wheels. Replacement of the turbine governors is needed for all HPPs, as well as general equipment repairs and renovation. Average utility could be improved up to 1500 hours. These recommendations were done by the Swiss consultant Elektrowatt engineering for the World Bank, EBRD and the World Development Association.

The investigations carried out show a feasible potential of 156 new HPPs with a total capacity of 2800 MW and 800 small scale HPPs with a capacity of less than 2 MW each. Priority is given to Sreden Iskar, Gorna Arda, Sredna Vatcha, and Danube. The advantages of HPPs would be:

- safe,
- no direct emissions,
- no fuel costs,
- it is estimated that about 75% of investments are put in local equipment (no hard currency needed), construction works and local staff (employment).

Three HPPs are present along the Arda river in Haskovo region. Table 6.13 shows technical performance indicators of these HPPs. Clearly, the operation time is very low and full load utility ranges from 4% to 11%. The study mentioned above signals possibilities for increase of the generator capacity in Kardgali and 6% output increase in Ivailovgrad by replacement of turbine wheels.

Table 6.13 *Technical indicators of Hydro Power Plants in the region of Haskovo*

Plant	Project indicators			1992 indicators			Average indicators		
	Capacity [MWe]	Utility [hours/year]	Production [GWh]	Capacity [MWe]	Utility [hours/year]	Production [GWh]	Capacity [MWe]	Utility [hours/year]	Production [GWh]
Kardgali	106	1550	164	106	490	52	106	990	105
Studen kladenetz	60	3610	217	60	962	58	60	2567	154
Ivailovgrad	108	2010	217	108	558	60	108	1470	159
Total: kaskada 'Arda'	274	2182	598	274	620	170	274	1525	418

7. NATIONAL AND REGIONAL ENERGY BALANCES

7.1 Energy balances

The energy balance of a country or a region gives an overview of energy supply and demand. For the year 1993, the energy balance for Bulgaria is presented in table 7.1 and for Haskovo in table 7.2. Energy carriers are presented in columns, while the different sectors or categories of energy consumption are written in rows. The energy balance consists of three main parts, viz. primary energy balance, final energy supply and final energy demand.

The first part, primary energy balance, accounts primary energy carriers (and electricity) that are imported, extracted (production), storaged or exported from the country or the region.

The second part, final energy supply, accounts the difference between consumption and production of energy carriers in the energy supply sector. Consumption (use) is designated with a minus sign, production with a plus sign. Transportation losses, non-energy consumption of industry and consumption of energy production industry are accounted for in separate lines. For Haskovo, however, energy consumption of the energy production industry is accounted for in the final energy supply part, since this has the advantage that consumption is visible for each energy supply subsector. Furthermore, for Haskovo non-energy consumption is included in the third part, final energy demand, since no distinction could be made between energy and non-energy consumption.

The final energy demand accounts for all final energy carriers consumed by each economic sector. Eastern European statistics account steam production in industry to the energy supply, and account steam consumption of industry in the final energy demand. European Union statistics account fuel consumption of industry in final energy demand, whether it is used for steam or not. Exception is steam generated by Combined Heat and Power which delivers electricity to the public electricity grid, which is accounted for in energy supply. For Haskovo, the EU method has been used because only fuel consumption data of industry was available, except for large CHP producers, which were included in energy supply. Furthermore, fuel consumption for transportation is accounted for in the sector transport, not in the sector for which transport has taken place (e.g. households, industry etc.).

It must be noted that data collection has taken place on more types of energy carriers than mentioned in the tables. For instance data on demand for lignite, hard coal, briquettes, cokes, wood, municipal waste etc. have been collected and are available, but for reasons of presentation these energy carriers are categorized as 'solids'. The same applies for oil, gas and renewables. A detailed regional energy balance is presented in Appendix D.

National balance

Manufacturing & construction and residential buildings used together 80% of total electricity consumption. Electricity consumption accounted for one fifth of total final energy demand. Electricity consumption per capita is comparable with countries like UK, Denmark, and the Netherlands and higher than Greece, Spain, and Italy.

However, Bulgarian GDP is not close to their GDP. Final oil consumption has the highest share in total final energy demand (FED), viz. almost one third. A share of 86% of total final oil consumption is used for transportation purposes (freight and passenger). Solids and gas have very modest shares, viz. 13% and 11% but are also used for steam and heat generation for industry and residential buildings. Including steam and heat generation and non-energy use, gas consumption has a share of 40% of energy consumption in industry. Renewable energy is hardly applied in demand sectors. It concerns 0.2 PJ solar energy used by solar boilers in manufacturing and services and 0.8 PJ geothermal energy used for baths (services) and heating (agriculture and manufacturing).

Obviously, industry has the largest share of over 40% in final energy demand. Including steam generation and non-energy consumption, it accounts for about half of final energy demand. Transport accounts for more than a quarter of final energy demand, residential for slightly less. However, shares are 24% and 20% if industrial non-energy consumption and steam generation are included in the total demand. Public services, agriculture, and commercial sector have a very low share of FED of 7% together.

The electricity sector uses mainly uranium and lignite (90% of fuel mix). It should be noted that uranium is presented in fossil fuel equivalents, with an average conversion efficiency of 37.5%. Transportation losses of electricity are quite high (12%).

The primary energy balance illustrates that Bulgaria is very dependent on energy imports. Uranium from Russia, hard coal from Ukraine, gas from Russia and oil from CIS countries are forming the major part (about 75%) of primary energy requirements. The rest of primary energy requirements consists mainly of indigenous lignite production.

Regional balance

The regional balance for Haskovo is consistent, but has a higher level of aggregation with respect to the economic sectors. Agriculture and commercial demand could not be distinguished as separate sectors. Electricity demand of both sectors is included in public services. Fuel consumption of these sectors, the majority being small consumers, is mainly included in residential demand. Transport is excluded from the data collection. Note that non-energy consumption and most fuels for steam production are included in FED for industry. Other differences between table 7.1 and table 7.2 are the following:

Table 7.1:
- wood is included as a non-renewable fuel,
- non-energy consumption is specifically listed.

Table 7.2:
- wood is included as a renewable fuel,
- non-energy consumption is included in final energy supply.

Table 7.1 *National energy balance for Bulgaria for the year 1993 [PJ]*

Energy carriers	Electr	Heat	Urani um	Hard coal	Brown coal	Briquet	Coke	Wood non-ren	Natur al gas	Refinery gas	Coke gas	Crude oil	gasoline	kerosene	gasoil	LPG	naphta	heavy oil	solar heating	geo thermal	hydro	total
Primary energy																						
Import	6		153	101					158			236	6	1	17	1	5	10				694
Production				6	207			8	2			2							0.2	0.8	7	234
Export	6												6		16							29
Stock changes				10	5				-1			-4	1	8	4			6				29
Primary energy balance	0		153	118	212			8	159			234	1	9	5	1	5	16	0.2	0.8	7	929
Final energy supply																						
(use (-)/prod (+))																						
Briquettes production					-27	26																-1
Cokes production				-31			21				6											-4
Oil refinery										8		-234	67	9	51	3	1	83				-11
Public electricity	137		-153	-49	-163				-22									-14			-7	-271
Process steam		83		-22	-2			-2	-30								-4	-34				-12
Public district heat		60		-3	-13				-37									-18				-12
Final energy supply	137	143	-153	-105	-205	26	21	-2	-89	8	6	-234	67	9	51	3	-3	-17			-7	-309
Transportation losses	17	6					1		3													27
Final non-energy cons.									24				30									54
Cons. en. prod. industry	22	19		1					3		2							12				59
Final energy demand																						
Agriculture	2	3															1	5		0.4		12
Man. & const.	39	78		1	1		15		42	1	2					1		9	0.1	0.1		192
Public services	10	6			1			1	0								1	1	0.1	0.3		18
Commercial buildings	5	1							0								1					8
Residential buildings	36	27		2	6	26		6								2						105
Transport	3	1											42	17	57		1	9				778129
Final energy demand	94	115		4	8	27	15	7	42	1	2		42	17	57	3	3	24	0.2	0.8		464
Statistical errors	4	3		8	-1		5	-1	-2	7	2		-4			1	-1	-3				18

Table 7.2 *Regional energy balance for Haskovo region for the year 1993 [PJ]*

Energy carriers	Electricity	Heat	Brown coal	Briquettes	Natural gas	Gasoil	Naphta	Heavy oil	Renewable wood	Hydro	Total
Primary energy											
Import			10.6		12.7	0.2	0.1	9.3			32.9
Production			154.8						0.9	0.7	156.5
Export	22.0			22.6							44.6
Stock changes											
Pimary energy balance	-22.0		165.4	-22.6	12.7	0.2	0.1	9.3	0.9	0.7	144.8
Final energy supply											
(use (-)/prod (+))											
Briquettes production	-1.3	-6.7	-26.9	26.4							-8.5
Cokes production											
Oil refinery											
Public electricity	39.9	6.7	-137.1		-0.1			-0.9		-0.7	-92.1
Process steam	0.2	2.9	-1.4		-2.1						-0.4
Public district heat	0.1	0.9						-1.2			-0.2
Final energy supply	38.9	3.8	-165.4	26.4	-2.1			-2.1		-0.7	-101.3
Transportation losses	5.1	0.3			0.1						5.5
Final non-energy consumption											
Cons. en. prod. industry	2.2										2.2
Final energy demand											
Agriculture											
Man. & const.	3.5	3.1			10.4			7.2			24.2
Public services	2.3	0.1		0.2		0.2	0.1		0.0		2.9
Commercial buildings											
Residential buildings	3.7	0.3		3.5		0.1	0.1		0.9		8.5
Transport											
Final energy demand	9.6	3.4		3.8	10.4	0.2	0.1	7.2	0.9		35.6
Statistical errors											

After correction for transport demand, which is not present in the table, demand for electricity has an even higher share in the final energy demand than on the national level, viz. 20% versus 17%. Especially the residential sector is responsible for this higher share: more than 40% of households' energy consumption consists of electricity while this is 34% for the country. The share of solids (mainly briquettes) of household consumption is similar for Haskovo and the country, viz. 40%. Solids are mainly used in households, and not in industry, with the exception of Agrobiochim (which is included in supply). Natural gas has a share of 50% in industrial FED, which is higher than that on the national level, viz. 43%. The oil share in industrial FED is 30%, which is comparable with the country. A big difference with the national level is the small share of district heat in demand of residential and public buildings. Renewables are used in the form of wood from forestry companies and coal distribution companies (Toplivo). Geothermal energy and solar boilers are used but no data are available yet.

The regional final energy demand structure is not very different from the national demand structure. After correction for transport demand, industry accounts for more than half of FED, residential for 18% and public services for 6%.

Final energy supply is very interesting with respect to electricity production. Huge amounts of lignite, three times more than regional FED, are used for electricity production (TPPs Maritsa). Almost one third of national electricity production is located in Haskovo, based on domestic resources. Only approximately a quarter of the produced electricity is consumed in Haskovo. Electricity consumption of the mines in the region is included in the energy supply table. Lignite is also used in Galabovo for the production of briquettes, but only the losses are included in the supply table. Losses in the mining process and transportation to customers are not included in the table. Heavy oil consumption and heat and electricity production of the district heating in Kazanlak are included in the supply table. So is lignite and gas consumption and heat and power production of the CHP from Agrobiochim (Stara Zagora).

The main part of the production of the briquette factory is in the primary energy balance under solids in the row 'export', viz. export outside the region to the rest of the country. Also the main part of the electricity production is delivered to the rest of the country. Lignite is mainly produced by the Maritsa East and Marbas mines, although some lignite is received from a neighbouring region. Small quantities of hard coal are also imported. Natural gas and oil products are from outside the region and the country. Renewable energy concerns hydropower from kaskada Arda.

About a quarter of Haskovo primary energy requirements is imported in the form of natural gas, solids, and oil products from outside the region. Indigenous production is even larger than primary energy requirements, so that export outside the region in the form of high quality electricity and improved quality lignite (viz. briquettes) is about one third of primary requirements.

7.2 Reliability

The regional energy balance presented in the previous paragraphs looks quite accurate by its nature, viz. a table with numbers, even with decimals. The decimals in the regional energy balance are not included to indicate accuracy but are only used for reasons of presentation; regional energy consumption concerns considerably smaller quantities than national energy consumption. Here it is also mentioned that statistical errors of regional energy balance data are not zero but included in the export figures of energy carriers. However, some parts of the energy balance are quite precise while others are not. This section clarifies data sources and data reliability in order to give an impression of strong points but also weak spots in the assessed regional energy balance.

The national energy balance has been assessed by Energoproekt and was approved by the COE. Therefore, it will not be discussed here.

Regional final energy demand figures were collected from the following regional energy supply companies:

- electricity by municipality, sector, and large consumer from NEC Haskovo, NEC Stara Zagora and NEC Kardgali,
- coal, briquettes, and wood by municipality and sector from Toplivo Haskovo, Toplivo Stara Zagora and Toplivo Kardgali,
- wood consumption by sector and municipality from the regional forestry company;
- oil products such as heavy oil, diesel, naphtha to small consumers by municipality from Petrol,
- heavy oil to large consumers by firm from the refinery in Burgas,
- gas consumption by firm from Bulgargas Stara Zagora.

As became already clear from the balance, agricultural and commercial sectors are not distinguished separately in the municipal statistics. Fortunately, these sectors are quite small. Electricity consumption of these sectors is implicitly included in public services. The main part of fuel consumption of the sectors, being small consumers, is implicitly included in residential, the rest in industry. Industrial consumption is so large that it will not be affected to a large extend. However, residential consumption could be influenced by this. But, since oil products for agricultural transport have not been included in the balance, agriculture demand is very small and identical to residential energy consumption. There are no heated greenhouses in Haskovo.

Heavy oil supply to large consumers have been accounted to industry, assuming that public buildings are not fired with heavy oil.

Fuel consumption is quite accurate, for as far as sources for fuels have been taken into account. For instance, data on oil products from gas stations have not been collected, based on the assumption that fuels from gas stations are exclusively used for transport. However, no LPG demand was given by Petrol, implying that LPG for cooking could be purchased at stations.

Non-registered wood consumption is included in the balance. Renewable energy in the form of solar boilers or geothermal springs are not included, although it is known that both forms are used. The quantities will be small though.

Another leak in the balance could be coal purchased directly from the mines in Maritsa or the briquettes factory in Galabovo. Illegal electricity consumption is covered in the balance: it is included in the category losses.

The following data concerning final energy supply have been provided by Energoproekt, being a specialist on national energy supply for years:

- production and consumption of the Troianovo mines of Maritsa East and the Marbas mines in Dimitrovgrad,
- production, consumption and losses of the briquettes factory in Galabovo,
- heat and electricity production and fuel consumption of Kazanlak district heating, Agrobiochim CHP, Maritsa East TPPs, and Maritsa-3 TPP,
- production of HPP kaskada Arda.

A few remarks are in place. Heat produced by the district heating in Kazanlak is delivered to households, public buildings and industry. The division between sectors has been made on the basis of the Kantor Phare report on energy efficiency.

Transportation losses of heat of the district heating in Kazanlak have been estimated at 10% (source: Kantor Phare report on energy efficiency). Losses of electricity produced for consumption outside the region have been estimated on the basis of the percentage of national losses (12%). NEC estimated that the losses of electricity consumed in the region are higher, in the order of 15%. Natural gas losses are based on information of Bulgargas Stara Zagora, which estimate regional losses to be 1.3%. Average national losses in the natural gas network are estimated to be 1.8%. Coal losses in mining processing and transportation to the consumers are not explicitly included in the energy balance.

Summarizing, fuel consumption in energy supply and demand have the right order of magnitude. Some hidden energy consumption, mostly in the form of exotic or non-commercial energy carriers, may be missed in the energy balance. Weakly assessed categories are renewables and non-registered, non-renewable wood (solids). Furthermore, some oil product consumption could be lacking in the balance, wrongly being considered as automotive fuels. The residential demand could be influenced by implicit inclusion of commercial and agriculture fuel consumption.

Since energy consumption of commercial fuels seems to be covered quite completely, the primary energy balance can be seen as quite accurate, except for oil products.

8. NATIONAL AND REGIONAL EMISSIONS

It is very relevant to have information on environmental impacts of some emissions in the region, although it is not directly included in the objectives of the tasks 'Data collection' and 'Assessment of energy supply and demand'. A first impression can be given by annual emissions of SO_2 and CO_2 in the region in comparison with national emissions.

SO_2 and CO_2 emissions have been chosen because both are relatively easy to calculate, in contrast with for instance NO_x, based on the sulphur and carbon content and lower heating value of the fuel, assuming that no Flue Gas Desulfurization equipment is in use. Nevertheless, calculated emissions are based on average emission factors, and sulphur contents and heating values are uncertain and disputable. The emission factors which have been used for the SO_2 emissions estimates are presented in table 8.2.

Despite this uncertainty, a first estimation of regional emissions was made, and in order to be compatible, a national emission estimation was made in a similar way. It is very well possible that the calculated values differ from official emission calculations. In this section, first objective is to compare regional and national emissions.

The SO_2 and CO_2 emissions as have been calculated for the year 1993 are presented in table 8.1. National SO_2 emissions are high, mainly because of the use of lignite in energy supply. For instance, SO_2 emissions are around 200 kton in the Netherlands, 750 kton in Slovakia and 2300 kton in the Czech Republic. Considering the fact that Maritsa East is located in Haskovo region, it is not surprising that main part of national emissions is from Haskovo region. Nevertheless, it is very impressive that more than 50% of national SO_2 emissions originate in Haskovo.

At the same time, it means that end-use sectors have hardly a contribution to regional SO_2 emissions. Comparing with the national sector contributions, public services of Haskovo has a relatively high contribution, due to a higher consumption and in particular larger use of lignite and briquettes. In the country, in contrast with the region, a high share of district heating limits emissions in end-use sectors.

Regional SO_2 emissions in manufacturing & construction are about one ninth of national industrial SO_2 emissions. This is the combined result of a lower specific energy consumption and mainly a higher consumption of heavy products from oil in industry in the region. Emissions from non-energy consumption are included in these emissions, because the non-energy consumption in the region is not explicitly known. Therefore, emissions are called potential emissions, as opposite to actual emissions. Also, emissions from conversion in steam boilers are included in these emissions. Residential SO_2 emissions per capita are slightly lower for the region compared with the country, just as residential energy consumption per capita. Emissions from fuel combustion for district heating, particularly relevant for the country, are included in energy supply. The same applies for electricity consumption, which is more applied for heating in the region than in the country.

It should be noted that SO_2 emissions from Maritsa East power plants are planned to be reduced by the installation of Flue Gas Desulphurisation equipment in the near

future. In section 6.5. these plans have been described. FGD could reduce emissions with 90% of the current level. However, operation costs will be high if such large amounts of sulphur have to be absorbed.

Regional CO_2 emissions contribute a high share of almost 30% to national CO_2 emissions. This share is not as high as the regional SO_2 emission share, which is explained by the fact that CO_2 is emitted to some extend by all fossil fuels used in all sectors. The national energy supply sector contributes more than 50% to national CO_2 emissions, while the regional energy supply emits approximately 46% of those emissions. CO_2 emissions from the public sector are relatively high in Haskovo. This is due to a high overall consumption and in particular a high share of briquettes and lignite consumption, in contrast with a high share of district heating for the country.

CO_2 emissions from industry in Haskovo are relatively low due to lower specific energy consumption, a lower coal share and a higher gas share. Residential CO_2 emissions are relatively low in the region due to low overall energy consumption and renewable wood consumption, of which the net emission factor is 0, are responsible for the low CO_2 emission per capita.

