Empirical Assessment of the Impacts of Ecological Taxation in the Czech Republic
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1 Summary

The paper describes a project comprising the development of an analytical framework for policy instrument assessment and the application of the framework to an assessment of ecological taxation in the Czech Republic. The project has been financed by the Danish Environmental Protection Agency as support to the Ministry of the Environmental of the Czech Republic. The responsibility of the content and results are solely the authors.

The context of the project is important. The main objective was to present empirical assessments of ecological taxation in order to support the process of policy preparation. Thus, the starting point for the project was to develop an assessment framework which based on available data could provide empirical estimation of some of the major effects of introducing ecological taxation.

Regarding the methodological considerations, the paper describes that the availability of data for economic assessment and the characteristics of a transition economy implies that empirical analysis has to be based on a pragmatic approach. The developed framework comprise such an approach where the formulation of a simulation model based on existing data can provide important empirical results.

Applying the developed framework for strategic policy instrument assessment to two alternative taxation scenarios for the Czech Republic has provided an overview of:

- the impacts on households expenditure, industry production costs, tax revenue and environment
- institutional requirements for implementation of ecological taxation
- political feasibility introducing ecological taxation
- capacity for ecological taxation

Starting from the most recent EU proposal for minimum tax rates on motor fuels, heating fuels and electricity, two alternative tax scenarios has been defined. One comprises the EU proposal, the other includes a larger tax on brown coal and other heating fuels while no increase on motor fuels. The scenarios imply relative price increases in the order of 30% to 50% compared to present level of energy prices. The main results regarding the impact assessments are:
• an increase in the energy expenditure of households equal to 2 - 3% of after tax income (which again is equivalent to 1000-2000 CZK per person per year),
  – largest relative increase for pensioners and low income groups, up to 5%
• an increase in production costs of manufacturing industries from 1-2%
  – largest increase for metal and non-metal mineral producing industries, up to 4-5%
• providing a net tax revenue in the order of 35-50 billion CZK per year
• under the cautious assumption of a relationship between energy price and energy consumption equivalent to an international level (price elasticity of 0.3) the impact on emissions will be in the order of 5-10% reduction in the main air pollutants.

The institutional assessment has indicated that the tax scenarios could be implemented within existing structures and in general seems to imply relative low administrative costs. However, the assessment of the political feasibility has indicated that the support at present is very low.

Considering that present situation with low VAT on many energy products (though it is about to be changed to the normal 22% rate by January 1, 1998), subsidy on important products like electricity, the prospect for energy taxes as part of an ecological tax reform appear to be more a medium or long term initiative than an immediate possibility.

What is very important to note is that this assessment has only provided elements to the policy preparing process. There are two major extensions. Firstly, the impact assessment need to be further elaborated. For example, the estimation of the environmental effects should be qualified. Also with respect to the compensation analysis, especially the possibility of other alternatives industry compensation could be investigated. Secondly, the consequences of ecological tax reform should be compared to other policy instruments and if such a comparison would suggest ecological taxation as environmental policy instrument, the actual implementation need detailed preparation.

The application of the basic approach, represented by the developed framework for strategic policy instrument assessment, has demonstrated the usefulness of such a structuring of the analysis and there is a potential for a broader use of the framework in analysing other policy instrument.

Furthermore, the results has been used to initiate discussions between the major actors in the Czech Republic regarding environmental taxation.
2 Introduction

This paper is based on the results of a larger project: "Institutional strengthening for implementation of economic instrument in the environmental policy in the Czech Republic". This project has been financed by the Danish Environmental Protection Agency as part of the support to the Ministry of the Environmental of the Czech Republic. The project has been made in co-operation with Dr. Jirina Jilkova of the University of Economics in Prague.

The aim of this paper is:

- describe a methodological framework which was developed and
- present the results of applying the framework to an empirical assessment of ecological taxation in the Czech Republic.

By these two objectives it our hope to give an example of how an empirical assessment can be made using immediately available data and thereby create quantitative results as an important input to the policy process.

This study was as mentioned part of larger support project directed towards the implementation of economic instruments in the environmental policy. This overall project have contained a number of activities like other specific policy assessments and experience exchange activities. The assessment of ecological tax reform is however the main activity in the project.

Among the factors for choosing environmental taxation and ecological tax reform as the object for a detailed assessment the following can be mentioned:

- High energy consumption is one of the main reasons for a high level of air pollution. This fact suggests that there could be a potential effect on pollution of increasing the taxation of the energy products.
- Today the level of energy taxation is generally low except for motor fuels.
- The level of income taxation in the Czech Republic is low in an international comparison. However, the payment of social contribution by the employers are high.
- Although the official unemployment rate is low, the continued transition process could increase the unemployment as the restructuring of large manufacturing enterprises take place.
• The perspective for the Czech Republic is therefore a reform which will reduce the use of pollution resources and maintain a high level of employment through the transition phase.
• Additionally, the approximation of the Czech environmental legislation to EU could imply the introduction of taxation of a number of energy products.

On this background, ecological taxation and ecological reform was selected as the main instrument for in-dept analysis of the project.

Before the next chapters presenting the assessment framework and the empirical application, the use of the term “ecological tax reform” and ecological or environmental taxation should defined.

Firstly, the terms environmental, ecological or green taxation are used synonymously. Secondly, the main focus is the introduction and change of existing energy taxation. As energy taxation constitutes the main body of environmental taxation, focus in the project was environmental taxation.

However, different forms of general compensation or recycling of the tax revenue were also included in the assessment justifying the use of the term “ecological tax reform assessment”. An assessment of ecological tax reform is very comprehensive if all aspects need to be covered; for example, a macro-economic assessment would often include estimation of employment impacts.

This assessment has a more narrow focus and therefore one might lack some macro-economic impacts like employment effects which are not included in the assessment. The background and consideration behind the delimitation of the assessment will be explained further in the following section.
3 General approach for the assessment

The process of preparing policy proposals can be viewed in many ways. Differences in culture and tradition will often play a significant role. In the following we present a framework for strategic policy assessment, which is based on the following assumptions:

- the process of policy preparing should be based on clearly defined objectives;
- the assessment of policies should attempt to assess the policy impacts in relation to the defined objectives.

The process of policy preparing involves many steps. An ideal path could comprise the elements shown in Figure 3-1 below.

![Figure 3-1 The policy preparation process.](image)

In this project the outset has been that introducing ecological taxation as part of an ecological tax reform already was identified as a potential policy instrument. Thus, the assessment of ecological taxation and ecological tax reform is confined to the step called “strategic policy assessment” which include the assessment of
impacts of a number of alternative taxation schemes combined with compensation measures, institutional requirements and other implementation constraints.

These elements of policy assessment are almost always important and no matter how the policy instrument has been identified, it is a condition for successful implementation that impacts, requirements and constraints are properly assessed. In the following these elements are combined in what can be called a *framework for strategic policy instrument assessment*. This framework is illustrated in Figure 3-2.

**Figure 3-2  Sketch of the Framework for policy assessment**

The framework comprises three levels of assessments:

1. **Level:** Definition of taxation alternatives
   Estimation / assessment of impacts: environmental, economic, financial, distributional etc.

2. **Level:** Assessment of factors determining feasibility of implementing a new taxation scheme.

3. **Level:** Assessment of background factors for improved efficiency of a new taxation scheme.

The three levels can be understood as describing degrees of necessity in the preparation process. It is the core of the assessment to define a specific taxation scheme and to evaluate the impacts of this scheme. The second level regarding the political and institutional feasibility is less needed in the process, but if these aspects are not sufficiently covered, the implementation will be difficult and
through the political discussion and the relative power of the stakeholders, modification of the proposed taxation scheme is likely. Level 3 represents issues which will improve the effect of the instrument if the aspects are included.

The specific assessments of impacts are described in the subsequent chapters. The overall considerations behind the framework structure and the selection of impact assessment approach are discussed in the following.

3.1 Framework structure and methodology for impact assessment

As ecological taxation is an issue involving a number of actors including different ministries, the process of preparing actual policy proposals need co-operation and co-ordination. The methodological framework contains the elements which was identified as important for the first step in an policy preparing process.

