PD-ABE-381

RMA/CSFR-PR-02

COMPONENT #4: ENERGY PRICING RECONNAISSANCE TRIP REPORT - CZECHOSLOVAKIA

May 18 - 29, 1991

U.S. EMERGENCY ENERGY PROGRAM FOR EASTERN AND CENTRAL EUROPE

(USAID Project #: 180-0015)
(USAID Contract #: EUR-0015-C-00-1006-00)

RESOURCE MANAGEMENT ASSOCIATES OF MADISON, INC.

PD-ABE-381

RMA/CSFR-PR-02

COMPONENT #4: ENERGY PRICING RECONNAISSANCE TRIP REPORT - CZECHOSLOVAKIA

May 18 - 29, 1991

U.S. EMERGENCY ENERGY PROGRAM FOR EASTERN AND CENTRAL EUROPE

(USAID Project #: 180-0015)
(USAID Contract #: EUR-0015-C-00-1006-00)

Resource Management Associates of Madison, Inc.
520 University Avenue, Suite #300, Madison, WI 53703, U.S.A., Telephone: (608) 283-2880 Facsimile: (608) 283-2881 Telex: 469 453

TABLE OF CONTENTS

I. Introduction and Overview 1

II. Summary of the Bratislava Workshop 2
- A. General Description of the Workshop 3
- B. Summary of the Workshop Sessions 3

III. Followup Activities 10
- A. Slovak Ministry of Economy (SME). 10
- B. The Institute of Economics, Czechoslovak Academy of Sciences. 11
- C. The Ministry of Economy CSFR, The Department of Oil and Gas. . . 11
- D. Ministry of Economy: Czech Republic. 11
- E. VUPEK. 12
- F. Meeting with Mr. Dyba 12
- G. Meeting with Mr. Lazarcik, Federal Energy Agency 12

IV. POTENTIAL FUTURE TECHNICAL ASSISTANCE 12
- A. Modelling and Policy Analysis Assistance to the Slovak 12
- B. Industrial Energy Conservation Programs and Policies. 13
- C. Macroeconomic Impacts of Energy Price Increases. 13
- D. Regulatory Options for the Power Sector 13
- E. LEAP Modelling 13
- F. Privatization and the Use of Private Sector Resources 14

Appendices:

- A. LEAP Data Base and Preliminary Scenarios
- B. RMA Industrial Energy Pricing Model: Comparison of Two Scenarios (1988-2000) for CSFR
- C. RMA Transportation Energy Use and Emissions Model: Effects of Shifting 20% of Rail Freight Tonnage to Trucks
- D. Excerpts from the "Proceedings of the Workshop on Energy Pricing Reform in Czechoslovakia". Bratislava, Czechoslovakia, May 21-22
- E. List of Participants from the Workshop on Energy Pricing Reform in Czechoslovakia. Bratislava, Czechoslovakia, May 21-22

I. Introduction and Overview

The May 18-29, 1991 trip to Czechoslovakia (or CSFR) was centered around a two-day workshop which was held in Bratislava. In addition to the workshop, meetings were held with key individuals in both Bratislava and Prague. The May trip was preceded by a reconnaissance visit in March, which identified for the CSFR team the issues which it was desirable to address in May. The team consisted of Harvey Salgo (Team Leader: Tellus), Jack Huddleston (RMA), Bruce Biewald (Tellus), and Bronek Dutkiewicz (Intratech). Wes Foell (RMA) attended the workshop and some of the meetings, but was primarily occupied with industrial conservation matters.

For purposes of context, it is useful to briefly recapitulate the March visit. The March trip entailed numerous meetings with key energy and environmental leaders in the CSFR. The broad objectives of that reconnaissance were twofold: (1) to ascertain what energy issues were most important, and (2) to determine which issues should be addressed in May. That is, we attempted to both identify and prioritize the issues.

The May workshop and subsequent meetings evolved out of this process. One result of the May trip is that models from Tellus (LEAP and its associated Environmental Data Base (EDB) and ECO, a conservation analysis tool) and RMA (industrial and transport) are in the hands of organizations at the federal level and in both the Czech and Slovak Republics.[1] It is believed that the models could become effective planning and scenario development tools for those organizations and for those who, in turn, rely upon their studies.

This report summarizes the workshop discussions and the subsequent meetings, as well as the potential for further assistance. Some preliminary scenarios were provided to the present users of LEAP/EDB and the RMA models. The LEAP scenarios are not summarized here, although a base case is provided as Appendix A.[2] The scenarios prepared

---

[1] LEAP disks and documentation have been placed with Jan Klacek, Director, Institute of Economics of the Czechoslovak Academy of Sciences; Maria Vlckova, Ministry of Economics of the Slovak Republic; Jiri Dudorkin, Associate Professor and Head of Department, Czech Technical University (the latter also requested Tellus' ECO model, which performs conservation analyses and is in possession of it as well). RMA's models are have been placed with the Czechoslovak Academy of Sciences and the Ministry of Economics of the Slovak Republic.

[2] These scenarios were developed for expositional purposes primarily to demonstrate the power of the software tools. As noted in the text, the objective was to provide the tools and the assistance so that our CSFR counterparts could develop their own scenarios. Because of the transition from command to market principles, and for other reasons as well, we must continue to provide assistance in their efforts.

by Dr. Huddleston, utilizing the RMA industrial and transport models are provided as Appendix B and C. It is anticipated that the organizations using LEAP/EDB will have begun to produce their own scenarios sometime in September or October. Because of the sophistication of our CSFR counterparts, particularly in modelling, a major objective of the project is to provide the tools which will allow the CSFR organizations to do their own scenario development. Our team members function as advisors to those organizations.

This report is organized in the following manner. Section II is a discussion of the workshop, including the various sessions and the papers prepared by the team and by some CSFR participants. Many of these papers have been assembled in a conference proceedings document and are attached here as Appendix D. Section III is a discussion of the followup meetings. Section IV is a brief conclusion, which contains a discussion of potential technical and policy assistance.

II. Summary of the Bratislava Workshop

The discussion in this section is in two parts. Part A is a general description of the workshop, while B is a summary of each workshop session.

A. General Description of the Workshop

The workshop was held over a two day period. Because of the generally high level of the participants Appendix E, it was not possible to schedule it for more days. The workshop format was informal, with a limited number of prepared presentations (first morning only); the balance was a series of discussions and exchanges on a variety of key issues. In addition, a compilation of reference materials was provided to the participants. It was agreed that the reference materials would be considered "preliminary" and that, as the issues continued to be refined, additional pertinent materials would be provided.

The workshop was planned and organized with the extensive assistance of Mr. Vladislav Hauptvogel who also attended for both days. Papers were prepared by both team members and selected CSFR participants. The team papers were designed to address a variety of market-related issues. The CSFR papers, prepared by the different energy sectors -- coal, electricity and heat, oil and natural gas -- were intended to describe the evolving situation as regards pricing in each.

The sessions were designed to be open and frank, hence the decision (concurred in by the CSFR participants) to make them informal. Each of the substantive sessions is described briefly below. The afternoon sessions on the first day examined key issues in each energy sector: electricity and heat (chaired by Mr. Salgo), coal (chaired by Mr. Huddleston), oil and

natural gas (chaired by Mr. Dutkiewicz).[3]

Because many important issues cut across the various energy sectors, the second day dealt with cross-cutting topics. One morning session was devoted to a detailed examination of the RMA and Tellus models.[4] This session was led by Mr. Huddleston and Mr. Biewald. A second morning session concerning interfuel issues was led by Mr. Dutkiewicz. Mr. Salgo led a discussion of environmental issues with a focus on whether, and if so how, to incorporate environmental costs into energy prices. The session during the final afternoon was devoted to a summing up by both the team and selected CSFR participants from each session.

B. Summary of the Workshop Sessions

This section briefly summarizes each substantive workshop session. Reports from each group were prepared by selected CSFR participants and presented to the workshop as a whole during the final afternoon. As noted above, the first morning was devoted to the formal presentation of papers which had been prepared in advance by both team members and some CSFR participants. The papers have been attached here as a portion of Appendix D and are not further discussed in this report. Thus, this recapitulation begins with the afternoon of the first day of the workshop, during which the first substantive exchanges of information took place.

Afternoon of the First Day

Electricity and Heat

The electricity and heat discussion focused on four principal topics, each of which will be discussed briefly below:

(1) Conservation and the efficient use of resources

(2) Privatization

(3) Environmental costs and prices

---

[3] Formally, the sessions were jointly led by the team and CSFR counterparts. As a practical matter, each discussion was led by the team member indicated.

[4] This session led to followup meetings over the next several days during which more detailed demonstrations and discussions concerning the models were held. The workshop session and the meetings led directly to the acceptance of the models by the organizations mentioned earlier.

(4) Interfuel issues

The need for a significant conservation effort is recognized widely in the CSFR and was reflected in this discussion. It was understood that resource conservation will have major benefits for the environment. Some of the exchange focused on the use of private sector resources -- such as energy service companies -- for the delivery of conservation services. A discussion of least cost planning and what it has meant for U.S. utilities also took place. In addition, an early version of federal legislation was brought to the group's attention and was discussed. (A more detailed discussion was held during a followup meeting in Prague later in the week.) The group also discussed problems related to the significant amount of master-metering in the heating sector, limitations in the infrastructure (for the delivery of conservation measures), and problems concerning weaknesses in the ability to finance the acquisition of conservation measures by consumers.

The discussion of privatization focused on two of its quite different aspects: the privatization of the present utility sector, and the use of private sector resources (such as private power developers and energy service companies) for the delivery of electricity or heat. The discussion devoted approximately equal time to both subject areas. The participants had more exposure to the issues involved concerning privatization of the utilities. The issues surrounding the use of private sector resources was somewhat newer to most, although several pointed out that some factories sell power to the grid at present. However, when the discussion turned to the manner in which private sector resources are being contracted for in the U.S. and elsewhere it was clear to the participants that there were substantial differences of both kind and degree.

The discussion concerning environmental costs and prices focused on both the costs to be internalized and issues concerning the remaining "externalities". The participants were aware of the general issues. The discussion centered on a variety of topics: appropriate mechanisms (theoretical, regulatory) for determining what environmental costs should be internalized and how those would evolve over time; whether the country could afford to include environmental costs into its energy prices, given that energy prices were rising significantly; whether to include externalities costs prior to the time that prices (in the absence of externalities) were set correctly; methods for the valuation and incorporation of externalities into energy prices; the prospective operation of the U.S. federal Clean Air Act.

The interfuel issues focused on concerns about the impacts of decisions concerning one fuel (or electricity) upon other fuels. For instance, the impact of the inclusion of externalities into electricity prices would have a significant impact upon the coal industry. Many of the questions and issues concerning interfuel matters were postponed so as to be addressed in the discussion on this topic which was held on the following day of the workshop.

Coal (or solid fuels)

The solid fuels discussion session met in the afternoon of Tuesday, May 21. This group was

composed of individuals representing the brown coal mines in North Bohemia and Slovakia, the hard coal mines of Moravia, the CSFR ministries of Finance and Economy, and the Czechoslovak Academy of Sciences.

A general background on coal production in the two republics was presented by Mr. Klask of the North Bohemia brown coal mines. After this discussion a list of questions was developed by the entire group. The list of questions was as follows:

(1) Should coal prices be determined "region-wide" or at "individual mine sites"?

(2) What alternatives to "production costs" can be used for setting coal prices?

(3) How will differential prices for Czech and Slovak coal affect output in the various mines?

(4) What subsidies and incentive programs exist for the coal sector in the U.S.?

Considerable discussion was focused on the question of region-wide versus individual site pricing. It is clear that production costs and quality vary among the various coal producing regions of Czechoslovakia. As coal prices begin to approach world prices it is apparent that several mining-processing operations will become unprofitable and will likely be closed. These operations would have closed earlier had there not been a well established system of cross-subsidies across the mining sector.

Pricing mechanisms also received some discussion. The current movement is toward implementation of a system of "criterion" prices. This system, which is intended for the transition period to full market prices, basically establishes maximum prices that individual producers can charge. The maximum ceiling provides some economic protection to consumers while leaving an economic incentive to producers able to charge below-criterion prices.

The discussion session also briefly covered mining pricing and assistance programs in the U.S. Topics covered included ownership options, price setting arrangements, unions, natural resource taxation, and governmental subsidies.

As a general conclusion to this session, all participants agreed that the direction being taken by Czechoslovakia is consistent with other industrialized countries and should proceed as currently planned.

Oil and Gas

Eight people attended the discussion group representing the refining industry (Slovnaft), the gas industry (CPP), the Federal Ministry of Economics and Czech and Slovak Republics. The major topic of discussion centered on the present and anticipated methods of determining petroleum prices both in the CSFR and foreign countries, and the volatility and uncertainties of the international oil markets. The preoccupation with the problems on the oil side left little time for detailed discussion of the problems facing the gas industry or the topic of the interaction between environmental aspects and pricing implications. The general conclusions of the discussions are given below.

Gas

(1) The participants discussed the possibility of the transition of the Czechoslovak gas industry to a market economy. It was believed that the Czechoslovak gas industry is already comparable to that of the other European countries. One of the major problems is the diversification of supplies which currently come exclusively from the Soviet Union.

(2) Problems during the Transition Period.

a) adjustment of prices to the real costs.

b) price differentiation for seasonally dependent industries.

(3) There was general agreement concerning the limitation of state intervention into pricing.

(4) Due to a relative oversupply of natural gas on the world market, anticipated gas prices and the environmental advantages of gas, continued expansion of gas consumption can be expected.

(5) Future privatization of the gas industry will follow the general tendencies observed elsewhere.

Crude Oil and Petroleum

(1) Long Term Price Predictions

Price predictions are very complicated at present and there is a general tendency to abandon such predictions and rely on the futures market as more representative of the latest thinking on both crude oil and final product prices.

(2) Price Changes

Price changes should be flexible and reflect the market situation. The intervention by the Government should be limited to a minimum. The only exceptions should be during crisis situations and other dislocations.

(3) Crude Oil Purchasing Monopoly

The current import monopoly for crude oil held by Chemapol and Petrimex should be abolished and import licenses should be issued to the individual refineries.

(4) Price Relationship of Major Products

During the last decade there has been an increase of gasoline and diesel prices relative to crude oil. Heavy fuel oil prices have declined relative to crude oil, partially due to the environmental debit of heavy fuel oil relative to other fuels.

(5) Privatization

It was generally considered that conditions for privatization of the refinery sector were very favorable at this stage.

(6) Taxation

Many voiced the opinion that taxation should be done as close to the end-user as possible in order to avoid the price distortions with other fuels and thus avoid improper signals being sent to the customer.

(7) Government Intervention

Many felt that this should be limited only to the importation volumes and that such intervention should last only as long as the Czechoslovak currency is not fully convertible.

Morning of the Second Day

The morning began with a presentation to the entire workshop concerning modelling (and the LEAP model in particular) by Mr. Biewald. After his talk, three discussion sessions were held: modelling, environmental issues, and interfuel issues. The modelling group was co-chaired by Dr. Huddleston and Mr. Biewald; Mr. Salgo led the environmental group, and Mr. Dutkiewicz the group concerned with interfuel issues. As noted earlier, these sessions were designed to address issues and questions which cut across the individual energy/fuel areas. Each of the sessions is discussed below.

Modelling

Bruce Biewald and Jack Huddleston co-lead the session on economic and energy models. Biewald covered models developed by Tellus and Huddleston covered the industrial and transportation models developed by RMA.

Two policy analyses were developed prior to the workshop that illustrated the use of the RMA models. These were presented and discussed by Dr. Huddleston. The two policy analyses were entitled: (1) RMA Transportation Energy Use and Emissions Model: Effects of Shifting 20% of Rail Freight Tonnage to Trucks; and (2) RMA Industrial Energy Pricing Model: Comparison of Two Scenarios (1988-2000) for CSFR. Both papers are included in Appendix B and C.

Mr. Biewald presented LEAP, EDB, and ECO. During this session, alternative scenarios were developed using LEAP and the base case Appendix A developed for this purpose. The models were made available throughout the workshop, so that participants could sit down and experiment with them. This type of hands-on interaction offered an informal opportunity to learn about the models' scope and features. Several of the participants were interested in the various Tellus and RMA models; followup meetings and other communication was arranged so as to provide additional information and, ultimately, the software.

All participants in this session were apprised of the possibility that computers and models would be transferred to appropriate organizations within Czechoslovakia at the conclusion of the current project.

Interfuel Issues

The session on interfuel pricing and other issues was attended by people from the oil, gas, coal sectors and from Federal and Republic Governments. A very lively discussion highlighted the different outlook on pricing inherent in the different energy sectors and reflected their competitive outlook in a free market situation. The meeting also served to highlight the need for more inter-sectorial discourse on pricing and competition. General conclusions of the sessions are presented below.

(1) In general the Natural Gas industry is of the opinion that it is generally competitive within the CSFR and in the European context. An example of its competitive position is the current experience of loss of markets to oil in the cement sector.

(2) The coal sector representatives felt that the sector needs some protection at this stage to survive because of cost and environmental considerations. The major preoccupation is one of social responsibility; they advocate subsidy and transitional

support rather than any move to interfuel competition.

(3) The petroleum sector participants are optimistic that under a free market system they will be able to compete effectively with the other fuels. The major uncertainty appears to be the extent and duration of Government intervention in the pricing of their products.

Environmental Issues

The discussion focused primarily on two broad matters: the theory behind and the structure of the U.S. Clean Air Act, and actual methods for the valuation of externalities and their incorporation into the resource selection and utilization processes. As regards the Clean Air Act, much of the discussion concerned the use of market mechanisms to drive the pollution reduction. There was some question as to its usefulness in Czechoslovakia at the present time, given the limited experience with the market generally, as well the relatively limited access to financing (required to undertake pollution reduction investments). Many in the group were sufficiently interested in the approach and want to re-examine the issue in more detail during our next visit.

There was much discussion concerning proper approaches for the valuation of environmental externalities. Some expressed the view that the proper method must include an estimate of damages. There was a discussion of 'second best' solutions, which might be preferable to ignoring externalities until damage estimates are estimated without controversy. The approaches utilized in the U.S. -- in such jurisdictions as Massachusetts, New York, and Nevada -- were discussed as examples of such 'second best' solutions.

It was apparent from this meeting that there is much interest in continuing such discussions. Plans are in process for meetings on these matters during the September trip to Czechoslovakia.

May 19 Afternoon Session

During the afternoon there were reports to the workshop members as a whole from each of the individual substantive groups. These comments are not summarized here, since they are duplicative of the discussion above.

The workshop was terminated with comments from Mr. Wes Foell, Mr. Harvey Salgo, and Mr. Vladislav Hauptvogel.

III. Followup Activities

A series of followup meetings was held by members of the team following the workshop in

Bratislava. Each is discussed briefly below.

A. Slovak Ministry of Economy (SME). The technical team met with members of the Slovak Ministry of Economy (and the Slovak Power Board) in Bratislava on Thursday, May 23. Primary representatives from the SME were Ing. Maria Vlckova and Ing. Anna Snahnicanova. The principal representative from the Slovak Power Board was Mr. Lehota.

During this meeting it was made clear that SME would be interested in being the recipient of the computer models in the Slovak Republic and that they would be willing to serve as a clearing-house for others in the Republic wishing to use the models. SME also expressed keen interest in having the RMA industrial model modified to reflect republic level data. The SME representatives agreed to supply necessary specification of 2 sectors to be included and all data that would be used by RMA staff. The central focus of SME interest is in the impacts on industrial output of changing energy prices.

The principal concern of the Slovak Power Board attendees was similar. In their view, the Slovak industries are disproportionately energy intensive and, hence, will suffer correspondingly from energy price increases. Much of the discussion focused on industrial electricity tariffs and any mechanisms for relieving such impacts.

Ing. Vlckova and Ing. Snahnicanova met again with team members in Prague on May 27. Similar themes and agreements were once again expressed.

B. The Institute of Economics, Czechoslovak Academy of Sciences. The four-member technical team met with various members of the Institute of Economics, Czechoslovak Academy of Sciences in Prague on Friday, May 24. Ing. Petr Kacvinsky who had attended the workshop in Bratislava served as the organizer of this meeting.

After brief introductory remarks, small groups were formed to discuss specific energy pricing-related research and questions. Mr. Biewald met with a modelling group which had expressed interest (during the Bratislava workshop) in utilizing LEAP for its country-wide scenario building efforts. As noted earlier, the Academy has requested and received the LEAP model and its associated Environmental Data Base (EDB). Mr. Salgo met with a small group which was interested in pursuing matters related to environmental costing and pricing. The Academy has been working on the issue of environmental costs and energy prices and was interested in exploring the issues further.

Dr. Huddleston and Mr. Dutkiewicz met with the "macroeconomics" group. Detailed discussion were held in this group on various macroeconomic topics. Specific attention was given to the assumptions and underlying data used in the VUPEK national economic forecasts. In addition, two areas were identified as unmet critical research needs. The first area pertained to information on programs and policies used in the U.S. to promote industrial energy conservation. The second area pertained to industrial responses to rising energy prices in the U.S. during the period of the 1970s. It was agreed that information on

both topics could be assembled and distributed to appropriate organizations in the near future.

The macroeconomic implications of increasing crude oil price and ex refinery prices on downstream industries was discussed at some length, especially as it applies to the petrochemical industry. Current oil allocations to this sector have resulted in a reduction in operating capacity of approximately sixty percent of 1990 levels. This has resulted in a decline of chemical exports to less than half of 1990 levels. The macroeconomic impact of artificially restricting chemical production and export (a major source of foreign currency) was considered as an area that needs some critical analysis.

C. The Ministry of Economy CSFR, The Department of Oil and Gas. Present at the meeting, from the CSFR, were Me. E. Rohlava, V. Jakoubik, and J. Hynek. The DOG is responsible for monitoring petroleum prices and refinery operations in the CSFR and provides major input into the price policy mechanism. They are currently studying the economics of petroleum supply and the mechanism for establishing prices in different countries. In this regard they would like assistance in analyzing the methodology and performance of refinery economics in the U.S. Points of special interest are: the methodology for establishing petroleum prices in the U.S.; the costs of refining; ex refinery prices; taxes (VAT, state and federal); profit margins (refining, distribution and retail) for each individual product -- Gasoline, Diesel, Light Fuel Oil, and Heavy Fuel Oil.

D. Ministry of Economy: Czech Republic. Present was Mr. J. Vopalensky. Mr. Vopalensky, formerly with the Federal Ministry of Finance, was primarily responsible for the establishment of petroleum prices in the CSFR, prior to moving to the Czech Ministry of Economy. The current pricing policies were discussed in detail for each sector of the petroleum industry as well as the expectation for future pricing policy changes. The basic issues underlying the current policy are (a) a desire to decrease, as much as possible, the consumption and, hence, import of crude oil (raising again the issue of conservation), and (b) to control windfall profits to refiners and distributors.

E. VUPEK. Vupek, a federal energy research organization, is carrying out a comparative study of energy utilization between the CSFR and other countries, especially those in Western Europe. They are also including the U.S. in their analysis. Information was requested on the pricing history of coal, oil, gas and electricity in residential and industrial uses.

F. Meeting with Mr. Dyba: Mr. Dyba, of the Ministry of Economy of the Czech Republic, was interested in a synopsis of the workshop and a brief description of the various discussion topics and points of view. We discussed each of these matters. Mr. Dyba, for his part, conveyed his thoughts concerning the role of the republics in energy matters, which he believed would be growing significantly. On the whole, the meeting was more of a briefing than a substantive discussion of energy issues.

G. Meeting with Mr. Lazarcik, Federal Energy Agency: Mr. Lazarcik, who attended the workshop, had primary responsibility for drafting the statute--referenced earlier - concerning the encouragement of conservation efforts. This statute was brought to our attention by Mr. Lazarcik, during the workshop (session on Electricity and Heat). Mr. Lazarcik requested the Mr. Salgo review the statute and meet after the workshop to discuss any concerns with it. This meeting was, principally, a detailed discussion of the statute. There was also some discussion about the RMA Industrial Conservation Project, principally to update Mr. Lazarcik (and two of his subordinates) about the status of the project.

IV. Potential Future Technical Assistance

As a result of the Bratislava workshop and subsequent follow-up meetings, several areas for future technical assistance were identified. A brief discussion of three of these topics concludes this trip report.

A. Modelling and Policy Analysis Assistance to the Slovak Ministry of Economy.

The Slovak Ministry of Economy (SME) expressed deep interest in receiving assistance in the energy pricing reform area. In particular, SME would like assistance in the area of assessing possible negative economic impacts associated with rising energy prices. To facilitate this analysis SME would like to have an RMA industrial model that represented the Slovak industrial structure and economic data.

It was tentatively agreed that, within current project budget constraints, technical assistance could be provided in this area. SME agreed to provide model structure and data information to RMA staff in Madison. As of this date this information has not been received.

B. Industrial Energy Conservation Programs and Policies.

Considerable interest has been expressed in developing information on industrial energy conservation programs and policies in the U.S. CSFR representatives are convinced of the merits of industrial energy conservation, but sense a lack of information on options and requirements for specific programs they might implement. Financial aspects of industrial energy conservation programs are of special interest to the CSFR representatives.

A 1/2-1 day workshop on industrial energy conservation programs, policies and planning would be appropriate technical assistance in this area.

C. Macroeconomic Impacts of Energy Price Increases.

Significant concern was expressed about negative macroeconomic consequences that may result from increasing energy prices. This is expressed at a general level at the

Czechoslovak Academy of Sciences and at a more specific level at the Slovak Ministry of Economy.

Two types of technical assistance are needed in this area. First, selected sectoral analysis in needed by SME for several industrial sectors that are crucial to the Republic's economy. For example, considerable interest was expressed in the impacts on the aluminum industry of rising electricity prices.

The Czechoslovak Academy of Sciences is more interested in the response of the U.S. industrial sector to embargo-induced energy price increases in the 1970s. A comparison of U.S. and Western European experiences during the 1970s would be a useful technical assistance product in this area.

D. Regulatory Options for the Power Sector

There was significant interest in questions concerning regulation and regulatory structures, including various possible approaches to tariff design (particularly in the industrial sector). These issues will be pursued during the meetings scheduled for September. The regulatory issues will be especially important in the event that there is a division of generation and transmission between the two republics, with different wholesale prices in each.