Table 8.1 *Estimates of SO_2 and CO_2 emissions for Bulgaria and Haskovo region for the year 1993*

Sector	SO_2 emission			Potential CO_2 emission		
	[kton]		National share [%]	[kton]		National share [%]
	Bulgaria	Haskovo	Haskovo	Bulgaria	Haskovo	Haskovo
Energy supply	1398	923	66	32729	14907	46
Agriculture	9			460		
Man. & constr.	199	22	11	16696	1460	9
Public services	6	1	24	251	47	19
Commercial	1			156		
Residential	155	16	10	4152	390	9
Transport	28	3	*11*	9366	*1041*	*11*
Total	1796	965	54	63811	17845	28

Italic values for transport are derived by taking a share of the national value proportional to the population

Table 8.2 *SO_2 emission factors and corresponding sulphur contents used in the analysis*

Fuel	SO_2 factor [kg/TJ]	S-content [dry mass-%]
Average lignite	5700	2.1
Haskovo lignite	6337	2.6
Briquettes	4543	4.0
Imported hard coal	1419	1.7
Heavy oil	1760	3.5
Gasoil	191	0.4
Gasoline	18	0.04
Natural gas	0	0.00
Wood	20	0.01
Biogas/waste	40	0.04

9. MUNICIPALITY COMPARISON

The energy consumption pattern of the region of Haskovo will be analysed in this chapter by comparison of energy consumption indicators of the 27 municipalities, as already illustrated by figure 3.1. The municipal final energy demand is described firstly, whereafter the energy demand of the three distinguished sectors, namely manufacturing and construction, public services and residential sector are presented. The chapter ends with a municipality characterization, based on economic indicators of municipalities.

Energy saving potentials have been estimated for each municipality. The industrial energy saving potential of a municipality is based on the difference between the actual industrial energy intensity and a national benchmark of the industrial energy intensity. The energy saving potentials of public services and the residential sector of a municipality are based on the difference between the municipal and regional specific energy consumption. Here, a national benchmark is not used due to reasons of data availability and data comparability. This characterization must be interpreted as a first indication of the size of energy saving potentials present, based on available data and related to Bulgarian standards. It provides a background for a following bottom-up assessment of energy saving potentials.

The energy supply sector is not included in this analysis, simply because of the fact that most of the existing energy supply companies in the Haskovo region have a regional or even a national impact. In Chapter 6 a detailed description is given of the CHP and TPP power plants in the region of Haskovo. More available municipality data is listed in Appendix E.

9.1 Final energy demand

In Haskovo a few municipalities can be distinguished, which consume a more than average amount of energy, as illustrated by figure 9.1. The high energy consumption is a result of the presence of industrial enterprises, of which the large consumers already have been mentioned in chapter 6: Agrobiochim in Stara Zagora, Arsenal in Kazanlak and Neochim and Vulkan in Dimitrovgrad. Enterprises in Haskovo regional industry are consuming mainly electricity and oil, except for Agrobiochim, Neochim and Vulkan (natural gas).

In figure 9.2 and 9.3 the total energy consumption per municipality by fuel and by sector are given. From figure 9.2 it can be concluded that the fuel demand structure of considered municipalities vary to a large extent, which is quite obvious. For example, oil is mainly used in the industrial sector. Therefore, the oil consumption of municipalities having a high developed industrial sector is quite significant.

Large energy consuming municipalities, having an energy consumption of about 10000 TJ, are Dimitrovgrad and Stara Zagora. In the industrial sector of these municipalities natural gas is consumed. Municipalities, having a middle energy consumption of 1000-5000 TJ, are Galabovo, Haskovo, Kardgali, Kazanlak and Radnevo. These municipalities are characterized by a significant fuel share of oil, consumed in the industrial sector. For the industrial areas of the following

mended to analyse the possibilities of switching from oil to natural gas, solids or renewables: Dimitrovgrad, Stara Zagora, Galabovo, Haskovo, Kardgali, Kazanlak Radnevo and also Harmanli, where the share of oil consumption of total energy consumption is quite substantial.

The energy consumption of the other municipalities, having a low energy consumption, is strongly influenced by the demand of households and public services. Consequently, the share of solid fuels, renewables (wood) and (here and there) electricity is large in these municipalities. The residential demand for oil is negligible, due to the increased price of naphta over the last years. In the past years, natural gas was not an alternative for residential use, simply because of the fact that a gas distribution network is not present for small consumers. The residential energy demand of Galabovo and Tchirpan, having a considerable energy consumption, appear to be high (figure 9.3) and not typical compared to other large energy consuming municipalities. This is also reflected by a large share of solid fuels in total energy consumption. Therefore, the available residential energy demand data of Galabovo and Tchirpan are considered to be not reliable.

In Galabovo, where the briquette factory is situated, about 25% of regional solid fuel demand is consumed. The solid fuel consumption of Galabovo is assigned to the residential sector, leading to an extremely high and thus questionable specific energy consumption per household (176 GJ/household). Apparently, a relatively large amount of the (regional) solid fuel consumption is assigned to the residential sector of the municipality of Galabovo.

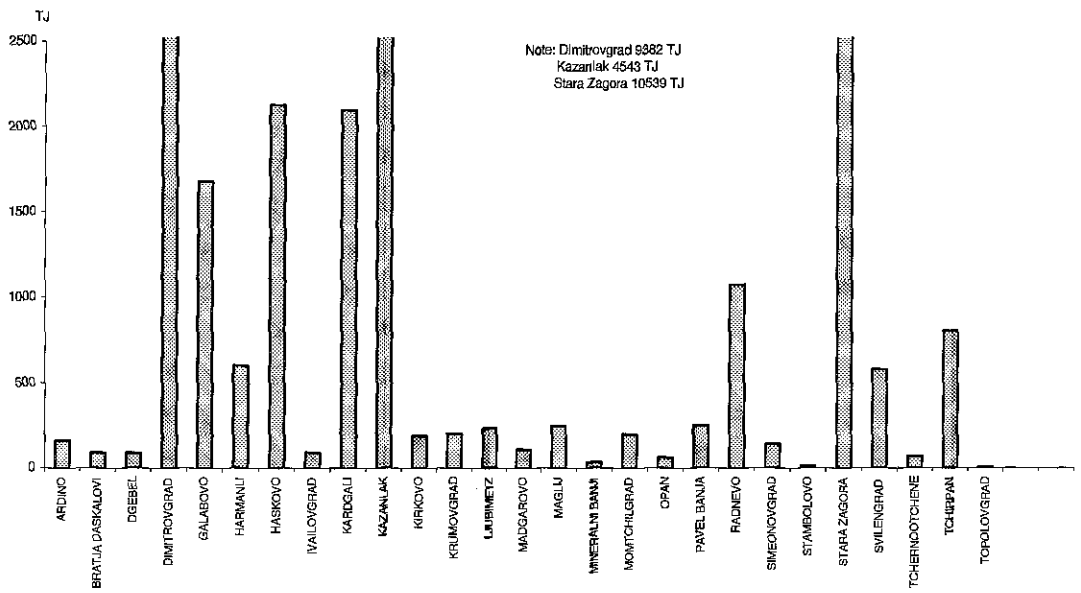


Figure 9.1 *Total energy consumption per municipality in the Haskovo region, year 1993*

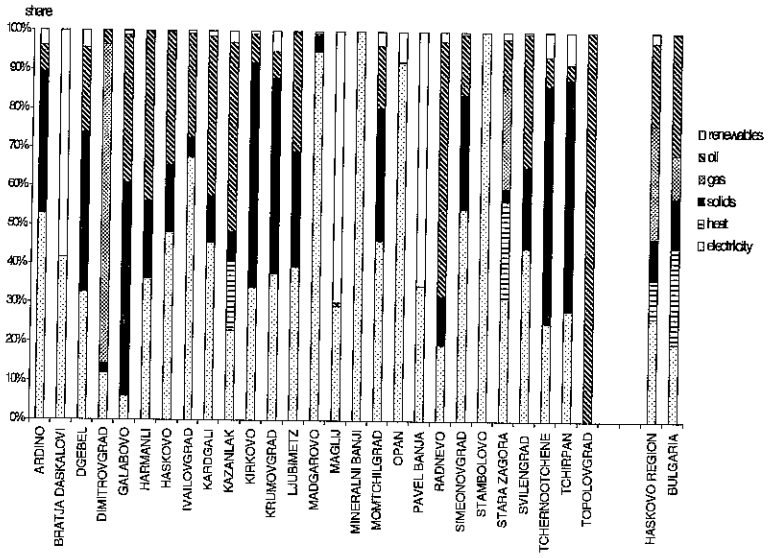


Figure 9.2 *Total energy consumption per municipality in the Haskovo region by fuel, year 1993*

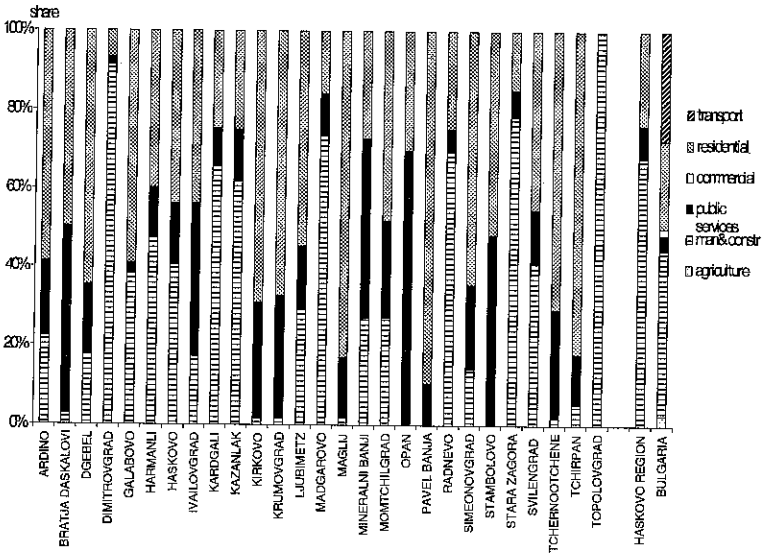


Figure 9.3 *Total energy consumption per municipality in the Haskov region by sector, year 1993*

In table 9.1 figures of energy consumption and energy consumption indicators (hereafter called indicators) are summarized for all municipalities. For these indicators a municipality ranking is calculated. Grey areas displayed indicate that the municipality indicator is among the 6 highest of all municipalities in the Haskovo region. For this, the ranking of fuel consumption indicators are not based on the absolute figure of the specific indicator, but on the fuel consumption shares of total municipal energy consumption. For example, looking at table 9.1 it can be seen that the electricity consumption in Madgarovo is quite small (104 TJ). However, a grey area is displayed because of the fact that in Madgarovo the electricity share of total energy consumption is among the 6 highest of all municipalities in the region.

The data from table 9.1 form the basis for the sector discussion of municipalities in the next paragraphs.

Table 9.1 *Energy consumption data and indicators of municipalities in Haskovo region (for explanation grey areas: see text paragraph)*

Municipality comparison 1993	Energy consumption							Sectoral energy consumption			Indicators		
	total	electricity	heat	solids	gas	oil	renewables	man & constr	public	residential	man & constr	public	residential
	[TJ]	[TJ]	[TJ]	[TJ]	[TJ]	[TJ]	[TJ]	[TJ]	[TJ]	[TJ]	[kJ/Leva]	[GJ/cap]	[GJ/m^2]
Ardino	160	85		58		11	6	36	30	94	1136	1.7	0.16
Bratja Daskalovi	90	37		0		0	53	3	43	45	10244	3.5	0.10
Dgebel	87	28		36		19	4	15	15	56	179	1.4	0.13
Dimitrovgrad	9382	1129		232	7677	342	2	8577	187	618	5225	2.6	0.33
Galabovo	1678	106		917		638	18	646	41	991	1297	2.3	2.02
Harmanli	600	216		122		261	1	286	75	239	562	2.4	0.29
Haskovo	2128	1023		368	1	729	7	862	335	931	277	3.3	0.37
Ivailovgrad	92	62		5		25	1	16	36	40	257	3.5	0.13
Kardgali	2095	955		253		861	26	1378	201	517	492	2.6	0.25
Kazanlak	4543	1057	772	343		2240	131	2701	602	1240	1291	6.8	0.57
Kirkovo	190	64		110		14	1	3	56	131	140	1.7	0.13
Krumovgrad	202	76		102		14	11	3	63	136	43	2.0	0.17
Ljubimetz	231	91		69		71	1	68	37	126	704	3.0	0.36
Madgarovo	109	104		4		1	1	80	12	17	2052	2.9	0.15
Maglij	246	72		0		2	172	5	37	205	40	1.5	0.32
Mineralni Banji	32	32		0		0	0	9	15	9	1198	1.9	0.04
Momtchilgrad	200	92		69		32	7	54	50	96	206	2.4	0.16
Opan	61	56		0		0	5	0	42	18	71	9.2	0.11
Pavel Banja	249	86		0		0	163	0	26	222	8	1.5	0.52
Radnevo	1073	209		134		703	27	745	63	265	124	2.4	0.36
Simeonovgrad	140	76		41		22	1	20	30	90	234	2.6	0.29
Stambolovo	11	11		0		0	0	0	5	6	0	0.7	0.02
Stara Zagora	10539	3323	2637	330	2729	1340	179	8249	725	1565	1373	4.1	0.37
Svilengrad	578	257		121		198	3	237	80	261	518	3.0	0.39
Tchernootchene	67	17		41		5	4	1	18	47	0	1.5	0.18
Tchirpan	804	229		478		31	66	42	101	660	80	3.4	0.84
Topolovgrad	5	0		0		5	0	5	0	0	25	0.0	0.00
Haskovo region	35592	9494	3409	3834	10407	7562	886	24042	2925	8625	969	3.2	0.36

9.2 Manufacturing & construction

The energy consumption of municipalities is strongly related to the local economic activity. The production structure of the Haskovo region is quite similar to the national industrial structure, as already illustrated by figure 4.2 and figure 5.10. In Haskovo the main industrial activities take place in Dimitrovgrad, Haskovo, Kardgali, Kazanlak, Radnevo and Stara Zagora. In Dimitrovgrad the economic output is to a large extend determined by Neochim and Vulkan, in contrast with Radnevo, where the economic output is distributed over smaller industrial energy consumers. However, in the Haskovo region the contribution of small industrial energy consumers to total industrial final energy demand is hardly substantial.

In figure 9.4 the industrial energy consumption of all municipalities is presented. The energy consumption in Dimitrovgrad and Stara Zagora contribute to 70% of total industrial energy consumption in Haskovo. In Dimitrovgrad more than 70% of regional gas demand is consumed, mainly by Neochim. The industrial fuel demand structure of Stara Zagora is diverse (see Appendix E), in contrast with other municipalities. This is a result of the presence of large industrial consumers, which use natural gas and heat.

Small industrial consumers only demand electricity and oil. This is illustrated by the fuel demand structure of Radnevo, where the industrial economic output is at the same level of Stara Zagora (see Appendix E), but having a high share of oil products in total industrial energy demand.

In figure 9.5 the actual and estimated energy intensity of the industrial sector of all municipalities are presented. The actual energy intensity is based on available data of total industrial energy demand and total industrial economic output. The estimated energy intensities are based on subsectoral economic output data and national subsectoral energy intensities. This approach is already described in paragraph 5.3. From figure 9.5 it can be seen that for 12 municipalities the actual energy intensity is higher than the estimated energy intensity. In other words: compared to the current national level a lower industrial energy consumption could be expected. This can be induced by two factors: the energy efficiency of industrial production processes is relatively low or the industrial production of energy intense products is quite high. A low energy efficiency implies a considerable energy saving potential for energy saving measures and energy efficiency improvements of industrial production processes. The energy saving potential for energy saving measures and energy efficiency improvements of industrial production processes seems to be substantial in the considered 12 municipalities. This is particularly the case for Dimitrovgrad, Madgarovo and Stara Zagora, where the actual energy intensity is larger than the national averaged energy intensity.

As already discussed in paragraph 5.3, the estimated energy intensity is quite sensitive for the assumed benchmark of the energy intensity of the sector 'Others'. After increasing the energy intensity of the sector 'Others' from to 67 to 400 kJ/Leva, the average regional estimated energy intensity comes to the same level as the actual regional energy intensity. The estimated energy intensities of the industrial sector in Dgebel, Kirkovo, Krumovgrad, Madgarovo, Mineralni Bani and Momtchilgrad increase more than 50%. The economic output of the industrial sector of these municipalities is to a very large extent determined by the sector 'Others' (see also Appendix E). Only for the municipalities Kirkovo, Momtchilgrad and Svilengrad the estimated energy intensity come to the same level as the actual energy intensity. Of all large and middle energy consuming municipalities (Dimitrovgrad, Stara Zagora, Galabovo, Haskovo, Kardgali, Kazanlak and Radnevo), the increased energy intensity of the sector 'Others' only significantly affect the estimated energy intensity of Haskovo. As mentioned in paragraph 5.3, the actual energy intensity of the industrial sector in the region of Haskovo region is about 10% lower than the national level. The difference could be partly explained by differences in industrial structure.

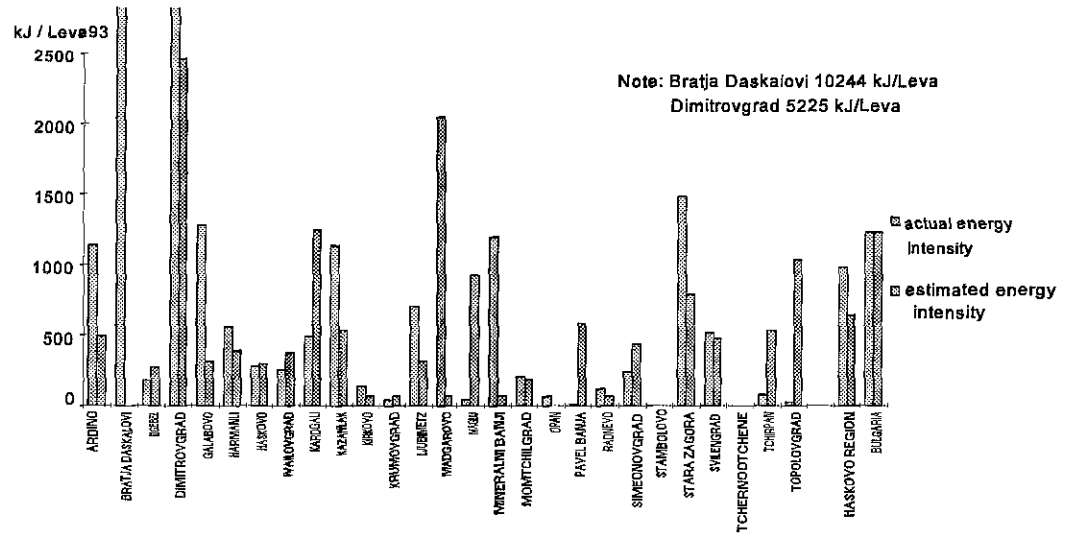


Figure 9.5 *Actual and estimated energy intensity of the manufacturing and construction per municipality in the Haskovo region, year 1993 (for Bratja Daskalovi, Opan, Stambolovo and Tchernootchene no economic output data are available)*

Here it is added that the influence of the subsector 'Others' is not significant. The difference is mainly determined by the other subsectors.

It is noticed that in Dimitrovgrad, Kardgali, Kazanlak, Madgarovo, Radnevo and Stara Zagora the share of industrial energy consumption of total final energy demand is relatively large. This implies that industrial energy saving measures and energy efficiency improvements will substantially affect the total energy consumption of these municipalities.

