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Long-term macroeconomic modelling of the Bulgarian economy to analyse the effects of anticipated changes in the energy sector

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**LONG-TERM MACRO ECONOMIC MODELLING
OF THE BULGARIAN ECONOMY
TO ANALYSE THE EFFECTS
OF ANTICIPATED CHANGES IN
THE ENERGY SECTOR**

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Abstract

The middle and long-term forecasts of the economy for transition countries is an important challenge in order to understand better the effects of anticipated changes.

During the accession negotiation between Bulgaria and the EU the continuation of the Kozloduy Nuclear Power Plant was a major stake both for Bulgaria and for the EU, such that various different options have been intensively discussed. In order to establish a transparent and factual basis different aspects have been analysed among which the consequences of the energy sector, in the local and over-regional economy, in social and environmental aspects. During the process of analysis it appeared appropriate and useful to analyse in-depth also the complex effects on the macro-economy of Bulgaria. In particular, negative and positive effects triggered in sectors others than the energy sector was to be evaluated. For this purpose a macro-econometric model INFORBG of the Bulgarian economy was developed. The model is disaggregated into 14 economic sectors. It represents the system of national accounts and describes the interdependent developments of some 250 macroeconomic variables. Thus it permits to set up consistent quantitative scenarios. In order to assess the macroeconomic consequences of an early closure two scenarios – one describing a deferred closure and the other one describing an early closure - were compared with each other.

The model and its calculation results demonstrated a good example for practical use of macro-economic models in analysing anticipated changes in the economy of transition countries.

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1 INTRODUCTION

The negotiations for the accession of Bulgaria to the European Union have been concluded in the year 2004. Within the framework of the agreements between Bulgaria and the European Union Bulgaria committed to the early closure of the VVER 440 units 1 to 4 of KNPP in 2006 and the community committed to provide assistance in support of the closure and decommissioning of the VVER 440 units of the KNPP.

To support the dialogue between the negotiating parties at the end of year 2003 a project *“Economic, Environmental and Social Consequences of the Closure of VVER 440 Units at Kozloduy Nuclear Power Plant”* was initiated by both sides: The European Commission, DG Enlargement and the Bulgarian Government. The result was a report, which provides an independent assessment of the social-economic and environmental impact of the closure of VVER 440 units 1-4 of Kozloduy Nuclear Power Plant (Arcadis, Plejades 2004). The analysis comprised the analysis of different scenarios including the scenario of agreed early closure of units 1-4 of KNPP with the scenario of continued operation of units 1-4 of KNPP. Different scenarios form the baseline for the comparisons performed:

EARLY CLOSURE SCENARIO: Shutdown of the units 1 to 4 of KNPP on committed dates (end 2002 for units 1 and 2 and end 2006 for units 3 and 4 respectively), upgrade of units 5 and 6 of KNPP, comprehensive electricity generation upgrade and replacement scenario for this case as developed by NEK. This scenario is referred to as “scenario 1”.

DEFERRED CLOSURE SCENARIOS: continued operation of the units 1 to 4 of KNPP, upgrade of units 5 and 6 of KNPP, comprehensive electricity generation upgrade and replacement scenario for this case as developed by NEK. This scenario is referred to as “scenario 0”.

Based on the scenarios an in depth analysis of the economical, social and environmental consequences was undertaken. The in depth analysis comprised not only the direct consequences but included also the evaluation complex interactions of different macro-economic parameters and a long term forecast of the Bulgarian macro-economy in order to compare the differences of the two scenarios. The tool for the comparison of this two scenarios is the macroeconomic model INFORBG (**IN**terindustry **FOR**ecast of **Bul**Garia).¹ It is a disaggregated, long term, interdependent model of the Bulgarian Economy. The parameters of this model are calculated with econometric methods.

This paper aims to give an overview of the macroeconomic analysis made within the framework of the above mentioned project. It comprises a short description of the macroeconomic situation of Bulgaria in the period from 1991 to 2002, an overview of the used data for the macro-economic modelling, a description of the macroeconomic model, some main results of the forecasts and the macro-economic analysis and some conclusions from the exercise made.

¹ The model INFORBG was built in cooperation with the GWS. GWS has expert knowledge in handling large macroeconomic models and has established a system of input-output models, which are linked via a bilateral trade model. This system is called GINFORS (**Global IN**terindustry **FOR**ecast **S**ystem) (Meyer/Lutz 2002, Meyer/Lutz/Wolter 2003, 2004). For the time being, GINFORS is used in the EU-Project MOSUS (www.mosus.net). The German model INFORGE (Distelkamp et al. 2003) and the environmentally extended version PANTA RHEI (Meyer et al. 1998, Bach et al. 2002, Lutz et al. 2005) are used since 1996 by German ministries and public research institutions.

2 MACROECONOMIC SITUATION OF BULGARIA IN THE PERIOD FROM 1991 TO 2002

During the period of economic transition the development of the *population* and the development of the *prices* or the inflation rate were exceptional in Bulgaria. The *population* decreased from almost 9 million people in 1990 to 7.9 million in 2001. That is an annual average shrinkage of –0.9 percent. (NSI 2002b, p49). The main reason for the decreasing population is the decreasing birth rate and the increasing death rate (NSI 2002b, p59). Another point is the migration of the fertile age groups to foreign countries.

Between 1992 and 1995 the *annual inflation* rate was around 50 percent. In 1996 it became more than 100 percent and in 1997 the *inflation rate* was almost 1000 percent per year. In 1997 the Bulgarian currency was connected directly to the German Mark. After this measure the *inflation rate* decreased in 1998 to 25 percent and after 1999 it was in a common range between 3.5 and 7.0 percent.

Against this background the development of the *GDP in prices of 2000* and its components is described. As it is shown in Table 1 the *real GDP* had almost the same value in 2002 (29.2 billion BGN) as it had eleven years before in 1991 with 29.1 billion BGN. Hence there was no growth during these eleven years. In the meantime between 1991 and 2002 it shrank to 27.1 billion BGN in 1993, increased to 27.9 billion BGN in 1995 and decreased again in 1997, which is sometimes described as the worst year in Bulgaria, to 23.8 billion BGN. Since 1998 the growth rates of the *real GDP* in Bulgaria are positive in a range of almost 2.3 percent in 1999 and 5.4 percent in 2000. Because of the decreasing population the *real GDP per capita* has an annual growth rate higher than 5 percent since 2000.

The biggest part of the GDP is the *private consumption (households consumption expenditures inclusive non-profit institutions serving households)*. It has an average share of 67.0 percent during that period with a minimum in 1997. Since 1998 *private consumption* grew a little bit faster than the GDP. For instance *private consumption* grew 10.9 percent in 1999 and 5.2 percent in 2001 but Bulgaria is in the extraordinary situation that parts of the consumption is financed by dissavings and private credits.¹

Table 1: Gross domestic product and its components in prices of 2000

	1991 (million BGN)	2002 (million BGN)	Average share in %	Average annual growth rate in %
Private consumption	16709.8	20322.3	67.0	1.8
Government consumption	7620.4	5056.0	19.2	-3.7
Investments	3532.1	5682.6	13.4	4.4
Changes in inventories	1146.6	333.7	1.0	-10.6
Exports of goods and services	5292.7	17437.6	43.1	11.4
Imports of goods and services	5161.2	19666.1	43.7	12.9
GDP	29140.5	29166.1	100.0	0.0

Source: NSI (2003): Main Macroeconomic Indicators 2002, Sofia, p58 and own calculations.

The *government consumption (final consumption of the government and collective consumption) in prices of 2000* decreased from 7.6 billion in 1991 to 5.1 billion in 2002. The *share of government consumption at*

¹ In the sector accounts of 2001 the *private consumption in current prices* is 20.6 billion BGN, and the *disposable income of households in current prices* is only 16.6 billion BGN (NSI 2002a p189). Hence the savings were minus 3.9 billion BGN. Most of these *dissavings* were financed by credits. The rising of credits happened in the last years because of changes in the Bulgarian credit system. The classification of the sector accounts may be another reason for this phenomenon, because small enterprises with less than 10 employees belong to the households sector and not to the sector corporations. In these small enterprises the credits could be used for investments.

the GDP shrank from 26.2 percent in 1991 to 14.9 percent in 1996 and arose again to 17.9 percent in 2000. Since 2000 this share is almost stable.

The *investments* (gross fixed capital formation) in prices of 2000 is a component with an average annual growth rate of 4.4 percent since 1991 and about 17.5 percent since 1998. The share at the real GDP grew from 12.1 percent in 1991 to 19.5 percent in 2002.

The development of the *foreign trade* shows the opening of the Bulgarian frontiers to Western Europe. Since 1991 the *exports of goods and services* (5.3 billion BGN) and the *imports of goods and services* (5.2 billion BGN) were more than tripled in the background of a constant GDP. It is a negative impact for the GDP that the *imports* (20.0 billion BGN in 2002) arose faster than the *exports* (17.4 billion BGN in 2002). Hence the *net exports* in became negative. The absolute advantage of Bulgaria in international trade is the low level of wages compared to other European countries and it should contribute to future economic development.