E. LEAP Modelling

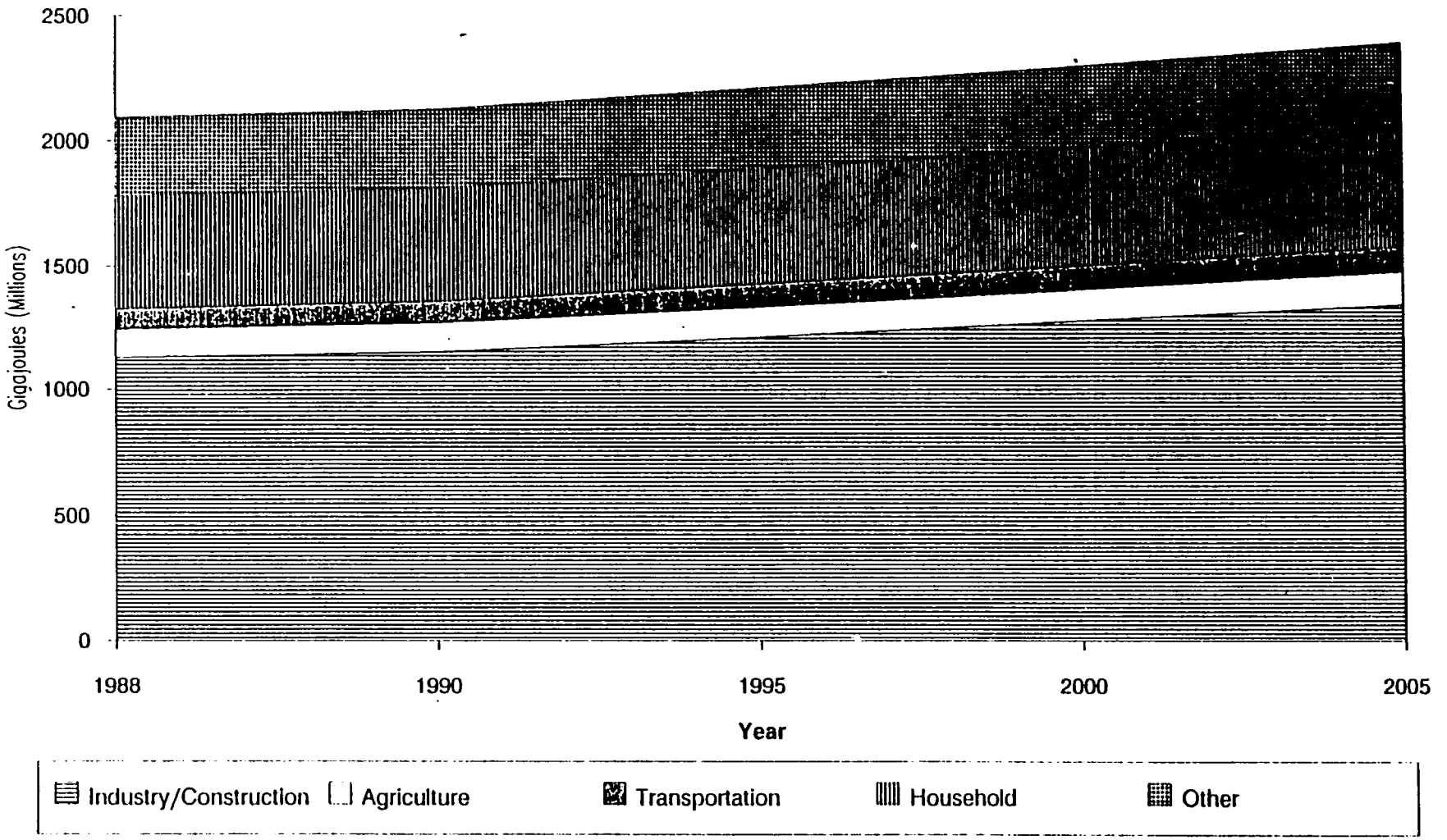
As noted in the text of this report, LEAP has been installed in three locations within Czechoslovakia. There is a need to assist the users in the development of appropriate scenarios and in the interpretation of results. Numerous questions and issues will arise as the scenarios become increasingly detailed. The assistance will be particularly useful when the users link the LEAP energy data to the Environmental Data Base (EDB) which will have to be modified to reflect the technologies prevalent in the CSFR.

F. Privatization and the Use of Private Sector Resources

There was considerable interest expressed concerning the use of private sector resources, such as private power developers and energy service companies. There was particular interest in the consideration of ways to encourage the growth of domestic companies of that sort. In order to effectively utilize such resources, there must be an adequate infrastructure: planning, solicitation/evaluation, contracting, appropriate 'protection' for foreign investments (concerning currency devaluation, for example), and so on. Assistance will be necessary for the development of that infrastructure.

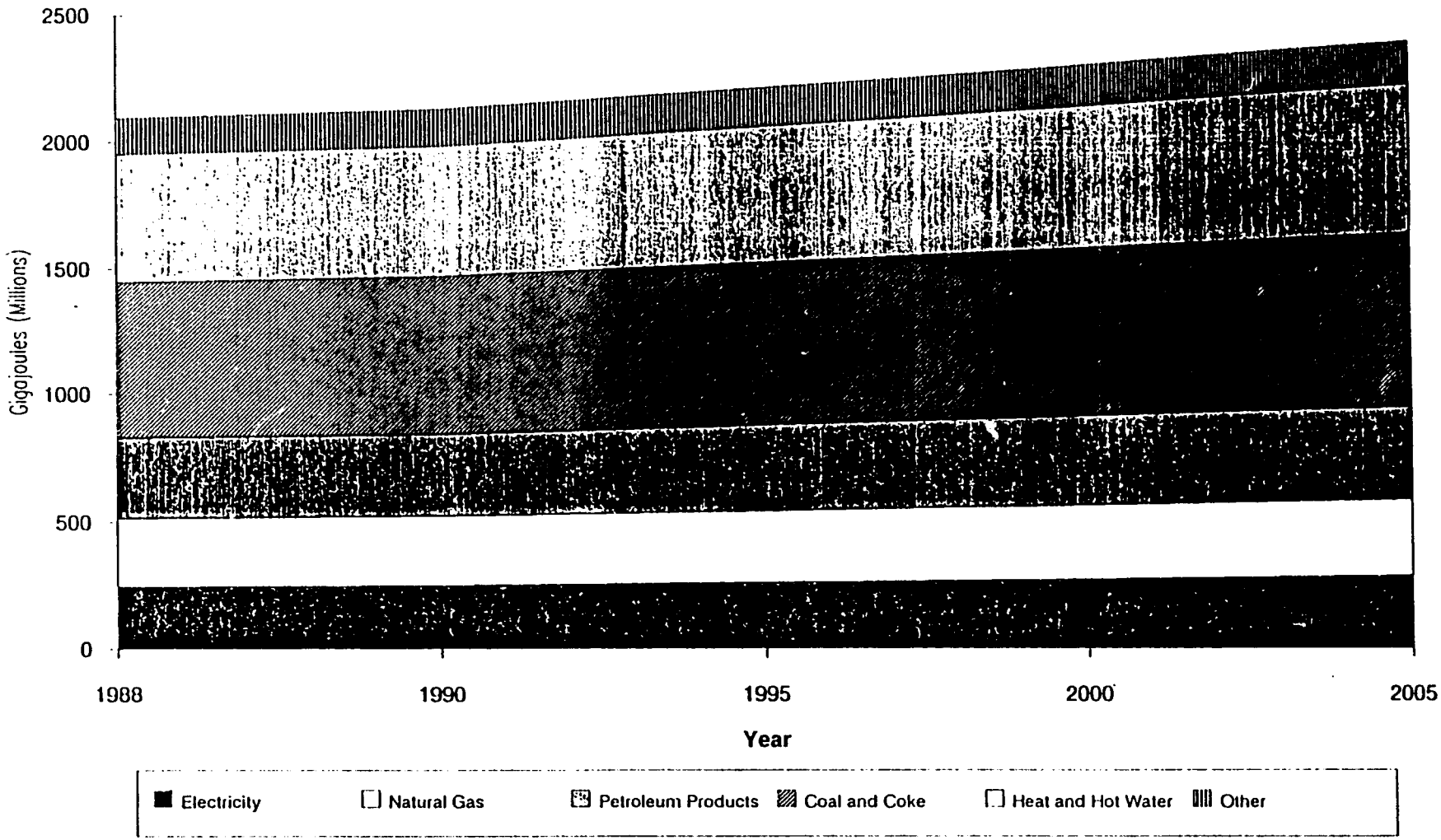
APPENDIX A: LEAP Data Base and Preliminary Scenarios

Total Energy Demand for Czechoslovakia by Sector
Base Case

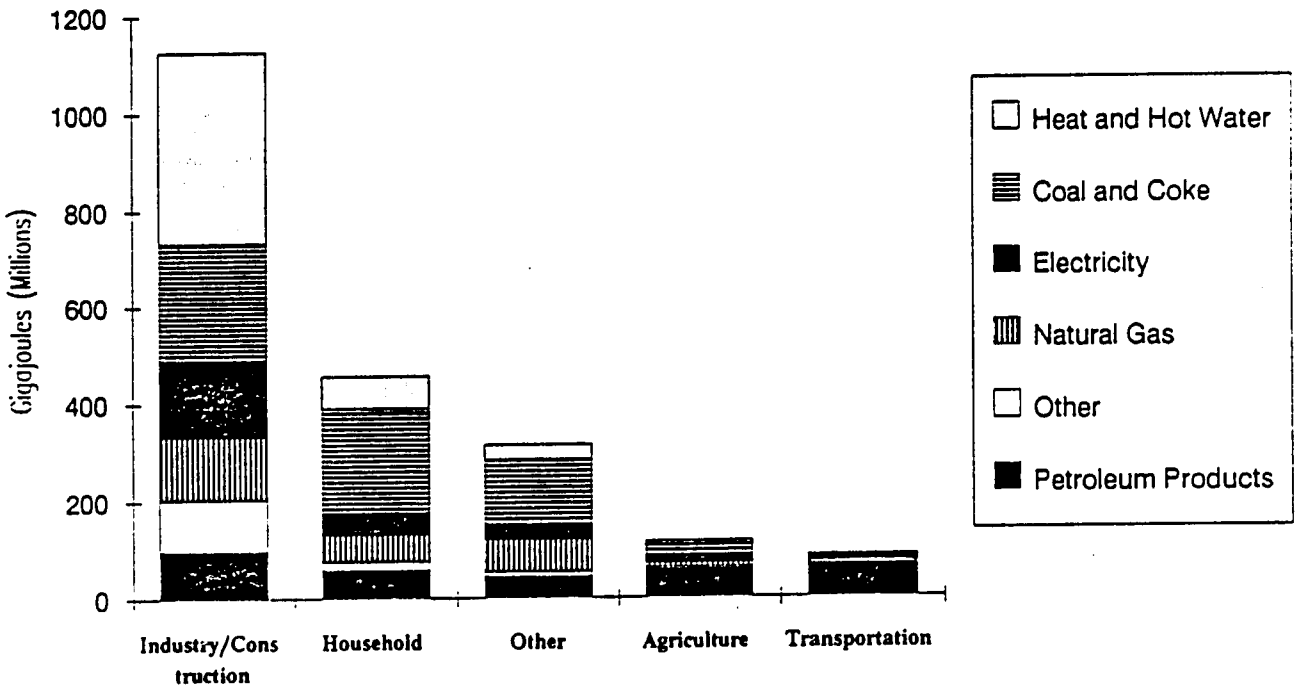


15

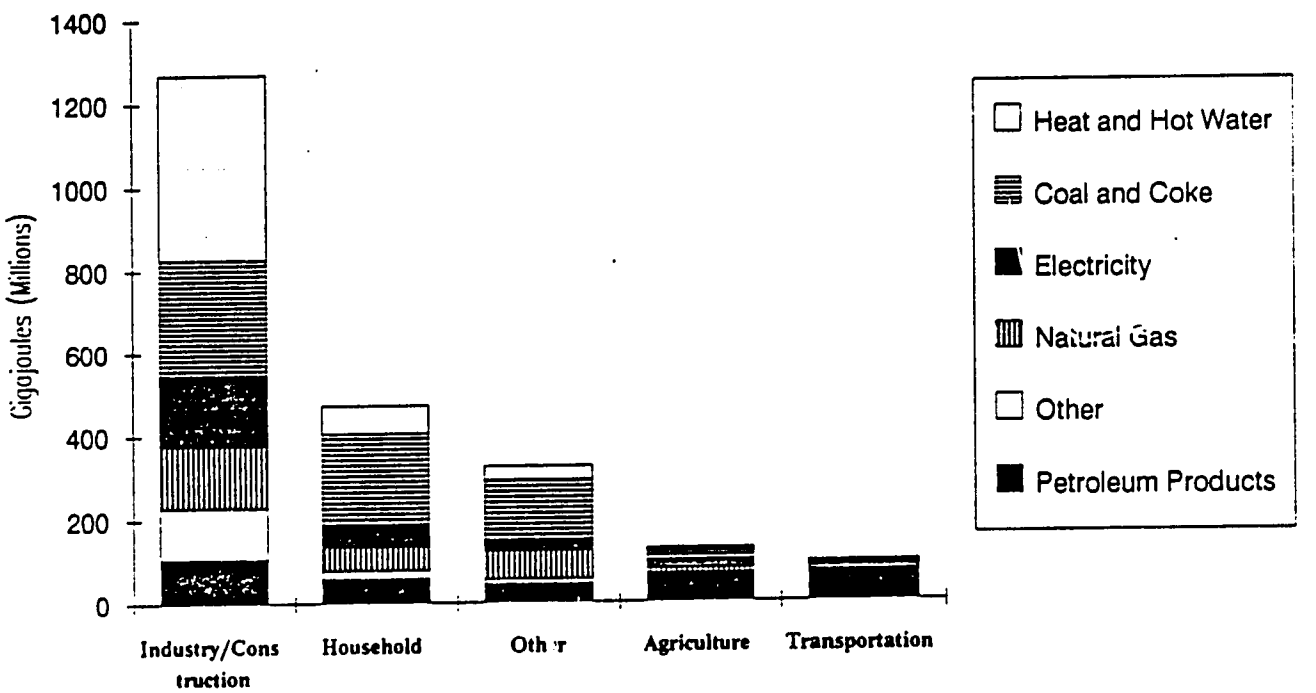
Total Energy Demand for Czechoslovakia by Fuel
Base Case



Total Energy Demand For Czechoslovakia by Sector and Fuel
Base Case 1988



Total Energy Demand for Czechoslovakia by Sector and Fuel
Base Case 2000



Total Energy Demand For Czechoslovakia
Base Case

Year	1988	1990	1995	2000	2005
	Millions of Gigajoules				
ELECTRICITY	250.39	254.38	264.91	275.94	287.5
NATURAL GAS	264.33	267.76	277.01	286.66	296.74
GASOLINE	68.4	68.88	70.28	71.73	73.22
KEROSENE	8.2	8.36	8.77	9.2	9.65
DIESEL FUEL	151.76	154.58	161.93	169.65	177.74
HEAVY FUEL OIL	52.02	52.96	55.43	58.02	60.74
STEAM COAL	51.73	52.31	53.9	55.57	57.3
SORTED BRWN COAL	323.14	325.34	331.9	338.63	345.56
COKING COAL	0	0	0	0	0
STEAM BROWN COAL	1.64	1.67	1.75	1.84	1.94
COKE	244.18	248.47	259.69	271.47	283.83
HEAT AND HOT H2O	503.31	511.95	534.6	558.35	583.26
COKE-OVEN GAS	36.57	37.31	39.21	41.21	43.31
TOWN GAS	31.42	31.76	32.71	33.69	34.71
OTHER SOLID FUEL	12.27	12.38	12.68	13	13.33
OTHER LIQ FUELS	2.39	2.44	2.56	2.69	2.83
LIGHT FUEL OIL	31.69	32.09	33.17	34.3	35.48
PROPANE/BUTANE	6.12	6.16	6.28	6.4	6.53
OTHER GAS FUELS	26.38	26.91	28.28	29.72	31.24
BLAST FURN GAS	29.33	29.92	31.44	33.05	34.73
Total	2095.28	2125.64	2206.54	2291.15	2379.65

Gross Fuel Consumption in Czechoslovakia
Base Case

	1988	1990	1995	2000	2005
	Millions of Gigajoules				
ELECTRICITY	278.22	282.65	294.35	306.6	319.44
NATURAL GAS	267.01	270.47	279.81	289.56	299.74
GASOLINE	72	72.5	73.98	75.51	77.07
KEROSENE	8.63	8.8	9.23	9.69	10.16
DIESEL FUEL	159.75	162.72	170.45	178.57	187.1
HEAVY FUEL OIL	54.75	55.75	58.35	61.08	63.94
OTHER PETRO PROD	0	0	0	0	0
CRUDE OIL	729.3	740.43	770.91	802.95	836.59
STEAM COAL	247.47	251.43	261.93	272.91	284.42
SORTED BRWN COAL	1541.44	1564.04	1624.4	1687.5	1753.48
COKING COAL	667.15	677.17	703.42	730.95	759.83
STEAM BROWN COAL	18.51	18.77	19.45	20.16	20.9
COKE	249.16	253.54	264.99	277.01	289.62
HYDRO	15.82	15.82	15.82	15.82	15.82
NUCLEAR	335.24	335.24	335.24	335.24	335.24
HEAT AND HOT H2O	559.24	568.84	594	620.39	648.07
COKE-OVEN GAS	36.57	37.31	39.21	41.21	43.31
REFINERY FEEDST.	52.37	53.17	55.25	57.44	59.73
TOWN GAS	31.42	31.76	32.71	33.69	34.71
OTHER SOLID FUEL	21.63	21.86	22.5	23.16	23.85
OTHER LIQ FUELS	51.43	52.13	53.95	55.85	57.86
LIGHT FUEL OIL	33.35	33.78	34.92	36.11	37.35
PROPANE/BUTANE	6.45	6.49	6.61	6.74	6.87
OTHER GAS FUELS	71.69	72.84	75.81	78.92	82.2
BLAST FURN GAS	29.33	29.92	31.44	33.05	34.73

Note: Includes distribution losses, and intermediate process uses.
This report double counts energy, so that totals are inappropriate.

Primary Energy Supplies for Czechoslovakia

	1988	1990	1995	2000	2005
	Millions of Gigajoules				
DOMESTIC SUPPLY					
ELECTRICITY	0	0	0	0	0
DIESEL FUEL	0	0	0	0	0
HEAVY FUEL OIL	0	0	0	0	0
OTHER PETRO PROD	0	0	0	0	0
CRUDE OIL	0	0	26.11	0	0
STEAM COAL	299.93	303.89	314.39	325.37	336.88
SORTED BRWN COAL	2962.76	3001.9	3105.56	57.24	0
COKING COAL	1055.86	1071.01	1110.86	1152.63	1196.41
STEAM BROWN COAL	109.4	110.84	114.67	118.68	122.87
COKE	0	0	0	0	0
HYDRO	15.82	15.82	15.82	15.82	15.82
NUCLEAR	335.24	335.24	335.24	335.24	335.24
HEAT AND HOT H2O	0	0	0	0	0
REFINERY FEEDST.	52.37	53.17	55.25	57.44	59.73
OTHER SOLID FUEL	21.63	21.86	22.5	23.16	23.85
OTHER LIQ FUELS	51.43	52.13	53.95	55.85	57.86
PROPANE/BUTANE	0	0	0	0	0
OTHER GAS FUELS	71.69	72.84	75.81	78.92	82.2
TOTAL	4976.13	5038.69	5230.13	2220.35	2230.85
IMPORTS	Millions of Gigajoules				
ELECTRICITY	21.59	21.59	21.59	21.59	21.59
NATURAL GAS	267.01	270.47	279.81	289.56	299.74
GASOLINE	0.88	0.88	0.88	0.88	0.88
KEROSENE	0.39	0.39	0.39	0.39	0.39
DIESEL FUEL	4.29	4.29	4.29	4.29	4.29
HEAVY FUEL OIL	2.2	2.2	2.2	2.2	2.2
OTHER PETRO PROD	10.11	10.11	10.11	10.11	10.11
CRUDE OIL	729.3	740.43	744.81	802.95	836.59
SORTED BRWN COAL	0	0	0	3156.84	3327.71
COKING COAL	0	0	0	0	0
COKE-OVEN GAS	36.57	37.31	39.21	41.21	43.31
TOWN GAS	31.42	31.76	32.71	33.69	34.71
BLAST FURN GAS	29.33	29.92	31.44	33.05	34.73
TOTAL	1133.1	1149.36	1167.45	4396.77	4616.27
EXPORTS (-)	Millions of Gigajoules				
ELECTRICITY	-10.62	-10.62	-10.62	-10.62	-10.62
GASOLINE	-3.14	-3.77	-5.24	-6.82	-8.5
KEROSENE	-10.32	-10.44	-10.74	-11.06	-11.4
DIESEL FUEL	-39.1	-39.1	-39.1	-39.1	-39.1
HEAVY FUEL OIL	-139.78	-141.72	-146.76	-152.06	-157.63
OTHER PETRO PROD	-210.61	-213.67	-221.64	-230.01	-238.8
STEAM COAL	-52.46	-52.46	-52.46	-52.46	-52.46
SORTED BRWN COAL	1421.32	-1437.86	-1481.16	-1526.59	-1574.23
COKING COAL	-388.71	-393.85	-407.45	-421.69	-436.6
STEAM BROWN COAL	-90.88	-92.07	-95.22	-98.52	-101.97
COKE	-36.67	-36.67	-36.67	-36.67	-36.67
LIGHT FUEL OIL	-13.43	-13.72	-14.44	-15.2	-16.01
PROPANE/BUTANE	-9.15	-9.35	-9.84	-10.36	-10.92
TOTAL	2426.19	-2455.28	-2531.35	-2611.17	-2694.91
TOTAL SUPPLY	3683.04	3732.77	3866.23	4005.96	4152.22

Energy Balances for Czechoslovakia
Base Case 1988

	CRUDE OIL	PETRO PROD	COAL/ COKE	NATURAL GAS	HYDRO-GEO/NUC	ELEC-TRICITY	OTHER	HEAT & H20	TOTAL
				Millions of Gigajoules					
INDIGENOUS		52.37	4427.95		351.06		144.75		4976.13
EXPORTS		-425.52	-1990.1			-10.62			-2426.19
IMPORTS	729.3	17.88	36.58	267.01		21.59	60.74		1133.1
TOTAL SUPPLY	729.3	-355.28	2474.48	267.01	351.06	10.97	205.5		3683.04
COKE PRODUCTION			-285.83						-285.83
COAL PRODUCTION			-771.26						-771.26
GAS PRODUCTION									
CRUDE PRODUCTION									
REFINING	-729.3	690.22							-39.08
DISTRICT HEATING			-289.62				-82.64	316.43	-55.84
ELECTRICITY			-457.85		-351.06	267.25	-21.07	242.81	-319.92
DISTRIBUTION		-16.75	-12.67	-2.67		-27.82		-55.92	-115.83
FINAL CONSUMPTION		318.2	657.26	264.33		250.39	101.78	503.31	2095.28
Industry/Construction		95.42	283.86	130.53		151.93	70.59	393.6	1125.93
Agriculture		58.13	20.02	10.1		15.46	3.22	7.45	114.38
Transportation		62.95	4.27	0.96		13.49	0.11	3.97	85.75
Household		57.91	213.45	55.72		44.04	17.77	66.86	455.75
Other Productive		0.71	1.02	0.49		1.73	0.13	2.27	6.35
Other Non-Productive		43.08	134.65	66.54		23.74	9.95	29.17	307.13
TOTAL		318.2	657.26	264.33		250.39	101.78	503.32	2095.28

Energy Balances for Czechoslovakia
Base Case 2000

	CRUDE OIL	PETRO PROD	COAL/ COKE	NATURAL GAS	HYDRO- GEO/NUC	ELEC- TRICITY	OTHER	HEAT & H20	TOTAL
				Millions of Gigajoules					
DIGENOUS		57.44	1653.92		351.06		157.94		2220.35
KPORTS		-464.62	-2135.92			-10.62			-2611.17
IPORTS	802.95	17.88	3198.06	289.56		21.59		66.73	4396.77
TOTAL SUPPLY	802.95	-389.31	2716.06	289.56	351.06	10.97		224.67	4005.96
OKE PRODUCTION			-313.68						-313.68
OAL PRODUCTION			-836.68						-836.68
AS PRODUCTION									
RUDE PRODUCTION	-3.09								-3.09
EFINING	-799.86	757.00							-42.87
ISTRICT HEATING			-307.96				-87.88	336.46	-59.38
LECTRICITY			-535.38		-351.06		-24.64	283.93	-331.51
ISTRIBUTION		-18.38	-13.62	-2.90				-62.04	-127.60
FINAL CONSUMPTION		349.30	708.73	286.66			112.15	558.35	2291.15
ndustry/Construction		107.52	319.86	147.09		171.20	79.55	443.52	1268.73
Agriculture		65.50	22.56	11.38		17.42	3.63	8.40	128.88
Transportation		70.94	4.82	1.08		15.20	0.12	4.47	96.63
Household		59.95	220.97	57.68		45.59	18.40	69.21	471.81
Other Productive		0.80	1.15	0.55		1.94	0.15	2.56	7.15
Other Non-Productive		44.59	139.39	68.89		24.58	10.31	30.20	317.95
TOTAL		349.30	708.73	286.66		275.94	112.15	558.35	2291.15

23

APPENDIX B: RMA Industrial Energy Pricing Model Comparison of Two Scenarios (1988-2000) for CSFR

TABLE OF CONTENTS

1.0 Introduction 1

2.0 Elements of Regional and National Economic Change 1

3.0 Energy-induced Changes to the CSFR Economy 4

4.0 Summary 16

25

1.0 Introduction

Changing energy prices can have significant impacts on national and regional economies. Working through influences on the prices of goods and services and through impacts on disposable incomes, changing energy prices can play a major role in reshaping or restructuring economic structures.

This paper develops a conceptual model of a national and regional economy and describes how elements of these economies change in response to internal and external stimulus. This conceptual model under-girds an industrial simulation model that has been developed by Resource Management Associates of Madison, Wisconsin. This model is applied to the Czechoslovakian national economy for the period 1988-2000 under two different energy price scenarios. The purpose of this analysis is to demonstrate the role of energy price changes in the restructuring of a national economy such as Czechoslovakia.

2.0 Elements of Regional and National Economic Change

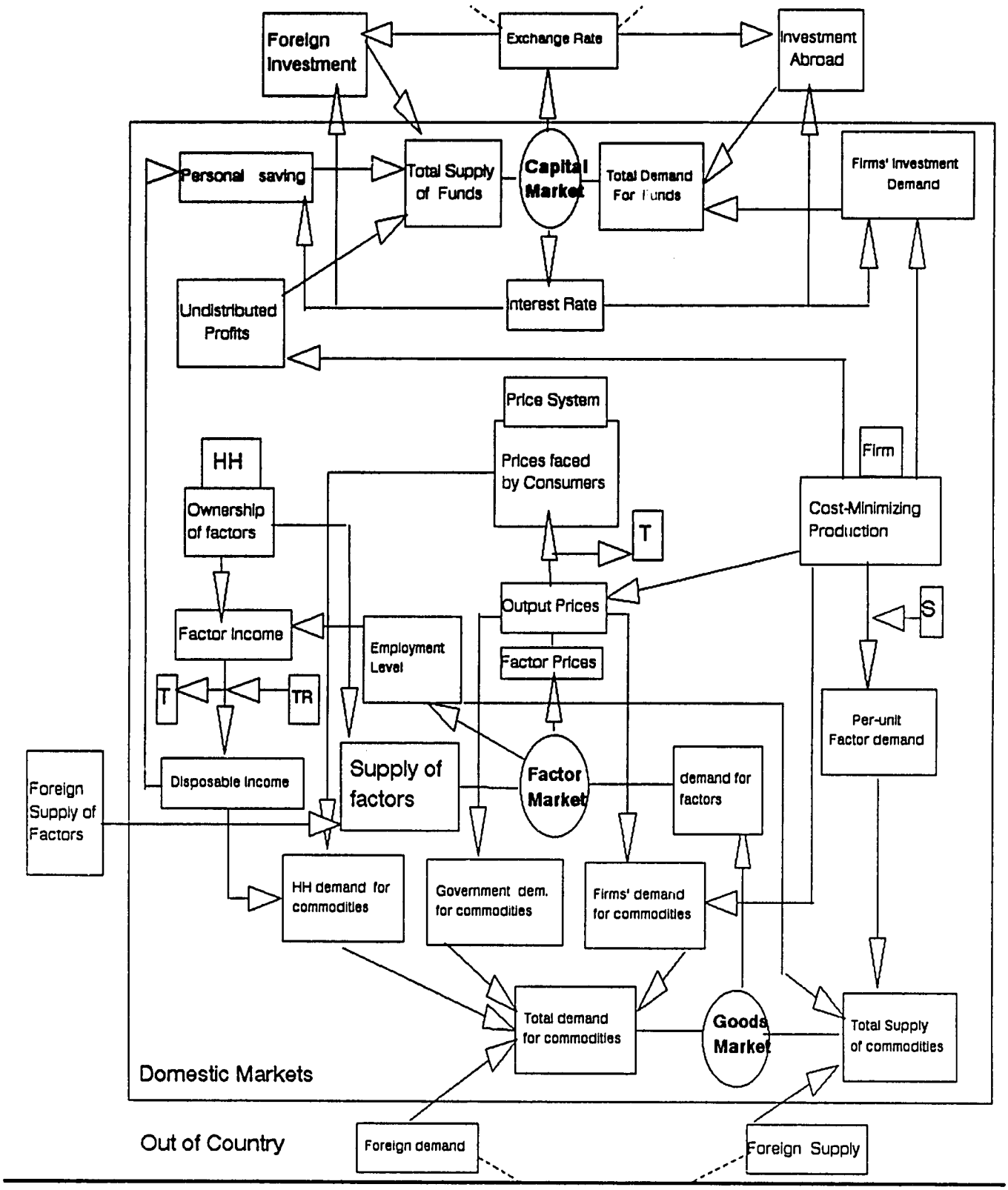
Figure 1 is a visual demonstration of how an economy works. It links the different sectors of the economy and traces the routes through which price or income changes can affect the various agents in the economy. To better understand the diagram, we can use it to describe the likely effects of rising energy prices.