The estimated energy intensity of the industrial sector in Radnevo is considerably higher than the actual energy intensity. This is a result of the high economic output of the industrial sector in Radnevo. However, the reliability of the economic output data seems to be questionable: in the year 1993 the level of economic output per capita is more than 8 times higher than the regional level. As a matter of fact, for Radnevo only total industrial economic output data is available. Industrial activities are developed in the sectors food, beverages & tobacco. The large energy consumers are mainly energy supply companies. Apparently, the economic output of these enterprises are included in the figure of economic output of the industrial sector of Radnevo.

9.3 Public services

The presence of public services in municipalities is strongly related to the number of inhabitants. Therefore, total energy consumption of public services is large in Dimitrovgrad, Haskovo, Kardgali, Kazanlak and Stara Zagora (figure 9.6). The specific energy consumption per capita of public services in Bratja Daskalovi, Ivailovgrad, Kazanlak, Opan, Stara Zagora and Tchirpan are higher than the average level in the region (figure 9.7). The pattern of the specific energy consumption per capita is quite uniform, but the regional specific energy consumption of public services is about 45% higher than the national level. This could be partly explained by

the fact that the regional electricity consumption of agriculture, the commercial sector and transport is included in the public electricity consumption, which is not the case for national data. As a matter of fact, the public energy consumption is lower than the national level for only 9 municipalities.

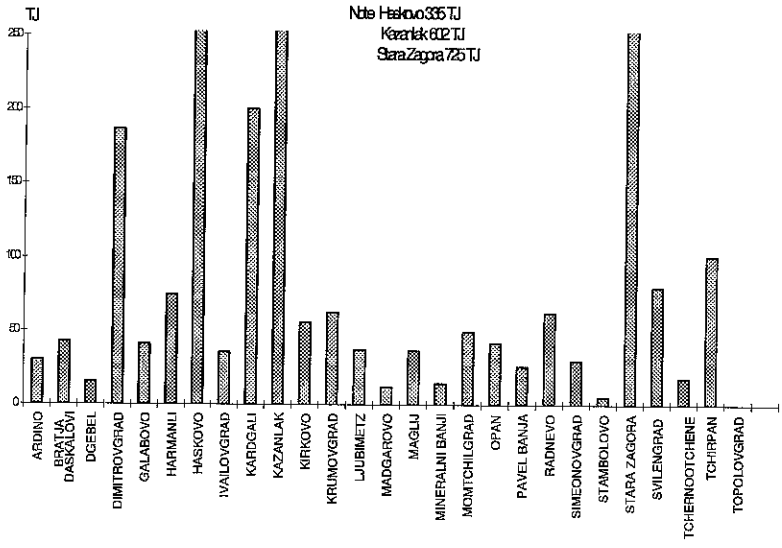


Figure 9.6 *Energy consumption of public services per municipality in the Haskovo region, year 1993*

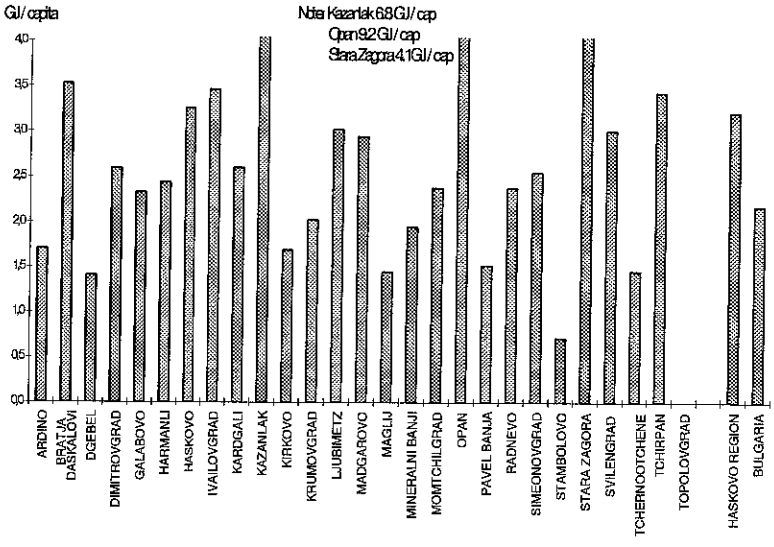


Figure 9.7 *Energy consumption of public services per capita per municipality in the Haskovo region, year 1993*

In Appendix E the fuel demand structure of public services per municipality is given for the year 1993. The electricity share of total energy consumption amounts for 79% (Haskovo region) resp. 52% (national level). Differences of fuel demand structure which can be observed between municipalities are likely to be determined by local financial conditions or a steady energy demand behaviour, set by technical restrictions, ideas about comfort, local climate conditions or an habituation to the specific end-use technology.

9.4 Residential sector

In paragraph 5.5 it is mentioned that the specific energy consumption of the residential sector in the Haskovo region is about 10% lower than the national average. This could be a result of several factors, as for instance the high share of electricity (all energy losses are assigned to the electricity supply sector), the 10% lower number of degree days, counterbalanced by the higher share of primitive and brick houses in the Haskovo region. Here the residential energy demand is analysed on the basis of several energy consumption indicators which are available for the municipalities in the Haskovo region.

In figure 9.8 and figure 9.9 the total energy consumption resp. the specific energy consumption are presented. Large residential energy consumers are Dimitrovgrad, Stara Zagora, Galabovo, Haskovo, Kardgali, Kazanlak and Tchirpan. As already noticed in paragraph 9.1, the residential energy consumption in Galabovo and Tchirpan, being 155 GJ/household (2.0 GJ/m^2) resp. 61 GJ/household (0.8 GJ/m^2) in the year 1993, are questionable high. Furthermore, residential energy demand in Kazanlak (where district heating is utilised) and Pavel Banja are also above the regional average. The residential specific energy consumption in Mineralni Bani is extremely low. However, the demand for geothermal energy is not included in the residential energy demand data of Mineralni Bani, as illustrated in Appendix E, where the fuel demand structure of the residential sector of all municipalities are given.

Comparing the fuel demand structure per municipality, structural differences appear to be quite large. In municipalities having a large share of primitive and brick dwellings (see Appendix E), the share of wood and solids are high. Higher shares of electricity can regularly be found in municipalities having a relatively large amount of concrete-frame and concrete-panel dwellings. These type of households are not equipped with chimneys. Here it concerns particularly Dimitrovgrad, Haskovo, Kardgali, Kazanlak, Radnevo and Stara Zagora, of which Radnevo is quite small (about 20000 inhabitants). Furthermore, the specific residential energy consumption (GJ/household or GJ/m^2) in these municipalities is compared to other municipalities relatively high (after correction of the residential energy demand data of Galabovo and Tchirpan to more realistic values). It is likely that this is a result of the expected higher average income in these municipalities. Unfortunately, due to a lack of sufficient data, this assumption can not be fully verified. However, it can be noticed that in these municipalities a high industrial economic output per capita can be found (see Appendix E). Obviously, not only local financial circumstances but also habituation on comfort standards of electrical heating systems can result in a relatively high specific residential energy consumption.

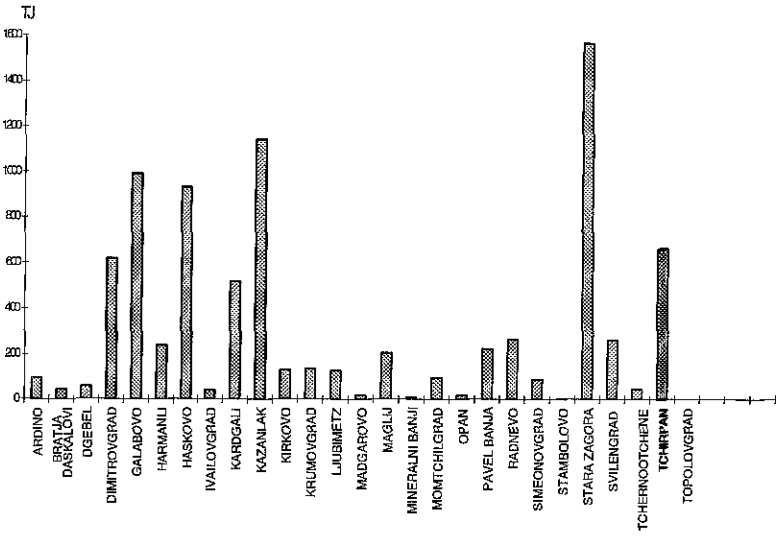


Figure 9.8 *Energy consumption of the residential sector per municipality in the Haskovo region, year 1993*

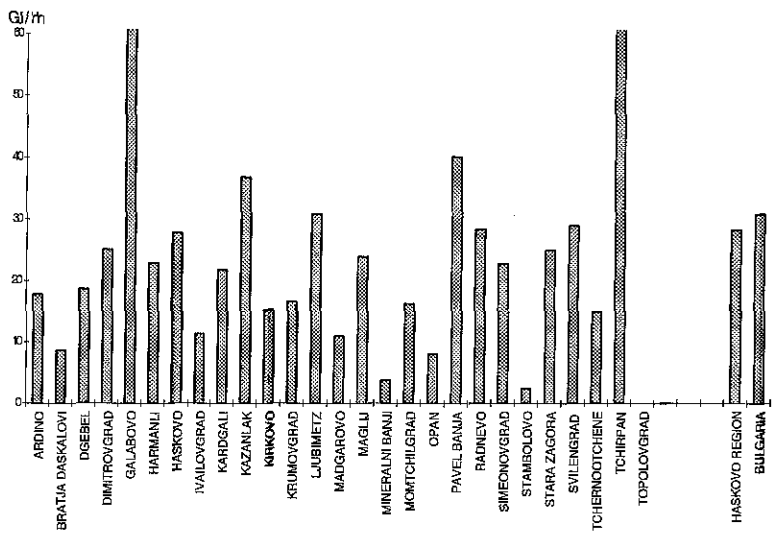


Figure 9.9 *Energy consumption of the residential sector per household per municipality in the Haskovo region, year 1993*

Summarized it can be concluded that the specific residential energy consumption is expected to be higher in municipalities having a well developed industrial sector, a high amount of inhabitants and a high share of concrete-frame and concrete-panel dwellings. Furthermore, it is noticed that in these municipalities the share of electricity consumption of total residential energy consumption is high. Energy conversion losses of the electricity production sector are not included in the figures of specific residential energy consumption. Therefore, energy saving measures are likely to be significant in electrical heated concrete-frame and concrete-panel dwellings.

9.5 Municipality characterization

The socio-economic context in a municipality is important to understand the present situation and to evaluate potentials for future developments. An economic characterization, carried out by the Regional Office in Haskovo, is combined with a first estimate of energy saving potentials within different energy demand sectors of the individual municipalities. The analysis - municipality characterization - result in a top-down (macro-economic) indication of prioritised municipalities and energy demand sectors in respect of regional energy saving actions.

Energy saving potential characterization

The municipal energy saving characterization in the present report is based on the approach as described in figure 9.10.

Energy saving potential industrial sector

= Industrial economic output x (actual energy intensity - estimated energy intensity)

The actual energy intensity is based on available data of total industrial energy demand and total industrial economic output. The estimated energy intensity is based on subsectoral economic output data and national subsectoral energy intensities (see also paragraph 5.3 and 9.2).

Energy saving potential public services

= number of inhabitants x (GJ/cap public services municipality - GJ/cap public services regional average)

Regional average level of specific energy consumption of public services is equal to 3.2 GJ/cap, year 1993.

Energy saving potential residential sector

= number of total square metres of dwellings x (GJ/m^2 residential sector municipality - GJ/m^2 residential sector regional average)

The regional average of specific energy consumption of the residential sector is equal to 0.31 GJ/m^2, year 1993. The residential energy demand data of Galabovo and Tchirpan are corrected to more realistic values. As a result of this, the average of specific energy consumption decreases from 0.36 GJ/m^2 to 0.31 GJ/m^2.

Figure 9.10 *Approach municipality characterization based on estimated energy saving potentials*

It is noticed that the industrial energy saving potential of a municipality is based on the difference between a municipal indicator (actual industrial energy intensity) and a related national benchmark of this indicator (estimated industrial energy intensity). However, the energy saving potentials of public services and the residential sector of a municipality are based on the difference between the municipal specific energy consumption and a regional benchmark (regional average).

Here, a national benchmark is not used mainly because of two reasons:

- Data comparability: because of statistical differences the municipal energy consumption of public services is not comparable with the national level. The regional electricity consumption of agriculture, the commercial sector and

transport is included in the electricity consumption of public services, which is not the case for national data. Therefore, the regional specific energy consumption of public services is about 45% higher than the national level (see paragraph 9.3).
- Data availability: because of a lack of national indicator data (i.e. m^2, type of dwellings etc.) the municipal energy consumption of the residential sector can not be compared appropriately with national residential energy consumption data.

The height of the energy saving potentials as assessed according to this approach must be considered as relative to the national energy saving potential (industrial sector) resp. regional energy saving potential (public services and residential sector). This implies that the contribution of a municipality to the regional energy saving potential can be negative. It is decided to use the following energy saving potential definition:
- A positive municipal energy saving potential calculated relative to the benchmark implies a high municipal energy saving potential.
- A municipal energy saving potential of approximately zero calculated relative to the benchmark implies a medium municipal energy saving potential.
- A negative municipal energy saving potential calculated relative to the benchmark implies a low municipal energy saving potential.

The assessed energy saving potential is the summarized potential of energy efficiency improvements of energy conversion processes, structural energy saving measures (for example fuel switch) and energy saving measures which affect the demand level. Evidently, for small municipalities having a low energy saving potential, the implementation of energy saving measures can still be very attractive.

The approach should be considered as a first but useful indication. It gives an overview of the presence of local energy saving potentials, based on available data. In table 9.3 the results of the approach are presented.

Economic characterization

The Regional Office of Haskovo has carried out an economic study in which municipalities are characterized according to economic criteria. It provides a useful socio-economic context for the municipal energy saving potential characterization. The economic characterization is categorized by the economic potential and the economic adaptation level of municipalities. The economic potential is based on the long term economic perspective of a municipality, identified by the following criteria:
- financial and capital conditions: current economic activities, current technical conditions, existence of financial funds etc.,
- current social conditions, i.e. labour force, unemployment rates, education level and qualification degree of the population.

Indicators are for example the economic output, economic output per capita, labour force and unemployment rates.

The economic adaptation level for economic incentives is identified by the following criteria:
- current development of economic production,
- process of economic restructuring and privatization,
- attractiveness for foreign investments in specialized activities.

Indicators are for example the development of economic output, amount of enterprises which are out of business, amount of foreign capital invested etc. In table 9.2 the results of the economic characterization are presented. Municipalities which score high on both economic potential and adaptation have good chances on a good economic future. These municipalities are indicated by the grey area.

The results of the municipality analysis of energy saving potentials are presented in table 9.3. Energy saving potential in industry is presented horizontally, saving potential in public services and residential sector are presented vertically. Note that, unlike in table 9.2, these axes represent independent and complementary information. A high industrial energy saving potential is likely to be found in Stara Zagora, Kazanlak, Dimitrovgrad and Galabovo. Besides the large difference between the actual and estimated energy intensity of these municipalities, a large and high energy intense industry is present. The economic potential of these municipalities is also considered as being high. The level of economic adaptation differs for these municipalities.

Table 9.2 *Municipality characterization based on economic indicators of municipalities in the Haskovo region (source: Regional Office Haskovo)*

Economic characterization		Economic potential		
		high	medium	low
Economic adaptation level	high	Kazanlak; Haskovo	Svilengrad	Dgebel; Simeonovgrad
	medium	Stara Zagora; Dimitrovgrad; Kardgali	Topolovgrad; Harmanli	Ivailovgrad; Krumovgrad; Ljubimetz; Madgarovo; Mineralni Bani; Momtchilgrad
	low	Galabovo; Radnevo	Tchirpan; Maglij	Ardino; Bratja; Kirkovo; Opan; Pavel Banja; Stambolovo; Tchernootchene

Table 9.3 *Municipality characterization based on estimated energy saving potentials of municipalities in the Haskovo region, year 1993*

Energy saving potential characterization		Manufacturing and construction		
		high	medium	low
Public services and residential sector	high	Stara Zagora; Kazanlak	Svilengrad	Haskovo; Pavel Banja
	medium	Dimitrovgrad; Galabovo	Harmanli; Ljubimetz	Radnevo; Tchirpan
	low		Ardino; Kirkovo; Madgarovo; Mineralni Bani; Momtchilgrad	Bratja; Dgebel; Ivailovgrad; Kardgali; Krumovgrad; Maglij; Opan; Simeonovgrad; Stambolovo; Tchernootchene; Topolovgrad

A high potential of energy saving measures which can be implemented in public services and the residential sector is likely to be found in Stara Zagora, Kazanlak, Svilengrad, Haskovo and Pavel Banja. This is mainly a result of the high specific energy consumption of the residential sector in these municipalities. Obviously, the energy saving potential of public services and the residential sector in Svilengrad and Pavel Banja is significantly lower than in Stara Zagora, Kazanlak, and Haskovo, simply because of the lower number of inhabitants. Generally, it can be seen that a low potential of energy saving measures which can be implemented in public services and the residential sector can be found in small municipalities, for which the economic potential is also considered as being low. Exceptions to this rule are only Kardgali (low energy saving potential, high economic potential), Topolovgrad (low energy saving potential, medium economic potential) and Maglij (low energy saving potential,

medium economic potential). As already mentioned before, for municipalities having a low energy saving potential, the implementation of energy saving measures can still be very attractive.

The municipalities of Haskovo and Kardgali, but also Madgarovo are quite exceptional. The energy consumption and economic output of the industrial sector of the municipality of Haskovo is quite considerable. However, the actual energy intensity is lower than the estimated energy intensity, resulting in a low industrial energy saving potential, especially when it is compared to other large municipalities. On the other hand, the energy saving potential of the residential sector is high. In Haskovo energy saving policies should primarily focus on the residential sector. Kardgali can be considered as even more exceptional than Haskovo. The energy consumption is among the highest in the region, but energy savings are likely to be relatively low, as can be seen in table 9.2. Haskovo and Kardgali, but also Radnevo, are having a low industrial energy saving potential, while the economic potential is high.

Here also Madgarovo is mentioned: the total energy consumption of Madgarovo is only 109 TJ in the year 1993, but the energy saving potential of the industrial sector seems to be quite considerable. Looking at figure 9.5, it is likely to conclude that the actual energy intensity of Madgarovo, which is based on available data, is too high and thus not reliable.

Obviously, a detailed assessment of municipal energy demand should be carried out in order to get a better insight in the presence of energy saving potentials in the Haskovo region. Table 9.1 and table 9.2 provides a first assessment prior to a following bottom-up assessment of municipal energy saving potentials. As a matter of fact, table 9.1 provides an overview of regional energy demand indicators, of which some suggestions for energy saving measures can already be extracted.

Recommendations

In table 9.2 grey areas displayed indicate the economically strong and flexible municipalities. The economic potential and economic adaptation level are both required for being economically successful in the near future. In table 9.3 grey areas displayed indicate a high potential of energy saving measures for the industrial sector and/or public services and the residential services.

Municipalities which score well with respect to both economic and energy saving indicators are likely to have:

- a good economic infrastructure and economic future which enhances transfer of information,
- energy saving potential, not only in one selected company but probably in the particular sector,
- a high relative energy saving per consumer or investor, which increases profitability and thus interest of the consumer.

The following municipalities fulfill these criteria with respect to a particular sector (indicated between brackets are medium potential sectors):

–	Kazanlak	industry	public/residential
–	Haskovo		public/residential
–	Stara Zagora	industry	public/residential
–	Dimitrovgrad	industry	(public/residential)
–	Svilengrad	(industry)	public/residential

Again, it does not mean that profitable energy saving potential is absent in other municipalities. However, it indicates municipalities and sectors with potentials in macro-economic terms.