In the Bulgarian statistics the *gross output by economic activity groups* is divided into 14 activity groups, which are given in Table 2. The data are available from 1996 to 2002. The *total gross output* grew by 1.4 percent in the average. The biggest *shares at the total gross output in prices of 2002* has the sector *manufacturing* with 29.8 percent in the average from 1996 to 2002 followed by the *agricultural sector* with 14.8 percent, the *transport and communications sector* with 11.2 percent and the *real estate, renting and business activities sector* with 9.2 percent.

Table 2: Gross output by economic activity groups in prices of 2000 in million BGN

Economic activity group	1996 (million BGN)	2002 (million BGN)	Average share in %	Average annual growth rate in %
1 Agriculture, forestry, hunting and fishing	7610.1	7887.2	14.8	0.6
2 Mining and quarrying	1118.1	969.5	2.0	-2.3
3 Manufacturing	17991.3	16779.9	29.8	-1.2
4 Electricity, gas and water supply	2434.9	3698.5	5.6	7.2
5 Construction	2602.6	3208.0	5.1	3.5
6 Trade, repair of motor vehicles, ect.	4350.9	4551.7	7.5	0.8
7 Hotels and restaurants	910.1	1001.8	1.7	1.6
8 Transport and communications	4722.2	7770.4	11.2	8.7
9 Financial intermediation	2709.6	1298.1	2.4	-11.5
10 Real estate, renting and business activities	4896.4	5198.3	9.2	1.0
11 Public administration, social security, etc.	2053.8	3001.3	4.8	6.5
12 Education	1086.8	1305.0	2.2	3.1
13 Health, social work and veterinary activity	1078.7	1337.3	2.1	3.6
14 Other community, social and personal services	709.6	1110.4	1.5	7.7
Total	54275.2	59117.3	100.0	1.4

Source: NSI (2003): Main Macroeconomic Indicators 2002, Sofia, p64 and own calculations.

The sector *electricity, gas and water supply* has an average share of 5.6 percent at the total output. This is also the sector with the third highest annual growth rate of 7.2 percent in this period. The highest growth rate has the *transport and communications sector* with 8.7 percent. One reason for the increasing *transport sector* is the increase of foreign trade. The growth in *communication* is reasoned in the enormous backlog demand and the growth which follows a worldwide trend in this sector. *Other community, social and personnel services* grew by 7.7 percent. The relative share of these sectors grew too. The output of the *agricultural sector* is almost stable with a growth of 0.6 percent. Shrinkages are in the *mining sector* (-2.3 percent) and the *manufacturing sector* (-1.2 percent). The strong decrease in the *financial intermediation sector* happened from 1996 to 1997. After 1997 this sector grew again.

Table 3: Cost shares of electricity, gas and water supply at the sectoral production in 1997

Activity Group	Electricity, gas, water cost share in percent	Activity Group	Electricity, gas, water cost share in percent
Agriculture and related service activities	0.6	Manufacture of office machinery and computers	4.2
Hunting, forestry, logging, fishing; related service activities	2.2	Manufacture of electrical machinery, radio, tv and communication equipment	3.5
Mining of coal and lignite	14.3	Manufacture of medical, precision and optical instruments watches, clocks	7.0
Extraction of crude petroleum and natural gas	2.4	Manufacture of motor vehicles, trailers and semi-trailers	9.1
Mining of uranium, thorium and metal ores	5.3	Manufacture of transport equipment	5.0
Other mining and quarrying	7.1	Manufacture of furniture	12.2
Production, processing and preserving of meat and meat products	8.0	Manufacture of other industrial products; recycling	7.3
Manufacture of dairy products	6.4	Electricity, gas and water supply	7.9
Manufacture of other food productions	1.6	Construction	1.5
Manufacture of beverages	2.7	Trade	1.9
Manufacture of tobacco products	1.8	Maintenance and repair	3.2
Manufacture of textiles	3.1	Hotels and restaurants	2.5
Manufacture of wearing apparel	2.6	Land transport; transport via pipelines	7.0
Dressing and dyeing of fur; leather products manufacture of footwear	3.6	Water and air transport	1.2
Manufacture of wood and products of wood	5.1	Supporting and auxiliary transport activities; activities of travel agencies	5.1
Manufacture of pulp, paper and paper products	5.7	Maintenance of road network	3.3
Publishing	6.1	Post and communications	1.3
Printing and reproduction of recorded media	2.7	Financial intermediation	1.5
Manufacture of coke, refined products and nuclear fuel	3.4	Other business activities	2.7
Manufacture of other chemical products	7.0	Real estate activities; renting of machinery and equipment	0.5
Manufacture of rubber and plastic products	6.1	Research and development	4.6
Manufacture of other non-metallic mineral products	8.7	Education	4.7
Ferrous metallurgy	6.3	Health and social work	4.5
Non-ferrous metallurgy	8.1	Public administration and defence; compulsory social security	3.2
Casting of metals	8.2	Activities of membership organizations	12.3
Manufacture of fabricated metal products	4.0	Other service activities	6.2
Manufacture of machinery and equipment	2.0	Total uses - domestic output	3.3

Information about the cost structure of different sectors are available in the *input-output table*. The *input coefficients* of an input-output table are equivalent to the cost shares of each input. Table 3 shows the cost shares of *electricity, gas and water supply* in 53 sectors. Here it can be seen that the *costs share of electricity* is between 0.5 percent in the *real estate activities* and 14.3 percent in the *mining sector*. The sectors *manufacture of furniture* and *activities of membership organisations* have also cost shares of *electricity, gas and water costs*, which are higher than 10 percent. In the average this cost share is 3.3 percent. That means, even with strong price increases in the electricity sector the cost shares will not raise to extraordinary high levels.

Looking to the *employment*, which is shown in Table 4 it can be seen that the *labour force (employment plus unemployment)* (NSI 2002b, p89ff) decreases from 3.85 million people in 1993 to 3.63 million people in 2002. Hence the *labour force* has similar growth rates as the *population*. The *employment* decreased faster than the *labour force*. Therefore the *unemployment* increased from 0.63 million people in 1993 to 0.66 million people in 2001. The *unemployment rate* increased from 16.3 percent in 1993 to 18.2 percent in 2001 and is considerably high.

Table 4: Population and labour data

	1993	2001	Average	Average annual growth rate in %
Average annunal population (million)	8.47	7.91		-0.8
Labour Force (million)	3.85	3.63		-0.7
Employed (million)	3.22	2.97		-1.0
Unemployed (million)	0.63	0.66		0.7
Unemployment rate (percent)	16.27	18.24	14.9	

Source: NSI (2003) Statistical Yearbook 2002, Sofia, p 53, p89, p96.

3 DATA

The data which are used in the model are data of the National Statistical Institute of Bulgaria (NSI), data of the National Electricity Company (NEK), data of the International Monetary Fund (IMF), data of the Organisation for Economic Co-operation and Development (OECD) and data from the world economic model GINFORS (Meyer/Lutz/Wolter 2003, 2004) of the Gesellschaft fuer Wirtschaftliche Strukturforschung (GWS). The main part of the data is provided by the NSI.

The *GDP by final expenditure approach* like it is shown in Table 1 is used in *current prices* and in *prices of 2000* from 1991 to 2002 (NSI, 2003, p58ff). The *prices* itself with 2000 as the base year are used too.¹

Some data of the national accounts are published in the disaggregation of 14 activity groups which are shown in Table 2. These disaggregated data are:

- The *gross output at basic prices*, the *intermediate consumption* and the *gross value added* (in *current prices*, in *prices of 2000* and the *prices (2000=100)*) (NSI, 2003, p101ff).
- The *wages and salaries by economic activity groups at current prices* (NSI, 2003, p142ff).
- The *employed by economic activity groups in persons* (NSI, 2002b, p89ff).
- The *employees under labour contract by economic activity groups in persons* (NSI, 2002b, p91ff).