An increase in the price of energy is an increase of one of the components of the factors prices. Higher factor prices will increase the costs of production which in turn means higher output prices and higher prices to the consumers. Faced with higher prices, households, the government and other firms will demand less of the good produced. By how much the overall demand for its product will be reduced for a specific industry depends on two factors, 1) The energy intensity of that industry and 2) The price elasticity of the demand for that product. A very energy intensive industry uses a large quantity of energy in its production process. Increased energy prices will therefore increase the costs of production more than it does for a less energy intensive industry. Price elasticity refers to the responsiveness of the demand side to price changes. The more of a necessity a product is or the fewer substitutes for a good exist, the less demanders will be able to reduce the consumption of that good as prices increase. In that case the demand is said to be inelastic. If it is easy for consumers to do without a specific product, the demand for the good is said to be elastic because consumers will reduce the consumption of that good a lot if prices increase.

The diagram indicates, though, that the story does not end here. As the demand decreases, less will be traded in the goods market. Firms will start to produce less so that fewer factors will be needed by the firms. Idle resources such as unemployed workers or unused machines do not receive any factor incomes. Less money will be in the economy to spend or save so that the industry will experience further reductions in the demand for goods and

26

Figure 1: Elements of A National Market Economy



HH - Households T - Taxes TR - Transfers to Private Households
S - Subsidies to the Industry

services, an effect known as the multiplier effect[1]. Once again the result for a specific industry depends on an elasticity, this time the income elasticity of demand. Households, other firms and the government have less money to spend on consumption goods. Usually they will not reduce the consumption of all goods and services by the same amount. The income elasticity of demand captures the responsiveness of the demand for a specific good as income changes.

Firms react to higher energy prices as well. As factor prices increase, it will become more expensive for the firm to produce any given level of output. Firms know that the demand for their product will decrease if they charge a higher price. In order to maintain the production level firms will therefore try to keep the output prices low by reducing the costs of production. Two responses are possible, 1) Firms will try to improve the energy efficiency of production and 2) firms will try to move away from the production of highly energy intensive goods toward the production of goods that use less energy in its production process. It depends on the structure of a specific industry whether and how easily a firm can make its production process more energy efficient, or how easily it can change its product line. In the economy as a whole, however, there will be movements away from energy intensive products and a rise in overall energy efficiency.

Another effect that we can observe comes from the capital market. As less money is in the economy, households will have less money to save and firms will have less profits to retain. The result is that less funds are available for the firms to borrow in order to buy new machinery or engage in other kinds of investment expenditures. This will further dampen the economy by reducing firms' demand for other firms' products.

The diagram also shows the effect of possible interventions by the government or the effects of any interaction with foreign countries. Both these factors can significantly alter the course of the economy. From the diagram it can be seen how the government may effect the situation with monetary or fiscal policy actions. Lower taxes or higher personal transfers will increase disposable income and hence increase demand as will higher direct demand by the government. Lower corporate taxes or larger subsidies will enable firms to sell their products at a lower price which will also spur the economy. These positive effects of higher government outlays will obviously have to be weighted against the effects of these outlays on the budget deficit.

---

[1] The multiplier effect result because of the circularity of the diagram. As more is demanded by consumers or the government or by foreign consumers, more will be traded in the goods market, the demand for factors increases, employment rises, factor incomes increase, more income is in the economy, more goods will be demanded and so forth. The net result of the multiplier effect is that any additional dollar spent on consumption will result in more than a dollar increase in overall demand. Similarly, any dollar less spent on consumption will result in more than a dollar reduction in total demand.

3.0 Energy-induced Changes to the CSFR Economy

In the transition to a market economy, structural changes within the CSFR Economy will occur due to changes in energy and other prices. The changes in the energy sector will significantly affect the overall economic reforms occurring in CSFR. The most significant changes are likely to occur within the industrial sector, especially because it is the largest consumer of energy. Energy prices have risen significantly in the last three years and are expected to rise again to reach world market levels.
While these price reforms are important to economic reform, the macroeconomic impacts of these reforms should be considered before changes are made. As discussed in Section 2.0, changes in the output, fuel use mix, energy efficiency, and production cost of goods will occur in the industrial sector. The impact of energy price reforms will also have an impact on; employment, income, imports, exports, and government expenditures and revenues.

3.1 Energy Price Reform Scenarios

The Industrial Sector Energy Demand Model (Industrial Model) (©Resource Management Associates, 1991) was used in the last Energy Pricing Reform Workshop as a tool to simulate the effects of energy price changes on the energy demand and output of nine large industrial subsectors. Due to their complicated nature, the effects of other commodity price changes are not incorporated into the Industrial Model. The purpose of this discussion is to expand the discussion on the effects of energy price changes on output and energy demand to explore and compare the indirect effects on employment and income using the results of the scenarios. The influences of government policies, investment within industries, and the import/export market on energy use and industrial output are also explored, although little data is available on these effects.

The basis of the changes are the exogenous underlying industrial output growth and the price forecasts. Price elasticities of energy demand and output are also used within the model and will be discussed later.

3.1.1 Output and Energy Demand Impacts

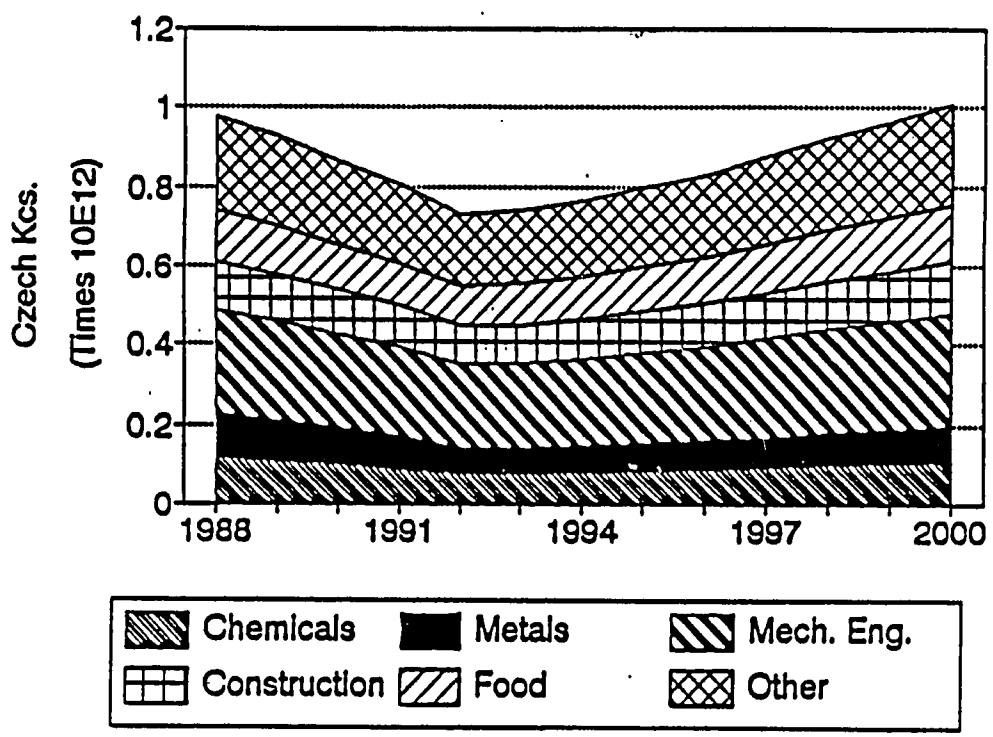
Baseline Scenario The Baseline Scenario is based on projections of exogenous underlying growth rates and price increases for the period 1988 to 2000 (see Table 1). Energy prices are expected to increase through 1992 and then stabilize through the year 2000. These price increases reflect the current government plans for price increases. The projected industrial output is shown in Figure 2. The output declines through 1992 and then increases until it slightly exceeds 1988 levels in 2000. The intersectoral changes in output are perhaps more interesting. The highly energy intensive industries such as the Metals and Chemicals sectors show an overall decline in output over the entire period, while the less energy intensive industries; Construction and Mechanical Engineering, show a slight increase.

TABLE 1. Industrial Output and Energy Price Annual Growth Rates for Baseline Scenario

	88-91	91-92	92-94	94-96	96-00
Industrial Output					
Mining	-4.52%	-4.80%	2.34%	4.30%	5.00%
Chemical					
Ferr. Metals	[all industrial sectors are projected to change at the same annual rate before energy price changes are introduced]				
Non-Ferr Metals					
Mech. Eng.					
Construction					
Forest Products					
Food					
Other					
Energy Prices					
Electricity	7.7%	53.0%	0.0%	0.0%	0.0%
District Heat.	65.5%	0.0%	0.0%	0.0%	0.0%
Coal	9.9%	50.1%	0.0%	0.0%	0.0%
Coke	10.0%	47.0%	0.0%	0.0%	0.0%
Petroleum	136.6%	0.0%	0.0%	0.0%	0.0%
Natural Gas	0.6%	47.1%	0.0%	0.0%	0.0%
Other Gas	65.0%	47.1%	0.0%	0.0%	0.0%

FIGURE 2. Industrial Output: 1988-2000

Baseline Scenario



230

The energy demand results of this scenario are shown in Figure 3 for the 1988-2000 period. The entire industrial sector energy use declines until 1992 and then increases through the end of the period. Thus the energy demand follows the pattern of industrial output, except that energy demand does not reach its 1988 levels in the year 2000. This indicates that industries are responding to the higher cost of energy by reducing its energy use.

The energy intensities of each industrial subsector are shown in Table 2. As shown, each industry has a different energy consumption per unit of output or energy intensity. Therefore, energy price increases will impact each industry differently. For example, industries which have higher energy intensities, such as Ferrous Metals or Chemicals, tend to decrease their energy intensities by a greater percentage than other less energy-intensive firms. The firms generally reduce their intensities in three ways; 1) reduce energy consumption through energy management practices and installation of energy efficient technologies, 2) fuel switching and 3) if they are unable to reduce consumption, output will be reduced.

Economic Price Scenario. The Economic Price Scenario differs from the Baseline Scenario in that it assumes that price changes will follow a path to reach "economic" or world market levels (as determined by the World Bank) in the year 2000 (see Table 3). The World Bank estimated that these price levels are needed to meet economic costs or, where relevant compete in the world market. This scenario uses the same underlying industrial output growth rates and price increases through 1992 as the Baseline Scenario.

As shown in Table 3, prices will increase significantly in order to meet economic costs by the year 2000. District heat prices will rise the most over the period 1992-2000, followed by electricity, coal and coke. Petroleum pricing will be determined by the unpredictable fluctuations in the world market, but this scenario expects that these prices will decline relative to their 1992 levels.

The industrial output levels for each subsector resulting from the Economic Price Scenario simulation are shown in Figure 4. As shown the industrial output declines through 1992 and then increases. Unlike the Baseline Scenario, the output does not return to its 1988 level. This scenario shows that the industrial output could fall short of the year 2000 output in the Baseline Scenario, by as much as 5% or 77,352,000,000 Kcs.. This effect shows that demand for goods will decline if their price rises, due to higher energy costs.

TABLE 2. Industrial Energy Intensities: 1988 and 2000 (TJ/million Kcs output)

Sector	1988	2000
Mining	1.53	1.36
Chemicals	1.66	1.46
Ferrous Metals	3.95	3.53
Non-Ferrous Metals	1.31	1.18
Mechanical Engineering	0.42	0.37
Construction	0.89	0.77
Forest Products	1.40	1.29
Food	0.45	0.40
Other	0.44	0.40

FIGURE 3. Industrial Energy Use

Baseline Scenario

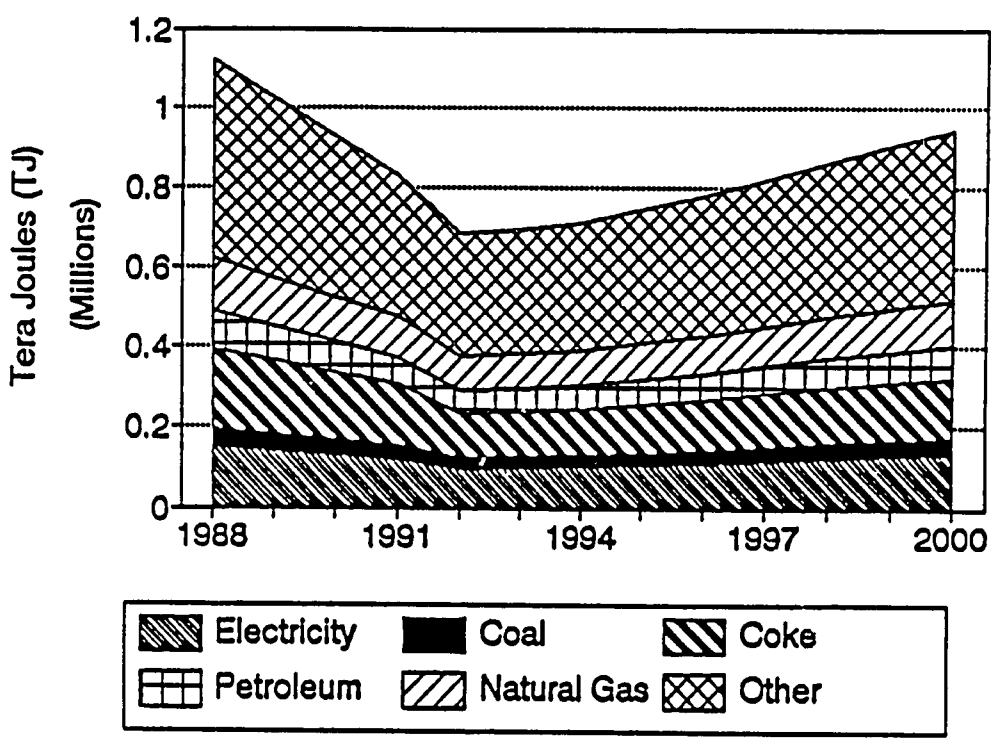
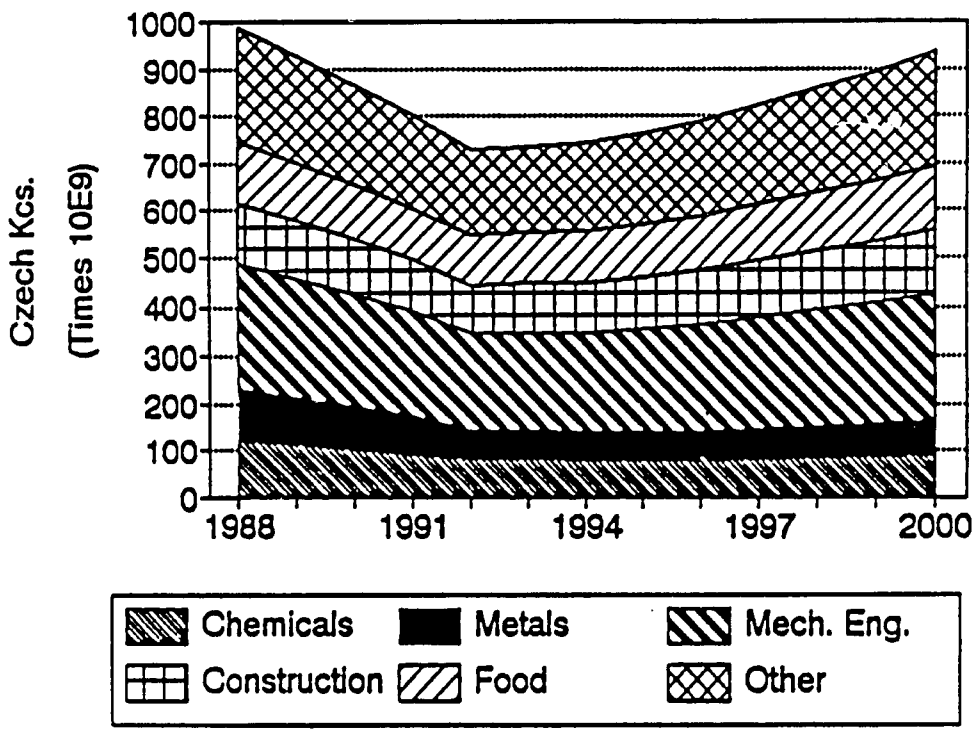


TABLE 3. Annual Rates of Change of Energy Prices Under the Economic Price Scenario

Energy Prices	88-91	91-92	92-94	94-96	96-00
Electricity	7.7%	53.0%	5.7%	5.7%	11.7%
District Heat.	65.5%	0.0%	31.6%	31.6%	73.2%
Coal	9.9%	50.1%	20.3%	20.3%	44.8%
Coke	10.0%	47.0%	9.9%	9.9%	20.9%
Petroleum	136.6%	0.0%	-6.6%	-6.6%	-12.8%
Natural Gas	0.6%	47.1%	2.2%	2.2%	4.4%
Other Gas	65.0%	47.1%	2.2%	2.2%	4.4%

FIGURE 4. Industrial Output: 1988-2000

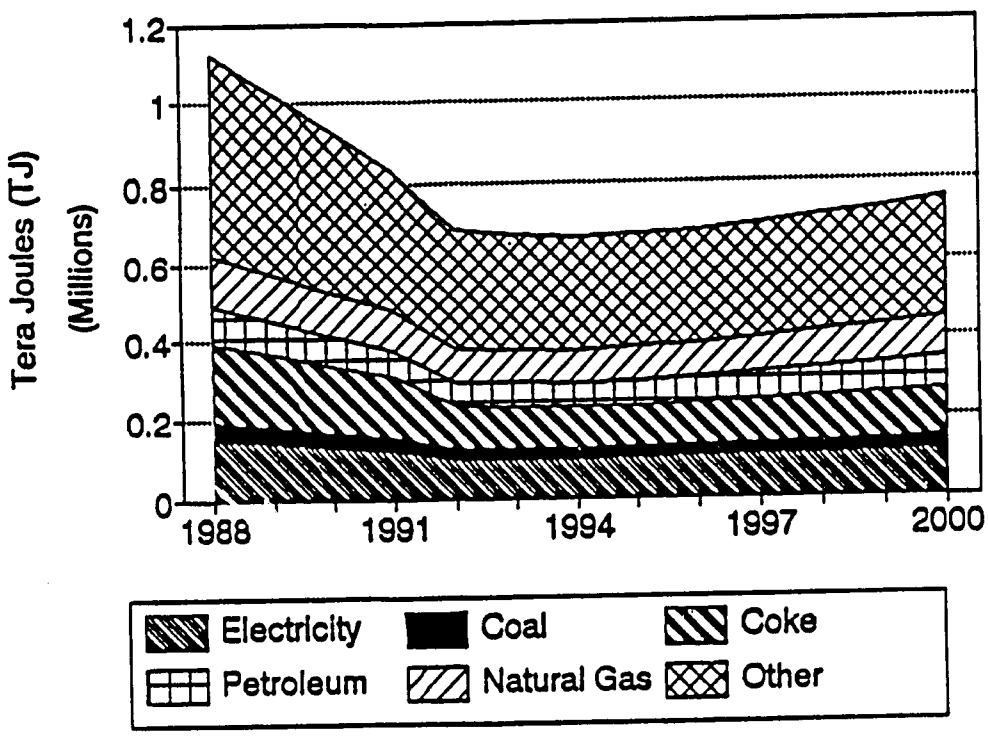
"Economic Price" Scenario



33

The aggregate energy use of the industrial sector fell by more than 30% and over the period 1988-2000, whereas, energy use decreased by only 15% in the Baseline Scenario. Figure 5 shows the industrial energy use by fuel type over the scenario period. Once again the energy use follows the output pattern and declines until 1992, and then increases to meet output levels, but is still less than the Baseline Scenario energy use levels. In order to reduce energy use by 30%, industries will have to manage their energy use more efficiently and make significant technological changes in energy efficiency. Investment in energy efficient equipment will be complicated by the reduction in output and associated capitalavailability. If Czechoslovakian industries are to remain competitive on the world market, most of these changes will be necessary.

FIGURE 5. Industrial Energy Use
"Economic Price" Scenario



24

3.1.2 Employment Impacts

Employment is directly impacted by the change in industrial output. The employment-output ratio for the entire industrial sector in 1988 was approximately 2.0 (see Table 5), and varies for each industrial subsector. Assuming this ratio stays constant over time, changes in employment levels under each scenario can be determined. It should be noted that using a constant employment-output ratio only provides a rough estimate of future employment, because this relationship is likely to change over time due to other factors.

Baseline Scenario. The industrial sector output for the Baseline Scenario over the period 1988 to 2000 declines until 1992 and then returns to 1988 levels as discussed above (see Table 4 and Figure 2). Employment for the industrial subsectors for the entire period is shown in Table 5, assuming constant employment-output ratios. Table 6 shows the decline in total industrial employment over the period relative to the base year 1988. By the year 1992 about 517,000 workers will become unemployed. This loss is to be regained as output reaches its 1988 levels. Since the output in the Chemicals and Metals industry do not quite reach their 1988 output levels by 2000, the employment also is below the 1988 level by approximately 10,000 and 24,000 workers, respectively. It may be unrealistic to assert that the same workers unemployed in 1992 will be completely reabsorbed into the same or other industries over the eight year period of industrial growth. This shift in employment may require training of the work force that cannot take place due to lack of capital. Also, if labor costs increase, labor may be replaced by less-costly capital. Therefore, employment may not reach its 1988 levels in the year 2000.

Economic Price Scenario. Similar to the Baseline Scenario employment follows the pattern of output, which declines over the 1988-2000 period in the Economic Price Scenario. Table 7 shows the employment for the industrial sector under the Economic Price Scenario. Employment goes from about 2 million in 1988 to just above 1.85 million in 2000, showing a net loss of almost 150,000 workers. This is about a 7% unemployment increase over the period. In addition to the Chemicals and Metals sectors, which also showed an overall loss of workers in the Baseline Scenario, the Mining and Forest Products sectors are projected to lose about 3,000 workers. This is a significant loss of workers from the industrial work force. Some of these workers may be reabsorbed by other sectors such as the service industry, the government, or foreign industries. In order to significantly turn this drop in employment around, new investments and industries must be formed. This will require new infusions of capital, perhaps from foreign markets. Once energy consumption has been decreased and energy prices stabilize, more capital will be available for new investments, given that other material costs do not rise significantly. It is difficult to predict the length of time needed to make these transitions.

Because of the negative social impacts of increased unemployment, the government may intervene in the decline of industrial output. The government must analyze the trade-off between allowing industrial production to fall under free-market conditions and attempting to maintain high employment rates. The government may choose to subsidize industries or

35

TABLE 4: GROSS INDUSTRIAL PRODUCT (Millions of Czech Kcs)

Baseline Scenario

	1988	1991	1992	1994	1996	2000
Mining	89389	72436	66241	69377	75472	91736
Chemical	121231	90153	79888	83670	91021	110636
Ferr.Met.	94313	73811	55780	58421	63553	77249
NF metals	18156	14710	12071	12642	13753	16717
Mech.Eng.	258655	217392	201653	211201	229755	279268
Construc.	127685	105385	98007	102647	111665	135729
Forest Pr	44077	36497	34498	36131	39305	47776
Food Ind.	132934	111107	104876	109841	119491	145242
Other	106366	90309	83303	87247	94911	115365
TOTAL	992806	811799	736315	771178	838925	1019719

TABLE 5: EMPLOYMENT - BASELINE SCENARIO

Subsectors	Employment/ Output Ratio	Number of Workers 1988	1991	1992	1994	1996	2000
Mining	1.50	134000	108586	99299	104001	113137	137519
Chemical	0.95	115000	85519	75782	79370	86343	104950
Ferr.Met.	1.34	126000	98610	74521	78049	84905	103203
NF metals	1.65	30000	24306	19945	20889	22724	27622
Mech.Eng.	3.05	789000	663131	615122	644246	700843	851879
Construc.	0.58	74000	61076	56800	59489	64716	78662
Forest Pr	3.02	133000	110128	104095	109023	118601	144160
Food Ind.	1.19	158000	132057	124651	130553	142022	172628
Other	4.16	443000	376125	346944	363371	395293	480481
TOTAL	2.02	2002000	1636999	1484784	1555085	1691698	2056269

TABLE 6: Decrease in Employment from Base Year

Baseline Scenario

	1991	1992	1994	1996	2000
Mining	-25414	-34701	-29999	-20863	3519
Chemical	-29481	-39218	-35630	-28657	-10050
Ferr.Met.	-27390	-51479	-47951	-41095	-22797
NF metals	-5694	-10055	-9111	-7276	-2378
Mech.Eng.	-125869	-173878	-144754	-88157	62879
Construc.	-12924	-17200	-14511	-9284	4662
Forest Pr	-22872	-28905	-23977	-14399	11160
Food Ind.	-25943	-33349	-27447	-15978	14628
Other	-66875	-96056	-79629	-47707	37481
TOTAL	-365001	-517216	-446915	-310302	54269

76

TABLE 7A: GROSS INDUSTRIAL PRODUCT (Millions of Czech Kcs)
Economic Price Scenario

	1988	1991	1992	1994	1996	2000
Mining	89389	72436	66241	68485	73577	87335
Chemical	121231	90153	79888	77485	78205	82493
Ferr.Met.	94313	73811	55780	54693	55734	59643
NF metals	18156	14710	12071	12107	12624	14133
Mech.Eng.	258655	217392	201653	207264	221328	259393
Construc.	127685	105385	98007	101657	109581	130973
Forest Pr	44077	36497	34498	35198	37309	43079
Food Ind.	132934	111107	104876	107537	114561	133635
Other	106366	90309	83303	86011	92265	109119
TOTAL	992806	811799	736315	750437	795184	919804

TABLE 7B: EMPLOYMENT - Economic Price Scenario

Subsectors	Employment/ Output Ratio	Number of Workers 1988	1991	1992	1994	1996	2000
Mining	1.50	134000	108586	99299	102664	110297	130921
Chemical	0.95	115000	85519	75782	73502	74186	78253
Ferr.Met.	1.34	126000	98610	74521	73069	74460	79682
NF metals	1.65	30000	24306	19945	20006	20859	23352
Mech.Eng.	3.05	789000	663131	615122	632239	675138	791251
Construc.	0.58	74000	61076	56800	58915	63508	75905
Forest Pr	3.02	133000	110128	104095	106208	112577	129989
Food Ind.	1.19	158000	132057	124651	127814	136163	158833
Other	4.16	443000	376125	346944	358224	384271	454466
TOTAL	2.02	2002000	1636999	1484784	1513262	1603494	1854790

37

energy prices over a longer period of time in order to allow new industries to emerge. Thus, allowing workers to make an intersectoral shift.

