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No 85

ECONOMIC INTELLIGENCE REPORT

THE ENERGY BASE FOR INDUSTRIAL EXPANSION IN THE EUROPEAN SATELLITES 1950-75

CIA/RR ER 60-18
July 1960

CENTRAL INTELLIGENCE AGENCY
OFFICE OF RESEARCH AND REPORTS

~~CONFIDENTIAL~~

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FOREWORD

This report presents a preliminary evaluation of the adequacy of the supply of energy in the European Satellites (excluding Albania) to support the rate of industrial growth apparently planned for 1959-65 and to maintain that rate of growth through 1975.

The method employed was to determine the past relationship between the growth of the supply of energy and the growth of industry in the European Satellites, individually and collectively, and then to use this relationship to estimate the energy required to support the rate of industrial expansion indicated by present Satellite plans. The validity of results obtained by this method depends on the accuracy of the following assumptions:

1. No new major resources of fuels will be discovered that will drastically change the production of energy in the Soviet Bloc.

2. No major changes will occur in technology that will significantly alter patterns of supply and demand.

3. Different forms of energy for the most part are interchangeable, and there is sufficient flexibility within the Satellites to provide energy in the required form in cases where substitution is impossible.

4. The rate of change in the relative portion of the total supply of energy available for industrial use in the future will be similar to that attained during 1950-58.

5. The rate of increase in efficiency of utilization of energy will be no greater in the future than it was during 1950-58.

The estimates of future requirements for energy should be regarded as preliminary indications of the general order of magnitude rather than as precise forecasts of such requirements. The exact effects of a number of factors that will influence the size of both total requirements for energy and requirements for imports cannot be determined without a considerable amount of additional research. In the future, significant changes may occur in the structure and mix of industrial production and in the sources and uses of energy. It is possible that the efficiency of utilization of energy will increase at a faster rate from 1959-65 than it did during 1950-58. Failure to fulfill plans for production of nuclear power would result in a supply of energy smaller

than that shown in this report as the estimate for 1975, and would result in larger requirements for imports by the European Satellites in 1975.

The nature of the data available for use in this report also limits precision in estimating future supplies of energy or requirements for energy. Only limited information is available on future plans for trade in solid fuels and electric power. Except in the case of three of the European Satellites for which very preliminary estimates of nonindustrial consumption of energy were available, it was impossible to exclude nonindustrial uses of energy from the data used in establishing the relationship between industrial growth and increases in the supply of energy during 1950-58.

Measurement of the growth of industrial production in the European Satellites presented a difficult problem. Neither official indexes of past industrial growth, which are known to be subject to an upward bias in varying degrees depending on the country and the year, nor estimates of this growth prepared by this Office, which are believed to be a more realistic measurement of actual achievements, are comparable methodologically to planned goals for industrial production in 1965. Estimates shown in the body of this report, based on official indexes of gross industrial production and on estimates of the net supply of energy, are those believed best for representing probable future developments and for illustrating the final conclusions reached in the several analyses.

In spite of the imperfections in the data, the methodology and conclusions appear to be reasonable for 1965. The results for 1975, of course, are much less reliable because the cumulative effect of changes mentioned above will, in time, progressively invalidate the specific relationship of requirements for energy to industrial growth established during 1950-58.

Details of production, trade, and net supply of the various forms of energy for the individual European Satellites are available in this Office.

CONTENTS

Appendixes

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Tables

Charts

Following Page

THE ENERGY BASE FOR INDUSTRIAL EXPANSION IN THE EUROPEAN SATELLITES* 1950-75

Summary and Conclusions

The European Satellites** may have difficulty in achieving the rate of industrial growth apparently planned for 1959-65 with the supply of energy estimated to be available during that period. For the years 1966-75 it probably would be impossible to maintain the same rate of industrial expansion planned for 1959-65 with the indicated supplies of energy in the Satellites.

The European Satellites apparently plan about a 9.3-percent average annual rate of increase in industrial production during 1959-65. If the relationship between increases in industrial production and in the supply of energy remains approximately the same through 1965 as it was in 1950-58, a total of about 413 million tons*** of standard fuel† would be required to achieve the planned level of industrial production. It is estimated that the European Satellites will produce approximately 353 million tons of standard fuel in 1965, and preliminary plans for trade in 1965 provide for a net import of about 11 million tons of standard fuel. With a total supply of 364 million tons of standard fuel, the Satellites probably could support an average annual rate of increase of 7 to 8 percent in industrial production during 1959-65. If the 9.3-percent rate of increase is to be achieved, however, a net import of as much as 60 million tons of standard fuel may be required. The USSR could supply this quantity of energy in 1965 from its estimated exportable surplus of 50 million tons of petroleum (75 million tons of standard fuel) without adversely affecting its own supply of energy, but after satisfying the needs of the Sino-Soviet Bloc, only limited quantities of Soviet oil would be available for export to the non-Bloc countries.

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* The estimates and conclusions in this report represent the best judgment of this Office as of 1 April 1960.

** Except for general comments, Albania is excluded.

*** Tonnages are given in metric tons throughout this report.

† Different forms of energy, normally measured in dissimilar units, have been converted to a common unit -- standard fuel -- defined as having a calorific value of 7,000 kilocalories per kilogram. Calorific values used for all fuels are given in Table 2, Appendix A.

No plans are available for industrial production beyond 1965 for the European Satellites, except for Poland. If the 9.3-percent rate of increase in industrial production were continued from 1966 to 1975, the requirements for energy could not be met from sources of supply in the Soviet Bloc unless new sources of energy were obtained or unless future requirements for energy were reduced substantially by major advances in technology or by changes in the pattern of industrial output. The estimated requirement for energy in 1975 would be about 893 million tons of standard fuel, but the estimated production of energy would be a maximum of 500 million tons, necessitating a net import of about 393 million tons of standard fuel. The exportable surplus of energy in the USSR in 1975 may amount to 150 million to 200 million tons of standard fuel. During the entire period 1959-75 it is probable that a 7-percent average annual rate of increase in industrial production could be attained from supplies of energy available in the Bloc.

I. Total European Satellites

From 1950 through 1958, each 1-percent increase in industrial production* (1950 = 100), on the average, was accomplished with an increase of about 0.5 percent** in the net supply of energy.*** Production, trade, and net supply of energy for the years 1950-58, 1965, and 1975 are shown by type in Table 3† and for the same years by country in Table 4.††

Available information indicates that plans for growth in industrial production in the individual European Satellites during 1959-65 apparently provide for about a 9.3-percent average annual increase in industrial production for the Satellites as a whole. If the relationship between the growth of industrial production and the supply of energy that was established during 1950-58 is assumed to apply in the

* Based on officially announced indexes of gross industrial production. (For details on the indexes used and the effects of the alternative use of an index of net industrial production for 1950-58 prepared by this Office, see Table 5, p. 25, below, and Appendix C.)

** The exact figure is 0.470 percent. (See the charts, Figures 1 and 2, following p. 4, below, and Appendix C.)

*** The term net supply of energy as used in this report comprises the domestic production of primary energy plus the net balance of trade in primary and secondary fuels.

† Appendix A, p. 17, below.

†† Appendix A, p. 23, below.

future,* approximately 413 million tons of standard fuel** will be required in 1965 (see the chart, Figure 1***). Available information indicates that plans for the Satellites provide for total production of energy of about 367 million tons of standard fuel in 1965. It is estimated, however, that the actual production of energy in 1965 will be approximately 353 million tons of standard fuel,† primarily because of the probable underfulfillment of the optimistic goals for production of brown coal in Poland and Bulgaria.†† Thus it would appear that the Satellites will require net imports of about 60 million tons of standard fuel in 1965 if plans for industrial production are to be achieved. It is important to consider that the limits attached to this estimated requirement for imports are 30 million to 90 million tons of standard fuels.††† In addition, it has been impossible to determine the extent of any change that may occur in the relationship that existed between the growth of industrial production and the

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* This assumption makes no allowance for the effect of more rapid increases in savings of inputs than occurred during 1950-58, for future changes in the industrial product mix, or for changes in the share of total consumption of energy accounted for by nonindustrial consumption.

** The index of industrial production for the total Satellite area would be 467 in 1965, and the index of requirements for energy for the same year would be 272. The range of the requirements for energy is from 401 million to 425 million tons of standard fuel based on plus or minus three standard errors of estimate. As a control, indexes of industrial production that were prepared by this Office were correlated with rough estimates of past and future industrial consumption of energy. An estimated requirement for energy in 1965 of about 420 million tons of standard fuel was obtained by this method. The close agreement between requirements for energy obtained by the two methods may be partly attributable to offsetting biases in the data that were used in correlating officially announced increases in industrial production with increases in the supply of energy (see Appendix C).

*** Following p. 4.

† The range of the estimate of production is from 335 million to 371 million tons of standard fuel, based on a range of error of plus or minus 5 percent. (For details of the estimate of production, see Appendix B.) This range of production of energy would support a level of industrial production that could be achieved by an average annual increase of 5 to 7 percent.

†† See Table 6, Appendix B, p. 32, below.

††† The range of requirement for imports is based on the differences between estimated minimum requirements for energy and maximum production of energy (as a lower limit) and between the estimated maximum requirements for energy and the minimum production of energy (as an upper limit).

supply of energy. In any event, the Satellites will become net importers of energy by 1965, although this area as a whole was a consistent net exporter of energy during 1950-58. Such exports during 1950-58 averaged about 17 million tons of standard fuel per year, but the quantity has declined during the past several years.

The present estimate of probable net imports of energy in 1965 by the European Satellites as a whole, based on fragmentary information on planned trade for all sources of energy, is about 11 million tons of standard fuel.* The estimated supply of energy in 1965 -- 364 million tons of standard fuel -- would be adequate to support a level of industrial production that could be achieved by an average annual rate of increase of about 6.7 percent during 1959-65. The range of this estimated rate of increase would be 5.0 to 8.3 percent.** On the preliminary supposition that the efficiency in the utilization of energy will increase at a faster rate than in the past, it is estimated that at least a 7-percent, and possibly an 8-percent, average annual increase in industrial production could be attained through 1965 with the estimated supply of 364 million tons of standard fuel. If an increase of 9 percent or more is to be accomplished, however, the USSR may have to supply a significant portion of its exportable surplus of energy.

It is estimated that in 1965 the USSR will have an exportable surplus of about 50 million tons of petroleum (equivalent to 75 million tons of standard fuel***). Information available on plans indicates that the European Satellites expect to receive about one-third of this Soviet surplus. In addition, it is estimated that about 8 percent of the surplus is destined for Communist China and the Asiatic countries of the Sino-Soviet Bloc. The remainder probably will go to non-Bloc countries. (Estimates of net imports of energy -- 11 million tons of standard fuel -- by the Satellites in 1965 were based on this evidence, as shown in Table 3.†) Thus, if necessary, the USSR could supply the Satellites with as much as 60 million tons of standard fuel.†† Under these circumstances the USSR also could supply the estimated needs of the Asiatic countries of the Bloc in 1965 but

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* See Table 3, Appendix A, p. 17, below.

** Based on the range of the estimated supply of energy, plus or minus three standard errors of estimate of the regression of industry on energy. (See the chart, Figure 2, following p. 4, above.)

*** Based on current Soviet plans for production and on estimates of consumption of petroleum in 1965.

† Appendix A, p. 17, below.

†† The range of the requirement for energy is from 30 million to 90 million tons of standard fuel.