Table 5: Aggregated sector accounts of 2001 in million BGN in current prices

no	Code	Account / Name	Non-financial and financial corporations (S.11+S.12)	General government (S.13)	Households and NPISHs (S.14+S.15)	Nominal sector	Total economy (S.1)	Rest of the world (S.2)
I. Production account / External account of goods and services								
Resources								
1	P.1	Output at basic prices					60650	
2	D.21-D.31	Taxes less subsidies on products					3893	
Uses								
3	P.2	Intermediate consumption					34834	
4	B.1*g	GDP at market prices,					29709	
5	B.11	External balance of goods and services						2250
6	K.1	Consumption of fixed capital					3365	
7	B.1*n	NDP at market prices					26344	
II. 1.1. Generation of income account								
Resources								
7	B.1*n	NDP at market prices					26344	
Uses								
8	D.1	Compensation of employees					10381	154
9	D.2	Taxes on production and imports, paid					4228	
10	D.3	Subsidies, received (-)					-700	
11	B.2n	Operating surplus, net	6807	0	2808	-539	9076	
12	B.3n	Mixed income, net			3359		3359	
II. 1.2. Allocation of primary income account								
Resources								
11	B.2n	Operating surplus, net	6807	0	2808	-539	9076	
12	B.3n	Mixed income, net			3359		3359	
13	D.1	Compensation of employees			10470		10470	65
14	D.2	Taxes on production and imports, received		4228			4228	
15	D.21	Taxes on products		4090			4090	
16	D.211	Value added tax		2641			2641	
17	D.212	Taxes and duties on imports, excl. VAT		195			195	
18	D.214	Taxes on products, excl. VAT and import taxes		1254			1254	
19	D.29	Other taxes on production		138			138	
20	D.3	Subsidies, paid (-)		-700			-700	
21	D.4	Property income	1422	536	145		2103	1368
	P.119	Adjustment for FISIM				539		
Uses								
22	D.4	Property income, payable	1632	1106	118		2856	615
23	B.5*n	National income, net	6058	2958	16664		25680	

Source: NSI (2003): Main Macroeconomic Indicators 2002, p181ff.

¹ NSI publishes the data in current prices and in previous year prices. To get a time series of a price index with only one base year the prices are chained with common methods. Furthermore an adjustment to the equations and definitions has to be made. Critics and problems to chain prices are given by Brümmerhoff (2000, p. 219) and von der Lippe (2000, 2001).

The *sector accounts* are published by the NSI (2003, p181ff). The published data were aggregated for the model INFORBG as it is shown in Table 5, which shows the data of 2001 as an example. In the model a time series of this data is used with the columns *corporations*, *households and NPISHs*, the *nominal sector*,¹ the *total economy*, and the *rest of the world*.

INFORBG uses 42 rows of the sector accounts. Compared to the NSI publication some aggregated positions are used and in a few accounts the disaggregated positions are used. The sector accounts result in the *Net-lending/Net-borrowing* of the four mentioned institutional sectors mentioned above.

A main part of the model is the Bulgarian *input-output table in current prices*. This table has 53 sectors, the common primary inputs and the common types of final demand. In this table the inputs are classified by purchasers.

In the *balance of payments* statistics the *exports and imports of goods and services* are given again. There are also the *income account*, the *capital account* and the *financial account* included in the model.

The OECD provides deep disaggregated data of the international trade. These data were forecasted by the GWS in the model GINFORS until 2020. This long term forecast of international trade is taken in the Bulgarian model as exogenous.

¹ The *nominal sector* consists only of the value of *FISIM* (*financial intermediation services indirectly measured*).

Table 5 (continued): Aggregated sector accounts of 2001 in million BGN in current prices

2001	Code	Account / Name	Non-financial and financial corporations (S.11+S.12)	General government (S.13)	Households and NPISHs (S.14+S.15)	Nominal sector	Total economy (S.1)	Rest of the world (S.2)
II. 1.2. Secondary distribution of income account								
	Resources							
23	B.5'n	National income, net	6058	2958	16664		25680	
24	D.5	Current taxes on income, wealth, etc.		2396			2396	
25	D.61	Social contributions	141	3325			3466	
26	D.62	Social benefits other than social transfers in kind			3898		3898	
27	D.7	Other current transfers	386	2915	943		4244	49
	Uses							
28	D.5	Current taxes on income, wealth, etc.	1289	13	1094		2396	
29	D.61	Social contributions			3466		3466	
30	D.62	Social benefits other than social transfers in kind		3943			3943	4
31	D.7	Other current transfers	943	1787	371		3101	1314
32	B.6n	Disposable income, net	4353	5851	16574		26778	
II. 3. Redistribution of income in kind account								
	Resources							
32	B.6n	Disposable income, net	4353	5851	16574		26778	
	Uses							
35	P.3	Final consumption expenditure		5175	20643		25818	
II. 4.1. Use of disposable income account								
	Resources							
33	D.8	Adjustment for the change in net equity of households in pension funds reserves			158		158	
	Uses							
34	D.8	Adjustment for the change in net equity of households in pension funds reserves	158				158	
36	B.8n	Saving, net	4195	676	-3911		960	
III. 1.1. Change in net worth due to saving and capital transfers account								
	Changes in liabilities and net worth							
36	B.8n	Saving, net	4195	676	-3911		960	
37	D.9	Capital transfers, receivable	250	43	89		382	0
	Changes in assets							
38	D.9	Capital transfers, payable (-)	-3	-339	-40		-382	0
III. 1.2. Acquisition of non-financial assets account								
	Changes in liabilities and net worth							
39	K.1	Consumption of fixed capital	2547	437	381		3365	
	Changes in assets							
40	P.5	Gross capital formation	4698	1035	408		6141	
41	K.2	Acquisitions less disposals of non-financial non-produced assets	277	-277				
42	B.9	Net-lending (+) / net borrowing (-)	2014	59	-3889		-1816	1816

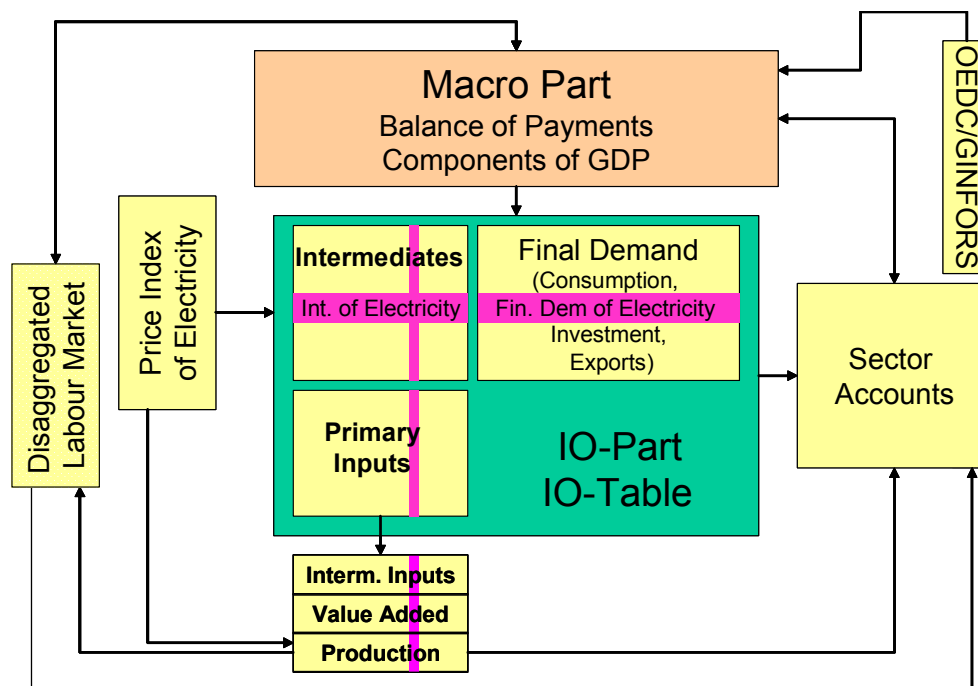
Source: NSI (2003): Main Macroeconomic Indicators 2002, p181ff.

4 THE MODEL INFORBG

A rough overview of the macroeconomic model INFORBG is given in Figure 1. Forecasts with this model are calculated until 2020. The parameters of this model are calculated with econometric methods. In the model the exports and imports of Bulgaria were calculated. These data are influenced by the Bulgarian demand for *imports* and demand of the *rest of the world* to Bulgarian goods and services and the belonging prices. With these trade data and other data the *balance of payments* is forecasted. The *components of the GDP* are forecasted. These components are influenced by the *sector accounts* and *foreign trade* data. Then these macroeconomic data like the *consumption*, the *investments* and *exports* are disaggregated into the 53 activity groups of the *input-output table* and added up to the *disaggregated final demand*. With the help of the *final demand* and the *input-output table* the *disaggregated output*, the *disaggregated intermediate consumption* and the *disaggregated value added* are calculated. These results influence the components of the sector accounts, which influence again the GDP components. The disaggregated *labour market* is connected with the model via the disaggregated output. In connection with the wages the employment has again an influence to the GDP components and to the *sector accounts*. Several position in the electricity sector are exogenous.

In the model the *exports of goods* and the *exports of services* are determined by the *world market demand* for Bulgarian goods, which are given by variables of the model GINFORS (Meyer/Lutz/Wolter 2003, 2004). In the simulations the *exports of goods* are given exogenously with a strong growth. Here it is assumed that the low production costs in Bulgaria and the possibility to produce good quality will have an additional effect on the demand of Bulgarian goods.