3.1.3 Income Effects

As discussed in Section 2.0 the loss of employment and slowdown of production will cause a loss of income. A loss of income both reduces spending and savings available for investment in expansion in the industrial sector. The average annual income of the workers in the industrial sector was 361,110 million Kcs in 1988. The industrial output was 992,806 million Kcs, giving an income-output ratio of 0.36. Assuming that this ratio is constant over the period 1988-2000, the impact on income can be determined under the conditions of each scenario.

Under the Baseline Scenario industrial workers' income losses would drop by 96000 million Kcs in 1992 relative to the year 1988. This income could be regained as employment and output increases, but if the industrial income-output ratio changes this may not hold true.

Under the Economic Price Scenario, output declines overall to 919,800 million Kcs in 2000, therefore, industrial income could drop by as much as 8% or 29,980 million Kcs.. This drop in income will result in a decrease in demand for goods. As mentioned in Section 2.0, every Krown which is not spent on consumption will result in more than a Krown reduction in total demand, due to the multiplier effect. Thus, the macroeconomic impacts will be greater than suggested the figures given above. Savings will also decline reducing the capital available for reinvestment. A more in-depth analysis of the effects of lost income within the economy should be considered before large price increases are made.

3.1.4 Other Macroeconomic Impacts

The Industrial Model is not intended to capture effects of government interventions or imports/export markets. Since it is not clear what the government is going to do or what political and financial limitations it might face, government activity was not included in the model. The effect of domestic changes on the exchange rate, on foreign trade and foreign competition is even harder to predict and was therefore left out as well. It should be kept in mind, however, that both the foreign sector as well as the government have significant influence on the course of the economy.

3.1.5 Role of Price and Income Elasticities

The drivers of the model are underlying exogenous growth rates of industrial output, changes in energy prices, and two distinct elasticity parameters; the price elasticity of demand for energy and the price elasticity of output. The growth rates and price changes are developed by the user based on expected policy choices. The elasticity terms within this model were based on long term responses to energy price changes in the U.S., because no empirical historical time series analyses have been completed within Czechoslovakia to

determine their magnitude. Even in the U.S. little is known about the magnitude of these parameters. The elasticities in the model are by no means intended to show the "true" relationship between output and demand with prices. They do, however, allow the user to simulate the influences of policy decisions on energy prices, energy efficiency, and economic growth.

Price elasticities of demand are included in the Industrial Model in a straightforward way. As prices increase, demand decreases resulting in a fall in energy use. Table 8a shows the own-price elasticity parameters by subsector and for each fuel. These partial elasticity terms represent long-term responses for each individual energy price increase. These parameters do not take into account the relative price increases of other fuels, and their substitutability, even though, cross-price elasticities are a more realistic representation of real world conditions. These elasticities are negative representing that for every percentage increase in energy prices, demand will decline by a unit percentage. For example, in the Chemicals sector, under the Baseline scenario, the elasticity of electricity is -0.20. Electricity prices are expected to change by 7.7% from 1988 to 1991. The resultant decline in energy use is about 1.5% (or 98.5% of the previous period's energy demand), as shown in Table 8b. Own-price elasticities vary between -1 and 1. The closer the elasticity is to -1, the greater the reduction in fuel demand per unit percentage increase in energy price, or the more elastic the industry becomes in reducing its fuel use. Table 8a and 8b show that the Mechanical Engineering, Construction and Food industry are expected to be more responsive to all fuel prices in reducing their demand by a greater percentage.

Higher energy prices will negatively influence Gross Domestic Product of the industrial sector, which in turn will reduce the predicted growth rate of the economy and hence further reduce output. A possible response of the firms is captured in a parameter called output price response. This feature in the model shows an expected response to higher prices; 1) for those industries unable to substitute another fuel or factor for energy, output will decline (despite expected economic growth); and/or 2) firms will shift their mix of energy input away from the relatively more expensive energy (the one whose price has increased relatively more than the other energies) towards the relatively less expensive ones.

The output responses are calculated similarly to the price elasticity of demand, except they do take into account the substitutability of fuels. For every percentage increase in fuel prices there is a percentage decline in output. Table 9a shows that the output response parameters vary by subsector and fuel type For example, the output in the chemicals sector is expected to decline by a greater percentage due to increases in district heat and natural gas price increases as compared to coal prices.

Although the elasticity terms in the Industrial Model are not based on empirical studies, they do allow the model user to conceptualize the output and energy demand responses to energy price increases. These elasticities are used under a partial equilibrium system within these models and therefore may not capture the full impacts of the energy price changes.

TABLE 8A: ENERGY PRICE RESPONSE BY SUBSECTOR AND FUEL TYPE:

	Electric	Dis.Heat	Coal	Coke	Petrol	Nat.Gas	Oth.Gas
Mining	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20
Chemical	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23
Ferr.Met.	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20
NF metals	-0.22	-0.22	-0.22	-0.22	-0.22	-0.22	-0.22
Mech.Eng.	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24
Construc.	-0.25	-0.25	-0.25	-0.25	-0.25	-0.25	-0.25
Forest Pr	-0.16	-0.16	-0.16	-0.16	-0.16	-0.16	-0.16
Food Ind.	-0.25	-0.25	-0.25	-0.25	-0.25	-0.25	-0.25
Other	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20

TABLE 8B: Industrial Energy Model
(Percentage change in energy use due to price changes)
Projected Year 1991

Policy Matrix 1991

	Electric	Dis.Heat	Coal	Coke	Petrol	Nat.Gas	Oth.Gas
Mining	0.985	0.904	0.981	0.981	0.842	0.999	0.905
Chemical	0.983	0.891	0.978	0.978	0.820	0.999	0.891
Ferr.Met.	0.985	0.904	0.981	0.981	0.842	0.999	0.905
NF metals	0.984	0.895	0.979	0.979	0.827	0.999	0.896
Mech.Eng.	0.982	0.886	0.978	0.977	0.813	0.999	0.887
Construc.	0.982	0.882	0.977	0.976	0.806	0.999	0.882
Forest Pr	0.988	0.923	0.985	0.985	0.871	0.999	0.923
Food Ind.	0.982	0.882	0.977	0.976	0.806	0.999	0.882
Other	0.985	0.904	0.981	0.981	0.842	0.999	0.905

TABLE 9: OUTPUT PRICE RESPONSE FOR EACH SUBSECTOR AND FUEL TYPE

	Electric	Dis.Heat	Coal	Coke	Petrol	Nat.Gas	Oth.Gas
Mining	-0.30	-0.10	-0.20	-0.05	-0.20	-0.10	-0.10
Chemical	-0.30	-0.52	-0.10	-0.14	-0.22	-0.55	-0.30
Ferr.Met.	-0.65	-0.40	-0.65	-1.02	-0.30	-0.22	-0.20
NF metals	-0.80	-0.34	-0.13	-0.08	-0.10	-0.40	-0.15
Mech.Eng.	-0.22	-0.10	-0.02	-0.06	-0.11	-0.10	-0.06
Construc.	-0.10	-0.15	-0.12	-0.05	-0.18	-0.10	-0.05
Forest Pr	-0.08	-0.12	-0.10	-0.04	-0.10	-0.08	-0.05
Food Ind.	-0.10	-0.10	-0.05	-0.05	-0.11	-0.08	-0.05
Other	-0.20	-0.10	-0.12	-0.04	-0.10	-0.10	-0.05

4.0 Summary

National and regional economic change occurs in response to numerous forces and is difficult to predict with meaningful accuracy. The conceptual and microsimulation models presented here, however, are important tools in anticipating the economic consequences of a changing energy world. While not precise, these models help in understanding the role of energy in a changing economic structure.

41

APPENDIX C: **RMA Transportation Energy Use and Emissions Model**
Effects of Shifting 20% of Rail Freight Tonnage to Trucks

RMA Transportation Energy Use and Emissions Model

Effects of Shifting 20% of Rail Freight Tonnage to Trucks

In this case study the freight portion of the transportation model is used to evaluate the changes in energy use and emissions when 20% of the tonnage from freight trains is switched to trucks in 1988 and projected out to the year 2000. This movement is done on a ton kilometer basis; so that CSFR's train and truck freight moves the same net distance per year. When freight is switched from rail to roadway the model shows that net energy use increases because diesel-fueled trucks are much less efficient per ton shipped than trains. Electricity demand decreases (by about 20%) and diesel demand increases (by about 40 %), resulting in decreased SO2 and increased NOx emissions.

To analyze how energy demand and emissions change, due to the shift, from trains to trucks, two scenarios, 1A and 1B, were compared to a base scenario and each other. (The base scenario is outline in appendix 4 and in the User's Guide to the Transportation Energy Demand and Emissions Model.) The two scenarios are run with the same economic growth indicators and fuel prices as the base case scenario. Scenario 1A is run with the same vehicle characteristics as the base case scenario, except that 20% of the ton kilometers are shifted from rail onto roadways. Scenario 1B assumes that as long-haul train shipping is replaced by trucks both the average fuel efficiency and trip length of the trucks will increase.

1. Base Case

The summary of Base Case Freight Transportation energy demand and emissions are given on Table 1.

2a. Scenario 1A

Assumptions:

1) Net ton kilometers remain the same as in the base case. 20% of the ton-km from railroads were shifted to the roadways (trucks).
2) Trip length remains fixed for both trains and trucks.
3) Fuel efficiencies are the same as for the base case.
4) Truck speed remains the same (vehicle speed is set at 32 km/hour in the emissions model).
5) The electricity is generated from the same mix of fuels (soft coal, hard coal, hydro, nuclear, gas and oil) as in 1988.

4B

Results:

Energy demand and emissions for the base case are given in Table 1
Energy demand and emissions for the Scenario 1A are given in Table 2

Comparison between Base Case and Scenario 1A energy demand and emissions are given in Table 3.

2b. Scenario 1B

Assumptions:

1) Net ton kilometers remains the same as the base case.
2) Trip length for trucks increases from 18.5km to 109.6km, as long-haul trucks replace freight trains. (See section 6 for the calculation of trip length.)
3) Fuel efficiency of the truck fleet increases from 34.49 to 31.04 liters/100km (a 10% improvement). This is due to the assumption fuel efficiency improves when trucks run faster with fewer stops on the highway system.
4) Truck speed remains the same (limited by emissions model, see section 5).

Results:

Energy demand and emissions for Scenario 1 B are given in Table 4.

Comparison between Base Case and Scenario 1B energy demand and emissions are given in Table 5.

Comparison between Scenario 1A and Scenario 1B energy demand and emissions are given in Table 6.

2c. Summary Tables

Energy use and emissions for the three scenarios are compared in Figures 1-4. Note that emissions in scenarios 1A and 1B are the same. This is because total vehicle kilometers remain the same and the improved fuel efficiency of the trucks, in scenario 1B, is not incorporated into the emissions model (see section 5).

3 Comparison of Fuel Costs, Emmissions and Electric Capacity Generation

3a. Change in fuel expenditure for 1991

Fuel costs (1991):

Diesel 18 Kcs/litre
Electricity 0.71 Kcs/Kwh

Scenario 1A

(+292x10^6 litres)(18 Kcs/litre) = +5.256x10^9 Kcs
(-330x10^6 Kwh)(0.71 Kcs/Kwh) = -.234x10^9 Kcs

Total cost: 5.022x10^9 Kcs

Scenario 1B

(+205x10^6 litres)(18 Kcs/litre) = +3.690x10^9 Kcs
(-330x10^6 Kwh)(0.71 Kcs/Kwh) = -.234x10^9 Kcs

Total Cost: +3.456x10^9 Kcs

These calculations show the fuel costs associated with switching freight from rail to road. More importantly they show the benefit (1.5 billion Kcs) of the improved truck fuel efficiencies. Since this scenario is based on improved fuel effiency due to higher speeds and better roads, it is likely that even greater benefits could be achieved by replacing inefficient trucks with fuel efficient trucks.

3b. Change in Emissions

If only base-load brown-coal fired power plants were shut down due to electricity demand reduction in scenarios 1A and 1B, the NOx and SO2 emissions are also reduced as compared to the base case for the year 1991 as shown below.

Emissions from brown-coal fired power plants:

NOx: .972 grams/Kwh
SO2: 6.98 grams/Kwh

NOx:

(330x10^6Kwh)(.972 g/Kwh)(10^-6 tonne/g) = 320 tonnes

SO2:

(330x10^6Kwh)(6.98 g/Kwh)(10^-6 tonne/g) = 3,293 tonnes

45

3c. Base Load Capacity Reduction

Reduction in base load capacity for 1991 due to the decreased electricity demand in scenarios 1A and 1B as compared to the base case is shown below.

(330x10^3 Mwh/year)(year/8,760 hours) = 37.6 MW of capacity

4 Discussion

There are several issues associated with the costs and benefits of utilizing trucks in replacement of trains to haul 20% more tons of goods. Some issues are: 1) whether it is cost effective from a refinery standpoint to increase diesel production, 2) whether utilizing trucks will facilitate privatization of transportation and industries and 3) whether it is more costly to maintain the roadway versus railway infrastructure.

If refineries significantly increase their production of diesel, typically production of gasoline increases as well. If it is anticipated that the use of passenger automobiles, hence gasoline demand, will increase rapidly in the future, then creating a increased market for diesel fuel is appropriate. The flexibility of the refineries, added costs and the characteristics of the crude oil should be considered before a shift from trains to trucks is made.

It is possible that increased use of trucks may facilitate privatization but this may be a more costly option. It will be extremely difficult to privatize and generate competition in CSFR railway system. Because of low entry costs in the trucking sector, competitive free-market conditions will prevail in this sector. Truck transportation is more flexible than the railways. Trucks are better suited to support a widely distributed production and sales infrastructure typical of a private market-based economy. Relying on the railway network may act to hinder privatization of the CSFR economy.

On the other hand, with a large shift of tonnage from rail to road large investments must be made to improve roadways, docking facilities and to purchase trucks. Roads will have to be repaired more frequently. An analysis of the full costs and benefits of increasing truck utilization should be undertaken before the shift is made.

5 Limitations of the transportation model

a. Note emissions should change with fuel efficiency, but as discussed above net truck emissions in scenarios 1-A and 1-B do not change, although fuel efficiency does. Calculated emissions for petroleum fueled vehicles do not include effects of fuel efficiency. The emissions data base was derived from the average emissions for American pre-emissions control (pre-1974) vehicles. This emissions data (grams per kilometer traveled) is dependent on vehicle speed not fuel efficiency. The emissions modeled is further limited because it lacks data for vehicles traveling faster than 32 km/hour.

b. There is no information in the emission portion of the model to calculate emissions for diesel or diesel-electric trains. The model only contains emission data from the power stations for electric powered trains.

6 Calculations

For average truck trip length in scenario 1-B.

(TNtlb)(1 - TKtb/TKts) + (TKtlb)(TKtb/TKts)

(255km)(.385) + (18.5km)(.615) = 109.6 km

TNtlb = Train trip length base case
TKtb = Truck trips base case
TKts = Truck trips scenario 1-B
TKtlb = Truck trip length base case

47

Year	Diesel 10^6 liters	Electricity Twh	NOx tons/year	SO2 tons/year
1988	1140	1806	43266	7215
1991	741	1647	35328	6492
1992	705	1501	33597	5948
1994	739	1572	35187	6230
1996	840	1711	38279	6777
2000	976	2079	46528	8237

Table 1. Energy use and emissions for the freight sector; base case scenario.

Year	Diesel 10^6 liters	Electricity Twh	NOx tons/year	SO2 tons/year
1988	1588	1445	69533	6498
1991	1033	1317	56701	5785
1992	983	1201	53951	5321
1994	1029	1258	56506	5573
1996	1120	1368	61470	6063
2000	1362	1663	74717	7370

Table 2. Energy use and emissions of the freight sector: 1A scenario.

Year	Diesel 10^6 liters	Electricity Twh	NOx tons/year	SO2 tons/year
1988	448	-361	26267	-717
1991	292	-330	21373	-707
1992	278	-300	20354	-627
1994	290	-314	21319	-657
1996	280	-343	23191	-714
2000	386	-416	28189	-867

Table 3. Difference in energy use and emissions between the Base Case and 1A scenarios.

	Diesel 10^6 liters	Electricity Twh	NOx tons/year	SO2 tons/year
1988	1455	1445	69533	6498
1991	946	1317	56701	5785
1992	901	1201	53951	5321
1994	943	1258	56506	5573
1996	1126	1368	61470	6063
2000	1247	1663	74717	7370

Table 4. Energy use and emissions of the freight sector: 1B scenario.

Year	Diesel 10^6 liters	Electricity Twh	NOx tons/year	SO2 tons/year
1988	315	-361	26267	-717
1991	205	-330	21373	-707
1992	196	-300	20354	-627
1994	204	-314	21319	-657
1996	186	-343	23191	-714
2000	271	-416	28189	-867

Table 5. Difference in energy use and emissions between the Base Case and 1B scenarios.

Year	Diesel 10^6 liters	Electricity Twh	NOx tons/year	SO2 tons/year
1988	-133	0	0	0
1991	-87	0	0	0
1992	-82	0	0	0
1994	-86	0	0	0
1996	-94	0	0	0
2000	-115	0	0	0

Table 6. Difference in energy use and emissions between the 1A and 1B scenarios.

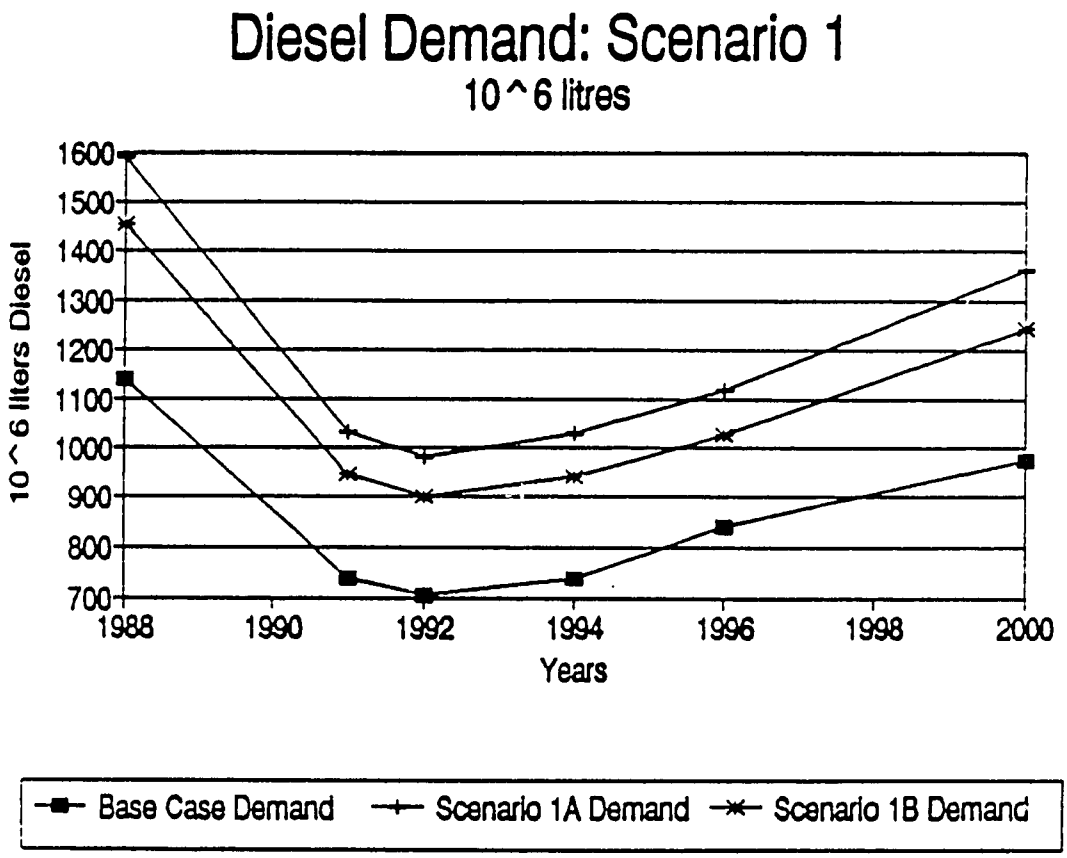

Diesel Demand: Scenario 1
10^6 litres
10^6 liters Diesel
1600
1500
1400
1300
1200
1100
1000
900
800
700
1988
1990
1992
1994
1996
1998
2000
Years
Base Case Demand
Scenario 1A Demand
Scenario 1B Demand

Figure 1.

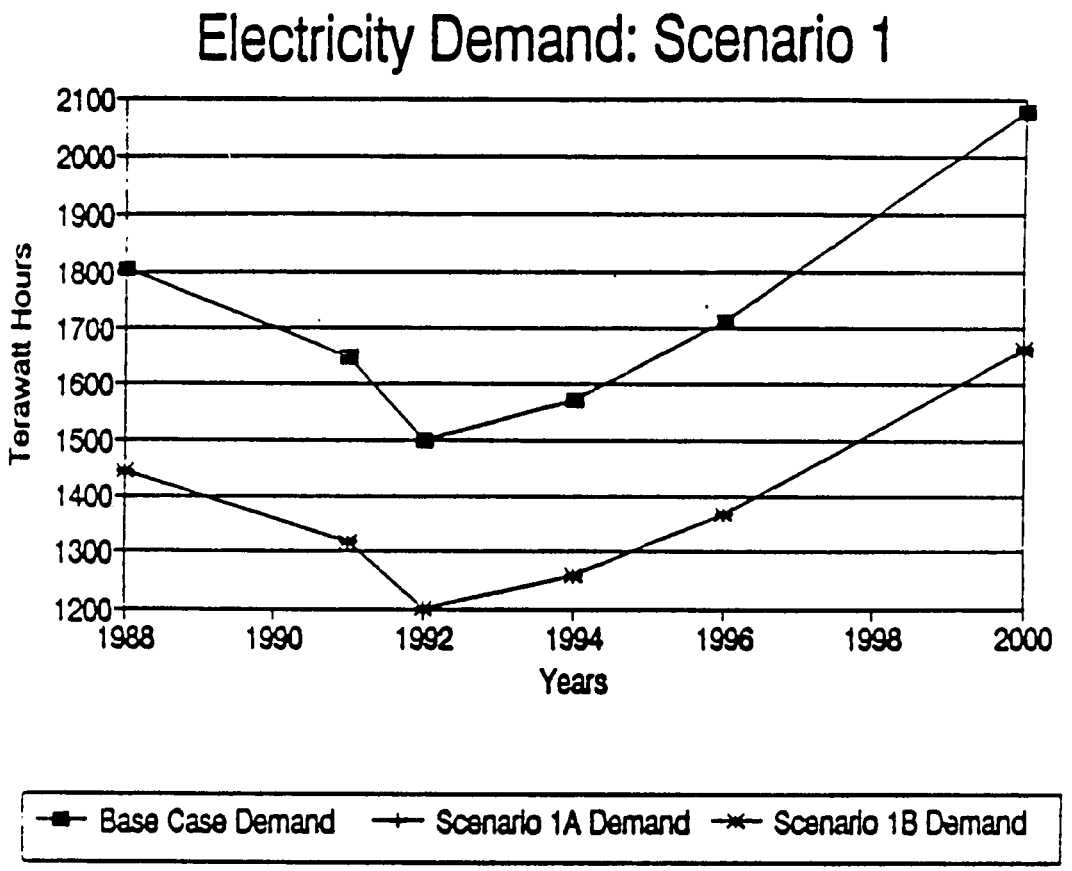

Electricity Demand: Scenario 1
Terawatt Hours
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1988
1990
1992
1994
1996
1998
2000
Years
Base Case Demand
Scenario 1A Demand
Scenario 1B Demand

Figure 2.

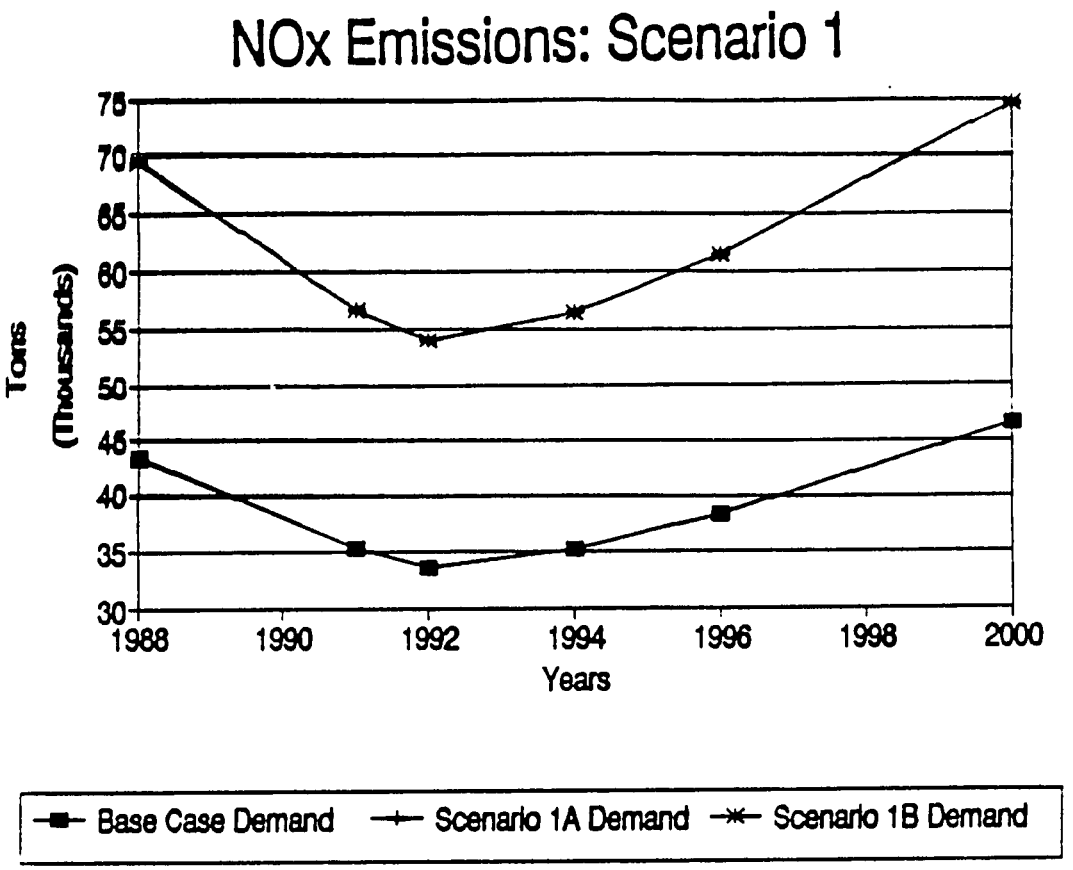

NOx Emissions: Scenario 1
Tons
(Thousands)
75
70
65
60
55
50
45
40
35
30
1988
1990
1992
1994
1996
1998
2000
Years
Base Case Demand
Scenario 1A Demand
Scenario 1B Demand

Figure 3.