10. SUMMARY AND CONCLUSIONS

The executed tasks 'Data Collection' and 'Assessment of Energy Demand and Supply' resulted in a database on energy related issues for the region of Haskovo in a national context, which can be regarded as a good starting point for the development of a Regional Energy Concept for Haskovo and as a basis for the Regional Energy Centre to execute its future tasks. The analysis of the collected data presented in the report provided a characterization of the energy supply and energy demand in relation to economic and other activities in the region of Haskovo which can be summarized as follows.

Haskovo population decreased over the period 1985 to 1993 from 1.03 to 0.90 million people. This is a decrease of about 12%, which is large compared with the decrease of the country population of about 6% over the same period. Regional labour force decreased alarmingly from 50% of the population in 1985 to 26% of the population in 1993. This is not a national trend. Unemployment rates in terms of percentage of the labour force are (therefore) not high, about 12% for the region in 1994 compared to 13.5% for Bulgaria. Differences in characteristics between municipalities are large.

Energy supply

Haskovo region locates energy suppliers of national importance. The Maritsa East mines produce about 70% of national coal production and are considered to be profitable. The mines provide lignite to the main briquette factory in the country, in Galabovo, which produces briquettes for the whole country (26 PJ). Furthermore, lignite is supplied to three thermal power plants in Maritsa East which generate almost one third (40 PJ) of the national electricity production. The power plants are in unsatisfactory condition (30% gross efficiency, 50-60% utility), but rehabilitation seems likely and profitable. The rehabilitation plans include flue gas desulphurisation measures, which are necessary: due to the low quality of the lignite, in terms of a low calorific value and a high sulphur content, approximately half of the national SO_2 emissions and more than 90% of Haskovo SO_2 emissions originate in Maritsa East complex.

Only one district heating plant is in operation, in the city of Kazanlak. It supplies heat to 1.7% of the regional households and some industries and public buildings. In the country as a whole, 17% of households is connected to a district heating system. In Kazanlak, the heavy oil fired combined heat and power plant has a low utility due to decreased heat demand in industry, and is not profitable due to world market oil prices and the social price level of heat set by the Committee of Energy. In Kazanlak, specific energy consumption (per square metre) is among the highest in the country. Reasons for this high specific energy consumption such as building state, losses in piping etc. have to be investigated.

The natural gas network in Haskovo is not very elaborated. It reaches only Stara Zagora (gas distribution station), Dimitrovgrad and Haskovo where a few large industrial consumers are located. It concerns chemical plants, building material factories and thermal power plant Maritsa 3. The level of gasification is higher than in the country, i.e. 50% of industrial energy consumption (including non-energy consumption). Plans for gasification of households have been developed at national level. In the region, Stara Zagora and Haskovo are being considered for gasification of

households since both are connected to the natural gas grid, both cities' household demands are large (economy of scales) and pollution is very high (briquettes in Haskovo) or electricity is used for heating (Stara Zagora).

As in the country, regional use of renewables has been limited up to now. Approximately 0.7 PJ electricity is generated in three hydropower plants in Kardgali and Ivailovgrad. They have to be updated, and due to bad hydrological conditions in the country, utility has been low. Nevertheless, additional potential for hydropower is present. Wood is used in considerable amounts (about 1 PJ) for heating in households. The wood share in regional energy consumption is comparable with that in the country. Waste potentials are hardly used but will be investigated since they are thought to be considerable for the region, about 1 PJ. Potentials for solar boilers and geothermal springs are thought to be considerable too, although they are hardly used. Only Mineralni Banji and Pavel Banja are famous for their geothermal springs and try to base tourism on their presence.

About a quarter of Haskovo primary energy requirements is 'imported' from outside the region in the form of natural gas, solids, and oil products. Indigenous production is even larger than primary energy requirements, so that 'export' out of the region in the form of high quality electricity and improved quality lignite (i.e. briquettes) is about one third of primary energy requirements.

Energy demand

Regional energy demand and fuel mix are quite similar to those of the country as a whole, which is remarkable when considering the very large energy supply sector present in Haskovo. Regional final energy demand dropped 60% over the period 1990-1993 to a level of 36 PJ. The share of industry in final energy demand decreased from 77% to 68% (without transport). These developments are comparable with the trends on a national level. The energy demand for public services in the region decreased substantially less than in the country.

The fuel mix in industry consists for a large part of 50% of natural gas. This natural gas consumption can be accounted mainly to two chemical firms producing fertilizers, viz. Agrobiochim (Stara Zagora) and Neochim (Dimitrovgrad). In fact, these two companies in Stara Zagora and Dimitrovgrad are mainly responsible for these two cities having the largest municipal energy consumption in the region. Both municipalities have a final energy demand of about 10 PJ, together more than half the regional final energy demand.

Haskovo industry can be characterised as about 20% less energy intense than the national industry. However, this is not due to a more energy efficient production but due to a different sectoral structure of industry. Industrial branches which are well developed in the region are food, textile, chemicals, and machinery.

The collected industry data give the impression that after a decline in the past, energy intensity is increasing rapidly since 1993. This is mainly caused by structural changes, i.e. energy intense industries such as chemicals and basic metals showed a (relative) growth. Furthermore, decreasing efficiencies due to bad maintenance and low utilities of equipment could have contributed also.

Residential final energy demand has a substantial part of 24% of total final energy demand. Similar as to the nation, regional consumption of naphta for heating purposes almost disappeared in the last years due to price increases. Electricity consumption for heating in households exists in about one third of households which is higher than for Bulgaria. Also public services and commercial sector have high shares of electricity in final energy consumption. In the country, district heating is more developed. Specific energy consumption in households is about 10% lower than national specific consumption in locally heated households. This can be explained by the climate in Haskovo, which can be characterised as warmer than average, since the number of heating degree days is 10% below average. Furthermore, the number of square metres per dwelling is a little below national average. Also, electric heating results in small conversion losses in the house itself. The relatively high share of electric heating as such could fully explain the lower specific energy consumption in households. Finally, non-registered wood cutting in the rural areas leads also to a (wrongly) lower accounted average consumption. Taking into account all these reasons for a lower specific energy consumption in Haskovo households, it is concluded that energy consumption in households is lower than the national average, but higher than expected.

National context

The regional and municipal information was analysed in a national context. The national energy situation functioned as a reference point or benchmark, not only to characterize the regional situation, but also to provide information and insight on the context of regional energy trends and factors. The following national factors, policies and regulation were found to be highly relevant for understanding the present energy situation in Haskovo region.

The developments of the fuel mix and energy intensity in the region are similar to those of the country. Of course this is due to the national regulation and policies, in particular fuel prices. For instance, oil has become very unattractive since oil prices are more or less on world market level. Heat and electricity prices are still being set by the Committee of Prices. These prices are kept low relative to production costs. Furthermore, heat tariffs are on a fixed price basis in stead of a variable price basis which results in a lack of incentives for cost and thus energy savings.

A typical example is the average specific heat consumption in district heated dwellings which is about 2.5 times higher than fuel consumption, including high conversion losses of for instance briquettes stoves, in locally heated dwellings. Levels of comfort are higher in district heated dwellings, but also at the costs of locally heated dwelling owners.

The growing energy intensity of the last few years is a second example. Due to low prices of heat and electricity, production of the energy supply sector increased relative to energy demand. Therefore, primary energy intensity of the country was in 1993 at the same level as in 1990. Structural changes, energy conservation and efficiency improvements in end-use sectors have been completely counterbalanced by relative increases of energy production with low conversion efficiency of energy supply sectors. But even in end-use sectors, final energy intensity is increasing again after having dropped substantially. In the industry in Haskovo, energy intensity increased alarmingly, due to a recovery and thus relative increase of energy intense chemical and basic metal industry.

Focus

Based on estimated energy saving potentials due to high volume of energy demand and relatively high specific energy consumption, municipalities have been prioritized as a background for the bottom-up assessment of municipal energy saving potentials. A socio-economic characterization of municipalities, made by the Regional Office in Haskovo, served as an economic context for prioritization.

The characterization implicated the following focal points for further analysis in the project in respect of energy saving potentials:

– Kazanlak	industry	public/residential
– Haskovo		public/residential
– Stara Zagora	industry	public/residential
– Dimitrovgrad	industry	(public/residential)
– Svilengrad	(industry)	public/residential

Medium energy saving potential in a particular sector are indicated between brackets.

It does not mean that profitable energy saving potential is absent in other municipalities.

Data collection

The execution of the tasks also provided experience on the applicability of the approach chosen, especially with respect to data availability and compatibility. Experiences of setting up a regional database were as follows.

In general, data on national level are available in many formats, since the national energy situation has been studied very well. At regional level, most data necessary for the analysis were available too. The sectoral split of energy supply and thus demand data is an exception. Energy demand data of agriculture and commercial sector are implicitly included in the other sectors. Also, the split of energy demand by industrial branch and energy service in households and public and commercial sectors could not be made. Remarkably, this type of data are available at national level, and national energy intensities have been used to estimate energy demands by branch and energy service.

Fortunately, all the data available on regional level are also available on municipal level.

The energy supply companies in the region, i.e. regional offices of national energy supply companies such as NEC, Toplivo, Bulgargas and Petrol provide in fact energy supply data. This means that distinctions on the purpose of energy consumption can hardly be made. This results in incompatibility of the assessed regional energy balance and the national energy balance. For instance, non-energy consumption and non-CHP industrial steam generation can not be distinguished from fuel consumption for other purposes. Fortunately, the format of the national final energy demand can be adjusted to the regional balance by taking fuel consumption for non-energy and industrial steam generation out of the energy supply balance and include it in the national final energy demand. A similar action has taken place for fuel consumption for transport, which is dispersed over all sectors in the national final energy demand. Fuel consumption for transport in the region is only known as a whole from filling stations, without knowing which purpose or sector the automotive fuel has been used

for. So, in order to make the national and regional balances compatible, automotive fuels have been subtracted from sectoral final energy demands in the national final energy demand table.

By coincidence, this means that the regional energy balance is presented in the EU format. So, the strong point of the Bulgarian or CEEC format of the energy balance is that the EU format can be calculated from it, and not vice versa.

To support the bottom-up approach used in other tasks of the project, energy consumption data of companies with a relatively large energy consumption were collected. The list of companies is quite complete since the total 1994/1995 energy consumption of these companies is higher than 1993 industrial final energy demand of the total region.

Reliability

Data have been collected from all regional energy suppliers, the Regional Office in Haskovo and Energoproekt.

Fuel consumption in energy supply and demand have the right order of magnitude. Some hidden energy consumption, mostly in the form of exotic or non-commercial energy carriers, may be missed in the energy balance. Weakly assessed categories are renewables and non-registered, non-renewable wood (solids). Furthermore, some oil product consumption could be lacking in the balance, wrongly being considered as automotive fuels. The residential demand could be influenced by implicit inclusion of commercial and agriculture fuel consumption.

Since energy consumption of commercial fuels seems to be covered quite completely, the primary energy balance can be seen as quite accurate, except for oil products.

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[9] *Toplivo Haskovo, Toplivo Stara Zagora and Toplivo Kardgali.*

[10] *Regional forestry company.* Haskovo.

[11] *Petrol Haskovo.*

[12] *Refinery in Burgas.*

[13] *Bulgargas Stara Zagora.*

[14] *Regional Office Haskovo.*

APPENDIX A. ENERGY DEMAND AND ENERGY SUPPLY DATABASE

For this study an energy demand and energy supply database is developed for mainly two reasons:

- As a basis for assessment of the regional energy supply and demand pattern in order to develop a regional energy concept.
- To provide a database to the Regional Energy Centre (REC) as a basis for further work.

The database actually consists of two individual parts: a national database and a regional database, being an overview of all municipalities of the region of Haskovo. International standards of energy demand and energy supply figures (EU format) and economical classifications (ISIC format) are used in order to compare in the future the regional energy situation with international databases, standards etc.

The filled database will allow for analysing the regional energy situation in order to fulfil the following objectives:

- Development of a method for establishment of regional energy balances in Bulgaria and illustration of this method by the actual example of Haskovo.
- Characterization of municipal energy consumption and supply.
- Assessment of the regional energy supply and consumption pattern of Haskovo.

The database has been designed in such a way that characterization and assessment is possible by combining energy data with physical, demographic or economic activity data into energy consumption indicators which characterize the municipal energy consumption over the region. For this indicator data are collected as for example demographic data on population, unemployment, area use, amount of companies per industrial subsector, amount of employees per subsector, gross output per year per subsector, amount of households and dwellings, m^2 per dwelling, type of dwelling etc.

The database, submitted in Excel, consists of 5 different sheets: area indicator data, area final energy demand data, point source energy demand data, point supply technology demand data and point supply technology trend data. These sheets are set up in a general format and can be used for national level, but also for municipal level data collection. Two definitions of final energy demand are distinguished: final demand for fuels and final demand for energy services. Here 3 tables are presented: the area final energy demand sheet of the industrial sector, the area final energy demand sheet of the residential sector and the point supply technology trend data sheet.

Table A.1 *Data sheet energy demand manufacturing and construction*

National level for ISIC tabulation category: Manufacturing & construction Area: Final energy demand 1994 [TJ]	ISIC division name ISIC division number	food, beverages & tobacco 11	textile and ready made clothing 12	etcetera
Final energy demand				
Furnace heat				
Steam, hot water, heating & cooking				
Steam for process heat				
Hot water				
Heating				
Cooking				
Electricity				
Electricity for process power				
Lighting				
Specific electricity use				
Rest				
Total final energy demand				
Final energy demand/input				
Hard coal				
Brown coal				
Lignite				
Briquettes				
Coke				
Slate				
Wood				
Peat				
Agriculture waste, straw				
Municipal waste				
Gasoline (not for transport)				
Kerosen				
Gasoil (not for transport)				
Heavy oil				
Light oil				
LPG				
Naphta				
Methanol				
Natural gas				
Town gas				
Blast furnace gas				
Coke gas				
Refinery gas				
Biogas				
Solar (heating)				
Solar (photovoltaic)				
Wind				
.....				
Total fuels				
Public process steam (not self-produced)				
Public district heat (not self-produced)				
Public electricity (not self-produced)				
Total final energy demand				
Final demand for transportation				
Gasoline				
Gasoil				
Electricity				
Total final energy demand for transport				

Table A.2 *Data sheet energy demand residential sector*

National level
for ISIC tabulation category: Residential buildings
Final energy demand 1994

Blocks	heating TJ	hot water TJ	cooking TJ	lighting TJ	elec use TJ	total TJ
Hard coal						
Brown coal						
Lignite						
Briquettes						
Coke						
Slate						
Wood						
Peat						
Agriculture waste, straw						
Municipal waste						
Gasoline (not for transport)						
Kerosen						
Gasoil (not for transport)						
Heavy oil						
Light oil						
LPG						
Naphta						
Methanol						
Natural gas						
Town gas						
Blast furnace gas						
Coke gas						
Refinery gas						
Biogas						
Solar (heating)						
Solar (photovoltaic)						
Wind						
.....						
Total fuels						
Public process steam (not self-produced)						
Public district heat (not self-produced)						
Public electricity (not self-produced)						
Total final energy demand						

Table A.3 *Data sheet point supply technology trend data (presented data serve as an example)*

National level
Mining & energy supply companies and large point sources
Point source technology trends

ISIC division name	ISIC division number	name of site	customer	Capacity 1994		Specific units	Configuration	Commissioned	Decomissioned	Development of capacity: Fuel source	Efficiency	Utility	CO_2-emissions	SO_2-emissions	NOx-emissions	Particulate emissions	Production costs	Abatement & efficiency improvements	Planned investments 1994-2005
				[amount]	[unit]	[amount]	[description]	[in year]	[in year]	[description]	[%]	[%]	[g/GJ input]	[g/GJ input]	[g/GJ input]	[g/GJ input]	[Leva/GJ output]	[description]	
						300	large brown coal fired condensing power plant	1960	2000	locally extracted brown coal	32	65						none	decommissioning cost
public supply of electricity	401	Maritza-East	national electricity grid	500	MWe	200	large brown coal fired condensing power plant	1980		locally extracted brown coal	35	70						disposal of fly ash; flue gas desulfurization	retrofitting & abatement costs
						250	large brown coal & biomass fired condensing power plant	2003		locally extracted brown coal; local waste of biomass	43	80						disposal of fly ash; flue gas desulfurization	total investment costs new power plant
public supply of electricity	401	Maritza-West	national electricity grid			250	large natural gas fired condensing power plant	1975	1998	imported natural gas from Russia	32	70							

APPENDIX B. INTERNATIONAL STANDARD INDUSTRIAL CLASSIFICATION

The International Standard Industrial Classification of All Economic Activities (ISIC) is issued by the Department of International Economic and Social Affairs of the United Nations. The ISIC format was initiated to harmonize international economic classifications, mainly for reasons of comparability. It was recommended to member states to adopt as soon as possible the ISIC format. The original version was issued in the year 1948. For this study the third revision of the ISIC format, issued in 1990, is used for setting up the energy demand and energy supply database for the region of Haskovo and Bulgaria as a whole.

The ISIC format make use of an hierarchical system of categories, subdivided in divisions, groups and classes. The energy demand and energy supply database only consists of the level of divisions, for this study considered as being appropriate. Here the outline of the classification as used for the database is presented in table B.1.

Table B.1 *Energy demand and energy supply database classification*

	ISIC division number
Agriculture *companies*	
ISIC tabulation category	11
A01	12
Combined farming (crops & cattle)	13
Total agriculture companies	A01
Manufacturing & construction companies	
ISIC tabulation category	
D+F	
Food, beverages & tobacco	15+16
Textile and ready made clothing	17+18
Leather products	19
Wood, paper & pulp	20+21
Chemicals, chemical products & plastics	24+25
Non-metallic mineral products	26
Basic metals & metal products	27+28
Machinery and equipment	29
Electronics & electrical equipment	31+32
Motor vehicles & trailers	34
Furniture	36
Construction	45
Total	D+F

Table B.1 *Energy demand and energy supply database classification (continuation)*

	ISIC division number
Mining & energy supply companies	
ISIC tabulation category	13
C+E	10
Brown coal mining	10
Lignite mining	10
Peat mining	10
Natural gas extraction	11
Crude oil extraction	11
Oil refinery	23
Coke production	23
Briquettes production	23
Town gas production	23
Biogas production	23
Municipal waste collection	23
Public supply of electricity	401
Public supply of natural gas	402
Public supply of district heat and steam	403
Total	C+E
Public services buildings	
ISIC tabulation category	
L+M+N+O	
Public administration	75
Post and telecommunications	64
Old peoples house & social work	853
Hospital & human health	851
School	80
Indoor sporting accommodations	924
Total	L+M+N+O
Commercial sector buildings	
ISIC tabulation category	
G+H+J	
Retail shops	50+51+52
Retail warehouses	52
Retail supermarkets	52
Hotels and restaurants	55
Banking and other financial intermediates	65+66+67
Other large commercial buildings	
Total	G+H+J
Residential buildings	
ISIC tabulation category	
P	
Blocks	95
Single family houses ordinary	95
Single family houses primitive	95
Total households	P
Public transport companies	
ISIC tabulation category	
I	
Public transport bus	60
Public transport tram	60
Public transport trolley bus	60
Private passenger transport by car	60
Private freight transport by truck	60

APPENDIX C. MUNICIPALITY DESCRIPTIONS

The following municipality descriptions serve as background information to the data collected for this study. The municipality descriptions are delivered by Energoproekt.