Figure 1: The structure of the macro economic model INFORBG



The *imports of goods and services* depend on the *total domestic demand of goods*, which is the sum of private and government consumption, investment and exports: That means the Bulgarian demand needs a specific share of imports. In the simulations it is assumed that this share decreases in the long run, because it is possible for the Bulgarians to substitute imports by domestic products.

Figure 2: Modelling the GDP and its components in INFORBG

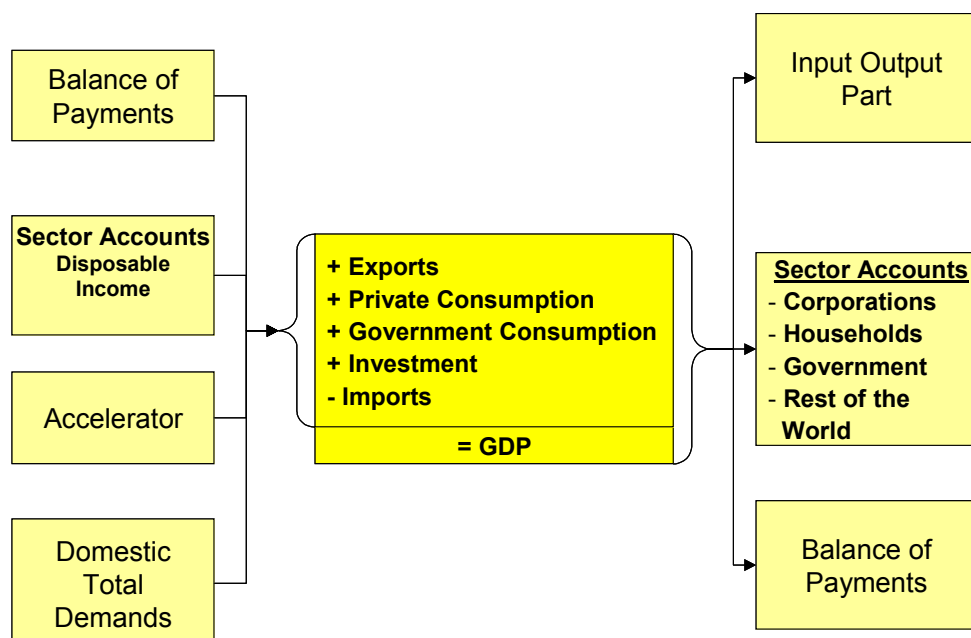
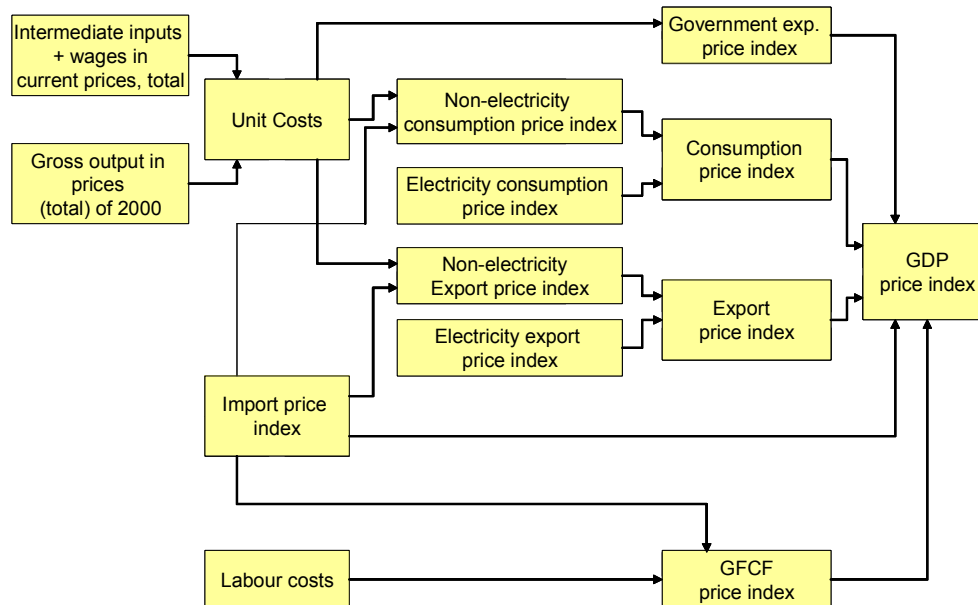


Figure 2 shows the calculation and the role of the GDP in the model. As described above the *exports of goods and services* are calculated by the *balance of payments*. The *imports of goods and services* are

determined by the *total domestic demand of goods* and influences the *balance of payments* from the other direction.

The *private consumption* and the *government consumption* depend on the *disposable income* of the households and the government respectively, which are calculated both in the *sector accounts*. The *gross fixed capital formation* depends with an accelerator function on the GDP. All elements of the GDP influence the *input-output part*, the *sector accounts* with all its institutional sectors and the *balance of payments*.

Figure 3: Modelling the prices in INFORBG



As seen in Figure 3 the *price indices* of the *GDP components* are influenced by the *macro unit costs* and the *import price index*. The *import price index* is determined by the trade data of the world trade model GINFORS. They are growing in the average by around 2 percent. The *macro unit costs* are defined as the *intermediate inputs in current prices* plus the *wages and salaries in current prices* divided by the *total gross output in prices of 2000*. These components influence the *government expenditure price index*, the *non-electricity consumption price index* and the *non-electricity export price index*. Together with the exogenous *electricity consumption price index* and the exogenous *electricity export price index* the last two price indices influence the *private consumption price index* and the *export price index*, respectively. The *price index of gross fixed capital formation* depends on the *import price index* and the *labour costs* which have an impact on the investments in construction. These price indices influence the *sectoral output price indices*.

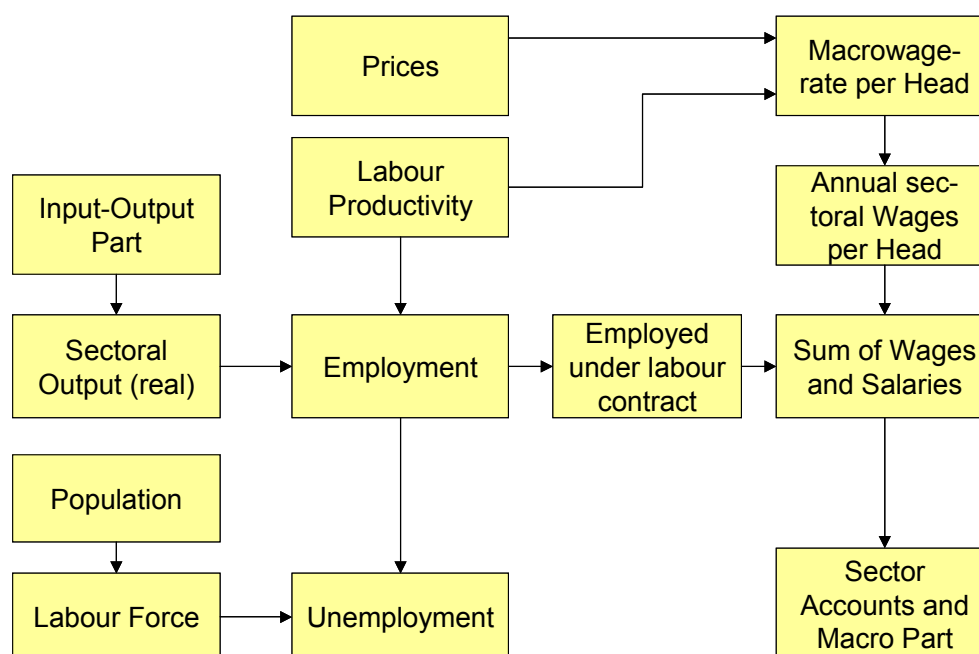
In the *input-output part* of the model the above calculated components of the GDP were disaggregated. The exogenous electricity consumption and the exogenous electricity export are directly related to their input-output element. These columns are added to the disaggregated final demand.

The input coefficients of the *electricity, gas, water supply sector* depend on *electricity prices*. All other coefficients of this matrix are constant. With the Leontief inverse and the final demand the disaggregated output of 53 activity groups is calculated and aggregated to 14 activity groups. The division of the *gross output in current prices* with the *output price indices* delivers the *gross output in prices of 2000*. Here the disaggregated *value added* and the *intermediate consumption* are calculated too. The *total output at basic prices* and the *intermediate consumption* effect the *sector accounts*.

A short overview is given for the *sector accounts*. The *resources* and parts of the *uses* of the *production account* depend on the results of the input-output table. In the *generation of the income account* the *consumption of employees* depend on the *wages and salaries*. In the *secondary distribution of income account* the final consumption *expenditure* of *general government* and of *households* is equivalent to the corresponding macro variables. The *gross fixed capital formation* can be found in the *acquisition of non-financial asset account*.

All other variables are explained by definitions or by adequate estimations. For the model building it was important that the *net-lending or net-borrowing* of all institutional sectors as a result of the sector accounts were in an appropriate range during the forecast period.