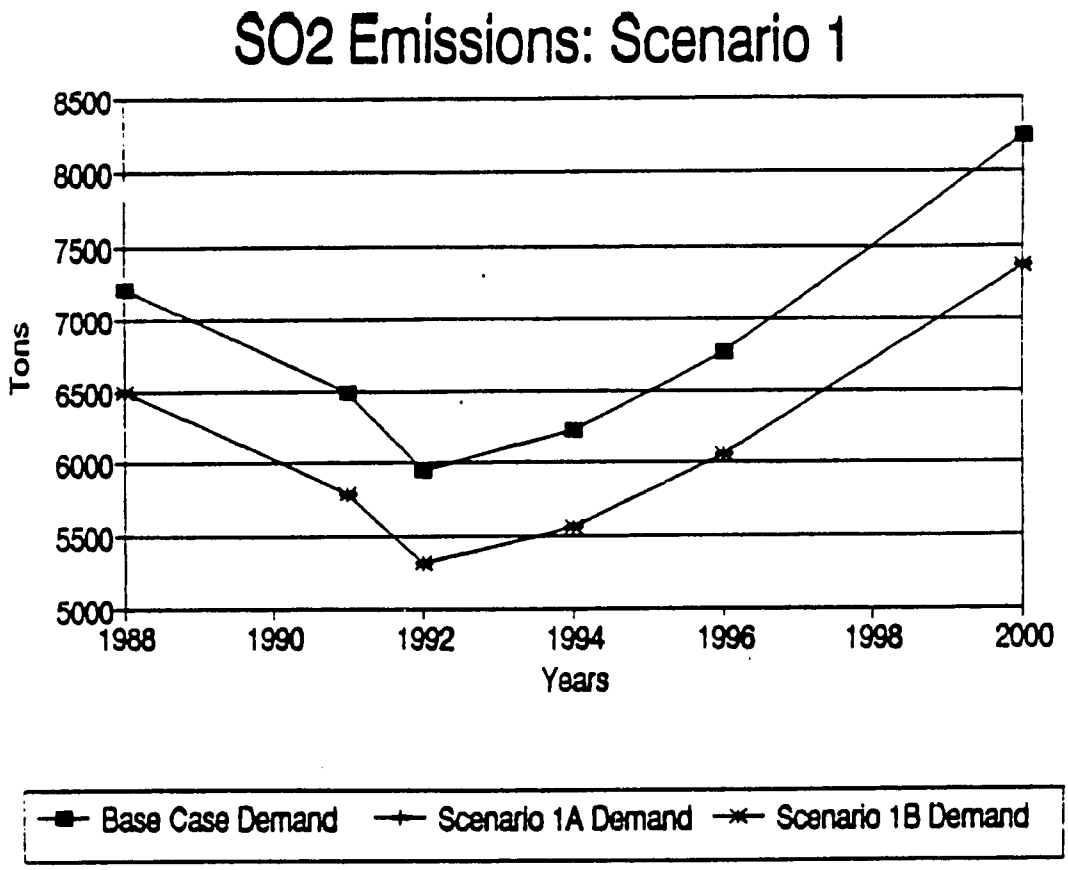

SO2 Emissions: Scenario 1
8500
8000
7500
7000
6500
6000
5500
5000
Tons
1988
1990
1992
1994
1996
1998
2000
Years
Base Case Demand
Scenario 1A Demand
Scenario 1B Demand

Figure 4.

1988 mode	fuel	Ton Km per year 10^6	Vehicle Km/Year 10^6	Diesel 10^6 liter	Electricity Twh	Fuel Use 10^3 GJ	NOx tons/year	SO2 tons/year
Train	diesel	22578	36	320		11853		
	electricity	51751	83		1806	6521	961	6336
Truck	diesel	23767	2377	820		30330	42305	879
		98096	2496	1140	1806	48704	43266	7215
1991								
Train	diesel	18387	30	208		7702		
	electricity	47179	76		1647	5944	876	5776
Truck	diesel	19355	1935	533		19709	34452	716
		84921	2041	741	1647	33355	35328	6492
1992								
Train	diesel	17504	28	198		7333		
	electricity	43016	69		1501	5420	799	5266
Truck	diesel	18426	1843	507		18763	32798	682
		78946	1940	705	1501	31516	33597	5948
1994								
Train	diesel	18333	30	208		7680		
	electricity	45053	73		1572	5677	836	5516
Truck	diesel	19298	1930	531		19651	34351	714
		82684	2033	739	1572	33008	35187	6230
1996								
Train	diesel	19943	32	262		8354		
	electricity	49011	79		1711	6175	910	6000
Truck	diesel	20994	2099	578		21378	37369	777
		89948	2210	840	1711	35907	38279	6777
2000								
Train	diesel	24241	39	274		10155		
	electricity	59573	96		2079	7506	1106	7293
Truck	diesel	25518	2554	702		25985	45422	944
		109332	2689	976	2079	43646	46528	8237

Appendix 1: Shipping Rates, Energy Use and Emissions for the base case Scenario

1988 mode	fuel	Ton Km per year 10^6	Vehicle Km/Year 10^6	Diesel 10^6 liters	Electricity Twh	Fuel Use 10^3 GJ	NOx tons/year	SO2 tons/year
Train	diesel	18062	29	256		9482		
	electricity	41401	67		1445	5216	767	5069
Truck	diesel	38633	3863	1332		49300	68766	1429
		98096	3959	1588	1445	63998	69533	6498
1991								
Train	diesel	14709	24	167		6162		
	electricity	37743	61		1317	4756	701	4621
Truck	diesel	31461	3146	866		32037	56000	1164
		83913	3231	1033	1317	42955	56701	5785
1992								
Train	diesel	14003	24	159		5866		
	electricity	34413	61		1201	4336	639	4213
Truck	diesel	29951	3146	824		30499	53312	1108
		78367	3231	983	1201	40701	53951	5321
1994								
Train	diesel	14666	24	166		6144		
	electricity	36042	58		1258	4541	669	4412
Truck	diesel	31369	3137	863		31943	55837	1161
		82077	3219	1029	1258	42628	56506	5573
1996								
Train	diesel	15955	26	181		6683		
	electricity	39208	63		1368	4940	728	4800
Truck	diesel	34125	3412	939		34749	60742	1263
		89288	3501	1120	1368	46372	61470	6063
2000								
Train	diesel	19393	31	220		8124		
	electricity	47658	77		1663	6005	885	5835
Truck	diesel	41479	4148	1142		42238	73832	1535
		108530	4256	1362	1663	56367	74717	7370

Appendix 2: Shipping Rates, Energy Use and Emissions for the 1A Scenario

1988 mode	fuel	Ton Km per year 10^6	Vehicle Km/Year 10^6	Diesel 10^6 liters	Electricity Twh	Fuel Use 10^3 GJ	NOx tons/year	SO2 tons/year
Train	diesel	18062	29	256		9482		
	electricity	41401	67		1445	5216	767	5069
Truck	diesel	38633	3863	1199		44369	68766	1429
		98096	3959	1455	1445	59067	69533	6498
1991								
Train	diesel	14709	24	167		6162		
	electricity	37743	61		1317	4756	701	4621
Truck	diesel	31461	3146	779		28832	56000	1164
		83913	3231	946	1317	39750	56701	5785
1992								
Train	diesel	14003	23	159		5866		
	electricity	34413	55		1201	4336	639	4213
Truck	diesel	29951	2995	742		27448	53312	1108
		78367	3073	901	1201	37650	53951	5321
1994								
Train	diesel	14666	24	166		6144		
	electricity	36042	58		1258	4541	669	4412
Truck	diesel	31369	3137	777		28748	55837	1161
		82077	3219	943	1258	39433	56506	5573
1996								
Train	diesel	15955	26	181		6683		
	electricity	39208	63		1368	4940	728	4800
Truck	diesel	34125	3412	845		31273	60742	1263
		89288	3501	1026	1368	42896	61470	6063
2000								
Train	diesel	19393	31	220		8124		
	electricity	47658	77		1663	6005	885	5835
Truck	diesel	41479	4148	1027		38013	73832	1535
		108530	4256	1247	1663	52142	74717	7370

Appendix 3: **Shipping** Rates, Energy Use and Emissions for the 1B Scenario

APPENDIX 4

Table 1. Personal Transport by Vehicle Type for CZECHOLSOVAKIA in 1988

Vehicle Type	Average Trip Length KM	Load Factor Persons/ Vehicle	Fuel Efficienies			Person Trips Per Day
			Electricity KWH/100K	Gasoline L/100K	Diesel L/100KM	
Train	48.20	180.00	987.00		332.00	1131233
Subway	5.65	80.00	286.00			1222800
Trolley Car	4.02	40.00	191.60			860720
Street Car	6.50	40.00	385.00			1924923
Bus	5.75	21.00			39.80	2115169
Car	10.00	2.00		11.00		15528767

Table 2. Freight by Vehicle Type for CZECHOSLOVAKIA in 1988

Vehicle Type	Trip Length KM	Load Factor Tons/ Vehicle	Fuel Efficiencies		Tons Shipped/Day	
			Electricity KWH/100K	Diesel L/100KM	Electric	Diesel
Train	255	621	2167.4	881.1	566014	243580
Truck	18.5	10		34.49		3519733.43

APPENDIX D: **Excerpts from the "Proceedings of the Workshop on Energy Pricing Reform In Czechoslovakia"**
Bratislava, Czechoslovakia
May 21 - 22, 1991

The Experience in the United States Concerning Two Price and Planning Issues: Environmental Costs and The Utilization of Private Sector Energy Resources

Prepared by:
Harvey Salgo
Tellus Institute

.54

The Experience in the United States Concerning Two Price and Planning Issues: Environmental Costs and The Utilization of Private Sector Energy Resources

Prepared by: Harvey Salgo of the Tellus Institute, May 10, 1991

I. Introduction

This paper addresses two developments in energy policy in the United States: (1) the growing involvement of the private sector in the provision of energy services, and (2) the movement toward the inclusion of environmental costs in the selection of resources and in the pricing of energy services. The focus of the paper is on the electric power sectors which, in the U.S., is substantially regulated.[1] While the paper concerns the experience in the United States, there are parallels and examples in other countries as well.

The growth in the utilization of private sector energy services -- both for power generation and conservation -- has resulted in a new understanding of what is, and what is not, a "natural monopoly", which will be an important topic at our May 21-22 workshop in Bratislava. The increasing consideration of non-internalized environmental costs (so-called "externalities") in the selection and use of resources reflects a recognition that energy use has consequences which are not adequately accounted for in traditional market or regulatory pricing. This is also an important topic for our workshop discussions.

[1] In the U.S. many aspects of the natural gas industry are also extensively regulated, although this paper does not address that industry directly. In the U.S., contrary to Czechoslovakia, relatively little heat or steam is provided from large central plants; and, in general, heat and steam transactions are not regulated.

60

In order to understand these two developments, it will be useful to begin with some background information concerning U.S. energy policy and the structure of the utility industry. After this discussion, the paper addresses the private sector involvement and environmental costs. In general, the paper is written from a practical rather than a theoretical perspective.

II. Background

The United States has hundreds of electric and gas utilities, most of which are investor owned; that is, the equity capital is from the private sector. These investor owned utilities (or IOUs as they are often referred to) -- as well as other types of utilities[2] -- are extensively regulated. Sales to all users -- residential, commercial, industrial -- are regulated by the state Public Utilities Commissions, of which there are 50. Sales between utilities, which are common in the U.S., are regulated by the Federal Energy Regulatory Commission.[3]

In general, all utility prices and tariffs (rate structures) are regulated, which means that they must be approved by the appropriate regulatory authority. However, the states differ somewhat concerning regulation of utility planning, with some exercising significantly more oversight that others.

---

[2] The other types of utilities include so-called municipal systems, which are 100% debt financed, rural electric cooperatives, and federal power agencies (such as the Tennessee Valley Authority and the Bonneville Power Authority).

[3] FERC regulates transactions between utilities -- which are known in the U.S. as **wholesale** transactions -- while the PUCs regulate sales to all consumers (industry, commercial, residential) -- which are known as **retail** transactions. It is important to note that the terms **wholesale** and **retail** are used quite differently in the U.S. and Czechoslovakia.

61

The utilities differ significantly in size and scope. Some are as large as 20,000 MW or so, while others are only a few hundred MW or less. Until recently, the larger utilities either built and operated their power plants with their own staffs or commissioned engineering companies to build them and turn them over to the utilities for operation.

In the past 12 years or so, another option has emerged; power plants now are often built, owned and operated by non-utility companies.[4] In these instances, power is sold to the utility under a long-term contract (typically 20 years) which specifies the price to be paid for the electricity and other important terms and conditions.

The growth of the non-utility generating companies would not have been possible without the passage by the U.S. Congress of the federal Public Utilities Regulatory Policies Act (or PURPA) in 1978. PURPA changed regulation in important ways which encouraged non-utility generation. At this time, a large portion of new electric generation will be provided by these companies. One source estimates that, between 1990 and 1999, 12,255 MW of new non-utility generation will be added in the U.S. This represents 21% of the planned additions.[5] It is no longer assumed that electric generation, unlike transmission and distribution, is a natural monopoly.

PURPA led to a fundamental change in the ways in which utilities in the U.S. obtained electric generation. Because the change was so fundamental, it took several years

---

[4] The term "non-utility generation" (or NUGs) is widely used in the U.S., but it is sometimes confusing or misleading. For example, some utilities have set up separate subsidiaries which own and operate power plants in the territories of other utilities. These projects function as NUGs even though they are fully or partially owned by a utility outside the territory. Even though the term non-utility generation is used, it also refers to situations such as the one just described.

[5] North American Electric Reliability Council, *Electricity Supply and Demand for 1990-1999*, Princeton, New Jersey.

62

from its passage in 1978 until there were significant numbers of non-utility power plants. It took time for lenders and equity investors to be comfortable with the new business; contract provisions had to be negotiated; utilities had to revise their ways of thinking about new power plants; fuel providers had to be willing to provide long-term contracts to these private companies; there had to be a demonstration that the power plants would be operated reliably; and so on.

At this time, non-utility private power projects of varying sizes (from less than 1 MW to many hundreds of MW) and fuel types (coal, gas, oil, hydro, other renewable fuels) are operating. Some are cogenerators (providing both electricity and steam or heat), while others are not. There are even some non-utility generating companies which own and operate nuclear plants, although this presents problems which are quite different from those concerning fossil plants, for example.[6]

In addition to the provision of power from non-utility sources, the private sector is also providing conservation services to the utilities and their customers. In recent years, there has been a very rapid growth in energy service companies which perform these services.

The growing interest in conservation in the U.S. has been prompted by a desire to reduce the dependence on foreign sources of fuels, such as oil and natural gas,[7] as well as

---

[6] One of the issues which has arisen concerns nuclear plant decommissioning and what would happen if a private owner were unable to afford to decommission the plant safely, or safely dispose of spent nuclear fuel. In other words, the question is whether or not all nuclear unit functions can or should be privatized.

[7] Despite the wealth of U.S. domestic fuel resources, some portions of the country are resource poor. New England, for example, is relatively heavily dependent upon external fuel (oil and gas) as compared with other regions such as the Southwest.

an increasing concern with the environment. The environmental concerns have led to the consideration of a wide variety of policies, including selective taxes and more restrictive control of a number of pollutants. This paper discusses the development of two types of approaches in the utility field: (1) the federal Clean Air Act which allows a certain amount of SO2 emissions annually, and which encourages trading in the "allowances", and (2) the inclusion of so-called environmental externalities in the resource acquisition process.

III. Private Sector Energy Services

As noted above, PURPA is an Act which was passed by the U.S. Congress and signed into law by the President. PURPA requires that special consideration be given to certain types of private power projects[8] and that the state Public Utilities Commissions require the utilities which they regulate to purchase power from such projects. The approaches taken by the 50 PUCs to the implementation of PURPA have been quite different from one another. One approach, which is often used now, is to require that the utilities identify their needs for power (or conservation services) and solicit proposals competitively from energy services companies; thus, the energy services companies compete to provide the desired resources. This has become known as "competitive bidding" for resources.

Whatever the approach taken, increasing the utilities' reliance on private sector resources requires the development of a significant infrastructure. A substantial effort is

[8] Prior to PURPA it was virtually impossible to structure a transaction between a private power project and a utility. If one could be arranged, it would be regulated by the FERC. PURPA changed the law to allow such sales from cogenerators and renewable resource projects (hydro, solar, biomass, and others) to take place without regulation. Over time, other projects -- such as thermal plants which do not cogenerate -- are being built and operated privately as well.

necessary. The rest of this section discusses some selected issues concerning the development of a private power program.

In addition to the planning which utilities traditionally undertake to identify resource needs, there must be staff capable of creating acceptable requests for proposals, evaluating proposals from different companies, and assessing the capabilities of the companies to deliver the proposed services, whether it is power from a power plant or conservation.[9] In addition, it will be necessary to devote a significant amount of time to learning about and negotiating acceptable contractual arrangements. In the U.S. we have found that this is especially difficult and time consuming the first time that it is tried. However, as the market develops, and the buyers (utilities) and the sellers (private sector energy services companies) gain more experience with each other, the requirements for each of the tasks tends to decline. In other words, as the market 'matures', reduced staff and related requirements will result.

It is also important that the requirements for private power project financing be understood by all parties. These facilities are most often financed by so-called project financing (or non-recourse) mechanisms. To secure this sort of financing many conditions must be in place. These include acceptable power purchase contract terms, a belief that the contracts can be enforced, acceptable fuel agreements, a clear understanding that profits may be repatriated, some protection against the risks of currency devaluation, and so on.

---

[9]There are a variety of types of resource solicitations in the U.S. electric industry. In some instances, the utility will be quite specific concerning the type of facility it wants built and operated privately. In other circumstances, a utility might identify the number of megawatts it needs (in power and/or conservation) plus some other criteria -- such as timing, dispatchability, reliability, and so on -- and ask for proposals without specifying the precise type of facilities or services it is seeking. What method or approach is preferable will depend upon the specific circumstances of the utility.

65

If there is interest in Czechoslovakia in developing a private power program with foreign investment, it will be necessary for the Government to consider numerous policy matters: for example, whether it is willing to provide any protection against currency devaluation. Interesting approaches to currency protection have developed elsewhere and will be important to consider.[10]

It will also be important for the Government to consider the macroeconomic impacts of a private power program: for example, the impact on the balance of payments, the national capital development budget and the debt situation. Similarly, it will be necessary to evaluate the financial impact on the utility and electricity consumers, as well as potential impacts on the utility operations.

Another matter which it is critical to address concerns the maximum amount to pay for private power or any energy services. In the U.S. (and many other countries) the price to be paid for power or conservation services is generally limited by a utility's avoided cost.[11] Avoided costs may be calculated in various ways, but, in practice, avoided costs often refer to the costs that the utilities expect to incur for their next one or more power resources. Avoided costs are significantly affected by a number of important assumptions, including the finance costs for any future "avoidable" resource. What will be the real costs of borrowing in the future? If there are equity investors in the country's power sector -- that

---

[10] Problems will arise if the payments for power are in one currency (such as the Czech currency) and debt service must be paid in another (such as U.S. currency). It is possible to consider ways to disaggregate the payment stream so that, for example, the portion of the payment which must go to debt service is in one currency (dollars, for instance, or a basket of hard currencies), while the portions which are for fuel, labor, profits, and so on, are in one or more other currencies.

[11] As will be discussed and explained in the next section of this paper, in some instances the cost of the environmental externalities associated with the "avoidable" power plant have been added to avoided costs.

is, the utility is privatized (much like a U.S. IOU) -- what will be the cost of that equity? And what capital structure should be assumed in the calculation of avoided cost?[12] Naturally, other issues will also have to be addressed carefully as well.

To summarize, in order to develop a business environment which will effectively attract and utilize private sector energy services companies (power or conservation), several steps must be taken. In addition to comprehensive planning -- now often referred to as least cost planning -- it will be necessary to develop:

- an appropriate legal and regulatory structure;
- an understanding of the contract and other requirements so that such projects may be financed and undertaken;
- an understanding of what sort of contractual arrangements will best suit the country's needs, including whether or not joint ventures with private entrepreneurs will be considered in appropriate circumstances;[13]
- methods for soliciting projects (which need not be "competitive bidding"), evaluating proposals, and selecting the best projects;
- an appropriate approach to the calculation of avoided costs;

---

[12] U.S. investor-owned utilities typically have capital structures which are in the range of approximately 45 - 50% equity with the balance in short and long-term debt. Private power projects often have 20% equity or less; that is, they are much more highly leveraged, which is what is meant by having a greater portion of debt in the capital structure. Obviously, the finance costs for any project will depend upon both the capital structure and the costs of the debt and equity components.

[13] An example of a contractual decision which it is necessary to make is as follows. Several countries have expressed a preference for private power projects which the developers Build, Own, Operate, and eventually Transfer to the host utility. These are known as BOOT arrangements. In the U.S., on the other hand, most private power projects are not contractually bound to transfer ownership to the utility. The two different approaches have very different implications for contracting and financing.

- rules and procedures for the integration of private resources into utility operations, including rules for monitoring operation and maintenance;
- an understanding of the macroeconomic impacts of such a program;
- appropriate policies concerning such matters as: repatriation of profits, whether or not to provide any special incentives or protection;
- and so on.

As mentioned earlier, it will take significant time and effort to successfully integrate private energy services companies into the country's power sector. Indeed, it took many years to integrate non-utility private companies into the U.S. system. Fortunately, it is possible to learn from the U.S. experience of recent years and avoid the mistakes which were made in the process.

IV. Environmental Costs

There has been a growing concern with environmental issues in all countries. In the U.S and elsewhere all power plants must meet the environmental requirements which are in place when they are constructed and operated. The costs of meeting these requirements become part of the plant costs and, in our terms, we would say that these costs have been "internalized". For example, the equipment which is necessary to reduce coal particulate emissions to required levels would be included in the cost of the power plant; that is, it would be an internalized cost which is paid for by the utility and is passed on to the consumers of electricity in the rates that they pay to the utility.

It is evident, however, that even after all environmental regulations have been met there are still air emissions and other environmental impacts. These impacts are, in economic terms, environmental "externalities".[14] Because the externalities associated with different plants (gas versus coal, for instance, or between the types of coal facilities) will not be the same, the question is whether to consider the different externalities impacts in the selection of resources.

An example will be useful; the one which follows is entirely hypothetical. Suppose that the cost of power from a new coal plant is expected to be $.06/kwh (6 cents/kwh)[15] on a levelized basis and that the expected cost from a natural gas plant is $.075/kwh (7.5 cents/kwh) on a levelized basis.[16] Both of the plants will be built to satisfy all existing environmental requirements, but the environmental externalities associated with the coal plant are greater than those for the gas plant. In other words, the remaining emissions and other impacts from coal exceed those from the gas plant. Which plant should the utility build? Or, if the plants are private power projects, which should it contract with for power?

If environmental externalities are not a factor in the decision making process, then the choice is the coal plant. It is less expensive and, as indicated above, it is assumed that all other aspects of the plants -- such as reliability -- are the same.

---

[14] More generally, an externality is the impact on, or cost to, society which results from the production and consumption of goods and services. The externalities associated with electricity production and consumption include air and water emissions, used nuclear fuel, impacts on waterways from hydro construction and operation, and so on.

[15] The examples use U.S. dollars for costing. At an exchange rate of 28 kcs/$, $.06/kwh = 1.68 kcs/kwh.

[16] The assumption for this hypothetical example is that all other aspects of the plants are the same. That is, it is assumed that they are the same size, are equally reliable, have equivalent access to fuel and so on. These assumptions are made so that we may focus solely on the issue of cost and environmental externalities.

69

However, if the difference in the externalities associated with the two plants are to be a factor in the selection process, which one should be chosen? It is not possible to answer this question until we determine whether the difference in the costs which the environmental externalities impose on society is more or less than 1.5 cents/kwh, which is the difference between the cost per kilowatthour from gas (7.5 cents) and coal (6 cents) generation in our hypothetical example.

In the U.S. there is a growing consensus that the different environmental impacts should be considered; but there is not yet agreement as to how that should be done.[17] Whatever the approach taken, the fundamental question remains: how much more should consumers pay for cleaner power in this and other examples? It is precisely because there are so many possible real world examples and situations that a comprehensive analytical approach to the problem is required.

One approach is to estimate, in monetary terms, the cost to society of the different emissions and other impacts. For example, one would estimate a value for each emission on, for example, a $/ton basis. Thus, if the emission of a hypothetical pollutant were valued at $10/ton -- that is, its impact on society is estimated to be $10/ton -- one could compare the two power plants on that pollutant. One would estimate the amount of the pollutant expected from the coal and gas plant and (with appropriate assumptions concerning the amount of electricity to be generated from each plant) compare their impacts on a $/kwh basis. And, if all the emissions were valued with a similar methodology, the externalities

[17] At this time, relatively few state Public Utilities Commissions (PUCs) require utilities to include externalities in their selection and operation of resources. It is likely, in my view, that the number will increase substantially. In addition, as noted in this paper, the federal Clean Air Act will impose some changes on utility decisions.

70

associated with the plants could be compared directly. If the externalities costs per kwh exceed 1.5 cents/kwh one would choose the gas plant; if less than 1.5 cents/kwh, the coal facility would be selected.

Placing monetary values on environmental externalities is known as "monetizing" the externalities. Other approaches, such as a less formal ranking of the impacts of the different pollutants are also possible. Regardless of the method used, however, one should not lose sight of the central problem: how to decide between resources with different costs and different environmental impacts.

The tables and graph on the next three pages illustrate the use of monetized externalities. The first page is an example of air emissions costs for a gas combined cycle (CC) plant without selective catalytic reduction (SCR)[18] The table demonstrates how the calculation would be made for this hypothetical plant which uses gas for 40% of its generation and oil for the remaining 60%; the calculation (2.70 cents/kwh) is in 1989 dollars. The next page shows emissions coefficients for selected plants.[19] Emissions coefficients are the pounds (lbs)/MWH of emissions of the various pollutants. Finally, the graph shows the emissions costs for the resources identified on the previous page.[20] Unless one uses emissions costs which are significantly different from those used in these examples, it is evident that there are large differences among facilities.

---

[18] Selective Catalytic Reduction or SCR is a catalytic method by which a significant amount of NO_x is removed from the exhaust gases. SCR is required for intermediate and baseload gas combined cycle plants in several states in the U.S.

[19] SCR has been defined in the previous footnote. NYPP refers to the New York Power Pool and NEPOOL to the New England Power Pool. The system margin in both instances is an estimate for each hour of the year of the emissions from the facilities which would be turned down were load to decline by a MW.

[20] Please note that the calculations for this graph are in 1990 dollars not 1989 dollars as in the first table.

