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Energy policy in Romania: A Computable General Equilibrium Model

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Abstract

This study presents the consequences of the Romanian accession to the European Union and more precisely the adherence to the Single Market of electricity and the adoption of the consequently legislation. The analysis is also carried on the study of CO2 tradable permits as market instrument of the environmental policy. Therefore we propose a CGE model designed for a small open economy, with four production factors (KLEM), four types of households and four productive sectors (two energy sectors, one energy intensive and a non-intensive energy sector). The aim is to estimate the impact of the new energy policy of increase in prices, state subsidies removal and participation to the tradable permit market. These impacts are observed on both levels of the Romanian industrial competitiveness and the households' welfare through a qualitative analysis. Our results document a new energy strategy for a more sustainable growth path of the Romanian economy.

JEL classification: C68; P28; Q54

Keywords: transition, energy, CO_2, tradable permits

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1. Introduction

The European Union enlargement in May 2004 to 25 members and thereafter to 27 (Romania including) presents a real challenge for the Union internal cohesion, in terms of production, productivity and employment. As for the Romanian integration, with a GDP per capita 30% lower than the EU (25) average, the income and employment disparities will be widened even more.

This analysis proposes to identify the nature of these disparities and some possibilities to apply the cohesion policy to the Romanian characteristics. The paper treats the matters of social and economic rebuilding and focuses on the structural disparities in the energy sector with damages on both growth and environment. To this end, it builds a strategy of sustainable development which grants importance to environment into investment decisions.

The methodology is a computable general equilibrium model applied to Romania through the energy sector and assesses the effects of a new economic policy; that consists in the reduction of state subsidies and the use of new environmental instruments, with consequences on the price level. The energy tariffs increasing on the households level is analysed by considering the living standard indices and changes induced on the consumption basket structure. The aim is to evaluate the redistributive effects of the new price policy, the social benefits and consequently the disparities between poor and riche households. We notice as exogenous factors the international environment and energy prices, the pre-accession Funds and the international agreements. Nationally, we take into account the economic performance of Romania, its efforts of attaining EU environmental standards and the transitional actions while converging to European Union.

Studies carried on the EU enlargement (Baldwin and alii, 1997) show that advantages of eastern countries are definitely higher than profits of the member states. We thus expect an increase in the Romanian welfare consequently to the enlargement. But the accession supposes the adoption of several measures like removing state subsidies with repercussions on the price policy; partly adopted during the 90s, this program had as outcome the cut in the household's real income (Cosse, 2003). Thereby we debate in this paper the issue on the expected increasing in welfare on the short and medium run. Then we will deepen more the analysis for finding a proper fiscal policy with no significant budgetary and social distortions.

The paper is divided into five sections as follows: section two describes empirically the characteristics of the energy sector and analyses the structure of the Romanian household consumption; section three presents the theoretical specifications of the model; next we analyze several fiscal and economic policy packages and evaluate the simulations results under three scenarios of development; the fifth part concludes.

2. Empirical approach

Romania had the most difficult starting point of transition among Eastern Europe countries. The autarkical policies led to an excessive focusing on heavy industries and big infrastructural projects. During the 80s, fast refunding of the foreign debt of 11 billion USD (20-30% of the GDP) imposed severe constraints on the population, with limitation of the imports and worsening of the obsolete technological capital (Salles, 2003).

From 1991, the new governments began an institutional reorganization in all sectors and on all economic levels, by a graduated approach in order to protect social interests. The specificity of Romania, ten years after transition, appears in the economic structure: important industrial assets, high energy consumption, weight of public investment and poor quality of institutions (Labaronne, 2003). The originality of the eastern transition is that the democratic shutter preceded the economic reconstruction; thus Romania fulfils the political criteria of Copenhagen but it hasn't yet a functional market economy. Consequently economic reforms didn't allow to obtain sustainable economic and social profits. Poverty strongly increased and the share of the poor population was for 20% to 40% in 1999 (World Bank, 2002).

Since 2000 Romania has recorded progress in its reform and economic reorganization, partly due to negotiations with the EU (Helsinki, 1999). Indeed for all candidate countries accession to European Union had a favourable impact on the political and economic institutional reforms. The recent indicators show positive developments in Romania: growth of the GDP of 5.3% in 2001, 5% in 2002 and 4.5% in 2003; the inflation of 50% in 1999, fell to 18% in 2002; the provisions of central bank were 7 billions USD at the end of 2002 (either the equivalent of five months of importations); the budget deficit was maintained to 3.1% GDP in 2001 and 2002; exportations volume was the highest ever in 2002; the rate of unemployment fluctuates around 8% and the foreign direct investments is increasing (Salles, 2003).

The economic recovery has been driven by strong growth in exports, primarily the re-export of processed inputs from EU countries which reflects progress in economic reforms over the last few years, including setting the real exchange rate at a competitive level. It's a response to the initiating bank and enterprise privatization and to the renewed access to international financial markets (World Bank, 2002). Even if Romania remains the poorest candidate country (2000 USD/ inhabitant, 5000 in PPP), economic indicators appear favorable to future evolutions.

2.1 The energy sector

This section recalls the main characteristics of the Romanian energy sector and builds the particular framework of transition towards liberal system of organisation.

Romania had a significant production of energy resources on the European level from the very beginning of the XXth century; it still holds a diversified energy resources portfolio (coal, oil, gas, hydropower, uranium). But Rumanian energy sector has had serious financial problems since 1989: gas, heat and electricity prices were maintained below the production costs, and especially below the marginal long run cost. Moreover, the low rate of energy bills collection weakened the sector financial performance. Consequently, the lack in investment maintained old and inefficient installations, and thus the primary energy production was declining. Energy independence is currently stable (77,3% in 2000), due to the demand fall for 50% (1989-2001), but will decrease next (50,1% in 2030 (EC, 2003)), because the

national oil production will stabilize to its maximum extraction potential, the gas production is declining and the not-profitable coal mines will be closed. In spite of the consumption fall, energy intensity remains four times higher than the European standards, and three times higher than American indices (Cornillie and Fankhauser, 2002), in reason of slow reorganization of state companies.

2.1.1. Structural reforms

Energy sector remains the most socialist industry in eastern European countries with ideological, geopolitical and social objectives ignoring essential economic criteria. Romanian structural reorganization started by laws and institutions reforming. This policy tried setting contractual relations between agents, in order to consider the real production cost in the decision-making; the aim was that government and households could conceive energy beyond its public functions as a costly service. The current objectives are to set up a more transparent regulation for guiding energy companies towards profit and for reducing their role as wellbeing and employment instrument; it gives also the opportunity to attract more private investments.

The failure of the former state policy generated a controversial debate about the organisation of the energy model to adopt. This debate opposed the French to the Anglo-Saxon model and the French model appeared more appropriate, at least for gas and electricity sectors. The organizational structure of this model seems indeed closer to the energy sector legacy, providing protection towards both competition and external influences (Von Hirschhausen and Waelde, 2000). Besides, it's based on central planning and gives priority to important projects as nuclear power construction. Appling the French model during the 90s was obviously a mistake: it maintained the inefficiency in the power sector and reinforced the state monopoly influence (Leca, 1998).