Figure 4: Modelling the labour market in INFORBG



The *labour market* of INFORBG is described in Figure 4. Here the *employment of the 14 activity groups* is determined by the *sectoral gross output in prices of 2000* - which is a result of the input-output part - and the *sectoral labour productivity*. The *sectoral labour productivity* is explained by trends. Here the forecasted growth rates are compared with historical (1991-2002) productivity growth rates, which are reached in other transition countries.¹ The total labour productivity grows similar as the GDP.

The *labour force* - which is regressed on the population, minus the *employment* - delivers the *unemployment*. The difference between the *employed* and the *employed under labour contract* are the *self-employed*. With the assumption, that the *share of the self-employed at the total employment* is constant in the different sectors, the *employed under labour contract* can be calculated easily.

The *annual wage per head* on the macro level is influenced by a the *GDP price index* and the *labour productivity on the macro level*. This *annual wage per head* on the macro level determines the *annual sectoral wages*. The multiplication with the *employed under labour contract* delivers the *wages and salaries* on the macro level. This variable determines the *compensation of employees* in the sector accounts.

¹ Disaggregated sectoral growth rates of Poland and Hungary were taken from OECD statistics (OECD 2002, p556 and p562)

5 SCENARIOS AND SIMULATIONS

In the main study several scenarios and simulations are considered. In this paper only two scenarios are described. This is a *Deferred Closure Scenario* and an *Early Closure Scenarios*. In the *Deferred Closure Scenario* the planned life-time of KNPP ends in the year 2004 / 2005 for unit 1 and 2 and in 2013 / 2014 for unit 3 and 4. In the *Early Closure Scenario* it is assumed that the units 1 and 2 were closed in 2002 and units 3 and 4 will be closed in 2006.

Hence the following two scenarios are simulated and considered:

Scenario 0, deferred closure of KNPP:

- Closure of units 1 and 2 in 2007 / 2008
- Closure of units 3 and 4 in 2013 / 2014

Scenario 1 early closure of KNPP:

- Closure of units 1 and 2 in 2002
- Closure of units 3 and 4 in 2006

The inputs for the different scenarios and simulations are results of the calculations of engineers and social economists. These inputs are different *prices*, which influence the prices of the macroeconomic model. The *exports of electricity* which are exogenous variables for the model. Different calculations for *replacement investments* in the electricity sector which influence the *gross fixed capital formation*. The different *dividends* and the *transfers* between KNPP and the government, which were booked in the *sector accounts*. The transfers to *laid-off employees* of KNPP which influence the *sector accounts*. The *laid-off employees* of the electricity sector which have a direct impact to the *labour market*.

In the next subsection the assumptions and conditions for both scenarios are described. Then the differences between the scenarios are shown.

5.1 COMMON ASSUMPTIONS FOR ALL SCENARIOS

For all scenarios it is assumed that Bulgaria becomes an "extended workbench" of its neighbour countries. That means that other EU-countries and some non-EU-countries will invest in Bulgaria and produce different goods in Bulgaria. Hence it is assumed that foreign companies will invest in Bulgaria and that these investment will lead to a high growth of exports, which is the pillar of the GDP growth. This growth is of about 4.6 percent in the average for each year.

On the other side the imports will arise not so fast as the exports. It is assumed that Bulgaria is capable of substituting imported goods. Therefore Bulgaria's net export will become positive in 2010 or 2011 depending on the scenario.

The above mentioned assumptions will be realistic, if Bulgaria establishes different conditions of growth including:

- Perfect competition
- Building up its infrastructure
- Stability of the law and legal certainty
- Well educated people

Further assumptions in these simulations are:

- The *population* decreases like the forecast of the United Nations to 6.8 million people in 2020.

- The Bulgarian Leva has a fixed exchange rate to the Euro until 2020.
- The EURO and the US\$ converge to an exchange rate of 1:1 in 2020.
- The actual situation of dissavings reverses to a positive *savings quota* of 6 percent in 2020.
- The *savings quota of the government* is 5 percent of the *disposable income* and 95 percent the *disposable income* is spend in *government consumption expenditures*.¹
- An import substitution is modelled in the long run. That means Bulgaria's economy will substitute products, which are actually imported by domestic products.

5.2 DIFFERENT ASSUMPTIONS AND PRIMARY EFFECTS

Electricity prices for each scenario were evaluated separately based on the available production facilities, expected loss reduction in transmission and distribution and the price regulation under SERC auspices. These prices are taken as

1. the *output price index of the electricity, gas and water supply*,
2. the *intermediate consumption price index of electricity, gas and water supply*,
3. the *household consumption price index of electricity, gas and water supply*,
4. the *export price index of electricity gas and water supply*,

Gas and water is included because of the disaggregation level of the macroeconomic data. In all cases these price indices increase earlier in Early Closure Scenario and later in the Deferred Closure Scenario. The values of the pairs of prices are the almost the same in 2020 in both scenarios. The time series of the Early Closure Scenario is concave and the time series for the Deferred Closure Scenario is convex.

The effect of a higher **output price index of electricity** reduces the *output of electricity in prices of 2000*, and therefore the total *output in prices of 2000*. This has effects to the *macro unit costs*, which increase in this situation. The *output in current prices* is not influenced directly by this measure.

The **intermediate consumption price index of electricity** has an influence to the costs structure of all other sectors. It is assumed that a price increase in the electricity sector leads to a reduction of electricity inputs in all other sectors, because of the modelled price elasticity. Further it is assumed that this reduction of electricity input can be reached without additional investment.

With an increase of the **household consumption price index of electricity** the *nominal consumption of electricity* increases, and the *nominal non-electricity consumption* decreases. The whole *households consumption expenditure in current prices* decreases. With the increase of the *household consumption price index of electricity* it comes also to a small increase of the *price index of the households consumption expenditure* – that means the price index of the whole consumption. This price increase of the whole consumption reduces the *non-electricity household consumption* and the whole *household consumption in prices of 2000*. One reason for this behaviour is the assumed price elasticity of 0.5. Hence the *real electricity consumption* decreases after a price increase.

The **export price index of electricity** is similar in both scenarios until 2011 because Bulgaria has a long-term contract about electricity exports with its neighbour Turkey. After 2012 the price index in the Early Closure Scenario increases faster than in the Deferred Closure Scenario. In 2020 both prices are again on the same level. This price index affects the nominal electricity exports.

¹ In the *sector accounts* the savings are calculated before *capital transfers*, *consumption of fixed capital* and *gross fixed capital formation* of the government. Hence it is possible to get a negative *finance account balance (net lending / net borrowing)* with positive savings.

The **electricity exports in prices of 2000** are given exogenously. Like the price index these exports are similar until 2011. After 2012 the electricity exports in prices of 2000 increase faster in the Early Closure Scenario than in the Deferred Closure Scenario. In 2020 the electricity exports are on the same level in both scenarios. An increase in this sector increases the total exports and therefore the GDP.

Multiplication of this price index with the *electricity export in prices of 2000* leads to the *exports of electricity in current prices*. That means an increase of this price index has only an influence on the *nominal export* and not on the *real exports*. The influences to the GDP in current prices are positive and the effect to the *real GDP* is positive, too. If Bulgaria gets higher prices of electricity exports, this higher income in Bulgaria can be spend to different goods, and that has a positive effect in the real GDP.

In all simulations it is assumed that the electricity market will be liberalized and that new power plants will be build by foreign electricity companies. The annual allocation of this **additional investment in the electricity sector** is given as follows: In the Early Closure Scenario the major amount of replacement investments is needed in the years from 2004 to 2010. In this period these investments are 889 million BGN in the average, which is 52 percent more as in the Deferred Closure Scenario. The replacement investment of the Deferred Closure Scenario are enormously higher between 2011 and 2015 with an average of 1000 million BGN compared to 568 million BGN in the Early Closure Scenario. After 2016 the replacement investments are quite similar in both scenarios. What are the implementations for the model?

- a) The real macro investment – *gross fixed capital formation* – increases on different paths. The calculation into nominal terms is made automatically.
- b) Investment increases in the position *gross capital formation* of the *non-financial and financial corporations* in the *changes in assets accounts* of the sector accounts.

The primary effect of different paths of *investment increase* are different paths of GDP in real and nominal terms. The impacts to the *financial account balance* of corporations in the *sector accounts* are negative. The corporations are investing more than the pure additional investment before because of the accelerator/multiplier effect.

The **reduction of dividend payments of KNPP to the government** influences the sector accounts. Here the government loses dividends in the Early Closure Scenario. In the sector accounts the *property income, payable* of the *corporations* in the *uses side* of the *allocation of primary income account* is reduced. On the other side the corresponding variable *property income* of the *government* sector is negatively influenced. The reduction of paid *dividends* have positive effects to the income of the *corporations*, to their *disposable income* and to their *financial account balance*. A reduction of received dividends decreases the *disposable income of the government*. Therefore it decreases the *government consumption expenditure* and the *GDP*.