41

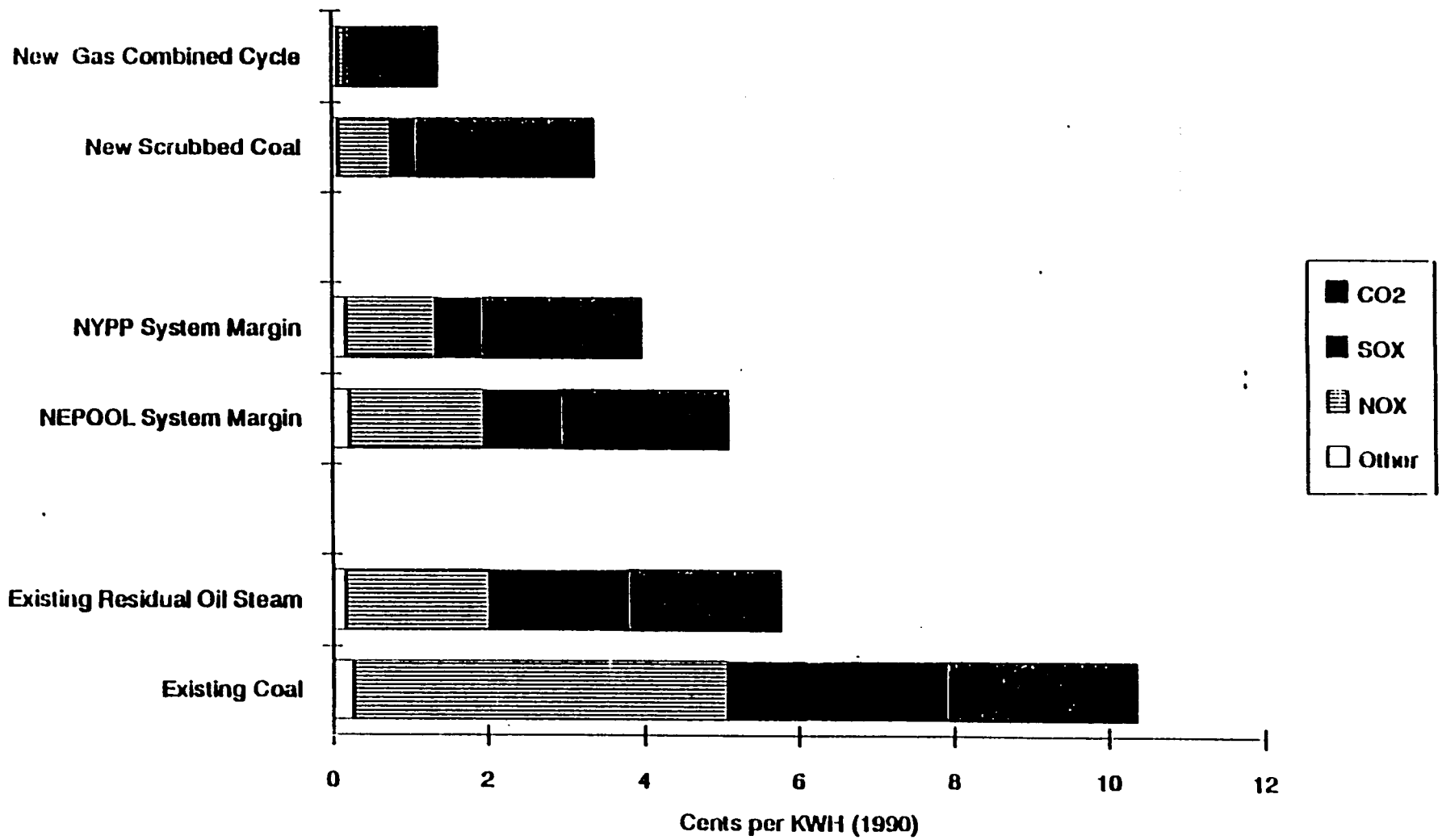
EXAMPLE CALCULATION OF LEVELIZED AIR EMISSIONS COST: CC WITHOUT SCR

Air Emissions	Value (1989$/lb)	Air Emissions (lbs/MWH)		Emission Cost (Cents/KWH)	
		Natural Gas	No. 2 Oil	Natural Gas	No. 2 Oil
Nitrogen Oxides	3.25	3.2	4.0	1.04	1.30
Sulfur Oxides	0.75	0.005	2.56	0.00	0.19
Total Particulates	2.00	0.01	0.01	0.00	0.00
Carbon Monoxide	0.43	0.017	0.15	0.01	0.01
Volatile Organic Compounds	2.65	0.27	0.13	0.07	0.03
Carbon Dioxide	0.011	952	1330	1.05	1.46
Methane	0.11	0.015	0.013	0.00	0.00
Nitrous Oxide	1.98	0.063	0.265	0.01	0.05
	Totals (1989 Constant Cents/KWH)			2.18	3.04
	Weighted Average Cost (40% Gas, 60% Oil)				2.70

EMISSIONS COEFFICIENTS FOR SELECTED RESOURCES
(Lbs. per MWH)

	NO_x	SO_x	TSP	CO	VOC	CO_2	CH_4
New Gas Combined Cycle with SCR	0.30	0.01	0.01	0.17	0.27	1013	0.02
New Scrubbed Coal	2.02	3.84	0.29	0.23	0.04	1922	0.01
NYPP System Margin (Baseload)	3.42	7.24	0.70	0.44	0.06	1716	0.02
NEPOOL System Margin (Baseload)	5.11	12.17	0.84	0.54	0.10	1815	0.02
Existing Residual Oil Steam	5.46	22.07	0.65	0.35	0.05	1670	0.02
Existing Coal	14.07	35.48	1.22	0.23	0.04	2061	0.02

EMISSIONS COSTS FOR SELECTED RESOURCES



At this point it is useful to recall the discussion of avoided cost. It should be clear that if a utility's avoided cost were the cost of a gas combined cycle plant or coal plant (or whatever), that could be calculated in an appropriate manner both with and without the addition of environmental externalities. The examples provided here demonstrate how such externalities values could be calculated and added to conventional avoided costs. Where utilities consider externalities in their selection of resources, avoided costs with externalities added defines the maximum price to be paid for any resource provided by the private sector or other company, such as another utility.

It is important to bear in mind that in any circumstance in which environmental externalities results in selecting the more expensive option, there will be cost consequences for electricity consumers. Obviously, this matter will weigh heavily in any decisions concerning the use of environmental externalities for resource selection purposes. The Tellus Institute has completed an analysis of the potential rate impacts in the state of Massachusetts and the New England region which showed, in those specific situations, that the electricity price impacts would not be great.[21]

A related matter which is under discussion in the U.S. -- but which is not yet in practice -- concerns environmental externalities and plant operations. Power plants are currently dispatched on the basis of their variable costs, which are principally fuel and other costs (such as some maintenance) which vary with plant operations. If one were to add the costs of externalities to the variable costs of plant operations (since emissions are proportional to kilowatthours generated), one would get a different dispatch order than if

[21] H. Salgo, B. Biewald, S. Bernow: *The Potential Impact of Environmental Externalities on New Resource Selection and Electric Rates*, for and with the Massachusetts Department of Energy Resources, January 3, 1991.

75

only variable costs are considered. The issue is whether or not to alter the dispatch order to reflect some or all of the environmental costs.[22]

The cost consequences of such a change will depend upon the power plants in the system under consideration. Thus, it is hard to generalize about them. Clearly, they could be substantial. In any event, as noted above, the matter is still being debated. No state (or the federal government) requires any utility to undertake environmental dispatching based on externalities.[23]

The U.S. federal government recently (November, 1990) enacted Clean Air Act Amendments which refer only to SO_2 (sulfur dioxide) and NO_x (nitrogen oxide) only. The requirements concerning SO_2 are much more detailed, however. The Act applies to all U.S. utilities and non-utility power plants. Utilities will be given a certain number of "allowances", each of which is an authorization to emit one ton of sulfur during a specified calendar year. If the emissions exceed the level permitted by the allowances, the penalties in the Act must be paid.

Because some utilities will reduce their need for allowances more than others[24], it is anticipated that those with a surplus will sell them. That is, the Act anticipates that a market in allowances to emit SO_2 will develop in the U.S. Part of a utility's planning

---

[22] Obviously, there will be technical constraints to consider. Not all plants are able to cycle, for example. The discussion in the text does not address these important issues which would have to be considered in any detailed consideration of the matter.

[23] This is not the same matter as ordering a power plant to shut down on occasion because of local air quality problems. This is sometimes done. Rather, the issue concerns a fundamental change in the plant dispatch algorithm.

[24] The possible reasons for this are numerous. Fewer allowances will be needed if: load growth is reduced, through conservation, for example; cost-effective pollution control investments are made; cleaner power plants are constructed; and so on.

responsibility will be to optimize the utilization of its allowances. It is likely, in my opinion, that this will require a reconsideration of the decision making process for the dispatch of power plants.

Consider an example. Suppose a utility's least expensive (lowest variable cost) plants produced the most SO_2 and that its more expensive plants produced the least. This utility would now compare the savings it anticipates from the use of the least expensive plants with the amount it could receive from the sale of the allowances which it would no longer need if it were to use, instead, its more expensive, but less polluting, power plants.

There are other options for reducing SO_2 which would be considered in addition to, or instead of, changes in the dispatch order. In general, the lowest cost options should be undertaken first. Such options might include emissions reduction retrofits and fuel switching where that is possible. The best resource plans will consider the full range of available emissions reductions options.

V. Conclusion

In the past few years there have been several significant changes in the U.S. electric utility industry. The growth in the use of private sector energy services -- to provide both power and conservation -- has been rapid. The result has been a shift in the allocation of risk and reward; that is, the private sector is now absorbing some of the risks of project failure. In addition, there has also been a revision in thinking concerning what constitutes a natural monopoly in the utility industry. Electric generation, unlike transmission and distribution, is not considered a natural monopoly to be provided by a single firm under

17

strict regulation. Instead, many firms compete to provide electric generation under terms and conditions defined in long-term contracts.

To some extent the change in thinking about natural monopoly in electric generation reflects changes in technology and costs. It had been anticipated that the economies of scale which were evident in the industry until recently would continue as plant sizes grew.[25] It is apparent, however, that at some point diseconomies arise and that, in any event, there are some advantages to having relatively small plants on the system. In other words, the trend toward the addition of smaller size plants has made it easier for the private sector to raise capital and compete to provide electricity.

The issue of externalities is not new to economists. It has been widely recognized that the production and consumption of commodities imposes costs on society which are not recovered in the prices charged for the good. In the electric utility industry it is obvious to all observers that the externalities are substantial. However, it is only recently -- principally because of an increasing concern with environmental matters -- that serious consideration has been given to incorporating the cost of externalities into energy prices. There are serious questions and debates about how to measure the costs and, once measured, how to incorporate them into energy prices. However, despite the questions, there is a growing recognition that the differences in the environmental impacts of various energy resources cannot be ignored.

[25] Economies of scale in electric generation mean that as size (MW) increases unit costs ($/kwh) decline.

78

Petroleum Prices in a Volatile International Market

Prepared by:
Bronek Dutkiewicz
INTRATECH, Inc.

79

PETROLEUM PRICES IN A VOLATILE INTERNATIONAL MARKET

1 Introduction

No country, whether they import or export crude oil, whether they are self sufficient in energy or not, can totally isolate themselves from the impact of the international oil market. Hence, international oil prices have a direct impact on the individual consumer, the petroleum sector companies, and especially the Government Agencies whose responsibility it is to oversee the efficient supply and consumption of energy.

In the immediate aftermath of the Gulf War and the associated violent swing in international crude oil prices it is easy to despair about the stability and security of oil price and supply. To put international oil prices in perspective, however, it is important to look at the longer term trends that are developing, rather than at the short-term disruptions that plague the global oil supply. This paper reviews what has happened to oil prices in the past, why these changes have taken place, and what can be expected in the future.

2 Historical Oil Price Experience

2.1 Long - Term Prices

Contrary to immediate impressions crude oil prices have remained relatively constant for a long period. Figure 1 shows the price of crude oil from the beginning of the twentieth century to the present date. This figure shows crude oil prices in both actual dollars and dollars adjusted for inflation. For the most part during this century oil prices have been remarkably stable. Four cases of supply disruption and resulting price escalation have occurred - in 1920 as a result of the Mexican oil embargo, in 1973 due to the OPEC Oil embargo, in 1979 due to the Iranian disruptions, and most recently as a result of the Gulf War and the UN oil embargo.

In fact, from the beginning of the century to the late sixties, crude oil prices increased only marginally in real terms. During this period oil prices were influenced to a large extent by the existence of an oil company cartel (the Seven Sisters), excess oil production world wide, and price/import controls by the major oil producer and consumer i.e. the U.S.

During the fifties and sixties, the domestic U.S. price of oil was controlled by volumetric oil production controls in Texas and Louisiana, and imports were restricted through the Mandatory Import Policy Program. This control of domestic and international oil prices by the U.S. came to an end when domestic oil consumption exceeded production at the end of the sixties and the U.S. could no longer act as the swing producer. The U.S. was replaced as the swing producer by OPEC in the early 1970's. Since then the international oil market has gone through some very significant changes, in essentially two distinct periods of development. The seventies were a time of rapid price escalations, supply disruptions and uncertainty of consumer reaction to the changes taking place. The next ten years were a period when many of the excesses of the seventies were reversed.

80

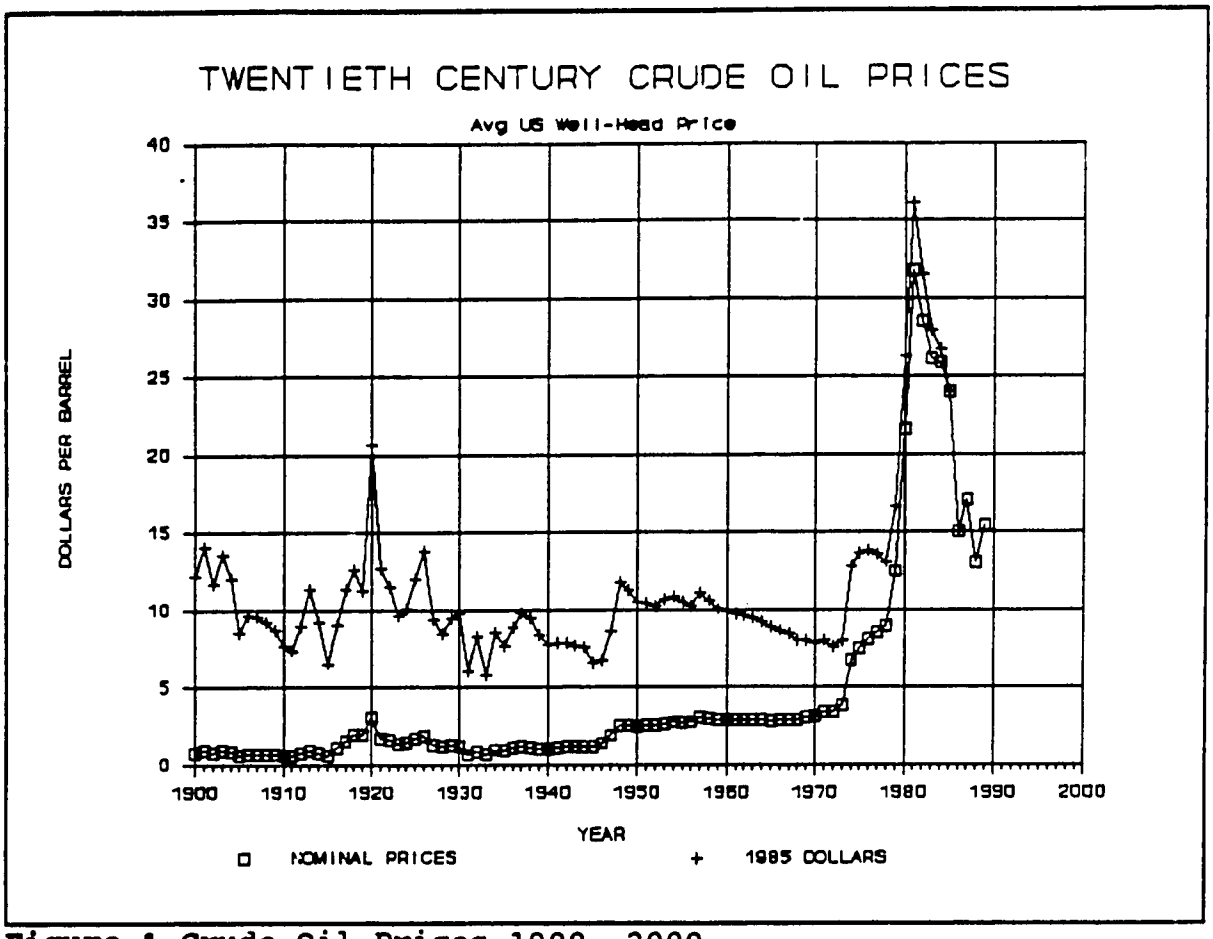


Figure 1 Crude Oil Prices 1900- 2000

2.2 The Seventies

The seventies saw a major change in world crude oil markets as manifested by two major disruptions during the decade. The first in 1973 was the OPEC oil embargo an the second in 1979 caused by the Iranian oil disruptions. As a result of the 1973 embargo prices jumped to a then astronomical level approaching $10 per barrel ($75/MT) and to above $30 per barrel in 1980.

During this period certain firm preconceptions prevailed within the OECD countries. In hind sight these were:

o That world crude oil production was peaking and that further production would be very expensive. Marginal new sources of energy would thus come from new sources of energy. Synthetic fuels from coal and shale, solar, wind, etc. would become the marginal source of energy and set oilprices.

o That the crude producers cartel would be effective for a sustained period, and that they would maintain prices at alternative energy source substitution levels.

- 81

o The problem of higher oil energy prices could best be solved by the establishment of Energy Policy at the National level, and centrally micro-managed.

o That Governments could effectively control oil prices and isolate consumers from the volatility of oil prices.

o That oil supply and consumption patterns were hard to change and price inelastic.

The overall result during the seventies was for most oil consuming countries to move to more central government control of their energy sectors in general and of the petroleum sector specifically. For example, in the U.S. the response was to control oil and natural gas prices, mandate oil consumption patterns, invest heavily in alternative energy technologies and other enact preferential energy taxation measures.

On the supply side the oil producers believed that rising oil prices could go on indefinitely and prices of $100 per barrel ($700/MT) were expected by the turn of the century. This was predicated on the expectation that the synthetic fuels from coal, shale, and other sources would become the marginal source of fuels and hence set the price of oil.

On the demand side, attempts to stabilize prices through price controls lead to shortages and administrative nightmares, and reversal in production investment.

2.3 The Eighties

Supply/Demand and Prices

The decade of the eighties, saw the reversal of most of the popular held notions that had been developed during the seventies. A combination of the inability of OPEC to maintain a cohesive cartel, and a higher than anticipated price sensitivity of oil production and consumption, lead to a reversal in the oil price escalations achieved in the previous decade.

Four distinct periods of crude oil price change can be discerned during the decade as shown in Figure 2. During the period 1980 to 1983, prices declined by almost 50% from the highs associated with the Iranian Oil embargo. This period was marked by highly volatile and declining crude oil prices. Petroleum product prices, relative to crude oil, remained fairly constant. For the next three years crude oil prices remained fairly stable. Petroleum product prices on the other hand changed relative to crude prices.

In 1986 crude oil prices declined suddenly and precipitously. OPEC adopted netback pricing in an effort to regain control of oil prices and to provide some stability for crude oil importers. Numerous formulas were attempted linking crude oil prices to international product prices. These attempts failed to curb the volatility of oil prices and did not manage to return prices to previous levels.

In 1987 OPEC phased out netback pricing and adopted prices quotes with the intent of

82

stabilizing crude oil prices at an objective price of $18 per barrel ($130/MT). This did not happen and crude oil prices bounced around the $10-22 per barrel range for the next three years.

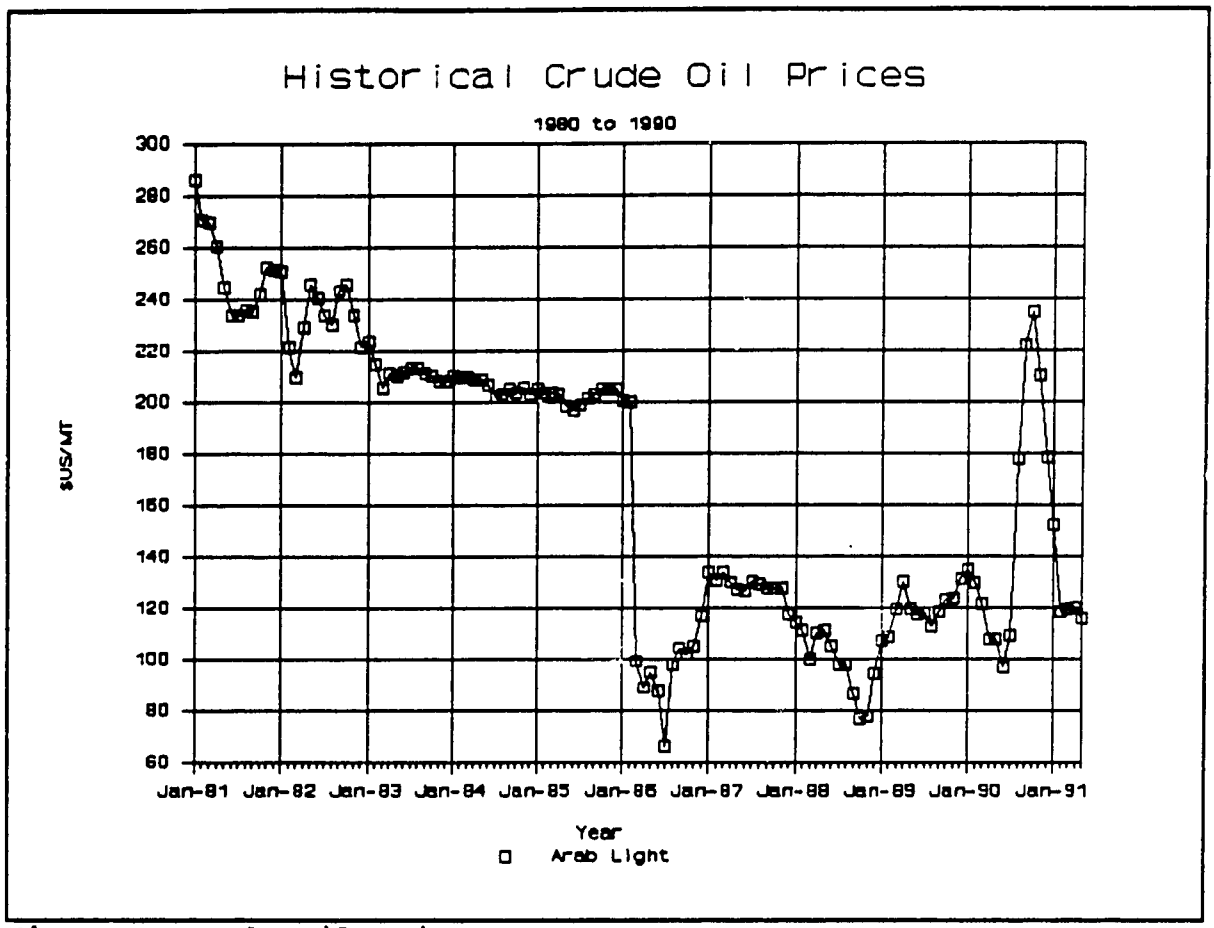


Figure 2 Crude Oil Prices

Many reasons have been postulated for the precipitous drop in crude oil prices in 1986. Most centered on the ability of OPEC to maintain cartel cohesion, and other political rationals. While the inability of OPEC to control the supply of oil was a factor, changes in consumption patterns were equally important in depressing crude oil prices.

During the late seventies and early eighties world oil consumption growth rates were almost flat due to higher prices and the resultant recession.

At the same time the supply of crude oil, both in OPEC and outside, increased as a response to the increase in oil prices. This imbalance was further accelerated by massive substitution of oil by coal and natural gas. Heavy fuel oil consumption in the OECD countries decreased by 44% between 1980 and 1987, dropping by 43% in the US, 49% in Europe and 47% in Japan. (Figure 3) The magnitude of this substitution was not recognized at the time with most forecasters still predicting continued growth of heavy fuel

83

oil demand.

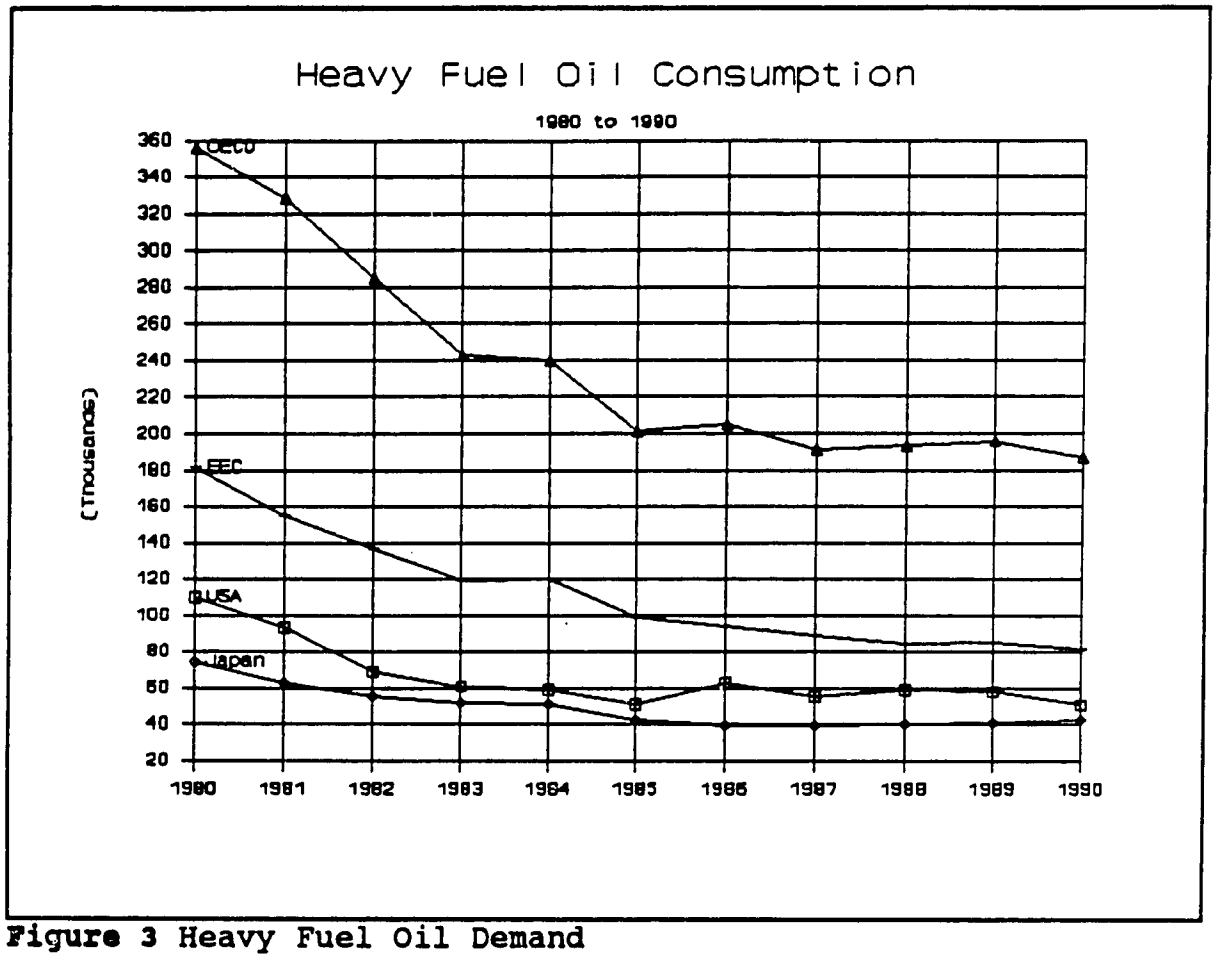


Figure 3 Heavy Fuel Oil Demand

At the same time the price of heavy fuel oil continued to rise, even though the price of coal and other alternatives were falling. The British Coal Miners strike in the mid-eighties may have contributed to the expectation of higher fuel oil prices. Another possible explanation was that oil refiners facing the erosion in distillate prices tried to make up for this loss by increasing the revenue on the bottom of the barrel.