Thus, the model choose is at least in theory the Anglo-Saxon liberal system. The Romanian government adopted an reorganization plan in three stages (IEA, 2000): firstly (June 1998) the state monopoly was transformed into a holding (Conel) with two power production units (Termoelectrica and Hidroelectrica) and a distribution company (Electrica). In a second stage (2000), in order to privatizing the production and distribution companies, the holding was divided into profit centres. From 1998, regulation agencies were established (National Authority of Regulation, 1999) and the power trade was made possible with the founding of the power market administrator (Opcom SA).

The energy sector remains the state property excepted for the half of the oil sector. The next stage of reorganization consists in the power production privatization, excepted for the hydropower company and the distribution unit. The distribution and transmission market remains under the state regulation, while the opening degree of the power market is 33% of the total demand and 25% for the gas market.

Following we analyse the energy pricing policy and its macro-economic incidence on public finance, foreign trade and balance of payments, as well as on competitiveness and real wages.

2.1.2. The reform of the energy prices

The government adjustment of the price policy consists in setting prices and removing state subsidies by respect of economics principles. But cost recovering policy means that prices

increase above the agents' and population's possibilities to pay the bills; moreover, it creates a new inflationary spiral. Despite all, Romanian government applied a gradual pricing policy towards cost recovering prices. The retail price of natural gas increased from 40 USD/ 1000 m3 for households (60 USD in industry) in 2001 to 124,5 USD/ 1000 m3 in 2003 (respectively 114,1 USD/ 1000 m3). Until the membership date, tariff will increase up to 170 EUR/1000 m3 (D. I Popescu, Minister of Economy, Adevarul, November 2003).

The power production price is close to its production cost. It fluctuates between 40 and 52,8 USD/ MWh, which accounts for 50% of the EU average price (Cosse, 2003). In particular, hourly pricing was introduced for better reflecting the marginal costs and the capacity load. In the heat sector, the national price is about 70-80% of the average production costs. This price is twice lower than the EU price, but comparable with prices in other transition countries. In spite of these tariff adjustments, serious distortions persist in the energy sector and in interindustrial relations. Their origin is found in the weak performance of bill collection, the lack of investment and several forms of subsidies and compensations. The modernization of the obsolete power and heat sectors strongly depends on the investment possibility. Currently, the lack of profit and investments delayed the energy park renewal. In the heat and electric sectors, the losses are respectively 25-40% and 10% of the production. As for the private investments, the actual price structure and business environment do not offer yet the necessary incentives for implying the private sector.

The total amount of subsidies is about 5% of the GDP (2000-2001), higher than the budget deficit (3-4% of GDP; Salles, 2003). Industry benefits the most of these subsidies (3% of GDP). Households receive subsidies too, without criterion of the income amount and the poorest of them benefit of financial state assistance also (0.1% of GDP, 2001). Heat is subsidized upstream, through budgetary assistances granted for the coal sector (0.5% of the GDP), and downstream, through price subsidies allowed for households. Subsidies remain no transparent and most of them are not recorded in the central budget (Cosse, 2003), reflecting the weakness of the budget management.

The quasi-fiscal expenditures are a common practice within the state-industry framework and take different forms: tax arrears, state guarantees, and prolongation of the due repayment (0,5% -1,5% of GDP). Such practices relieve the financial charge of power companies, but encourage the culture of the non payment (2,8%, 2001). The state company, Conel, used to collect energy bills in forms of cash (50%), barter (25%) and debts (25%, IEA, 2000). Each company is concerned about the survival of its suppliers and customers for securing the future of its activity (Locatelli, 1999). Countries in transition provide a special business environment with inertial factors from the central planned system as barter and compensations.

Another characteristic for eastern countries is the high level of energy intensity. The energy consumption path was different in the Eastern Europe: the oil shocks hit the Western Europe and did not affect the Eastern development protected against international price fluctuation by the relationship with Russia.

2.1.3. Energy intensity

Romania's intensity is about four times higher than the EU average (about 1,4 tce/1000 USD (Cosse, 2003)) in reason of climate and economic structure (the weight of the heavy industry in the GDP and a certain reserve of the governments to restructure this sensitive sector). The EU enlargement towards East is a good opportunity for the transition countries to adopt

policies for a more sustainable development. The first step is the possibility to transfer efficient less polluting technologies through both free trade and technological assistance. Thus a fall in the energy intensity is expected at least for the industrial sector, as households' transition towards Western life style will generate a more polluting consumption (extensive transport style, public transport decline and large habitats, etc).

Our analysis presents the energy consumption forecasts and emphasis the incidence of the intensity evolution on the economy and households. Thus, comparing with other transition countries trends, some factors appear dominant such as the economic reform. In this context, a study of Cornillie and Fankhauser (2002) uses as explicative variables for intensity: the privatization, the structural reorganization and the energy reform. We will review next explanatory factors with a determinant role in the energy intensity's reduction, as energy price, technical progress and power sector reform. Thus increased energy price by 100% would lead to a decrease in energy intensity of 17% (EBRD, 2002). Energy prices and collection rate set the importance of price signals; the collection rate plays a strongly unfavourable role for the energy intensity and varies from 80% to 95% (Ahrend, Martins, 2003). Our CGE model takes this rate into account in the calibration stage by reducing the real consumer price with the amount of uncollected bills.

Energy intensity is a decreasing function with the technical progress. Potential of intensity reduction is important for Romania as technological choices are not accomplished yet. Moreover, transfers of efficient technologies from EU will be significant in the context of the partnership with the EU member states. The economic reform progress is a measure of firm reorganization and privatization, of prices liberalization and financial discipline[2]. Countries whose reforms are most advanced, have the lowest intensity, as transition creates the proper structures and incentives for the energy intensity reduction. The role of the energy intensity played on Romanian power evolution determined us to choose it as criterion of sectorial disagregation; we considered thus as threshold the EU average intensity.

Further we present the household general framework and we review some considerations on the poverty concepts for enable us to fix the poverty line; finally, we will rebuild the household consumption basket according to four productive sectors.

2.2. Households

General data and results are provided by the Romanian Institute of Quality Life Research, ICCV (2003), and the National Statistics Institute, INS (2003).

The residential power consumption in Romania was one of the poorest in Europe since several decades. Moreover, it was affected by the price liberalization and by the reducing of the state role into productive sectors. The remove of the budgetary subsidies since 1990 revealed the high costs of energy production and distribution and reflected the inefficiency of the central planned system (ICCV, 2003). The price liberalization started for households in 1997 when policy became unbearable for an important part of population. Large disparities between price increase and reduced capacity to pay energy bills, created pressures and distortions in the consumption sphere. That accentuated the general trend of social disintegration by evicting the over-debted households or by disconnecting them from the heat

[2] The study carried by the EBRD (Cornillie et al, 2002) points the multi-collinearity between variables of privatization and restructuration: deleting the variable of privatization decreases the effect of the restructuration and vice versa (page 14).

network. Poverty increased and accentuated the social polarization: the Gini coefficient rose from 20 to 30 (Lovei and alii, 2000; World Bank, 2003).