The assessment of impacts with the objective of presenting empirical results could be an input to qualify the discussions among the main actors involved.

Therefore, the methodology for impact assessment has been based on the principles that the assessment should apply fairly available data, be easy to make, and provide an overview of the main effects.

Basically, one can distinguish between the following types of effects:

- first order financial effects (the immediate effect calculated as the tax rate time current consumption)
  - households
  - industries
  - public sector

- second order effects (include the price effect on the consumption)
  - environmental impacts
  - employment, inflation, trade balance etc.
  - second order effects on households
  - second order effects on industries
  - second order effects on public sector budgets

- final effects, where all feed back mechanisms in the economy are included

The methodology for impact assessment can be based on different kinds of simulation models. These models can be grouped into:

- micro simulation models of first order financial impacts (partial models)
- traditional macro models for forecasting of economic growth
- general equilibrium models for simulation of sector effects of policy measures
We have chosen to use simple models like micro simulation models for households and industries. This choice is based on the fact that the conditions for using more advanced macro-models are not fulfilled as we see it.

These main conditions for using advanced economic models are:

- data availability and quality
- stable institutional structures
- marginal or small changes can be analysed

The data availability should enable the estimation of own price and cross price elasticities. If long time series of the relevant data sets are available it will give the best results. Cross section data could be used instead. As the third and less satisfactory solution is the use of results of estimations not directly related to the model in use. This could for example be transfer of elasticities from international studies. However, the last option will only be feasible if the economies are of similar structure.

In case of the Czech Republic no macroeconomic or general equilibrium model is available. The estimation of such models is very resource demanding and one of the main conditions are the existence of long time series of the major variable in the models in order to estimate the model or estimate the price elasticities.

The structure of the Czech economy is still different from the Western European countries and thus the transfer of values is not viable. Moreover, the institutional and economic structures are under transformation and thus the condition of stable structures are not fulfilled.

One of the main economic implications of the transition is the deregulation of prices which means major changes in the relative prices and the possible size of the energy taxes could also imply significant changes in the final prices of energy products. Accordingly, the assessment cover not small and marginal changes and the use of economic models is not supported but this condition either.

The elements of the framework in level 2 and 3 of the assessment identifies some of the main constraints which a policy preparing actor must take into account in order to make the implementation feasible and efficient. In the specific context, the most important for the Czech Ministry of Environmental was to start the process and discussions with other actors. Accordingly, the impact assessment was the most important element to focus on. However, the institutional set-up and political feasibility was also analysed reasonable detailed. In this paper we focus on the result of the impact assessment. In appendix 1, the main results of the assessment of level 2 and 3 are included.
4 The Simulation model

The simulation model is a very simple model. Basically, the model calculates consequences from a tax scenario by multiplying the quantity of energy consumption by the marginal price change for the relevant segment. Further, the model calculates energy savings resulting from the price changes based on own price elasticities.

The model allows the user to change basic data on energy consumption, prices, employment etc. and other assumptions like price elasticities in order to keep the model up to date when new data becomes available.

4.1 Overview

The impact assessment has been set up in a spreadsheet model.

The simulation model consists of five levels:

- Policy
- Data
- First order effects
- Second order effects
- Results

A given tax scenario is analysed by defining the tax scenario in the policy level. Thereafter, the results from the analysis is given in the result level. The intermediate levels are just for intermediate calculations.

4.2 Policy variables

The policy is defined by

- Energy taxation system
- Compensation scheme
Energy taxation system
Presently, the price of fuels and some energy products are subsidised, and only motor fuels are taxed. For some fuels, like the domestic produced brown coal the price per GJ is relatively low, while the price on important liquid fuels are significantly higher.

The energy taxation system is defined by the increase in taxes for the following types of energy:

- **Coal**
  - Hard steam coal
  - Hard coal for coke production
  - Brown coal and lignite
  - Briquettes
  - Coke
- **Fluid fuels**
  - Light fuel oil
  - Heavy fuel oil
  - Diesel
  - Petrol
- **Gas**
  - Natural gas
  - Town gas
  - Coke gas
- **Refined energy**
  - Heat
  - Electricity

Further, the model allows individual taxes on the following sector:

- Households
- Industries
- Agriculture
- Building industry

The segmentation on sectors has been included in order to make it possible to put lower taxes on eg. agriculture or construction industries.

Compensation scheme
As the concept of ecological tax reform comprise a reduction in income taxes to accompany the increase in green taxes, the revenue from the increased energy taxation should be recycled in some way. Here, two alternatives has been selected:

- Recycling of revenue that imply a neutral effect for each sector as a whole.
• Disproportionate recycling of revenue: all revenue is recycled to the industry sector.

For the first alternative, it is assumed that the income tax for households is reduced. The total reduction in income tax payment is set to be equal to the additional payment from the energy taxes. Thus the total tax payment from the household sector is constant.

If the revenue from the energy taxation should be recycled to the household sector, decreasing the income tax appears to be the most direct way. Here, such reductions in income taxation have been analysed in order to estimate the distributional effect of combining higher energy taxation with lower general income taxation in a revenue neutral way.

The recycling measures for households comprise:

• specific reductions tax rate
• changes in tax rate bounds
• a special tax allowance for pensioners

The compensation scheme to industries works by subsidy calculated per employee. Which is in accordance with the intentions in the ecological tax reform.

The recycling of revenue to the commercial sectors is done by way of reducing the social security contribution calculated as total amount to be recycled divided by total number of employees. For the first alternative, the reduction in social contribution is set equal to the total tax payment from the sectors. In the second alternative, the reductions in social contributions only include the manufacturing industries.

Regarding the recycling of revenue, it is important to note:

• there is no direct relation between the energy tax payment and the reduction in social contributions,
• it is only at the aggregate level that tax payment and reduction in social contribution is equal, and
• even in a situation where an individual company will face a reduction in social contribution equal to the increased energy tax payment, the relative price between energy and employment have changed. Thus, there is an incentive to reduce the consumption of energy.

4.3 First order effects

The first order effects are the effects with no changes in consumption and production. The main first order effects is:

• Total revenue
• Distribution of tax burden on sectors
• Distribution of tax burden on households (socio-economic groups)
Basically, the first order effects is calculated as energy consumption multiplied with the tax increase for the relevant segment.

Revenue assessment only include the revenue effects of the proposed tax schemes. Energy savings as a result of the energy price increase lead to reductions in the revenue from the new tax, compared to the first order effects, but also to reductions in other taxes mainly VAT.

4.4 Second order effects

The reason why the analysis is split up in first and second order effects is to obtain transparency in the analysis. Further, there is significant differences in the assumptions in the first order effects and the second order effects. While the first order effects assumes business as usual, the second order effects is based on critical assumptions about price elasticity.

The main second order effects are:

- Energy savings (reduced revenue, environmental effects, foreign currency)
- Macro economic effects (competitive power, employment, etc.)

The main second order effects comprises the reduction in energy consumption due to the tax on energy. But other macro economic aspects such as competitive power of the industry, social efficiency and effect on unemployment are important to assess before implementing a comprehensive tax reform. Proper estimation of secondary effects requires reliable elasticity measures and a macro econometric model which is able to predict reliable effects in the future.

In the case of the Czech Republic no macro economic model is yet available and the use of such models in a transition period is questionable as econometric models are not well suited for simulating changes in fundamental institutional structures such as the transition of the CEE economies.

The estimation of environmental effects is very difficult. It depends on the change in energy consumption, which can take place through:

- reduction in energy consumption due to the general price increase of energy products,
- substitution effects due the change in the relation between different type of fuels and energy.

In this analysis only the first effect is included.

The energy savings are calculated based on assumptions about the size of the price elasticity. These assumptions are transferred from the Danish macro economic model "ADAM", which has recently been developed in order to take en-
ergy consumption more explicit into the model. The Danish elasticities is dis-
cussed in more detail later in the paper.

Calculating energy savings based on price change and elasticity require that the
price changes are small. To avoid implausible results from the model calculations
of energy savings when larger price changes are analysed the model uses the
following a non linear calculation of the energy savings:

\[
\text{Energy saving percent} = ((1+El*\Delta P /1000)^{1000})-1
\]

Where El refers to the elasticity and \(\Delta P\) refers to the price change. This formula
 corresponds to splitting the price change up in 1000 small changes.