Figure 1

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EUROPEAN SATELLITES

Relationship of Industrial Production to Supply of Energy 1950-58, and Projection for 1965 and 1975

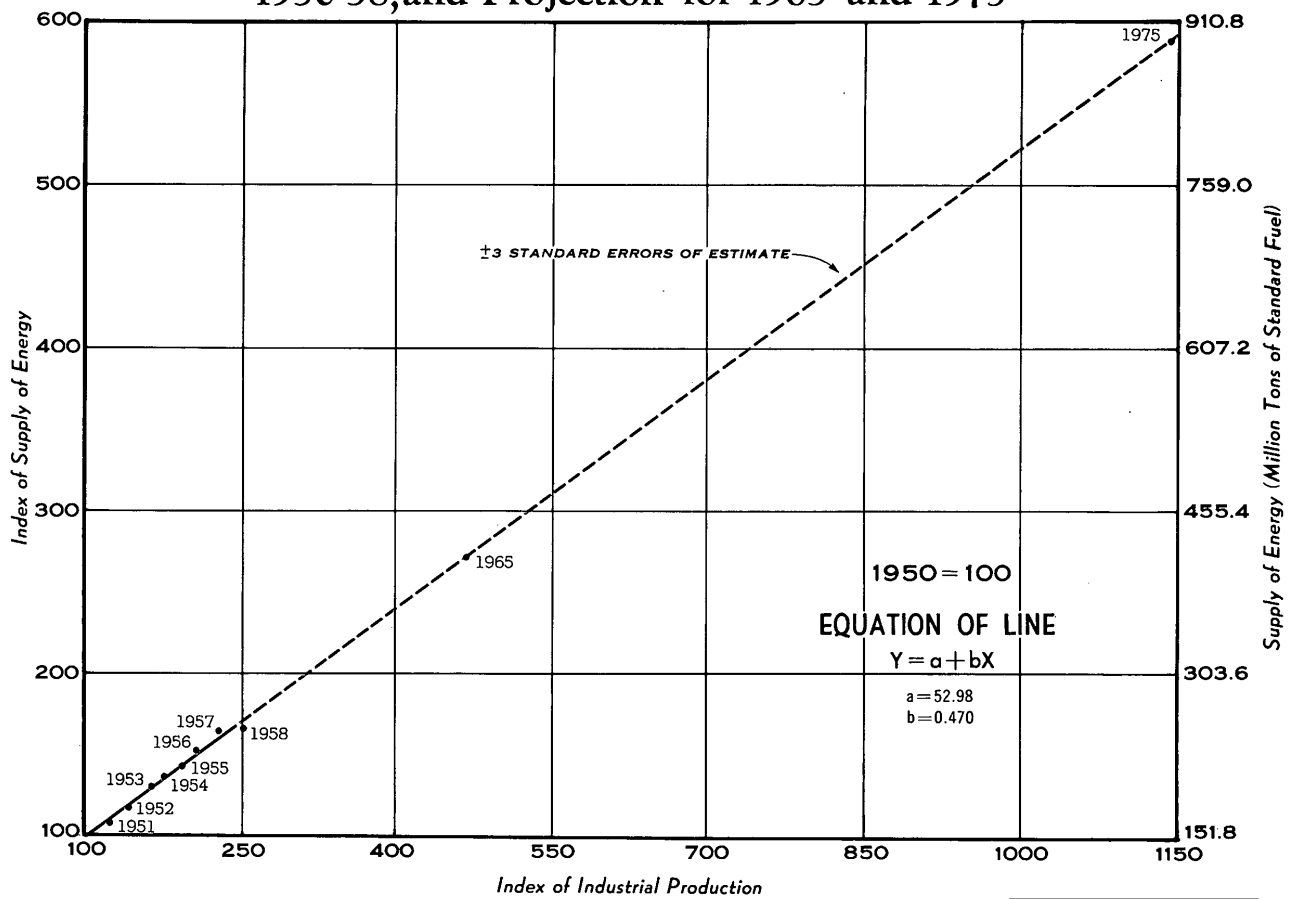

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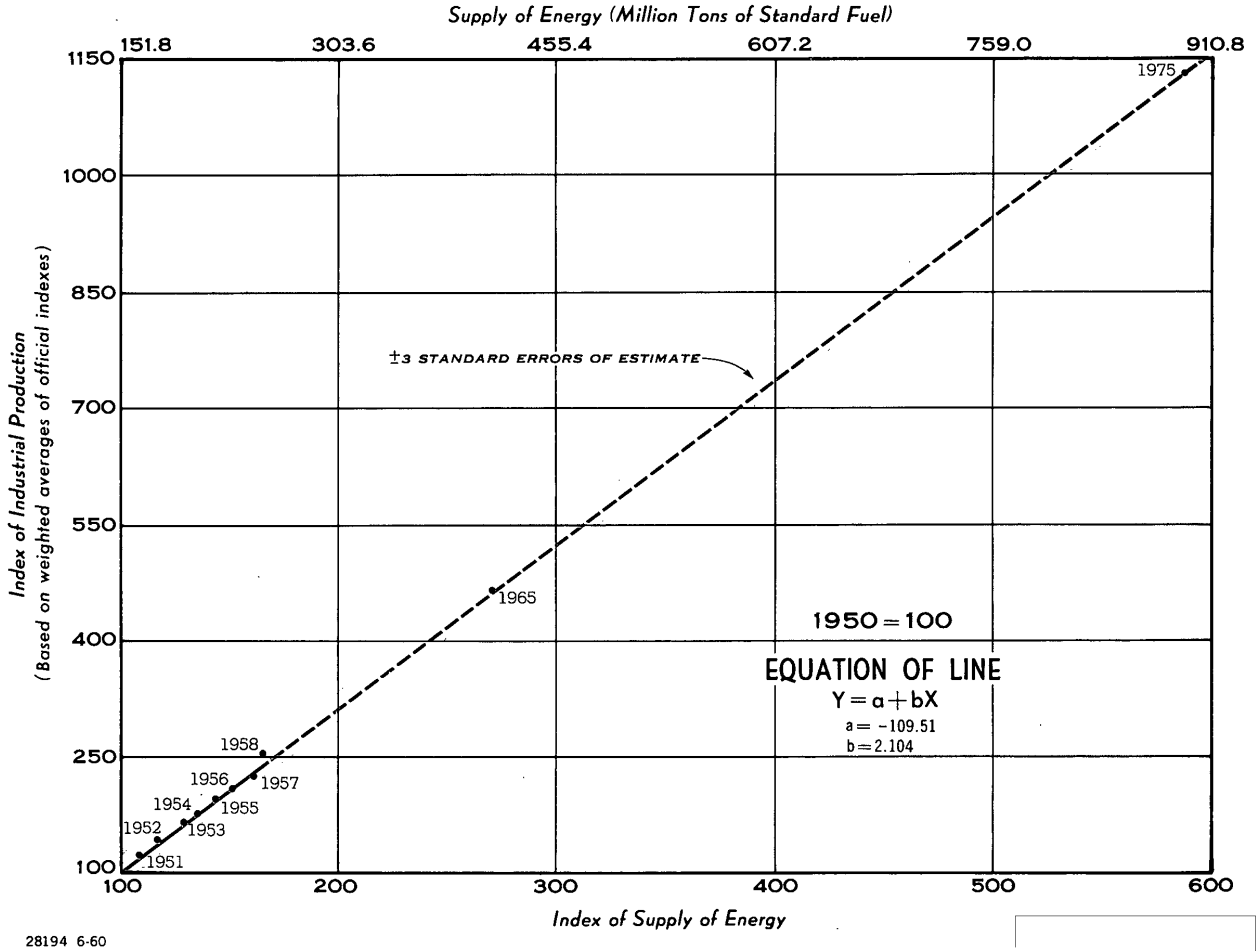
Figure 2

EUROPEAN SATELLITES

Relationship of Supply of Energy to Industrial Production 1950-58, and Projection for 1965 and 1975



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would have to reduce the quantity of petroleum exports to non-Bloc countries to about 6 million tons. This amount is considerably less than the 14.5 million tons of petroleum exported to non-Bloc countries by the USSR in 1959. If the USSR were required to supply only the lower limit of the range of the estimated requirements for energy -- 30 million tons of standard fuel -- there would be little difficulty on the basis of the energy available. The USSR not only could supply Communist China and the Asiatic countries of the Bloc in 1965 but also could export about 25 million tons of petroleum to the Free World.*

The USSR also could supply coal to the European Satellites in 1965. Unless production of coal is increased beyond the present goals of the Soviet Seven Year Plan (1959-65), however, only the relatively small quantities of high-quality coal necessary to satisfy the specialized requirements for hard coal and coke of the Satellites will be available.

No information is available on planned rates of increase in industrial production beyond 1965. If the past relationship between the growth in industrial production and the supply of energy continues to be applicable,** it appears that a 9.3-percent rate of industrial growth could not be maintained during 1966-75. Continuation of this rate of industrial production during 1966-75 would require about 893 million tons of standard fuel*** in 1975. Because production of energy in the European Satellites in 1975 is estimated at about 500 million tons of standard fuel,† a net import of about 393 million tons of

* If the requirement for energy were 90 million tons of standard fuel, the Sino-Soviet Bloc would be unable to supply the quantity needed, and the rate of industrial production would have to decrease or the Bloc would have to seek sources of energy in the Free World. It is extremely unlikely, however, that the Satellites will require this quantity of energy in 1965.

** It is recognized that other factors, such as supplies of labor, construction, or investment, also will affect the rate of industrial production. These factors cannot be evaluated, however, without an over-all study of economic plans of the Satellites.

*** The index of industrial production for the total Satellite area would be 1,138 in 1975 (1950 = 100), and the index of the requirements for energy for the same year would be 588. The range of the requirements for energy is from 881 million to 905 million tons of standard fuel, based on plus or minus three standard errors of estimate.

† The range of the estimate of production is from 450 million to 550 million tons of standard fuel, based on a range of error of plus or minus 10 percent. For the estimate of production and the probable inclusion of the excess supply of energy originally estimated for nuclear energy by 1975, see Appendix B.

standard fuel* would be required in 1975. Very preliminary information on plans for trade indicates a net import of at least 40 million tons of standard fuel in 1975.

It is estimated that the USSR will be capable of exporting about 100 million tons of petroleum (equivalent to 150 million tons of standard fuel) in 1975. Although the USSR could supply large amounts of coal by 1975 (in addition to the specialized requirements for hard coal and coke), it probably could not supply the remainder of the energy needed.

It is estimated, however, that an average annual rate of increase of 7 percent in industrial production probably could be achieved during the entire period 1959-75 with the estimated supply of energy. Therefore, if the Satellites were to attempt to achieve an average annual rate of increase of 9 percent in industrial production during 1966-75, it is probable that a significant amount of energy would have to be obtained from outside the Soviet Bloc.

II. Individual European Satellites

The sum of the requirements for energy to fulfill the 1965 plans for industrial production in the individual European Satellites (415 million tons of standard fuel) agrees very closely with the estimate of the requirements for energy based on a 9.3-percent average annual increase in industrial production for the Satellites as a whole during the period 1959-65 (413 million tons of standard fuel**). The total production of energy in 1965 is estimated at 353 million tons of standard fuel, thus necessitating a net import of about 62 million tons of standard fuel if the goals for all of the countries are to be attained. A summation of requirements, production, and net trade in energy for the individual Satellites in 1965 is shown in Table 1.***

A. East Germany 1/†

From 1950 through 1958, official East German statistics indicate an average annual increase of 11.6 percent in gross industrial production.†† The accompanying average annual increase in supplies of

* The range of the requirement for imports is from 331 million to 455 million tons of standard fuel (see the last footnote on p. 3, above).

** For an explanation of the reason why the results do not agree exactly, see Appendix C.

*** Table 1 follows on p. 7.

50X1

†† The average annual increase in industrial production is estimated by this Office at 9.8 percent.

Table 1

Planned Increases in Industrial Production and Estimated Requirements for, Production of, and Net Trade in Energy in the European Satellites a/
1965

Country	Planned Average Annual Increase in Industrial Production, 1959-65 (Percent)	Million Metric Tons of Standard Fuel		
		Requirements for Energy	Production of Energy	Net Trade in Energy b/
East Germany	9.4	127	101	+26
Poland	8.8	108	102	+6
Czechoslovakia	9.1	84	77	+7
Rumania	10.0 c/	47	48	-1
Hungary	7.6	29	17	+12
Bulgaria	14.7	20	8	+12
Total	9.3 d/	415 e/	353 f/	+62 g/

a. Excluding Albania.
b. Data on net trade differ from data on trade in Table 4, p. 23, below. Data in this table are based on an estimate of actual production and on estimated requirements for energy, whereas data in Table 4 are computed from information on trade plans. The symbol + indicates imports; the symbol - indicates exports.
c. Estimated from 1959 Plan.
d. A weighted average of the planned rates of increase of the individual Satellites. (For the weights used, see Appendix C.)

Table 1

Planned Increases in Industrial Production and Estimated Requirements for, Production of, and Net Trade in Energy in the European Satellites a/
1959-65
(Continued)

e. Sum of the requirements for energy for the individual Satellites. The range of the requirement for the Satellites as a whole on the basis of plus or minus 3 standard errors of estimate of the regression of the supply of energy on industrial production is 401 million to 425 million metric tons of standard fuel. The corresponding range for the total requirements of the individual Satellites is 397 million to 433 million metric tons of standard fuel and agrees very closely with the above range.
f. The range of the estimate of production is from 335 million to 371 million metric tons of standard fuel.
g. Sum of the estimated requirements for imports of the individual Satellites. (The range of the net imports for the Satellites as a whole is 43 million to 79 million metric tons of standard fuel.) This estimate may be compared with the estimated requirements for imports of 60 million metric tons of standard fuel (range 30 million to 90 million metric tons), based on the 9.3-percent average annual increase in industrial production for the Satellites as a whole.

energy was only 5.5 percent. The recovery of industrial production to prewar levels in East Germany was rather slow because of Soviet removal of materiel from the country, thus making the 1950 base a comparatively low one. After Soviet policy changed to make increased quantities of industrial materials available for East German industry, the repair, expansion, and modernization of industrial facilities resulted in prompt and substantial increments in industrial output. Development of heavy industry, however, has brought about increased requirements for imports of fuels that are in short supply domestically, such as hard coal, metallurgical coke, and crude oil.