The analysis of the consumer expenditure structure explains the incapacity of payment for most of households. According to this data, during 1990-2002, food expenditure had the most important weight (about 45%) for all households (excepting for managers) followed by public utilities expenses (about 19% of the consumption expenditure (2000)). This weight is even more important in 2002 for urban employees, unemployed and retired. Thus, the residential environment influences the weight of expenditure for public utilities; villages have a less developed infrastructure and consequently households felt less the shock of utilities price increasing. Since 1997 this rise generated for poor households the reduction in the energy consumption down to a minimal level with zero price elasticity. Maintaining the same model of consumption creates deficits in the budget of low income households or modifies the quality of their consumption. That involves the reduction in the quality of life, which accentuates the current phenomenon of social disintegration, especially for the households setting on the minimum threshold of decent life. Therefore government support to the poorest groups was allowed and included during 2002 a Minimum Income Guarantee program (0.4% of GDP) and an increase in child allowances and pensions.

The low income households represent a significant part of the population, since the wages decreased. In spite of this fall, the share of taxes in wages remains high (22.6%). Although the number of employees fell after 1989 of about 50%, they are the most important taxpayers with a significant share of 70% in the state budget. Thus they sustain the inefficiency of the public utilities system with subsidies granted to rich households too.

This context leads us to reconsider the social income distribution mechanisms in order to find a proper policy for the expected price increasing consequently to the Romanian accession to European energy market. This rise will be economically sustainable only under economic recovery involving increases in the income level; that's because the precarious economic household's situation is considered as temporary and the welfare relatively GDP elastic (ICCV, 2003).

Surveys carried out on the household budgets from January to December 2002 (INS, 2003) allow us to assess the income and expenditure structure and to analyse thus the Romanian socio-economic situation. The households division into deciles reflects the best the correlation between the consumers' expenditure and their incomes[3] (see appendix1).

The consumer program tests in this model a budgetary policy of subsidies removing and of enforcement of the poor households' assistance. According to the ICCV data (Mihailescu and alii, 2003), about 30% of the Romanian population lives under different poverty degrees (extreme (1%), absolute (17%) and relative (29.6%)). Next we assess the poverty line and we recall considerations on the relative and absolute poverty.

Defining the relative poverty line has as starting point the principle that poor are people excluded from the minimal standard life as defined by a state[4]. This indicator takes into

[3]Households' disagregation by deciles is done considering the individual income deflated with the price index from January 2002. Each decile is an increasing distribution with the individual income.

[4] That is the concept applied by the EEC in the campaign against poverty: are considered poor the individuals, families or groups whose material, cultural and social resources are so weak that people are excluded from the minimal standard life as defined by the society (Concialbi, 1998).

account the necessary resources for a modern life, which exceed the biological or traditional needs.

1) We retain a first welfare indicator as the current consumption expressed in monthly expenditure. This relates to expenditure for food, utilities and non food products. We consider the average consumption of the ten deciles (meaning 6 516 504 lei/month/household), which shares the deciles D1-D6 into poor and D7-D10 into rich category.

2) According to the World Bank methodology, we consider that the relative poverty line is about 2/3 of average consumption for decent life. This criterion requires more information about the decent life standard consumption basket. Lack of this information, we cannot use the available data which refers to the real actual average consumption, and not to standards. It is definitely lower than the amount required by the modern decent standard of living and it would classify the households relatively poor in the decile D1 and the rich people into D2-10. This classification is certainly not relevant.

3) Kiuila and Sleszynski (2003) apply in a CGE model to Poland a poverty line as income average, which is contested by Lovei and alii (2000), because individuals of transition countries don't completely declare their incomes. According to this criterion applied to Romanian deciles, we obtain a threshold of 6584 989 lei, which groups the D1-D6 deciles in the category of the poor households and D7- D10 in the rich category.

4) If we consider the relative poverty as resources deficit (ICCV, 2003), a fourth indicator appears as the save formula (difference between incomes and expenditure). Appling this criterion, households relatively poor belong to D1- D5 deciles and the rich to D6- D10. The limit of this indicator is that it takes into account the income whose declaration may be incomplete.

5) If we analyze poverty as an absolute concept, we consider as poor persons who can not satisfy some fundamental needs (food, clothing, housing, health, etc). This criterion makes comparable the situation between countries and it is the equivalent to 2 USD/day in national currency (World Bank). Thus, the poverty rate in Romania becomes 20.5%, meaning the D1 and D2 deciles.

After recalling poverty lines concepts, we question about the relevance of each one, in term of correlation between the formal income and the monthly consumption. Thus, in order to know if the informal incomes affect our results, we call upon works relating to informal flows of the Romanian households (Amelina and Ali, 2003). These flows include 1) earnings from informal wages, small scale agricultural production and leasing of lend; 2) inter-households transfers (gifts, goods, services) and 3) exchanges. The results of this study show that the informal transfers represent 8.5% of the household's incomes and 12.3% of their consumption; in particular, it shows neutral effect for the inter-households transfers. That enables us to consider as relevant the following criteria:

Table1. The distribution of households (P/R) according to four criteria:

Average consumption P R	Average income P R	- Save + P R	World Bank (absolute poverty = 20,5%)
D1-D6 D7-D10	D1-D6 D7-D10	D1-D5 D6-D10	D1, D2 D3-D10

We consider then several poverty thresholds dividing population into absolutely poor (D1 and D2), relatively poor (D3, D4 and D5), households living on the minimum decent life threshold (D6 and D7) and rich households (D8, D9 and D10). The consumption structure expenditure is presented in appendix 2 and 3; reduced state subsidies will be compensated next by social programs for poor and by state incentives for applying save-energy measures to households (thermic isolation, household equipments and new cars, etc.).

World Bank studies (2003) show a strong correlation between the poverty line and the economic recovery: a growth of 5% of GDP/inhabitant would decrease the poverty by 50% until 2007. This correlation was valid in 1996 and 1997, but from 1999 economic growth elasticity of poverty decreased from 3.2 (absolute value) in 1996 to 1.8 in 2002. Choosing the appropriate policy requires deepening the analysis by the residential and employment criteria in order that economic growth generates income inequality reduction.

3. Characteristics of the CGE model

3.1 According the methodology to the issue

The choice of modelling framework is based on the CGEM ability to assess future developments of the energy supply and demand. The starting point is provided by various models applied to developed countries (SPOT-Belgium (Brechet, 1999), MEGAPESTE-France (Beaumais, 1995), GEMINI-E3, etc.) or in transition countries (PRINCE-Poland (Piazolo, 2000), CGE LI-Lithuania (Galinis, van Leeuwen, 2000), EFOM-ENV-Romania (Voogt and Al, 1998), CGEM – Romania (World Bank, 2002)).

Applying the CGE model we reproduce the connexions between economic indicators taking into account the direct effects of policy changes, but also the indirect impacts induced by the economy as a whole. For a transitional framework, this aspect presents the interest to assess the feedback effects of a policy whose results would be difficult to estimate in reason of the actual unstable path of growth. As for the data base, the CGEM is more faithful empirically than an econometric model based on passed estimations; thus, it cuts the statistical constraint related to the data relevance, distorted by frequent structural changes. The statistical needs are limited to one year data and require the building of the social accounting matrix based on national accounts.

The analysis of the Romanian development focuses on complex interactions existing between economy, energy and environment. The model type appropriated to the country profile rests on models applied to small open economy[5]. While considering transitional characteristics as the institutional structure and the agents' budgetary constraints, our model is build under neoclassical assumptions for the consumer and the producer behaviour. Comparing with standard models, the originality is set here by the use of CO2 tradable permit equation, by households' disagregation in four types and by the applied transitional systemic changes.