Region: Haskovo

Population	: 907002 inhabitants in 1993
Registered labour force	: persons in 1993.
Total territory	: 13753107 thousand m^2
Agriculture area	: 7152000 thousand m^2 (58% of total area)
Forests	: 5421137 thousand m^2 (39.4% of total area)
Urban	: 465000 thousand m^2
Cultivated area	: 4619224 thousand m^2 (33.6% of total area)
inc. 55% of total cultivated area	: grain crops
3.2% of total cultivated area	: vegetables
15.4% of total cultivated area	: technical crops
8.2% of total cultivated area	: grain fodder
5.6% of total cultivated area	: orchards and vineyards

During 1993 year 1351000 thousand m^2 area is occupied with wheat (or 30% of total cultivated area) especially in municipalities of Haskovo, Dimitrovgrad, Svilengrad, Stara Zagora, Opan, Chirpan, Radnevo and Bratia Daskalovi. Average middle production of wheat for 1993 307 kg/thousand m^2. This production is lower than in previous years because of the lack of rains.

The middle production of wheat for 1993 in:

- Dimitrovgrad 430 kg/thousand m^2
- Haskovo 380 kg/thousand m^2
- Stara Zagora 350 kg/thousand m^2
- Chirpan 355 kg/thousand m^2
- Opan 340 kg/thousand m^2

About 13000 thousand m^2 area is occupied with rye.

About 525000 thousand m^2 area is occupied with barley in municipalities of Dimitrovgrad, Bratia Daskalovi, Galabovo, Opan, Radnevo, Stara Zagora and Chirpan.

About 168000-220000 thousand m^2 area is occupied with maize and the yearly production of it is 55000-57000 tons.

Municipality: Haskovo

Population	: 102796 inhabitants in 1993
Registered labour force	: 25776 persons in 1993
Registered unemployment	: 9.63% in December 1994
High population density	: 139.4 persons/km^2
Birth rate	: 14.17/1000 persons
Natural growth	: -0.63/1000 persons

From 412229 active persons in Haskovo region in 1994 about 11.38% (46923 persons) are living in Haskovo municipality. Municipality with low relative share of durable actives per person in the material sphere - 27000 Leva or 7.55% of region total durable actives.

Agriculture

Middle average of wheat production	380 kg/1000 m^2
Middle average of pepper production	1600-1800 kg/1000 m^2
Middle average of cucumber production	1800 kg/1000 m^2
Middle average of peaches production	420 kg/1000 m^2
Middle average of apricot production	180-220 kg/1000 m^2

Farming of cattle - there is a poultry farm with capacity of 3000000 poultry but now their production has decreased to 412000.

In the municipality there are 7 big industrial electricity consumers with capacity over 500 kW and about 19 small industrial electricity consumers with capacity under 500 kW. In the municipality are mainly developed the following manufacturing:
- textile and ready made clothing industry,
- machinery and equipment industry,
- electronics & electrical equipment industry,
- food, beverages & tobacco industry.

Some of the biggest enterprises in the municipality are:
- Chimmash
  Machinery and equipment industry. It has specialized in the production of modern and unique equipment for cutting and rolling of metals, technological equipment for chemistry, energy system, metallurgy, biotechnology and food industry. The total sale in 1994 36 million Leva and in 1995 38.35 million Leva.
- Rodina
  Food, beverages & tobacco industry. The main production markets a private firms in Bulgaria, Ukraine, Macedonia, Albania, Greece, France etc., ZMM - machinery and equipment industry. The main markets for their production are Bulgaria, Hungary, Russia, Macedonia, Greece. This enterprise is an unique one for the region. Occupied persons: 160 in 1989 and 78 in 1994.
- Avtomatika
  Electronics & electrical equipment industry. The average use of units is very low - 20-30%. Occupied persons: 311 in 1989 and 100 in 1994.
- Manuela
  Textile and ready made clothing industry.

- Svila 91
  Textile and ready made clothing industry. Occupied persons: 337 in 1991 and 164 in 1994.
- Textilni vlakna
  Textile and ready made clothing industry. Occupied persons: 67 in 1989 and 41 in 1994. The total sale in 1993 45.09 million Leva and in 1994 65 million Leva.
- MIR
  Textile and ready made clothing industry. The biggest sewing enterprise in the region. Occupied persons: 640 in 1994.
- Tih Trud
  Textile and ready made clothing industry. The total sale in 1989 5.48 million Leva and in 1993 11 million Leva.
- Astika
  Food, beverages & tobacco industry. The biggest private enterprise in the region. The total sale in 1992 167.2 million Leva, 1993 239 million Leva and in 1994 382 million Leva.
- Vinprom: food, beverages & tobacco industry. Occupied persons: 186 in 1990 and 123 in 1994.
- Bulgaricum: food, beverages & tobacco industry. It is a milk manufacturing enterprise with a capacity 200 ton/day but it is working with 28-30 ton/day or 15% of its capacity.
- Biala Zvezda
  Food, beverages & tobacco industry. It is a mill manufacturing enterprise, working on full capacity.
- Still
  Food, beverages & tobacco industry. It is a soft drink manufacturing enterprise. The total sale in 1991 35.4 million Leva, 1992 48.7 million Leva, 1993 50.7 million Leva and in 1994 65 million Leva.
- Poligraf South
  Other industry. It is a printing and publishing manufacturing enterprise.

Municipality: Bratia Daskalovi

Population	: 12151 inhabitants in 1993
Registered labour force	: 2372 persons in 1993
Registered unemployment	: 36.5% in December 1994
Low population density	: 23.3 persons/km^2
Birth rate	: 9.58/1000 persons
Natural growth	: 16.7/1000 persons

A typical small village municipality. Municipality with a critical social economic situation. Municipality with low potential and middle adaptation. It is one of the municipalities with very rare population density. The reason for this is that some of the biggest towns in the region became attractive for the most active part of the inhabitants.

The population density declined from 25.6 persons/km^2 in 1985 to 23.3 persons/km^2 in 1993. The population in working age is about 36.2% from total population in the municipality. There is a tendency according which the population share over working age is rising. The percent of the occupied people with middle and low education to the

total number of occupied people in the municipality is 70.9%. From 412229 active persons in Haskovo region in 1994 about 0.88% (3628 persons) are living in Haskovo municipality. The number of unemployed people in the municipality is typical for such kind of municipality. Typical for it is the opening and close down of small and middle enterprises. There has been closed down some of the enterprises on the territory of the municipality: 'Svetlina' in the village Orizovo, Mirovo and Plodovitovo, workshop 5300 in Bratia Daskalovi. The future of municipality is connected with the development of small and middle enterprises in food, beverages & tobacco industry. In 1992 a private enterprise for process agriculture production has been established in the village Orizovo. In 1994 a workshop for process milk has been established. But this two workshops are not sufficient for the municipality.

- A very high level of unemployed people.
- Low production dynamic.
- Population's income is significantly below the middle region member.
- The last years production is negative.
- The existing enterprises are or economically mined or are put in the position of a financial collapse.
- Insufficient percent of technical and social structure build.

Agriculture

Middle average of wheat production	307 kg/1000 m^2
Middle average of barley production	328 kg/1000 m^2
Middle average of oats production	150-180 kg/1000 m^2
Middle average of pepper production	1600-1800 kg/1000 m^2
Middle average of tomato production	2100-3000 kg/1000 m^2

Fruits: apples about 30 thousand m^2 with sorts 'Greinsmitt', 'Golden superlative', 'Red superlative', 'Aivania', 'Fudji'.
Grape: the most famous sort is 'Merlo', 'Kaberne sovinion', Pamid, and 'Bulgar'.
Peaches: 500 thousand m^2 with middle production of about 180-220 kg/1000 m^2. The main sorts: 'Hungarian', 'Alberta', 'Umberto' and 'Banderolska earlier'.

In the municipality there are 2 industrial electricity consumers with capacity under 500 kW. In the municipality is mainly developed the non-metallic mineral products manufacturing.

Some of the biggest enterprises in the municipality are:

- Stomana - non-metallic mineral products industry.
- Tchepino - non-metallic mineral products industry.

Both of them have declined their electricity consumption in the period 1990-1994.

Municipality: Ardino

Population	: 17782 inhabitants in 1993
Registered labour force	: 1869 persons in 1993
Registered unemployment	: 22.3% in December 1994
Under and middle population density	: 46.2 persons/km^2
Birth rate	: 13.54/1000 persons
Natural growth	: 5.12/1000 persons

A small village municipality. It is one of the municipalities with under and middle population density which decline from 72.0 persons/km^2 to 46.2 persons/km^2 for the period 1985-1993. The positive birth growth in 1986 has much declined from 17.37 to 13.54% per thousands. Declination with 14% number of occupied industrial workers in 1993 in comparison with 1990, declination with 2% of number of occupied agricultural workers. High relative share of unemployment 22.2% from the active population in the municipality (in comparison with 13.02 for the region). A municipality with very low relative share of durable actives per person in the material sphere 48000 Leva and 0.22% of the total durable actives in the region. Owned Agricultural area 7.4 thousand m^2/person.

Agriculture: potatoes, peanuts, with average annual production 1500 ton/1000 m^2. In the municipality there are 1 big industrial electricity consumers with capacity over 500 kW and about 7 small industrial electricity consumers with capacity under 500 kW. In the municipality are mainly developed the following manufacturing:
- textile and ready made clothing industry,
- machinery and equipment industry,
- basic metals & metal products,
- food, beverages & tobacco industry.

There are 3 working workshops and 11 not-working workshops.
- 'Orphei' - Ardino town
  Textile and ready made clothing industry, for sportive dresses, 250 working places in 1989.
- 'Orphei' - village Bjal Izvor
  Textile and ready made clothing industry, for sportive dresses, 140 working places in 1989.
- 'Orphei' - village Padina
  Textile and ready made clothing industry, for sportive dresses, 100 working places in 1989.
- Workshop in village Brezen
  Textile and ready made clothing industry, about 100 working places in 1989.
- Workshop for plastics - village Diamandievo
  140 working places in 1989.
- 'Ahrida' - village Gorno Prahovo
  Textile and ready made clothing industry, 394 working places in 1989.
- Sewing workshop in village Mlechino
  51 working places in 1989.
- Wearing workshop in village Bogatinovo
  44 working places in 1989.
- Workshop for carpets in village 'Gorno Prahovo'
  23 working places in 1989.
- Knitting workshop in village Borovitza
  18 working places in 1989.
- Jakardtex in Ardino town
  36 working places in 1989.

Some of the biggest enterprises in the municipality are:

- Gorubso
  Basic metals & metal products industry.
- Ardino
  Machinery and equipment industry.
- Artex
  Textile and ready made clothing industry.
  The total sale in:
  - 1991 6.48 million Leva
  - 1992 12.75 million Leva
  - 1993 18.96 million Leva
  - 1994 24.37 million Leva
- Jakardtex
  Textile and ready made clothing industry.

Municipality: Djebel

Population	: 10948 inhabitants in 1993
Registered labour force	: 1103 persons in 1993
Registered unemployment	: 5.87% in December 1994
Under and middle population density	: 46.0 persons/km^2
Birth rate	: 18.61/1000 persons
Natural growth	: 8.46/1000 persons in 1986

- Under and near middle population density from 94.1 to 46.0 persons/km^2.
- Declination of number of registrated labour force: 29%.
- Owned Agriculture are 7300 m^2.
- A municipality with very low relative share of durable actives per person in the material sphere 6700 Leva and 0.22%.
- Agriculture: peanuts, tobacco.
- In the municipality there are 6 small industrial electricity consumers with capacity under 500 kW.

In the municipality are mainly developed the following manufacturing:

- textile and ready made clothing industry,
- machinery and equipment industry,
- food, beverages & tobacco industry.

Municipality: Kardjali

Population	: 77164 inhabitants in 1993
Registered labour force	: 21576 persons in 1993
Registered unemployment	: 11.62% in December 1994
High population density	: 120.2 persons/km^2
Birth rate	: 17.99/1000 persons
Natural growth	: 4.77/1000 persons

High population density from 163.1 to 120.2 persons/km^2. From 412229 active persons in Haskovo region in 1994 about 8.9% (36688 persons) are living in Karjali municipality. Municipality with middle relative share of durable actives per person in the material sphere - 31000 Leva or 6.55% of region total durable actives.

Agriculture

- Middle average of tobacco production 180 kg/1000 m^2.

In the municipality there are 10 big industrial electricity consumers with capacity over 500 kW and about 41 small industrial electricity consumers with capacity under 500 kW. In the municipality are mainly developed the following manufacturing:

- textile and ready made clothing industry,
- machinery and equipment industry,
- wood, paper & pulp industry,
- food, beverages & tobacco industry,
- non-metallic mineral products,
- basic metals & metal products.

Some of the biggest enterprises in the municipality are:

- OTZK
  Basic metals & metal products. Main markets: Turkey, Greece, Romania, Macedonia, Ukrain, Russia, Hungary, Czeck and Slovakia and many countries from the Near and Far East. The total sale in 1994 2500 million Leva and the expectations for 1995 3800 million Leva. The enterprise has survived the serious critical decrease from the period of 1989-1990 when the zinc production has been 28 thousand ton in 1989, 21.4 thousand ton in 1991, 26.2 thousand ton in 1994, the lead production has been 34.8 thousand ton in 1989, 19 thousand ton in 1991, 35 thousand ton in 1994, the sulphur acid production has been 47.9 thousand ton in 1989, 36.3 thousand ton in 1991, 43 thousand ton in 1994.
- Bentonit
  Non-metallic mineral products industry. The volume of sales is rising.
- Breza
  Wood, paper & pulp industry. The enterprise is in a heavy financial condition. It is not working on full capacity.
- Trakija
  Wood, paper & pulp industry. The total sales is 54000 Leva in 1994. The enterprise has workshops not only in Kardjali but also in Momchilgrad, Djebel and Ardino.
- Pnevmatika
  Machinery and equipment industry. The activity of the enterprises organized in two municipalities: Karjali and the village Komuniga in Chernoochene municipality. Main markets: Germany, Netherlands, Belgium, France.
- Arda
  Instrument, machinery and equipment industry. Main markets: Egypt, Italy, Greece, Israel, Pakistan, Austria, etc.
- Monek
  Jug - machinery and equipment industry. Main markets: Russia, Cypre, Turkey, Italy etc.
- Bistretz
  Machinery and equipment industry. The total sales are: 10.18 million Leva in 1993, 14 million Leva in 1994, 16 million Leva in 1995.

- Formoplast
  Machinery and equipment industry. In 1994 the export for Russia, Macedonia and Near East is about 24 million Leva. The expectation for the export in 1995 is 30 million Leva.
- Orfei
  Textile and ready made clothing industry. Main market: 85% of the production is for Germany.
- Ahrida
  Textile and ready made clothing industry. Main markets: Finland, Germany and The Netherlands. It is working on 80% capacity.
- Monijak
  Food, beverages & tobacco industry. It is a bread manufacturing enterprise. The total sales are: 0.502 million Leva in 1991 and 8 million Leva.
- Bulgartabac
  Food, beverages & tobacco industry. It has a capacity of 15 million ton tobacco and the export is between 90-95%. Main markets: former USSR republics, USA, Western European countries, Far East, Egypt.

Municipality: Kirkovo

Population	: 33083 inhabitants in 1993
Registered labour force	: 2407 persons in 1993
Registered unemployment	: 24.31% in December 1994
Under and middle population density	: 65.1 persons/km^2
Birth rate	: 16.99/1000 persons in 1986
Natural growth	: 6.37/1000 persons

Under and near middle population density from 83.0 to 65.1 persons/km^2. From 412229 active persons in Haskovo region in 1994 about 4.19% (17272 persons) are living in Kirkovo municipality. Municipality with very low relative share of durable actives per person in the material sphere 2600 Leva or 0.26%.

- Owned Agriculture are 5100 m^2.
- Agriculture: peanuts.

In the municipality there are 11 small industrial electricity consumers with capacity under 500 kW. In the municipality are mainly developed the following manufacturing:
- textile and ready made clothing industry,
- machinery and equipment industry,
- non-metallic mineral products industry.

Municipality: Krumovgrad

Population	: 31068 inhabitants in 1993
Registered labour force	: 3648 persons in 1993
Registered unemployment	: 21.36% in December 1994
Under and middle population density	: 37.4 persons/km^2
Birth rate	: 14.71/1000 persons
Natural growth	: 5.47/1000 persons

Under and near middle population density from 53.1 to 37.4 persons/km^2. From 412229 active persons in Haskovo region in 1994 about 3.43% (14139 persons) are living in Krumovgrad municipality. Municipality with very low relative share of durable actives per person in the material sphere 4000 Leva or 0.32%.

- Owned Agriculture area: 10800 m^2/person.
- Agriculture: tobacco.

In the municipality there are 7 small industrial electricity consumers with capacity under 500 kW. In the municipality are mainly developed the following manufacturing:
- textile and ready made clothing industry,
- leather products industry,
- non-metallic mineral products industry.

Municipality: Momchilgrad

Population	: 20826 inhabitants in 1993
Registered labour force	: 3977 persons in 1993
Registered unemployment	: 13.73% in December 1994
Under and middle population density	: 56.7 persons/km^2
Birth rate	: 19.51/1000 persons in 1986
Natural growth	: 8.78/1000 persons

Under and near middle population density from 85.1 to 56.7 persons/km^2. From 412229 active persons in Haskovo region in 1994 about 2.49% (10264 persons) are living in Momchilgrad municipality.

- Owned Agri culture are: 7300 m^2.
- Agriculture: tobacco.

In the municipality there are 2 big industrial electricity consumers with capacity over 500 kW and 10 small industrial electricity consumers with capacity under 500 kW. In the municipality are mainly developed the following manufacturing:
- textile and ready made clothing industry,
- machinery and equipment industry,
- non-metallic mineral products industry,
- basic metals & metal products.

Municipality: Chernoochene

Population	: 12459 inhabitants in 1993
Registered labour force	: 827 persons in 1993
Registered unemployment	: 12.34% in December 1994
Under and middle population density	: 36.7 persons/km^2
Birth rate	: 5.26/1000 persons
Natural growth	: 4.48/1000 persons

Under and near middle population density from 45.0 to 36.7 persons/km^2. From 412229 active persons in Haskovo region in 1994 about 1.4% (5771 persons) are living in Chernoochene municipality.

In the municipality there are 1 big industrial electricity consumers with capacity over 500 kW and 3 small industrial electricity consumers with capacity under 500 kW. In the municipality are mainly developed the following manufacturing:
- textile and ready made clothing industry,
- machinery and equipment industry.

Municipality: Opan

Population	: 4601 inhabitants in 1993
Registered labour force	: 1556 persons in 1993
Registered unemployment	: 16.99% in December 1994
Low population density	: 17.6 persons/km^2
Birth rate	: 5.65/1000 persons in 1986
Natural growth	: 25.52/1000 persons

Low population density from 21.9 to 17.6 persons/km^2. From 412229 active persons in Haskovo region in 1994 about 0.33% (1360 persons) are living in Opan municipality. Municipality with middle relative share of durable actives per person in the material sphere 45000 Leva.

Agriculture

middle average of wheat production	340 kg/1000 m^2
middle average of barley production	328 kg/1000 m^2
middle average of oats production	150-180 kg/1000 m^2 tobacco
middle average of cotton production	80-85 kg/1000 m^2
middle average of sunflower production	95-110 kg/1000 m^2
middle average of oats production	150-180 kg/1000 m^2

Municipality: Maglish

Population	: 25263 inhabitants in 1993
Registered labour force	: 4385 persons in 1993
Registered unemployment	: 14.22% in December 1994
Low population density	: 31.8 persons/km^2
Birth rate	: ?/1000 persons
Natural growth	: 4.12/1000 persons

Low population density from 32.8 to 31.8 persons/km^2. From 412229 active persons in Haskovo region in 1994 about 2.47% (10182 persons) are living in Maglish municipality.

Agriculture

middle average of barley production	150-180 kg/1000 m^2
middle average of strawberry and raspberry production	300 kg/1000 m^2

roses and lavender.