The **transfers between KNPP and public funds for decommissioning and waste** are paid during the life time of KNPP. Hence they are higher in the Deferred Closure Scenario than in the Early Closure Scenario. In the model these transfers influences the sector accounts. The transfers for decommissioning have to be paid by the KNPP, that means by the *corporations* to the public funds, which means the government in the model. In the *secondary distribution of income account* of the *sector accounts* the *other current transfers* of the *uses side* are increased. On the other side the *other current transfers* of the *resources side* of the government are increased. An effect in the sector accounts is, that the *financial account balance* of the corporations decreases. In the *general government* the *disposable income* increases. Therefore the *government expenditure* increases, which has a positive impact to the GDP. The *financial account balance* of the general government is stable.

The **layoffs at KNPP** are calculated by the socio-economist of the main project. In the macroeconomic simulation it is assumed that 50 percent of the ex-employees of KNPP will find a new job in the first year after they are laid off. 25 percent will find a job in the second year and the last 25 percent will find a job in the third year after the layoff. Hence pure additional unemployment from KNPP will increase earlier in the ECS than in the DCS. In the model the variable *employees under labour contract* of the sector *electricity, gas and water supply* is reduced by these data.

As a secondary effect the total *sum of wages and salaries* decreases in this simulation. This has an effect to the *compensation of employees* of the *uses* side of the *generation of income account* in the *sector accounts*. Another effect in the *sector accounts* is at the *resources* side of the *allocation of primary income account* of the *households*. This effect leads to a decreasing *disposable income* and therefore to a decreasing *GDP*. On the labour market the layoffs decrease *employment*, which leads to higher *unemployment*.

The **redundancy payments** are paid immediately after the layoffs. In the *sector accounts* the *social benefits others than social transfers in kind* are affected as follows: In the *secondary distribution of income account* the *social benefits others than social transfers in kind* of the *general government* at the *uses side* are increased. On the *resources side* of the same account the *social benefits others than social transfers in kind of the households* are increased. One effect is that the disposable income is reduced on the government side, which has negative impacts to the government consumption expenditure and therefore to the *GDP*. The opposite effect is on the *households side* of the *disposable income*, which has positive effects to the *households consumption expenditure* and therefore to the *GDP*.

Additional transfers from the European Union were assumed by the experts in the main study. In the two simulations of this paper the additional transfers are not considered.

6 RESULTS

Looking to Table 6 it can be seen that the average annual growth rate of the *GDP* in prices of 2000 is 4.6 percent in both scenarios. The major part of this growth comes from the *exports of goods and services*, which grows by 5.4 percent. Another part of the growth comes from the relatively reduction of *imports of goods and services*, which increase only by 3.2 percent. The *government consumption expenditures* increase by 4.2 percent. *Households consumption expenditures* increase by 2.6 percent in the average. That means the growth is almost the same in both scenarios, but the paths are different.

The *GDP per capita* will grow by 5.4 percent per year. This is more than the *GDP* itself because of the shrinking population. With the amount of 9585 BGN or 4901 Euro in 2020 the *GDP per capita* of Bulgaria will be still far away from the average of the EU15, which was 20936 US\$ or about 19287 Euro in 2000 (NSI 2002b, p611).

Table 6: GDP and its components in prices of 2000 in million BGN and GDP per capita in prices of 2000 in thousand BGN

GDP and its components in prices of 2000 (BGN) and GDP per capita	Sce. 1 and Sce. 0			Sce. 1 minus Sce. 0		Diff. in %		Av. Annual Growth in %	
	2001	2010	2020	2010	2020	2010	2020	2001-2020	2001-2020
Gross domestic product	27841	43784	64979	724.6	3.5	1.7	0.0	4.6	4.6
Households consumption expenditures	19479	24598	31479	448.4	0.7	1.8	0.0	2.6	2.6
Government consumption expenditures	4852	7886	10588	52.6	2.0	0.7	0.0	4.2	4.2
Gross fixed capital formation	5188	11346	11674	682.3	-5.4	6.0	0.0	4.4	4.4
Changes in inventories	681	889	921	142.2	2.5				
Exports of goods and services	16398	27738	44230	-93.6	4.5	-0.3	0.0	5.4	5.4
Imports of goods and services	18756	28673	33913	507.3	0.9	1.8	0.0	3.2	3.2
GDP per capita in thousand BGN	3.5	6.0	9.6	0.1	0.0	1.7	0.0	5.4	5.4

In Table 7 the shares of the components of the *GDP* of Scenario 1 and Scenario 0 are shown. Here it can be seen that the *gross fixed capital formation* in 2010 is higher in the Early Closure Scenario 1 than in Scenario 0. The behaviour of *export of goods and services* is opposite. The shares of the *households consumption expenditures*, the *government consumption expenditures* and of the *imports of goods and services* are almost stable in both scenarios.

Table 7: Shares of GDP components in prices of 2000 in percent

Shares of GDP components in prices of 2000 in percent	Sce. 1					Sce. 0				
	2001	2005	2010	2015	2020	2001	2005	2010	2015	2020
Year	2001	2005	2010	2015	2020	2001	2005	2010	2015	2020
Households consumption expenditures	70.0	62.5	56.2	51.7	48.4	70.0	62.4	56.1	51.9	48.4
Government consumption expenditures	17.4	18.9	18.0	17.2	16.3	17.4	19.1	18.2	17.1	16.3
Gross fixed capital formation	18.6	24.2	25.9	23.2	18.0	18.6	23.8	24.8	23.5	18.0
Changes in inventories	2.4	2.0	2.0	1.1	1.4	2.4	1.4	1.7	2.0	1.4
Exports of goods and services	58.9	60.3	63.4	66.5	68.1	58.9	61.2	64.6	65.1	68.1
Imports of goods and services	-67.4	-67.8	-65.5	-59.6	-52.2	-67.4	-67.8	-65.4	-59.5	-52.2
Gross domestic product	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

In Figure 5 it is shown that the path of the growth between both scenarios is different. In the Early Closure Scenario the *GDP in prices of 2000* is higher between 2004 and 2010 and lower between 2011 and 2015 compared to Scenario 0. The differences are shown in Figure 6. Here it can be seen that the positive differences between 2004 and 2010 are more than 800 million BGN in 2009. The negative impact after 2011 reaches almost 1600 million BGN.

Figure 5: GDP in prices of 2000 in million BGN in scenario 1 and scenario 0

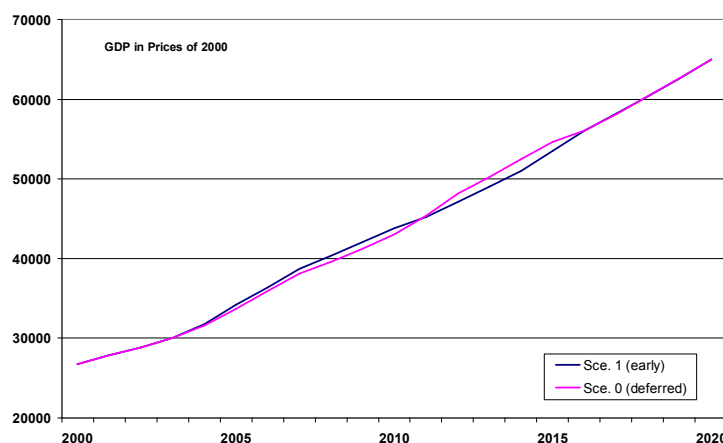


Figure 6: GDP in prices of 2000 in million BGN, difference between scenario 1 and scenario 0

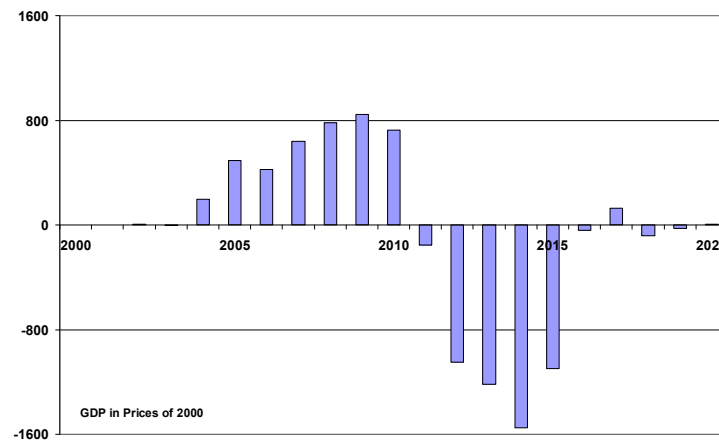
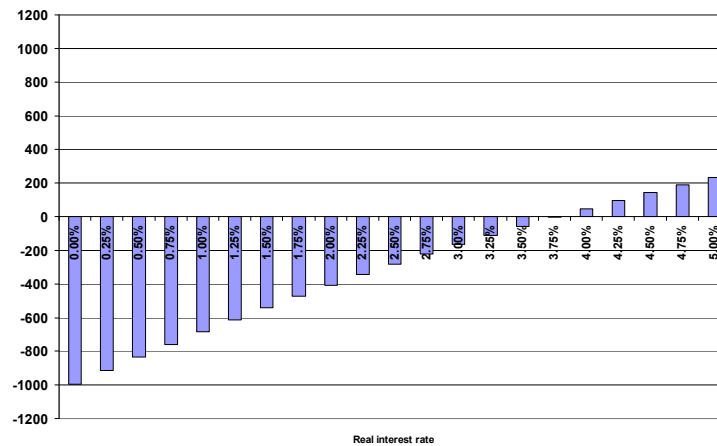