The study carried on factorial interactions and possible substitutions between energy and other inputs requires distinguishing between capital (K), energy (E), labour (L) and the no energy intermediate consumption (M).

[5] Even if from the point of view of the size, Romania is one of the biggest country of the Eastern European Countries, its behaviour on the energy market is price-taker.

The economy is segmented in this preliminary stage of analysis into four sectors. Taking into account the issue profile and the high energy intensity level, we distinguish two energy sectors (electric and no electric) and two productive sectors (energy intensive and less energy intensive). Analysing the energy intensity can explain some aspects of the development trends and can emphasize essential factors of the fall in both energy supply and demand and their intersectorial implications.

The threshold distinguishing the intensive sector from the less energy intensive is considered the EU average (0.4 toe/1000 USD which we convert in tce/1 billion ROL, meaning about 38, 41 tce/1 billion ROL). Thus, the industrial branches below this threshold belong to the less energy intensive sector and industries above it form the intensive one (Appendix 4). The energy consumption includes electricity, heating and other energy sources: coal, coke, gas, petroleum products and no conventional energy sources.

The productive sectors have the following components:

1. Electric Sector (SEL)
- 1.1 Thermo power
- 1.2 Hydropower
- 1.3 Nuclear power

2. Energetic non electric Sector (SNEL)
- 2.1 Coal
- 2.2 Gas
- 2.3 Crude oil and petroleum products

3. Energy intensive Sector (SIE)
- 3.1 Industry
  - 3.1.1 Metallurgy
  - 3.1.2 Chemistry and chemical products
  - 3.1.3 Equipments and metal machinery
  - 3.1.4 Other non-metallic mineral products
  - 3.1.5 Pulp, paper and paper products
  - 3.1.6 Water collection, treatment and distribution
  - 3.1.7 Metalliferous ores quarrying
- 3.2 Transports

4. Non intensive energy Sector (SNIE)
- 4.1 Industry
  - 4.1.1 Food, beverages and tobacco
  - 4.1.2 Textile and textile products
  - 4.1.3 Furniture
  - 4.1.4 Wood processing
  - 4.1.5 Rubber and plastics processing
  - 4.1.6 Construction
  - 4.1.7 Textile, fur and leather wearing apparel
  - 4.1.8 Leather goods and footwear
  - 4.1.9 Waste recovering
  - 4.1.10 Publishing houses, polygraph and records prod
  - 4.1.11 Other no classified activities
- 4.2 Services
- 4.3 Agriculture

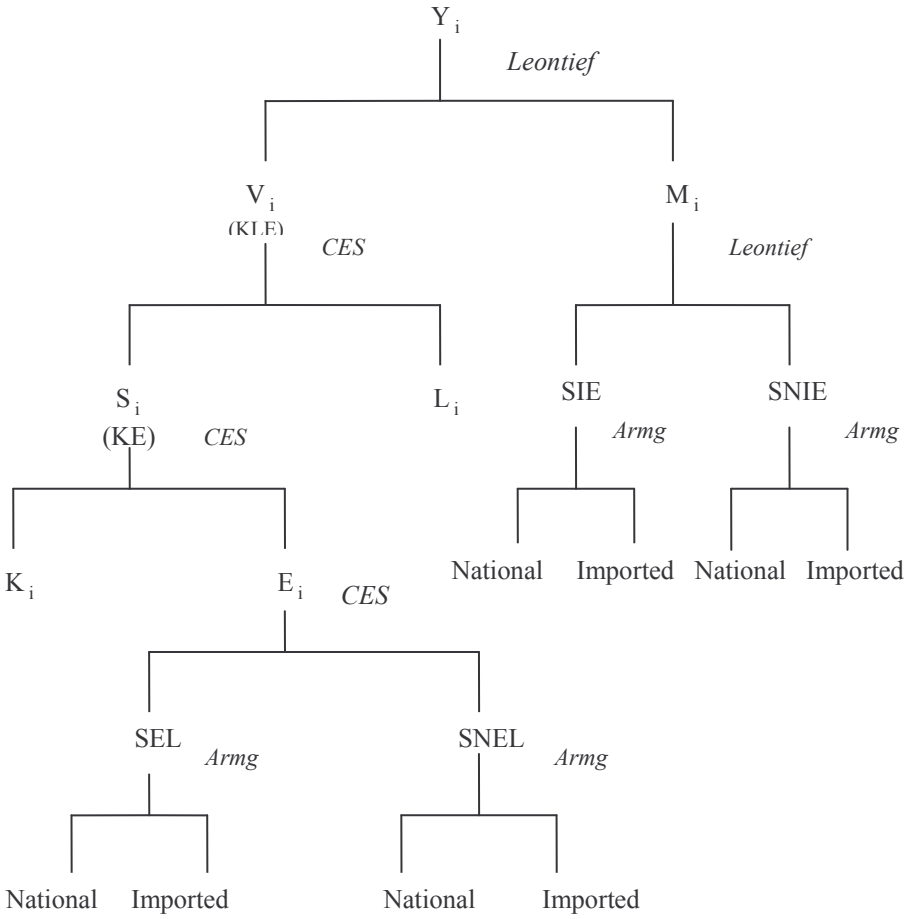
3.2 The CGEM specifications

3.2.1 The production sector

Producer behaviour is described under neoclassical assumptions of intertemporal substitutions. The emphasis on productive rigidities (see section 3.2.4) and particular institutional structure allows building the actual economic framework in Romania. We analyze the producer behaviour under the perfect competition assumption, since factors are no accumulable and the production function is on constant returns of scale. Indeed, the industrial financial situation (see section 2.1) emphasis the finding that Romanian firms are interested in keeping a small size even if in the long run they would have more benefit while accumulating factors. Expected benefits are in terms of investments, competition climate, reduced losses and energy efficiency.

The productive structure follows the same principle for all production sectors, but substitution elasticities and technical parameters vary. For example, substitution between capital and labour are stronger in the capital intensive sectors (electric sector) that in the labour intensive ones (services; Pizzati, 2002).

Figure1. The productive structure



For each sector we describe a standard producer which is looking for an optimal distribution of the production factors. His program provides the minimization of factors' costs with respect of the production function. On the higher level of the structure, the firm distributes its production between the non-energy intermediate consumptions (M) and an aggregate (V) of

capital-labour-energy; we use a Leontief function, with assumption of complementarity between both factors.

On the second level, no energy consumption is segmented in goods provided by energy intensive and less intensive sectors (according to a CES function). With respect on their origin, goods are domestic or imported, under the Armington's assumption (1969) of imperfect substitutability between imported and domestic goods. The choice of a CES specification is justified by the substitutions possibilities between energy sources which production in intensive and less intensive sectors is based on. The forecasts of the EC (2003) show a downward trend in use of coal, gas and oil until 2030, and a rise on behalf of the nuclear power and the renewable resources (hydro, biomass, waste).