In the municipality there are 2 small industrial electricity consumers with capacity under 500 kW. In the municipality are mainly developed the following manufacturing:
- wood, paper & pulp industry.

Some of the biggest enterprises in the municipality are:
- Buk Gurkovo
  Wood, paper & pulp industry. Main markets: Greece, Macedonia and Arabian countries. Occupied persons: 376 persons in 1989, 155 in 1994.
- Dabrava
  Wood, paper & pulp industry. Occupied persons: 76 persons in 1994.

Municipality: Galabovo

Population	: 17679 inhabitants in 1993
Registered labour force	:10463 persons in 1993
Registered unemployment	: 43% in December 1994
Under and middle population density	: 51.6 persons/km^2
Birth rate	: 9.56/1000 persons in 1986
Natural growth	: 8.06/1000 persons

Under and middle population density from 59.4 to 51.6 persons/km^2. From 412229 active persons in Haskovo region in 1994 about 1.9% (7832 persons) are living in Galabovo municipality. Municipality with middle relative share of durable actives per person in the material sphere - 40000 Leva or 1.62%

Agriculture

middle average of barley - corn production	328 kg/1000 m^2

In the municipality there are 2 big industrial electricity consumers with capacity over 500 kW and 1 small industrial electricity consumers with capacity under 500 kW. In the municipality are mainly developed the following manufacturing:
- briquettes production
- lignite mining.

Municipality: Chirpan

Population	: 29505 inhabitants in 1993
Registered labour force	: 8128 persons in 1993
Registered unemployment	: 26.56% in December 1994
Under and middle population density	: 56.3 persons/km^2
Birth rate	: ?/1000 persons
Natural growth	: 6.19/1000 persons

Under and middle population density from 60.0 to 56.3 persons/km^2. From 412229 active persons in Haskovo region in 1994 about 2.04% (8409 persons) are living in Chirpan municipality. Municipality with middle relative share of durable actives per person in the material sphere - 31000 Leva or 2.15%.

Agriculture

middle average of wheat production	355 kg/1000 m^2
middle average of barley production	328kg/1000 m^2
middle average of maize production	329-550 kg/1000 m^2
middle average of tomato production	2100-3000 kg/1000 m^2
middle average of pepper production	1600-1800 kg/1000 m^2
middle average of cucumber production	1800 kg/1000 m^2
middle average of sunflower production	95-110 kg/1000 m^2
Area sown with vineyards	15 million m^2

In the municipality there is 1 big industrial electricity consumer with capacity over 500 kW and 11 small industrial electricity consumers with capacity under 500 kW. In the municipality are mainly developed the following manufacturing:
- textile and ready made clothing industry,
- machinery and equipment industry,
- food, beverages & tobacco industry.

Some of the biggest enterprises in the municipality are:
- Budushtnost
  Machinery and equipment industry. Occupied persons: 750.
- Tcharita
  Textile and ready made clothing industry. Main sales in 1989 16.426 million Leva and in 1994 64.53 million Leva. About 90% of the production is for Germany. It is working on full capacity. Occupied persons: 954 in 1989 declines to 554 in 1994.
- Vinzavod
  Food, beverages & tobacco industry. About 90% of the production is for export. Main markets are: Russia, Ukrain, Moldova and Germany. Occupied persons: 368 in 1989 declines to 268 in 1994.
- Tchirpan plod
  Food, beverages & tobacco industry.

- Parvi mai
  Food, beverages & tobacco industry. Occupied persons: 111 in 1989 declines to 108 in 1994. It is working on 66% of its capacity.

Municipality: Radnevo

Population	: 26403 inhabitants in 1993
Registered labour force	: 18686 persons in 1993
Registered unemployment	: 8.79% in December 1994
Under and middle population density	: 48.9 persons/km^2
Birth rate	: ?/1000 persons
Natural growth	: 6.97/1000 persons

Under and middle population density: from 50.5 to 48.9 persons/km^2. From 412229 active persons in Haskovo region in 1994 about 2.92% (12037 persons) are living in Radnevo municipality. Municipality with big relative share of durable actives per person in the material sphere - 364000 Leva or 22.95%.

Agriculture

middle average of wheat production	307 kg/1000 m^2
middle average of barley production	328 kg/1000 m^2
middle average of maize production	329-550 kg/1000 m^2
middle average of pepper production	1600-1800 kg/1000 m^2
middle average of cucumber production	1800 kg/1000 m^2
middle average of almond production	70-80 kg/1000 m^2
middle average of sunflower production	95-110 kg/1000 m^2

In the municipality there are 3 big industrial electricity consumers with capacity over 500 kW and 2 small industrial electricity consumers with capacity under 500 kW. In the municipality are mainly developed the following manufacturing:
- lignite mining industry,
- public supply of electricity,
- food, beverages & tobacco industries.

Some of the biggest enterprises in the municipality are:
- Troianovo 1
  Lignite mining industry. Stocks of the mine are about 360 million ton. About 60% of coal are suitable for briquetting. The production of the mine is 6.487 million ton.
- Troianovo-north
  Lignite mining industry. Stocks of the mine are about 850 million ton. The production of the mine is 7.612 million ton.

Municipality : Pavel Banja

Population	: 16980 inhabitants in 1993
Registered labour force	: 2554 persons in 1993
Registered unemployment	: 18.62% in December 1994
Low population density	: 32.8 persons/km^2
Birth rate	: ?/1000 persons
Natural growth	: 3.95/1000 persons

Low population density from 37.6 to 32.8 persons/km^2. From 412229 active persons in Haskovo region in 1994 about 1.76% (7255 persons) are living in Pavel Banja municipality. Municipality with low relative share of durable actives per person in the material sphere.

Agriculture

middle average of nut production	65-70 kg/1000 m^2
middle average of strawberry and raspberry production	267 kg/1000 m^2

In the municipality there is 1 small industrial electricity consumers with capacity under 500 kW. In the municipality are mainly developed the following manufacturing:
- textile and ready made clothing industry.

Some of the biggest enterprises in the municipality are:
- Hristo Botev: textile and ready made clothing industry.

Municipality: Stara Zagora

Population	: 175588 inhabitants in 1993
Registered labour force	: 50481 persons in 1993
Registered unemployment	: 12.35% in December 1994
High population density	: 174.2 persons/km^2
Birth rate	: ?/1000 persons
Natural growth	: positive/1000 persons

High population density from 176.2 to 174.2 persons/km^2. From 412229 active persons in Haskovo region in 1994 about 20.47% (84363 persons) are living in Stara Zagora municipality. Municipality with high relative share of durable actives per person in the material sphere - 55000 Leva or 22.35%.

Agriculture

middle average of wheat production	350 kg/1000 m^2
middle average of barley production	328 kg/1000 m^2
middle average of maize production	329 -550 kg/1000 m^2
middle average of tomato production	2100-3000 kg/1000 m^2
middle average of pepper production	1600-1800 kg/1000 m^2
middle average of cucumber production	1800 kg/1000 m^2
cultivated area sown with vineyard	15 million m^2
middle average of cherry production	400 kg/1000 m^2
middle average of apricot production	180-220 kg/1000 m^2
middle average of strawberry and raspberry production	267 kg/1000 m^2
middle average of sunflower production	95-110 kg/1000 m^2

In the municipality there are 22 big industrial electricity consumers with capacity over 500 kW and about 24 small industrial electricity consumers with capacity under 500 kW. In the municipality are mainly developed the following manufacturing:

- chemicals, chemical products & plastics,
- textile and ready made clothing industry,
- machinery and equipment industry,
- electronics & electrical equipment,
- wood, paper & pulp industry,
- food, beverages & tobacco industry,
- non-metallic mineral products,
- basic metals & metal products.

Some of the biggest enterprises in the municipality are:

- Progres
  Basic metals & metal products. The enterprise has survived the serious critical decrease from the period of 1989-1990 when the production has been 13431 ton in 1989, 9680 ton in 1990, 4112 ton in 1991, 1206 ton in 1992, 1185 ton in 1993, 1300 ton in 1994. Occupied persons: 964 in 1989, 355 in 1994.
- Bore
  Non-metallic mineral products industry. Occupied persons: 977 in 1992, 400 in 1994. It is working with capacity not than 15-20%.
- Sredna Gora
  Wood, paper & pulp industry. The enterprise is in a heavy financial condition. It is not working on full capacity.
- Mebel
  Wood, paper & pulp industry. The total production has been 39.7 million Leva in 1989, 97.05 million Leva in 1991, 138.42 million Leva in 1993, 246.11 million Leva in 1994. Main markers: Ukrain, Russia. It is working on 78-80% of its capacity.
- Preskov
  Machinery and equipment industry. It is working on 10% of its capacity.
- Metalik
  Machinery and equipment industry. It is in good financial position.
- Beroe
  Machinery and equipment industry. Main markets: Russia, Germany, Austria, The Netherlands, France.
- Dezintegrator
  Machinery and equipment industry.

- DZU
  Electronics & electrical equipment industry. Main markets: Germany, Italy, USA, Check republic. Occupied persons: 8527 in 1989, 2214 in 1994.
- Svetlina
  Electronics & electrical equipment industry.
- Agrobiochim
  Chemicals, chemical products & plastics industry. Its export is 55% of the total production of the enterprise. Occupied persons: 3821 in 1989, 3140 in 1994. Main products of the enterprise are:
  - Ammonium nitrate with capacity of 500000 ton, the production is 447943 ton in 1989, the production is 300918 ton in 1992, the production is 241416 ton in 1993, the production is 249471 ton in 1994.
  - Ammonium sulphate with capacity of 120000 ton, the production is 110500 ton in 1989, the production is 62454 ton in 1992, the production is 39600 ton in 1993, the production is 55110 ton in 1994.
  - Caprolactam with capacity of 25000 ton, the production is 25000 ton in 1989, the production is 11820 ton in 1992, the production is 7730 ton in 1993, the production is 9880 ton in 1994.
- Natalia
  Textile and ready made clothing industry. Occupied persons: 596. Main markets: Finland, Sweden, France.
- Modno obleklo
  Textile and ready made clothing industry.
- Bisser Oliva
  Food, beverages & tobacco industry.
- Menada
  Food, beverages & tobacco industry. Main markets: UK, Belgium, Netherlands, Finland.
- Mesokombinat
  Fod, beverages & tobacco industry. Main markets 33% of the production is for the region and 67% of it is for the country.
- Serdika
  Food, beverages & tobacco industry. It is a milkmanufacturing enterprise. Occupied persons: 311 in 1989, 187 in 1994. Main foreign markets: Livan, USA, Austria.
- DF P. Enev
  Food, beverages & tobacco industry. It is in very bad financial position.

Municipality: Kazanlak

Population	: 88434 inhabitants in 1993
Registered labour force	: 29457 persons in 1993
Registered unemployment	: 7.43% in December 1994
High population density	: 139.2 persons/km^2
Birth rate	: ?/1000 persons
Natural growth	: -2.28/1000 persons

High population density from 143.8 to 139.2 persons/km^2. From 412229 active persons in Haskovo region in 1994 about 9.97% (41117 persons) are living in

Kazanlak municipality. Municipality with high relative share of durable actives per person in the material sphere - 78 000 Leva or 15.2%.

Agriculture

middle average of oats production	150-180 kg/1000 m^2
middle average of cherry production	400 kg/1000 m^2
middle average of nut production	65-70 kg/1000 m^2
big cultivated areas sown with roses	-

In the municipality there are 10 big industrial electricity consumers with capacity over 500 kW and about 7 small industrial electricity consumers with capacity under 500 kW. In the municipality are mainly developed the following manufacturing:

- chemicals, chemical products & plastics,
- textile and ready made clothing industry,
- machinery and equipment industry,
- electronics & electrical equipment,
- wood, paper & pulp industry,
- food, beverages & tobacco industry.

Some of the biggest enterprises in the municipality are:

- Arsenal
  machinery and equipment industry. The enterprise has survived the serious critical decrease from the period of 1989-1990. Occupied persons: 15623 in 1989, 12597 in 1991, 11269 in 1993 and 12402 in 1994.
- NITI
  Machinery and equipment industry. It is in bad financial position.
- Kaproni
  Machinery and equipment industry. Occupied persons: 2746 in 1989, 1025 in 1993 and 798 in 1994. It is working with 60% of its capacity.
- M+C Hidravlik
  Machinery and equipment industry.
- ZINO
  Machinery and equipment industry. Occupied persons: 570 in 1989, 255 in 1994. Main markets: France, Germany, Austria, Italy, Canada.
- Bulgarska roza
  Chemicals, chemical products & plastics.
- Katex
  Textile and ready made clothing industry. Total sails: in 1989 70.769 million Leva, in 1991 170.401 million Leva, in 1993 332.926 million Leva, in 1994 577.9 million Leva. Occupied persons: 3083 in 1989, 2155 in 1994. Main markets: USA, France, Spain and Italy.
- Filtex
  Textile and ready made clothing industry. Over 95% of its production is exported. Main markets: Greece, Sweden.
- Parvi Mai
  Other industry. Main markets: Sweden, Denmark, USA, Macedonia, Germany. Occupied persons: 560 in 1989; 320 in 1994.

Municipality: Harmanli

Population	: 30713 inhabitants in 1993
Registered labour force	: 5887 persons in 1993
Registered unemployment	: 17.99% in December 1994
Under and middle population density	: 44.1 persons/km^2
Birth rate	: ?/1000 persons
Natural growth	: -3.55/1000 persons

Under and middle population density from 47.4 to 44.1 persons/km^2. From 412229 active persons in Haskovo region in 1994 about 3.14% (12944 persons) are living in Harmanli municipality. Municipality with middle relative share of durable actives per person in the material sphere - 1.62%.

Agriculture
middle average of tobacco production: 100-130/1000 m^2
cultivated areas sown with apple trees: about 1 million m^2
cultivated areas sown with vineyards.

In the municipality there are 2 big industrial electricity consumers with capacity over 500 kW and about 11 small industrial electricity consumers with capacity under 500 kW. In the municipality are mainly developed the following manufacturing:
- non-metallic mineral products,
- textile and ready made clothing industry,
- machinery and equipment industry,
- electronics & electrical equipment,
- wood, paper & pulp industry,
- food, beverages & tobacco industry.

Some of the biggest enterprises in the municipality are:
- Keramika
  Non-metallic mineral products industry. It is working on full capacity.
- Modis
  Wood, paper & pulp industry. It is in relatively good financial position.
- Prof. Kr. Dobrev
  Electronics & electrical equipment. Occupied persons: 1086 in 1989 and 165 in 1994. The total sales in 1989 have been 22 million Leva, in 1994 9.2 million Leva.
- Hatex
  Textile and ready made clothing industry. It is working with capacity of about 70%.
- Zlatna Trakia
  Food, beverages & tobacco industry. It is working on full capacity. It is in good financial position.
- Victoria 1
  Food, beverages & tobacco industry. Its capacity for meat production is about 100 ton/month.
- Serdika
  Food, beverages & tobacco industry. It is milk manufacturing enterprise.
- Tobacco prom.
  Food, beverages & tobacco industry. Its annual production is about 2300-2500 ton.

Municipality: Svilengrad

Population	: 26616 inhabitants in 1993
Registered labour force	: 6094 persons in 1993
Registered unemployment	: 17.59% in December 1994
Low population density	: 38.0 persons/km^2
Birth rate	: ?/1000 persons
Natural growth	: -4.04/1000 persons

Low population density from 38.7 to 38.0 persons/km^2. From 412229 active persons in Haskovo region in 1994 about 2.9% (11955 persons) are living in Svilengrad municipality. Municipality with middle relative share of durable actives per person in the material sphere - 39000 Leva or 2.32%.

Agriculture

middle average of wheat production	307 kg/1000 m^2
middle average of oats production	150-180 kg/1000 m^2
middle average of tomato production	2100-3000 kg/1000 m^2
middle average of cucumber production	1800 kg/1000 m^2
middle average of almond production	70-80 kg/1000 m^2
middle average of nut production	65-70 kg/1000 m^2
cultivated area sown with vineyard	14 million m^2
cultivated area sown with apple trees	2.2 million m^2

In the municipality there are 3 big industrial electricity consumers with capacity over 500 kW and about 9 small industrial electricity consumers with capacity under 500 kW. In the municipality are mainly developed the following manufacturing:
- textile and ready made clothing industry,
- machinery and equipment industry,
- food, beverages & tobacco industry.

Some of the biggest enterprises in the municipality are:
- Unimet
  Machinery and equipment industry. Occupied persons: 140.
- Peralno oborudvane
  Machinery and equipment industry. Occupied persons: 157 in 1989 and 82 in 1994.
- ZMM
  Machinery and equipment industry.
- Koprina
  Textile and ready made clothing industry. It is one of the biggest textile enterprises in the country with annual capacity 16000 thousand linear meters texture. About 50% of the production is for export.
- Traki
  Food, beverages & tobacco industry. It has capacity of about 2500 ton meat, 900 ton meat products and 1100 minced meat. Occupied persons: 15.

Municipality: Simeonovgrad

Population	: 11718 inhabitants in 1993
Registered labour force	: 1840 persons in 1993
Registered unemployment	: 11.08% in December 1994
Under and middle population density	: 52.7 persons/km^2
Birth rate	: ?/1000 persons
Natural growth	: 4.94/1000 persons

Under and middle population density from 57.9 to 52.7 persons/km^2. From 412229 active persons in Haskovo region in 1994 about 1.23% (5070 persons) are living in Simeonovgrad municipality.

Agriculture

middle average of cotton production	80-85 kg/1000 m^2

In the municipality there are 2 small industrial electricity consumers with capacity under 500 kW. In the municipality are mainly developed the following manufacturing:
- textile and ready made clothing industry,
- machinery and equipment industry.

Some of the biggest enterprises in the municipality are:
- Maritza
  Textile and ready made clothing industry. Its export production is over 70%. Main markets: Austria, Germany. Total sales in 1990 7.752 million Leva and in 1994 20.849 million Leva.
- Hebar
  Machinery and equipment industry. Main markets: Russia, Ukrain, Macedonia, Albain. Total sales in 1990 21.938 million Leva, 1991 27.978 million Leva, 1992 61.602 million Leva, 1993 61.675 million Leva, 1994 80.364 million Leva.

Municipality: Mineralni Bani

Population	: 7452 inhabitants in 1993
Registered labour force	: 858 persons in 1993
Registered unemployment	: 13.02% in December 1994
Low population density	: 34.1 persons/km^2
Birth rate	: ?/1000 persons
Natural growth	: -4.62/1000 persons

Low population density from 36.5 to 34.1 persons/km^2. From 412229 active persons in Haskovo region in 1994 about 0.76% (3133 persons) are living in Mineralni bani municipality. Municipality with low relative share of durable actives per person in the material sphere - 6600 Leva or 0.22%. In the municipality there are 2 small industrial electricity consumers with capacity under 500 kW. In the municipality are mainly developed the following manufacturing:
- basic metals & metal products.

Municipality: Madgarovo

Population	: 3974 inhabitants in 1993
Registered labour force	: 1072 persons in 1993
Registered unemployment	: 13.45% in December 1994
Low population density	: 16.1 persons/km^2
Birth rate	: ?/1000 persons
Natural growth	: positive/1000 persons

Low population density from 20.7 to 16.1 persons/km^2. From 412229 active persons in Haskovo region in 1994 about 0.47% (1937 persons) are living in Madgarovo municipality. Municipality with middle relative share of durable actives per person in the material sphere - 38 600 Leva. In the municipality there is 1 big industrial electricity consumer with capacity over 500 kW and 1 small industrial electricity consumers with capacity under 500 kW. In the municipality are mainly developed the following manufacturing:
- basic metals & metal products.