According to the East German Seven Year Plan, gross industrial production in 1965 is to be 88 percent above that in 1958, 2/ indicating an average annual rate of growth of 9.4 percent. On the basis of past relationships between industrial production and the supply of energy (see the chart, Figure 3*), a supply of energy of 127 million tons of standard fuel** would be required to achieve the stated goal for industrial production. It is estimated that East Germany will produce about 101 million tons of standard fuel in 1965 and that the net requirement for imports would be equal to about 26 million tons of standard fuel.*** Preliminary estimates indicate that net imports of energy by East Germany in 1965 may be about 18 million tons of standard fuel, resulting in a net deficit of about 8 million tons of standard fuel. This deficit might be filled by changes in plans for imports of energy, by more rapid improvement than during 1950-58 in the efficiency of utilization of energy, or by changes in the commodity composition of industrial products that would change the quantity of imports needed.

B. Poland 3/

Economic plans for Poland in 1965 and 1975 appear to call for a higher rate of growth in industrial production than the probable supplies of energy will be able to support.

From 1950 through 1958, official Polish statistics indicate an annual rate of increase in gross industrial production of 13.5 percent† and an average annual rate of increase in the supply of energy of 5.4 percent (see the chart, Figure 4††). In 1958 a 9.4 percent increase

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* Following p. 10.

** The range of the requirement for energy is from 122 million to 133 million tons of standard fuel.

*** The range of the requirement for net imports is from 21 million to 32 million tons of standard fuel.

† The average annual increase in industrial production is estimated at 8.8 percent by this Office.

†† Following p. 10.

in gross industrial production was attained in spite of a decrease in the supply of energy, occasioned by a sizable increase in exports of hard coal. Some of this apparent decrease in the supply of energy may have been offset by sudden large imports of fuels at the end of the year or by the possible use of stockpiles of fuels.

Poland is the only one of the European Satellites that has published long-range plans (through 1975) for industrial production. Plans call for an average annual increase of 8.8 percent from 1959 through 1965 and for an average annual increase of 8.4 percent from 1966 through 1975. 4/

Fulfillment of the plan for 1965 would result in an index of industrial production of 500 (1950 = 100), as shown in Figure 4.* If it is assumed that the relationship between growth in industrial production and in the supply of energy will be the same in the future as it was during 1950-58, the requirement for energy in 1965 would be 108 million tons of standard fuel.**

Poland plans to produce approximately 107 million tons of standard fuel in 1965, the bulk of which is to consist of 111.5 million tons of hard coal and 27 million tons of brown coal. Although Poland has ample coal resources, the considerable investment and time required to develop new mines militate against fulfillment of the goal for production of hard coal. Poland also has emphasized that fulfillment of the goal for production of brown coal depends on technical and financial assistance from East Germany and on imports of coal mining equipment from East Germany. It is believed that East Germany can supply the necessary aid only by sacrificing its own plans for production of brown coal. Although either country may achieve its goal for production of brown coal in 1965, plan fulfillment by both countries appears unlikely. For the purposes of this report, it is estimated that East Germany will fulfill its goals for production of brown coal and that Poland will be unable to do so, although further study of changes in the structure of production and of possibilities for more rapid improvements in the efficiency of the utilization of energy could modify this tentative conclusion. A more reasonable estimate of probable Polish production in 1965, therefore, is 110 million tons of hard coal and 16 million tons of brown coal.

* Following p. 10.

** The range of the requirement for energy is from 103 million to 113 million tons of standard fuel (see Appendix C).

Figure 3

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EAST GERMANY

Relationship of Industrial Production to Supply of Energy 1950-58, and Projection for 1965

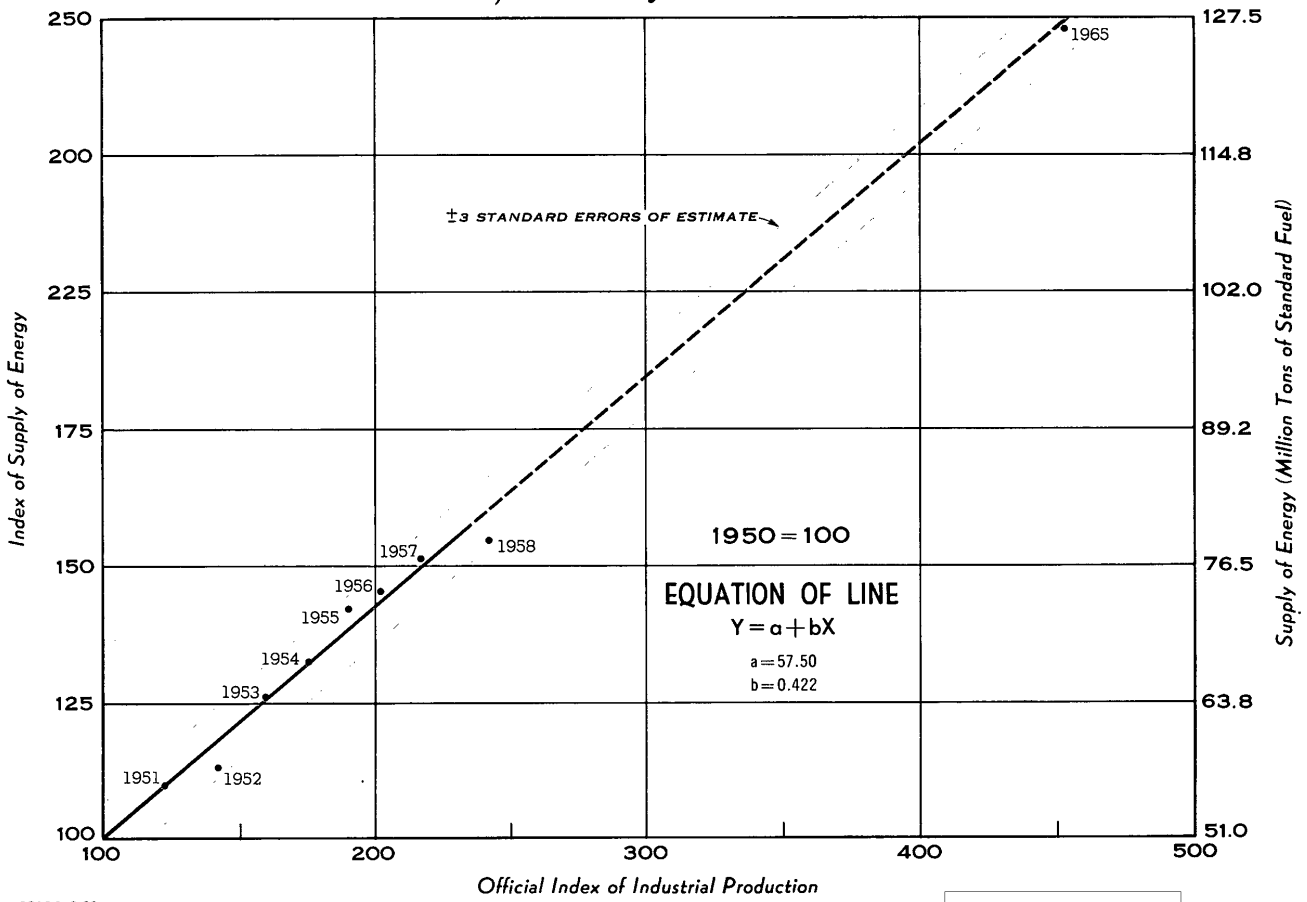

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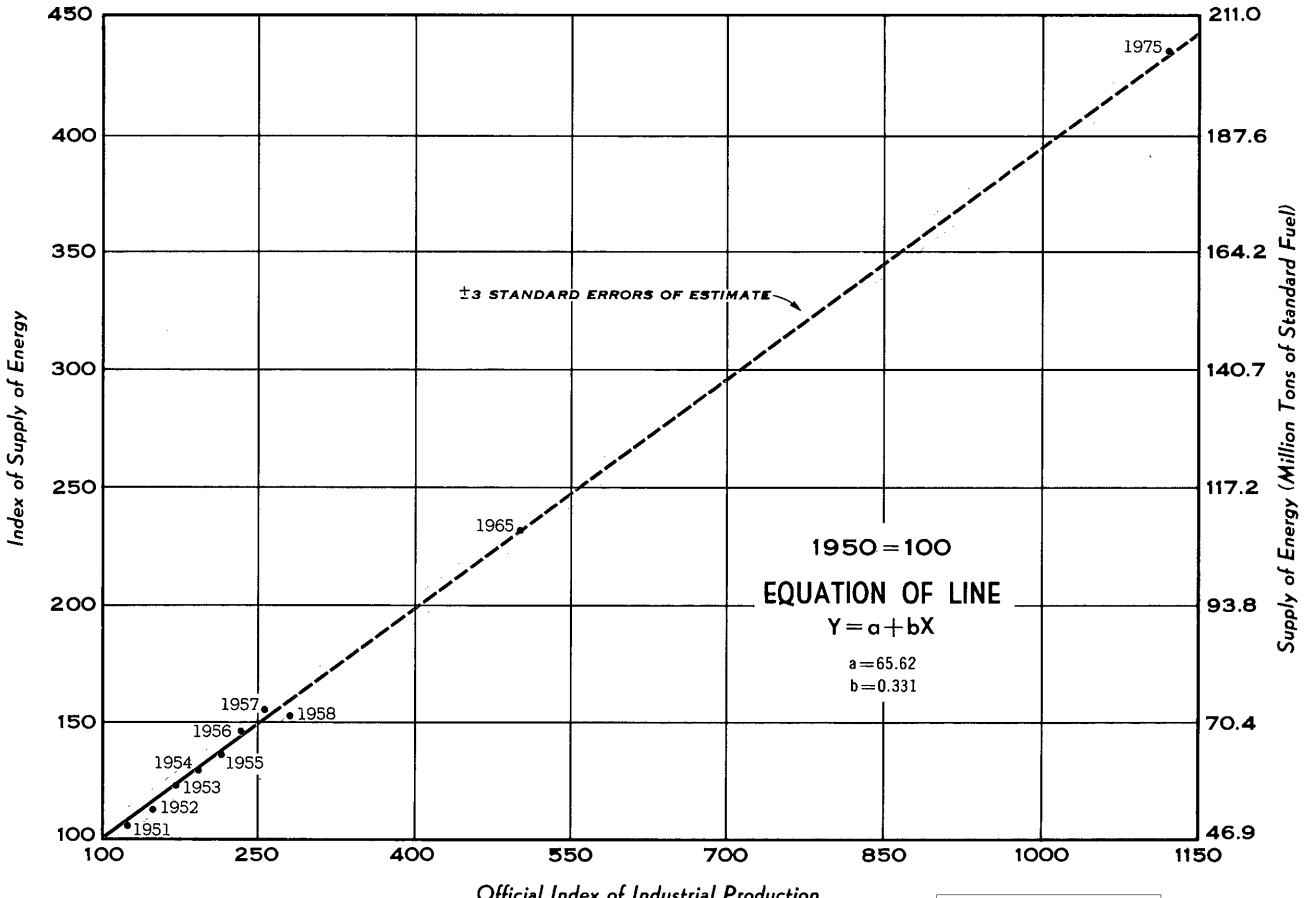
Figure 4

POLAND

Relationship of Industrial Production to Supply of Energy 1950-58, and Projection for 1965 and 1975



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After allowing for production of petroleum, natural gas, and hydroelectric and nuclear power, it is estimated that the total Polish production of energy in 1965 will be about 102 million tons of standard fuel. Fulfillment of the goal for industrial production for 1965 would require Poland to become a net importer of about 6 million tons of standard fuel.* In the past, Poland has been a major net exporter of energy, and, during 1950-58, net exports of energy averaged about 20 million tons of standard fuel per year. Exports of hard coal and coke have been a principal source of foreign exchange for Poland, accounting for at least 40 percent of the value of all Polish exports. Preliminary information indicates that Poland expects to export approximately 15 million to 16 million tons of hard coal per year throughout the period 1959-65. This position as a net exporter appears to be incompatible with the realization of the goals for industrial production in 1965.