The composite KLE breaks up into factors such as labour and the capital-energy composite (S), since substitution between capital and energy is different from substitution between energy and labour, being in particular stronger in the long run. The capital-energy composite has an important weight in all productive structures, in respect with our issue profile focused on opportunities to reduce the energy intensity by technological capital's contribution. And this potential is important in all the sectors. In industry, energy intensity can decrease by 8,6% per annum until 2010 and by 3,8% annually until 2020; in the tertiary, this potential is respectively by 1,6% and 1,1%, etc. (European Commission, 2003). We apply at this level the same program: the producer minimizes factors' costs according to a CES technology. At the lowest level, energy is segmented into electric and non-electric consumption provided by the domestic and imported production.

Aspects of central planned economies are noticed in the closure rules in form of rigidities of both prices and supply (the power sector) since state interference is made mostly through subsidies and regulation. Models applied to countries in transition (Zalai, 1998) compute the part of the net income considered as the return on capital by subtracting from the producer's price the part of subsidies which affects the user's price:
Selling_Price = Production_Price * (1- subsidies_rate)

3.2.2 The tradable permit system

Modelling the tradable permit market consists in explicitly introducing them into the production function. The starting point for our study is the production structure of the G-Cubed model (McKibbin and Wilcoxen, 1992), the so-called primal approach. The program depends on the individual producer objective to abate the pollution quantity and on the marginal abatement cost: if cost exceeds the permit price, the producer chooses to buy permits proportionally with the exceeding pollution; in the contrary case, the producer chooses to reduce pollution and to sell the permit surplus.

The implementation of the international tradable permit market depends on the Kyoto Protocol's ratification (1997). It includes parties to the United Nations Framework Convention on Climate Change and its objective is to reduce the greenhouse gas emissions by 5.2% below 1990 levels in the commitment period 2008 to 2012. Romania ratified the Protocol in 2001 and its commitment is to reduce the CO2 emissions by 8% below the 1989 level. Considering the abatement of CO2 pollution which is about 50% from 1989 (see appendix 5), Romania would be definitely a net seller on the international market.

On the European Union level, the directive 87/2003/CE establishing a tradable permit market was adopted on July, 2003 and its starting point is the mechanism of flexibility of the Kyoto Protocol. The market opening is planned for January 1st, 2005 and concerns the members of the EU (25) only. The program is designed to start over two periods, 2005-2007 and 2008-2012, and it trades emissions resulting from five activities as energy, metalliferous ores quarrying, mineral industry, ceramic products and paper pulp industry.

Permit trade principle is the same for both agreements, but the quotas distribution mechanism is different: for the Kyoto Protocol, the Romanian objective to reduce by 8% its emissions below the 1989 level is already accomplished since its carbon dioxide emissions have decreased by 51.39%. This instrument becomes no more restrictive for Romanian pollutant industries and the only incentive to reduce pollution will be the potential trade gains.

As for the quotas allowance in the EU, each country must declare its own objectives for reducing the overall emissions and the principle for distribute them between polluters[6]. The national commitment has to be quite restrictive and coherent with the Kyoto Protocol: both commitments are compatible and the experience of applying the European directive will serve to the Protocol setting and the emissions monitoring.

Carbon dioxide pollution is set according to the primar energy consumption and an emission coefficient depending on sectorial specificities and technological process:
$CO2i = CoeffCO2i * SNELi$

The primar energy price becomes function on permit price and depollution objective:
$PSNEL\_final * ESNEL = PSNEL * ESNEL + PPEN * (CO2 - CO2obj)$.

3.2.4. The consumer

The overall consumption is divided into public (2.2.5.1) and private consumption (2.2.5.2).

State is not described as an optimizer agent and its activity is assessed following expenditure and incomes accounts of the base year (Goulder, 1992). Thus, incomes are determined endogenously in form of value added taxes (VAT), income taxes and import taxes (DDD). Governmental expenditures is set exogenously with possibility to induce exogenous shocks on the social transfers and state subsidies: RG = VAT + DDD + Income tax

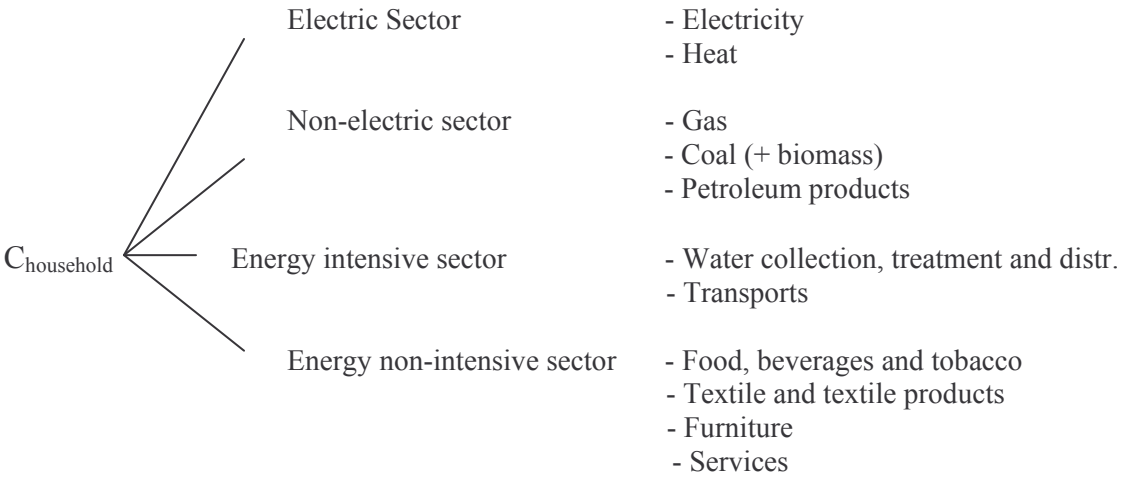
DG = DGc + TRS + SUBV.

Social security contributions (employees (CSS) and employers (CSE)) are transferred to households and the social security account appears as an independent account:
TR = CSS + CSE. We make the assumption of budget deficit (DP= RG – DG).

The household consumption is divided into electric and non-electric goods and energy intensive and non-intensive ones, as presented in figure 3 whose nomenclature is provided by INS (2003).

[6]The Directive provides a 'cap and trade' system where large energy consuming industries receive free CO2 emission permits (each permit allows to reject one tone of carbon dioxide). At the end of each year, companies must present as many permits as CO2 emissions rejected. Companies having polluted more than their number of permits must buy additional permits on the market. Otherwise, companies will resell their surplus permits. If a company does not manage to acquire sufficient quotas to cover its CO2 emissions during the first period (2005-2007), a fine of 40 EUR is applied to each missing quota. For the following period (2008-2012), the sanction goes up to 100 EUR (Directive 2003/87/EC of the European Parliament).

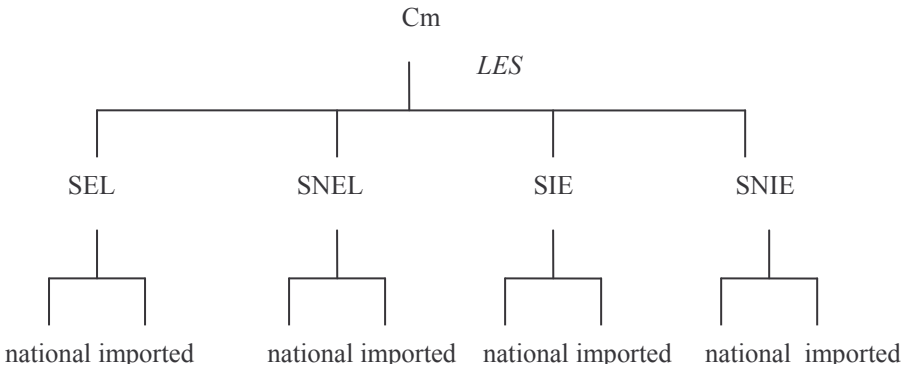
Figure3. The structure of the private consumption



Households do not consume directly products provided by the following sectors: The crude oil; Metallurgy; Chemistry and fibres; Equipments and metal machinery; Other no metallic mineral products; Pulp, paper and paper products; Metalliferous ores quarrying; Wood processing; Rubber and plastic products.