When the price changes are small or just within ± 50% this procedure gives the
same result as a simple linear calculation (Price change multiplied with elas-
ticity). However, with high price increases (eg. more than 100%) this non linear
formula secures that energy consumption in the corresponding energy source do
not drop below zero.

It has been tried to estimate price elasticity figures based on Czech data, however
unsuccessfully, as can be seen from the following section. The reason is primar-
ily that data series are to short. Creating longer data series is not expected to im-
prove the estimations since the demand end supply has not been characterised by
equilibrium for before 1990.

**Price elasticity form Czech Republic (1990-1996)**
The Czech Republic from 1990 and still ongoing is in a transition phase. There-
fore the elasticity calculated from the observed energy use and price relations is
very unreliable.

Inefficient use of energy before the strengthening of the market economy would
lead to over estimation of the reactions to the price increases on the different en-
ergy sources. Time lag in adoption to the new prices will lead to underestimation
of the price elasticity.

In the following sections the development in prices and brown coal use in the
manufacturing industry is analysed as an example. Other energy types and sec-
tors has been analysed and gives more unreliable or inconsistent results. Re-
membering the situation probably far away from equilibrium these elasticity
measures are very unreliable as estimates for future behavioural changes.

**Brown coal use in manufacturing industry**
Table 4-1 shows production, energy intensity and brown coal price in the manu-
facturing industry from 1990 to 1995.

*Table 4-1 Production, brown coal price and brown coal consumption in the
industry sector, 1990 - 1995*
### Table 4-1

<table>
<thead>
<tr>
<th>Year</th>
<th>GDP const prices 1984, billion CZK</th>
<th>Brown Coal final cons, Industry</th>
<th>Energy intensity, PJ brown coal per mia 1984 CZK</th>
<th>Real Brown coal price index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989</td>
<td>309.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1990</td>
<td>264.7</td>
<td>128.9</td>
<td>0.49</td>
<td>209.7</td>
</tr>
<tr>
<td>1991</td>
<td>223.2</td>
<td>99.5</td>
<td>0.45</td>
<td>202.2</td>
</tr>
<tr>
<td>1992</td>
<td>224.3</td>
<td>102.5</td>
<td>0.46</td>
<td>238.9</td>
</tr>
<tr>
<td>1993</td>
<td>212.1</td>
<td>78</td>
<td>0.37</td>
<td>284.9</td>
</tr>
<tr>
<td>1994</td>
<td>208.3</td>
<td>74</td>
<td>0.36</td>
<td>275.1</td>
</tr>
<tr>
<td>1995</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Kilde: IEA, World Bank Development Indicators and Czech contribution.

Figure 4-1 shows the data in Table 4-1 graphically.

**Figure 4-1  Production, brown coal price and brown coal consumption, 1990 - 1995**

As can be seen from Figure 4-1, the real price of brown coal has increased from 200 1989 CZK per ton in 1990 to approx. 300 1989 CZK per ton in 1994. At the same time the energy intensity (PJ/billion CZK) has fallen from approx. 500 PJ brown coal to 350 PJ brown coal per million CZK.

In a log-linear regression the price elasticity of brown coal consumption is estimated to be -0.529. The estimation is shown in Table 4-2.
Table 4-2  Estimation of price elasticity of brown coal, 1990 - 1995

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-.529</td>
<td>.329</td>
</tr>
<tr>
<td>(Constant)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log of production</td>
<td>.1621</td>
<td>.538</td>
</tr>
<tr>
<td>log of energy price</td>
<td>-.1337</td>
<td>4.376</td>
</tr>
</tbody>
</table>

a. Dependent Variable: log of brown coal cons,

As can be seen the elasticity is estimated to be -0.529, but a very unreliable estimate, since the significance level is 0.249 and further the elasticity is higher than what is normally expected.

The reduction in brown coal use is not necessarily a real energy saving but can also reflect a general substitution to other energy sources.

Estimation of price elasticity measures for other energy types and sectors gives more unreliable results, i.e. wrong sign or insignificant parameter estimates.

Price elasticity estimations from Denmark

Because of the problems with estimating reliable price elasticity from Czech data, the environmental effects estimation is based on Danish price elasticity measures. Such analysis will not be able to give a very detailed description of the environmental effects in the Czech Republic.

Since the energy efficiency of the Czech Republic is generally lower relative to Denmark, it is expected that the potential for energy savings are higher in the Czech Republic compared to Denmark. Therefore, transfer of price elasticity measures to calculate energy savings is expected to underestimate the real effects in the Czech Republic. On the other hand, price elasticity from Denmark is calculated over a period more than 30 years back in time, covering periods where energy intensity in Denmark was more comparable with the Czech situation today.

Private car travel demand is subject to analysis in many countries including Denmark. In the Danish travel demand study (PETRA) a medium short/long run price elasticity from petrol price to private car km is estimated to approximately -0.3 (COWI, 1997). This would reflect an elasticity of petrol consumption a little higher (-0.4 to -0.5) since price increase would result in a more energy efficient car fleet. This estimate is comparable to the short run elasticity in other international studies reporting elasticity of petrol consumption with respect to petrol price of -0.3 in the short run and -0.8 in the long run (Goodwin, 1992).

In the late eighties much effort was put into electricity savings. In Denmark a major study showed a price elasticity of -0.1 (Nielsen, 1992).
Danish Macro economic model, ADAM
Adam is a very comprehensive macro economic model of the Danish economy. The model consist of more than 1,400 equations and endogenous variables and more than twice the number of exogenous variables.

The model is based on empirical data of the Danish economy more than 30 years back in time.

Table 4-3 shows the price elasticity of energy demand estimated on empirical data for Denmark.

Table 4-3 Price elasticity in the Danish macro economic model ADAM

<table>
<thead>
<tr>
<th></th>
<th>Short run price elasticity</th>
<th>Long run price elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Agriculture</strong></td>
<td>-0.05</td>
<td>-0.4</td>
</tr>
<tr>
<td><strong>Manufacturing</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goods to construction sector</td>
<td>-0.08</td>
<td>-0.35</td>
</tr>
<tr>
<td>Food production</td>
<td>-0.08</td>
<td>-0.1</td>
</tr>
<tr>
<td>Basic metal</td>
<td>-0.15</td>
<td>-0.18</td>
</tr>
<tr>
<td>Drink and tobacco</td>
<td>-0.12</td>
<td>-0.26</td>
</tr>
<tr>
<td>Transport equipment</td>
<td>-0.22</td>
<td>-0.22</td>
</tr>
<tr>
<td>Chemicals and chemical products</td>
<td>-0.07</td>
<td>-0.31</td>
</tr>
<tr>
<td>Other manufacturing</td>
<td>-0.14</td>
<td>-0.19</td>
</tr>
<tr>
<td><strong>Manufacturing</strong></td>
<td>-0.11</td>
<td>-0.22</td>
</tr>
<tr>
<td><strong>Trade and service</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trade</td>
<td>-0.24</td>
<td>-0.24</td>
</tr>
<tr>
<td>Financial services</td>
<td>-0.43</td>
<td>-0.43</td>
</tr>
<tr>
<td>Other services</td>
<td>-0.39</td>
<td>-0.39</td>
</tr>
<tr>
<td>See transportation</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Other transportation</td>
<td>-0.2</td>
<td>-0.21</td>
</tr>
<tr>
<td>Public service</td>
<td>-0.18</td>
<td>-0.18</td>
</tr>
<tr>
<td><strong>Total trade and service</strong></td>
<td>-0.26</td>
<td>-0.26</td>
</tr>
<tr>
<td><strong>Construction</strong></td>
<td>-0.08</td>
<td>-0.13</td>
</tr>
<tr>
<td>Agriculture, Manufacturing, Trade and Service and Construction</td>
<td>-0.17</td>
<td>-0.26</td>
</tr>
<tr>
<td>All excl. energy production</td>
<td>-0.17</td>
<td>-0.24</td>
</tr>
</tbody>
</table>

Source: Statistics Denmark, Working Paper

The long run elasticity has been used in the present analysis. The overall price elasticity used is approximately -0.24 which implies that 10% increase in energy prices results in 2.4% reduction in energy consumption.
4.5 Results

All results from the tax assessment are collected in one workbook. The result workbook consist of the following sheets indicating which type of results the model is providing.