Achievement of goals for industrial production in 1975 would require that Poland be an even greater net importer of energy. If the planned rate of growth in industrial production for 1975 were attained, the index for industrial production would be 1,120, as shown in Figure 4.** On the basis of the past relationship between industrial growth and supplies of energy in Poland, about 204 million tons of standard fuel*** would be required. Plans for 1975 call for production of about 150 million tons of standard fuel, consisting primarily of 135 million tons of hard coal and 60 million tons of brown coal. It is estimated that production in 1975 actually will be about 125 million tons of standard fuel, consisting of 125 million tons of hard coal and 30 million tons of brown coal, with the remainder including petroleum, natural gas, and hydroelectric and nuclear power. Therefore, it would appear that Poland will require net imports of about 79 million tons of standard fuel† in order to achieve the goal for industrial production set for 1975. It is unlikely that this goal can be fulfilled unless significant changes occur in the efficiency of utilization of energy or in the commodity composition of industrial production.

C. Czechoslovakia 5/

Plans for industrial production in Czechoslovakia in 1965 appear to have been made on the basis of a consideration of the adequacy

* The range of the requirement for imports is from 1 million to 11 million tons of standard fuel.

** Following p. 10, above.

*** The range of the requirement for energy is from 199 million to 209 million tons of standard fuel.

† The range of the requirement for imports is from 74 million to 84 million tons of standard fuel.

of the probable supplies of energy. The Czechoslovak Third Five Year Plan (1961-65) indicates that gross industrial production in 1965 will be 101.3 percent above that in 1957 6/ and that the index of industrial production would be 413 (1950 = 100*). During 1950-58, each 1-percent increase in industrial production was accomplished with an increase of about 0.6 percent in the supply of energy (1950 = 100), as shown in the chart, Figure 5.** On this basis, approximately 84 million tons of standard fuel*** would be required to support the level of industrial output planned for 1965, although production of energy in Czechoslovakia for that year is estimated at about 77 million tons of standard fuel. Thus net imports of energy would have to be 7 millions of standard fuel† if the plan goal is to be achieved. It is estimated that net imports in 1965 actually will be about 7 million tons of standard fuel.

D. Rumania 7/

No long-range plans for industrial expansion in Rumania are available. The average annual rate of increase in industrial production achieved from 1950 through 1958 was 13.1 percent.†† Plans for 1959 call for a 10-percent increase above production in 1958. Continuation of a 10-percent rate of growth through 1965 would result in an index of industrial production of 521 for 1965. On the assumption that the past relationship between industrial development and supplies of energy continue, about 47 million tons of standard fuel††† would be required in 1965, as shown in the chart, Figure 6.‡ It is estimated that approximately 48 million tons of standard fuel will be produced in Rumania in 1965. Thus, continuing the 10-percent rate of industrial growth, Rumania could be a net exporter of 1 million tons of standard fuel‡‡ in 1965. During 1950-58, Rumania was a net exporter of about 8 million tons of standard fuel per year, in the form of petroleum.

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* An index based on the estimate prepared by this Office would be 316.

** Following p. 12.

*** The range of the requirement for energy is from 82 million to 86 million tons of standard fuel.

† The range of the requirement for imports is from 5 million to 9 million tons of standard fuel.

†† The average annual increase in industrial production estimated by this Office is 10.7 percent.

††† The range of the requirement for energy is from 44 million to 50 million tons of standard fuel.

‡ Following p. 12.

‡‡ The range of the estimate is from net exports of 4 million tons of standard fuel to net imports of 2 million tons.

CZECHOSLOVAKIA

Figure 5

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Relationship of Industrial Production to Supply of Energy 1950-58, and Projection for 1965

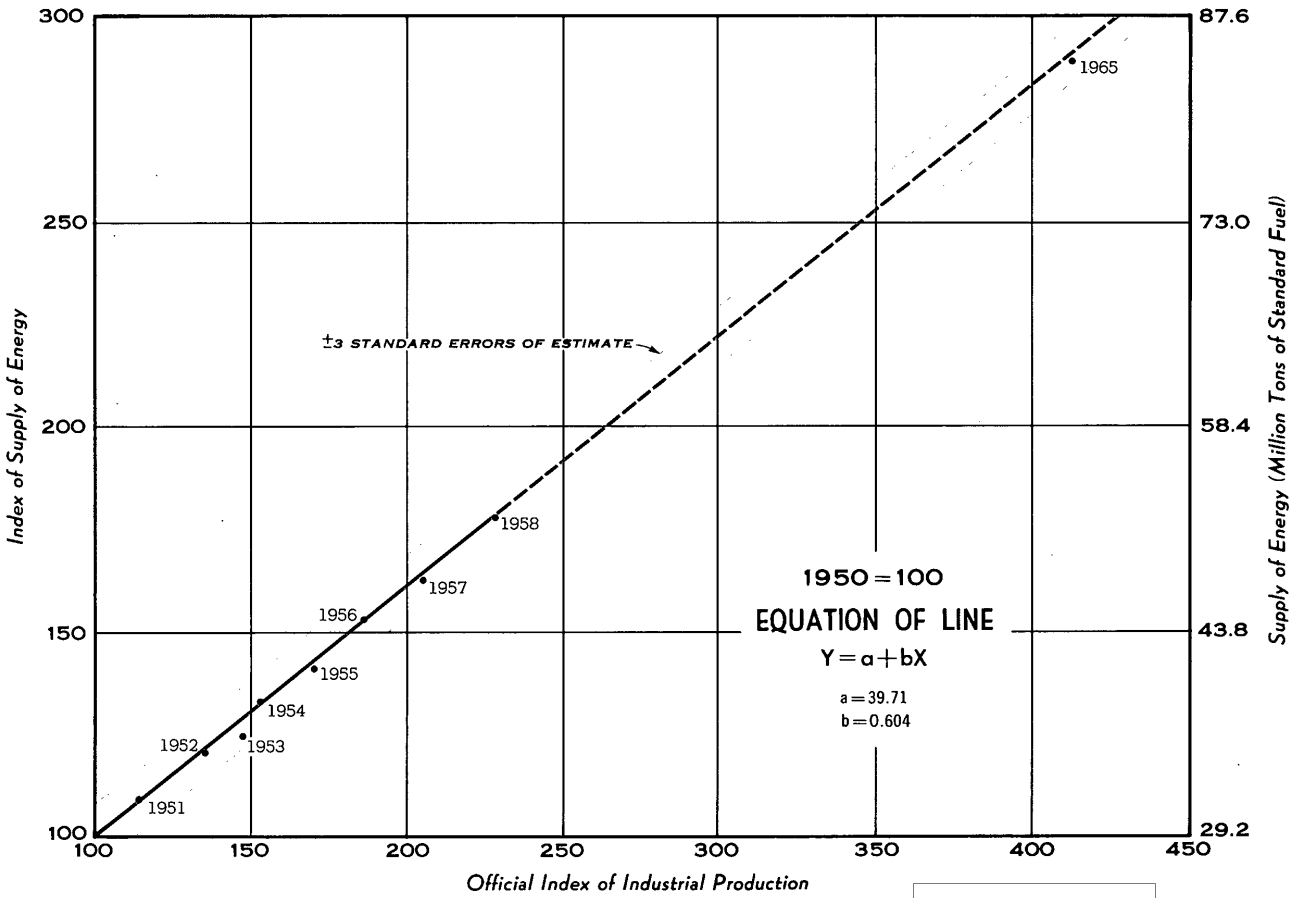

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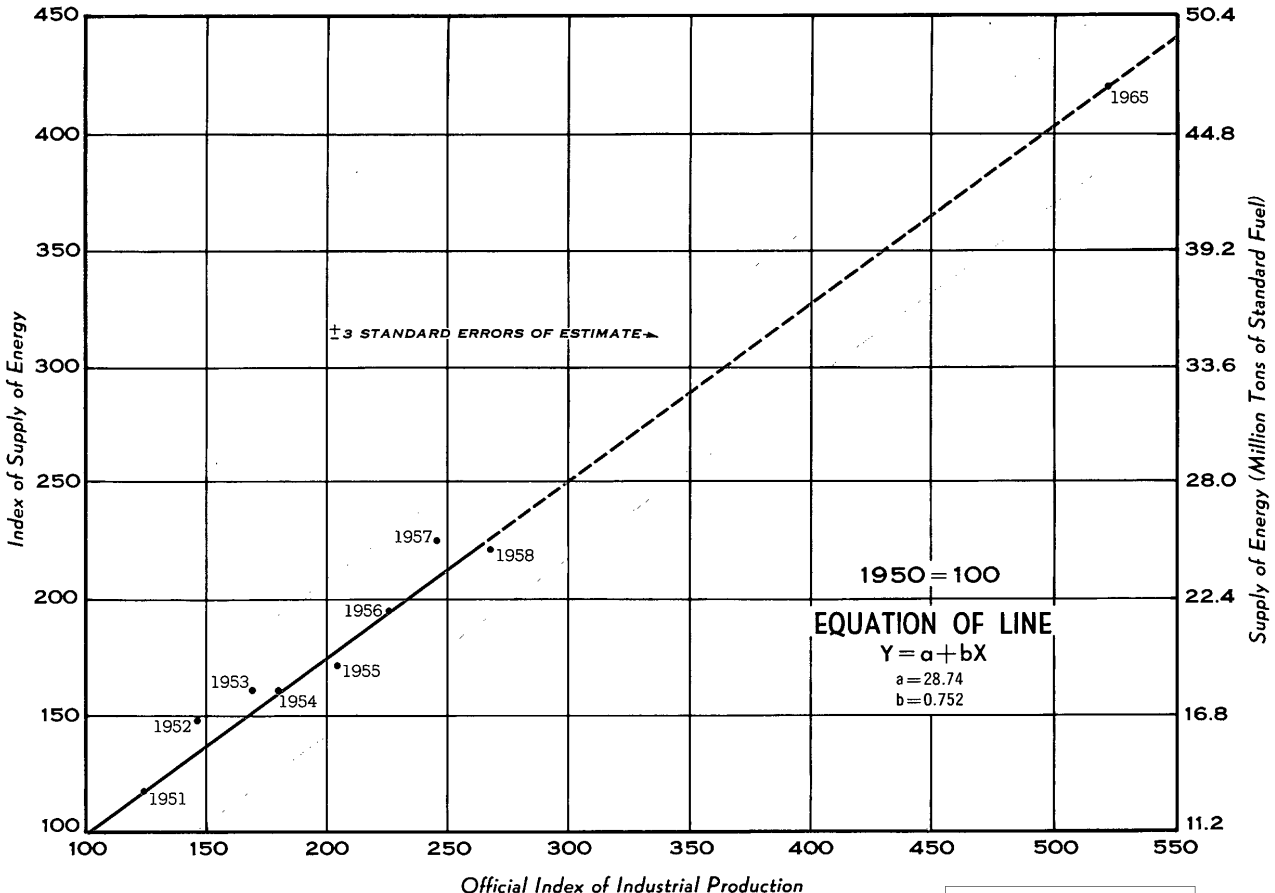
Figure 6

RUMANIA

Relationship of Industrial Production to Supply of Energy 1950-58,and Projection for 1965



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E. Hungary 8/

Hungary plans to increase industrial production in 1965 to at least 65 to 70 percent above that in 1958, 9/ or an average annual increase of about 7.6 percent if the midpoint of this range is used. On the basis of the relationship between industrial growth and supplies of energy that existed during 1950-58,* achievement of the 1965 goal for industrial production would require about 29 million tons of standard fuel,** as shown in the chart, Figure 7.***

Plans for 1965 envision production of about 30 million tons of poor-quality coal, which will account for more than 80 percent of the total estimated production of energy -- 17 million tons of standard fuel. Although it is believed that this goal can be attained, Hungary will require net imports of about 12 million tons of standard fuel† in 1965.

F. Bulgaria 10/

From 1950 through 1958, Bulgaria actually achieved an average annual rate of growth of 14.1 percent in industrial production,†† although original plans for 1958-62 envisioned an average annual increase of 10 percent in gross industrial production. Subsequently, under the "leap forward" program, the plan for industrial production was increased to provide for an average annual rate of increase of 14.7 to 18.9 percent during 1958-65. These goals for 1965 appear to be overly optimistic, but, for purposes of projection, the lower range of the plan was used.

The only available plan goals for production of energy by Bulgaria are those for coal, which call for the production of 1.2 million tons of hard coal and 35 million to 45 million tons of brown coal and lignite in 1965. Realization of these goals would mean a total production of 16 million to 19 million tons of standard fuel in 1965, enough to support the level of industrial production that would be achieved by an average annual rate of growth of 10 to 14 percent if it is assumed that the past relationship between the growth of industrial production and the supply of energy continues. Realization of the goals

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* See Appendix C.

** The range of the requirement for energy is from 27 million to 31 million tons of standard fuel.

*** Following p. 14.

† The range of the requirement for imports is from 10 million to 14 million tons of standard fuel.