Some of the biggest enterprises in the municipality are:
- Madgarovo
  Basic metals & metal products. It is in a bad financial position.

The production of lead concentrate declined from 28.069 million Leva in 1992 to 6.049 million Leva in 1993. The production of zinc concentrate declined from 46.016 million Leva in 1992 to 14.397 million Leva in 1993.

Municipality: Ljubimetz

Population	: 12318 inhabitants in 1993
Registered labour force	: 1847 persons in 1993
Registered unemployment	: 12.99% in December 1994
Low population density	: 35.7 persons/m^2
Birth rate	: ?/1000 persons
Natural growth	: -9.04/1000 persons

Low population density from 38.96 to 35.72 persons/m^2. From 412229 active persons in Haskovo region in 1994 about 1.28% (5277 persons) are living in Ljubimetz municipality.

Agriculture

middle average of melon and water melon production	1400-1500 kg/1000 m^2
middle average of almond production	70-80 kg/1000 m^2
cultivated area sown with apple trees	0.89 million m^2

In the municipality there are 4 small industrial electricity consumers with capacity under 500 kW. In the municipality are mainly developed the following manufacturing:
- machinery and equipment,
- non - metallic mineral products,
- food, beverages & tobacco industry,
- textile and ready made clothing.

Some of the biggest enterprises in the municipality are:

- ZMM Ljubimetz
  Machinery and equipment. Occupied persons: 346 in 1989 and 50 in 1994.
- Sakar
  Food, beverages & tobacco industry. Occupied persons: 71 in 1992, 67 in 1993, 65 in 1994. The production of wines has declined from 6948 ton in 1992 to 4300 ton in 1994. The production of brandy has declined from 1630 ton in 1992 to 440 ton in 1994.
- Budeshte
  Non-metallic mineral products. Occupied persons: 146 in 1992, 102 in 1993, 93 in 1994. The total sales in 1992 7.189 million Leva, in 1993 11.303 million Leva, in 1994 23.385 million Leva.
- Detelina
  Textile and ready made clothing. The annual total sales are about 7-8 million Leva. Its main production is for export.

Municipality: Ivailovgrad

Population	: 10355 inhabitants in 1993
Registered labour force	: 2189 persons in 1993
Registered unemployment	: 18.84% in December 1994
Low population density	: 14.3 persons/km^2
Birth rate	: ?/1000 persons
Natural growth	: 3.22/1000 persons

Low population density from 16.9 to 14.3 persons/km^2. From 412229 active persons in Haskovo region in 1994 about 1.08% (4452 persons) are living in Ivailovgrad municipality.

Agriculture

middle average of nut production	65-70 kg/1000 m^2
middle average of almond production	70-80 kg/1000 m^2

In the municipality there are 4 small industrial electricity consumers with capacity under 500 kW. In the municipality are mainly developed the following manufacturing:

- machinery and equipment,
- non-metallic mineral products,
- textile and ready made clothing.

Some of the biggest enterprises in the municipality are:

- Egida
  Electronics & electrical equipment. It is working with 30% of its capacity.
- Armira
  Textile and ready made clothing. The total sales for 1991 2.411 million Leva, for 1992 1.03 million Leva, for 1993 0.285 million Leva. Occupied persons: 120.

Municipality: Stambolovo

Population	: 7534 inhabitants in 1993
Registered labour force	: 783 persons in 1993
Registered unemployment	: 13.34% in December 1994
Low population density	: 27.2 persons/km^2
Birth rate	:-/1000 persons
Natural growth	: -2.09/1000 persons

Low population density from 43.1 to 27.2 persons/km^2. From 412229 active persons in Haskovo region in 1994 about 0.86% (3545 persons) are living in Stambolovo municipality. Municipality with low relative share of durable actives per person in the material sphere - 0.24%.

Agriculture
cultivated area sown with vineyards.

Municipality: Topolovgrad

Population	: 18483 inhabitants in 1993
Registered labour force	: 3545 persons in 1993
Registered unemployment	: 18.11% in December 1994
Low population density	: ? persons/km^2
Birth rate	: ?/1000 persons
Natural growth	: -9.28/1000 persons

From 412229 active persons in Haskovo region in 1994 about 1.84% (7585 persons) are living in Topolovgrad municipality.

Agriculture

middle average of oats production	150-180 kg/1000 m^2
middle average of almond production	70-80 kg/1000 m^2

Municipality: Dimitrovgrad

Population	: 72041 inhabitants in 1993
Registered labour force	: 20520 persons in 1993
Registered unemployment	: 9.23% in December 1994
High population density	: 127.8 persons/km^2
Birth rate	: ?/1000 persons
Natural growth	: ?/1000 persons

High population density from 139.9 to 127.8 persons/km^2. From 412229 active persons in Haskovo region in 1994 about 7.61 (31388 persons) are living in Dimitrovgrad municipality. Municipality with high relative share of durable actives per person in the material sphere - 62 000 Leva or 10.24%.

Agriculture

middle average of wheat production	430 kg/1000 m^2
middle average of barley production	328 kg/1000 m^2
middle average of oats production	150-180kg/1000 m^2
middle average of tomato production	2100-3000 kg/1000 m^2
middle average of cucumber production	1800 kg/1000 m^2
middle average of pepper production	1600-1800 kg/1000 m^2
middle average of sunflower production	95-110 kg/1000 m^2
middle average of cotton production	80-85 kg/1000 m^2

In the municipality there are 4 big industrial electricity consumers with capacity over 500 kW and about 19 small industrial electricity consumers with capacity under 500 kW. In the municipality are mainly developed the following manufacturing:
- chemicals, chemical products & plastics,
- non-metallic mineral products,
- textile and ready made clothing industry,
- machinery and equipment industry,
- wood, paper & pulp industry,
- food, beverages & tobacco industry.

Some of the biggest enterprises in the municipality are:
- Vulkan
  Non-metallic mineral products industry.
  Some of the main products of the enterprise are:
  - Cement production in 1991 211855 ton, in 1992 193266 ton, in 1993 219964 ton, in 1994 272269 ton.
  - AZ pipes production in 1991 146917 m, in 1992 108551 m, in 1993 96065 m, in 1994 85752 m.
  - AZ plates production in 1991 292385 m^2, in 1992 297582 m^2, in 1993 115615 m^2, in 1994 358764 m^2.
  - Asbestos cardboard production in 1991 280813 kg, in 1992 245903 kg, in 1993 278252 kg, in 1994 249502 kg.
- Simat
  Non-metallic mineral products. Occupied persons in: 1989 304, 1994 115. The enterprise is with good financial results. It is working on 55% of its capacity.
- Artescos
  Non-metallic mineral products.
- Kamenetz-91
  Wood, paper & pulp industry. It is working with capacity of about 33% in 1995. The total sales are: in 1991 13.378 million Leva, in 1992 5.736 million Leva, in 1993 4.906 million Leva. Occupied persons: in 1991 155, 1994 53.
- Klimateh
  Machinery and equipment industry: Occupied persons: in 1992 157, in 1994 134.
- Neochim
  Chemicals, chemical products & plastics. Main products of the enterprise: ammonia production in 1990 127000 ton in 1991 87000 ton, in 1992 40000 ton, in 1993 33000 ton, in 1994 80000 ton, ammonium nitre production in 1990 579000 ton, in 1991 342000 ton, in 1992 262000 ton, in 1993 202000 ton, in 1994 400000 ton. The main markets of the production are: Turkey, Greece, Macedonia: Occupied persons: in 1989 4527, in 1994 3160. It is working on 65% of its capacity.

- Trikon
  Textile and ready made clothing industry. It is the biggest textilmanufacturing enterprise in the country. The max capacity is 500000 m/month. In 1994 it is working on 12-15% of its capacity. Main markets: Finland, Sweden, Turkey. Trakia: 52 - textile and ready made clothing industry. Its annual production in 1989 1.28 million number dresses, in 1993 0.125 million number dresses, Gergana - textile and ready made clothing industry. The production for 1991 is 1.518 million number dresses: 1993 is 0.252 million number dresses. Occupied persons: in 1991 772, in 1993 388, in 1994 299. It is working on 60% of its capacity.
- Maritza
  Food, beverages & tobacco industry. It is working on 60-70% of its capacity.
- ChimreMontstroy
  Machinery and equipment industry. The total sales in 1992 22.045 million Leva, in 1993 15.034 million Leva, in 1994 17.974 million Leva.

APPENDIX D. REGIONAL ENERGY BALANCE HASKOVO

Here the regional energy balance for the year 1993 is presented. This version is more detailed than the regional energy balance as already presented in chapter 7.

Table D.1 *Regional energy balance [PJ] for Haskovo region for the year 1993 (part 1 of 3)*

Energy carriers	Electricity	Heat	Uranium	Hard coal	Brown coal	Briquettes	Coke	Unknown solids	Wood (non-renewable)	Peat (non-renewable)	Agriculture waste, (non-renewable)	Municipal waste
Primary energy												
Import				0.0	10.6			1.0				
Production					154.8							
Export	23.0					23.6						
Stock changes												
Primary energy balance	-23.0			0.0	165.4	-23.6		1.0				
Final energy supply												
Mining & energy supply (use (-)/prod (+))												
Coal	-2.2											
Briquetting	-0.3	-6.7			-26.9	26.4						
Coking												
Oil												
Refinery												
Gas												
Public electricity	39.9	6.7			-137.1							
Industrial CHP	0.2	2.9			-1.4							
Public district heat	0.1	0.9										
Final energy supply	37.6	3.8			-165.4	26.4						
Transportation losses	5.1	0.4										
Final non-energy consumption												
Cons. en. prod. industry												
Final energy demand												
Agriculture												
Manufacturing & const.	3.5	3.0										
Public services	2.3	0.1		0.0	0.0	0.2		0.0				
Commercial buildings												
Residential buildings	3.7	0.4		0.0	0.0	2.6		0.9				
Public transport												
Final energy demand	9.5	3.4		0.0	0.0	2.8		1.0				

Table D.1 *Regional energy balance [PJ] for Haskovo region for the year 1993 (part 3 of 3)*

Energy carriers	Natural gas	Refinery gas	Blast furnace gas	Coke gas	Biogas	Wood (renewable)	Peat (renewable)	Agriculture waste, straw (renewable)	Solar	Geothermal	Hydro	Wind
Primary energy												
Import	12.7											
Production						0.9					0.7	
Export												
Stock changes												
Primary energy balance	12.7					0.9					0.7	
Final energy supply												
Mining & energy supply (use (-)/prod (+))												
Coal												
Briquetting												
Coking												
Oil												
Refinery												
Gas												
Public electricity	-0.1											
Industrial CHP	-2.1										-0.7	
Public district heat												
Final energy supply	-2.1										-0.7	
Transportation losses	0.1											
Final non-energy consumption												
Cons. en.prod.industry												
Final energy demand												
Agriculture												
Manufacturing & const.	10.4											
Public services						0.0						
Commercial buildings												
Residential buildings						0.9						
Public transport												
Final energy demand	10.4					0.9						

Table D.1 *Regional energy balance [PJ] for Haskovo region for the year 1993 (part 2 of 3)*

Energy carriers	Crude oil	Gasoline	Kerosene	Gasoil	Non-energy	LPG	Naphtha	Methanol	Heavy oil
Primary energy									
Import				0.2			0.1		9.3
Production									
Export									
Stock changes									
Primary energy balance				0.2			0.1		9.3
Final energy supply									
Mining & energy supply (use (-)/prod (+))									
Coal									
Briquetting									
Coking									
Oil									
Refinery									
Gas									
Public electricity									
Industrial CHP									-0.9
Public district heat									
Final energy supply									-1.2
									-2.1
Transportation losses									
Final non-energy consumption									
Cons. en. prod. industry									
Final energy demand									
Agriculture									
Manufacturing & const.									7.2
Public services				0.2			0.1		
Commercial buildings									
Residential buildings				0.1			0.1		
Public transport									
Final energy demand				0.2			0.1		7.2

APPENDIX E. MISCELLANEOUS MUNICIPALITY DATA

In chapter 9 the energy consumption pattern of the region of Haskovo has been analysed by comparison of energy consumption indicators of the 27 municipalities. The energy consumption indicators are obtained from the database as developed for this study. In this Appendix more energy consumption indicators are presented. Annual data are reported for the year 1993.