- Energy price increases
- Companies prices VAT and TAX
- Price and tax rates for households

- Household expenditure - EU tax
- Household expenditure - Coal tax

- Compensation of households 1
- Compensation of households 2
- Compensation of industries

- Energy savings
- Loss of revenue due to savings

- Reductions in emissions

The first three sheets show the price increase caused by the tax increase. The price increases are calculated for different energy products and for different segments of consumers.

Generally, price increases are highest for industries. This is caused by the fact that industries generally pay a lower price in the initial situation. The only exception being that industries pay a higher price for electricity relative to private households.

In the energy expenditure section the increase in energy cost is measured relative to income and segmented in household types:

- Employee
- Self employee
- Farmers
- Pensioners

Each of these types of households are further segmented in income groups. Because of data, farmers, pensioners and self employee are segmented in four income groups while employee are segmented in 10 income groups.

Based upon the assumptions about price elasticity and price increases, expected energy savings are calculated. It is stressed that the price elasticity is not based upon Czech Republic data but upon danish data covering a period from 1950 to 1990. When actual price elasticity becomes available in the Czech Republic it is recommended that the danish data to be substituted for actual Czech Data.
5 Empirical assessment of ecological taxation

The empirical assessment is illustrated for two alternative tax scenarios. This chapter describes the effects of these two alternative tax scenarios.

Firstly, the tax scenarios are described, then revenue effects are analysed for different segments of the Czech economy. Finally, the behavioural effects on energy consumption is analysed.

5.1 Tax scenarios

Two alternative taxation schemes, hereafter called taxation scenarios, has been defined. The scenarios included tax rates for each fuel or energy product.

1. EU tax scenario: tax scenario based on the recent EU proposal for minimum rates for motor fuels, heating fuels and electricity (EU 97 (30) Final)

2. Coal tax scenario: alternative tax scenario with higher tax on brown coal and other solid fuels as well as higher tax rates on electricity. The scenario assumes no increase in the motor fuel taxation.

The level of taxation implied in the scenarios is approximately 20 CZK/GJ (EU scenario) and 55 CZK/GJ (Coal tax scenario). The motor fuels in the EU tax scenario are taxed with 150-250 CZK/GJ

The energy taxation system is defined by the increase in taxes for different types of energy and for different sectors.

Table 5-1 Defines energy taxation in the EU tax scenario.
Table 5-1 Marginal tax rates for one scenario - (EU tax scenario)

<table>
<thead>
<tr>
<th>ITEM</th>
<th>house-holds</th>
<th>others</th>
<th>agricul</th>
<th>build.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hard steam coal</td>
<td>427.16</td>
<td>408.37</td>
<td>408.37</td>
<td>408.37</td>
<td>ton</td>
</tr>
<tr>
<td>Hard coal for coke production</td>
<td>408.37</td>
<td>408.37</td>
<td>408.37</td>
<td>408.37</td>
<td>ton</td>
</tr>
<tr>
<td>Brown coal and lignite</td>
<td>247.75</td>
<td>215.29</td>
<td>215.29</td>
<td>215.29</td>
<td>ton</td>
</tr>
<tr>
<td>Briquettes</td>
<td>408.54</td>
<td>408.54</td>
<td>408.54</td>
<td>408.54</td>
<td>ton</td>
</tr>
<tr>
<td>Coke</td>
<td>474.84</td>
<td>474.84</td>
<td>474.84</td>
<td>474.84</td>
<td>ton</td>
</tr>
<tr>
<td>Other solid fuels</td>
<td>408.37</td>
<td>408.37</td>
<td>408.37</td>
<td>408.37</td>
<td>ton</td>
</tr>
<tr>
<td>Total solid fuels</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light fuel oil</td>
<td>0.87</td>
<td>0.87</td>
<td>0.87</td>
<td>0.87</td>
<td>liter</td>
</tr>
<tr>
<td>Heavy fuel oil</td>
<td>0.87</td>
<td>0.87</td>
<td>0.87</td>
<td>0.87</td>
<td>liter</td>
</tr>
<tr>
<td>Diesel</td>
<td>5.99</td>
<td>5.99</td>
<td>-5.63</td>
<td>-5.63</td>
<td>liter</td>
</tr>
<tr>
<td>Petrol</td>
<td>8.56</td>
<td>8.56</td>
<td>8.56</td>
<td>8.56</td>
<td>liter</td>
</tr>
<tr>
<td>Other liquid fuels</td>
<td>1.06</td>
<td>1.06</td>
<td>1.06</td>
<td>1.06</td>
<td>liter</td>
</tr>
<tr>
<td>Total liquid fuels</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural gas</td>
<td>0.61</td>
<td>0.61</td>
<td>0.61</td>
<td>0.61</td>
<td>m3</td>
</tr>
<tr>
<td>Town gas</td>
<td>0.84</td>
<td>0.84</td>
<td>0.84</td>
<td>0.84</td>
<td>kg</td>
</tr>
<tr>
<td>Coke gas</td>
<td>0.84</td>
<td>0.84</td>
<td>0.84</td>
<td>0.84</td>
<td>kg</td>
</tr>
<tr>
<td>Other gaseous fuels</td>
<td>0.84</td>
<td>0.84</td>
<td>0.84</td>
<td>0.84</td>
<td>kg</td>
</tr>
<tr>
<td>Total gaseous fuels</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electricity</td>
<td>0.08</td>
<td>0.08</td>
<td>0.08</td>
<td>0.08</td>
<td>kWh</td>
</tr>
</tbody>
</table>

The effect on consumer prices is shown in the Figures below. It should be noted that the average price increase on electricity is low in both scenarios because existing price on electricity is relatively high and thus the percentage increase is lower.

Figure 5-1 and Figure 5-2 below shows the increase in consumer prices resulting from the EU tax scenario and the coal tax scenario.
Figure 5-1 Effect on final consumer prices of the EU tax scenarios

![Graph showing the effect on final consumer prices of the EU tax scenarios.](image)

The size of the tax rates can be compared with other price elements, like VAT, subsidies etc. In Figure 5-3 below, all the elements which the total consumer price consists of are illustrated.

Figure 5-2 Effect on final consumer prices of coal tax scenario

![Graph showing the effect on final consumer prices of the coal tax scenario.](image)
Generally, industries pay a lower price initially. When the same tax increase is imposed to private households and industries, the price increase for industries result in a higher relative increase relative to households.

Figure 5-3 Decomposing consumer prices

Putting the size of the tax increase into perspective, the increase in tax rates can be compared with the VAT (at 5% and at 22%) and the existing tax or subsidy.

- The rate increase in the EU tax scenario is at size comparable with changing VAT from 5 to 22%,
- For electricity, removal of the subsidy and 22% VAT will have a larger effect on final price than the proposed tax increase.

5.2 Impact on household sector

The impacts on households are estimated as the increase in energy expenditure as a result of increased energy prices. The effects in this section only include the 1. order effects (no behavioural effect on consumption included).\(^1\)

The households are segmented into four categories of occupation (employees, self-employed, farmers and pensioners) and within each type of occupation, the households are segmented into income groups.

---

\(^1\) The model also provide information on household expenditure after energy savings. These results are not shown here because of limitations.
Private households use approximately 10% of their net income on energy consumption. The structure of the expenditures imply that pensioners use a larger part of their income on heat and electricity relative to other types of households. On the other hand, pensioners use a smaller part of their income on transport fuels relative to other types of households².

In the EU tax scenario, the increase in energy expenditures will increase total expenditure by 2-2.5% (equivalent to 1000-2000 CZK per person per year) for all four types of households (employees, farmers, self-employed, and pensioners).

In the Coal tax scenario, energy tax will increase total expenditures by approximately 5% for pensioners and 2% for the other types of households.