†† The average annual increase in industrial production estimated by this Office is 11.2 percent.

for production of coal appears unlikely, however, for the equipment is only now being ordered and the development work necessary for achievement of the goal for 1965 could not be completed by that time. The achievement of the 14.7-percent rate for 1959-65 would mean a requirement for 20 million tons of standard fuel* in 1965, as shown in the chart, Figure 8.**

Present estimates of probable production of energy in Bulgaria in 1965 are about 8 million tons of standard fuel. Unless the average annual rate of increase in industrial production during 1959-65 is to be lower than 14.7 percent, Bulgaria will be a net importer of about 12 million tons of standard fuel*** in 1965.

G. Albania

Albania has been excluded from consideration in this report because data on industrial production are lacking. This country's contribution to the supply of energy in the European Satellites is less than 0.5 percent in any year. Albania is deficient in supplies of hard coal and coke for the development of heavy industry, but it has adequate resources of petroleum to supply its needs. The planned production of crude oil in 1965 has been reported at 2.5 million tons. Although this goal may be too high, Albania may become the second largest producer of crude oil in the Satellites by 1965.

* The range of the requirement for energy is from 19 million to 21 million tons of standard fuel.

** Following p. 14.

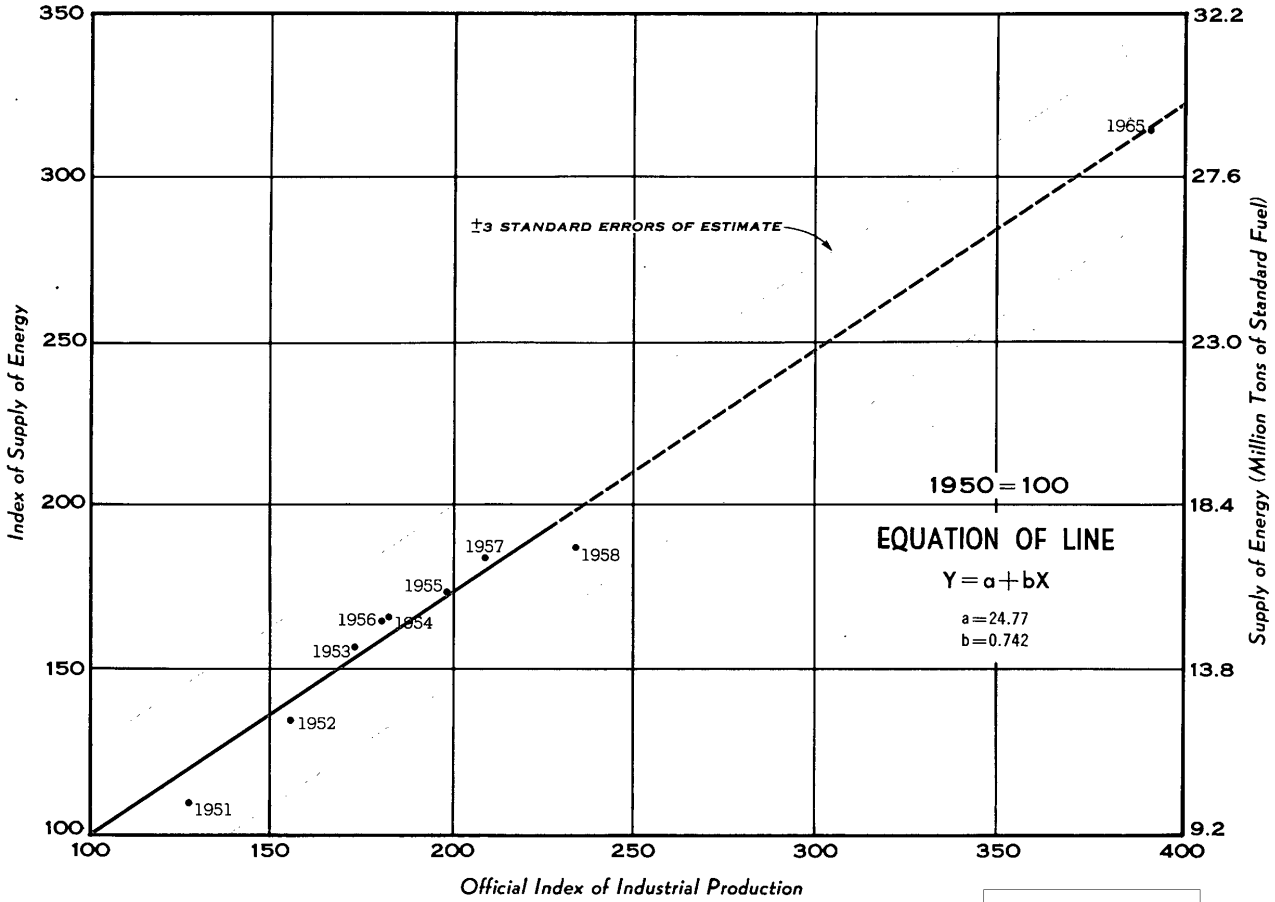
*** The range of the requirement for imports is from 11 million to 13 million tons of standard fuel.

50X1

Figure 7

HUNGARY

Relationship of Industrial Production to Supply of Energy 1950-58, and Projection for 1965



28199 6-60

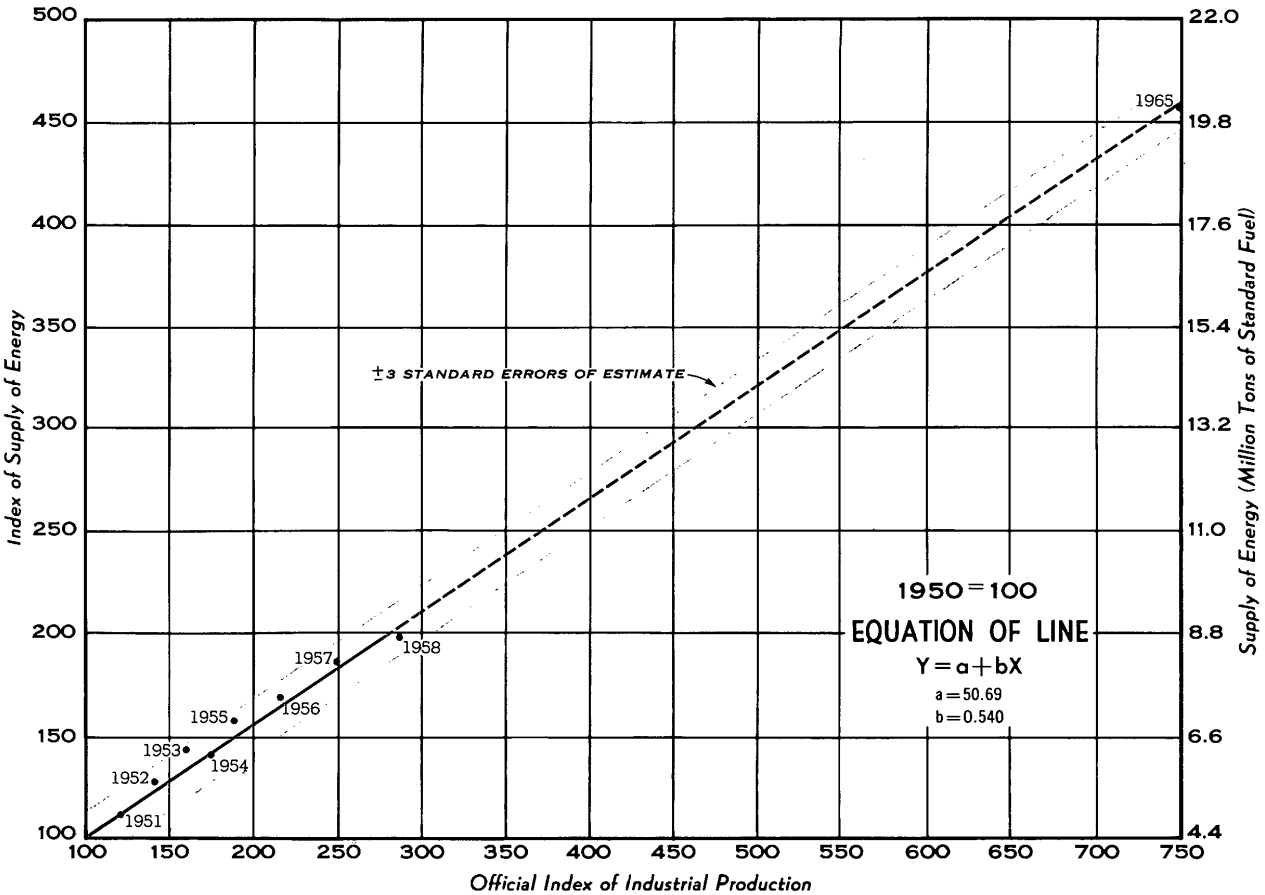
50X1

Figure 8

50X1

BULGARIA

Relationship of Industrial Production to Supply of Energy 1950-58, and Projection for 1965



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APPENDIX A

STATISTICAL TABLES

Table 2

Calorific Values of Sources of Energy in the European Satellites a/
1958

Source	Unit	Bulgaria b/	Czechoslovakia c/	East Germany d/	Hungary e/	Poland f/	Rumania g/
Hard coal	Kilocalories per kilogram	5,000	5,090	6,000	4,608	6,000	6,500
Brown coal	Kilocalories per kilogram	3,600	3,550	2,200	3,405	2,000	3,300
Lignite	Kilocalories per kilogram	1,800	2,102	N.A.	2,032	N.A.	
Crude oil	Kilocalories per kilogram	10,000	10,500	10,500	10,000	10,500	10,500
Hard coal coke	Kilocalories per kilogram	6,000	6,500	6,100	6,500	6,500	6,400
Brown coal coke	Kilocalories per kilogram	N.A.	4,500	4,500	4,500	N.A.	4,500
Brown coal briquetts	Kilocalories per kilogram	5,000	5,000	4,700	3,600	4,600	4,500
Fuelwood h/	Kilocalories per cubic meter	1,750	1,750	1,750	1,750	1,750	1,750
Peat	Kilocalories per kilogram	N.A.	3,000	3,000	3,000	N.A.	N.A.
Natural gas h/	Kilocalories per cubic meter	9,000	9,000	9,000	9,000	9,000	9,800 i/
Natural gas liquids	Kilocalories per kilogram	N.A.	N.A.	N.A.	10,900	10,900	N.A.
Petroleum products j/	Kilocalories per kilogram	11,000	11,000	11,000	11,000	11,000	11,000
Hydroelectric power h/	Kilocalories per kilowatt-hour	2,800	2,800	2,800	2,800	2,800	2,800
Nuclear power	Kilocalories per kilowatt-hour	2,800	2,800	2,800	2,800	2,800	2,800

a. Excluding Albania.
b. 11/
c. 12/
d. 13/
e. 14/
f. 15/
g. 16/
h. 17/
i. Including natural gas liquids.
j. The calorific value of all imports, on a weighted basis, approximates that for diesel fuel.

Table 3

Estimated Production of, Trade in, and Net Supply of Energy
in the European Satellites, by Type a/*
1950-58, 1965, and 1975

Million Metric Tons of Standard Fuel

Source of Energy	1950	1951	1952	1953	1954	1955	1956	1957	1958	1965	1975
Solid Fuels											
Production											
Hard coal	83.9	87.9	91.2	95.1	98.6	101.5	102.9	102.6	104.9	126.3	143.2
Brown coal	66.7	73.3	78.7	84.8	89.5	97.4	101.7	106.8	111.6	152.5	186.4
Lignite	1.2	1.6	2.1	2.5	2.8	3.2	3.3	3.7	4.3	8.2	16.9
Fuelwood	6.5	6.6	6.6	6.8	6.0	6.0	6.2	6.0	6.0	b/	b/
Peat	0.1	0.1	0.1	0.2	0.2	0.5	0.5	0.4	0.4	b/	b/
Total c/	158.5	169.5	178.7	189.4	197.1	208.7	214.6	219.5	227.3	287.0	346.5
Trade d/											
Hard coal e/	-18.5	-19.0	-18.2	-14.5	-13.7	-14.4	-11.8	-5.9	-9.2	-8.7	-9.0
Brown coal f/	-2.1	-1.9	-2.5	-2.9	-3.8	-4.7	-3.8	-4.2	-4.1	-0.8	-0.8
Fuelwood	Negl.	Negl.	Negl.	Negl.	+0.1	+0.1	+0.1	+0.2	+0.1	b/	b/
Coke	+2.6	+2.5	+3.0	+3.4	+4.1	+4.4	+3.8	+4.3	+4.3	+4.9	+5.4
Briquettes	+0.1	+0.1	+0.1	+0.3	+0.2	+0.2	+0.2	+0.2	+0.1	b/	b/
Total c/	-17.9	-18.3	-17.5	-13.7	-13.2	-14.4	-11.5	-5.5	-8.8	-4.6	-4.4

* Footnotes for Table 3 follow on p. 21.