The anomaly of rising fuel oil prices in the face of declining demand and declining coal prices could not be sustained and led to a sudden drop in fuel oil prices in 1985. This drop and continuous weakness in consumption was the most probable cause of the precipitated drop in crude oil prices a year later.

The relationship between crude oil, fuel oil and coal prices during this period is shown in Figure 4. The increasing gap between heavy oil prices and coal during this period is evident. This gap has now been closed and it appears that coal is now presenting a real floor for oil prices. In spite of the volatility of fuel oil prices the long term price trend appears to be testing the coal competition on the international market.

84

This interaction of energy prices and demand indicates the underlying supply demand pricing mechanism does work in the international market, and that deviations from the free market relationship cannot be sustained for any length in time.

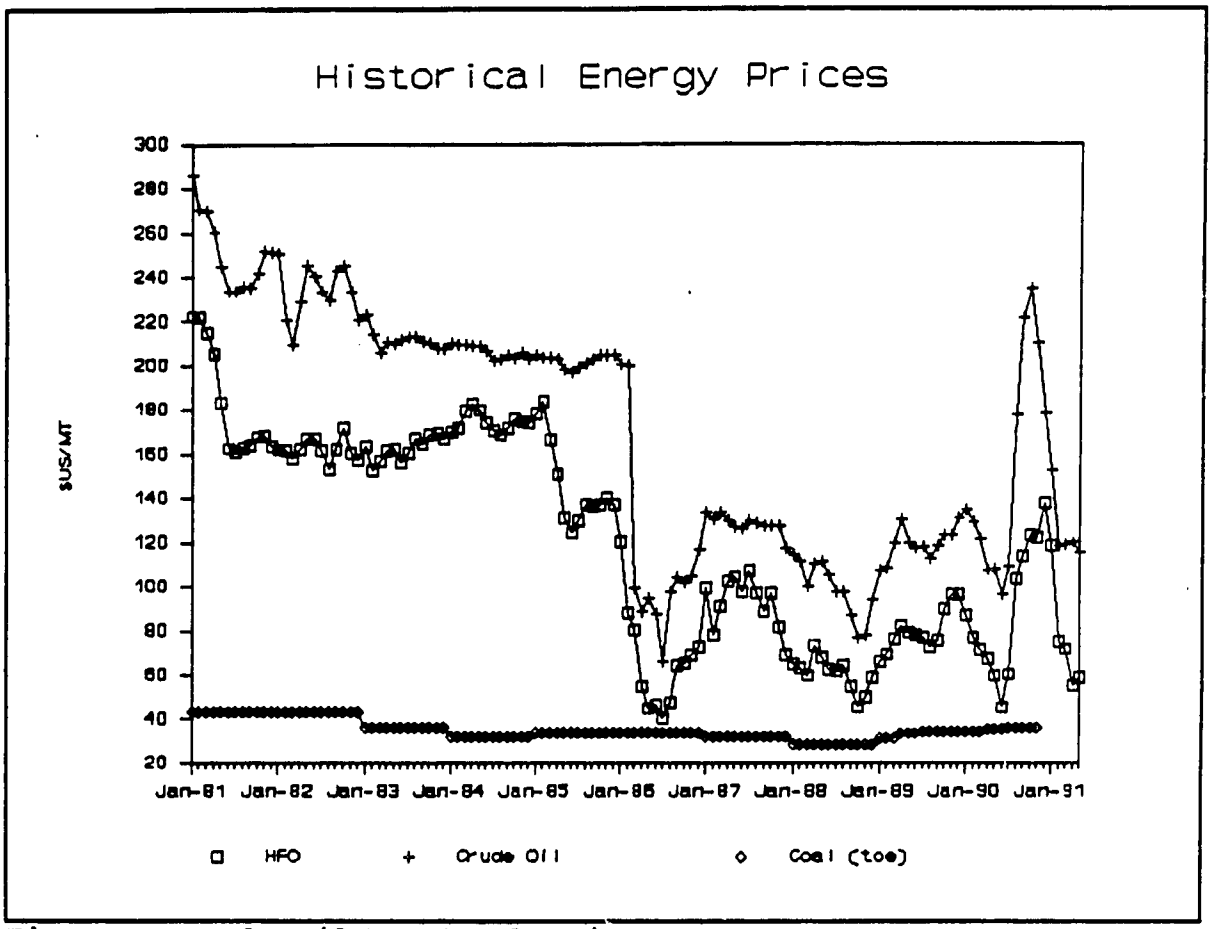


Figure 4 Crude Oil/HFO/Coal Prices

2.3 Oil Price Volatility and Risk

Another big changes in the international market resulting from the turmoils of the seventies was the development of Futures Markets. The experience of the seventies lead to the realization that wide swings in oil prices were to be expected in future. Individual countries responded by building up strategic reserves of oil and entering in coordinated consumer emergency agreements. At the same time, individual consumers, oil companies and the financial community responded by the creation of price hedging mechanisms. The New York Merchantile Exchange (NYMEX) in the US; the International Petroleum Exchange (IPE) in Europe; and the Singapore Monetary Exchange (SIMEX) in the Far East, expanded crude oil and product trading activities in response to the need for risk management in the energy area.

This was a turning point in international oil trade, resulting in the globalization of oil markets and providing transparent pricing of crude oil and product prices.

There has been considerable discussion of whether the growth of these futures markets serves to stabilize or accentuate the volatility of international oil prices and whether the markets are an extension of the petroleum sector or purely a vehicle for speculation. Irrespective of the point of view, there is no doubt that the expansion of the futures markets in the eighties has radically changed the international oil market.

3 General Lessons Learned in the Seventies and Eighties

Looking back at the last two decades there are some very important lessons to be learned, and should be heeded lest we repeat them in the future. Some of the main lessons that should be noted are:

o National Energy Policies - Comprehensive national energy policies, no matter how seductive, are almost impossible to determine, are too cumbersome to implement and too slow to react to changes in the international oil situation. Invariably the attempt at intervention leads to problems larger than problems that they are trying to solve.

o Free Markets - There is no example of a truly free petroleum sector. There are only different degrees of intervention, at least for anything more than a short duration. Even the most ardent free market proponents will have their special reasons to intervene in special cases. Most frequently, differential taxation, and mandated volume controls (consumption and/or trade) are not recognized as price controls or limitations on the free market system.

o Alternative Fuel Technologies - The alternative sources and technologies to the use of petroleum have been researched and analyzed ad infinitum during the last two decades and no viable "major substitute" has been identified. While alternative technologies will be a factor, they will not replace oil in the foreseeable future.

o Competitive Energy Prices - The degree to which oil can be substituted by natural gas and/or coal was underestimated in the last two decades, and oil has been losing market share to natural gas and coal. This substitution is still continuing. Energy experts, forecasters, oil producers , and especially OPEC, have consistently, underestimated the price sensitivity of oil consumption; over-estimated the price sensitivity of oil production; and underestimated the degree that substitution can take place. The net result has been that the seventies and eighties were characterized by consistent attempts of the oil producers to prop up prices unsuccessfully. The price trend has been toward the competitive price of oil. Only major disruptions - Wars and Embargoes - have managed to raise oil prices for any length of time.

86

4 Oil Product Prices

Individual oil products respond to their own market forces which may differ substantially from that of crude oil prices. The dynamics of product prices are often overlooked in the focus of crude oil. Frequently it is impossible to distinguish the main driving forces, whether crude oil prices are setting product prices or whether product prices drive crude oil prices. Many forecasters and planners still retain the concept of a fixed relationship between crude oil and the major products. This leads to problems in the management of domestic energy prices, even during times of stable crude oil prices. The impact on investment decisions can be severe.

During the last two decades interfuel prices have fluctuated over a substantial range. Figure 5 shows the price of gasoline, diesel and residual fuel oil relative to crude oil for the period 1980 to date.

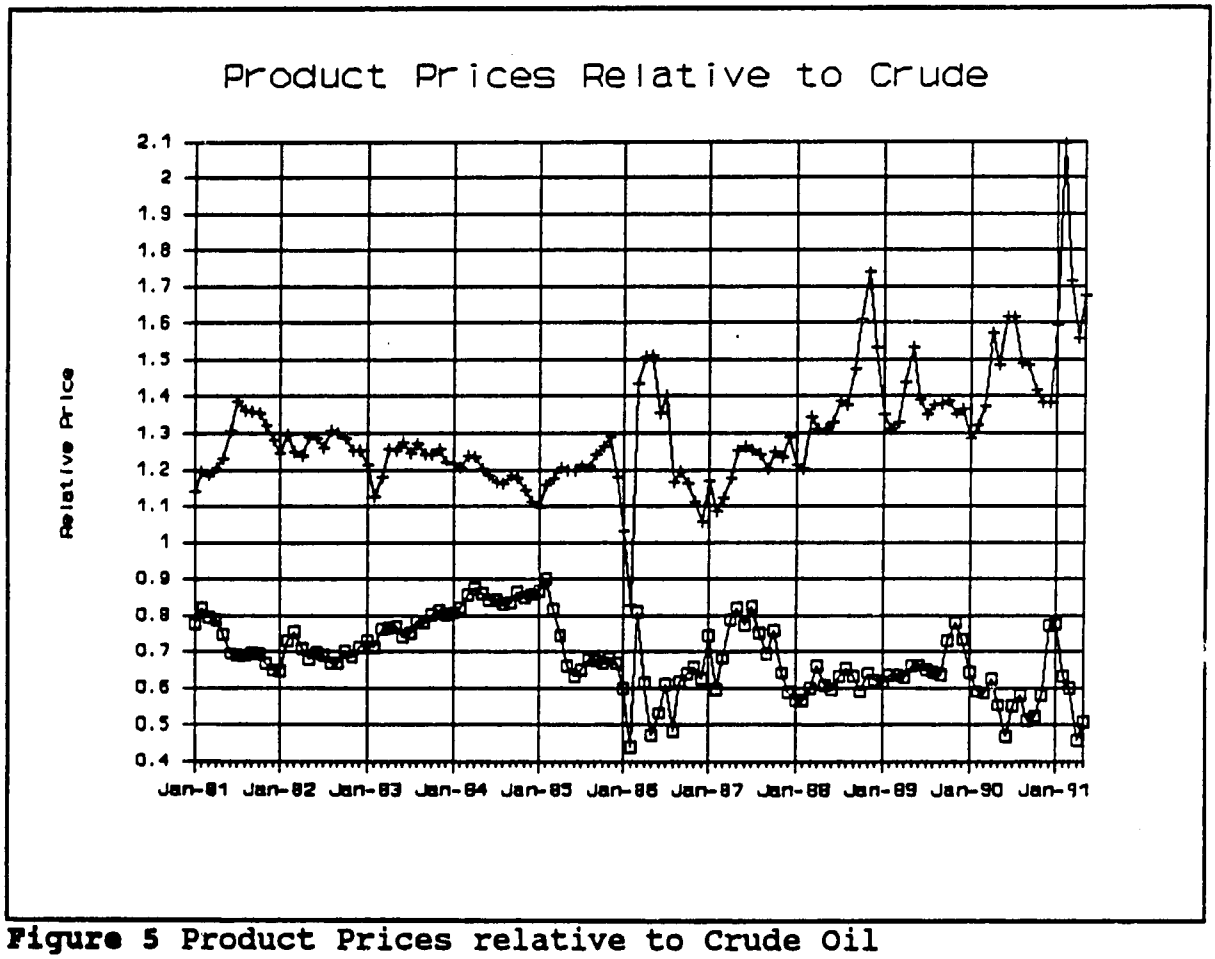


Figure 5 Product Prices relative to Crude Oil

27

The distinct variations in prices both seasonally and with respect to time should be noted. The short term seasonal trends are well recognized and understood. The longer term trends are less readily apparent. During the first half of the eighties all three prices - gasoline, diesel and heavy fuel oil converged with crude oil. The second half saw a reversal of this trend, with the spread between distillate and heavy fuel oil increasing.

5 Product Market Structure and Prices

Up to the present it has been the tendency in many countries to maintain a protected domestic petroleum sector. Crude oil is preferentially imported and the domestic refining industry is protected from the importation of products. This is changing as product imports are being derestricted, and/or domestic prices are being linked to world product markets. While this generally improves petroleum supply economics, it can create problems for the domestic refining industry. A major determinant of refinery economics, and hence profitability, is the make up of the refinery product slate.

International petroleum product prices are determined by the market conditions in the major consumer countries i.e. the U.S., EEC and Japan. If these prices are imposed on a product slate that deviates significantly from the international average it can result in significantly different overall refinery economics. It is this difference in product slate valuation that differentiates refinery economics in different countries.

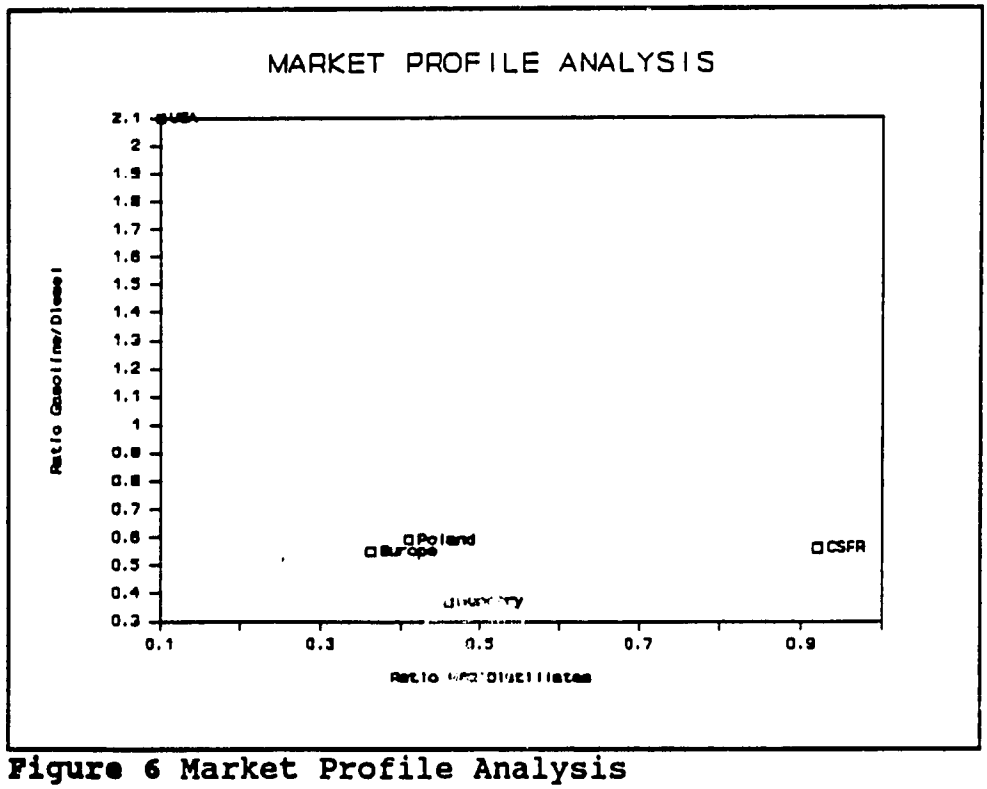


Figure 6 Market Profile Analysis

This difference in market profile in the U.S., Europe, and the CSFR is illustrated in Figure 6. For comparative purposes, the ratio of gasoline to diesel fuel is plotted versus the ratio of heavy fuel oil to distillate (gasoline plus diesel) produced.

This figure illustrates the heavy orientation of the U.S. market to transportation fuels, especially gasoline, and the low heavy fuel oil demand. In Europe and the CSFR a much larger proportion of heavy fuel oil is produced. These differences in market configuration combined with the difference in product prices can have a significant impact on the valuation of a refinery's production.

This impact of market profile is often overlooked when considering the relative economic viability of refineries in different countries. It is also the reason that some refineries may need some protection from outside competition if they are to be viable.

6 Future Outlook

The track record of forecasting international crude oil and product prices during the last decade has not been particularly successful. In general, most predictions have called for a short term drop in oil prices; followed by an increase in longer term prices at approximately the rate of inflation in the OECD countries. This sliding forecast is still very much in vogue today. However, for the last five years, cyclical oil price fluctuations have overshadowed any longer term trend, and has lead to a concentration on shorter term price fluctuations and how to cope with them.

The uncertainties and instabilities in oil pricing are expected to continue for the foreseeable future. Unfortunately it appears that the times of long term stable prices are over, and the future energy industry manager will have to cope with continued uncertainty. Some general certain general trends are discernable.

5.1 Supply Side Considerations

The major preoccupation in forecasting oil prices has been the supply of crude oil. This generally translated into trying to second guessing what OPEC will do and whether it will be effective. The methodology of predicting small demand/supply changes effected by OPEC and the resulting impact on world crude oil prices has not proved to be very effective. This was amply demonstrated when the loss of the Iraqi and Kuwaiti oil did not result in the dire shortages predicted. The ability to forecast crude oil prices will continue to be an extremely difficult task in the future.

The outlook for the stability of oil supply and price look worse than it has since the 1973 oil embargo. In fact the situation is not too dissimilar, the only difference being that the OPEC oil embargo has now been replaced by a UN mandated oil embargo. The combination of a destabilized Middle East situation and the troubles in the USSR hold great uncertainties for unexpected and large crude oil price excursions. The possibility of more frequent oil price spikes in the $30 plus region have to be considered.

Even in the absence of major oil disruptions, international oil prices should remain volatile,

89

but in a much narrower band. Most forecasts predict an ample supply of production capacity under normal situations. The tendency for OPEC to focus on a target price for crude above its economic parity value relative to coal and natural gas will continue to contribute to periodic price fluctuations.

5.2 Demand Side Considerations

The easily made conservation and substitution changes in the petroleum sector have already been made. Some further market share erosion to natural gas and coal is expected, though at a slower rate.

Environmentally driven changes in consumption patterns will be an increasing factor in the future. Forced substitution through mandated change to different fuels could be a characteristic of the nineties. Examples includes the use of oxygenates in transportation fuels, and lower sulfur emissions from heavy oils.

Most supply demand projections continue to show a significant imbalance between distillate and heavy fuel oil in the most markets, which would indicate a continuation of the depressed heavy oil markets and prices. The recent rationalization of the refining industry in Europe, and the build up of heavy oil upgrading capacity have helped dampen excess heavy oil production.

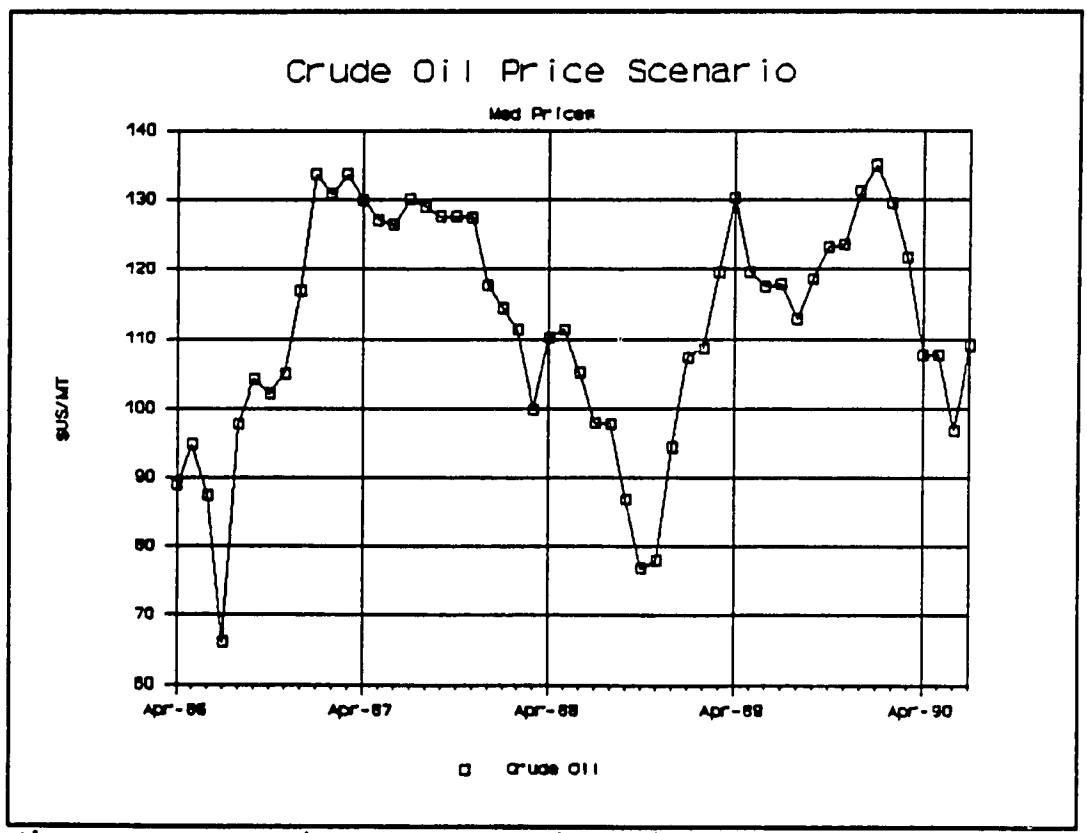


Figure 7 Scenario of Crude Oil Prices

90

The above scenario will most probably result in oil price profile similar to the period between mid 1986 and mid 1990. Crude oil and product prices during this period are shown in Figure 7 and 8. The amplitude and frequency of the crude oil and product prices fluctuations in this figure highlights the problems facing anyone dealing the uncertainty of future oil prices.

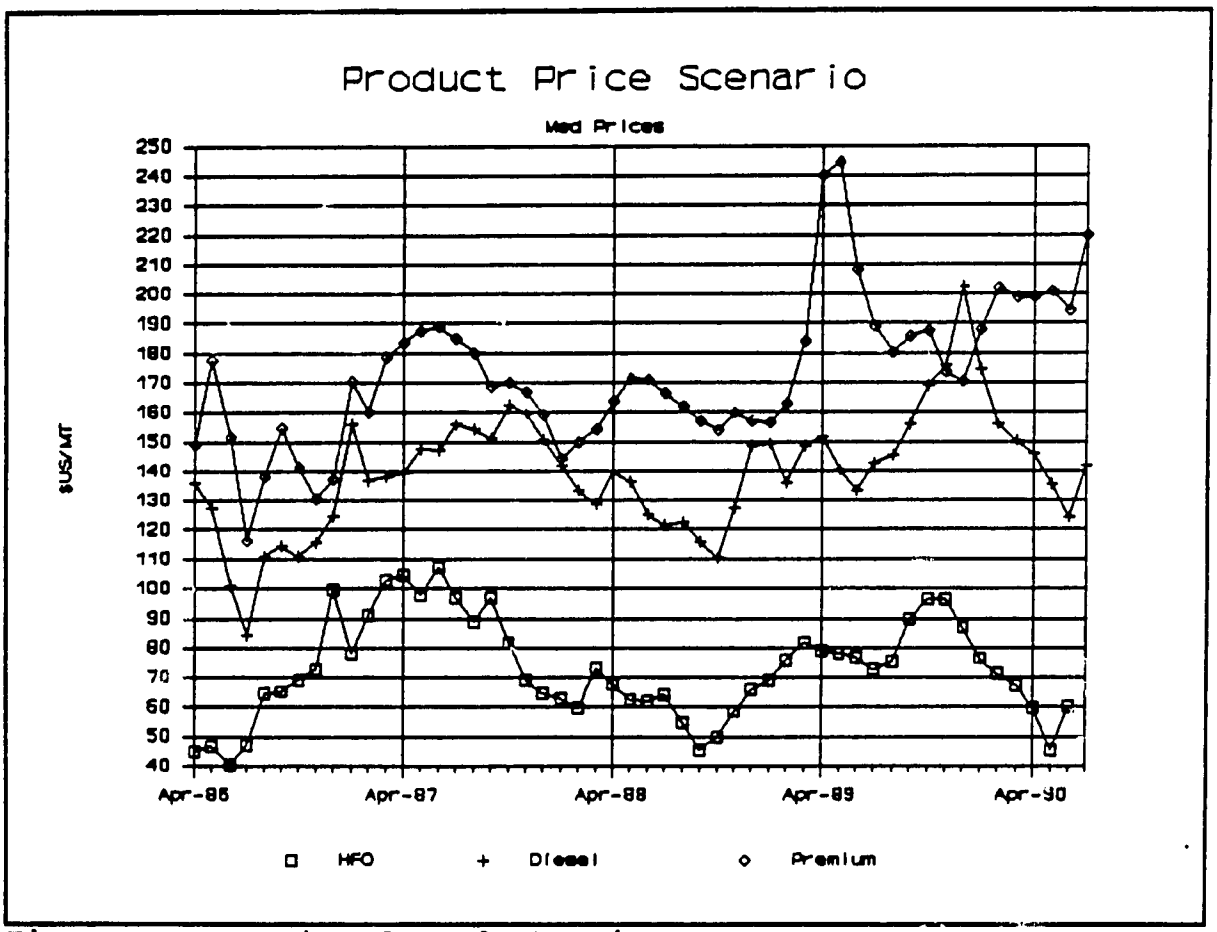


Figure 8 Scenario of Product Prices

-91

Practical Economic and Financial Issues of Energy Pricing Reform in Czechoslovakia

Prepared by:
Dr. Jack Huddleston
Resource Management Associates

-92

PRACTICAL ECONOMIC AND FINANCIAL ISSUES OF ENERGY PRICING REFORM IN CZECHOSLOVAKIA

prepared by:

Professor Jack R. Huddleston
University of Wisconsin-Madison
Madison, Wisconsin USA
Consultant to Resource Management Associates
Madison, Wisconsin USA

I. INTRODUCTION

Czechoslovakia, like other Eastern European countries, is undergoing rapid economic change. Ownership of productive capacity is changing from public to private enterprise; prices are increasingly being determined by market forces rather than government plans; and increased economic ties are being established with the broader world-wide market.

The energy sector in Czechoslovakia is a crucial segment of broader economic reforms occurring within the country. There is broad agreement that the historical price structure of Czechoslovakian energy resources has been low in comparison to other industrialized nations and that this structure has suffered from significant internal price distortions.

Major pricing reform is underway in each of the individual energy sectors of the country. In the long-run tradeable energy resources will be priced at comparable international levels and non-tradeable energy resources will be priced at (or approaching) long-run marginal cost. Determination of "correct" prices is a

93

crucial aspect of the overall energy pricing reform that is taking place within Czechoslovakia.

While pricing reform within individual energy sectors is important, the purpose of this paper is to assert that an equally important set of questions needs to be asked about the impacts of changing energy prices on the overall economy of the country. For example:

* What are likely impacts on national (and republic) industrial output of changing energy prices?
* What are likely impacts on national (and republic) employment and income of changing energy prices?
* What are likely impacts on national (and republic) environmental conditions of changing energy prices?
* How will imports and exports be affected by changing energy prices?
* What financial capital will be required to adequately meet industrial and residential responses to changing energy prices?
* What are likely impacts on national (and republic) government expenditures and revenues of changing energy prices?

These (and other similar) questions are broader than those traditionally considered in developing energy price reform within an individual energy sector. Although the general movement within Czechoslovakia is towards decentralized, market-oriented decision-making, it is questions such as the above that will need to be considered and planned for within the emerging governmental structure of the country.