Figure 5-4 illustrates the effect of the Coal tax scenario segmented in four income levels, where group no 1 is the poorest 25% of the households, group 2 is the 25% second poorest households etc.

Figure 5-4 Energy tax payment in percentages of income for each type of household in the Coal tax scenarios

The Coal tax scenario leads to higher increase in energy expenditure for the low income groups. This is true for all three types of households, and also for employee, which is not shown here.

Figure 5-5 shows the effect on total expenditure for the three types of households and for each of the two taxation scenarios.

² Se annex 2 for a more detailed description of household expenditure
From Figure 5-5 it can be seen that the tax burden of the EU tax scenario is distributed equally on the four different types of households.

On the contrary, in the coal tax scenario the pensioners are burdened harder compared to the other types of households.

**Recycling of revenue through income tax reductions.**

Using a mix of the three compensation measures (tax rate reduction, higher tax bounds and special tax allowance for pensioners), it possible to reduce the impact on disposable income to less than $\pm 0.5\%$, regardless if the households are segmented after occupation or income.

Figure 5-6 shows the tax burden of the coal tax scenario before and after the compensation.
Before the compensation, pensioners are taxed approximately 5% of their income, while the other types of households are taxed approximately 2% of their income. After the income tax compensation all types of households are unaffected by the tax scenario.

Figure 5-7 shows the tax burden of the coal tax scenario before and after the compensation for different income groups.

Before the compensation, the poorest households carry a larger share of the tax burden relative to the richest households. After the income tax compensation all types of households are unaffected by the tax scenario.
5.3 Impacts on economic sectors and industries

The impacts on the production sectors are analysed with respect to effects on:

- overall economic sectors like, transport, agriculture, manufacturing industry, trade and services, and
- a subset: manufacturing industries.

*Figure 5-8 The effect of the two tax scenarios on the production costs of sectors*

The two tax scenarios have different impact on the various sectors of the economy.

EU tax scenario has the largest impact on the production costs of transport activities. That means that the Transport industry and the households are affected.

The Coal tax scenario has the largest impact on manufacturing industries (2.5% increase in production costs) and the household sector (2.5% increase in total expenditure due to the higher energy taxes).
The effect of transport activities is not included at the industry level.

The EU tax scenario implies increases up to 3% with an average of 1%. While the Coal tax scenario implies increases up to 5% with an average of 2%.

In the EU tax scenario, the metal and non-metal mineral processing industries are most affected with an increase of 5%.

It should be noted that the energy industry itself is not included in the assessment of immediate impacts. The energy sector, mining and energy production, is the price of the output and accordingly the demand which is affected. A specific and detailed assessment of the energy industry is needed before implementation of new energy taxation.

**Recycling of revenue through reduction in other tax rates**

The effects of two alternative recycling schemes are estimated:

1. The manufacturing industries as a group are compensated with the same amount as they pay in tax (redistribution between industries)
2. The manufacturing industries are compensated as no 1 plus compensated with the revenue from taxing the household sector (a compensation scheme that imply no compensation to the households)
In both cases the relative recycling to each industry are based on reducing their social contribution payment. This is equivalent to a recycling proportion to number of employees in each industry. Figure 5-10 shows the combined effect of energy taxation and recycling through reduced social contributions on manufacturing industries.

**Figure 5-10 Changes in production cost before and after alternative compensation schemes in the industry**

The left column shows the increase in production cost resulting from the EU tax scenario. Wood industries are most affected with an increase of 3% from the EU tax scenario.

The middle column shows the change in production cost when all revenue from the EU tax scenario is recycled to the industries proportionate to employment. Such recycling of revenue over compensate sub industries with low energy intensity or high labour intensity like food industries, textiles and industries producing machinery. These sub industries will benefit from such a compensation scheme.

The right column shows the increase in production cost when revenue is recycled back to compensate both households and industries.

### 5.4 Environmental effects

**Energy savings**

The energy savings resulting from the energy price increase is calculated based on the assumptions regarding the price elasticity. The following section describes the energy savings for specific energy types in the sectors of the Czech economy.

For the EU tax scenario the main energy savings take place in motor fuels (transport activities).

In the Coal tax scenario, the main effect is reductions in the use of solid fuels and gas in industry and households.

The most significant effect of the EU tax is a relatively large reduction of 12 PJ fluid fuel per year in the transport sector, corresponding to a 12% reduction. Energy savings in the households, trade and service, agriculture and construction are small.
Table 5-2 Energy savings in the EU tax scenario

<table>
<thead>
<tr>
<th>Energy savings EU tax, PJ</th>
<th>Households</th>
<th>Trade, Services</th>
<th>Industry</th>
<th>Construction</th>
<th>Agriculture</th>
<th>Transport</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total solid fuels</td>
<td>8</td>
<td>1</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>22.4</td>
</tr>
<tr>
<td>Total liquid fuels</td>
<td>5</td>
<td>1</td>
<td>7</td>
<td>0</td>
<td>-2</td>
<td>12</td>
<td>22.5</td>
</tr>
<tr>
<td>Total gaseous fuels</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>11.6</td>
</tr>
<tr>
<td>Heat</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5.7</td>
</tr>
<tr>
<td>Electricity</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1.7</td>
</tr>
<tr>
<td>Total</td>
<td>21</td>
<td>7</td>
<td>25</td>
<td>0</td>
<td>-1</td>
<td>12</td>
<td>64.0</td>
</tr>
<tr>
<td>Relative</td>
<td>7%</td>
<td>4%</td>
<td>5%</td>
<td>0%</td>
<td>-2%</td>
<td>12%</td>
<td>5%</td>
</tr>
</tbody>
</table>

These figures are illustrated in Figure 5-11. As can be seen, a major share of energy savings in the EU tax scenario comes from liquid fuels. While heat and electricity only contribute to a limited degree.

Figure 5-11 Energy savings in the EU tax scenario

Figure 5-12 shows the energy savings in the coal tax scenario.
With no increase in liquid fuel price there is no energy savings for these fuels either. On the other hand the coal tax scenario result in larger energy savings in solid fuels and gas compared with the EU tax scenario.

Electricity savings are of a limited degree in both tax scenarios. This is due to a relatively high price in the initial situation.

**Reductions in emissions**

Based on the energy savings and emission factors, the effect on emissions has been estimated. Since the energy savings are based on price relationship valid for a medium term period, the effect on emission are also medium term.

Figure 5-13 shows reductions in emissions in the two tax scenarios.
The EU tax scenario are likely to imply the highest reductions in NO\textsubscript{x} (approximately 6%) emissions because of high tax rate on motor fuels and transport activities which are the main source of NO\textsubscript{x} emissions.

The Coal tax scenario implies reductions on CO\textsubscript{2} and SO\textsubscript{2} emissions in the order of 6-7% of present level of emissions.

There are factors that could point at higher effect of energy price increases in the Czech situation, for example, the high initial energy consumption. On the other hand, there are many constraint on household and industry behaviour like financial difficulties, short term investment decisions due to uncertain ownership structure and similar and high interest rates on loans.

5.5 Revenue effects

The immediate revenue (gross revenue) from imposing the new energy taxes are:

- The EU tax scenario: 45 billion CZK
- The Coal tax scenario: 55 billion CZK

The actual extra revenue from introducing the new and higher energy taxes will be less than the immediate (gross) revenue due to behavioural changes and less revenue form other taxes. Table 5-3 shows the loss of revenue due to energy savings and reductions in other taxes.

<table>
<thead>
<tr>
<th>Effect</th>
<th>Billions CZK</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Immediate revenue (without behavioural change)</td>
<td>45</td>
</tr>
<tr>
<td>2 Reduction in revenue due to energy savings</td>
<td>8-10</td>
</tr>
<tr>
<td>3 Reduction in revenue due to less VAT, excise duties etc.</td>
<td>2-3</td>
</tr>
<tr>
<td>4=1-2-3 Estimate of actual revenue in case of EU tax scenario</td>
<td>32-35</td>
</tr>
</tbody>
</table>

If the objective is a budget neutral reform, the compensating reductions in income tax or social contribution should be estimated as the gross revenue minus the final effects of energy savings and substitution between fuels.