Figure 7: Net present value of the GDP differences of the GDP in prices of 2000 in million BGN



The figures 5 to 7 demonstrate a transient increase of the GDP in the early years and a transient reduction of GDP in later years in case of early closure compared to deferred closure. In real values of 2000 it cumulates to significant higher GDP whereas in real values the cumulated difference to a significantly reduced GDP (up to close to 1000 Million BGN). As the additional financial assistance agreed between Bulgaria and the European Union is significantly higher and assuming that those additional transfers will be vested to a major part in infrastructure the GDP both in net present values as well as in real values will have no decrease but a significant increase, such that any eventual negative effects of early closure would be more than compensated. This is shown in Figure 8.

Figure 8: Comparison of effects on GDP and employment without and with additional financial assistance

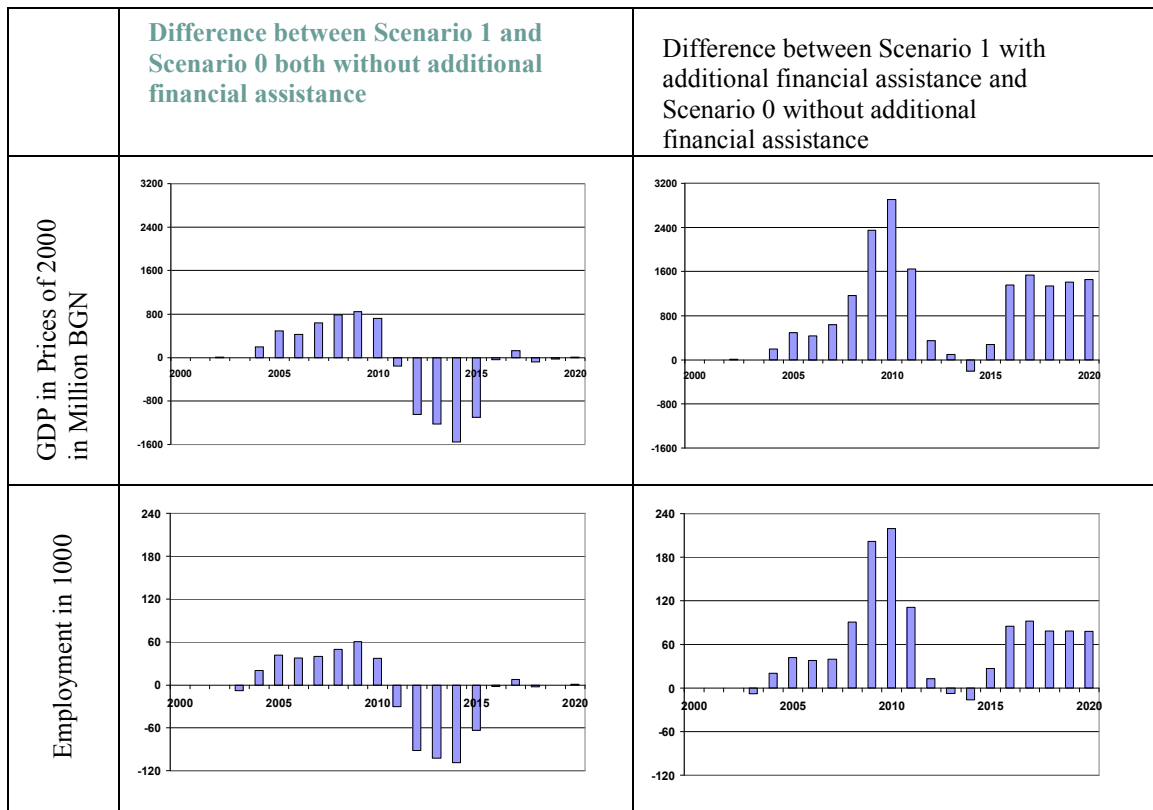
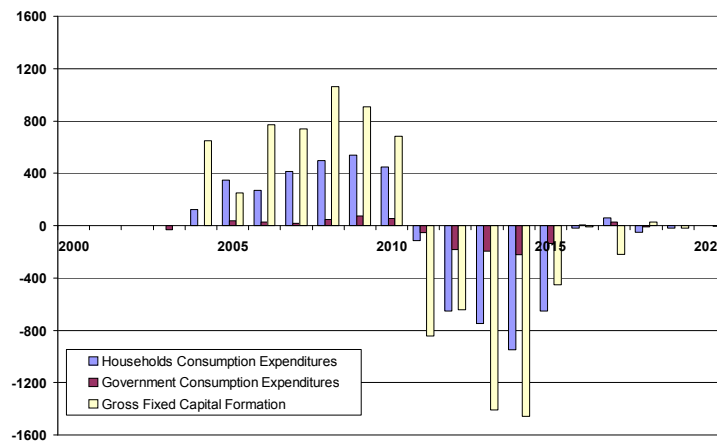
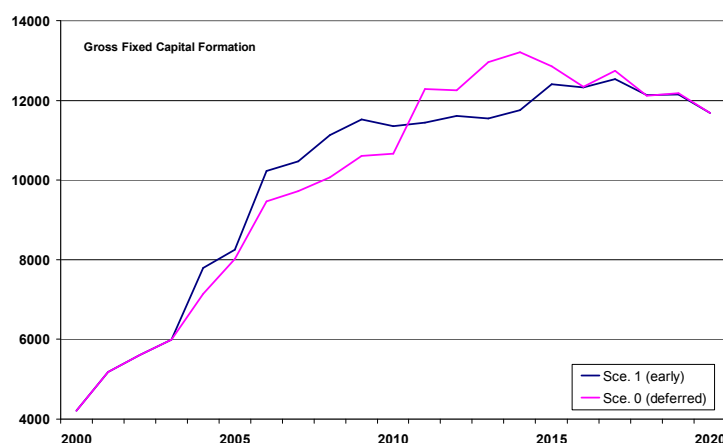


Figure 9: Components of the GDP in prices of 2000 in million BGN, difference between scenario 1 and scenario 0



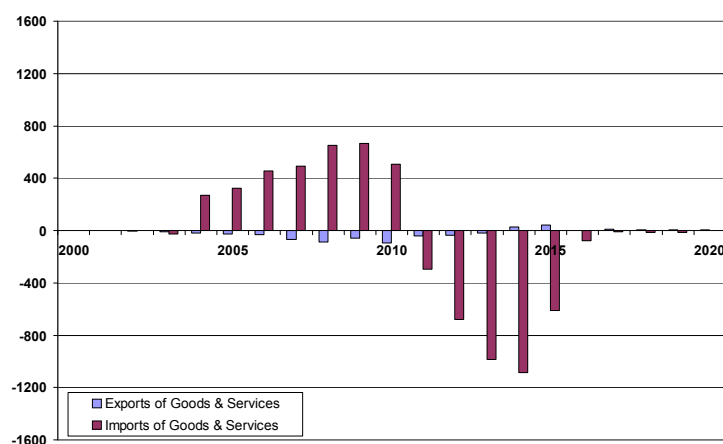
The differences of the *gross fixed capital formation*, the *households consumption expenditures*, the *government consumption expenditures* in both simulations can be seen in Figure 9. The biggest part of the differences comes from the investment paths. In the *early closure scenario* the replacement investments in the electricity sector happens earlier than in the *deferred closure scenario*. Therefore the absolute values of the *gross fixed capital formation* are given in Figure 10. Effects on the *government consumption expenditure* are very small. The effects to the *households consumption expenditures* comes from the higher income of the households, which results of the investment program.

Figure 10: Gross fixed capital formation in prices of 2000 in million BGN in scenario 1 and scenario 0



In both scenarios it is assumed that the demand of *exports of Bulgarian goods and services* is determined by the demand of foreign countries. This demand is always stable and the differences between both scenarios are very small as shown in Figure 11. They result of the different electricity exports. The additional demand of imports in the *early closure scenario* can be seen very well. Here it can be seen that replacement investments in the electricity sector need a lot of imported goods.