Table 3

Estimated Production of, Trade in, and Net Supply of Energy
in the European Satellites, by Type a/
1950-58, 1965, and 1975
(Continued)

Million Metric Tons of Standard Fuel

Source of Energy	1950	1951	1952	1953	1954	1955	1956	1957	1958	1965	1975
Net Supply											
Hard coal	65.4	69.0	73.0	80.6	84.9	87.1	91.1	96.6	95.6	117.6	134.2
Brown coal	64.6	71.4	76.2	81.8	85.8	92.8	97.9	102.6	107.6	151.7	185.6
Lignite	1.2	1.6	2.1	2.5	2.8	3.2	3.3	3.7	4.3	8.2	16.9
Fuelwood	6.5	6.6	6.6	6.8	6.0	6.1	6.3	6.3	6.2	b/	b/
Peat	0.1	0.1	0.1	0.2	0.2	0.5	0.5	0.4	0.4	b/	b/
Coke	2.6	2.5	3.0	3.4	4.1	4.4	3.8	4.3	4.3	4.9	5.4
Briquettes	0.1	0.1	0.1	0.3	0.2	0.2	0.2	0.2	0.1	b/	b/
Total c/	140.6	151.2	161.2	175.6	183.9	194.3	203.1	214.0	218.5	282.4	342.1
Petroleum											
Production											
Crude oil	8.6	10.4	13.3	15.3	16.9	18.8	18.9	18.6	18.9	23.4	28.4
Natural gas g/	5.3	6.6	8.2	9.2	9.5	10.1	10.9	12.2	12.9	26.5	31.9
Natural gas liquids	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	b/	b/
Total c/	14.0	17.1	21.6	24.5	26.5	28.9	29.9	30.8	31.9	49.9	60.2

Table 3

Estimated Production of, Trade in, and Net Supply of Energy
in the European Satellites, by Type a/
1950-58, 1965, and 1975
(Continued)

Million Metric Tons of Standard Fuel

Source of Energy	1950	1951	1952	1953	1954	1955	1956	1957	1958	1965	1975
Trade											
Crude oil h/	-5.0	-5.5	-6.3	-6.9	-8.3	-9.2	-7.0	-2.8	-4.1	+16.0	+42.5
Natural gas	+0.1	+0.1	+0.1	+0.2	+0.2	+0.2	+0.2	+0.2	+0.2	0	0
Petroleum products	+1.3	+1.5	+1.9	+2.3	+3.2	+3.2	+3.3	+3.7	+3.6	0	0
Total c/	-3.6	-3.8	-4.4	-4.5	-4.9	-5.8	-3.5	+1.1	-0.3	+16.0	+42.5
Net supply											
Crude oil	3.7	4.9	7.0	8.3	8.6	9.6	11.9	15.7	14.8	39.4	70.9
Natural gas	5.4	6.8	8.3	9.3	9.7	10.2	11.1	12.4	13.1	26.5	31.8
Natural gas liquids	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	b/	b/
Petroleum products	1.3	1.5	1.9	2.3	3.2	3.2	3.3	3.7	3.6	0	0
Total c/	10.5	13.3	17.2	20.0	21.6	23.2	26.4	31.9	31.6	65.9	102.7

Table 3

Estimated Production of, Trade in, and Net Supply of Energy
in the European Satellites, by Type a/
1950-58, 1965, and 1975
(Continued)

Million Metric Tons of Standard Fuel

Source of Energy	1950	1951	1952	1953	1954	1955	1956	1957	1958	1965	1975
Electric power											
Production											
Hydroelectric power	0.8	0.9	1.0	1.0	1.0	1.6	1.6	1.7	2.0	4.4	12.0
Nuclear power	0	0	0	0	0	0	0	0	0	11.2	80.4
Total	0.8	0.9	1.0	1.0	1.0	1.6	1.6	1.7	2.0	15.6	92.4
Grand Total c/											
Production	173.2	187.5	201.3	214.8	224.6	239.3	246.2	252.0	261.2	352.5	499.1
Trade d/	-21.4	-22.2	-21.9	-18.2	-18.1	-20.2	-15.0	-4.4	-9.0	+11.4	+38.1
Net supply	151.8	165.3	179.4	196.6	206.6	219.1	231.2	247.6	252.2	363.9	537.2

Table 3

Estimated Production of, Trade in, and Net Supply of Energy
in the European Satellites, by Type a/
1950-58, 1965, and 1975
(continued)

a. Excluding Albania.
b. No data are available on which the future production of fuelwood, peat, and natural gas liquids or the future trade in brown coal coke and fuel briquettes can be estimated. The exclusion of these sources of energy, however, should not cause any significant error in the estimate of the supply of energy after 1958.
c. Data are derived from unrounded figures and do not necessarily agree with the totals listed.
d. The symbol + indicates imports; the symbol - indicates exports.
e. Including hard coal coke.
f. Including brown coal coke and brown coal briquettes.
g. Including production of natural gas liquids in Rumania.
h. Including petroleum products.

Table 4

Estimated Production of, Trade in, and Net Supply of Energy in the European Satellites, by Country a/
1950-58, 1965, and 1975

Thousand Metric Tons of Standard Fuel

Country	1950			1951			1952			1953			1954			1955			1956			1957			1958			1965			1975		
	Production	Trade b/	Net Supply	Production	Trade b/	Net Supply	Production	Trade b/	Net Supply	Production	Trade b/	Net Supply	Production	Trade b/	Net Supply	Production	Trade b/	Net Supply	Production	Trade b/	Net Supply	Production	Trade b/	Net Supply	Production	Trade b/	Net Supply	Production	Trade b/	Net Supply	Production	Trade b/	Net Supply
East Germany	46,461	+4,513	50,974	51,104	+4,400	55,504	58,878	+4,781	57,659	57,322	+6,863	64,185	60,128	+7,188	67,316	66,338	+6,258	72,596	67,919	+6,211	74,130	70,060	+6,840	76,900	70,993	+7,349	78,342	100,597	+18,321	118,918	140,574	+26,357	166,931
Poland	69,854	-23,000	46,854	73,657	-24,444	49,213	76,194	-24,317	51,877	79,817	-22,788	57,029	82,134	-21,812	60,322	84,955	-21,677	63,278	85,674	-17,840	67,834	84,482	-11,654	72,828	85,588	-14,575	71,013	101,592	-11,827	89,765	125,469	-6,142	119,327
Czechoslovakia	28,471	+708	29,179	29,764	+2,373	32,137	32,747	+2,599	35,346	33,399	+3,206	36,605	36,074	+3,333	39,407	38,237	+2,943	41,180	42,111	+2,477	44,588	45,691	+1,746	47,437	50,182	+1,886	52,068	76,797	+6,646	83,443	130,948	+15,396	146,344
Rumania	16,044	-4,845	11,199	19,159	-5,834	13,325	23,887	-6,751	16,136	25,933	-7,864	18,069	27,205	-9,202	18,003	28,976	-9,877	19,099	30,581	-8,601	21,980	31,980	-6,680	25,300	32,951	-8,130	24,821	47,669	-9,503	38,166	60,600	-11,069	49,531
Hungary	8,247	+933	9,180	9,196	+1,015	10,211	10,962	+1,396	12,358	12,571	+1,883	14,454	13,346	+1,886	15,232	14,211	+1,777	15,988	12,708	+2,428	15,136	12,070	+4,839	16,909	13,558	+3,592	17,144	17,473	+6,055	23,528	25,159	+10,079	35,238
Bulgaria	4,169	+253	4,422	4,624	+320	4,944	5,259	+407	5,666	5,811	+491	6,302	5,746	+524	6,270	6,580	+348	6,928	7,187	+310	7,497	7,771	+487	8,258	7,956	+836	8,792	8,386	+1,829	10,215	16,381	+3,565	19,946

a. Excluding Albania. Data on trade in this table do not agree with data in Table 1. See Table 1, footnote b, p. 7, above.
b. The symbol + indicates imports; the symbol - indicates exports.

C-O-N-F-I-D-E-N-T-I-A-L

Table 5

Indexes of Industrial Production and Net Supply of Energy
in the European Satellites a/
1950-58

1950 = 100

Year	Total European Satellites			East Germany		Poland		Czechoslovakia		Rumania		Hungary		Bulgaria	
	Net Industrial Production	Gross Industrial Production	Net Supply of Energy	Gross Industrial Production	Net Supply of Energy	Gross Industrial Production	Net Supply of Energy	Gross Industrial Production	Net Supply of Energy	Gross Industrial Production	Net Supply of Energy	Gross Industrial Production	Net Supply of Energy	Gross Industrial Production	Net Supply of Energy
1950	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
1951	112	121	109	123	109	122	105	114	110	124	119	127	111	120	112
1952	123	143	118	142	113	145	111	135	121	146	148	155	135	140	128
1953	139	162	130	160	126	170	122	147	125	168	161	173	157	160	143
1954	145	175	136	176	132	190	129	153	135	179	161	182	166	174	142
1955	157	193	144	190	142	212	135	170	141	203	171	198	174	188	157
1956	165	206	152	202	145	231	145	186	153	225	196	180	165	216	170
1957	181	226	163	217	151	254	155	205	163	244	226	209	184	248	187
1958	198	251	166	241	154	278	152	228	178	267	222	234	187	287	199

a. Excluding Albania

APPENDIX B

FUTURE ENERGY BASE

1. Estimated Net Supply

Coal will continue to be the major source of energy in the European Satellites through 1975, although its contribution will decline from about 82 percent of the total supply of energy in 1958 to about 76 percent in 1965 and to 63 percent in 1975. If original plans are fulfilled, nuclear power may provide about 15 percent of the total available supply of energy by 1975. The contribution of petroleum and natural gas to the total supply of energy will continue to rise gradually -- to about 18 percent in 1965 and to about 19 percent in 1975. By 1975, imports of crude oil will provide at least one-half of the energy supplied by petroleum and natural gas.

No data are available with which to estimate the future production of fuelwood and peat or future trade in brown coal coke and fuel briquettes. The exclusion of these sources of energy, however, should not cause any significant error in the estimate of the supply of energy after 1958.

2. Estimated Production

a. Coal

Goals for production of coal in 1965 have been announced for the following countries: Czechoslovakia, 116 million to 117 million tons 18/; Hungary, 30 million tons 19/; and Bulgaria, 36 million to 46 million tons. 20/ East Germany has reported plans for production of about 295 million tons of brown coal in 1965 and 350 million tons in 1970. 21/ Poland has prepared long-range plans for production of about 139 million tons of coal in 1965 and 195 million tons by 1975. 22/ No information is available on goals for Rumania beyond 1960. Table 6* presents these plan data in comparison with estimates of probable production of coal in 1965 and 1975.

East Germany and Czechoslovakia have the resources and the apparent capabilities to achieve their planned goals. The East German goal for production of 350 million tons of brown coal in 1970 has been reported to be the maximum rate of production possible consistent with the resources, the investment required, the difficulties with overburden,

* Table 6 follows on p. 32.

and the labor force. 23/ It is estimated that, with the background of successful experience and competence attained in strip mining, East Germany can achieve the goal for 1970 and also can sustain production of 350 million tons annually through 1975. In Czechoslovakia the goal of producing 35 million to 36 million tons of hard coal and 81 million tons of brown coal in 1965 probably can be fulfilled. The estimated production of 145 million tons of coal (40 million tons of hard coal and 105 million tons of brown coal) in 1975 was obtained by extrapolation, using the data for 1950-58 and plans for 1960 and 1965.

Poland and Bulgaria appear to have established goals that may be difficult, or impossible, to fulfill. The probable level of production of coal in Poland is 155 million tons in 1975, considerably less than planned production of 195 million tons. Bulgaria probably has the resources to increase production considerably, but it will take time to obtain equipment and develop new mines. The extremely optimistic plan for production of 36 million to 46 million tons of coal by 1965 does not appear to be realistic at this time. Preliminary estimates of future production of coal by Bulgaria (18 million tons and 24 million tons in 1965 and 1975, respectively) have been based on projections of past rates of growth.

The Hungarian plan to produce 30 million tons of coal in 1965 appears to be reasonable. The planned increase in production is to be primarily in brown coal, the resources of which probably are adequate, and it is not out of line with that which has been achieved in the past. Production for 1975 (36 million tons) has been estimated on the basis of the same general rate of increase accomplished during 1950-58 and planned for 1960 and 1965.

Estimates of the future production of coal (approximately 12 million tons in 1965 and 16 million tons in 1975) in Rumania were made by projecting rates of production from the years 1950-58.