The consumer behaviour is described under a LES structure which allows assessing the minimal quantity for each basic good. The representative consumer program is the minimization of expenditures with respect of the consumption function. While calibrating, we will take into account the real price paid by the consumer: we introduce into the equilibrium equation the state subsidies and the non-payment rate:
Consumer_Price = Production_Price * (1- subsidies_rate – non_payment_rate)

Figure4. The structure of households consumption



The consumer general utility (U) computed after the model's resolution depends on goods and services consumption (u(C)) and leisure expressed as unworked time, according to a Stone-Geary specification. We assume thus reduced working time corresponds to increased welfare, but its impact on the population is actual relative in terms of income, inequality or poverty. It means that the unworked time could induce a certain disutility on the wellbeing while imposed by the labour market and not by the individuals' preference for the spare time.

Thus we find essential to correct the unworked time by an indicator of social inequality (IS), which has as starting point the welfare index of Osberg and Sharpe (2003). This index adjusts the leisure utility with the disutility of poverty intensity and income distribution inequality:

IS = G + SST.
The social inequality (G) is measured by the Gini's coefficient and the poverty intensity by the Sen-Shorrocks-Thon indicator equal to twice the poverty rate and the ratio of the poverty average deviation[7]:

$$SST = 2 * poverty\_ratio * \frac{\left| \overline{income}\_pover.threshold - pover.threshold \right|}{pover.threshold}$$

The consumption utility is a negative function of the CO2 pollution. We estimate thus the emissions costs taking into account the worldwide dimension of the climate change. Consequently we distribute the total social costs between countries according to the share of each country in the GDP (Osberg and Sharpe (2003)). The indicator of the social environmental costs (CE) has its starting point in estimations of Fankhauser (1995[8]) of about 20 EUR per ton of CO2 and it becomes in case of Romania as follows:
CE = 20 EUR/t * CO2world * GDPRou/ GDPworld.
General utility indicator (U) is a function on goods consumption computed for each type of household according to a program of expenditures minimization; it depends also on the CO2 pollution externalities, on the leisure and the poverty indicator such as:
$U(C, L, CE, IS) = \sum \beta i * \ln (Ci - Cmin\_i) - \ln CE + \ln (1- L) - \ln IS$

3.2.4 Equilibrium and closure rules

1°. On the goods and services market, the general equilibrium is ensured for three sectors (SEL, SIE, and SNIE):

$Yi + MXi = Cdom\_i + Ii + Mi + Ei + DGc + Xi \quad for \quad i = 1,2,3,4$
$PYi * Yi = PK * Ki + PL(i) * Li + PEi * Ei + PMi * Mi \quad for \quad i = 1,3,4$

The non electric sector (i=2) is treated separately in reason of supply particularities. The quantity of primar energy is fixed at the current level, reflecting the constraints of extraction capacities (World Bank, 2002). The price is fixed at the international level, but government sets subsidies to equilibrate supply and demand:
(International Price - Subsidies) * Y_SNEL = PKi * Ki + PL(i) * Li + PEi * Ei + PMi * Mi
Market equilibrium is set by additional endogenous importations.

For the market of the privatised services, prices are determined by the economy as in the case of non tradable goods; the prices of tradable goods are fixed in foreign currency since Romania is assumed to be a price taker in international markets.

2°. Labour market

We analyse the labour market equilibrium under two alternative assumptions: wages are flexible and secondly, wages are fixed to the economy wide average plus sector specific wage variations.

The difference between the two assumptions lies in the distributional consequences in terms of growth and employment. World Bank report (2002) shows that labour perfect mobility ensures a better distribution of resources across sectors, allowing labour to move toward

[7] Osberg et Sharp (2003) define the poverty deviation as the gap (%) between the threshold income and the average income of poor.
[8] Fankhauser S., 1995, Valuing Climate Change: The Economics of the Greenhouse, Earthscan, London.

sectors with greater growth potential. That involves positive consequences on the economic growth, on public deficit, on employment and standard of living. The second assumption is more realistic than the first one since it takes the unemployment into account, but remains more rigid to the labour allocation across sectors which will limit thus the effect of incomes distribution. However, both assumptions will have considerable impacts in term of employment in the power and energy intensive sectors in reason of the important weight of public sector on the labor market (60%, World Bank, 2002).

Walras law allows to check equilibrium on the capital market and to closure the model by the price capital.

4. Simulations

This section presents the main energy policies under several scenarios of development and the results will allow assessing changes in the production and consumption structure.

1. Our first scenario presents initial assumptions for 2002 (the reference year) and the results are outcome for 2007, supposing this date for the Romanian integration. This basic scenario (BAU) proposes the increase in the consumer prices according to the cost recovery policy; it supposes also to remove the state subsidies in part towards the investissement account of the energy sector and partly to the social assistance account. Adoption of no cost energy efficiency measures could reduce the power consumption by 15%. The total energy efficiency potential is estimated up to 10-50%, which would imply the fall of the energy imports with effects on the energy balance. Reduced subsidies will generate gains in the productivity of the production factors and consequently the increase in their remuneration. We will use the forecasts of economic growth (e.g. growth of the GDP by 5% per annum, during the period 2000-2010), as assessed by the European Commission (2003).

2. The second scenario completes the BAU scenario with the framework of the Romanian accession to the European Union; that supposes the free trade with the Member States and considers the transfers with/from Brussels and the Romanian participation to the European tradable permit market. The potential profits from this participation will be invested into the power sector and the energy intensive industry.

3. The third scenario is based on the same assumptions as the second, but it assumes the international ratification of the Protocol of Kyoto. The potential profits of 'hot air' will be transferred partly into the central budget and partly towards companies in alternative forms of (3.1) reduction of the social security contributions (labour becomes cheaper for firms) or 3.2) subsidies allowed for the credit cost (capital becomes less expensive). An alternative scenario 3.3) foresees transfers towards households in form of subsidies to private incomes.

4.1) Microeconomic implications

At the agent level, one of the most important expectations is the enforcement of the financial discipline and the change in firm budgetary constraints. According to Kornai's definition of "hard constraints" (1979), firms' expenses are limited to their financial capacity and serious difficulties can lead to the bankruptcy. In case of soft constraints, the state recovers possible loss. For the Romanian context the main source of soft budgetary is the low energy tariffs, the exemption from payment of taxes and energy bills with consequences on budgetary deficit, on productivity and growth rate.