Figure 11: Imports and exports in prices of 2000 in million BGN, difference between scenario 1 and scenario 0



To show the different price developments the *households consumption expenditure price index* is given as differences between both scenarios and in Figure 12 and in absolute values in Figure 13. In both figures it can be seen that this *price index* differs only a little bit between the Early Closure Scenario and the Deferred Closure Scenario. The higher *price index* in the Early Closure Scenario comes from the higher energy prices and from the higher demand during that period.

Figure 12: Price indices of households consumption expenditures (2000=100), differences between scenario 1 and scenario 0

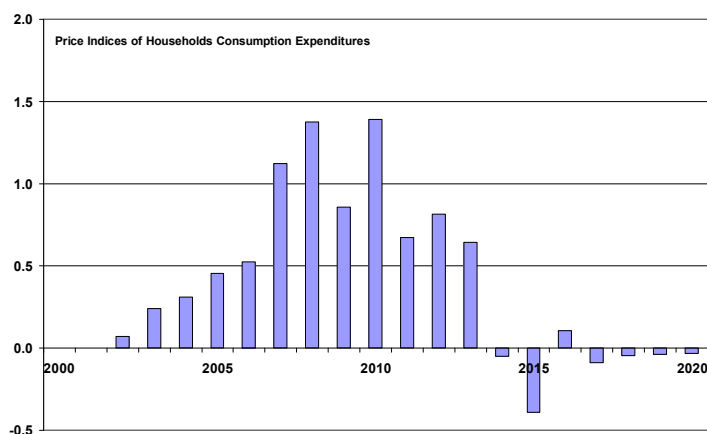
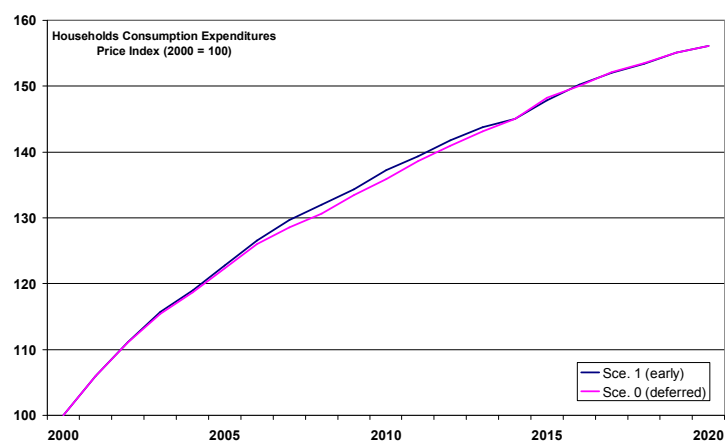


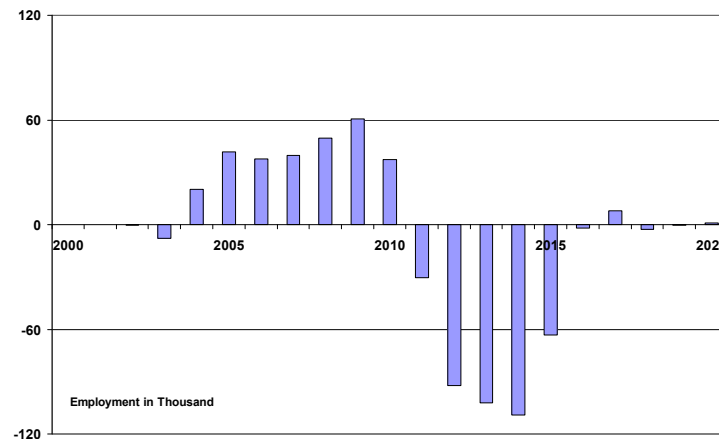
Figure 13: Price indices of households consumption expenditures (2000=100) in scenario 1 and scenario 0



Looking to Figure 14 it can be seen that the *employment* is up to 60.000 people higher until 2010 in the Early Closure Scenario 1. This increase is a result of the replacement investments. In both simulations the *employment in absolute values* is on a stable level of around 3 million employees for each year in both scenarios. Therefore the GDP growth results only from the labour productivity growth.

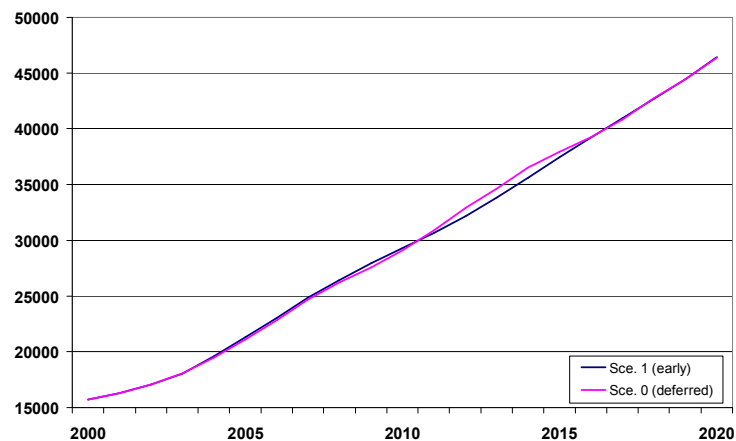
The unemployment in both simulations is influenced by the labour force, which depends on the population. In Bulgaria's situation of a decreasing population the labour force decreases. This decreasing labour force together with an almost stable employment leads to a decreasing unemployment.

Figure 14: Employment in thousand people, difference between scenario 1 and scenario 0



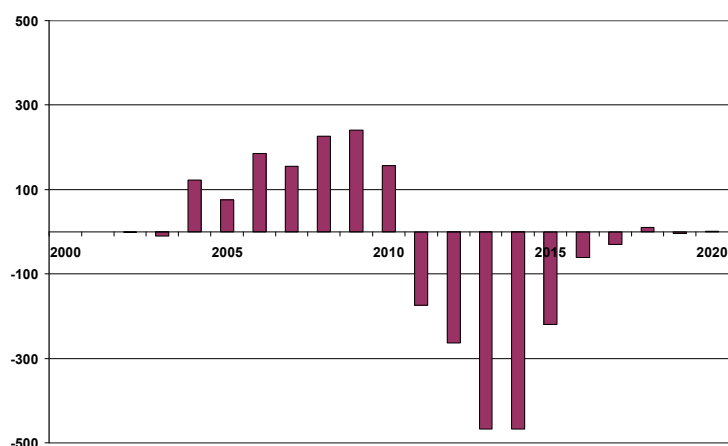
Results for the different sectors are given as examples for the manufacturing and the construction sector. Figure 15 shows the two paths of the *output of the manufacturing sector in prices of 2000*. The results are similar as before. Hence it can be seen that that the result in both scenarios will be almost the same in 2020. In the early closure scenario the manufacturing output is higher between 2004 and 2010 and lower between 2011 and 2015. After 2016 both paths are almost identical.

Figure 15: Output of the sector manufacturing in prices of 2000 in million BGN in scenario 1 and scenario 0



The differences are shown in the construction sector. It is shown in Figure 16 that the results of the early closure scenario are around 200 million BGN higher until 2010 and 300 million BGN lower between 2011 and 2016. After 2017 the difference is very small.

Figure 16: Output of sector construction in prices of 2000 in million BGN, difference between scenario 1 and scenario 0



7 CONCLUSIONS

A macro-economic analysis has been performed in order to assess the economy-wide consequences of an early closure of VVER 440 units at KNPP. In particular, negative and positive effects triggered in sectors others than the energy sector was to be evaluated.

In order to assess the macroeconomic consequences of an early closure two scenarios – one describing a deferred closure and the other one describing an early closure - were compared with each other. In the early closure scenario higher energy prices and earlier replacement investments as described in the earlier section of this paper were taken into account.

Earlier replacement investment creates a positive demand shock that is enforced by multiplier-accelerator effects and results in higher output and employment. These effects more than offset the negative consequences of higher energy prices. Assuming that sufficient productive capacity is available in Bulgaria to implement the replacement investment, in other words the productive capacity of the Bulgarian economy is under-utilised, significant additional price increases are not to be expected. Crowding out is not likely to occur if the replacement investment is financed through available sources (foreign or domestic).

After 2010 replacement investment is lower than in the case of deferred closure. This negative demand shock reduces output and employment relative to the deferred closure scenario. Cumulated over the period of analysis the gross domestic product in non discounted prices is lower in the early closure scenario compared to the deferred closure scenario. This is a clear indication of a negative consequence negative effect of the early closure on the macro-economy if no further mitigating actions are taken. The agreed additional transfers agreed during accession negotiation will more than compensate those negative effects providing that they are used in long-term investments with a substantial return for the Bulgarian economy (e.g. specific infrastructure investments).

The project demonstrated a good example for use of macro-economic models in analysing anticipated changes in different scenarios. As has been presented macro-economic models may be used to provide consistent calculations and forecasts which can be used for developing a better understanding of consequences of changes. Hence the use of macro-economic models improves substantially the decision basis and contributes to support responsible stakeholders in their decision.

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