Coal will continue to be the major source of energy produced and utilized in the European Satellites, but the percentage of the total production of energy represented by coal will decline about 18 percent from 1958 to 1975. Production of coal in 1958 accounted for approximately 221 million tons of standard fuel of the total production of energy of about 261 million tons of standard fuel. By 1975 the total production of energy may be equal to approximately 500 million tons of standard fuel, of which coal may represent 347 million tons. Since the mid-1950's, brown coal has exceeded hard coal as a source of energy. Plans for the future indicate that this trend will continue, as brown coal is to be produced in increasing quantities for the development of large thermal powerplants throughout the Satellites.

Poland and East Germany will continue to be the major producers of hard coal and brown coal in 1975, when Poland will produce about 75 percent of the hard coal and East Germany about 63 percent of all brown coal and lignite produced in the European Satellites. Czechoslovakia will maintain its position as an important producer of coal, accounting for about 23 percent of the hard coal and about 19 percent of the brown coal and lignite in the Satellites.

b. Crude Oil and Natural Gas

Only very fragmentary information is available on planned production of crude oil beyond 1960. No long-range plans concerning production of crude oil have been released by any of the European Satellites. In Rumania, the major producer, difficulties have been encountered in fulfilling the program for drilling. The rate of increase in production is declining, and it is doubtful that the goal of 13.5 million tons in 1960 can be achieved. Production of crude oil in Rumania for 1965 and 1975 has been estimated at 14 million and 17 million tons, respectively. Only Albania and Hungary appear to have the potential resources to increase production significantly above the level of 1958 of 400,000 tons and 830,000 tons, respectively. It is estimated, however, that the combined output of these two countries in 1975 -- about 3.5 million tons -- would represent less than 17 percent of the estimated total production of crude oil in the Satellites in that year. Because available evidence indicates a lack of oil resources in the other Satellites, little or no increase in production above the levels of 1958 has been estimated through 1975 for Bulgaria, Czechoslovakia, East Germany, and Poland.

Planned increases in production of natural gas through 1965 have been reported only for Czechoslovakia and Poland. 24/ Projections have been made for production of natural gas for these two countries in 1975 (Czechoslovakia, 4 billion cubic meters; Poland, 1 billion cubic meters) using data for 1950-58 and plans for 1960 and 1965. No information is available beyond 1960 on planned production of natural gas in Rumania, the largest producer by far. Estimates of future production of gas have been projected at approximately the same rate of increase as that for crude oil. (Estimates for 1965 and 1975 are 15 billion and 17 billion cubic meters, respectively.) No data are available on actual or planned Bulgarian production of natural gas for any postwar year. The relatively minor amounts of gas that may have been produced before 1958 or that may be produced in the future by Bulgaria have not been considered.

The estimated production of crude oil and gas in 1975 in the European Satellites may be equal to approximately 60 million tons of standard fuel, less than twice the amount produced in 1958. This

production may represent about 12 percent -- the same percentage as that for 1958 -- of the total production of energy in that year.

c. Electric Power

No specific details are available on which to base estimates of production of power from hydroelectric powerplants in the individual countries of the European Satellites. General plans, however, have been made to continue the development of this source of energy in the Satellites. Excluding the possible costly development of the potential of the Danube River, much of the available water resources of the Satellites has been developed or is in the planning stages of development. Thus it has been assumed that the Satellites will continue to develop this valuable source of energy but not as rapidly as was accomplished in the past. The construction of the "super" thermal powerplant and the initiation of production of nuclear power also will tend to restrict the rate of growth of production of hydroelectric power. During 1950-58, production of hydroelectric power increased from about 2 billion kilowatt hours (kwh) to 5 billion kwh, an increase of about 160 percent. Indications are that production of hydroelectric power may increase from about 7 billion kwh in 1960 to about 31 billion kwh in 1975. The contribution of this source of energy to the total production of energy in 1975 will continue to be less than 3 percent.

Considerable information exists on long-range plans for the utilization of nuclear energy. If these plans are achieved, nuclear power will be the most significant new source of energy. By 1975, about 16 percent (200 billion kwh or 80 billion tons of standard fuel) of the estimated production of energy from primary sources in the European Satellites may be supplied by nuclear power. Czechoslovakia is expected to begin operation in 1960 of the first nuclear powerplant (150 megawatts -- mw) in the Satellites. Nuclear power is to be produced from a 90-mw plant in East Germany in 1961, and Hungary and Poland plan to begin nuclear power operation by 1965. A continuous expansion of installed capacities for this source of energy is planned for these four countries.

In view of the relative scarcity and the high cost of other indigenous sources of energy, there is strong incentive to exploit nuclear power in the European Satellites. For purposes of this report, therefore, the goals for generation of nuclear power have been accepted in spite of the ambitious size of the investment required to achieve such production.*

* Recent information indicates that the original plans for production of nuclear power in the Satellites were optimistic. Czechoslovakia, East Germany, Poland, and Hungary have /footnote continued on p. 31/

3. Estimated Patterns of Trade

Some long-range plans are available on the proposed imports of crude oil by the European Satellites, but little additional information exists on patterns of trade in other sources of energy. In this report the data on trade for 1965 and 1975, therefore, are subject to considerable error. Plans have been reported for imports of about 15 million to 16 million tons of crude oil (22 million to 24 million tons of standard fuel) in 1965 and 35 million tons (52 million tons of standard fuel) in 1975 by Czechoslovakia, East Germany, Poland, and Hungary. These imports, which will come primarily from the USSR, will help to satisfy the increased demands for petroleum products and to provide for the development of petrochemical industries. Rumania, however, will continue to export petroleum products through 1975. Thus the pattern of trade in petroleum in the Satellites will change from a net export of 0.3 million tons of standard fuel in 1958 to a net import of about 42 million tons in 1975.

The following major assumptions have been made as a basis for estimating future trade in solid fuels:

a. Poland will attempt to maintain exports of hard coal at a level of 16 million to 17 million tons.

b. Poland will gradually increase the exportable surplus of brown coal, which will be shipped only to East Germany.

c. The demands for hard coal coke by the European Satellites will be supplied partly by Poland (at a constant annual rate of 2 million tons) and by Czechoslovakia (increasing gradually to a level of 1.5 million tons by 1975) and will be supplemented by imports from the USSR. It is estimated that net exports of coal will decline about 25 percent by 1975 -- from 13.3 million tons of standard fuel in 1958 to about 9.8 million tons in 1975.

In spite of the long-range plans for connecting power networks between contiguous European Satellites, it is assumed that there will be neither net exports nor net imports of electric power. The same conclusion was reached for natural gas.

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announced that nuclear powerplants will not be completed for about 1 to 7 years after the starting dates originally planned. Consequently, the requirements for imports of energy by the Satellites by 1975 will be even greater than estimated.

Table 6

Comparison of Available Plans with Estimates of Production of Coal in the European Satellites, by Country a/*
1965 and 1975

Million Metric Tons

Country	Type of Coal	1965 Plan	1965 Estimated Production	1975 Plan	1975 Estimated Production
Total European Satellites					
	Hard coal	154 to 155 b/	154	N.A.	174
	Brown coal and lignite	465 to 475 b/	447	N.A.	555
	Total	619 to 630 b/	601	N.A.	729
East Germany					
	Hard coal	3	3	N.A.	3
	Brown coal and lignite	295	295	350 c/	350
	Total	298	298	350	353
Poland					
	Hard coal	112	110	135	125
	Brown coal	27	16	60	30
	Total	139	126	195	155
Czechoslovakia					
	Hard coal	35 to 36	36	N.A.	40
	Brown coal and lignite	81	81	N.A.	105
	Total	116 to 117	117	N.A.	145

* Footnotes for Table 6 follow on p. 33.

Table 6

Comparison of Available Plans with Estimates of Production of Coal in the European Satellites, by Country a/
1965 and 1975
(Continued)

Million Metric Tons

Country	Type of Coal	1965 Plan	1965 Estimated Production	1975 Plan	1975 Estimated Production
Rumania					
	Hard coal	N.A.	1	N.A.	1
	Brown coal	N.A.	11	N.A.	15
	Total	N.A.	12	N.A.	16
Hungary					
	Hard coal	3	3	N.A.	4
	Brown coal and lignite	27	27	N.A.	32
	Total	30	30	N.A.	36
Bulgaria					
	Hard coal	1	1	N.A.	1
	Brown coal and lignite	35 to 45	17	N.A.	23
	Total	36 to 46	18	N.A.	24

a. Excluding Albania.
b. Excluding Rumania.
c. This figure was planned for 1970 but was reported as the maximum rate of production and, therefore, was used for 1975.

APPENDIX C

METHODOLOGY

1. Past Relationship Between Industrial Growth and Supplies of Energy

The relationship between growth of industrial production (either reported gross or estimated) and increases in the supply of energy in the European Satellites was found to be very close for the years 1950-58. Correlation of the index of industrial production with the index of the supply of energy in the Satellites as a whole for the 9 years 1950-58 (1950 = 100 on both indexes) resulted in a coefficient of correlation of 0.99 and a coefficient of determination of 0.98.* Similar high coefficients of correlation and determination were obtained by correlation of the indexes for individual Satellites.

This high degree of correlation is not unexpected when it is considered that both series are time series and would therefore be autocorrelated.**

In addition, some bias undoubtedly was introduced by the fact that energy was included in the calculation of the index of industrial production. It is believed, however, that at least 90 percent of the growth in industrial production in the European Satellites was directly associated with the increase in the supply of energy -- that is, the true coefficient of determination would not be less than 0.90.

Measurements of increments of industrial production involve difficult problems of methodology and estimation. Two types of measures of industrial growth are available for past years, as follows: official indexes of the gross value of production in fixed prices and estimates of net production calculated by this Office from sample commodity series weighted, insofar as possible, by labor costs. The official indexes are subject, in varying degrees, to an upward bias, especially

* The coefficient of correlation measures the degree of relationship between the variables -- that is, industrial production and the supplies of energy -- independent of the units or terms in which they were originally expressed. The coefficient of determination measures the relative amount or proportion of variation in one series that is associated with or explained by the variation in the other series.

** The internal correlation between members of series of observations whereby the value of each observation is partly dependent on the value of those that have immediately preceded it.

in the early years of the 1950-58 period. This bias is caused by the use of inflated prices and, in some cases, by increases in the degree of double counting in gross value. The indexes prepared by this Office are believed to provide a measure of industrial growth roughly similar to measures used in Western countries, but their quality varies among countries and years. For future years, only indexes from official plans are available. Little is known about the methods used to construct these indexes for future years, although they probably are crude price-weighted averages of commodity series. An unofficial Polish index for 1965 is believed to have been calculated in a manner similar to that used in constructing the indexes developed by this Office, but no such indexes are available for other countries. Use of either the index prepared by this Office for past years or the unofficial index of net production for future years in Poland results in approximately the same requirements for energy for 1965 and 1975 as are obtained by use of official indexes of gross industrial production for both periods. The calculated Polish requirements for energy in 1965 and 1975 are as follows:

	Million Tons of Standard Fuel	
Year	Gross	Net
1965	108	112
1975	204	203

Plan goals for the individual European Satellites probably are not exactly comparable either with the official indexes of industrial production published in the past or with the indexes of industrial production estimated by this Office. In the construction of plans, there is no incentive to inflate prices of new products or of modifications of old products as there is in calculating plan fulfillment. In recognition of the problem of noncomparability of data, the relationship between increases in industrial production and increases in the supply of energy was determined by using both types of indexes of industrial production.

The index of gross industrial production for the European Satellites as a whole for the years 1950-58 was developed from official indexes reported for each of the Satellites and weighted by rough estimates of the relative share of each country in the total industrial production of the Satellites, as follows:

Country	Percent	Country	Percent
East Germany	33	Rumania	9
Poland	24	Hungary	9
Czechoslovakia	21	Bulgaria	4

This index indicated an average annual rate of growth in industrial production of 12.2 percent during 1950-58, but it does overstate the actual growth in industrial production, especially during the early years of the period. The index of net industrial production prepared by this Office indicates that the actual average annual increase in industrial production for the European Satellites as a whole was only 8.9 percent during 1950-58. The net supply of energy during this period increased at an average annual rate of 6.5 percent. Thus, depending on whether the index of gross industrial production or the adjusted index prepared by this Office is used as the basis of calculation, every 1-percent increase in industrial production (1950 = 100) was, on the average, accomplished with an increase of 0.5 or 0.7 percent in the total net supply of energy (1950 = 100).

The inability to deduct nonindustrial consumption* of energy from the net supply of energy results in an overstatement of the quantitative increase in the energy supply accompanying or required to support each 1-percent increase in industrial production during 1950-58. Such overstatement is especially true during the early years of the period, when nonindustrial consumption of energy accounted for a larger percentage of total consumption of energy than it did in the latter part of the period. As a result of the inclusion of nonindustrial consumption of energy, correlation of total net supplies of energy with net industrial production introduces an upward bias in the resulting estimates of requirements for energy. If total net supplies of energy are correlated with gross industrial production, however, the overstatement of industrial growth, especially in early years, and the inclusion of energy consumed for nonindustrial purposes appear to be offsetting factors.