This paper does not answer all of the above questions. It does, however, attempt to demonstrate the importance of the cumulative effect of individual pricing reform decisions on the overall economy.

To accomplish this, the paper overviews in Section II an economic simulation model that has been developed for the Czechoslovakian national economy. This (preliminary) model, called the CSFR Industry Energy Price Model (INDMOD), has been developed utilizing available national data and economic relationships existing in other comparable countries. [A second model, CSFR Transportation Price Model (TRANSMOD) has also been developed.] In Section III the model is applied to two different energy price scenarios for the country as a whole, illustrating the impacts of further energy pricing reforms. Section IV discusses the implications of the simulation analysis for energy policy and planning in Czechoslovakia, including a discussion of the role for strategic planning in emerging national and republic governmental structures.

II. CSFR INDUSTRY ENERGY PRICE MODEL

Rising energy prices will have numerous aggregate, or macroeconomic impacts on the national and republic-level economies. Analysis of these impacts will require use of comprehensive economic models that allow interactions among fuels and that capture the output response to changing relative prices for energy and other goods and services.

a5

Two broad types of economic models have been developed and used for macroeconomic analysis of energy policy questions in the U.S. The first group is the statistically based (econometric) macroeconomic models. These models estimate relationships among national income, consumption, investment, savings, government spending and tax revenues, and imports and exports. Although relatively comprehensive in scope, these models require extensive economic data over long periods of relatively stable economic conditions. Radical economic change is not easily incorporated into these models.

The second group of macroeconomic analysis models is that of mathematical simulation models. These models take several forms and can consist of models with only a few economic relationships or models with hundreds of economic relationships. The current input-output (I-O) model used in Czechoslovakia is an example of the larger macroeconomic simulation model.

The CSFR Industry Energy Price Model (INDMOD), developed by Resource Management Associates of Madison, is a macroeconomic simulation model that has been developed specifically for use in energy policy analysis in Czechoslovakia. INDMOD simulates the consumption of seven energy resources (electricity, district heating, coal, coke, petroleum, natural gas and other gas) in nine industrial sectors (mining, chemical, ferrous metals, non-ferrous metals, mechanical engineering, construction, forest products, food and other) for the period 1988 to 2000.

-96

INDMOD is designed to simulate the influence of several important economic relationships and is based on the economic framework shown in Figure 1. According to this framework, changing relative energy prices will have two immediate impacts on the input side of the industrial sector. As energy prices increase, firms will begin substituting capital and labor for energy (for example replacing old boilers with more energy efficient boilers) and will substitute one fuel for another fuel (for example shift from coal to natural gas).

After these shifts and substitutions have occurred, some portion of the higher energy costs will be passed through to consumers in the form of higher output prices. These higher prices will affect the level of imports, exports and overall domestic consumption. Changes in these variables will affect national output levels which, in turn, will affect overall national employment and income.

A more complete description of INDMOD is contained in the INDMOD User Manual.

III. ANALYSIS OF INDUSTRIAL IMPACTS OF FURTHER PRICE REFORMS

INDMOD has been used to analyze the impacts of further energy price increases in the future. Two scenarios are simulated and compared in this analysis.

Baseline Scenario. The first, called the baseline scenario, is INDMOD's estimate of industrial output and energy use if currently planned energy price increases are implemented by 1992,

97

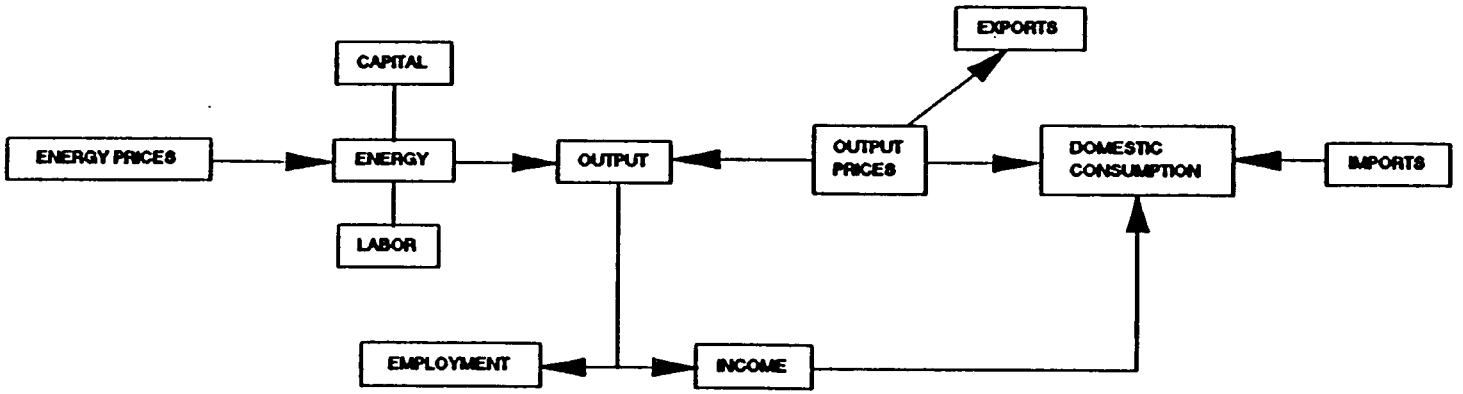


FIGURE 1: Influence of Energy in the Czechoslovak Economy

but not changed thereafter. This simulation is based on exogenous forecasts for energy prices and industrial growth rates through the year 2000. These rates of change, which were assembled from various government and research documents, are shown in Table 1.

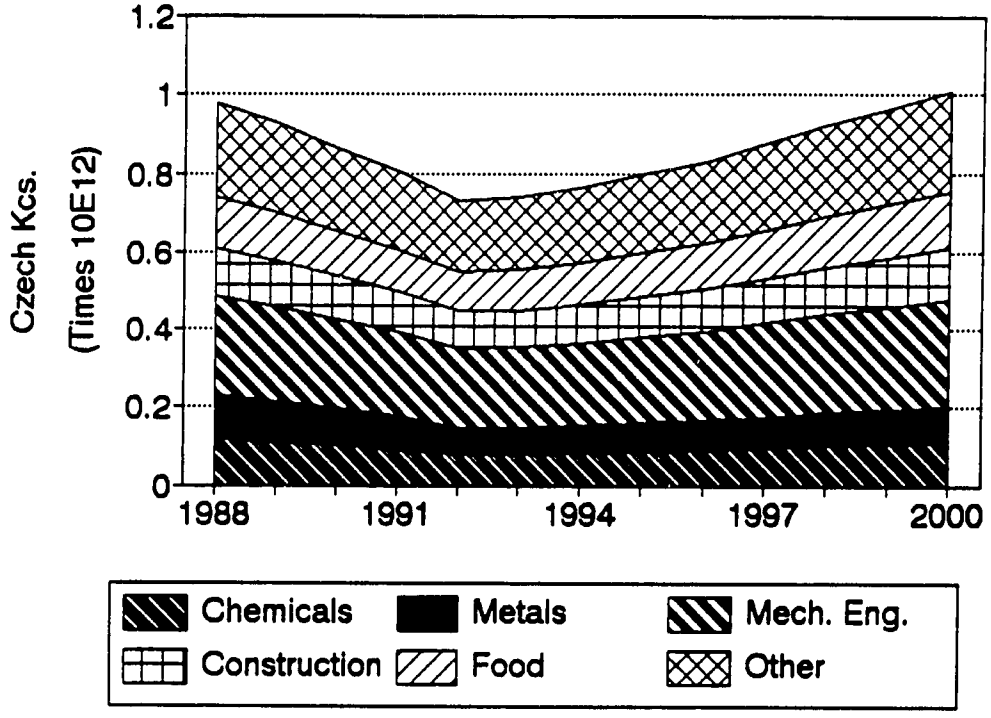
TABLE 1. Industrial Output and Energy Price Annual Growth Rates for Baseline Scenario

	88-91	91-92	92-94	94-96	96-00
Industrial Output					
Mining	-4.52%	-4.80%	2.34%	4.30%	5.00%
Chemical	[all industrial sectors are projected to change at the same annual rate before energy price changes are introduced]				
Ferr. Metals					
Non-Ferr Metals					
Mech. Eng.					
Construction					
Forest Products					
Food					
Other					
Energy Prices					
Electricity	7.7%	53.0%	0.0%	0.0%	0.0%
District Heat.	65.5%	0.0%	0.0%	0.0%	0.0%
Coal	9.9%	50.1%	0.0%	0.0%	0.0%
Coke	10.0%	47.0%	0.0%	0.0%	0.0%
Petroleum	136.6%	0.0%	0.0%	0.0%	0.0%
Natural Gas	0.6%	47.1%	0.0%	0.0%	0.0%
Other Gas	65.0%	47.1%	0.0%	0.0%	0.0%

Figure 2 shows the projected national industrial output by sector for the period 1988 to 2000. Given current forecasts of industrial output (without energy price changes) and future energy price increases, it appears that national output will

FIGURE 2. Industrial Output: 1988-2000

Baseline Scenario



100

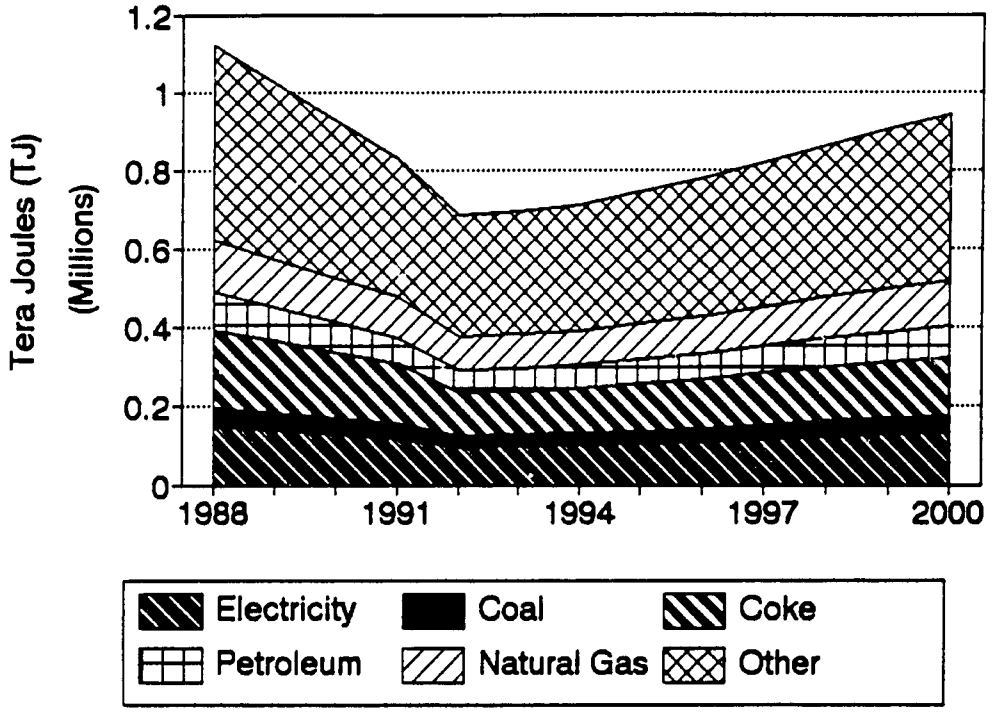
decline until about 1992 and then should begin a gradual return to previous levels of output through 2000. The construction and mechanical engineering sectors should experience slight increases in their share of overall national output, while metals and the chemical sector will decline in relative terms.

Figure 3 shows the corresponding energy use in the industrial sector over the 1988-2000 period. Energy use will decline as industrial output declines and will increase as output begins to increase in 1992. It is noticeable, however, that energy use in the industrial sector changes in fundamental ways due to rising energy prices. Although output levels should return to their 1988 levels by the year 2000, energy use in the industrial sector does not. Industries respond to higher energy prices by becoming less energy intensive.

Because each industrial sector has a different energy intensity in its production process, rising energy prices have different impacts on energy use among industrial sectors. Table 2 shows energy intensities for the nine industrial sectors for the beginning and ending years of the 1988-2000 period. It is clear that energy intensities in some sectors, such as ferrous metals, adjust more to energy price changes that do intensities in other sectors, such as food processing.

FIGURE 3. Industrial Energy Use

Baseline Scenario



102

TABLE 2. Industrial Energy Intensities: 1988 and 2000 (TJ/million Kcs output)

Sector	1988	2000
Mining	1.53	1.36
Chemicals	1.66	1.46
Ferrous Metals	3.95	3.53
Non-Ferrous Metals	1.31	1.18
Mechanical Engineering	0.42	0.37
Construction	0.89	0.77
Forest Products	1.40	1.29
Food	0.45	0.40
Other	0.44	0.40

Economic Price Scenario. There is some opinion that currently planned energy prices will remain below the true economic cost for several energy resources. To the extent that this is true, distortion will still exist in the country's energy price structure and over-consumption and investment will continue to occur.

The second scenario, the "economic price" scenario, replicates the earlier simulation with the exception that energy prices are assumed to reach World Bank estimates of their full economic cost by the year 2000. The same exogenous forecasts for national industrial output used in the baseline scenario are used in the economic price scenario. The anticipated rates of change in energy prices are shown in Table 3.

-107

TABLE 3. Annual Rates of Change of Energy Prices Under the Economic Price Scenario

Energy Prices	88-91	91-92	92-94	94-96	96-00
Electricity	7.7%	53.0%	5.7%	5.7%	11.7%
District Heat.	65.5%	0.0%	31.6%	31.6%	73.2%
Coal	9.9%	50.1%	20.3%	20.3%	44.8%
Coke	10.0%	47.0%	9.9%	9.9%	20.9%
Petroleum	136.6%	0.0%	-6.6%	-6.6%	-12.8%
Natural Gas	0.6%	47.1%	2.2%	2.2%	4.4%
Other Gas	65.0%	47.1%	2.2%	2.2%	4.4%

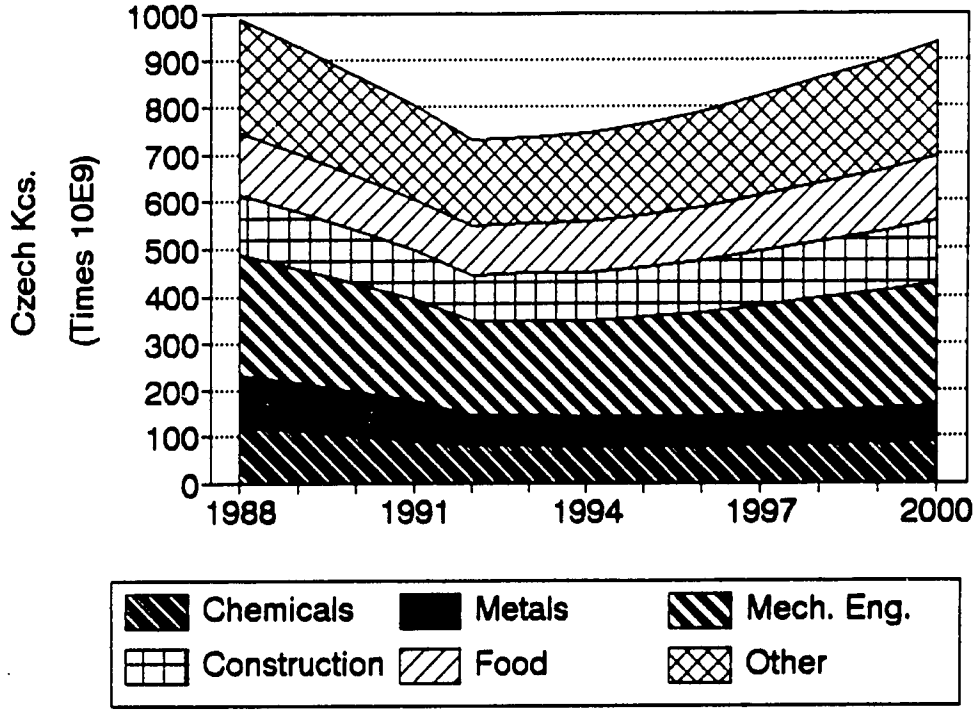
As shown in Table 3, prices will need to increase significantly if economic costs are to be recovered. This is especially true of electricity, district heating, coal and coke. Although petroleum pricing is volatile, it appears that these prices could be reduced in comparison to their anticipated 1992 levels.

Figure 4 shows the simulated national output by industrial sector under the higher energy pricing (economic price) scenario. Output will likely fall again until 1992 and then begin a slow expansion through 2000. With higher energy prices, however, output is not expected to return to its 1988 level by the end of the simulation period (2000). Output under the higher energy price scenario could be as much as 77,352,000,000 Kcs. lower than under the scenario with no further price increases past the 1992 levels. This is due to the decreased demand for domestic consumption that results from energy price-induced price increases in domestically produced goods and services.

104

FIGURE 4. Industrial Output: 1988-2000

"Economic Price" Scenario



- 125

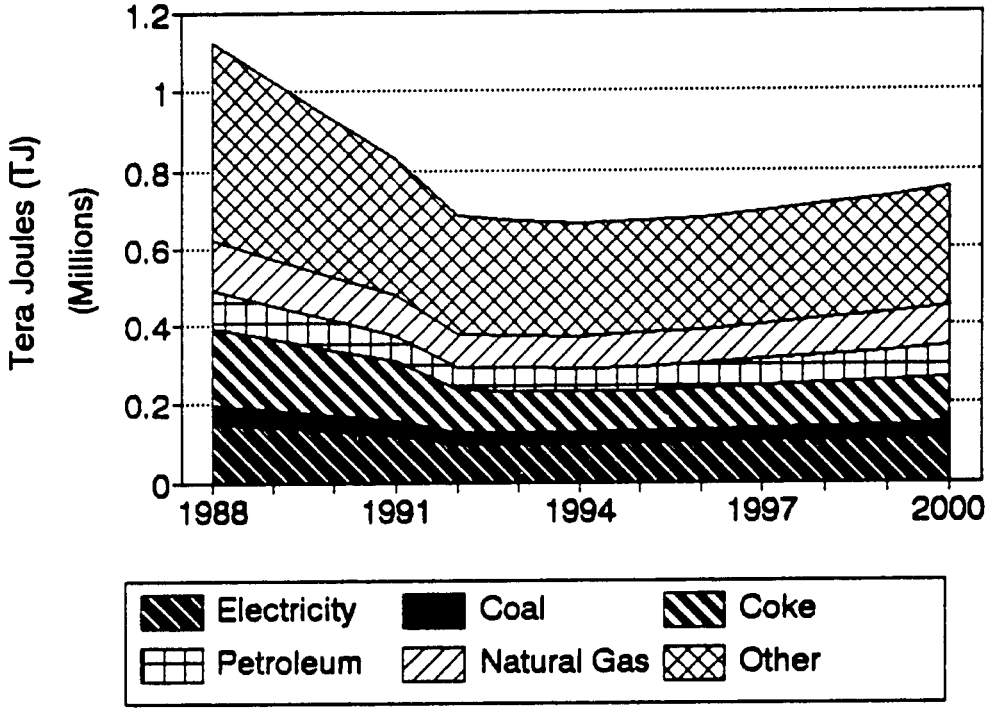
The impact of rising energy prices on industrial output is more easily seen in Table 4. This table shows how much exogenously forecasted industrial output growth rates are changed because of energy price increases. For example, output in the mining sector is forecast to decrease by 4.42% a year between 1988 and 1991 in the baseline scenario. Output in this sector will decrease by an even larger 6.77% a year if energy prices are increased to the economic price scenario levels. Even larger negative impacts on output growth are experienced in chemicals and metals. In general, as shown in Table 4, rising energy prices will accelerate industrial output declines and will dampen industrial output expansions.

TABLE 4. Effects of Energy Price Changes on Industrial Output Growth Rates

	88-91	91-92	92-94	94-96	96-00
Baseline Scenario					
All sectors	-4.52%	-4.80%	2.34%	4.30%	5.00%
Economic Price Scenario					
Mining	-6.77%	-8.55%	1.68%	3.65%	4.68%
Chemicals	-9.40%	-11.39%	-1.52%	0.46%	3.10%
Ferrous Metals	-7.85%	-24.43%	-0.98%	0.95%	3.31%
Non-Ferrous Metals	-6.78%	-17.94%	0.15%	2.11%	3.91%
Mech. Engineering	-5.63%	-7.24%	1.38%	3.34%	4.52%
Construction	-6.20%	-7.0%	1.84%	3.82%	4.77%
Forest Products	-6.10%	-5.48%	1.01%	2.95%	4.33%
Food	-5.80%	-5.61%	1.26%	3.21%	4.46%
Other	-5.31%	-7.76%	1.61%	3.57%	4.64%

FIGURE 5. Industrial Energy Use

"Economic Price" Scenario



107

Figure 5 shows the corresponding industrial energy use that would be required for the output levels shown in Figure 4. Under the economic price scenario, energy use in the industrial sector does not significantly expand after the 1992 decrease. The consumption of natural gas and petroleum products increases slightly in the industrial production process, while the use of coke, coal and electricity declines. In a general sense, economic cost pricing of energy resources will cause Czechoslovakian industry to make significant, long-run reductions in its overall energy intensity.

IV. IMPLICATIONS FOR ENERGY POLICY AND PLANNING IN CZECHOSLOVAKIA

Clearly, the analysis summarized in Section III is not complete. The current version of INDMOD is based on the best information available at this time, but this data has yet to be independently verified. INDMOD itself is not yet complete. Further development is needed (and underway) in the areas of: (1) cross elasticities of demand among fuels; (2) output links to imports and exports; (3) output and income links to government spending and revenues; (4) determinants (demand, supply and constraints) of national investment; (5) employment and income links; and (6) links between INDMOD and the environmental data base of the LEAP model.

This notwithstanding, the analysis presented in this paper does raise several important points for further consideration.

A. Energy price changes have multiple impacts. Energy pricing decisions should not only deal with the issues of marginal cost pricing or international tradeability of individual fuels. Prices determined for one energy resource affect the demand for not only that fuel, but also for other related energy resources. Higher energy prices ultimately also affect the demand for industrial output which, in turn, affects national (republic) employment, income and the governmental fiscal condition.

B. Aggregate impacts of individual decisions are significant and important. Energy price reform is an important element of the overall economic reform occurring in Czechoslovakia. Energy prices will play a key role in determining the pace and direction that economic restructuring takes within the country.

The overall impacts of energy pricing reform can be significant. Although these impacts will mostly be positive in the long-run, some short-run impacts may be significantly negative and may require some transitional assistance on the part of government. For example, if the current (1988) employment-output relationship continues in the future, national employment could be nearly 160,000 jobs lower if energy pricing reform conforms to the economic price scenario. Negative macroeconomic impacts of this proportion may require governmental intervention.

C. Role of strategic economic planning at the national and republic level. An underlying position of this paper is that strategic economic planning will be required at both the national and republic levels of government. In general terms, economic reform within Czechoslovakia is moving away from central planning and towards a market-oriented economy. While this movement is sound, it does not imply an absence of planning in a post-reform Czechoslovakia.

The nature of the planning function will, however, need to be different in a market-oriented economy. To a large extent the output and price setting functions of the central planning approach will no longer be necessary. There will be a need, however, for anticipatory (contingency) and strategic planning functions.

These planning functions arise from the need to coordinate and reconcile energy pricing reforms occurring in the individual energy sectors. For example, pricing decisions made in the coal sector have significant implications for pricing decisions being made in the electricity sector and should be made in this context. In addition, energy pricing reform will have significant impacts on other important sectors of the economy, such as the industrial sector and the financial capital sector. The strategic planning function would be a logical place for coordination with other affected sectors to occur.

In general, it is not sufficient for energy pricing reform to occur only within individual energy sectors. A coordinating, strategic planning function is required.

V. SUMMARY

This paper has attempted to illustrate that many important questions exist due to energy pricing reform that cannot adequately be addressed within individual energy sectors. There is a need at both the national and republic levels to implement a strategic planning function that coordinates and anticipates energy pricing reform. This planning function will require analytical techniques that are capable of capturing the macroeconomic and integrative aspects of energy in the economy.

The CSFR Industry Energy Price Model discussed here is currently still under development. Further data collection and model specification should enable economic models of this type to be used to answer many of the important energy pricing reform questions facing Czechoslovakia.

APPENDIX E: List of Participants from the Workshop on Energy Pricing Reform in Czechoslovakia. Bratislava, Czechoslovakia May 21-22

Workshop on

Energy Pricing

Bratislava, May 21-22
List of Participants

Sections: 1 - Electricity and Heat
2 - Solid Fuels
3 - Gas and Oils

Participants: a) decision makers
b) from utilities
c) others

Section 1: Electricity and Heat

a) decision makers

ing. Vojta	Federal Ministry of Finance
ing. Snahnicanova	Ministry of Economy of Slovak Republic
ing. Lubomir Kucera	Ministry for Economical Policy and Development of Czech Republic
(ing. M. Piha	Czechoslovak Academy of Science)

b) utilities

ing. Miroslav Stehlik	Czech Power Works
ing. E. Schmidt	Czech Power Works
ing. M. Vlcek	Czech Power Works
ing. Danielovsky	Czech Power Works
ing. Jozef Lehota	Slovak Power Works
ing. J. Dohnansky	Slovak Power Works
ing. Bujna	Slovak Power Works

Section 2: Solid Fuels

a) decision makers

ing. Karel Ullrich, advisor	Ministry of Finance of Czech Republic
ing. Ladislav Golka	Ministry for Economical Policy and Development of Czech Republic
ing. Jozef Szitas	Ministry of Economy of Slovak Republic

ing. Ungermann	Federal Ministry of Strategy Planning

b) utilities

ing. Karel Dlask	North-Bohemian Brown Coal Mines
ing. Miloslav Bures	North-Bohemian Brown Coal Mines
ing. Josef Simek	Slovak Coal Mines
ing. Jaromir Klasek	North-Moravian Mines

Section 3: Oils & Gas

a) decision Makers

ing. Jindrich Simek	Federal Ministry of Finance
ing. Michal Olah	Ministry of Finance of Slovak Republic
ing. Juraj Mrenica	Federal Ministry of Economy
ing. Jarovyj	Federal Ministry of Economy
ing. Baric	Ministry of Industry of Slovak Republic
ing. Kucler	Ministry of Industry of Czech Republic

b) utilities

Oils:

ing. Soun	Refinery Litvinov
ing. Durmin (ing. Zitnanova)	Slovnaft
ing. Vanco	Slovnaft

Gas:

ing. Arpad Demko	
ing. Vladimir Toman	Slovak Gas Works
ing. Vladimir Stepan	Czech Gas Works

Other Participants:

ing. Jicha (Energy Conservation)	Energy Agency Federal Ministry of Economy
ing. Polak	Federal Ministry of Environment
ing. Jilek	Czech Ministry of Environment
ing. Dano	Slovak Ministry of Environment

Research Scientists:

ing. Petr Kacvinsky	both Institute of Economics
ing. Soukup	Czechoslovak Academy of Science
ing. Kalous (heat)	EGU, Energy Research Institute
ing. Gavor (gas)	VUPEK, Energy Research Institute
ing. Handlir	Czech Technical University, Energy Economics and Management

American participants:

Jack Huddleston
Bruce Biewald
Bronek Dutkiewitz
Harvey Salgo
Wesley Foell

Czechoslovak project coordinators:

ing. V. Hauptvogel	Federal Ministry of Economy
ing. J. Marousek	SEVEn
ing. J. Zeman	SEVEn