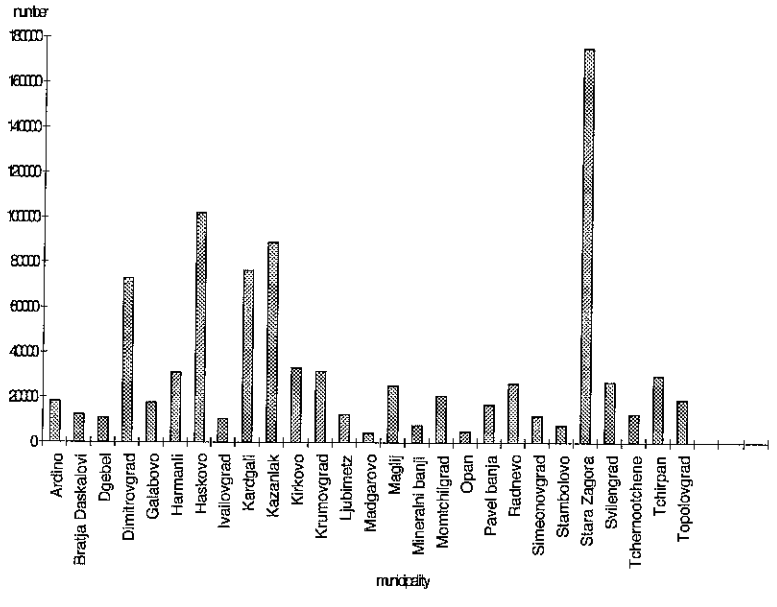

Figure E.1 *Population per municipality*

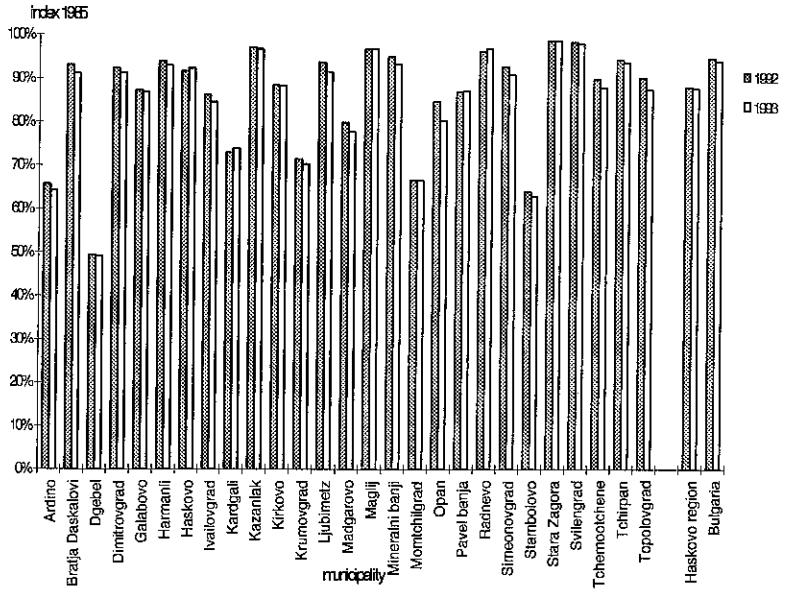

Figure E.2 *Population development per municipality*

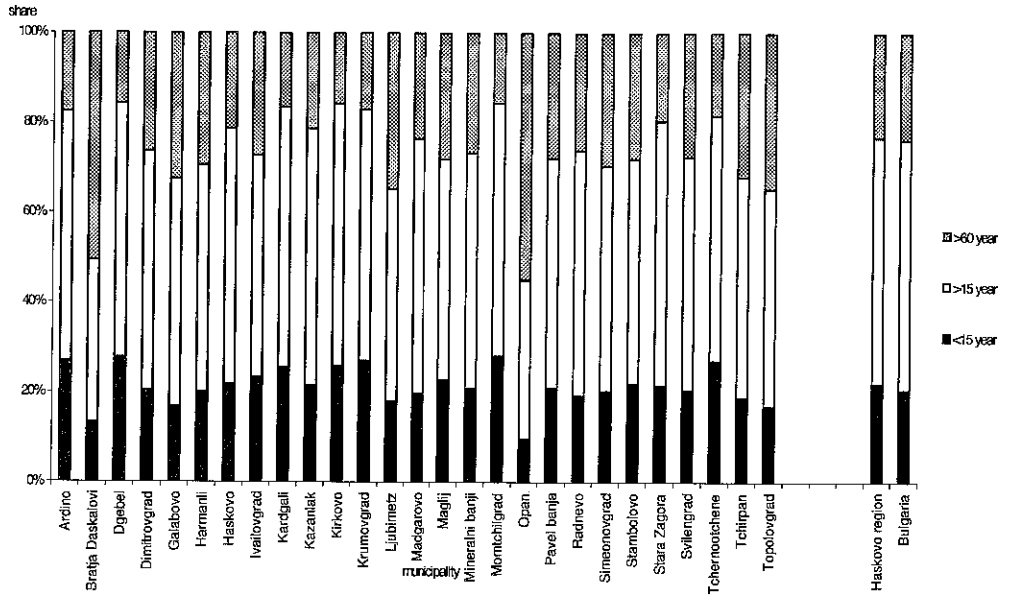

Figure E.3 *Population by age category per municipality*

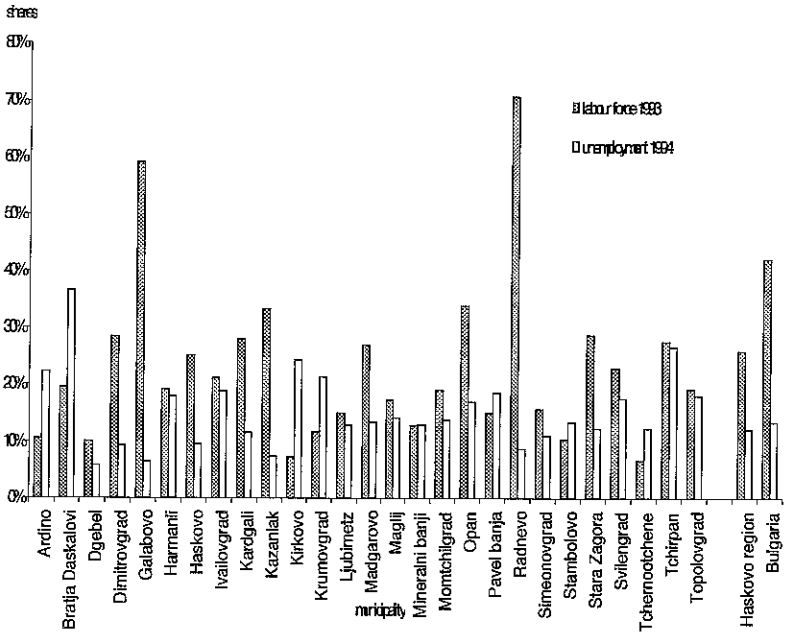

Figure E.4 *Labour force and unemployment rates per municipality*

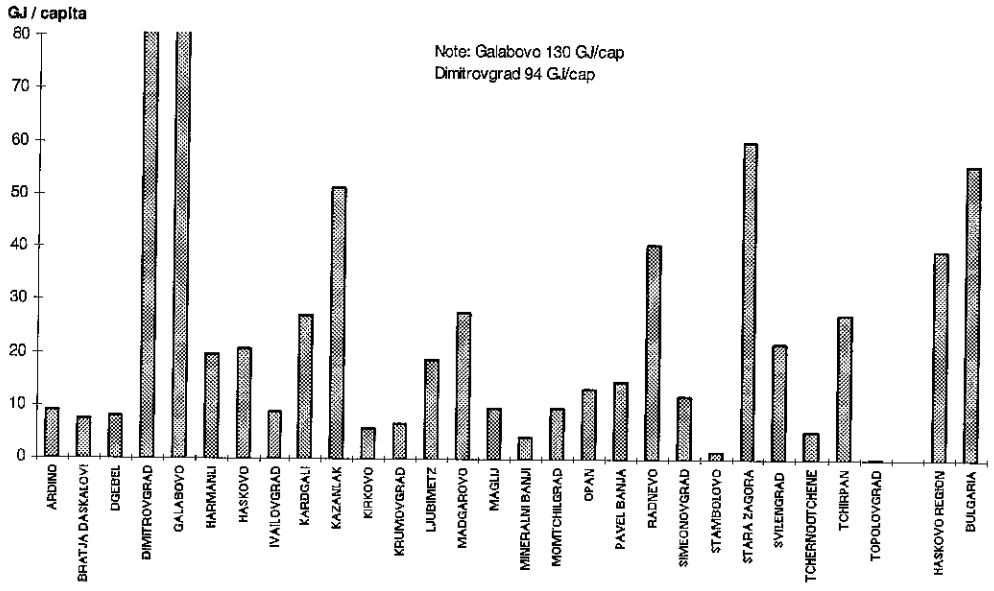

Figure E.5 *GJ/cap total energy consumption per municipality*

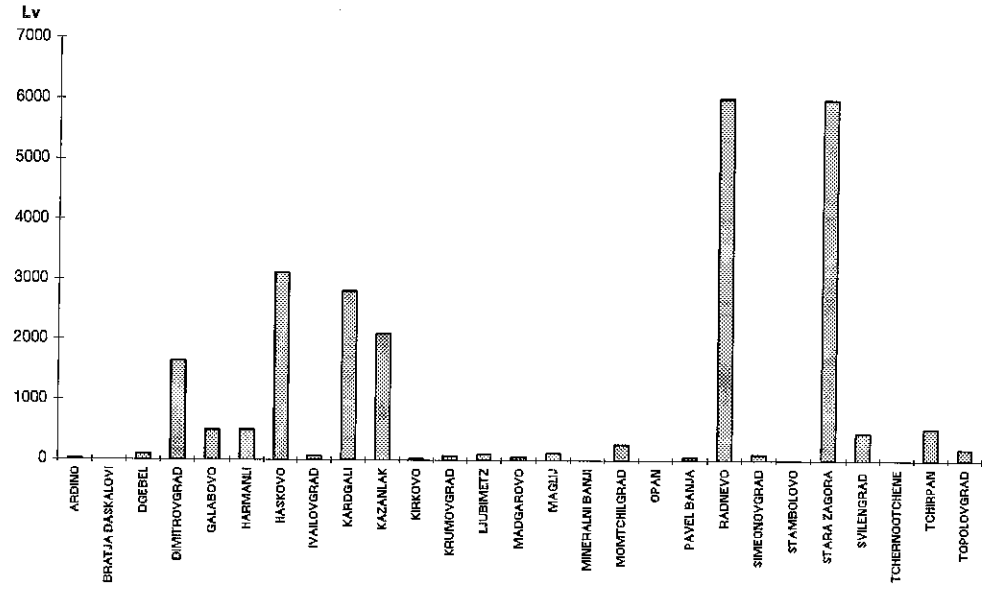

Figure E.6 *Economic output of manufacturing and construction per municipality, year 1993, Haskovo region*

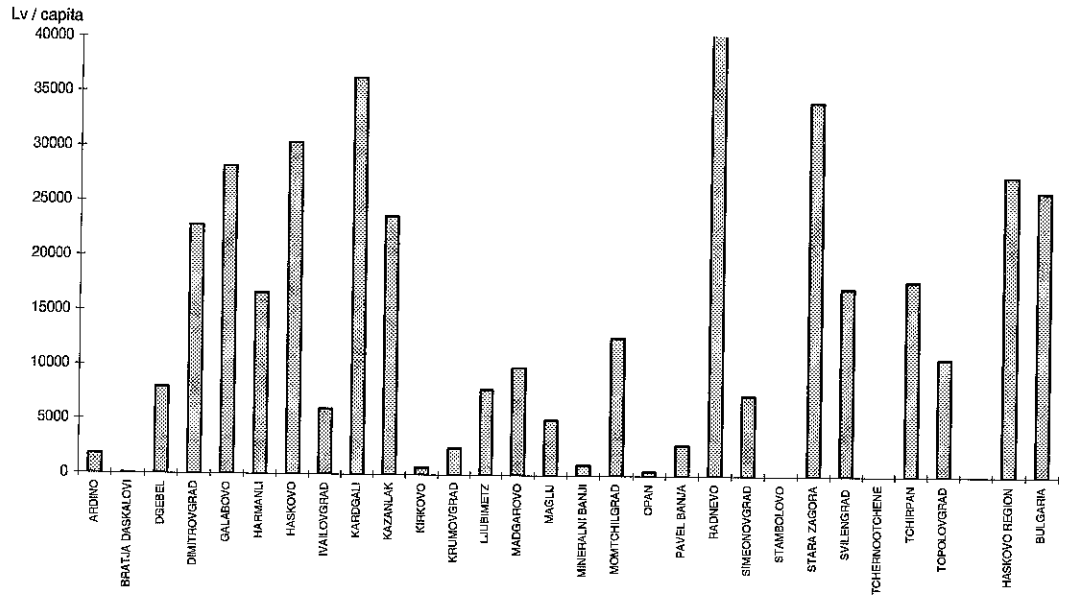

Figure E.7 *Economic output of manufacturing and construction per capita per municipality, year 1993, Haskovo region*

Table E.1 *Structure of economic output of manufacturing and construction per municipality, year 1993, Haskovo region*

Economic output man & construction	Food	Textile	Leather	Paper	Chemicals	Non-metallic minerals	Basic metals	Machinery	Electronics	Others	Construction	Total
Haskovo region 1993 (10e6lv93)	4910	1606	69	304	2059	497	1056	1552	411	10916	1435	24815
Ardino	0	18	0	0	0	0	0	3	0	6	5	32
Bratja Daskalovi	0	0	0	0	0	0	0	0	0	0	0	0
Dgebel	49	0	0	0	0	0	0	0	0	38	0	87
Dimitrovgrad	21	127	39	0	1033	197	0	26	0	70	128	1642
Galabovo	0	0	0	0	0	0	0	350	0	142	6	498
Harmanli	258	67	0	20	0	0	0	0	40	116	8	509
Haskovo	1231	288	20	15	0	0	0	152	0	1234	178	3119
Ivailovgrad	0	20	0	0	0	0	0	16	1	21	4	62
Kardgali	613	198	0	41	0	130	999	117	24	533	146	2801
Kazanlak	367	477	7	12	123	0	0	512	0	515	79	2092
Kirkovo	0	0	0	0	0	0	0	0	0	11	10	21
Krumovgrad	0	0	0	0	0	0	0	0	0	68	6	74
Ljubimetz	62	0	0	0	0	0	0	0	0	28	6	96
Madgarovo	0	0	0	0	0	0	0	0	0	29	10	39
Maglij	0	0	0	22	0	26	0	0	0	77	2	128
Mineralni Banji	0	0	0	0	0	0	0	0	0	2	5	7
Momtchilgrad	48	0	0	0	0	0	0	33	0	166	16	263
Opan	0	0	0	0	0	0	0	0	0	0	2	2
Pavel Banja	0	0	0	30	0	0	0	0	0	17	1	47
Radnevo	0	0	0	0	0	0	0	0	0	5817	205	6022
Simeonovgrad	0	16	0	0	0	0	0	62	0	5	3	86
Stambolovo	0	0	0	0	0	0	0	0	0	0	0	0
Stara Zagora	2012	122	3	165	903	92	0	183	345	1631	551	6007
Svilengrad	35	213	0	0	0	0	0	99	0	72	38	458
Tchernootchene	0	0	0	0	0	0	0	0	0	0	0	0
Tchirpan	214	60	0	0	0	0	57	0	0	184	12	527
Topolovgrad	0	0	0	0	0	51	0	0	0	133	14	198
Haskovo region	4910	1606	69	304	2059	497	1056	1552	411	10916	1435	24815
Bulgaria	52894	13082	3476	10454	43891	9036	23383	25871	12310	24809	0	2192

Table E.2 *Energy consumption manufacturing and construction by fuel per municipality, year 1993, Haskovo region*

Total energy consumption	Electricity	Heat	Solids	Gas	Oil	Renewables	Total
Haskovo region man&constr 1993 [TJ]	3470	2966	0	10407	7200	0	24042
Ardino	32	0	0	0	3	0	36
Bratja Daskalovi	3	0	0	0	0	0	3
Dgebel	1	0	0	0	14	0	15
Dimitrovgrad	607	0	0	7677	294	0	8577
Galabovo	10	0	0	0	636	0	646
Harmanli	41	0	0	0	246	0	286
Haskovo	186	0	0	1	675	0	862
Ivailovgrad	7	0	0	0	9	0	16
Kardgali	549	0	0	0	829	0	1378
Kazanlak	158	329	0	0	2214	0	2701
Kirkovo	3	0	0	0	0	0	3
Krumovgrad	3	0	0	0	1	0	3
Ljubimetz	8	0	0	0	60	0	68
Madgarovo	80	0	0	0	0	0	80
Maglij	3	0	0	0	2	0	5
Mineralni Banji	9	0	0	0	0	0	9
Momtchilgrad	31	0	0	0	23	0	54
Opan	0	0	0	0	0	0	0
Pavel Banja	0	0	0	0	0	0	0
Radnevo	55	0	0	0	690	0	745
Simeonovgrad	3	0	0	0	17	0	20
Stambolovo	0	0	0	0	0	0	0
Stara Zagora	1607	2637	0	2729	1276	0	8249
Svilengrad	53	0	0	0	185	0	237
Tchernootchene	1	0	0	0	0	0	1
Tchirpan	21	0	0	0	21	0	42
Topolovgrad	0	0	0	0	5	0	5
Haskovo region	3470	2966	0	10407	7200	0	24042
Bulgaria	39300	78000	18098	51800	10104	200	197502

Table E.3 *Energy consumption public services by fuel per municipality, year 1993, Haskovo region*

Total energy consumption	Electricity	Heat	Solids	Gas	Oil	Renewables	Total
Haskovo region public services 1993 [TJ]	2302	81	283	0	224	35	2925
Ardino	24	0	5	0	1	0	30
Bratja Daskalovi	17	0	0	0	0	26	43
Dgebel	12	0	3	0	1	0	15
Dimitrovgrad	145	0	7	0	35	1	187
Galabovo	32	0	8	0	2	0	41
Harmanli	60	0	3	0	11	0	75
Haskovo	284	0	12	0	37	2	335
Ivailovgrad	25	0	0	0	11	0	36
Kardgali	119	0	76	0	5	1	201
Kazanlak	492	81	7	0	23	0	602
Kirkovo	22	0	32	0	2	0	56
Krumovgrad	31	0	30	0	2	0	63
Ljubimetz	27	0	2	0	8	0	37
Madgarovo	11	0	0	0	0	1	12
Maglij	37	0	0	0	0	0	37
Mineralni Banji	15	0	0	0	0	0	15
Momtchilgrad	27	0	21	0	1	0	50
Opan	42	0	0	0	0	0	42
Pavel Banja	26	0	0	0	0	0	26
Radnevo	20	0	31	0	12	0	63
Simeonovgrad	26	0	1	0	3	0	30
Stambolovo	5	0	0	0	0	0	5
Stara Zagora	656	0	17	0	52	1	725
Svilengrad	67	0	4	0	9	1	80
Tchernootchene	5	0	12	0	1	0	18
Tchirpan	77	0	14	0	10	0	101
Topolovgrad	0	0	0	0	0	0	0
Haskovo region	2302	81	283	0	224	35	2925
Bulgaria	9600	5500	1623	140	1060	400	18323

Table E.4 *Energy consumption residential sector by fuel per municipality, year 1993, Haskovo region*

Total energy consumption	Electricity	Heat	Solids	Gas	Oil	Renewables	Total
Haskovo region residential 1993 [TJ]	3722	363	3551	0	138	851	8625
Ardino	28	0	54	0	6	6	94
Bratja Daskalovi	18	0	0	0	0	26	45
Dgebel	15	0	33	0	4	4	56
Dimitrovgrad	377	0	226	0	13	1	618
Galabovo	64	0	909	0	0	18	991
Harmanli	116	0	119	0	4	1	239
Haskovo	553	0	356	0	17	4	931
Ivailovgrad	31	0	5	0	5	0	40
Kardgali	287	0	177	0	27	25	517
Kazanlak	407	363	337	0	4	131	1240
Kirkovo	40	0	78	0	12	1	131
Krumovgrad	42	0	72	0	11	10	136
Ljubimetz	56	0	67	0	3	0	126
Madgarovo	13	0	4	0	0	0	17
Maglij	32	0	0	0	0	172	205
Mineralni Banji	9	0	0	0	0	0	9
Momtchilgrad	33	0	48	0	7	7	96
Opan	14	0	0	0	0	5	18
Pavel Banja	60	0	0	0	0	163	222
Radnevo	134	0	103	0	1	27	265
Simeonovgrad	48	0	41	0	1	1	90
Stambolovo	6	0	0	0	0	0	6
Stara Zagora	1061	0	313	0	13	178	1565
Svilengrad	138	0	117	0	4	2	261
Tchernootchene	10	0	29	0	4	4	47
Tchirpan	130	0	464	0	0	66	660
Topolovgrad	0	0	0	0	0	0	0
Haskovo region	3722	363	3551	0	138	851	8625
Bulgaria	36100	26800	39900	0	2135	0	104935

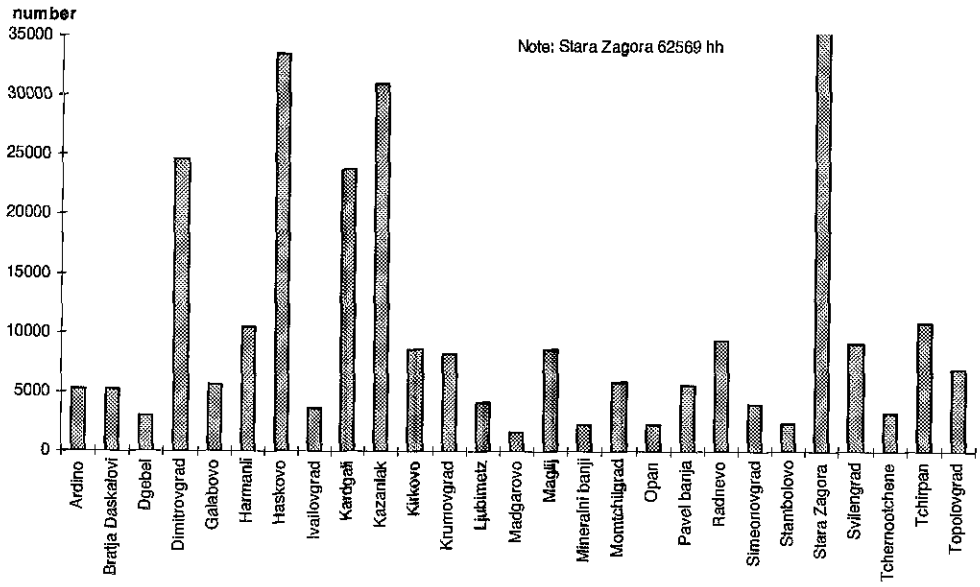

Figure E.8 *Amount of households residential sector per municipality, year 1993, Haskovo region*

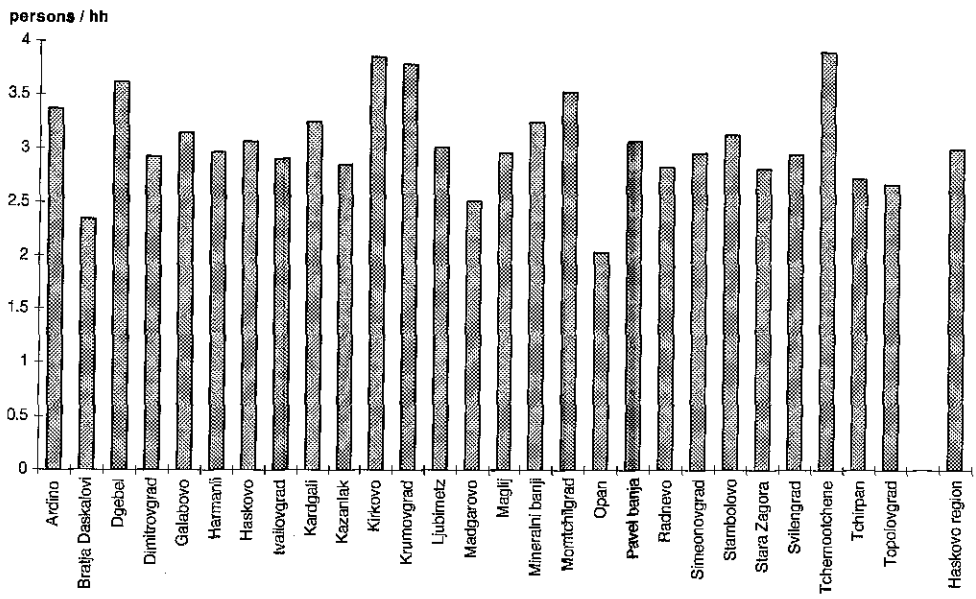

Figure E.9 *Amount of inhabitants per household residential sector per municipality, year 1993, Haskovo region*

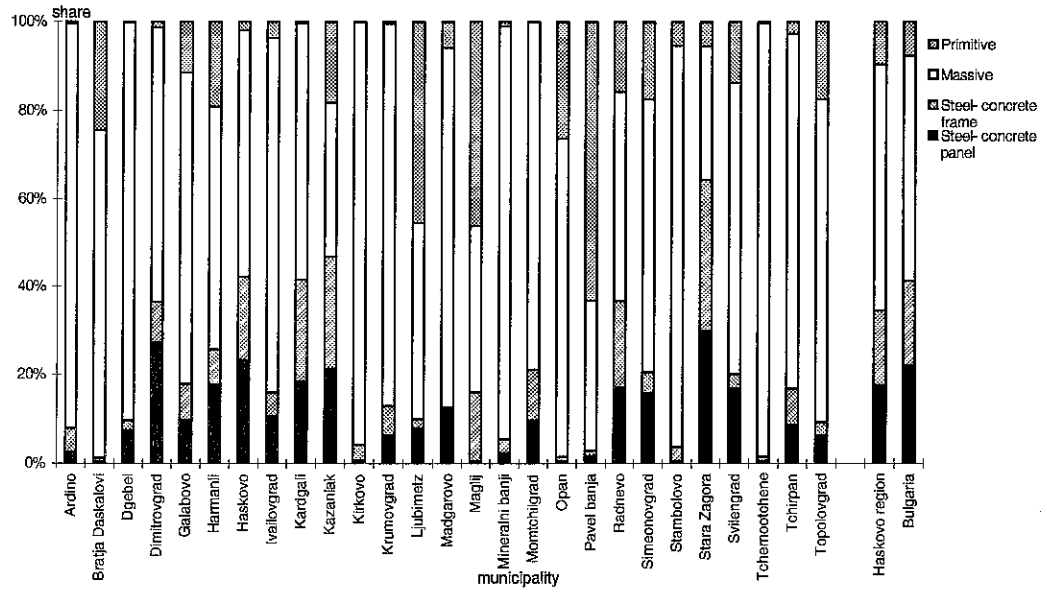

Figure E.10 *Type of dwelling residential sector per municipality, year 1993, Haskovo region*