A diminution/suppression of subsidies would involve the improvement of the energy efficiency and the increase in the labour productivity[9]. Indeed, the reinforcement of the budgetary constraints will play a favorable role to the optimal distribution of inputs. In practice, under the increasing pressure of international organizations (the IMF, World Bank and EU) while allowing financial support, Romania began a more restrictive policy on the budgetary and monetary level. The Italian experience at the end of the Eighties testifies to the importance of the supranational factors in the reduction of the State aid and in privatization. Bertero and Rondi (2000) showed that the EU requirements involved the reinforcement of the financial discipline, the increase in the factors' productivity and the reduction of public employment.

These are some positive results potential in the long run ensuring a sustainable economic growth. But in the medium term, a direct consequence (BAU) will be the fall of activity due to the rise in the inputs prices, since the fall of the State role into economy would imply the rise of energy prices. That is the case in sectors benefiting more from energy subsidies (World Bank, 2002) like the primar energy producers (coal, gas, and oil) and the energy intensive sectors (metallurgy, chemistry, equipment and metal machines of construction steel). Under the assumption of limited mobility of labor (the first alternative assumption), the decline of activity in these sectors implies the deterioration of the labour market. A direct consequence of the subsidies suppression is the fall of public employment and indirectly the fall of private consumption in the medium term. One can assume however that the increase in exports (in particular towards the countries of the EU) could compensate this disequilibrium and ensure a certain sustainability of the economy's growth.

At the budgetary level the subsidies cut would imply a reduction in the deficit and the increase in the State saving. Under the target of faster growth, the saving will be invested in the sectors which knew a strong expansion and which allowed the economic revival since 2000. They are sectors such as textile industry, electric and electronic components sector, production of the transport facilities and services. Investment redeployment towards these sectors will be certainly benefical in term of growth, but the fall of activity in the capital intensive sectors in favour of labour intensive sectors, does not design a path of sustainable and competitive growth in the long run.

With this respect, our model objective is to sustain sectors affected by that price policy by investing in more efficient and proper technologies (here subsidies are deployed partly to the capital account (scenario 2)). As for the sectors ensuring the medium run growth, their potential is more important under the second alternative assumption of labour flexibility; thus, consequently to the reinforcement of firms' budgetary constraints, labour will easily migrate from the public sector to the private labour intensive one.

The modernization of the energy intensive sectors will allow the respect of the environmental objectives committed by Romania and the exchange of quotas on the tradable permit market. First results of the reduction in the power consumption are potential profits in terms of both reduced energy costs and competitiveness gains. Energy substitutions will be taken into account according with the EC (2003) forecasts which show a downward trend in the use of

[9] The same results were obtained by Chisari, Estache and Romero (1998) in a CGE model applied to Argentina to energy sector under assumption of privatization. The consequences for the model were the fall of the input per unit of output (energy efficiency) and the fall of the labour factor (improvement of the labour productivity). Privatization of the energy sector generated the change in the input-output table, by the fall in absolute value of the factors demand.

coal, gas and oil until 2030 with the rise in the nuclear power and renewable resources (hydro, biomass and waste).

On the consumer side, the rise in energy prices will involve change in the consumption behaviour, especially for rich households. If for the most of poor households, the energy share in the consumption basket became fixed since the liberalization started in 1997, for the rest of the population there was an upward trend. We explain it by the transition towards the Western life model (preference for individual transport, large habitats and the reduction of the economies of scale, etc), by the increase in the supply capacities and by a general tendency to consume after the failure of the socialist mechanisms of rationing.
But rich households benefit more of state subsidies since they consume more energy than poor. So cutting subsidies and switching them by a social assistance for poor would place subsidies there where they belong: in state budget. It will be interesting to follow the change in rich households' behaviour regarding their energy demand as well as the demand of goods provided by other branches (leisure and luxury goods, etc). Even if these sectors are not in particular modeled, the change will be observed in the consumption basket structure according to substitution elasticities between goods and services.

Building the economy strategy coherent with the reduction of social inequalities requires to analyzing the poor household structure according to their professional statute. This disintegration enables us to have a first qualitative interpretation on the question who benefits more of the economic growth? In 2002, the structure of the absolute poor households was of 33% pensioners, 32% self-employed agriculture, 14% unemployed, 9% employee, 5% self-employee and employer and other (Gatti, 2003). With this information we can conclude that increased energy tariffs and lower social securities rates (scenario 3) reduce the financial expenses of employees (9%) and employers (5%); but it affects negatively other households' categories. Before any simulation, our qualitative analysis favours the alternative scenario 3.3), where increased incomes are refunded to all households.

But reduced labour costs could involve positive results because high rates of the social security contributions determined the evasion of private firms towards the informal sector. So we can expect positive results on the long run in the social security account if those firms will join the formal sector. Moreover, reduced social security rates are labour incentive, in particular under the assumption of perfect labour mobility (first alternative assumption).

The new social policy must be addressed to all poor household categories. But for the self-employed agriculture (32% of the absolute poor), an agricultural economic reform will be more suitable, in particular the improvement of the investment climate in the rural areas. That could be a proper issue of economic development and a better alternative for the incomes distribution. But designing a sectorial strategy of development requires the disintegration of economy into several productive sectors; our approach to four production sectors builds a global strategy with no detailed sectorial description (except for the power sector).

4.2) Macroeconomic implications

The expected results concern the public deficit, the trade balance and the saving-investment balance. The disequilibrium of the currant account is mainly due to the trade balance deficit: imports are twice higher than exports (World Bank, 2002). It is the consequence of higher imports of petroleum, gas and other mineral products reflecting both higher import prices and insufficient payment capacity. That affects the currant account balance through state subsidies and grants allowed to energy companies.

One of the implications of the new pricing reform is the fall in demand of primar energy and of energy imports under technological investment assumption (scenario 2 and 3.2); that involves the improvement of the currant account deficit and the setting the real exchange rate at a competitive level. The reinforcement of the firm financial discipline will imply the improvement of saving-investment imbalance too[10], but the issue is next how public resources will be distributed between the public and the private sector.

At the international level, the Romanian's accession to the EU (second scenario) will have benefit in terms of capital account, FDI and trade. We make the assumption of capital perfect mobility and of lower investment risks. Romanian trade agreements with the EU consist in the reduction of technical and tariff barriers, but the integration (conceived for 2007) involves the adoption of the common tariff system and the trade liberalization, except for the 'sensitive' products (Hare, 2000) such as agriculture, food, iron and steel, textile and other products specific to certain countries. Consequence of this liberalization, national and imported goods become more easily substitutable (we will make changes in the substitution elasticities).

On the state level, membership in the EU involves transfers from Brussels and contribution to the common EU budget depending on Romanian's tax revenues. Transfers from Brussels are connected to the structural funds and to the common agricultural policy (Piazolo, 1999). The focus here is on the structural funds, due to the uncertainty related to the common agricultural policy. Gross flows from Brussels will be about 4% of GNP (Baldwin, 1997) and besides, Phare funds will be granted to Romania (and Bulgaria too) for three years more after the adhesion.

Conclusion

This paper presented the complex relations linking State, households and energy which proves that adopting the energy policy cannot be analyzed at the level of isolated sectors: structural and pricing reforms have direct and indirect impacts on all markets and on all consumer categories. On the household level, the objective of subsidies suppression is based on findings that since they consume more energy, rich categories benefit more of state aids. As for the budgetary reform, it consists in the institutional and legislative change through a package of policies which can attain simultaneously economic, environmental and social objectives.