The estimated revenue can be compared to total tax revenue of 555 billion CZK in 1995. The net revenue of the two tax scenarios are thus equivalent to 6-8% of total tax revenue in 1995. Compared to the existing motor fuels tax (excise duty), which gave a revenue of 37 billion CZK in 1995, the two scenarios imply approximately a doubling of the revenue.
6 List of Literature


Empirical Assessment of the Impacts of Ecological Taxation in the Czech Republic


Stepanek, Zdenek and Jirina Jilkova: Ecological Tax Reform in the Czech Republic, Background Analysis, Prague, June 1997.


*Interviews:*

Anna Christianova, Ministry of Industry and Trade

Zdenek Fousek, Ministry of Industry and Trade

Erik Geuss, Ministry of the Environment

Ales Lisa, Department of Political Science, University of Economics, Prague

Jaroslav Marousek, executive director, SEVEn, The Energy Efficiency Center

Jan Skaloud, head of the department of political science, University of Economic, Prague

Zdenek Vinicky, Confederation of Industry of the Czech Republic Leopold Zubeck, Ministry of Transport and Communication
Appendix 1: Political and institutional aspects: 2. and 3. level of assessment

The appendix comprise very briefly the result of the level 2 and 3 assessments.

Institutional set-up
The main objective within the assessment of the institutional set-up has been to identify the necessary institutional requirements and changes in order to secure an effective implementation of ecological taxation.

The important questions:

1. What authorities shall be responsible for the different implementation functions related to ecological taxation?
2. How should the ecological taxation be designed with respect to the choice of tax base, point of imposition and means of minimising the burdens of administration and compliance?

The so-called neo-institutional approach is the source of inspiration. Institutions are defined as formal rules (like laws, etc.) and informal rules (like norms, traditions, etc.) which structure human and organisational behaviour. Thus, this approach leads also to focus on the informal aspects with relation to implementation.

The environmental and financial authorities should be the principal authorities in the process of preparation and implementation of ecological taxation. To secure a well-functioned co-operation between the two authorities it might be appropriate to establish a committee with representatives of both authorities with the task of preparing the introduction of ecological taxation and, later on, dealing with everyday administration of ecological taxation.

The proposed energy taxation, based on a recent EU recommendation, seems to be administratively simple to implement in Czech Republic. This is due to the following reasons:

• The points of imposition will be "high up" in the distribution chain, resulting in few points of tax collection.
• It is possibly to rely on existing tax structures and reporting systems.

It is, however, uncertain what the enforcement costs will be for different exemptions included in the reform and for the controlling of correct payment of energy taxes related to individual production of electricity.

Political feasibility
The objectives of this part of the assessment has been to:

• Investigate the different arguments in Czech republic related to tax reform and identify the political barriers for implementing a tax reform.
Discuss how the barriers could be overcome.

The attitude of the important political actors was analysed and the significance of the identified barriers was evaluated.

The level of political feasibility of ecological taxation is low. Only few actors support ecological taxation, many are sceptical. No actors reject the basic principles of ecological taxation, but consider it inappropriate to introduce the tax changes the next 5-8 years.

<table>
<thead>
<tr>
<th>Factors decreasing feasibility</th>
<th>Factors increasing feasibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>The political parties, in general, do not give high priority to ecological taxation.</td>
<td>The actors have no hostile attitude towards the basic rationale of ecological taxation.</td>
</tr>
<tr>
<td>Industry in general is sceptical and will strongly oppose drastic changes.</td>
<td>The comparison of Czech energy prices with other European countries makes it legitimate to consider raising energy prices.</td>
</tr>
<tr>
<td>Lack of strong environmental movement.</td>
<td>The wish to become member of the EU. The EU approximation process is potentially a strong factor but difficult to know the exact influence.</td>
</tr>
<tr>
<td>Not totally clear what the prime objective of ecological taxation is (environment, state budget and/or EU approximation?).</td>
<td></td>
</tr>
<tr>
<td>No uniform position within the state bureaucracy on the issue of eco-taxation. Strong ministries like Ministry of Finance and Ministry of Trade and Industry are very sceptical.</td>
<td></td>
</tr>
</tbody>
</table>

Many of the barriers identified can be lessen via initiatives like:

- better information to all affected
- goal clarification
- compensation arrangements
- better inter-policy co-ordination
- ecological taxation as part of policy packages
- the creation of a powerful "mediator" to forward the process
- consultation, gradual implementation and pre-announcement.

**Political-institutional capacity**
The aim is to analyse some important political-institutional background variables of importance for the policy planning process of ecological taxation and for a general understanding of the Czech environmental policy making capacity. Capacity is defined as a society’s ability to identify and solve environmental problems.

The study is build on the assumption that the choice of policy instruments must take into account the broader political-institutional context.

The policy process in Czech Republic has some features of importance for introduction of ecological taxation:

- The policy style is consensual rather than conflictual. This may facilitate learning processes. Furthermore, it constitutes a potential for establishing broad societal forums for discussions of ecological taxation.
- The amount and quality of societal planning in the fields of environment, transport and energy are mediocre. The subject of ecological taxation should be included in the planning efforts.
- The level of integration of environmental concern into sector policies is also mediocre, but increasing.
- The possibility of coupling the issue of ecological taxation with high ranking policy issues has not been explored sufficiently. There are in particular potentials for coupling ecological taxation with EU membership and economic issues. This may increase the political feasibility.

**Techno-economic capacity**

In order for an efficient implementation of green taxes, the general economic and technological environment should be supportive for changes. A general assessment of this aspect has not been made, however some examples have been analysed.

The assessment of techno-economic capacity has been carried out as an analysis of only a part of the energy system, the production of heat. The approach is based on the “capacity theory” (Jänicke 1997) and Nelson and Winther theory of technological changes.

- The knowledge of new technology is not a significant barrier to achieve a substitution effect of increased energy taxation.
- For many areas within the energy sector the investments are very extensive and have a long life time, implying that the effect of e.g. increased taxation will have a very long time of penetration.
- The ownership structure could be a barrier. For many enterprises the ownership is not settled and that could imply that there is present owner is not willing to engage in long term planning. As many energy investments are long term, this curbs the investments and reduce the effect of the taxation.
• The lack of financial resources is one of the most serious barriers. The financial constraints has two dimensions:
  
  – lack of financial resources with the companies and households, and
  
  – lack of possibilities for obtaining loans at long term conditions. Most of the available loan capital need to be paid back within three years.
Appendix 2: The Czech economy in figures

This section describes data and assumptions used to estimate the effect of the alternative tax scenarios. The section also serves as a quick overview for readers not familiar with the Czech economy.

Energy consumption in the following analysis is based on 1994 data according to ("Energy economy", 1994). However, the values have been adjusted to 1996 level by a factor equal to production growth from 1994 to 1996 in the specific sectors, assuming a production elasticity of unity. In the long run one would expect an elasticity from production lower than unity, but for this purpose the elasticity of unity is sufficient.

Household sector
The data covering the households' income and expenditures are based on interview data. The household survey data covers 1995, 1996 and the first quarter of 1997. Where 1997 figures are shown the figures for the first quarter are multiplied with a factor 4, assuming the rest of the year will proceed like the first quarter. This is a reasonable assumption regarding data without seasonal fluctuations like wage and use of private cars but more problematic regarding energy use to heating purposes. The model is based on 1996 data.

The household survey provides data for income and expenditure for 1996 divided on:
- type of household: employees, employee in the agricultural sector (called farmers), self-employed and pensioners
- income groups (income quartil): group no 1: the 25% of households with lowest income, group no 2 the 25% with second lowest incomes and similar for group 3 and 4 (i.e. group no 4 is richest 25% of the households)

Since the household expenditure data is based on interview data from a random sample, a perfect match cannot be expected between the national statistics and the statistics obtained from the household data.

While the average household in 1995 paid 10% of total net income to energy consumption, the pensioners paid 13%. In 1996, the difference has decreased mainly because of higher income growth for the pensioners.