Data were available for making crude estimates of industrial consumption of energy for East Germany, Poland, and Hungary. These data on industrial consumption were correlated with the index of net industrial production prepared by this Office for the same countries. Each 1-percent increase in net industrial production was accompanied by an 0.75-percent increase in industrial consumption of energy (1950 = 100). Estimates of requirements for industrial consumption in 1965 derived

* Nonindustrial consumption includes consumption by agriculture, transportation, communications, business, and households.

from this relationship indicate a probable total requirement for energy in 1965 approximately equal to that obtained by correlating the increases in gross industrial production with increases in the total net supply of energy.*

The index of the supply of energy in the European Satellites as a whole for 1950-58 was developed from data for the individual countries. The supply of energy consists of domestic production of primary fuels plus the net trade balance in primary and secondary fuels. Estimates of supplies of energy for 1950-58 are believed to be accurate within the range of plus or minus 5 percent.

The preparation and visual inspection of scattergrams and the computation of annual increments (first differences) in the series shown in Table 5** indicated that straight regression lines should be fitted by a formula of the type $Y = a + b X$ (using the method of least squares). The regression of the index of the supply of energy on the index of industrial production was computed to determine the increase in the supply of energy associated with a 1-percent increase in industrial production during 1950-58 (1950 = 100). (See equations in the legends of Figures 1, 3, 4, 5, 6, 7, and 8.***) As an aid in determining the levels of production that could be supported by a given quantity of energy, the regression of the index of industrial production on the index of the supply of energy also was computed. (See Figure 2.†)

In the method described above, it was possible to use the indexes shown in Table 5†† for the European Satellites as a whole, and for all individual Satellites, without any adjustment. For Hungary, however, a small increase in the index of industrial production in 1954 and an actual decline in the index in 1956 tend to obscure the secular trend of industrial development and the supply of energy during 1950-58. The so-called "New Course" program that began in 1953 and the uprising in the fall of 1956 were the principal causes of the deviations in the general trend of industrial development.

Several methods were considered for smoothing the curves, based on the original Hungarian data, to eliminate the atypical observations in 1954 and 1956. (a) Curves for the index of industrial production and for the index of the supply of energy were smoothed to approximate

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* See p. 41, below.
** P. 25, above.
*** Following pp. 4, 10, 12, and 14, above.
† Following p. 4, above.
†† P. 25, above.

logarithmic curves. Thus the indexes were adjusted and the formula for logarithmic curves ($Y = AX^B$, or $\log Y = \log A + B \log X$) was used to compute values for the deviant years more typical of the secular trend. (b) The atypical years were eliminated from a linear regression of the indexes of the supply of energy on the indexes of industrial production. (c) All data were used on a straight linear regression. All methods for Hungary showed no appreciable difference in the amount of energy required in 1965 to meet the planned rate of increase in industrial production. Consequently, as was true for the other European Satellites individually and for the Satellites as a whole, a straight regression line was fitted to a scattergram of the original index numbers.

2. Estimated Requirements for Energy

Future requirements of industry for energy will depend on the future level of industrial production. Because no plan goals have been set for industrial development in the European Satellites as a whole, two basic methods were used to estimate probable requirements for energy. The first method* was to extrapolate the index of gross industrial production for the Satellites as a whole (as shown in Table 5**) at the average annual rate of increase of 9.3 percent from 1958 through 1975. The second method*** was to add the estimated requirements for energy of the individual Satellites for the year 1965.

The estimate of a 9.3-percent average annual rate of increase in industrial production for the European Satellites as a whole during 1958-65 was derived as follows. (a) Plan goals for 1965 are available for all of the Satellites except Rumania. For Rumania, an estimated annual rate of increase based on plans for 1959 was continued through 1965.† (b) The planned or estimated average annual rates of increase in industrial production for the individual Satellites during the period 1959-65 were weighted by crude estimates of the relative share of each country in the total industrial output of the Satellites.†† The resulting average annual rate of increase in industrial production for the Satellites as a whole was 9.3 percent.

The average annual rate of increase of 9.3 percent in industrial production from 1965 through 1975 was extrapolated, not as an estimate of probable accomplishment but rather as a hypothesis for determining

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* See I, p. 2, above.
** P. 25, above.
*** See II, p. 6, above.
† For the planned average annual increase in industrial production in the individual Satellites during 1959-65, see Table 1, p. 7, above.
†† See p. 37, above.

whether or not available supplies of energy would be adequate to maintain that rate of industrial development.

Extrapolating the index of gross industrial production at an average annual rate of increase of 9.3 percent from 1959 through 1975 yielded an index of industrial production of 467 for 1965 and 1,138 for 1975 (1950 = 100). Indexes of the supply of energy that would be required to support these levels of industrial production were calculated of the basis of the relationship between the increase in industrial production and the increase in the supply of energy established for 1950-58. This relationship was described by the regression equation Yc = 52.98 + 0.470 X. The index numbers for industrial production for 1965 and 1975 became the X values in this formula. The result was an index of the supply of energy of 272 for 1965 and 588 for 1975. These indexes were then converted to terms of standard fuel by multiplying them by 151.8 million tons, the amount of standard fuel available in the European Satellites as a whole in 1950. This methodology was used to derive the estimated requirement for energy of 413 million tons of standard fuel in 1965 and 893 million tons in 1975 (and the related ranges*).

The planned average annual rate of increase in the individual European Satellites (and the estimated rate for Rumania) were applied to the indexes of gross industrial production for 1958 shown for the individual countries in Table 5.** In this manner an index number (1950 = 100) was obtained for industrial production in 1965 for each of the Satellites. These indexes were used as the X values in the regression equations that were found to describe the regression of energy on industry in the individual Satellites during 1950-58. Indexes of requirements for energy in 1965 were obtained for each individual Satellite and then were multiplied by the supply of energy in 1950 (in terms of standard fuel) in the appropriate country (see Table 4***). The results were the estimates of the requirements for energy (in terms of standard fuel) of the individual Satellites for 1965 (see Table 1†). Summation of these estimated requirements for the individual Satellites resulted in an estimated requirement of 415 million tons of standard fuel for the Satellites as a whole in 1965. No estimate of requirements in 1975 was made by this method, for the goals for industrial production in 1975 for all Satellites were not available.

There are slight differences in the result produced by the two methods. Although the average annual rate of increase of 9.3 percent for the European Satellites as a whole during 1959-65 was derived from

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* See I, p. 2, above.
** P. 25, above. See also II, p. 6, above.
*** P. 23, above.
† P. 7, above.

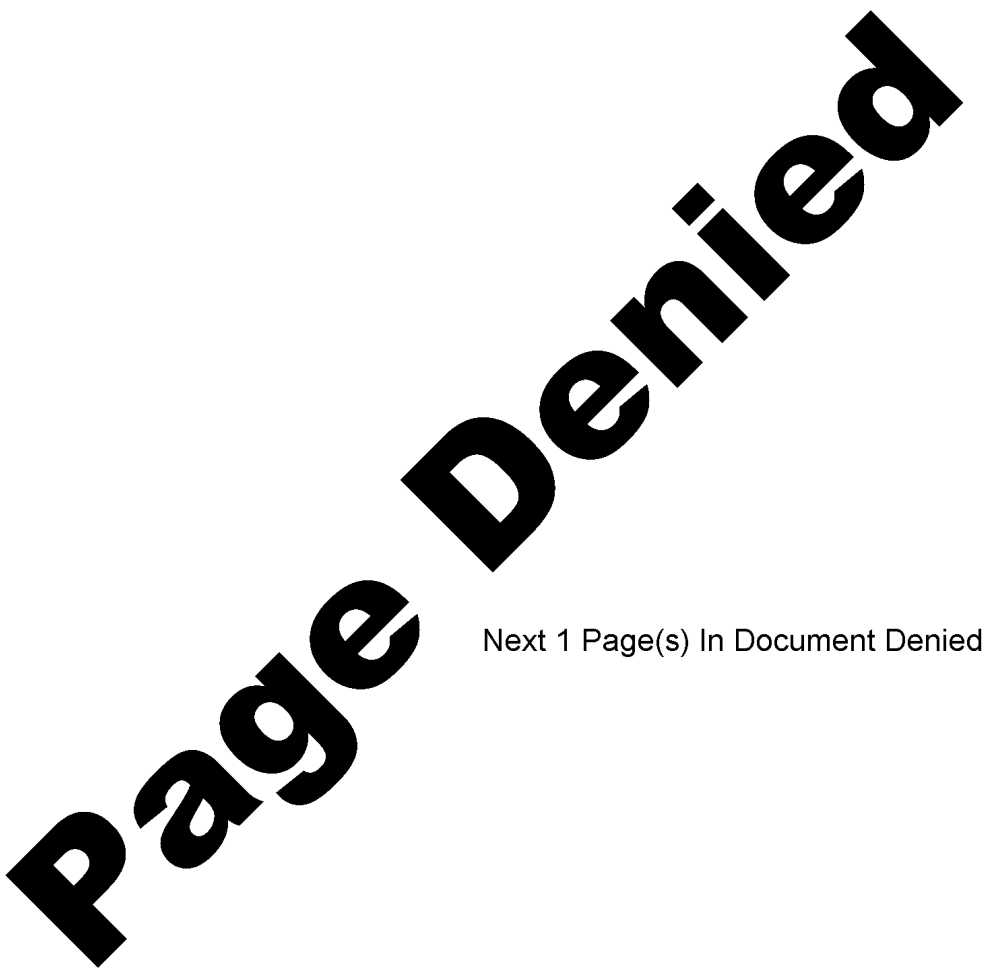
the rates of increase for the individual Satellites, some slight difference in results might have been introduced by the weighting, by rounding, and by the regression equations developed on the basis of data for 1950-58. The two methods of estimating the probable requirements for energy of the Satellites as a whole in 1965 appear equally valid, and the results are quite compatible.

To confirm the reliability of estimates obtained by the two related methods mentioned above, a third method was employed, using different data. Correlation of crude estimates of industrial consumption of energy in East Germany, Poland, and Hungary with indexes of net industrial production for these three countries prepared by this Office indicates that the energy required to support the planned level of industrial production in these three countries in 1965 will be about 190 million or 200 million tons of standard fuel, depending on data used. Average consumption of energy for nonindustrial purposes in these three countries accounted for about 30 percent of the total consumption of energy in 1950 and 27 percent in 1958. If it is assumed that nonindustrial consumption of energy as a percentage of the total consumption of energy will continue to decrease at about the same rate as it did during 1950-58, nonindustrial consumption will account for approximately 25 percent of the total consumption in 1965. Consequently, the total requirement for energy for the three countries in 1965 would be approximately 253 million or 267 million tons of standard fuel. Correlation of the total supply of energy with gross industrial production results in an estimated requirement for these three countries in 1965 of 264 million tons of standard fuel.

If it is assumed that the experience of these three Satellites is typical of that of the European Satellites as a whole and that nonindustrial consumption of energy accounted for 30 percent of the total consumption in 1950 and 27 percent in 1958, it is possible to correlate industrial consumption of energy (1950 = 70 percent of the consumption of energy) with net industrial production. Projection of the relationship revealed by such correlation indicates that fulfillment of plans for industrial production in the Satellites in 1965 would require an industrial consumption of energy of about 315 million tons of standard fuel. If it is assumed that in 1965 nonindustrial consumption of energy in the Satellites will be 25 percent of the total consumption of energy, the total requirement for energy will be about 420 million tons of standard fuel. Correlation of the total net supply of energy with gross industrial production results in an estimated requirement of 413 million tons of standard fuel. These estimates of the requirements for energy are very close and are considered to be more reasonable than the estimate of 445 million tons that is indicated by correlation of the total supply of energy with net industrial production.

For the first two methods, ranges were attached to all estimates of requirements for energy (and conversely to all estimates of levels of production that could be supported by a given supply of energy) on the basis of plus or minus three standard errors of estimate from the regression line. Just as the regression line is used to describe the secular trend, the standard error of estimate is used to establish normal limits for short-term fluctuations about that trend. In a normal distribution for one observation, 99.73 percent of the cases fall within a range of plus or minus three standard errors of estimate from the regression line. The normality of the distribution of data in this report was not tested. However, for any bivariant distribution whatsoever, no less than 89 percent of the known cases fall within plus or minus three standard errors of estimate from the regression line at the mean.

The limits established for the regression line were based on the computed mean observation. These limits are very precise for the area near the mean. The limits, however, become less reliable the further the observations are from the mean.



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