For the methodological aspects, economic context is described within a neo-classic framework which is completed by structuralist assumptions and some supply and prices rigidities in order to ensure the simulations' macro-economic coherence. Country specificities are in form of subsidies and inelasticity of the primar energy supply and the anticipation of the Romania's participation to the international tradable permit market.

The complete description of economic flows requires building an accounting social matrix for highlighting relations between production structures and incomes' distribution. Empirical testes will allow to argue more our economic analysis and will be used as basis for designing the sustainable growth strategy for the Romanian economy.

In this version the model describes a static framework of the linkages between economy, energy and environment. The issue is that static models lay out structural transformations induced by the transition: the path of growth is not stable yet and the accession process will affect more the speed of convergence towards stationarity. Consequently, our work will focus next on dynamic aspects of the long run reorganization, by introducing save and investment

[10]World Bank report (2002) estimates that reduced energy losses by 1.7% of GDP involves a net impact on the save-investment balance of public companies by 0.75% du PIB.

equations. We will also assess substitution possibilities between energy sources through a more advanced segmentation of the productive sector. We will deepen more the research on the household level too and we will analyze the consumers' behaviour for all deciles in order to get a more subtle finding on the income distribution.

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Appendix1. The structure of the consumption expenditure in Romanian by deciles, (ROL/household /month, 2002)

Dec	SEL		SNEL			SIE		SNIE				Expend	EBill
	Electr	Heat	Gas	Coal	Oil	Water	Transp	Textiles	Furnit	Services	Food		%
D1	97961	6723	49094	29208	17027	15528	53695	119322	77559	176000	2341704	2983063	**6,7**
D2	120429	11339	79487	41466	19812	24995	71239	152193	68001	229909	2422143	3238160	**8,41**
D3	140953	24213	100583	53734	34610	52304	93202	169144	82846	296865	2419797	3451922	**10,25**
D4	159571	43348	129664	85204	52860	72423	132457	189225	102181	382234	2452353	3784496	**12,43**
D5	192690	68403	168426	69712	72809	104520	165226	228774	105914	533806	2571590	4236557	**13,5**
D6	197812	106007	157556	74868	101049	137336	209074	248275	113248	596731	2482750	4355702	**14,63**
D7	221214	148585	175741	73550	132805	171028	280194	275278	137639	752099	2634805	4915682	**15,29**
D8	256020	187427	186437	52837	184066	206219	326916	354621	193933	919797	2803720	5540949	**15,64**
D9	282281	213679	206284	60107	267423	239707	432833	420287	213280	1141676	2992194	6272944	**16,41**
D10	336046	251458	219557	62501	519263	270087	875358	745355	442012	1976056	3302094	8666914	**16,02**

Source: INS, 2003

Appendix2. The expenditure structure of consumption basket by goods for absolutely poor households (PA), relatively poor (RP), households on the poverty threshold (PS) and rich households(R) (average/month, ROL, 2002)

Mén	SEL		SNEL			SIE		SNIE				DépCons	FactE
	Electr	En th	Gaz	Charb	Pr pétr	Eau	Transp	Textiles	Meub	Services	Alim		%
PA	218390	18062	128581	70674	36839	40523	124934	271515	145560	405909	4763847	6221223	7,59
RP	493214	135964	398673	208650	160279	229247	390885	587143	290941	1212905	7443740	11472975	12,17
PS	419026	254592	333297	148418	233854	308364	489268	523553	250887	1348830	5117555	9271384	14,98
R	874347	652564	612278	175445	970752	716013	1635107	1520263	849225	4037529	9098008	20480807	16,05

Appendix3. Expenditure consumption structure by sector (/month, ROL, 2002) and sectorial percentages:

Mén	SEL		SNEL		SIE		SNIE		DépCons	
	ROL	%	ROL	%	ROL	%	ROL	%	ROL	%
PA	236452	0,48	236094	0,48	165457	0,34	5586831	11,55	6224834	12,87
RP	629178	1,3	767602	1,58	620132	1,28	9534729	19,72	11551641	23,89
PS	673618	1,39	715569	1,48	797632	1,64	7240825	14,97	9427644	19,5
R	1526911	3,15	1758475	3,63	2351120	4,86	15505025	32,07	21141531	43,72

Appendix4. Sectorial energy intensity (current prices, 1999)

Sector	Energy consumption (C°) ,10^3 tce				Energy intensity (1tce/ billion ROL) $\frac{C}{\text{Pr}oduction}$ [11]	Production (billions ROL)
	Total	Electricity	Heat	Others		
Industry	12 344	2 503	676	9 165	**44,9442**	274651.4
1. Metallurgy	3 898	903	31	2 964	**110,517**	35 270.3
2. Chemistry	2 156	355	230	1 571	**94,345**	22 852.2
3. Equipments	1 600	354	121	1 125	**62,125**	25 754.5
4. Nonmetallic mineral products	1 592	223	28	1 341	**117,045**	13 601.6
5. Food, tabacco...	881	146	97	638	**14,345**	61 413.4
6. Constructions	403	72	32	299	**15,34**	26260.2
7. Pulp, paper	373	66	22	285	**89,294**	4 177.2
8. Textiles	236	37	22	177	**26,840**	8 792.8
9. Furniture	233	42	28	163	**24,997**	9 320.9
10. Wood	231	23	16	192	**22,993**	10 046.5
11. Water	212	154	8	50	**45,085**	4 702.2
12. Rubber	182	32	16	134	**25,986**	7 003.6
13. Clothes …	142	16	17	109	**10,248**	13 855.5
14. Metalliferous	77	57	0	20	**69,620**	1 106.0
15. Leather goods	51	7	5	39	**9.70**	5256.8
16 Polygraphy	6	1	3	2	**0.98**	6067.4
17. Waste	3	1	0	2	**1.96**	1528.5
Services	2 288	nd	nd	nd	**12,81**	178592,81
Transport	4 489	184	56	4 249	**85,00**	52809,702
Agriculture	664	97	106	461	**9,21**	72096,0

Source : ENERO, ICEMENERG, INS ,2002

[11] Energy intensity is the energy consumption (1 tce) relative to the total output (10^9 lei GDP), expressed in national currency (lei): 10^9 lei means 54 552.39 EUR (30/12/1999, http://cursvalutar.kappa.ro).

Appendix5. CO2 emissions from the consumption of fossil energies, million tons, 1989-2001

Romania	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Total	**195,89**	**174,86**	**134,73**	**126,98**	**124,5**	**116,63**	**122,72**	**125,5**	**119,51**	**99,92**	**87,27**	**89,53**	**95,22**
Coal	68,69	46,52	37,83	39,18	38,11	38,79	39,52	40,67	35,57	28,74	24,78	27,83	28,32
Gas	78,2	71,23	55,4	49,85	47,95	44,91	47,54	47,19	43,81	34,3	32,81	31,63	36,58
Oil	49	57,11	41,5	37,95	38,44	32,93	35,66	37,64	40,13	36,88	29,68	30,07	30,32
EU	**222,43**	**221,94**	**221,4**	**214,82**	**213,05**	**212,09**	**216,51**	**220,48**	**220,58**	**220,23**	**219,81**	**223,22**	**224,45**

Source: AIE, 2002