Table 6-1 Household expenditure related to energy consumption, share of income

<table>
<thead>
<tr>
<th>Total energy related expenditure</th>
<th>Average</th>
<th>employed</th>
<th>farmer</th>
<th>self employed</th>
<th>pensioners</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>10.3%</td>
<td>9.5%</td>
<td>10.6%</td>
<td>10.7%</td>
<td>13.8%</td>
</tr>
<tr>
<td>1996</td>
<td>10.3%</td>
<td>9.5%</td>
<td>11.1%</td>
<td>10.5%</td>
<td>12.4%</td>
</tr>
</tbody>
</table>

Pensioners' high expenditure related to energy consumption is primarily due to the high cost of heating and electricity.
As can be seen from Table 6-2 the pensioners pay approximately 11% of their income to heating purposes and electricity, while other types of households pay approximately 6% of their net income to these purposes.

Table 6-3 shows household expenditure to petrol (transport fuel) per year. As can be seen, the pensioners use very little petrol compared to the other types of households. The proportion of their net disposable income used for petrol is 2.3% while the other types of households pay 4-5% of their disposable income to petrol.

For pensioners, the relative share of income paid to energy purposes are almost the same for low income groups as for high income groups.

To sum up private households use approximately 10% of their net income on energy consumption. The structure of the expenditures imply that pensioners use a larger part of their income on heat and electricity relative to other types of households. On the other hand pensioners use a smaller part of their income on transport fuels relative to other types of households.

Figure 6-1 shows which fuels was used for local heating in 1995. The major part of energy for local heating purposes is natural gas covering 64% of total fuels for heating purposes. The remaining part is almost covered by (brown) coal.
Sectors
The Czech statistics divide the economy into the following sectors:

- Manufacturing industries,
- building industry,
- transport,
- trade and service,
- agriculture and
- households.

The manufacturing industries comprise 13 sub-industries.

Table 6-4 shows some macroeconomic indicators of the Czech economy. Trade and service is the largest sector employing 45% of total employment and producing 44% of total GDP. The industry sector employs 1,251 thousand people or one third of total employment producing one third of total GDP.

Table 6-4  Macro economic indicators of the Czech Republic, 1996

<table>
<thead>
<tr>
<th>ITEM</th>
<th>Households</th>
<th>Trade, Services</th>
<th>Industry</th>
<th>Building Industry</th>
<th>Agriculture</th>
<th>Transport</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP purchase price bill. CZK (1995)</td>
<td>551.8</td>
<td>404</td>
<td>72</td>
<td>61</td>
<td>73</td>
<td>1,160</td>
<td></td>
</tr>
<tr>
<td>Output bill. CZK</td>
<td>662</td>
<td>1,281</td>
<td>1,092</td>
<td>200</td>
<td>182</td>
<td>141</td>
<td>2,896</td>
</tr>
<tr>
<td>Employment 1,000</td>
<td>2,287</td>
<td>1,251</td>
<td>455</td>
<td>317</td>
<td>359</td>
<td>5,027</td>
<td></td>
</tr>
<tr>
<td>Energy cons. PJ</td>
<td>323</td>
<td>156</td>
<td>553</td>
<td>26</td>
<td>30</td>
<td>102</td>
<td>1,191</td>
</tr>
<tr>
<td>Energy cost bill. CZK</td>
<td>64</td>
<td>44</td>
<td>109</td>
<td>8</td>
<td>11</td>
<td>46</td>
<td>282</td>
</tr>
<tr>
<td>Energy intensity</td>
<td>10%</td>
<td>3%</td>
<td>10%</td>
<td>4%</td>
<td>6%</td>
<td>33%</td>
<td>10%</td>
</tr>
<tr>
<td>Labour intensity (empl./bill. GDP)</td>
<td>1.8</td>
<td>1.5</td>
<td>2.3</td>
<td>1.7</td>
<td>2.5</td>
<td>1.7</td>
<td></td>
</tr>
</tbody>
</table>

1 Net average income per person multiplied with total population
The overall energy cost (energy cost/output) is high, 10%. The highest energy intensity is found in the transportation sector and in the manufacturing industry. While trade and service and building industries have a relatively low energy intensity in the production. The labour intensity (employment per mill. GDP) is highest in the building industry and the transport sector and lowest in manufacturing industry.

Table 6-5 shows the final energy consumption in the Czech Republic in 1996.

<table>
<thead>
<tr>
<th>ITEM</th>
<th>Households</th>
<th>Trade And Services</th>
<th>Industry Building</th>
<th>Industry Agriculture</th>
<th>Transport</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hard steam coal</td>
<td>14</td>
<td>1</td>
<td>20</td>
<td>-</td>
<td>0</td>
<td>35</td>
</tr>
<tr>
<td>Coke production</td>
<td>-</td>
<td>-</td>
<td>16</td>
<td>-</td>
<td>-</td>
<td>16</td>
</tr>
<tr>
<td>Brown coal lignite</td>
<td>62</td>
<td>12</td>
<td>82</td>
<td>1</td>
<td>2</td>
<td>159</td>
</tr>
<tr>
<td>Briquettes</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>Coke</td>
<td>21</td>
<td>7</td>
<td>97</td>
<td>1</td>
<td>1</td>
<td>127</td>
</tr>
<tr>
<td>Other solid fuels</td>
<td>5</td>
<td>0</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>18</td>
</tr>
<tr>
<td>Total solid fuels</td>
<td>107</td>
<td>20</td>
<td>227</td>
<td>2</td>
<td>4</td>
<td>360</td>
</tr>
<tr>
<td>Light fuel oil</td>
<td>3</td>
<td>8</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>Heavy fuel oil</td>
<td>-</td>
<td>5</td>
<td>18</td>
<td>0</td>
<td>-</td>
<td>23</td>
</tr>
<tr>
<td>Oil</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>9</td>
<td>11</td>
<td>53</td>
</tr>
<tr>
<td>Petrol</td>
<td>34</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>36</td>
</tr>
<tr>
<td>Other liquid fuels</td>
<td>4</td>
<td>0</td>
<td>57</td>
<td>-</td>
<td>-</td>
<td>7</td>
</tr>
<tr>
<td>Total liquid fuels</td>
<td>41</td>
<td>16</td>
<td>78</td>
<td>12</td>
<td>13</td>
<td>96</td>
</tr>
<tr>
<td>Natural gas</td>
<td>69</td>
<td>51</td>
<td>80</td>
<td>7</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Town gas</td>
<td>5</td>
<td>3</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>19</td>
</tr>
<tr>
<td>Coke gas</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Other gaseous fuels</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total gaseous fuels</td>
<td>74</td>
<td>54</td>
<td>92</td>
<td>7</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Heat</td>
<td>50</td>
<td>31</td>
<td>78</td>
<td>2</td>
<td>2</td>
<td>163</td>
</tr>
<tr>
<td>Electricity</td>
<td>52</td>
<td>35</td>
<td>78</td>
<td>2</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Total final consumption</td>
<td>323</td>
<td>156</td>
<td>553</td>
<td>26</td>
<td>30</td>
<td>102</td>
</tr>
</tbody>
</table>


The industry sector uses approximately half of total energy consumption. The second largest sector is the household sector using approximately 25% of total final energy consumption. The major elements of the household energy use consist of solid fuels (mainly brown coal) natural gas and heat and electricity. In the official statistics, household consumption of petrol is included in the transport sector. We assume that 49% of petrol consumption is consumed by the household sector.
**Industries**

Table 6-6 shows the overall structure of the sub industries of the Czech industry sector. Overall the output of the manufacturing industry sector is 1,149 billions CZK. Excluding coke production and refineries reduces the total output to 1,091 billions CZK.

Food products and basic metal and fabricated metal production is the biggest sub industries producing goods for 125 billions together. The sub industry producing basic metal and fabricated metal products has the highest energy consumption, 158 PJ of total industry of 575 PJ in 1996.

**Table 6-6 Structure of the Czech Industry, 1996**

<table>
<thead>
<tr>
<th></th>
<th>Output basic prices</th>
<th>Employment</th>
<th>Energy consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>food products and beverage</td>
<td>207,074</td>
<td>134,614</td>
<td>13</td>
</tr>
<tr>
<td>textiles</td>
<td>57,877</td>
<td>128,139</td>
<td>34</td>
</tr>
<tr>
<td>leather and leather products</td>
<td>15,235</td>
<td>32,137</td>
<td>10</td>
</tr>
<tr>
<td>wood and wood products</td>
<td>17,600</td>
<td>24,740</td>
<td>21</td>
</tr>
<tr>
<td>pulp, paper and paper products</td>
<td>54,303</td>
<td>46,670</td>
<td>13</td>
</tr>
<tr>
<td>coke, refined petroleum and nuclear</td>
<td>57,345</td>
<td>6,271</td>
<td>0</td>
</tr>
<tr>
<td>chemicals and chemical products</td>
<td>103,950</td>
<td>60,601</td>
<td>42</td>
</tr>
<tr>
<td>rubber and plastic products</td>
<td>34,550</td>
<td>38,647</td>
<td>26</td>
</tr>
<tr>
<td>other non metal-mineral products</td>
<td>60,558</td>
<td>76,804</td>
<td>52</td>
</tr>
<tr>
<td>basic metal and fabricated metal prod</td>
<td>198,038</td>
<td>224,280</td>
<td>172</td>
</tr>
<tr>
<td>machinery and equipment</td>
<td>98,808</td>
<td>190,858</td>
<td>38</td>
</tr>
<tr>
<td>electrical and optical products</td>
<td>69,311</td>
<td>115,091</td>
<td>49</td>
</tr>
<tr>
<td>transport equipment</td>
<td>138,488</td>
<td>114,630</td>
<td>83</td>
</tr>
<tr>
<td>n.e.c.</td>
<td>35,740</td>
<td>63,671</td>
<td>24</td>
</tr>
<tr>
<td>Total industry</td>
<td>1,148,879</td>
<td>1,257,155</td>
<td>577</td>
</tr>
<tr>
<td>Total excl. coke and refineries</td>
<td>1,091,553</td>
<td>1,250,884</td>
<td></td>
</tr>
</tbody>
</table>
Table 6-7 Production, wages social contributions and export 1992

<table>
<thead>
<tr>
<th>Industry</th>
<th>Output</th>
<th>Wage</th>
<th>Social contribution</th>
<th>Export</th>
</tr>
</thead>
<tbody>
<tr>
<td>food products and beverage</td>
<td>17%</td>
<td>6%</td>
<td>2%</td>
<td>20%</td>
</tr>
<tr>
<td>textiles</td>
<td>8%</td>
<td>10%</td>
<td>4%</td>
<td>42%</td>
</tr>
<tr>
<td>leather and leather products</td>
<td>2%</td>
<td>12%</td>
<td>5%</td>
<td>48%</td>
</tr>
<tr>
<td>wood and wood products</td>
<td>2%</td>
<td>10%</td>
<td>4%</td>
<td>42%</td>
</tr>
<tr>
<td>pulp, paper and paper products</td>
<td>4%</td>
<td>8%</td>
<td>3%</td>
<td>28%</td>
</tr>
<tr>
<td>coke, refined petroleum and nu-</td>
<td>7%</td>
<td>2%</td>
<td>1%</td>
<td>14%</td>
</tr>
<tr>
<td>clear</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>chemicals and chemical products</td>
<td>6%</td>
<td>7%</td>
<td>3%</td>
<td>71%</td>
</tr>
<tr>
<td>rubber and plastic products</td>
<td>3%</td>
<td>8%</td>
<td>3%</td>
<td>39%</td>
</tr>
<tr>
<td>other non metal-mineral products</td>
<td>5%</td>
<td>13%</td>
<td>6%</td>
<td>49%</td>
</tr>
<tr>
<td>basic metal and fabricated metal</td>
<td>19%</td>
<td>8%</td>
<td>3%</td>
<td>37%</td>
</tr>
<tr>
<td>prod</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>machinery and equipment</td>
<td>11%</td>
<td>17%</td>
<td>8%</td>
<td>41%</td>
</tr>
<tr>
<td>electrical and optical products</td>
<td>6%</td>
<td>14%</td>
<td>6%</td>
<td>33%</td>
</tr>
<tr>
<td>transport equipment</td>
<td>8%</td>
<td>11%</td>
<td>5%</td>
<td>56%</td>
</tr>
<tr>
<td>n.e.c. (Furniture, recovered etc.)</td>
<td>4%</td>
<td>12%</td>
<td>6%</td>
<td>38%</td>
</tr>
<tr>
<td>Total</td>
<td>10%</td>
<td>4%</td>
<td>37%</td>
<td></td>
</tr>
</tbody>
</table>

Generally the Czech economy has a high export share of GDP since 37% of output is exported (was in 1992), higher than the level of export in Denmark of 29% and higher than average export share of Europe of 21%. These figures support the fact that the industry sector of the Czech Republic is dependent on trade on international markets.

Sub industries with relatively high export share of production are textiles (42%), leather and leather products (48%), wood and wood products (42%), other non metal-mineral products (49%), basic metal and fabricated metal products (37%) and transport equipment (56%).

Table 6-8 shows energy consumption in sub industries in the Czech Republic.
Table 6-8 Energy consumption in the industry sector, PJ, 1996

<table>
<thead>
<tr>
<th>Sub industry</th>
<th>Hard coal, coke</th>
<th>Brown coal, Briquet</th>
<th>Oil products</th>
<th>Gas</th>
<th>Heat</th>
<th>Electricity</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>food products beverage</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>textiles</td>
<td>3</td>
<td>2</td>
<td>8</td>
<td>15</td>
<td>0</td>
<td>5</td>
<td>34</td>
</tr>
<tr>
<td>leather and leather products</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>wood and wood products</td>
<td>2</td>
<td>1</td>
<td>17</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>21</td>
</tr>
<tr>
<td>pulp, paper and paper products</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>coke refined petroleum and nuclear</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>chemicals and chemical products</td>
<td>10</td>
<td>6</td>
<td>12</td>
<td>6</td>
<td>6</td>
<td>3</td>
<td>42</td>
</tr>
<tr>
<td>rubber and plastic products</td>
<td>5</td>
<td>3</td>
<td>4</td>
<td>7</td>
<td>0</td>
<td>7</td>
<td>26</td>
</tr>
<tr>
<td>other non-metal mineral products</td>
<td>8</td>
<td>4</td>
<td>7</td>
<td>14</td>
<td>16</td>
<td>3</td>
<td>52</td>
</tr>
<tr>
<td>basic metal and fabricated metal prod.</td>
<td>70</td>
<td>40</td>
<td>9</td>
<td>22</td>
<td>26</td>
<td>5</td>
<td>172</td>
</tr>
<tr>
<td>machinery and equipment</td>
<td>6</td>
<td>3</td>
<td>2</td>
<td>15</td>
<td>0</td>
<td>12</td>
<td>38</td>
</tr>
<tr>
<td>electrical and optical products</td>
<td>11</td>
<td>6</td>
<td>9</td>
<td>15</td>
<td>0</td>
<td>8</td>
<td>49</td>
</tr>
<tr>
<td>transport equipment</td>
<td>6</td>
<td>3</td>
<td>2</td>
<td>30</td>
<td>35</td>
<td>7</td>
<td>83</td>
</tr>
<tr>
<td>n.e.c.</td>
<td>5</td>
<td>3</td>
<td>4</td>
<td>8</td>
<td>0</td>
<td>4</td>
<td>24</td>
</tr>
<tr>
<td>Total industry</td>
<td>136</td>
<td>77</td>
<td>82</td>
<td>138</td>
<td>82</td>
<td>62</td>
<td>577</td>
</tr>
</tbody>
</table>


The major energy sources in the industry is hard coal and gas accounting for approximately half of the total final energy consumption in the industry. Hard coal alone accounts for 23% of total energy consumption. However, in the energy intensive industry "Basic metal and fabricated metal products" 40% of energy consumption comes from hard coal.

Gas also accounts for a large share of total energy consumption. "Textiles" and "Machinery and equipment" have a relatively high share of gas (40-43%) in their final energy consumption.

Oil products account for 15% of total energy consumption, but some industries like "wood and wood products" have a very high share (80%) of oil products in their energy consumption.